HARNESSING THE POWER OF LOCAL WOOD ENERGY

Ensuring a sustainable supply of woodchips for your school

(A community resource guide)

By Caitlin Cusack

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Executive Summary

While energy costs continue to rise with no end currently in sight, one Vermont community is developing a community energy plan that saves money, reduces their dependence on foreign oil, combats climate change, improves forest health, and supports local industries and workers. *Harnessing the Power of Local Wood Energy* is a community resource guide that weaves technical information with the personal stories of community members who want to heat their local school with sustainably produced woodchips. It details how a rural community can take advantage of the cost savings of wood energy while assuring that the wood is sourced and utilized in a "Sustainable, Efficient, Local, and Fair (SELF)" manner.

In 2006, Mt. Abe Union High School (Mt. Abe), located in Bristol, Vermont, became the 29th school in the state to install a woodchip heating system. The Mt. Abe community switched to woodchips because it was an affordable, renewable, carbon-neutral energy source that could be produced locally. After completing the installation, the community realized that in using woodchips to meet their school's long-term energy needs, they also wanted to conserve forest health, reduce carbon dioxide emissions, and support the local economy. To reach the goal of a sustainably produced, efficiently used, locally sourced, and fairly and equitably accessed wood heating system, they realized that they needed to address woodchip procurement at all points along the supply chain. Yet, as Robert Turner, Mt. Abe community member and forester, warned, "The natural resource world is being asked to absorb more stresses and provide more services than it ever has before, and we have to make sure as these demands are being made that we understand the limitations."

In order to better understand the challenges to woodchip procurement, individuals from the Forest Guild, Vermont Family Forests, the Starksboro Conservation Commission, the Biomass Energy Resource Center, the Vermont Department of Forests, Parks and Recreation, and the Northern Forest Alliance launched the first phase of the Mt. Abe Community Wood Energy Pilot Project in May of 2007. The Forest Guild recruited a summer intern from the Yale School of Forestry and Environmental Studies (sponsored by the Doris Duke Charitable Foundation) to work with Vermont Family Forests, Guild foresters, and Mt. Abe community members to identify key individuals and organizations and summarize the ecological, economic, and social challenges and opportunities to sourcing woodchips from small private and public forests.

Harnessing the Power of Local Wood Energy presents the results of the first phase of the pilot project. As a community resource guide, it uses the Mt. Abe project as a case study to provide a framework that other communities can use to develop a standard for sourcing SELF woodchips. While the guide is specifically geared toward ensuring a sustainable supply of woodchips for schools, it is also applicable to other community buildings.

The challenges to supplying Mt. Abe with wood from small, managed forests, as summarized in the guide, are economic, ecological, and social in nature. For one, the current low woodchip market price does not cover the harvesting and transportation costs on the small scale of most non-industrial private forestland. In addition,

schools have depended on large customers and the forest products industry to support the harvesting and production infrastructure. There is both uncertainty over how much wood to leave to conserve forest health and disagreement over the long-term ecological impacts of harvesting wood. The costs and benefits of woodchip production are not evenly distributed, and the general public lacks a basic understanding of the goods and services that their forests provide. Furthermore, the standards used to define sustainable forestry vary widely in respect to protecting forest values. In order to overcome these barriers, stakeholder needs should be identified and addressed. Loggers, woodchip producers, and landowners all need a reliable market and fair price for their wood. Woodchip producers and students, teachers, and administrators need a reliable supply of wood. Finally, landowners, students, and teachers want sustainably harvested woodchips.

Through the pilot project, the Mt. Abe community has had the opportunity to express its values and needs, an important process for building the trust and consensus necessary to identify and bridge potential obstacles to procuring SELF-woodchips. First and foremost, the price paid for woodchips needs to increase and the associated costs and benefits shared among the landowners, loggers, woodchip producers, and school according to effort and risk. If Mt. Abe were to increase the amount they pay for woodchips to $80/ton, equivalent to just $1.60/gallon of heating oil, that would create a market incentive for excellent forest management. Loggers, foresters, and woodchip producers could earn a livable wage, and the Mt. Abe community would still pay less than the current cost of heating oil. Greater collaboration among small heating facilities could increase their resilience to changing market conditions. The use of town forests as demonstration sites could help to educate the public about forest ecosystem goods and services.

Development of a local procurement standard to ensure protection of forest values would help overcome the barriers to ensuring a sustainable supply. A community can use different standards to protect the forest's ecological and socio-economic values. The standards used by the Mt. Abe wood suppliers range from minimal protection of forest values (such as harvesting wood according to local, state, and federal laws), to comprehensive protection of ecological and socio-economic values by using the Vermont Family Forest Management Checklist. In order for woodchips to be efficiently used, Mt. Abe plans to make basic energy-efficiency improvements, regularly maintain the woodchip heating system, and burn the right kind of wood at the appropriate range for moisture content. For Mt. Abe, there is plenty of forestland within five miles of the school. The exciting challenge for Mt. Abe is to determine the extent to which they can source their wood within that five-mile radius.

A number of steps that Mt. Abe is following to create a reliable supply of woodchips sourced using a SELF-standard include: consulting with local experts (like David Brynn and Robert Turner who are Guild foresters familiar with procurement standards), identifying the suppliers and elucidating the wood supply chain from forest to school, developing a community-accepted procurement standard, and increasing the number of local family-forest owners who contribute to the woodchip supply. These steps and other lessons learned from Mt. Abe are summarized in a series of toolboxes for quick reference.

By using this reference guide, *Harnessing the Power of Local Wood Energy*, rural communities throughout New England can profit from the Mt. Abe community's experience and work to develop their own community energy plan that saves money, reduces dependence on foreign oil, combats climate change, improves forest health, and supports the local economy.

I. Introduction

A Real-Life Fable for Today

Let me tell you the story of a town in Vermont that, over 200 years ago, rose out of the blood, sweat, and tears of a few brave souls. With only handsaws and plows, the first people to arrive cleared the oak, maple and birch trees to make way for a new life. In the beginning, they planted vegetables, put their cows out to pasture, and built portable sawmills and gristmills. Eventually word came to the valley that out west the soils were more fertile and less rocky, so the townspeople abandoned their stonewalls, wells and wooden-framed farm houses. When they left, the white pines reclaimed the old fields and the oak, maple and birch returned and hid any evidence that people lived there. Newcomers arrived in the valley and built two sawmills to produce lumber for many of their state's wood manufacturing industries. Soon the town gained national recognition as home to America's largest casket manufacturer.

Over the years the townspeople have had to compete with other towns within their region, across America, and eventually around the world for selling products from their farms and woodlands. When a bowling alley craze in Japan drove up the price of sugar maple, many of the town's furniture makers had to close their shops. An unraveling began. Mill owners found it harder and harder to find logs to feed the mill. At the two local mills, the high-pitched zing of the saws, as they cut through 80 years of growth, was heard much less frequently. With the quieter days, the people who worked in the mill left to find work elsewhere, and the unraveling continued. Industrial-scale agriculture in the west outcompeted family farms, and new housing developments grew from the family farms and woodlots once integral to the working landscape. People sought employment outside of their town and commuted longer distances. Gas prices and property values skyrocketed, and the original townspeople found it difficult to afford the property taxes and heat for their homes. After a fire in one of the mills, the zinging saw was silenced forever.

Yet out of the ashes of the burned-down mill a new economy has emerged. On Wednesday afternoons during the summer, local farmers bring their fresh produce and baked goods to hungry customers. The growl of the chainsaw can be heard off in the distance as a local logger cuts down a red maple that was marked by a forester. The logger then drags the log to the landing where a local trucker hauls it to the site of the burned-down mill. Here the great, great, great grandson of the man who built the mill pushes the log through the teeth of a chipper. Woodchips are spit out the other end and loaded into a tractor-trailer to be taken to the local high school. At the high

school, the trucker dumps the chips into the metal storage bin, and a conveyor belt then shuttles the chips to the gaping mouth of the boiler. Inside, the surging flames engulf the woodchips. The heat produced from their combustion is pumped through the building's arteries to a classroom where 10th grade students talk about where their woodchips came from. The woodchips spitting into the boiler are heating the children, the town's future.

Finding a solution for heating the classrooms to keep the children warm during cold Vermont winters has helped the town envision other parts of its future. In the future economy the townspeople have imagined, local landowners will work with foresters to sustainably manage their woodlots, and those landowners will be rewarded for their stewardship. Loggers will be able to afford health insurance, will be able to pay for new equipment, and will be supported in performing careful woods work. As a result of the forester's and logger's careful work, the rivers will run cleaner and clearer for swimming on hot summer days, and the forest soils will continue to support maple, birch and beech trees. The residents of the local community will support the local woodchip producers by paying an affordable price for a reliable supply of energy for their high school. The students will continue to have fun learning about the forest around them and will be actively engaged in meeting their school's energy needs.

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This story begins by detailing the changes in land use and local economy that have occurred over the last couple of centuries in Bristol, Vermont, and many other rural New England communities. Development, overseas competition, and rising energy costs threaten the diverse landscape, culture, and quality of life that many community members value about where they live. But Bristol residents and other local communities are fighting back with a fantastic plan for self-sufficiency. It begins with heating the local high school, Mt. Abe Union High School, with a local, renewable resource, and it ends with a more sustainable community. Like Rachel Carson's opening of Silent Spring, the story of Mt. Abe serves as a looking glass into what the future could be. Unlike Carson's, this story is one in which people move towards harmony instead of blight. The results for Mt. Abe are becoming more real than fable, and in time can become truly fabulous.

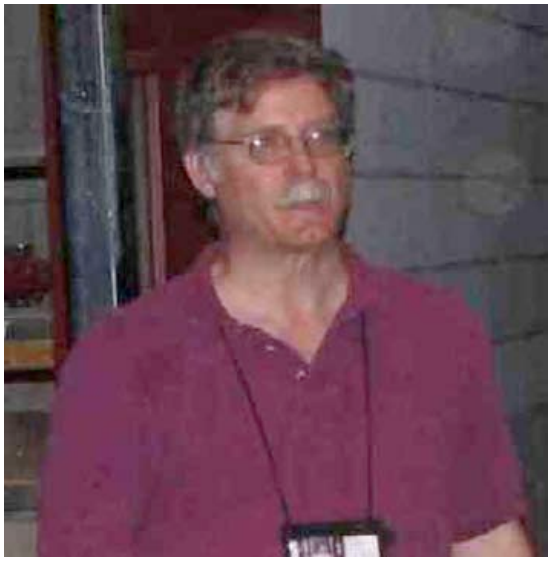
The photo on the far left of the cover is copyrighted by Vermont Family Forests. The photos in the Introduction are courtesy of the Bristol Historical Society. The row of pictures at the beginning of the Introduction from left to right show the north side of Main St in Bristol looking east, 1890; teams drawing lumber for a new post office, 1914; and employees at the Bristol Manufacturing Company, 1917. The row of pictures at then end of the Introduction depicts the Bristol Manufacturing Company, also know as "casket works", 1910; the Bristol Manufacturing Company logo, 1930, and the Claire Lathrop Bandmill in 1940.

The Real Story of Mt. Abe Union High School

The real-life story of the Mt. Abe community heating their high school with local wood, which begins with the urging of a few high school kids, may also sound like a fable. But this true story of Mt. Abe Union High School can serve as a guide of its own-- a step-by-step handbook of how to provide work for local community members, reduce dependence on foreign oil, and support careful forest management by using local wood as an energy source.

Switching to a local, renewable energy source

The Mt. Abe boiler started to become a reality in the fall of 2005 when Tom Tailer, a Mt. Abe physics teacher, challenged his class to get their school thinking about energy efficiency by promising $100 rewards for students whose energy-saving proposals were accepted by the school board. Ninth grade students Jesse-Ruth Corkins and Christine Kroll proposed converting the boiler in their high school from heating oil to woodchips. The students' leadership and enthusiasm, with the availability of 90% state aid, prompted the Mt. Abe school board to consider using woodchips to heat their school. After months discussing concerns and opportunities, residents of the five towns that send their children to Mt. Abe-- Bristol, Lincoln, Monkton, Starksboro, and New Haven-- approved the $150,000 local share of funding needed to construct the woodchip boiler. By the end of the first year after switching to wood heat, the community saved approximately 30% on the school-heating bill, nearly $27,000. As oil prices rise, the money invested in woodchip heating technology will continue to save the school money many times over.



"Education is an action verb."

Tom Tailer, Mt. Abe Union High School Physics Teacher

Planning to obtain woodchips in ways that conserve forest health

After Mt. Abe Union High School switched to woodchips, students and other residents of the Mt. Abe community began to consider how they wanted their forests to look after the wood had been removed and how to better support those involved in getting the wood to their school. More than 75% of the state of Vermont is forested, and currently the forest is growing more than is being harvested[1]. Therefore, some forestry professionals conclude that the "forest is full of energy."[2] But it is unclear how much wood can be removed from the forest without disrupting ecological processes and functions like nutrient cycling and habitat for soil dwelling organisms. With the boiler up and running, the Mt. Abe community is now developing a plan for obtaining woodchips in ways that conserve their forest's health.

[1] USDA Forest Service, 2004.
[2] Kingsley, 2006.

Inspired by Tom Tailer's students, a team of twelve 9th grade students of Caroline Camara's Earth Science class initially responded to their community's concerns about forest health as part of the Vermont Envirothon, a statewide competition for high school students involving natural resource issues. Caroline and her students took their questions about woodchip production and forest health to David Brynn, a local forester, Mt. Abe community resident, and the director of Vermont Family Forests[3] (VFF). David shared his community's concerns at a Vermont Town Forest Project meeting. At this meeting the project partners, described in Figure 1, decided to embark on the Mt. Abe Community Wood Energy Pilot Project to understand how to use the community's forests in ways that are Sustainable, Efficient, Local and Fair (SELF). David coined the SELF-acronym as an approach to measuring how the sourcing of woodchips for his town's high school could be done in ways that take care of the forest and the diverse group of people responsible for getting the woodchips to Mt. Abe's boiler. So how will we know if the woodchips are sustainably produced, efficiently used, locally sourced and fairly and equitably accessed? David answers:

***S**ustainable: We will know that we are practicing sustainable forestry… if the New Haven River and other streams are clearer, cleaner and more highly oxygenated after our work than they were before we did our work; if soils are productive and not compacted; if special places – ecologically fragile areas, places of beauty, and those possessing spiritual values – are maintained and conserved; if more carbon is sequestered.*

***E**fficient: We will know that we are being efficient if we use less total energy than before and if we squeeze out as many BTUs as possible in actual service.*

***L**ocal: We will know that it is local if we know the place where our wood was grown and harvested and who produced it for us; if local watersheds are woodsheds.*

***F**air: And we will know that it is fair if the landowners, loggers, truckers, processors, and customers are taken care of.*

David Brynn, Director of Vermont Family Forests

[3] "Family Forest" is a federally-registered trademark of the Vermont Family Forests Foundation.

Launching phase one of the Mt. Abe Community Wood Energy Pilot Project

In May of 2007 David and other working group members launched the first phase of the Mt. Abe Community Wood Energy Pilot Project. As part of getting the pilot project off the ground, I was engaged at the end of my first year of a Master's of Forestry program as a summer intern with Vermont Family Forests and the Forest Guild. My goals were to:

1. Identify the players involved in getting woodchips from the forest to the storage bin at Mt. Abe Union High School, and
2. Identify the challenges and opportunities for supplying Mt. Abe Union High School with woodchips using David's SELF-framework.

In order to meet these two goals I interviewed Mt. Abe community members involved in getting woodchips to Mt. Abe Union High School—from the landowners and foresters, to the loggers and woodchip producers, to Mt. Abe teachers and students. When I began my investigation of the Mt. Abe Union High School woodchip supply, it was hard for me to believe that ensuring a sustainable supply of woodchips for the local high school was anything other than a straightforward, environmentally sound proposition.

What I realized over the course of my summer in Bristol, and what may become apparent in your initial investigation, is that, in the words of Addison County forester, Chris Olsen, "wood doesn't flow like oil." Instead, there are significant ecological, economic and social challenges to getting wood from the forest to the storage bin. Robert Turner, a local forester and member of the Starksboro Conservation Commission, recognizes that "the natural resource world is being asked to absorb more stresses and provide more services than it ever has before, and we have to make sure that, as these demands are being made, we understand the limitations."[4]

Figure 1. Vermont Town Forest Project Meeting Partners

David Brynn, Vermont Family Forests

Jad Daley, The Northern Forest Alliance

Robert DeGeus, Vermont Department of Forests, Parks and Recreation

Bob Perschel, The Forest Guild

Adam Sherman, Biomass Energy Resource Center

Robert Turner, Starksboro Conservation Commission and R.J. Turner Co.

[4] R. Turner, personal communication, 2007.

Resource guide road map

The first part of this resource guide will present how and why communities in Vermont have installed woodchip heating systems in their schools. This guide will only briefly describe how to assess the feasibility of switching to a woodchip heating system because other resources, referenced at the end, address this issue in detail. Instead, this guide is divided into five additional sections:

Section II provides an overview of how to decide to install a woodchip heating system;

Section III focuses on how to determine the availability of woodchips;

Section IV summarizes the challenges and opportunities to ensuring a reliable supply of wood that is obtained in ways that conserve forest health;

Section V provides guidance on developing a local procurement standard using a SELF-approach.

Section VI outlines the cost of a SELF-woodchip and how to create a reliable supply of woodchips over the life of your school's boiler

Using the Mt. Abe pilot project as a case study, this guide provides a framework that other communities can use to develop a standard for sourcing woodchips in ways that are Sustainable, Efficient, Local and Fair. I weave together technical information with the stories of Mt. Abe community members. By sharing their stories I hope to provide a context within which your community can better understand how to implement a community wood energy project. While this guide is specifically geared towards schools, it can also be useful for other community buildings such as town offices and recreational centers.

II. Switching to a local, renewable heating source

Putting a woodchip heating system in place in your school

Since 1986, thirty-two schools in Vermont have installed woodchip boilers like the one at Mt. Abe, and about ten more will be constructed in the next couple of years[5]. Use the checklist in Toolbox 1 as a guide for substituting fossil fuels for a local, renewable energy source. The checklist provides a summary of how Mt. Abe addressed each step in switching to a renewable energy heating system. Of the 10 steps, I will address number four-- research and understand the availability of biomass fuel-- in more depth in Section III.

When many communities reached the final step, they decided to switch to wood heat because of the significant financial savings to taxpayers[6]. Even when state subsidies were not available to cover the construction costs, some communities still floated bonds to install woodchip-heating systems because the savings resulted in a positive cash flow after the first year[7]. The Mt. Abe community has taken an active step towards addressing global climate change and reducing their community's dependence on foreign oil by planning a community energy program centered on reducing energy consumption, improving energy efficiency, finding local and renewable energy substitutes, and improving forest health and vigor. School buildings provide many unique opportunities for community wood energy projects. According to Jeff Forward, energy consultant, "at schools it's as much about the people as it is about the technology or renewable energy." The people responsible for the woodchip heating system are often school staff or faculty, and very few involved students. But in the case of Mt. Abe, the students were the ones leading the change.

Mt. Abe Union High School, Bristol, VT

[5] A. Sherman, personal communication, June 10, 2007.
[6] J. Forward, personal communication, January 18, 2008.
[7] R. DeGues, personal communication, May 31, 2007.

TOOLBOX 1

Checklist for substituting fossil fuels for wood

The following steps will help your community determine if a woodchip heating system makes sense for your school. Moving from step 1 to 10 can take on average 18 months and requires a significant investment of money and time. The general approach outlined below is most likely applicable to other renewable energy projects.

1. Gauge initial interest in renewable energy by talking to members of your community.

In talking with community members get an idea of what the renewable energy options are in the local area. Renewable energy sources include solar, wind, water, biological materials, like wood, that can be burned, heat from the earth's interior, and hydrogen. For Mt. Abe there was significant initial interest in heating with wood.

2. Identify people with the technical expertise to address energy concerns in order to gain a basic understanding of the concept of burning wood for energy.

Mt. Abe contacted the energy consulting firm, Richmond Energy Associates, the Vermont Superintendent's Association School Energy Management Program, and the Biomass Energy Resource Center for advice.

3. Identify community needs and the resources available to meet those needs and then address community concerns.

Mt. Abe community members were concerned about rising oil prices and climate change. Mt. Abe students responded to the need for an affordable, environmentally friendly fuel for their school by exploring the potential for heating with wood. They discovered that there were a number of schools in Vermont already heating with wood, many people within their community knowledgeable about wood energy, state subsidies available to fund renewable energy projects, and two woodchip producers in their town.

4. Identify and involve key organizations or individuals who will benefit from or have a stake in wood energy

Involving key stakeholders at the local, state, and federal levels is important. Wood energy stakeholders fall into three general categories- education, energy, and forestry. Key stakeholders of the Mt. Abe wood energy project are shown in Figure 2. Stakeholders provide technical knowledge, financial resources, and organizational resources (Maker and Penny, 1999.) It is critical to include those in charge of making decisions early on. In the case of Vermont schools, the school board has the ultimate decision-making authority, therefore information and education should be targeted to them.

5. Find and support a "champion"

Jeff Forward, energy consultant for Mt. Abe, has found that in order to successfully implement wood energy projects, "there needs to be a champion to keep the idea alive in front of the decision makers." Maker and Penny (1999) describe the champion as "an individual who holds a position of respect and authority in the community, and who is effective at getting things done. They are often elected officials or senior municipal staff who know how to make good things happen for their communities." For Mt. Abe, the champions came in the form of 2 ninth graders and their teacher, Tom Tailer.

(Toolbox 1 cont.)

6. Do a preliminary screening of project viability

a. Research state air quality guidelines

Burning wood releases a number of pollutants, including fine particulates, sulfur dioxide, nitrogen dioxide, carbon monoxide, carbon dioxide, metals, polynuclear aromatic hydrocarbons (PAHs), polychlorinated dibenzofurans (PCDF), formaldehyde, benzene, and hexavalent chromium (Energy Risk Limited, 1996; Maker, 2004). The Clean Air Act requires EPA to set National Ambient Air Quality Standards for pollutants considered harmful to public health and the environment. EPA has selected six principal pollutants, "criteria" pollutants. Five of these criteria pollutants- carbon monoxide, nitrogen dioxide, lead, fine particulates, and sulfur dioxide, are released when wood is burned. Therefore it is important to ensure that emissions from the wood burning system do not adversely affect human health and the natural environment. Websites with information on federal and state air quality standards are found at the end of the guide.

b. Research and understand the availability of biomass fuel

See Section III of this guide for more information.

c. Research the availability of state or federal subsidies for the installation and/or maintenance of renewable energy systems.

The state of Vermont covered 90% of the construction costs of the Mt. Abe woodchip heating system but in 2006 the Vermont legislature suspended state aid for new construction projects. In some states there is no state aid for renewable energy projects. See the Resources Section for a list of potential federal aid programs.

7. Involve community members in planning

Part of the funding for public construction projects comes from the sale of bonds, which requires a district or town vote. Therefore keeping community members involved in planning generates community enthusiasm and ensures that concerns are addressed before ballots are cast. An excellent way to involve community members is to visit similar small woodchip system installations in your state or region (Maker and Penny, 1999).

8. Carry out a pre-feasibility study

A pre-feasibility assessment provides a generic cost assessment to help determine if the project is realistic for the site and if there is enough savings to justify the investment. When the Mt. Abe community did a pre-feasibility assessment they initially estimated that it would cost about $1 million to install the woodchip heating system.

9. Conduct a full feasibility assessment and analyze the costs and potential benefits of burning wood.

An important first step to conducting a full feasibility assessment is to have an energy audit done to determine how the school can conserve energy. Norm Etkind from the Vermont Superintendent's Association School Energy Program performed a free energy audit to look for energy efficiency and renewable energy opportunities. Organizations like BERC also perform energy audits.

(Toolbox 1 cont.)

A more thorough investigation of the Mt. Abe building revealed that there were considerable challenges to installing the woodchip storage bin in particular, which led to a doubling in the construction costs. In addition to site-specific construction costs, other direct and indirect costs and benefits should be weighed when choosing to switch to wood energy, as shown in Table 1. For more information on performing a feasibility assessment for a woodchip heating system see the resources section at the end of the guide.

Table 1. Direct and Indirect Costs and Benefits of Woodchip Heating Systems

Direct Costs	Indirect Costs	Direct Benefits	Indirect Benefits
Preliminary and Full Feasibility Assessment	Even with pollution control technology pollutants like CO, PAH, and formaldehyde, NO, metals, and benzene are released into the air.	$27,000 savings in 2006 after 1st year of operation. On average Vermont's schools saved about $50,000 each in the 2006-2007 heating season, totaling nearly $1.5 million (VTSASEMP, 2008)	Educational opportunities
Woodchip heating system parts and installation		Heating with renewable energy source	Support local economy

10. Decide whether to install a wood heating system.

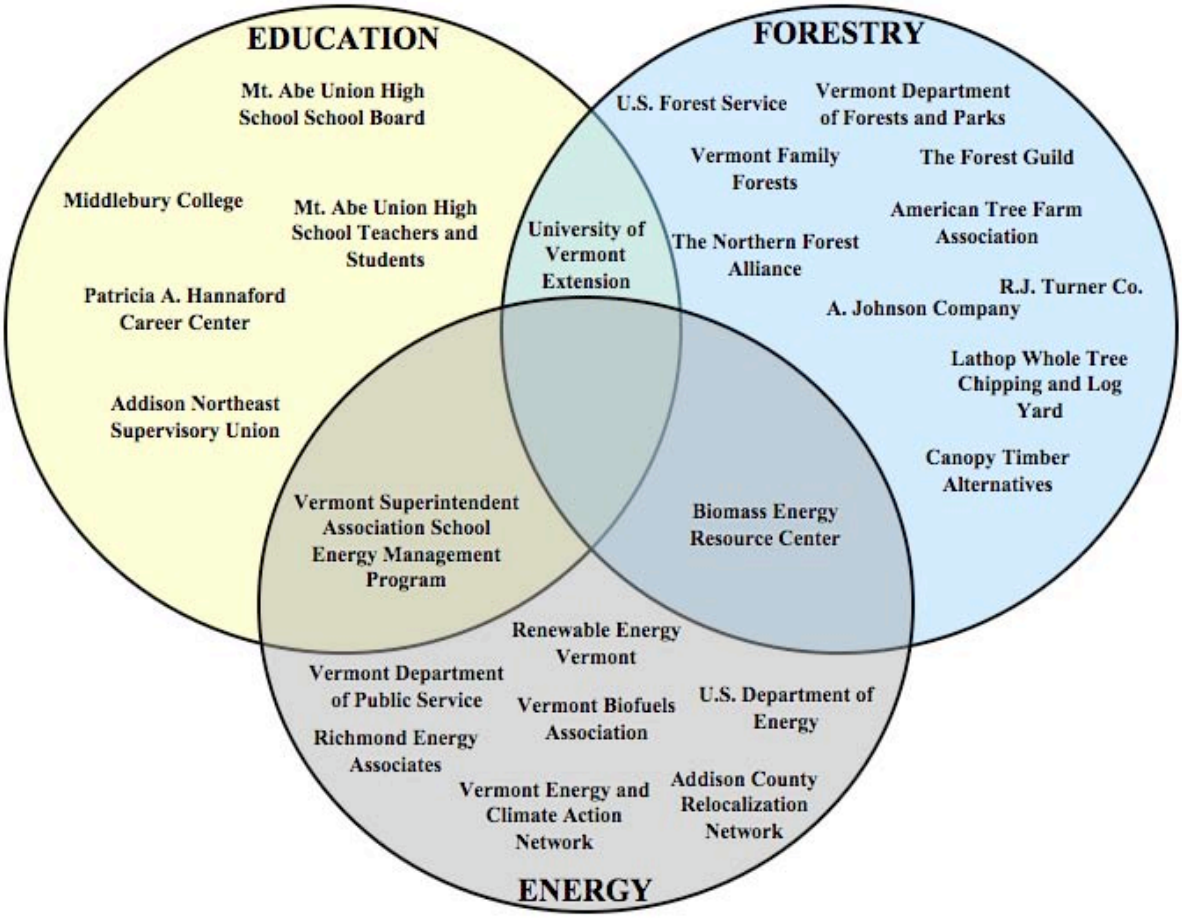
Providing an appropriate forum through which community concerns can be heard and addressed is critical to deciding whether to switch to wood heat. There were a series of community meetings at which the two 9th grade students presented the results of the feasibility study to the taxpayers of the five towns who then voted to fund the woodchip heating project.

Note: the 10 steps above are a combination of those proposed by Maker (2004), Maker and Penny (1999) and conversations with Jeffrey Forward, Robert Turner, David Brynn and other Mt. Abe community members involved in installing the woodchip boiler.

Once your community has decided to install a wood energy, Maker (2004) provides more information on:

1. Setting up the project structure for installing a wood energy system.
2. Selecting a biomass system.
3. Installing and commissioning the selected system.
4. Maintaining the system for peak performance.

Figure 2. Organizations and networks involved in wood energy for schools



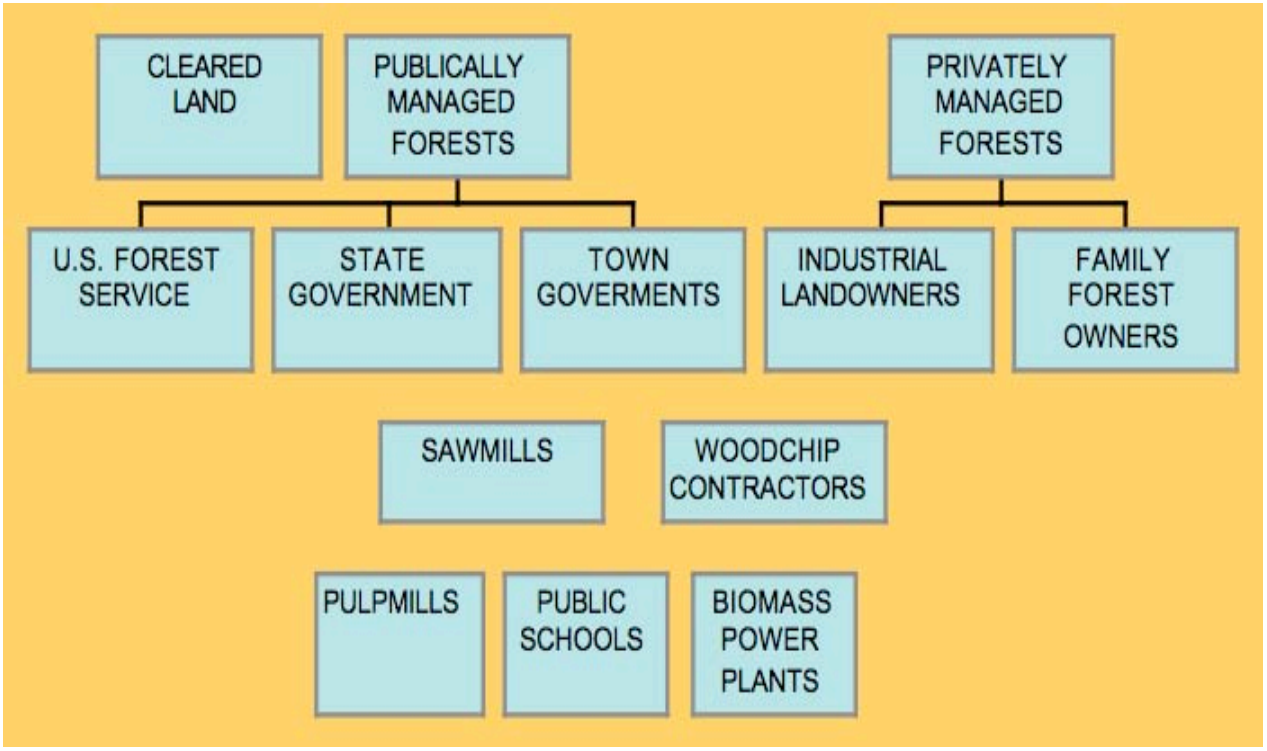
III. Determining the availability of woodchips for fuel

Woodchip production - from the forest to the storage bin

In order to better understand the availability of woodchips for fuel it is important to understand what it takes to get wood from the forest to its final resting place as a woodchip in your school's storage bin. I will introduce you to some of the landowners, foresters, loggers, woodchip producers, teachers, and students involved in addressing the energy needs of Mt. Abe Union High School. Your community may not have the exact same people or organizations, but the roles they play in fueling your school or community building with a renewable fuel will probably be similar.

The life of a woodchip starts as a tree growing in the forest. The tree is selected to be removed, cut down, and dragged to a level spot where it is loaded into a truck. The log is then hauled to a wood chipping facility where the round log is fed into the chipper. The chipper spits woodchips out the other side, which are then loaded into a tractor-trailer and delivered to a school for heat. We will start the journey of a woodchip at the school and work backwards, which I have found is an easier way for understanding the process than starting in the forest. Figure 3 summarizes the different options for woodchip production—from where the wood is sourced to where woodchips are produced, and finally to where they are used.

Figure 3. Different Options for Woodchip Sourcing, Production and Consumption



Who are the woodchip consumers?

In Vermont, large woodchip consumers include power plants, like Burlington Electric Department (BED), and pulp mills, like the International Paper (IP) Ticonderoga Mill, which burn approximately 380,000 tons[8] and about 800,000 tons[9] of woodchips/year respectively. Vermont schools together burned about 18,500 tons of woodchips during the 2006-2007 heating season.[10] BED and IP support a significant portion of the infrastructure-- loggers, their logging equipment, and special trucks for delivering woodchips, needed by Vermont's schools for the production and delivery of woodchips to their storage bins. There is a high risk of losing the harvesting infrastructure if the IP Ticonderoga Mill goes out of business[11].

Once you have a basic understanding of who the woodchip customers are, it is helpful to think about how the woodchips are produced.

How are woodchips produced?

There are two main types of woodchip producers: sawmills and chipping contractors. They directly supply woodchips to customers but also sell their woodchips through a third-party woodchip broker.

Chipping contractors

Jim Lathrop currently supplies Mt. Abe with woodchips. As a chipping contractor he takes low-quality wood from land-clearing or forest-harvesting activities and chips it in the woods or takes it back to a woodchip production facility shown in Figure 4. Jim produces two types of chips. In some cases the whole tree, including the branches and leaves, is fed into the chipper, thus producing what is called a "whole tree chip." Chipping contractors chip whole trees in the woods and feed the chips directly into tractor-trailers for delivery to wood-fired power plants and pulp mills. Oftentimes there is no screening out of oversized pieces of wood, so the chips are not uniform in size, which can jam small operating systems. Without screening, there is also a large amount or dirt, which decreases the amount of heat produced per unit of fuel. Because of these characteristics, small-scale woodchip heating systems cannot burn whole-tree chips.

Chipping contractors also feed the entire branch-free trunk, also known as a bole, into the chipper. A "bole chip" comes out the other end. Some of the older woodchip heating systems do not take bole chips, but the newer systems, like the one at Mt. Abe, are designed to use bole chips. The tree bole is often taken to a separate facility for chipping and bole chips do not contain twigs and branches, unlike whole tree chips. Because bole chips require more steps to produce, they are more costly than whole tree chips[12].

Figure 4. Lathrop Whole Tree Chipping and Logging yard, Bristol, VT

[8] Sherman, 2007
[9] A. Sherman, personal communication, April 16, 2008.
[10] VSASEMP, 2008.
[11] Sherman, 2007.
[12] A. Sherman, personal communication, June 19, 2007.

Sawmills

The high quality logs that Jim removes from the woods are sold to sawmills like A. Johnson Lumber, where the round trunk is turned into square boards for use in construction. In the 1950's about 19 sawmills were operating in the Mt. Abe area. Today, A. Johnson Lumber, located in Bristol, is one of six mills in the state that regularly supply chips to schools[13]. The waste or residual pieces from the manufacturing of lumber is sent to a chipper and made into "mill residue chips." The higher quality of a mill chips is largely due to a screening process. Compared to whole tree and bole chips, mill chips are screened to remove dust and oversized material to fit the needs of paper companies like International Paper. Therefore mill chips tend to be more uniform in size and do not contain bark, as bole chips often do[14]. There are some schools in Vermont that only use mill residue chips because the occasional larger pieces, that are not screened out when producing bole chips, jam the system. Toolbox 2 provides information on determining the availability of the woodchip supply.

Figure 5. A. Johnson Company, Bristol, VT

[13] A. Sherman, personal communication, June 19, 2007.

Where does the wood come from?

Now that you understand how a woodchip is produced, a next logical step is to investigate how the wood goes from being a standing tree in the forest to a log that is ready to be fed into a woodchipper.

The Forest Ecosystem

The journey of a woodchip begins as a tree growing in the forest. The forests of the Mt. Abe community are home to a diversity of plant and animals. Red backed salamanders, ground beetles, land snails, millipedes, short-tailed shrews, ruffed grouse, black bears, and fishers find food and shelter in the woods near Mt. Abe Union High School.[15] Animals depend on plants for food and shelter, therefore plant communities are a large factor in what wildlife are present. The presence and health of plant species is directly related to the soil. In particular, plants take up nutrients like nitrogen, potassium, phosphorous and calcium, for growth. Nutrients are then stored in plant parts (roots, stems, branches and leaves). When trees shed their leaves in the fall soil fungi and other soil dwelling organisms decompose the plant parts and cycle the nutrients back into the soil.

Forests play an important role in carbon cycling. One of the reasons that communities are choosing wood over oil is that burning wood decreases the amount of carbon dioxide emitted in energy production. When oil is used for energy, carbon is removed from underground reserves and released into the atmosphere. In contrast, through the process of photosynthesis, forests take carbon dioxide out of the atmosphere and convert it to oxygen and carbohydrates. About 30% of the carbon absorbed by northeastern forests is stored in the above-ground portion

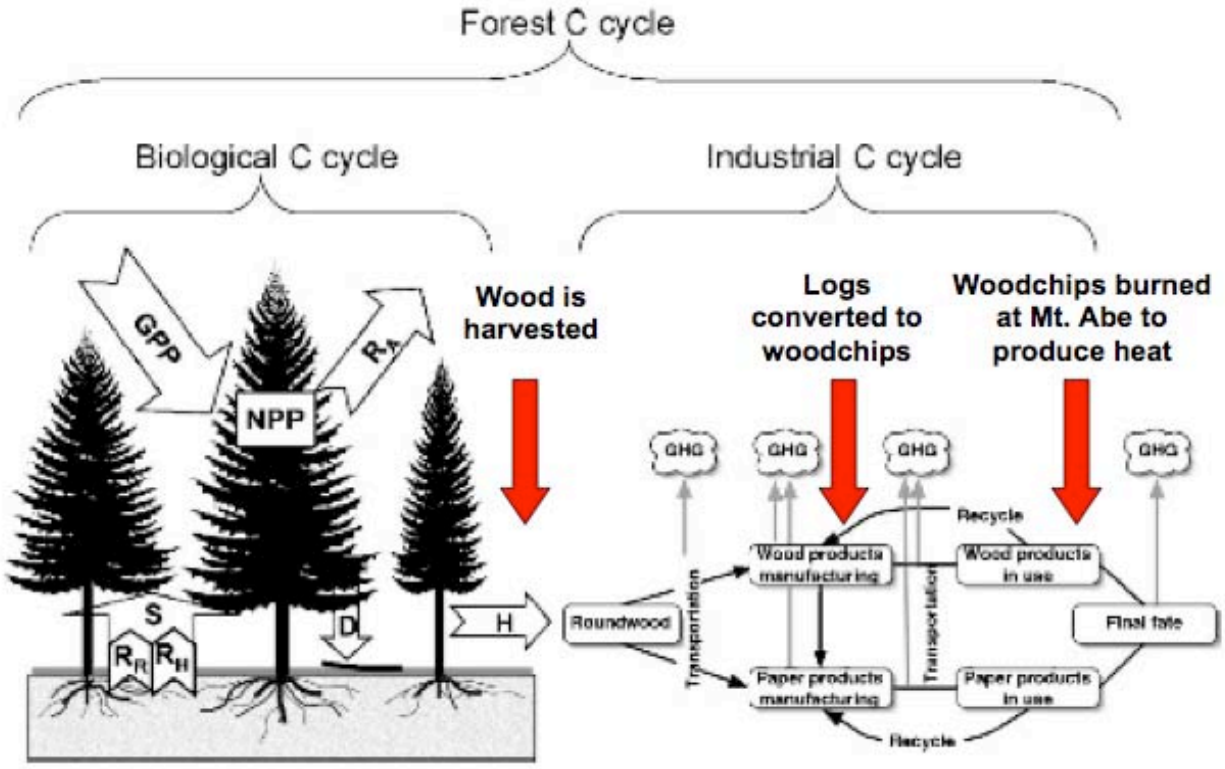
[14] A. Sherman, personal communication, June 19, 2007.

[15] Andrews, 2003.

of trees, about 60% is stored in the soil, and 10% is stored in the litter or debris.[16] By using wood for energy, the carbon dioxide produced by combustion is offset by the carbon dioxide reabsorbed by the remaining forest. As long as the wood is harvested at a rate less than what is able to grow back over a reasonable timeframe, there is no net gain in carbon dioxide to the atmosphere and wood is considered carbon neutral. As shown in Figure 7, the forest carbon cycle involves the interaction of the biological cycling of carbon in forest ecosystems and the industrial cycling of carbon in the manufacturing of forest products. Carbon dioxide is released through plant respiration (R_A), root respiration (R_R), and respiration of soil organisms (R_H). The industrial carbon cycle includes the transportation and manufacturing of wood products. Logging, although not included in Figure 7, requires the use of fossil fuels for running harvesting equipment and should be included in carbon accounting as part of the industrial carbon cycle. In the case of woodchip production, carbon is released when:

a. wood is harvested;
b. wood is transported from the forest to the woodchip production facility;
c. logs are converted to woodchips;
d. woodchips are transported to Mt. Abe; and
e. woodchips are burned to produce heat.

Figure 7. Conceptual Diagram of the Forest Carbon Cycle



Adapted from Figure 1 in Gower, 2003.

[16] Irland and Cline, 1999

TOOLBOX 2

Checklist for determining whether there is enough wood currently available to fuel your school

The following steps can help guide your community in determining whether there is enough biomass available to fuel your school.

1. Contact state and local forestry officials

At the Vermont Department of Forests, Parks and Recreation, Robert DeGeus, a wood utilization specialist, connects wood energy project leaders with people involved in the forestry industry. The types of individuals and organizations listed under Forestry in Figure 2 in Section II may be able to assist your school in determining the availability of wood for fuel.

2. Determine the regional supply of woodchips

State forestry departments like the Vermont Department of Forests, Parks and Recreation publish forest resource harvest summaries, which list the amount of woodchips produced for fuel and pulp. Organizations like BERC and the Vermont Department of Public Service have information on the demand for wood biomass.

3. Determine the fuel needs of your school

a. Quality, size and species of woodchip required

These systems most efficiently burn hardwood chips between 35-40% moisture content. The older systems can only handle mill residue chips but the newer systems like the one at Mt. Abe can burn bole chips.

b. Length and time of operating season

Typically these systems operate in Vermont from October to the end of April.

c. Amount of chips required to heat the school during a typical cold weather season

The amount of chips required to heat your school depends on the size of the school, length of the heating season, and energy efficiency of the building. Vermont schools burned an average of 596 tons in the 2006-2007 heating season.

4. Determine whether there are potential woodchip suppliers for your school

Vermont is fortunate to have the Biomass Energy Resource Center, which has a list of woodchip suppliers in Vermont like sawmills, woodchip contractors, and woodchip brokers, described in more detail in Section I. In the absence of a BERC-type organization, check the department in charge of land management at the local and state levels for the names of woodchip suppliers. Survey these producers to see:

a. If they produce the type of chips in the quantity needed for your heating system.
b. What they charge for woodchips.
c. If they are willing to sign a contract or is it first come, first serve.
d. How close the chip storage area is from your school.
e. If there are certain times of year when the supply is limited.
f. What is the farthest distance from which they source wood.

5. Select a woodchip supplier

For Mt. Abe, Jim Lathrop was a local taxpayer, located within a stone's throw of the school, sold woodchips at an affordable price, and was willing to sign a 2-year contract.

Landowners
The forests of Addison County are owned and managed by a number of different people and organizations. Public owners include the state of Vermont, the U.S. Forest Service, and municipal governments like the town of Starksboro. Private owners include private citizens and companies like A. Johnson Lumber and Lathrop Whole Tree Chipping and Logging.

Currently, larger private landowners like A. Johnson Lumber and Jim Lathrop, and some public landowners like the State of Vermont, and the U.S. Forest Service provide about half the wood for Mt. Abe. The other half comes from land cleared for development, vineyards and horse pastures[17].

Private landowners
Industrial forestland owners like A. Johnson Lumber own their land primarily to produce timber. They remove a lot of lower quality wood to make room for trees of higher quality to grow. The lower quality wood is sold to Burlington Electric Department for woodchips. In the last 20 years many forest products companies have sold off their timberland for a number of reasons, including debt reduction. According to Bill Sayre, manager of A. Johnson Lumber, the company has decided to keep their land to provide a backup supply of wood during tough economic times.

Family forest owners-- individuals and families or other groups of individuals who are not incorporated, own more than half the forestland in the region.[18] Currently small family forest owners, like Willy Osborne who owns 46 acres in Lincoln, VT, are not included in supplying woodchips to Mt. Abe.

Public landowners
About 2.3 million acres, or 23%, of the forestland in the region is publicly-owned. Of this 2.3 million acres, the U.S. Forest Service owns 9%, the State of Vermont owns 12%, and towns like Starksboro and Lincoln own the remaining 2% [19]. Some of the federal forestland, like the Bristol Wilderness Area, is protected from logging, mining or other natural resource extraction while other parcels are managed for multiple uses including wood products (like wood for fuel), forage, recreation, wildlife, and other benefits. The state of Vermont manages particular areas, like the Lewis Creek Wildlife Management Area in Starksboro, for wildlife—which means that logging is done to create habitat for different species like ruffed grouse, deer and moose. Municipal governments, like the town of Starksboro, own the remaining 165,000 acres.

Activity by previous landowners has had a strong influence on the forest we see today. Clearing of forest for agriculture and destructive harvesting practices that have removed many of the straight, high-quality trees have left many low quality trees.

Foresters
When Willy Osborne needed advice on owning and managing his forestland, he went to David Brynn at Vermont Family Forests (VFF). Like other consulting foresters, David provides a number of services to private landowners as part of his work with VFF, including the inventory and assessment of timber, plants, wildlife, and wetlands, and advice on the financial aspects of owning land. Just like an architect draws up the plans for constructing a building, foresters create plans for activities like harvesting timber, creating recreational trails, and protecting forest health and diversity. Foresters work with landowners to develop goals for managing their property. Willy values his land for scenic beauty; the protection and

[17] J. Lathrop, personal communication, July 26, 2007.
[18] Butler and Leatherberry, 2004.
[19] Butler and Leatherberry, 2004.

enhancement of forest health, including water quality, native biodiversity and site productivity; and as a place to find peace and solitude. VFF developed a long-term plan for how Willy could meet these goals, which in some areas involved harvesting trees. The National Woodland Owner's Survey (NWOS,) conducted by the U.S. Forest Service, found that the majority of family forest owners in the region share Willy's values and own their land for primarily non-timber benefits. The U.S Forest Service also found that, like Willy, the majority of family forest owners in the region were most concerned about paying property taxes.[20] Removing low quality wood from family forests to fuel schools like Mt. Abe has the potential, if well planned, to support family forest owner's management goals while also generating income to help pay property taxes. Enlisting consulting foresters in management not only ensures proper care of the forest ecosystem but foresters can also connect landowners with wood customers. When it is time to harvest trees foresters enlist the services of loggers and work with them to make sure forest health is protected and wood is harvested according to the management plan. Thus, foresters also serve as a facilitator between landowners and loggers.

How could community wood energy serve as a business opportunity for consulting foresters?

Many forester's clients have a lot of low quality wood to remove to improve the value of standing timber. Providing a market for this wood could bring landowners higher returns on their land. Projects like community wood energy provide a new way to engage private landowners in active forest management, which provides wood for the mills and more landowners in need of the services of foresters and loggers.

[20] Butler and Leatherberry, 2006

David Brynn (right) consults with Bill Torrey, logger, about the plan for harvesting timber from one of the properties managed by Vermont Family Forests.

Forest Harvesters

Forest harvesters, better known as loggers, are responsible for removing the tree from the woods and taking it to a clear, level area or landing, where it can be chipped or loaded onto a truck and taken to a woodchipping facility. There are two main types of forest harvesting systems used in Vermont—the conventional system and what is called a feller-buncher system[21]. In the conventional system, the logger cuts down the tree with a chainsaw, removes the branches and top, wraps a heavy cable around the trunk, and then drags out the trunk using a bulldozer or a skidder, shown in Figure 6. In contrast, a feller-buncher is completely mechanized and does not require the use of a chainsaw. Instead the operator sits in an enclosed cab and uses joysticks to direct the machine to where and what should be cut. The machine then lays the trees on the ground for the skidder operator to come and pick up. Due to the terrain and small size of land parcels in Vermont, most loggers, like Bill Torrey, use a chainsaw and skidder to cut and move logs out of the woods. The two main types of wood removed by both systems are: low quality logs that are crooked, have low

[21] VFF, 2004.

commercial value, or have other knots or defects; and high quality logs that are straight, fairly defect-free, and species like sugar maple and hickory used in furniture making or to produce lumber for construction. The logs are brought from the woods to the landing where a trucker then loads them onto the log truck.

Figure 8 summarizes the general path a woodchip takes to move from the forest to a school's woodchip storage bin.

Figure 6. Skidder

What does it cost to take wood from the forest to the woodchip storage bin?

Table 2 breaks out the general costs of producing woodchips. These costs are specific to the Mt. Abe community. Prices may differ in different regions.

Table 2. Pulling apart the current bole chip price

Type of cost	Current Price Paid ($/ton)	
Price paid to the landowner for low value wood	$0-$10.00	(1)
Chipping	$5.00	(2)
Transportation from the forest to chipping facility and then to schools	$10.00	(3)
Logging	$9.00-$15.00	(4)
Total: $24.00-40.00		

(1) J. Lathrop, personal communication, July 26, 2007; J. Anderson, personal communication, June 21, 2007.
(2) J. Lathrop, personal communication, July 26, 2007.
(3) Vermont Family Forests, 2004; Sherman, 2007; W. Sayre, personal communication July 9, 2007.
(4) Values were obtained from Peterson (2005) and represent the cost of forwarding in the Great Lakes Region. Estimates range from land clearing to selective harvesting operations.

Figure 8. Basic path of a woodchip from the forest to a school boiler

IV. Ensuring a reliable supply of wood that is obtained in ways that conserve forest health

Understanding the challenges and opportunities to sourcing woodchips over the life of your boiler

The first level of investigation detailed in Section III is important to determining the availability of woodchips for your school and understanding the basic process of how woodchips get to your school's storage bin. Interviewing community members involved in fueling your school also offers residents an opportunity to express their values and needs, which is important for building trust and consensus needed to address problems like energy supply.

Section IV will help guide your community in understanding the social, economic and ecological challenges and opportunities associated with:

a. Where the wood is harvested;
b. Who harvests the wood;
c. When the wood is harvested;
d. What landowners are included in providing wood;
e. How the wood is harvested, and
f. How the woodchips are produced.

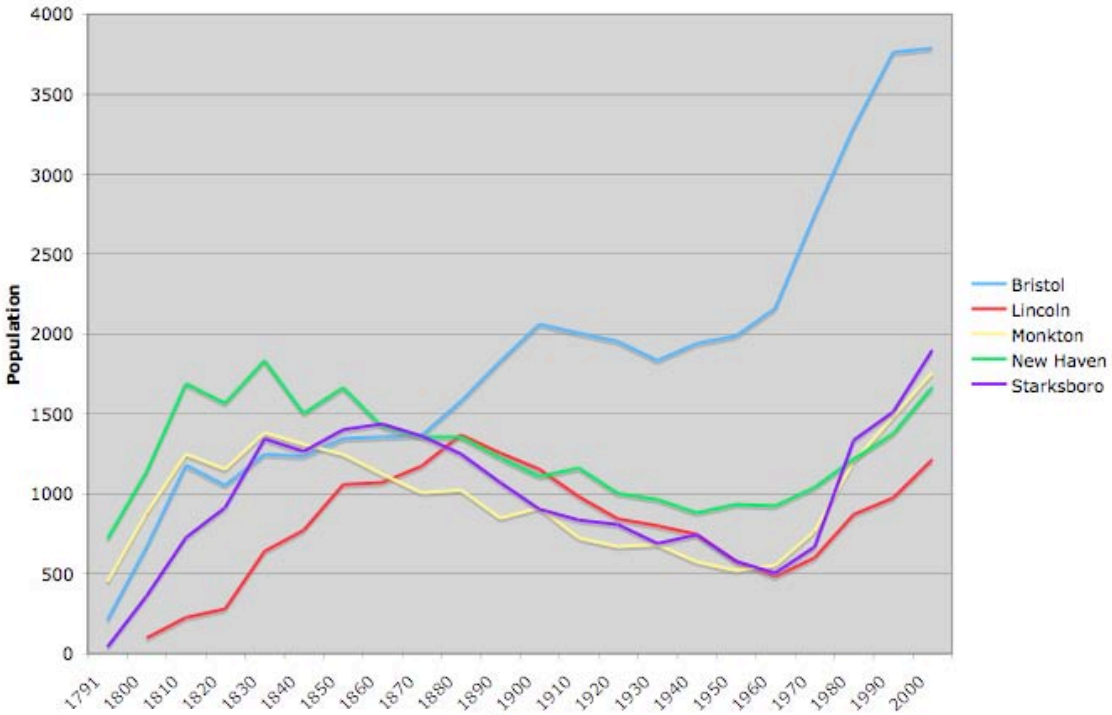
From where will the wood be harvested?

Currently, Jim Lathrop harvests half the wood from land cleared for development. Due to its close proximity to Burlington, Bristol and the other towns in the Mt. Abe community have significantly increased in population as shown in Figure 9. As a result, Jim has had a backlog of work. There are limited markets for low quality wood, besides woodchips, so providing wood from land clearing for heat ensures that it will not be wasted. One of the main reasons communities are switching to woodchips is that it is a carbon neutral heating source. Yet, if the woodchips are sourced from land where a permanent building sprouts instead of a new tree to uptake carbon dioxide, then carbon dioxide emissions are not being offset.

As shown in Figure 9, the population of Addison County has experienced more of a boom and bust instead of a steady growth rate.[22] Yet how much is the population expected to continue to increase? What happens to Jim's business and the Mt. Abe woodchip supply if a housing market crash halts land clearing? The community wants to keep people like Jim in business. Jim also clears land for horse pastures and vineyards and gets half his woodchips from managed forests. Carefully managed forests have the potential to provide a sustainable supply of wood for Mt. Abe and provide a potential opportunity for other forest workers and landowners to benefit. Transitioning from sourcing half the woodchips from land clearing to sourcing the majority from managed forests requires overcoming several important barriers.

[22] ACRPC, 2002

Figure 9. Population Change in 5-Towns of Mt. Abe Community



Source: ACRP, 2002

Harvesting wood from managed forests- the main barriers

Communities face a number of barriers to harvesting wood from managed forests. The loggers, foresters, and woodchip producers agreed on 2 main obstacles to harvesting woodchips for Mt. Abe: few new loggers are entering the profession and changing weather. Other issues regarding where and how the wood is harvested and how the woodchips are produced are also discussed.

Who will harvest the wood?

Tom Yager, A. Johnson forester, describes loggers as "very independent thinking, mechanically inclined, and resourceful workers." Many in the Mt. Abe community were concerned that as loggers retire there are not enough people entering the profession to replace them. Figure 10 indicates that the majority of loggers in Vermont are in the 25-55 year age range. The number of loggers in the 14-24 year age range who have entered the profession in the last 6 years on average equal the number of loggers in the 64-99 year age range who are expected to retire in the near future.[23] While the U.S. Census data presented in Figure 10 does not support the theory of a recent decrease in worker replacement it is likely that increasing fuel costs and depressed timber markets will

[23] U.S. Census Bureau, 2007.

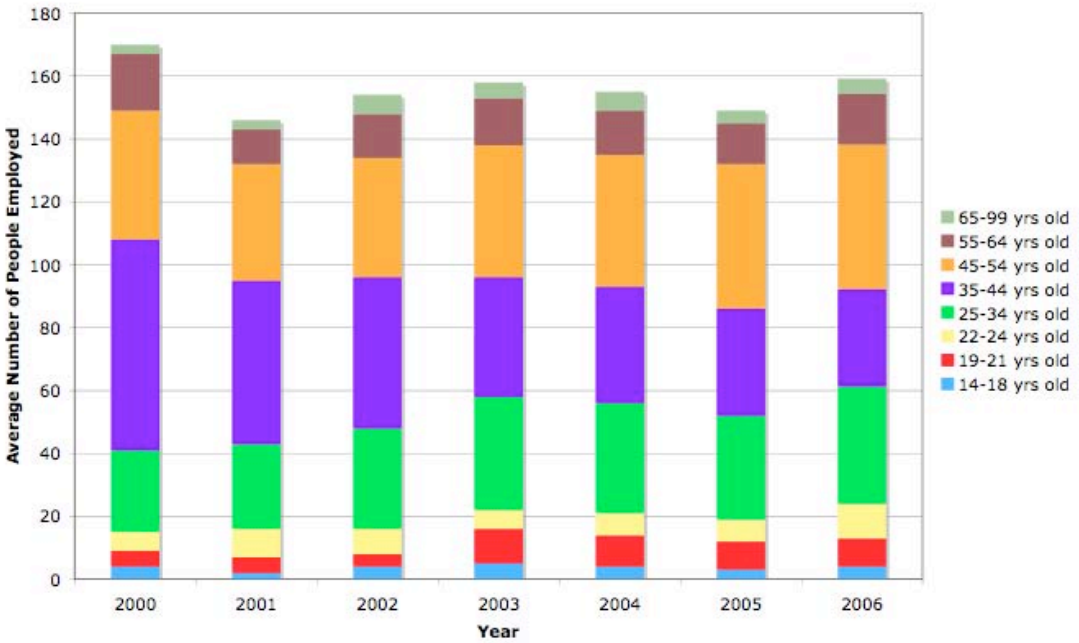
make the profession much less attractive in the near future.

As shown in Table 3, there are many benefits to being a logger. Yet Bill Torrey and others agree that the high risks make logging very unattractive. In 2005, the median annual income of loggers in Vermont was $24,000,[24] which is below the 2005 income limit of $33,550 considered low income for a one-person household in Addison County[25]. The ability of loggers to make a livable wage depends on a number of things including their living expenses, health insurance, monthly equipment payments, and maintenance, the price that mills are paying for logs, and bad weather that limits when they can harvest.

There are no official figures on the number of loggers without health insurance. Some loggers may have health insurance through an employed spouse, but many entering the profession may not have this option[26].

If the state or some other agency or organization were to offer affordable health insurance for loggers and if loggers were guaranteed that if they bring their logs to a mill or a log yard they will be paid a fair price, then the logging profession might look more attractive to young people with a desire to work outside. More training and mentoring opportunities for new forest workers will lower the risk of bodily injury and also increase the recruitment of new workers. The Hannaford Career Center and the Essex Center for Technology are two technical schools close to Mt. Abe that provide high school students with forestry skills. There are also training sessions available through programs like the Master Logger program. In order to continue attracting young people to become loggers, the risks detailed in Table 3 need to be addressed.

Figure 10. 2000-2006 Employment in the Logging Profession in Vermont



U.S. Census Bureau, 2007.

[24] R. DeGues, personal communication, February 14, 2008.
[25] HUD's PD&R, 2007.
[26] R. DeGues, personal communication, February 14, 2008.

Table 3. Costs and Benefits to Working as a Logger

Benefits to Being a Logger	Risks Associated with Working as a Logger	What can be done to minimize the risks?
Work outdoors.	Favorable weather conditions are needed to operate machinery without damaging soil and water quality (can't operate in wet weather).	Design affordable small-scale equipment that is more adaptive to changing weather conditions.
Gratifying work that requires unique skills and resourcefulness.	Hard, physical labor with significant risk for injury.	Increase training and mentoring opportunities. Provide affordable health insurance.
Option to work independently and be own boss.	High costs to entering the profession, including purchasing equipment and health insurance. Pay varies from job to job.	Pay loggers a livable wage for their services. Provide better access to capital in order to purchase new equipment.

When can the wood be harvested?

The second barrier that many Mt. Abe members agreed upon is wet weather, which limits loggers' ability to operate their harvesting equipment without eroding the soil and degrading water quality. There are certain times of the year when harvesting is limited due to wet weather, which in Addison County occurs from September to November and from April to June[27]. In recent years, many loggers commented that warm winters have significantly reduced the amount of time for harvesting wood, thereby reducing the supply. Last winter, the ground did not freeze until January and many loggers lost two months of work. A. Johnson Lumber had trouble finding logs during this time to manufacture for their customer's needs. The National Oceanic and Atmospheric Administration (NOAA) has documented a 1°F increase in temperature since the mid 1970's[28]. In the northern hemisphere, scientists have measured a decrease in the estimated maximum area of seasonally frozen ground from 1901 to 2002[29]. While these trends may seem to support cause for concern in terms of winter harvesting time, scientists are still uncertain about how an increase in temperature will affect freeze-thaw cycles. The duration of frozen ground is dependant on a number of factors including snow depth and air temperature. If the harvesting window continues to shrink, Mt. Abe will find it increasingly difficult to find wood. One solution is to make sure the woodchip contractor stores wood harvested during good logging conditions, like Jim Lathrop does for Mt. Abe.

[27] W. Sayre, personal communication, July 9, 2007; W. Torrey, personal communication, June 18, 2008.

[28] NOAA, 2008.

[29] Solomon et al., 2007.

Who owns the forests where the wood will be harvested?

Currently, a lot of the wood for Mt. Abe comes from large tracts of forestland owned by public and private owners like A. Johnson Lumber, Jim Lathrop, the US Forest Service, and the state of Vermont. But family forest owners, like Willy Osborne, own the majority of the forestland in the area. The following 2 subsections will focus on challenges to obtaining wood from family forestland, which, as shown in Figure 11, is one of the potential sources of wood for Mt. Abe. The price of woodchips, land tenure and attitudes toward harvesting wood are three challenges to sourcing wood from small privately managed forestlands.

a. Price of woodchips

The major obstacle that is blocking family forest owners within the five-town area from sending woodchips to Mt. Abe is that the current market price for woodchips does not cover the costs to harvest lower value wood on the small scale of most family forests. In 2006, Mt. Abe paid Jim Lathrop $32/ton for woodchips, which is equivalent to $0.64/gallon of heating oil at a time when residential heating oil costs $2.79/gallon[30]. This $32 price covers the cost of getting the wood from a standing tree to the log landing and then on to Jim's storage yard in Bristol where he chips it, and then delivers it to Mt. Abe. He is able to keep the price down because he works on large tracts of land with equipment able to harvest a lot of wood in a short period of time. Bill Torrey, who uses a chainsaw instead of large equipment to harvest trees and works with much smaller volume removals, says that $32/ton does not cover his costs for harvesting lower value wood. At least 50% of the volume Bill removes needs to be sawtimber size and quality. The sawtimber in effect subsidizes the removal of smaller, undesirable, or lower quality trees that can be turned into chips. Unfortunately, due to past land use and harvesting not enough large-sized trees of good quality are available on the small scale of many family forests.

b. Changing ownership

Land tenure is of particular concern. As people get older, they are faced with decisions concerning their ability to live on and care for their forested property. In conducting the National Woodland Owner Survey, the U.S. Forest Service found that about 39% of the land in the region owned by family forest owners was owned by people over age 65.[31] In the next couple of decades, the land owned by these forest owners will be changing hands. Changing forestland ownership is a significant concern when talking about ensuring a sustainable supply of woodchips over longer timeframes. For example, when Willy Osborne's children take over ownership of the property, he/she may decide to sell the property to a developer who then clears it for a new housing development. That piece of property will then no longer be able to supply wood after the property has been cleared. The U.S. Forest Service investigated the management plans of family forest owners to determine landowners' intentions for the next five years. USFS found that those who owned 17.5% of the forestland in the region indicated that they were transferring all or part of their property to their heirs. About 19% were planning on either selling or subdividing all or part of their land or converting to another land use in the immediate future.[32]

There are opportunities available for private landowners to sell their property or pass it on to heirs and ensure that it will remain as forestland. The Forest Legacy Program (FLP), a voluntary program run by the U.S. Forest Service in partnership with states,

[30] EIA, 2007.

[31] Butler and Leatherberry, 2006

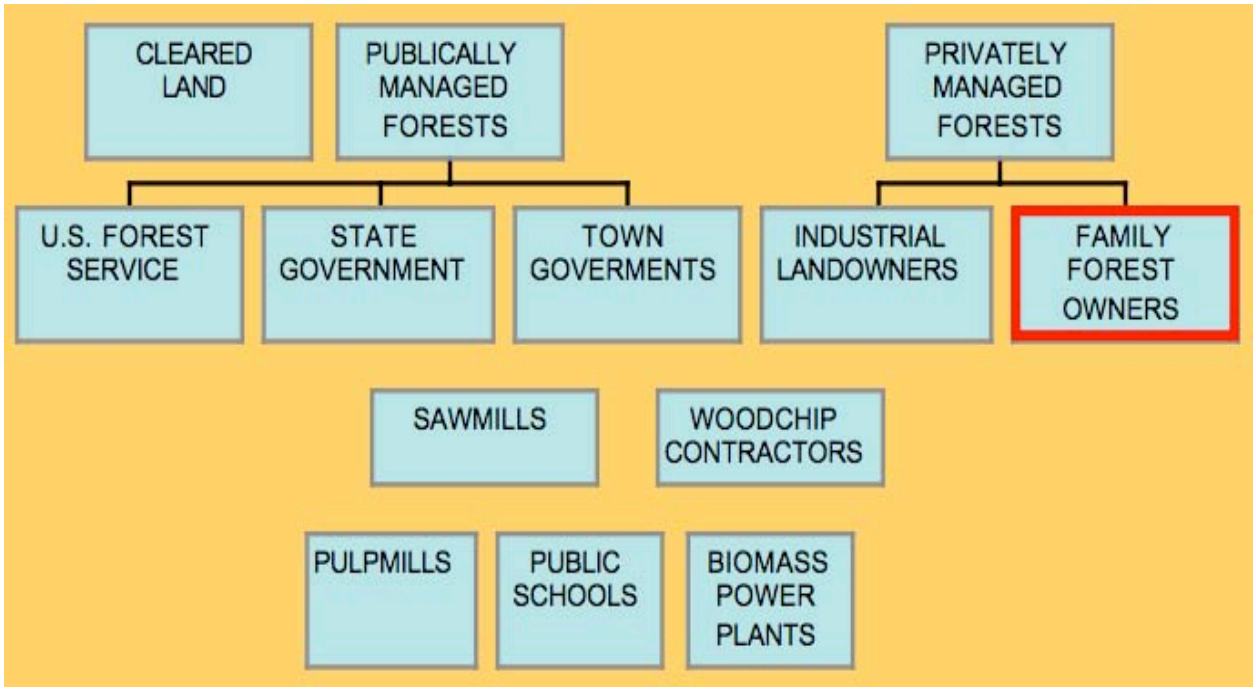
[32] Butler and Leatherberry, 2006.

focuses on the acquisition of conservation easements. These are legally binding agreements transferring a negotiated set of property rights from the landowner to the state or other organization like a land trust. Property rights are commonly described as a bundle of sticks, each stick representing a right or benefit from a piece of property. A private landowner may have the right to sell, lease, subdivide, and harvest timber from his/her property. The community has the right to tax, take for public use, and regulate the uses of a property. Landowners can negotiate a working forest conservation easement where they sell the right to develop a portion or all of their land to the state or a land trust but maintain the right to harvest timber and sell the property. Most FLP conservation easements restrict development, require sustainable forestry practices, and protect other values. Many landowners also benefit from reduced taxes associated with limits placed on land use.[33]

c. Attitudes toward harvesting wood

Many foresters in the area agreed that another challenge to obtaining wood for Mt. Abe from family forests is that selling wood is not a high priority for most family forest owners. Even if the new owner decides to keep the land as forestland, what is the likelihood that he/she will want to harvest wood for woodchips? Unlike industrial landowners, only 10% of family forest owners use their land primarily for timber production, and those 10% tend to be the owners of larger acreages. In the past 10 years only 24% of family forest owners harvested timber from their property. In addition, a distrust of loggers on the part of some landowners decreases the likelihood that they will harvest timber.[34] The U.S. Forest Service found that in the next five years, family forest owners of about 50% of the forestland plan on harvesting firewood and 12% plan on harvesting sawlogs and pulpwood, which could allow for the removal

Figure 11. Different Options for Woodchip Sourcing, Production and Consumption



[33] USDA Forest Service, 2008.

[34] Roper Public Affairs, 2008.

of lower quality wood for chips if the price was right.[35]

Just like the majority of family forest owners in the region, Willy Osborne finds that property taxes have been his biggest headache, so he would like to take advantage of the tax savings gained by enrolling his forest in the Use Value Appraisal (UVA) Program. The UVA program is a state program that taxes land managed for agriculture or forestry at a lower value than the "highest and best" use of the property, which is usually developed land. Most private land that is managed for timber and has a state-approved management plan, including land owned by large owners like A. Johnson Lumber and small owners like Willy Osborne, is eligible for inclusion in the UVA Program. The goal of the program is to provide disincentives for developing land and remove the heavy tax burden from private farmers and forest owners. The best place to start to engage family forest owners is to approach those already managing their land through the Use Value Appraisal Program. Mt. Abe could work with the county forester and consulting foresters to identify landowners who plan on harvesting wood in the next 5 years. In order to harvest wood some landowners like Willy Osborne need some assurance that their woods are not going to be damaged. Working with a forester and loggers certified through a program like the Master Logger Program may provide just the peace of mind needed for family forest owners to harvest wood.

[35] Butler and Leatherberry, 2006.

How will the wood be harvested?

Caroline and her students approached Vermont Family Forests with the goal of ensuring a continuous supply of woodchips. They and other Mt. Abe students wanted wood to be harvested from managed forests using careful management practices that conserve forest health. As Chris Olsen, Addison County forester, points out, "there is nothing natural about putting metal machinery into the woods." Therefore, it is the aim of sustainable forest management to limit the impacts that this type of activity has on the forest.

While trekking around the woods this summer with many of those responsible for taking care of the forestland in the Mt. Abe community, I heard different views on how to manage forests to conserve forest health. The different approaches to forest management are related in part to:

Forest ecology
Forest values, and
Timescale.

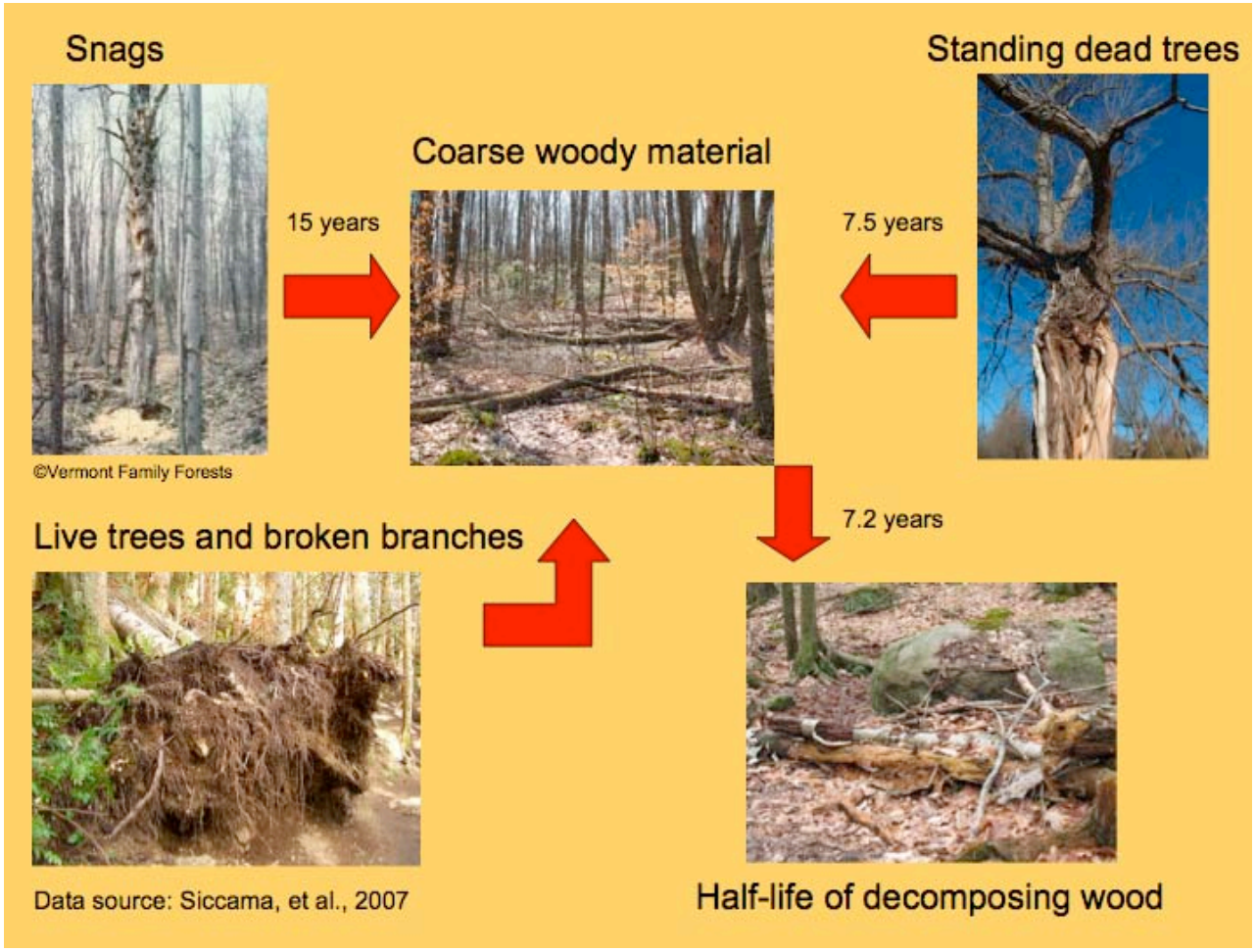
"It is exciting to work with students who want to make something happen that will directly affect their futures!

-Caroline Camara
Mt. Abe Union High School Earth Science Teacher

Forest ecology

Just as the human body needs vitamins and time to recover from surgery, a forest needs nutrients and time, among other things, to recover from logging. Some nutrients are lost when wood is removed for woodchips and other forest products. A percentage of the nutrients that are lost are in the trees that are removed. Others are lost through erosion of exposed soil following harvesting, and leaching of nutrients not taken up by plants. Woody material (standing as snags or on the forest floor as coarse woody material) in particular are important for cycling nutrients back to the soil and providing habitat for reptiles and amphibians. Branches and foliage in particular contain the largest amount of nutrients in trees[36]. Therefore, the ability of a forest to recover is related to the amount of wood left on-site. Wood ends up as downed woody material when it is knocked over during events like a windstorm. The different times for standing snags, downed live trees, and standing dead trees (similar to standing snags except the majority of branches are still present) to fall and decompose are shown in Figure 12. We can use this type of information to determine the amount of wood to leave on-site after harvesting. Currently, most loggers in the Bristol area cut the tree tops off and leave them on-site to decompose. Small stems between 4" and 10" in diameter are also left on-site depending on the logger and site conditions. As a market for wood energy develops more of this wood will likely be taken out of the forest and turned into woodchips.

Figure 12. Dynamics of Wood Decomposition in Northern Hardwood Forests

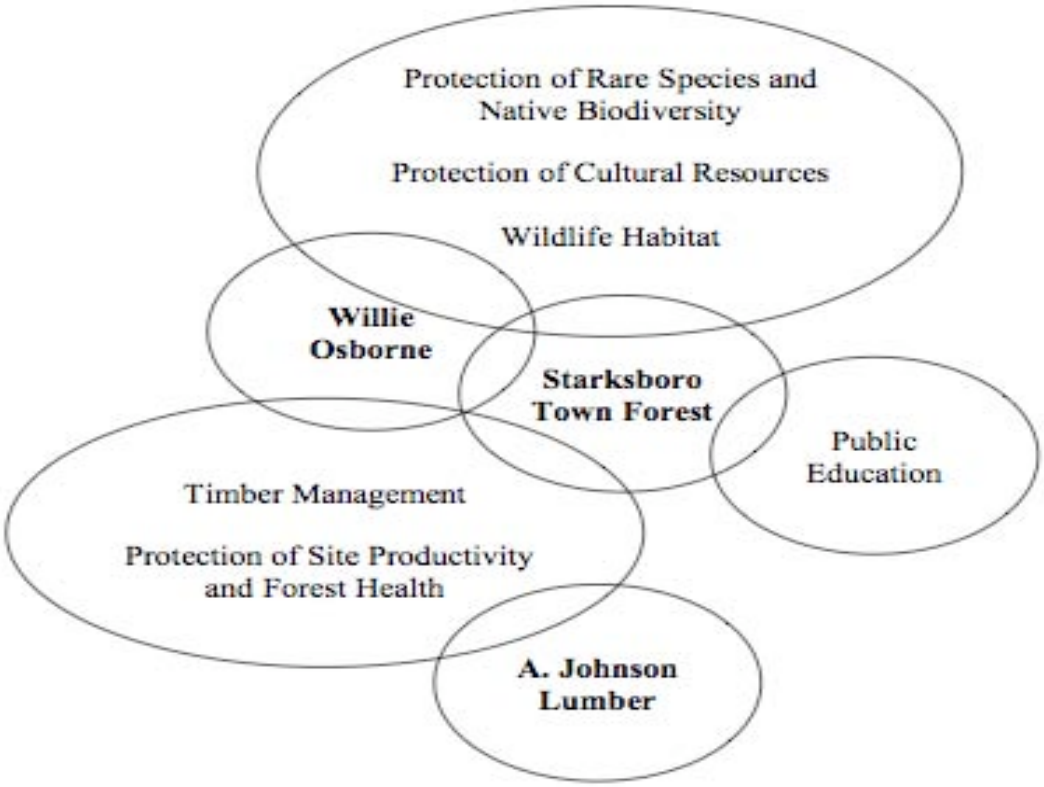


Forest values

Understanding why different people value the forest will help provide a basis for determining what goods and services should be protected and sustained when wood is harvested. For example, some of the landowners I talked with in the Mt. Abe community value their forest for different reasons. Figure 13 shows the main management goals for each of these landowners. Management goals are one indication of why someone values their forest. The three landowners I spoke with shared the common goal of producing high quality timber and protecting site productivity and forest health. In addition, the residents of Starksboro Town Forest and Willy Osborne want to manage their forest for non-timber benefits like biodiversity, cultural resources and education.

It is important to recognize that the values represented above are economic, ecological and social in nature. Timber management oftentimes, especially in the case of A. Johnson Lumber, represents an economic value. Native biodiversity and wildlife habitat can be considered ecological values and public education and cultural resources are social values.

Figure 13. Mt. Abe Community Landowners Management Goals



Timescale
It is hard to think in terms of our own lifetime let alone the lifespan of trees or future generations. Are we interested in ensuring high quality timber, enhanced site productivity, and healthy forests for another 10 years, 100 years or forever? Stephen Taylor, family forest owner, is currently managing his land so that when his son grows up he will have a healthy, beautiful, and productive forest to inherit. Mt. Abe students want environmentally friendly harvesting practices so that future generations of Mt. Abe students can experience the beautiful Green Mountains while also heating their school. Certainly in the next 20-30 years, over the lifespan of a typical woodchip boiler, there will be significant challenges to harvesting wood in ways that conserve forest health and other values. Section V provides some examples of how a community could harvest wood in ways that conserve forest health.

How will the woodchips be produced?

There are two options for where the woodchips are produced- in the woods or at a separate facility. If the woodchips are produced in the woods there a number of challenges, mainly that a large enough volume (28 tons/load) of wood needs to be removed to make it worth the trip, the landing needs to be about an acre in size[37], and the roads need to be strong enough to handle a large tractor trailer. This is how chips are produced from land clearing operations or on large tracts of forestland but is not feasible in the Starksboro Town Forest and most small family forest owner properties. In this situation the wood needs to be chipped at a separate facility.[38] Currently Vermont's schools source their woodchips from sawmills like A. Johnson Lumber and woodchip contractors like Jim Lathrop, where the woodchips are produced at a separate facility-- either a sawmill or log yard.

Challenges to sourcing woodchips from sawmills
A. Johnson was one of the first suppliers of woodchips to Vermont's public schools. The woodchips are a by-product of the manufacturing of wood products like construction lumber therefore the amount of woodchips produced is directly related to the amount of wood that is processed. There are only about 30 sawmills in Vermont that process enough volume to produce chips, 6 of them regularly supply woodchips for the schools.[39] Yet overseas competition has negatively impacted the wood products industry in Vermont. The number of sawmills in Vermont has decreased from 182 sawmills in 1997 to about 70 today[40]. The ability of sawmills to continue to supply schools with woodchips is uncertain. In addition, about 70% of the chips produced at A. Johnson go to International Paper (IP) and 30% go to Vermont schools[41], therefore the schools rely on large consumers, like Burlington Electric Department and International Paper to support the infrastructure (logging equipment to harvest the wood, trucks to transport the logs, tractor trailers to transport chips, chipping machines and storage areas) needed to produce woodchips.

Challenges to sourcing woodchips from woodchip contractors
The Lathrop Bandmill was one of the first mills along with A. Johnson to supply Vermont's schools with woodchips. After a fire burned down one of two sawmills in 2003 Jim Lathrop decided to go into the land clearing and chipping business. Jim

[37] R. Wilcox, personal communication, July 5, 2008.
[38] C. Olsen, personal communication, June 25, 2007.
[39] Sherman, 2007.
[40] Vermont Department of Forests, Parks and Recreation, 2005.
[41] W. Sayre, personal communication, July 9, 2007

saw a significant business opportunity in producing woodchips and was able to use the existing infrastructure of the remaining sawmill as a storage area. There is plenty of room in the yard to store logs. Now that Jim is a woodchip contractor, the amount of woodchips he is able to produce is no longer dependent on the volume of wood processed by the mill. Instead it is related to the amount of low quality wood Jim is able to remove during land clearing and forest harvesting operations. Jim sells sawlogs from land clearing jobs to other mills like A. Johnson and does his own chipping. Most of the chips go to Burlington Electric Department (BED) as whole tree chips and some go to International Paper (IP) as fuel chips for their boiler. Jim produces bole chips for Vermont's schools. In this scenario, the schools still rely on large consumers, like BED and IP to support the infrastructure needed to produce woodchips. With more public schools and Middlebury College switching to wood for heat, Jim estimates he may be supplying 10,000 tons of bole chips a year in the near future. With the construction of smaller heating facilities, there will be an increase in competition for higher quality bole and mill residue chips, which should eventually induce more chipping contractors to enter the business.

Community Wood Energy Meeting

The culmination of the first phase of the Mt. Abe Community Wood Energy Pilot Project was a Community Wood Energy Meeting where I presented what I heard over the course of the summer in terms of the challenges and opportunities to supplying Mt. Abe with woodchips. Twenty-one community residents gathered at Mt. Abe Union High School during the evening of August 2nd to celebrate a successful first year of operation of Mt. Abe's woodchip boiler, acknowledge what it takes to supply Mt. Abe with woodchips, and to explore the potential for sourcing the woodchips from local, sustainably-managed, forests. Talking with the players involved in fueling your school does more than increase community member's understanding of how woodchips get to your school. It also celebrates who is involved and provides community members with an opportunity to share their stories and express their concerns.

Robert Turner (left) and Mischul Brownstone chat after the Community Wood Energy Meeting held at Mt. Abe Union High School.

V. Building a Community-Accepted Procurement Standard

Developing a procurement standard that addresses ecological, social and economic aspects of woodchip sourcing

A procurement standard provides criteria for purchasing a product, in this case woodchips. A woodchip procurement standard can be developed to define how the wood is harvested, by whom, and from where. For example, Burlington Electric Department's (BED) procurement standard dictates that they will not take wood harvested from a deer yard, wetland, or Indiana bat habitat. BED has professional foresters on staff that go out in the field to verify where the wood comes from and that it is harvested in compliance with those three criteria. Mt. Abe's woodchips are harvested right from land within a 70-mile radius of their school, therefore there is an amazing opportunity for the Mt. Abe community, unlike most wood product's consumers, to see the forest management practices and to develop their own local procurement standard.

Working with local producers to procure materials for their school is not a foreign idea to some Vermont schools. In 2006 the Burlington School District procured over 2,600 pounds of local tomatoes, zucchini and carrots to be used in school meals through the work of the Burlington School Food Project (BSFP). The BSFP is a community-based initiative to find "ways to introduce healthier, local produce into the schools and teach children about nutrition and introduce them to the farmers next door." Some key components of BSFP that can be applied to introducing woodchips that are sustainable, efficient, local, and fair into a school's fuel supply include:

- Collaboration of a diverse group of organizations involved in public school education, production, and environmental education;
- Introduction of new local foods gradually over time;
- Approval of school board members for the participation of teachers in the development of curriculum integrating food, farm and nutrition with traditional disciplines;
- Introduction of legislation offering mini-grants to increase local products in school cafeterias, expand educational opportunities, and support the infrastructure needed to process local foods in school cafeterias;
- Assessment of the challenges to including local produce in school cafeterias; and
- Development and implementation of an annual School Food Action Plan.

Dana Hudson, the Northeast Regional Lead for the National Farm to School Program, points out that "Long-term change in the school food system requires more than just buying local lettuce and putting it on the cafeteria menu. Classroom, cafeteria, and community all need to be linked together to make an impact. It's important to have a wide variety of stakeholders committed to change and moving in the same direction."[42]

Likewise a diverse group of landowners, foresters, loggers, woodchip producers, school children and teachers will ideally continue to participate and collaborate in the planning and development of a procurement standard for woodchips. Using a participatory approach builds the trust and the consensus needed to create long-term solutions to problems like fueling one's

[42] Stafford, 2006.

school with a sustainable supply of woodchips.

The process that the town of Starksboro went through to develop the town forest management plan provides a good model for engaging community members in planning for how they want their woodchips to be procured. As part of the management plan development process, Starksboro held public meetings, surveyed residents for input, and led tours of the forest. Public forests, especially town forests, provide a good place for demonstrating how woodchips could be sourced using careful forest management and for "engaging a different set of people that would be attracted to other outreach activities like a group snowshoeing excursion."[43] Town forests in northern New England developed strategies for involving community members in planning for forest resources like hosting regular events to get people into the woods and documenting community member's stories.[44] Group excursions in town-owned forestland offer great opportunities for beginning conversations about fueling one's school with wood. Caroline Camara's students started their research for the Vermont Envirothon by spending an April day in the town forest with Robert Turner, and Chris Olson, Addison county forester. Challenges and opportunities to harvesting woodchips in the Starksboro Town Forest are outlined in Toolbox 3.

The goods and services provided by our forests are connected to multiple values, as shown in Figure 13. Therefore, a procurement standard ideally not only ensures ecological values are protected but also ensures social and economic sustainability. David provides his community with a framework for developing a woodchip procurement standard where woodchips are harvested in ways that are **S**ustainable, **E**fficient, **L**ocal and **F**air.

The next section presents the SELF framework and offers a guide for how the Mt. Abe community could work towards a SELF standard. A good place to start in developing a community-accepted procurement standard is to determine what ecological, social, and economic values your community wants to maintain when harvesting wood. Section IV discussed some reasons why people value their forests.

Fuels for Schools

At Mt. Abe Union High School, students continue to be involved in addressing the energy needs of their school. As part of their research for the Vermont Envirothon, Caroline Camara's students discovered a number of potential benefits to a local, reliable supply of woodchips sourced from healthy forests—

- keeping money local;
- improving forest health;
- creating local jobs;
- decreasing carbon dioxide emissions;
- decreasing transportation costs.

There are many other opportunities for involving students. Many school systems today are incorporating place-based educational opportunities into their curriculum. Mt. Abe's Vermont Envirothon project is one example of place-based education, where students gain an understanding of the economic and natural resource issues of where they live.

[43] R. Turner, personal communication, July 9, 2007.
[44] NCFCNFR, 2003.

TOOLBOX 3

Starksboro Town Forest- Demonstrating Careful Forest Management

Even though small in size, municipal forests play a strong role in educating the public about forestry and ecology, and David Brynn sees town forests as "an opportunity to demonstrate careful stewardship." At 287 acres, Starksboro Town Forest represents only a small fraction of the public land in the five-town area. The Starksboro Conservation Commission has the responsibility of caring for the town forest. In the opinion of Robert Turner, one of the Starksboro CC's founding members, the town forest can be used "as a vehicle to connect people to good forestry and connect the working landscape to the community." Over the course of the summer I worked with Robert and other members of the Starksboro CC to identify challenges and opportunities to including small public landowners, like Starksboro, in sourcing woodchips for their community's high school. There are a number of opportunities including:

a. The town forest has a certified forest management plan

In 2000, the Conservation Commission formed a Forest Advisory Board that worked with VFF and interested residents to develop the town's forest management plan. The management plan serves as a guide to make sure that any harvesting is done within the boundaries of sustainable management. Some of the town forest management objectives include education, protection of wildlife habitat, and high quality timber management, which are compatible with removing wood to fuel Mt. Abe. Robert sees community wood energy as a "vehicle to bring people in closer connection with the land and community."

b. Starksboro has already committed wood to other town projects

The Starksboro Town Forest has a history of harvesting, from firewood harvested in the 1980's to a recent harvest that generated $11,000, which was used by the town for other projects.

c. There is an active and engaged conservation commission

In the last couple of years 9 new members made up of people with backgrounds in health care, teaching, and conservation have joined the conservation commission.

Some of the challenges include:

a. Market price for woodchips

Similar to family forests, there is limited sawtimber value, small size, and challenging access to the town forest, which makes the removal of low quality wood difficult at the current market price for woodchips.

b. Harvesting wood is not a current priority of the Conservation Commission

Conservation Commission members are very concerned about development, therefore they are focusing their efforts on working with the town's planning commission to do a natural resource inventory to be used in land use planning. Some members were shocked by the amount of wood consumed by Mt. Abe and were more concerned about increasing energy efficiency.

c. There are many stakeholders

Unlike family forests, where there are often a small number of owners, town forests have a number of stakeholders with different opinions about how the town forest should be used. Ensuring that the forest is managed for the public benefit can require an extensive process that involves organizing regular events to get people into the forest, recruiting community members to be involved in planning, soliciting feedback, and listening to community members concerns.

Sustainable – The S in SELF

How will your community know if the wood is sustainably produced?

A number of different standards have been developed to ensure that wood is harvested in ways that protect ecological values. The Forest Guild[45] designed an incremental approach to assure that public values are protected when wood is harvested. I adapted this framework to illustrate how a woodchip procurement standard can be developed to ensure increasing levels of protection of ecological, economic and social values.

Levels 1 to 5 are based on existing standards. Level 6 addresses how the Mt. Abe community could develop a standard that encompasses a diverse grouping of ecological, economic and social factors.

Level 1 – Procure wood harvested in compliance with local, state, and federal laws

There are local, state and federal laws that regulate forestry activities. For example, the Vermont Department of Forests, Parks and Recreation regulates clearcutting on 40 acres or more. Forestry activities are also regulated under Vermont's Water Quality Statutes, the Federal Water Pollution Control Act, and the federal Endangered Species Act. Oftentimes, laws governing forestry only punish "egregious violations of forestry practices," like damage to water quality, rare species, and extensive cutting, but do not assure that many common forest values are conserved.[46] In terms of worker safety, the U.S. Department of Labor Occupational Safety and Health Administration developed a number of standards to protect loggers from exposure to hazards while on the job.

Level 2 – Procure wood from land where a professional forester was used to design the road layout and plan the harvest of trees

There are two types of professional status-licenses administered by states and certification awarded by professional forester associations. Some states, like Connecticut and Massachusetts, have state programs to license foresters. Licensing does not require a standard code of conduct for foresters related to forest management therefore, philosophies and practices vary between individuals.[47] In some states, like Vermont, anyone can call themselves a forester regardless of their training and knowledge.

Similar to lawyers and doctors, foresters join professional associations for sharing knowledge and networking. Professional organizations like the Society of American Foresters (SAF), the Forest Guild and the Association of Consultant Foresters differ in their principles, code of ethics, and policy statements. In order to be a SAF certified forester, one needs to have taken a required set of courses from an approved institution to be properly trained in forest management. It is important to investigate the principles, policies and advocacy of each of these organizations to understand what membership or certification requires.[48]

Level 3 – Procure wood from land where harvesting was conducted using Best Management Practices

Many states have voluntary minimal standards and practices, oftentimes called Best Management Practices (BMPs), for protecting soil and water quality when harvesting wood. Many foresters in the Mt. Abe community believe that protecting soil and water quality was important to maintaining and enhancing forest health and site productivity, therefore many follow the Acceptable Management Practices for Maintaining Water Quality on Logging Jobs

[45] Perschel, 2006.
[46] Ibid.
[47] Ibid.
[48] Ibid.

in Vermont[49]. Best Management Practices do not generally address other ecological values like the protection of biodiversity, forest health and productivity, and the contribution of forests to global carbon cycles.

Level 4 – Procure wood from land with a long-term management plan using commonly agreed upon practices of careful forest management

In order to rely on common definitions of careful forest management it is important to talk to foresters and loggers in your community to gain an understanding of how the forest harvesting is conducted and what standards are commonly used. For example, most loggers in the Mt. Abe community refrain from logging when the ground is wet in order to prevent rutting and damage to water quality.

Level 5 – Procure wood from land certified by forest management certification systems

There are a number of forest management certification systems available, but "they vary in their ecological principles, standards and degree of impartiality."[50] Within the Mt. Abe community, some third-party certification systems include the Forest Stewardship Council and the Sustainable Forestry Initiative. The American Tree Farm Association is another program that offers non-third party certification. Many foresters were frustrated with the idea that forests that have been certified as sustainable are the only well-managed forests. For some, certification has not changed the way they practice forestry but has only changed the level of documentation and reporting. Certification can be expensive and therefore it is typically not pursued by a majority of small family forest owners.

Level 6 - Procure wood from land using locally-based standards

Understanding why different people value the forest will help provide a basis for determining what goods and services should be protected and sustained when wood is harvested. Certain teachers, students and members of the Mt. Abe community are concerned about conserving forest health. Forest health is just one of the ecological values of forest ecosystems. An international community of forest professionals met in Montreal, Canada, in 1993 to develop comprehensive guidelines for measuring sustainable forest management. The group came up with six scientifically-based ecological values (criteria) that need to be maintained when harvesting wood, which are listed in the first column in Table 4. Yet, how does a community know whether these values are being protected? In response to this concern, the community of forestry professionals also developed actual ways to measure those different values (indicators.) Together, they are thus referred to as The Montreal Process Criteria and Indicators. An example of how harvesting wood could impact this value is listed in the second column of Table 4.

Vermont Family Forest (VFF) has developed a set of local standards, the Vermont Family Forest Management Checklist[51], which adapts the criteria outlined in the Montreal Process Criteria and Indicators to a number of natural community types found in Vermont. This checklist provides local guidelines that the Mt. Abe community can use to limit the impacts of harvesting wood on the ecological values of the forest. Examples of standards to limit the impacts of wood harvesting are provided in column three of Table 4. Other vegetation management guidelines are listed in the resources section.

[49] Vermont Department of Forests, Parks and Recreation, 1987.
[50] Perschel, 2006.
[51] VFF, 2006.

Table 4. Examples of How to Protect the Ecological Health of the Forest When Harvesting Wood for Woodchips

Ecological Criteria	*Example of how harvesting wood could affect these ecological values?*	*Example of what can be done to limit the impacts of harvesting?*
The conservation of biological diversity	The endangered Indiana bat spends its summers in the Champlain Valley of Vermont. Scientific studies have shown that the bat prefers to roost in tall, large diameter trees, located typically at low elevations and close to water (Watrous et al., 2006.) Harvesting wood could potentially eliminate Indiana bat habitat.	Keep at least 6 cavity, snag, and/or decadent, living trees per acre on average, with one exceeding 18 inches diameter breast height (DBH) and 3 exceeding 16 inches DBH.
Maintenance of the productive capacity of forest ecosystems Maintenance of forest ecosystem health and vitality	Nutrients are essential for plant growth and ecosystem function. About 70% of all nutrients in trees are stored in the leaves and smaller branches while the remainder are stored in the stem and larger branches (Irland and Cline, 1999.) Therefore, the ability of a forest to recover is related to the amount of wood left on-site.	Leave all materials that are less than 3 inches in diameter on-site. Biological legacies of the forest community -- including coarse dead wood, logs, and snags; trees that are large, living, and old; buried seeds; soil organic matter; invertebrates; sprouting plants; and mycorrhizal fungi -- should be protected to aid in post-harvest recovery.
Conservation and maintenance of soil and water resources	Heavy machinery in the woods can lead to soil compaction and erosion. Soil that leaves the site can enter streams and other water bodies. Increased amounts of sediment in streams can decrease the amount of dissolved oxygen and increase temperatures, making it difficult for fish to survive. In addition, soil that enters streams creates cloudy water for swimming.	Protective strips should be maintained between the road network and surface waters according to the Vermont Acceptable Management Practices for Maintaining Water Quality on Logging Jobs in Vermont. Truck roads, skid trails, and log landings should be built and maintained in compliance with the standards contained in the Vermont AMPs. Tree felling should be avoided on slopes exceeding 60%.
Maintenance of forest contribution to global carbon cycles	When you harvest a tree and burn it for fuel you release the carbon that was stored in the tree into the atmosphere. At a time when increases in carbon dioxide in the atmosphere are leading to changes in climate, this is a concern. In order to ensure that harvesting trees for wood energy does not increase the concentrations of carbon in the atmosphere, you have to make sure that the amount of wood harvested and burned is less than the amount that the forest is able to grow back within a reasonable timeframe, which is typically before the next removal.	Average annual removal of woody biomass from the site should not exceed 70% of the average annual growth. Grow the largest trees and use the longest rotations possible within site and log quality limitations. Intermediate treatments should generally raise the average (mean) diameter of the residual dominant and co-dominant trees of the forest while improving timber quality.

Guaranteeing wood is harvested in ways that conserve the social and economic benefits of the forest to meet societal needs

What became apparent in talking with the landowners and foresters is that careful forest management does not just protect ecological values but also addresses economic and social issues. John Anderson, owner of Canopy Log Yard, emphasized that definitions of sustainability need to include economic sustainability. John commented, "you have to be able to pay the people who do the work so that they make a decent living." Sustainability also includes using the forest for non-timber benefits like hiking, nature study and aesthetic values, and could be addressed by conserving what David describes as "special places-- places of beauty and those possessing spiritual values." Table 5 lists a number of socio-economic values, examples of how harvesting woodchips could affect those values and suggestions for how to limit the impacts of harvesting wood on those values.

Table 5. Examples of How to Protect Socioeconomic Values When Harvesting Wood for Woodchips

Socio-economic values	***Example of how harvesting wood for woodchips could affect these values?***	***What can be done to limit the impacts of harvesting on these values?***
Provide employment opportunities for a diversity of people	There are a number of people that are employed through forestry – loggers, foresters, sawmill workers and woodchip producers. Providing woodchips for heat is another employment opportunity. The increased mechanization of forest harvesting increases efficiency, can lower insurance costs and keeps companies competitive. But it also replaces human labor.	Balance opportunities for human labor with opportunities for mechanized forest work.
Support many different landowners and ownership objectives	A diversity of landowners and ownership objectives supports a wide range of economic opportunities.	Create a diverse supply base representative of the land ownership and range of objectives.
Protection of cultural resources	In New England stone walls, foundations from abandoned homesteads, stone piles, wolf trees, and apple trees are all relics of past land use. The movement of machinery and harvesting of trees whose roots are intertwined in many of these features could cause damage.	Limit harvesting in areas where cultural features occur.

(Table 5 cont.)		
Socio-economic values	***Example of how harvesting wood for woodchips could affect these values?***	***What can be done to limit the impacts of harvesting on these values?***
Enhancement of scenic beauty and places of peace and solitude	Harvesting wood can disturb the forest floor and make the area unsightly for a year or two after harvest. In addition, removal of trees can change the light levels and distribution of vegetation, which could have been what made a spot special.	Activities to protect soil and water quality, like avoiding spring harvests and/or rutting that extends beyond the A soil horizon, can preserve scenic beauty. Certain areas that have scenic or spiritual value may need to be protected from harvesting.
Enhancement of recreational activities	Walking, cross-country skiing, hiking, and bird watching are all activities that are enjoyed by recreationalists. While trees oftentimes need to be removed to create trails, harvesting can alter scenic views.	Provide scenic strips of vegetation along hiking trails where opening up the canopy is not desired. Strategically plan harvests to occur in areas that will open up scenic views.
Enhancement of high quality educational opportunities	There are significant educational opportunities in harvesting wood for one's local school.	Involve students in the planning of forest harvesting and post-harvest monitoring. Provide opportunities for adults and children to learn the skills, information, values and attitudes necessary to fulfill their potential as community members within or outside the region.

The socio-economic values presented were selected based on conversations with Mt. Abe community members and criteria developed as part of the Northern Forest Wealth Index (Northern Forest Center, 2000).

Efficiency – the E in SELF

How will your community know if the wood is efficiently used?
When I surveyed the Starksboro Town Forest with a couple members of the Conservation Commission (CC), they were shocked to find out that their school burned about 360 cords of wood each year. Pete, a new CC member, wondered if it was really necessary to use 360 cords to heat Mt. Abe. In sharing the facts about Mt. Abe energy usage with other community members, I received a similar reaction - does Mt. Abe need to consume 360 cords of wood annually? Stephen Taylor, who worked as an energy specialist with the Vermont School Energy Management Program, cautioned against just focusing on the cost of wood and oil and emphasized the need to address conservation and efficiency.

In order, as David asserts, "to squeeze out as many BTUs as possible in actual service," it will be important for the Mt. Abe community to address the efficiency of the fuel (woodchip), the efficiency of the boiler and other heating system parts, and how well the school building is insulated and ventilated.

What should be considered in addressing fuel efficiency?
Commercial woodchip systems with automated fuel delivery, like Mt. Abe's system, is much more efficient than home heating systems[52]. A woodchip boiler's efficiency varies depending on the species and size of the particle but is most affected by the moisture content.[53] During the burning of woodchips, moisture evaporates and absorbs energy and then escapes up the stack as water vapor. Therefore, the lower the moisture content, the higher the efficiency. Many small-scale woodchip boilers like the one at Mt. Abe require hardwood chips with 35-40% moisture content to burn most efficiently. Students can monitor the average moisture content of the chips they are receiving to ensure optimal efficiency, which provides a significant educational opportunity.

What should be considered in addressing the efficiency of the woodchip heating system?
The efficiency of the woodchip heating system itself depends on whether it is well maintained, the amount of excess air, and whether the system is operating at full capacity. If the system is not working near full capacity, then only a portion of the potential energy is released and pollutants like carbon monoxide and particulates may be produced.[54] Therefore, the schools only use wood for heat during the cold months of October through late April when they can operate at full capacity. Other times of the year they use fuel oil. Yet, what is the tradeoff between the production of more particulates by burning wood during the non-peak season and burning oil produced thousands of miles away? What level of efficiency is Mt. Abe willing to accept if it means decreased reliance on fossil fuels?

How does insulation and ventilation affect efficiency?
Mt. Abe Union High School was built in 1968 and based on the following figures, requires more wood to heat the same amount of space as a residential home. In a fuel assessment conducted by the Vermont Department of Public Service, residents who used wood as their primary heating fuel burned 4.8 cords of wood during the 1997-1998 heating season. In one heating season, Mt. Abe Union High School burns the equivalent of 75 Vermont households worth of wood.[55] Assuming an average house is 2000 ft^2, each cord of wood heats 417 ft^2 of residential space whereas the Mt. Abe boiler heats only 375 ft^2 of space. Differences in insulation and

[52] A. Sherman, personal communication, April 16, 2008.
[53] Maker, 2004.
[54] Maker, 2004.
[55] DPS, 2000.

ventilation most likely cause the difference in efficiency.

Insulation helps keep the warm heat created by burning woodchips from escaping. Leaks or cracks in the heating system or building can lead to loss of heat. Schools are ventilated to reduce moisture build up and to keep fresh air circulating throughout the school. If the ventilation system is not working properly, it can lead to harmful indoor air or release too much heat. In order to improve efficiency, ventilation and insulation may need to be addressed.

What can your community do to make sure the woodchips are efficiently used?

1 – Make basic energy efficiency improvements.
Most schools had an energy audit done when the woodchip heating system feasibility study was conducted. Jeff Forward, energy consultant recommends using the money saved by switching to woodchips to make energy efficiency improvements.

2 – Make sure that the woodchip heating system, including the boiler and heat transportation pipes, are properly cleaned, well maintained, and serviced according to the manufacturer's guidelines.

3 - Make sure that the school is burning the right kind of chips for your woodchip boiler within the appropriate range for moisture content that will ensure optimum efficiency.

Local – the L in SELF

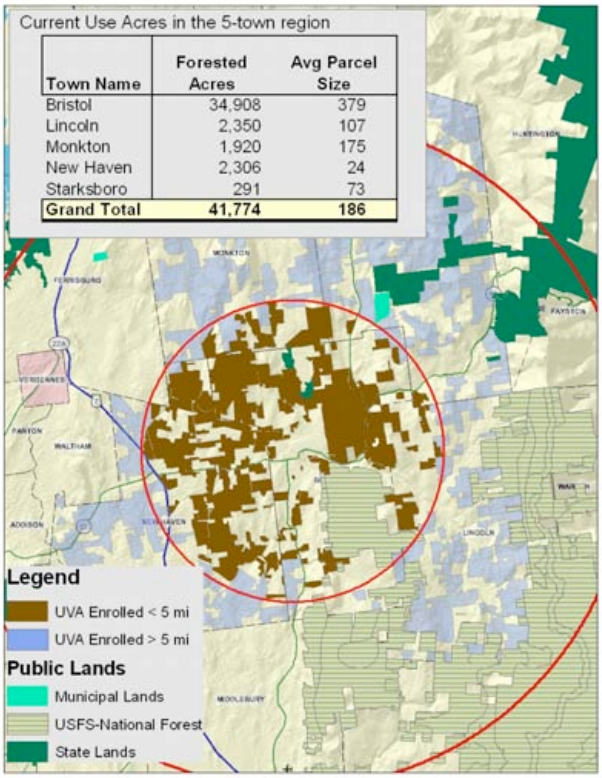
How will your community know if the wood is locally sourced?

Every Wednesday afternoon from June to October the Bristol town green hums with activity as farmer's market customers drool over apple horseradish relishes, juicy blueberries, and ripe red tomatoes. Farmer's markets have grown in popularity as more people shift from being omnivores—eating anything from anywhere—to what more and more Vermonters are calling localvores—eating food grown as close to home as possible. David presents his community with a similar localvore challenge: to consume not just the food to eat but the energy for heat from local producers. Sourcing woodchips locally provides a chance for Mt. Abe students to understand and inform others how a woodchip gets from the forest to the storage bin. The L in SELF also reduces the use of fossil fuels and reduces transportation costs, which Bill Sayre, manager of A. Johnson Lumber, says is the major cost for low value goods like woodchips. Sourcing woodchips locally continues to support local industries like Jim Lathrop's business or A. Johnson Lumber, forest workers like Bill Torrey, large local landowners like A. Johnson Lumber and Lathrop, and could eventually support small local landowners like Willy Osborn and Stephen Taylor.

So what does it take to meet David's local energy challenge-- to "know the place where our wood was grown and harvested and who produced it for us." The first step is to determine how many acres of managed forest are needed to supply 900 tons or 360 cords of wood to Mt. Abe each year. Using reasonable assumptions, 1,500 acres of managed forest in Vermont could provide 360 cords of wood annually without harvesting above the annual growth[56].

Within just 5 fuel miles of Mt. Abe Union High School (inner red circle of Figure 13), there are about 42,000 acres of private land enrolled in the UVA program (brown parcels), only 4% of which would total more than 1500 acres, as shown in Figure 14[57]. Plenty of land within the five towns alone can fuel Mt. Abe with wood.

Figure 14. Forestland Enrolled in Vermont's Use Value Appraisal (UVA) Program



[56] Figure calculated using the following assumptions: 2.24% annual forest growth rate, 65% of the net annual growth is of low quality wood, 50% of the net annual low grade wood removed goes to firewood and pulpwood and 50% to woodchips (Sherman, 2007.)

[57] Map produced by Robert Turner of R.J. Turner Co.

Fair – the F in SELF

Does the sourcing of wood from local woodlands equitably support forest workers and local industries?
If supplying Mt. Abe with woodchips is to be done fairly then, as David says, "the landowners, loggers, truckers, processors, and customers need to be taken care of."

Who is not included?
As was mentioned earlier, the current system does not include small family forest owners in the sourcing of wood for Mt. Abe. Including small family forest owners is not just a matter of fairness but also diversifies the supply base. For example, in Addison County, when the U.S. Forest Service reduced the amount of wood harvested from the Green Mountain National Forest, the wood supply significantly decreased. Not only sawmills like A. Johnson Lumber and the Claire Lathrop Bandmill were affected, but the effects rippled throughout the industry and put strain on cabinet and furniture makers.

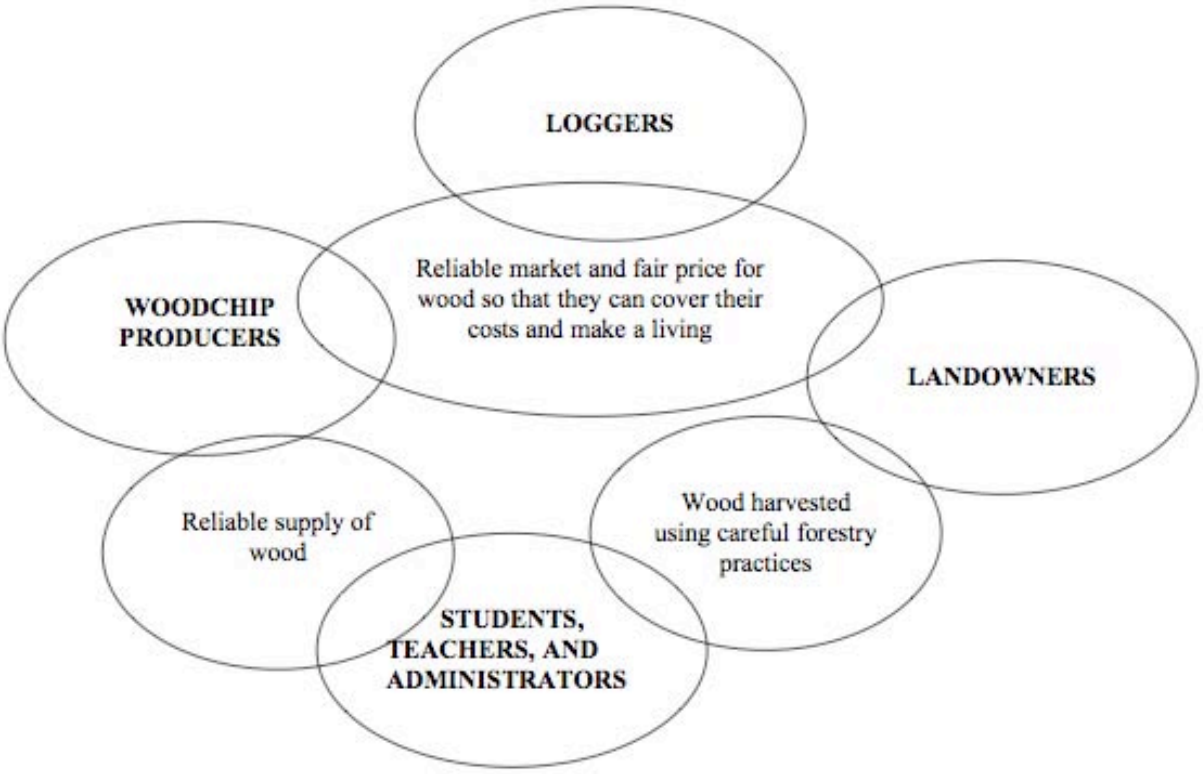
What does each of these groups need in order to be "taken care of"?
Table 5 summarizes the needs of all individuals with whom I spoke in each of the different groups of players—landowners, loggers, woodchip producers and students, teachers and school administrators.

Table 5. Each player's needs related to ensuring a reliable woodchip supply

Landowners	Loggers	Woodchip Producers	Students, Teachers and School Administrators
Fair price for their wood that helps them to cover the costs of good forest management, including the removal of low quality wood to improve the value of standing timber	Stable price and reliable market for their logs	Stable price and reliable market for their lumber and wood products	Reliable supply and cost effective price for woodchips
Guarantee that their woods aren't going to be damaged	Affordable health insurance	Reliable and cost effective supply of wood	Renewable energy harvested in ways that conserve forest health
	Access to capital for new equipment	Public education about the benefits of good forest management and the wood products industry	Educational opportunities

As shown in Figure 14, the loggers, landowners and woodchip producers all hope for a stable price and a reliable market for their wood. They all desire a fair price so that the can cover their operating costs. The loggers and woodchip producers and some, but not all landowners, depend on that fair price to make a living. Mt. Abe Union High School burns about 900 tons of woodchips/year, which, when combined with other institutional customers in the area, can provide a reliable market for woodchips. As one can see, if one of these players is removed then wood does not flow to Mt. Abe.

Figure 14. Where is the common ground?



How are the costs and benefits currently distributed?
In an ideal world the costs and benefits would be fairly distributed according to effort and risk among the landowners, loggers, truckers, woodchip producers and taxpayers in the 5-towns. Currently the Mt. Abe community is benefiting the most by receiving a reliable supply of woodchips for their high school at a cheap price equivalent to $0.64/gallon of heating oil.

What would it take for the costs and benefits to be more equally distributed?
The residents of Mt. Abe have the choice, as the consumer, to pay a fair price for the wood that heats their school. Mt. Abe students, teachers and administrators, and the woodchip producers would like a reliable supply of wood. It is the loggers and landowners who supply the wood that feeds the mill, goes through the chipper and heats the school. The health of the forest is dependant upon their careful management.

What can your community do to make sure the woodchips are fairly procured?

1 – Ensure forest workers earn a livable wage.

2 – Provide loggers, landowners and woodchip producers with a reliable market for their wood.

3 – Include a diverse group of landowners in supplying the school with woodchips.

4 – Protect forest worker safety by making sure that Occupational Health and Safety Administration standards are observed and that there is worker compensation in the event of an accident.

VI. Transitioning Towards a SELF Woodchip

What would it cost for Mt. Abe to ensure a reliable supply of chips sourced in ways that conserve forest health?

In the current system, the removal of wood for chips is dependent upon the global sawtimber market because the removal of sawtimber pays for the lower quality wood to be removed. In addition, the production of woodchips for small customers like Mt. Abe is also dependant on larger customers like Burlington Electric Department and International Paper. What happens if the International Paper plant in Ticonderoga, New York, or Burlington Electric Department shuts down? Small users, like schools, will not support the investment in the chipping machinery.

What would it take for the low quality wood to pay its way out of the woods? Currently, when wood is sourced from land clearing operations, the developer gives the wood to Jim and Jim in return clears the land at no charge. Jim sells the high quality wood to a sawmill and then chips the low quality wood and sells it to Burlington Electric Department, International Paper or public schools like Mt. Abe. Jim is able to remove low quality wood from large tracts of land but how much more would Jim have to charge Mt. Abe to pay loggers who use the conventional system of a chainsaw and skidder to work in small family forests?

Table 6 provides an estimate of what all the players would need in order to cover their costs and provide incentives for careful forest management that conserves forest health. On most forest properties, annual road maintenance and extra measures to protect soil and water quality during harvesting are not done. These two activities can reduce the impacts of putting metal machinery in the woods. The landowner and logger would be compensated for taking extra measures to ensure careful management. A forester is paid to mark trees, make sure ecological values are protected, and administer the timber sale. Transportation and chipping costs are also included in Table 6.

Table 6. Estimated Price for a SELF Woodchip

Type of Cost	Cost ($/ton)	References
Price paid to the landowner	$20	R. Perschel, personal communication, May 14, 2008
Marking and sale administration by forester	$5	R. Perschel, personal communication, May 14, 2008
Logging	$40	VFF, 2004; W. Torrey, personal communication, June 26, 2007, C. Klepz, personal communication June 25, 2007
Transportation to the woodchip production facility	$5	W. Sayre, personal communication, July 9, 2007; P. Fournier, personal communication, June 22, 2007
Chipping	$5	J. Lathrop, personal communication, July 26, 2007
Transportation to the school	$5	W. Sayre, personal communication, July 9, 2007; P. Fournier, personal communication, June 22, 2007
Total costs	**$80**	
Note: The cost to store woodchips and loss of value while they are being stored is not included in this estimate. Woodchips are priced based on their weight ($/ton). As woodchips dry they decrease in weight and therefore decrease in value for the woodchip producer.		

In 2008, if Mt. Abe agreed to pay $80/ton for woodchips, which is equivalent to just $1.60/gallon of heating oil, then family forest owners could potentially be included in sourcing wood for Mt. Abe. Landowners would be paid a fair price for good forest management, loggers and foresters would be paid a liveable wage, woodchip producers would have a cost effective price, and the Mt. Abe community would still be paying far less than the current cost of heating oil.

How could SELF woodchips be purchased?

In 2006 Mt. Abe signed a two-year woodchip supply agreement with Jim Lathrop. A procurement standard could be incorporated into future supply contracts. In 2006 Mt. Abe paid $32/ton for woodchips delivered to their storage bin. Jim harvests the wood, chips the wood and delivers the woodchips directly to the school. Similar to pre-buying oil and having the company fill one's oil tank, another option is to pre-buy the logs, store them at the school, and then pay Jim to come and chip them when the school needs fuel. In this scenario you would have two contracts-- one to buy the logs, which could be directly from a logger, and one to chip the logs.[58]

[58] A. Sherman, personal communication, April 16, 2008.

What benefits are received by supporting community members?

Starksboro, Vermont is one of those towns, like the other towns in the Mt. Abe community, where you need two hands to work and one hand to wave; a community where chicken soup shows up on your doorstep the minute you come down with the flu. According to Susan Jeffries, Starksboro Selectboard member, "Starksboro is a really unique community that has a real core of volunteers." When the elementary school's roof was in drastic need of repair, residents came out of the woodwork and replaced it in two days. In 1987, the Starksboro public library needed some new shelving so a collective effort of volunteers harvested maple from the town forest and used local business and labor to build the shelves. The tap holes from when the tree was used for maple sugaring can be seen in the shelving today.

Nearby Bristol is home to two wood-using industries founded over a hundred years ago. Since 1879 five generations of Jim Lathrop's family have provided jobs for the residents of Addison County. At its peak it employed 70 people. Founded in 1906, A. Johnson Lumber settled in Bristol Vermont in the late 1930's and currently employs 50 people. Yet, in the past two decades, employment has declined almost by half in the agricultural and forestry industries, and the largest increase has been in the service sector. Today, manufacturing, trade, healthcare and education employ the most people in Addison County. The town of New Haven used to have 16 dairy farms; it now only has about 3.[59] Residents of Bristol, Lincoln, Monkton, Starksboro, and New Haven are commuting longer distances to jobs.[60] As people spend more time in their cars, they have less time available for community involvement like fixing the local elementary school, bringing chicken soup to a sick neighbor, and participating in local school activities with their children. In addition, as employment in agriculture and forestry declines, fewer local residents are directly responsible for taking care of the diverse working landscape. While everyone can't be involved or don't want to be working in the woods or fields, most everyone wants to support the local farmers and woods workers who help maintain the patchwork quilt of farms and woodlots that so many love about Addison County.

In the case of Mt. Abe Union High School, we're only talking about 360 cords of wood. Yet, involving local landowners, taxpayers and children in fueling the school with wood can support the working landscape that so many enjoy, strengthen the bonds that hold the local community together, and can serve as a model for future community involvement.

Selling points for involving adults and seniors in a community wood energy project

1 - In many cases, a working forest is less of a tax burden than a new residential development (Irwin and Kraybill, 1999; American Farmland Trust, 2007)

2 - In order to preserve the pristine starry skies, quiet, traffic-free roads, and patchwork of open land and forests for wildlife that people value so much about where they live, they need to support those who are responsible for land management.

3 - If the adults have children in school, then community wood energy could help ensure a reliable and sustainable heat for their children and could also serve as an important place-based education opportunity.

[59] B. Bell, personal conversation, June 12, 2007.
[60] ACRPC, 2004.

Creating a reliable supply of woodchips that will continue to flow to your school throughout the life of the boiler (20-30 years)

Below is an example of steps a community can follow to work toward a more reliable supply of woodchips sourced using a SELF-standard.

1. Substitute wood for oil; a local, renewable energy source at an affordable price with a significant educational opportunity.

2. Identify local experts like foresters to address the issue of procurement standards to protect forest health and provide an opportunity for further student involvement.

3. Form a regional working group to address the issue of wood supply.

4. Identify the players, challenges, and opportunities to moving wood to your school. What other options are there beyond the current model? In parts of the U.S. where the majority of forestland is owned by non-industrial private landowners, this means involving family forest owners.

5. Celebrate and honor the players, and opportunities and challenges to current and future supply options.

6. Do a couple of demonstrations of how wood is harvested from local forests, chipped and delivered to the local school for heat.

7. Have regularly scheduled updates to keep stakeholders informed about changes in costs, benefits, and needs of different players.

8. Have a community forum to discuss why residents value the area where they live.

9. Develop a community-accepted procurement standard and incorporate it in a woodchip supply agreement.

10. Develop a portfolio of a diverse land base and advantages of a SELF woodchip.

11. Increase the amount of local family forest owners contributing to the woodchip supply. See Toolbox 4 for considerations for involving family forest owners.
    a. Increase the price paid for woodchips
    b. Aggregate landowners
    c. Involve “Model Owners”-- highly committed and engaged landowners who are currently practicing good land stewardship
    d. Target outreach to landowners not currently included in order to diversify the supply base

12. Sponsor a field day in which the community is able to visit each player doing their part in moving wood to Mt. Abe.

13. Scaling it up - can 360 cords become 3600 cords?

Toolbox 4

How to engage family forest landowners in fueling your school

There are a number of potential benefits for landowners if they harvest wood to heat their local school. Woodchips are produced from low-quality wood. By removing low-quality wood in their forest, landowners can improve the quality and value of the remaining timber. One can create scenic views and wildlife habitat by removing wood. Woodchip heating provides a market for this low-quality wood.

Many family forest owners are older and concerned about being able to pass their land on to younger family members, therefore messages related to inheritance and legacies will resonate (Butler, et al., 2007.) In general, messages appealing to family forest owner's love of the land and enjoyment of its beauty, privacy and wildlife may be received well (Roper, 2008).

Family forest owners' main source of information on land management is by word of mouth from other landowners and foresters. Members of the Sustaining Family Forest Initiative (SFFI), a diverse group of organizations and individuals interested in gaining knowledge about family forest owners in the U.S., recommends engaging a Model Owner-- a "highly committed and engaged" landowner who is currently practicing good land stewardship, to outreach to other forestland owners. Model Owners often "belong to or are leaders of organizations that work to improve the community, the land and wildlife" (Roper, 2008.) Consulting foresters will be able to easily identify Model Owners.

In addition to word of mouth there are a number of other sources that might get local landowners interested in community wood energy including, outdoor/forestry publications, local newspapers, local television, news, Public Broadcasting, and National Public Radio (Roper, 2008.) Town forests are another important way to demonstrate how private landowners can fuel their school with woodchips and practice careful forest management. See Toolbox 3 for a summary of the role town forests play in education and demonstration.

VII. Summary

As suggested by the many people involved in Mt. Abe's discussion of being Sustainable, Efficient, Local and Fair (SELF), the key to creating a local supply of community energy may be involving as many people as possible—as many selves as possible. In order to produce a SELF-woodchip, representatives from each step from the forest to the Mt. Abe woodchip storage bin need to be engaged in the discussion of woodchip procurement. Each of these players-- from the landowners to the school children, need to have relevant concerns addressed and be committed to finding common ground. A SELF-woodchip has the potential to provide a reliable supply of woodchips for small customers like Mt. Abe Union High School and has many direct and indirect ecological, social, and economic benefits. Yet, there are significant barriers to overcome in transitioning to a more reliable supply of woodchips.

Some of the economic challenges include:

- the current market price for woodchips is low, and therefore there is little financial incentive to remove low-quality wood that is made into woodchips. Instead the removal of low quality wood is subsidized by the removal of high quality wood;
- schools rely on the continued good health of the wood products industry, one of the largest producers of woodchips for schools and other small heating facilities in Vermont. Supply could become vulnerable if these producers went out of business;
- schools also rely on large consumers, like Burlington Electric Department, to support the infrastructure (logging equipment, trucks, etc.) needed to get woodchips to the school; and
- many small heating facilities are being built, which will increase the competition for higher quality mill residue and bole chips.

Some of the social concerns include:

- the costs and benefits of woodchip production are not evenly distributed. For example, some forest workers are not paid a fair wage for their work and are burdened with high health insurance costs;
- the general public lacks a basic understanding of the goods and services that their forests provide, and the standards used by those in the forestry profession to ensure that sustainable forestry is practiced vary, which makes community-wide agreement on a woodchip procurement standard difficult.

Some of the ecological concerns include:

- there is disagreement within the scientific community as to the amount of wood needed by the forest to repair itself following logging therefore it is difficult to determine how much wood to leave;
- little is known about the long-term impacts of harvesting wood on the ecological health of the forest, especially in an era when the climate and weather patterns are changing.

In order to ensure a reliable supply of wood for schools, the following actions will help overcome the barriers to sourcing a SELF-woodchip:

- increasing the price paid for woodchips and ensuring the costs and benefits are shared fairly among the landowners, loggers, woodchip producers and schools;
- demonstrating how wood can be harvested for a school from a private forest and town forest can help to increase public understanding of the goods and services

provided by their forests and monitor the ecological, social and economic costs and benefits.
- developing a local procurement standard to ensure that harvesting wood does not adversely affect the social and ecological goods and services provided by the forest;
- increasing collaboration among small heating facilities to decrease their reliance on the large producers, like the wood products industry, and large consumers, like Burlington Electric Department;

As Mt. Abe envisioned long ago, once the various issues have been addressed, local landowners will be rewarded for their stewardship and foresters and loggers will be supported in performing careful woods work. As a result of the loggers' and foresters' careful work, the rivers will run cleaner and clearer for swimming on hot summer days, and the forest soils will continue to support majestic maple, birch and beech trees. The students will continue to have fun learning about the forest around them and will be actively engaged in meeting their school's energy needs with a renewable fuel from within their community and not a fossil fuel produced in a foreign country. Some of what may seem like a fable to a reader in a faraway city is already happening in the Mt. Abe community.

Recently, on a warm summer night, instead of joining friends for a game of baseball or an ice cream cone, a group of Caroline Camara's 9th grade Envirothon Team stood in front of the decision-makers in the town of Starksboro to tell them why they thought their school should be fueled with wood from sustainably managed forests like the Starksboro Town Forest. They talked about local jobs, reduced transportation costs, reduced carbon dioxide emissions, and improved forest health- all benefits of sourcing their fuel from Vermont instead of the Middle East. These students have and continue to play an important role in the on-going dialogue about energy. "We can act as educators to our community," said 10th grader Harper Davis. "By doing all of this we hope to make our community a more environmentally friendly place to live." While Mt. Abe has several barriers on the path to making their community a more environmentally friendly place to live, as Starksboro Selectboard member, Susan Jeffries, noted, "if there was ever a town to decide how to use their town forest and resources wisely, this is it." This mindset prevails throughout the Mt. Abe community as they begin to address how they value their forests not just as a forest full of energy but as a source of beauty, life and self-sufficiency. If Mt. Abe is in the process of working toward this goal so can you.

VIII. References

Addison County Regional Planning Commission (ACRPC). 2004. Economy. In: The Addison County Regional Plan. 25 September. 2007 <http://www.acrpc.org/pages/publications/reg_plan.htm>

American Farmland Trust. 2007. Fact Sheet: Cost of Community Services Studies. American Farmland Trust Farmland Information Center. 25 March. 2008 <http://www.farmlandinfo.org/documents/27757/FS_COCS_8-04.pdf>

Andrews, J.S. 2003. Rapid Assessment for Reptiles and Amphibians on The Lincoln Town Forest, Lincoln, VT. Colby Hill Ecological Project. 11 February. 2008< http://www.familyforests.org/pdf/herptile-report.pdf>

Butler, B.J. and E.C. Leatherberry, 2004. America's Family Forest Owners. Journal of Forestry 102(7): 4-14.

Butler, B.J., and E.C. Leatherberry. 2006. National Woodland Owner Survey 2004 Preliminary Results for: Vermont and Selected Counties in New Hampshire, New York, and Massachusetts. USDA Forest Service, Forest Inventory & Analysis.

Butler, B.J., M. Tyrrell, G. Feinberg, S. VanManen, L. Wiseman, S. Wallinger. 2007. Understanding and Reaching Family Forest Owners: Lessons from Social Marketing Research. Journal of Forestry October/November 2007.

Department of Public Service (DPS). 2000. Vermont Residential Fuel Wood Assessment: 1997-1998. DPS Technical Report #48. Montpelier, VT. 26 November. 2007 < http://publicservice.vermont.gov/pub/other/residential_wood_fuel_assessment1998.pdf>

Energy Information Administration (EIA). 2007. Heating Oil and Propane Update. 22 October. 2007 <http://tonto.eia.doe.gov/oog/info/hopu/hopu.asp>

Environmental Risk Limited. 1996. Wood-chip fired furnaces testing project air emissions testing and public health impacts analysis. Prepared for the Coalition of Northeastern Governors, Washington, D.C. 6 December. 2007. < http://www.nrbp.org/pdfs/pub14.pdf>

Gower, S.T. 2003. Patterns and Mechanisms of the Forest Carbon Cycle. Annu. Rev. Environ. Resour. 28: 169-204.

U.S. Department of Housing and Urban Development's (HUD's) Office of Policy Development and Research (PD&R). Section 8 Income Limits. 15 February. 2008 <http://www.huduser.org/datasets/il/il05/index.html>

Irland, L.C., and M. Cline. 1999. Role of northeastern forests and wood products in carbon sequestration. Report to Northeast Regional Biomass Program; CONEG Policy Research Center Inc.; New York State Energy Research and Development Administration; College of Environmental Science and Forestry, State University of New York. 20 March. 2008 <http://www.nrbp.org>

Irwin, E. and D. Kraybill. 1999. Costs and Benefits of New Residential Development. Presented at the "Better Ways to Develop Ohio" conference, sponsored by the Ohio State University Extension, Columbus, OH, June 24-25, 1999. 27 February. 2008 <http://www-agecon.ag.ohio-state.edu/programs/ComRegEcon/costsdev.htm>

Kingsley, E. 2006. A Forest Full of Energy: Wood Grows as a Major Fuel in the Northeast. Northern Woodlands Spring 2006.

Maker, T. 2004. Wood-Chip Heating Systems: A Guide for Institutional and Commercial Biomass Installations. Biomass Energy Resource Center (BERC). 24 May. 2007 <http://www.biomasscenter.org/pdfs/Wood-Chip-Heating-Guide.pdf>

Maker, T. and J. Penny. 1999. Heating Communities with Renewable Fuels: The Municipal Guide to Biomass District Energy. Natural Resources Canada and U.S. Department of Energy. 26 November. 2008 <http://nrcan.gc.ca/es/etb/cetc/pdfs/heating_communities_with_renewable_fuels_e.pdf>

Minnesota Forest Resources Council. 2007. DRAFT Biomass Harvesting on Forest Management Sites in Minnesota. Developed as an additional chapter in “Sustaining Minnesota Forest Resources; Voluntary Site-Level Forest Management Guidelines”. 26 February. 2008 <http://www.forestrycenter.org/library.cfm?refid=98930>

National Community Forest Center, Northern Forest Region (NCFCNFR). 2003. Choices and Challenges in Town Forest Management. Report from a Community Forest Workshop. 9 September. 2007 <http://www.ncfcnfr.net/Summary%20Report%20on%20Workshop_final.pdf>

National Oceanic and Atmospheric Administration (NOAA). 2008. Climate of 2007 - in Historical Perspective Annual Report National Climatic Data Center. 15 February. 2008 <http://www.ncdc.noaa.gov/oa/climate/research/2007/ann/ann07.html>

Northern Forest Center. 2000. Northern Forest Wealth Index: Exploring a Deeper Meaning of Wealth. 8 September. 2007 <http://www.northernforest.org/downloads/nf-wealth-index.pdf>

Northern Woodlands. 2007. Mill Prices: Winter 2007. 15 February. 2008 http://northernwoodlands.org/articles/article/mill_prices_winter_2007/

Perschel, R.T. 2006. Ensuring Sustainable Forestry Through Working Forest Conservation Easements in the Northeast: A Forest Guild Perspective. The Forest Guild. 2 February. 2008 <http://www.forestguild.org/publications/research/2006/Forest_Conservation_Easements_Forest_Guild.pdf>

Peterson, D.R. 2005. The Real Cost of Extracting Logging Residue Study. Lumberjack Resource Conservation and Development Council, Inc. 5 May. 2008 <http://dnr.wi.gov/forestry/publications/Real-Cost-Extracting-Residue.pdf>

Roper Public Affairs. 2008. Family Forest Owners: Insights into Land-Related Stewardship, Values, and Intentions. Report on focus group findings prepared for the Sustaining Family Forests Initiative. 2 February. 2008 <http://sustainingfamilyforests.org/pdfs/Focus_Group_Report.pdf>

Sherman, A. 2007. The Vermont Wood Fuel Supply Study: An Examination of the Availability and Reliability of Wood Fuel for Biomass Energy in Vermont. Prepared by the Biomass Energy Resource Center or the Vermont Department of Forest, Parks and Recreation and Vermont Department of Buildings and General Services. 10 September. 2007 <http://www.biomasscenter.org/pdfs/VT_Wood_Fuel_Supply_Study.pdf>

Siccama, T.G., T.J. Fahey, C.E. Johnson, T.W. Sherry, E.G. Denny, E.B. Girdler, G.E. Likens, and P.A. Schwarz. 2007. Population and biomass dynamics of trees in a northern hardwood forest at Hubbard Brook. Canadian Journal of Forest Research 37: 737-749.

Solomon, S., D. Qin, M. Manning, M. Marquis, K. Avery, M.M.B. Tignor, H.L. Miller, Jr., Z. Chen, Eds. 2007. Climate Change 2007 The Physical Science Basis. Chapter 4 – Observations: Changes in Snow, Ice and Frozen Ground. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. 16 February. 2008 <http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_Ch04.pdf>

Stafford, S.H. 2006. Burlington School Food Project: A recipe for school and community partnership. The Center for Public Education. 5 May. 2008 <http://www.centerforpubliceducation.org/site/c.kjJXJ5MPIwE/b.3506591/k.446D/Burlington_School_Food_Project_A_recipe_for_school_and_community_partnership.htm>

USDA Forest Service. 2004. National Report on Sustainable Forests – 2003. FS-766. Washington: USDA Forest Service.

USDA Forest Service. 2008. Forest Legacy Program. 1 February. 2008 <http://www.fs.fed.us/spf/coop/programs/loa/flp.shtml>

U.S. Census Bureau, Data Integration Division. 2007. LEHD State of Vermont Industry Reports - Quarterly Workforce Indicators. Local Employment Dynamics. 20 February. 2008 <http://lehd.did.census.gov/led/datatools/qwiappssic.html>

Vermont Department of Forest Parks and Recreation. 1987. Acceptable Management Practices for Maintaining Water Quality on Logging Jobs in Vermont. 5 May. 2008 <http://www.vtfpr.org/watershed/documents/Amp2006.pdf>

Vermont Department of Forests, Parks and Recreation. 2005. Vermont Forest Resource Harvest Summary – 2005. 14 February. 2008 <http://www.vtfpr.org/util/for_utilize_harvsumm.cfm>

Vermont Family Forests. 2004. Biomass Fuel Assessment for Middlebury College. Prepared by the Biomass Assessment Team for Middlebury College. 5 May. 2008 <http://www.middlebury.edu/NR/rdonlyres/8C4C720B-B063-4245-B650-685184CD4C99/0/MCBiomassReport.pdf>

Vermont Family Forests. 2006. Forest Management Checklist: Practices to conserve healthy forests by protecting water quality, site productivity, and native biological diversity in forests managed for timber. 5 May. 2008 <http://www.familyforests.org/ecoforestry/documents/ForestManagementChecklist_000.pdf>

VSASEMP (Vermont Superintendents Association School Energy Management Program). 2003. Wood Chip Usage in Vermont Schools, 2002-2003 Heating Season. Summary of usage

patterns. Vermont Superintendents Association School Energy Management Program, Vermont Department of Forests, Parks and Recreation; and Vermont Department of Public Service, Energy Efficiency Division.

VSASEMP (Vermont Superintendents Association School Energy Management Program). 2008. Vermont Fuels for Schools -- Wood Fuel Survey Results for 2006-2007 Heating Season. Vermont Superintendents Association School Energy Management Program, Vermont Department of Forests, Parks and Recreation; and the Biomass Energy Resource Center.

Watrous, K., T. Donovan, R. Mickey, S. Darling, A. Hicks, S. Von Oettingen. 2006. Predicting minimum habitat characteristics for the Indiana bat in the Champlain Valley. Journal of Wildlife Management 70: 1228-1237.

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X. Community Wood Energy Resources

Community Renewable Energy
Northwest Community Energy provides an overview of renewable energy project scoping and planning including development, construction, and operations and maintenance, as well as cost management, risk management, and procurement.
http://www.nwcommunityenergy.org/project-design-management/project-scope-plan

The Massachusetts Division of Energy Resources has information on renewable energy programs and state and federal financial and tax incentives for businesses, municipal entities, and not-for-profit entities.
http://www.mass.gov/doer/programs/renew/renew.htm#biomass

Pahl, G. 2007. The Citizen-Powered Energy Handbook: Community Solutions to a Global Crisis. White River Junction, VT: Chelsea Green Publishing Company.

Smart Communities Network provides a number of resources and case studies on community energy projects in the United States.
http://www.smartcommunities.ncat.org/municipal/sstoc.shtml

Energy Efficiency
Princeton Energy Resources International, HPowell Energy Associates, and Alliance to Save Energy. 2004. School Operations and Maintenance: Best Practices for Controlling Energy Costs. Prepared for the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Weatherization and Intergovernmental Program, and Rebuild America EnergySmart Program.
http://www.ase.org/uploaded_files/greenschools/School%20Energy%20Guidebook_9-04.pdf

U.S. Department of Energy – Energy Efficiency and Renewable Energy
http://www.eere.energy.gov/consumer/your_home/energy_audits/index.cfm/mytopic=11160

Biomass Energy
Biomass Energy Resource Center
http://www.biomasscenter.org/

Northern Forest Biomass Energy Action Plan
http://www.familyforests.org/research/documents/NFBEIActionPlan7-14-07.pdf

Massachusetts Sustainable Forestry Bioenergy Initiative
http://www.mass.gov/doer/programs/renew/bio-initiative.htm

Biomass Heating Information
Biomass Energy Resource Center. 2007. Wood Pellet Heating Guidebook: A Reference on Wood Pellet Fuels & Technology for Small Commercial & Institutional Systems. Prepared for the Massachusetts Division of Energy Resources.

Maker, T. 2004. Wood-Chip Heating Systems: A Guide for Institutional and Commercial Biomass Installations. Biomass Energy Resource Center (BERC). http://www.biomasscenter.org/pdfs/Wood-Chip-Heating-Guide.pdf

Maker, T. and J. Penny. 1999. Heating Communities with Renewable Fuels: The Municipal Guide to Biomass District Energy. Natural Resources Canada and U.S. Department of Energy. http://nrcan.gc.ca/es/etb/cetc/pdfs/heating_communities_with_renewable_fuels_e.pdf

Woodchip Heating System Manufacturers

Messersmith Manufacturing, Inc
http://www.burnchips.com/

Chiptec Wood Energy Systems
http://www.chiptec.com/

Advanced Recycling Equipment, Inc.
http://advancedrecyclingequip.com/

SolaGen, Inc.
http://www.solageninc.com/

Air Quality Guidelines

National Ambient Air Quality Standards
http://www.epa.gov/ttn/naaqs/

VT DEC Air Pollution Control Division
http://www.anr.state.vt.us/air/index.htm

Fuels for Schools

Fuels for Schools
www.fuelsforschools.org

Massachusetts Technology Collaborative Green Schools Initiative
http://masstech.org/renewableenergy/green_schools.htm

Vermont Superintendent's Association School Energy Management Program
http://www.vtvsa.org/school-energy-management-program.php

Professional Forester Associations

The Forest Guild
http://www.forestguild.org/

The Society of American Foresters
http://www.safnet.org/

Forest Management

R.J. Tuner Co.
rjtco@gmavt.net

The Northern Forest Alliance
http://www.northernforestalliance.org/

Vermont Department of Forests and Parks
http://www.vtfpr.org/

Vermont Family Forests
http://www.familyforests.org/

Standards for Forest Management
Forest Stewardship Council
http://www.fscus.org/

Minnesota Forest Resources Council. 2007. DRAFT Biomass Harvesting on Forest Management Sites in Minnesota. Developed as an additional chapter in "Sustaining Minnesota Forest Resources; Voluntary Site-Level Forest Management Guidelines".
http://www.forestrycenter.org/library.cfm?refid=98930

Montreal Process Criteria and Indicators
http://www.rinya.maff.go.jp/mpci/

Perschel, R.T. 2006. Ensuring Sustainable Forestry Through Working Forest Conservation Easements in the Northeast: A Forest Guild Perspective. The Forest Guild.
http://www.forestguild.org/publications/research/2006/Forest_Conservation_Easements_Forest_Guild.pdf

Roe., J.H. and A. Ruesink. Natural Dynamics Silviculture: A Discussion of Natural and Community-Based Forestry Practices. The Nature Conservancy.
http://www.nature.org/wherewework/northamerica/states/vermont/files/pub_nds_doc.pdf

Ryder, R. and P.J. Edwards. 2005. Development of a Repeatable Regional Protocol for Performance-Based Monitoring of Forestry Best Management Practices. Northeastern Research Station General Technical Report NE-335.
http://www.fs.fed.us/ne/newtown_square/publications/technical_reports/pdfs/2005/ne_gtr335.pdf

Sustainable Forestry Initiative
http://www.aboutsfi.org/

Vermont Department of Forest Parks and Recreation. 1987. Acceptable Management Practices for Maintaining Water Quality on Logging Jobs in Vermont.
http://www.vtfpr.org/watershed/documents/Amp2006.pdf

Vermont Family Forests. 2006. Forest Management Checklist: Practices to conserve healthy forests by protecting water quality, site productivity, and native biological diversity in forests managed for timber.
http://www.familyforests.org/ecoforestry/documents/ForestManagementChecklist_000.pdf

Forest Stewardship and Estate Planning
U.S. Forest Service – Cooperative Programs
http://www.fs.fed.us/spf/coop/programs/loa/flp.shtml

U.S. Forest Service Northeastern Area – Estate Planning Options for Family Forests
http://www.na.fs.fed.us/stewardship/estate/estate.shtml

U.S. Forest Service - Forest Legacy Program.
http://www.fs.fed.us/spf/coop/programs/loa/flp.shtml

Logger Certification
Northeast Master Logger Certification
http://www.masterloggercertification.com/

Family Forest Owners
Sustaining Family Forests Initiative
http://sustainingfamilyforests.org/

Roper Public Affairs. 2006. Family Forest Owners: An In-Depth Profile. Prepared for the Sustaining Family Forests Initiative.
http://sustainingfamilyforests.org/pdfs/report_fullreport.pdf

Roper Public Affairs. 2008. Family Forest Owners: Insights into Land-Related Stewardship, Values, and Intentions. Report on focus group findings prepared for the Sustaining Family Forests Initiative.
http://sustainingfamilyforests.org/pdfs/Focus_Group_Report.pdf

Town Forests
Gould, S., C. Hancock, K. Hayes. 2004. Exploring Vermont's Town Forests: Practicing Conservation, Celebrating Local Heritage, and Building Community. The University of Vermont Green Forestry Education Initiative.

The Northern Forest Alliance Vermont Town Forest Project
http://www.northernforestalliance.org/townforest.htm

Community Visioning Process
A community must develop a vision in order to address sustainability. A community visioning process can often provide guidance for citizens who are unclear about a future course. This website identifies alternative approaches and resources that can assist the visioning process.
http://www.sustainable.org/creating/vision.html

Measuring Project Success
Whole Measures
The Center for Whole Communities is developing Whole Measures – an ethically-based, community-oriented standard on why and for whom land is restored and conserved. Whole Measures offers a means of describing and measuring the healthy relationships between land and people that we seek to create.
http://www.measuresofhealth.net/

The Northern Forest Wealth Index
http://www.northernforest.org/downloads/nf-wealth-index.pdf

Please contact Caitlin Cusack at caitlin.c.cusack@gmail.com with questions, comments or to request a hard copy.