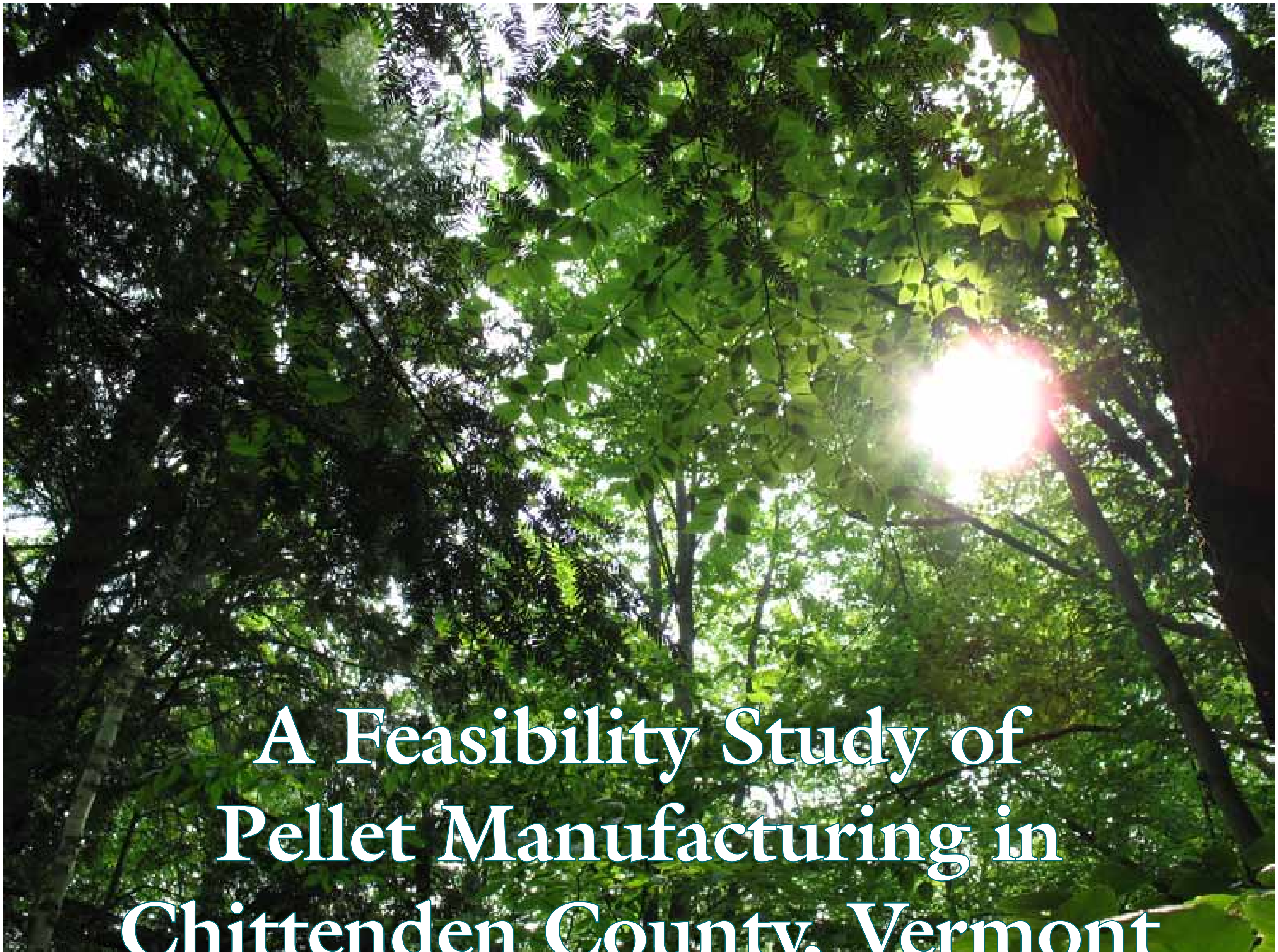

A Feasibility Study of Pellet Manufacturing in Chittenden County, Vermont

August 2011

BERC
Renewable • Reliable • Resourceful
Biomass Energy Resource Center

This study was supported through a generous grant from the Chittenden County Regional Planning Commission, thanks to American Recovery and Reinvestment Act funds.

Vermont Sustainable Heating Initiative (VSHI)

VSHI is a non-profit organization located in Essex, Vermont, dedicated to the establishment of affordability and sustainability in Vermont's home heating economy, believing that Vermont has the potential to be energy independent within the home-heating sector, and that this energy independence can and should be established in a manner that is socially, environmentally, and economically responsible. VSHI was founded after the 2008 Governor's Institute Winter Weekend where students brainstormed solutions to climate change and other environmental issues. VSHI members are volunteers and the team is made up mostly of students and science teachers, with three of the current board members being college students. Since its formation, VSHI has educated state lawmakers on the sustainable energy potential of Vermont's fiber shed, equipped low-income Vermont households with affordable (and fossil-fuel free) heating systems, and contracted the Biomass Energy Resource Center to analyze the feasibility of establishing a biomass densification facility in Chittenden County.

"It is with a grounding in the science and art of silviculture, an understanding of Vermont's forest history, a respect for the needs of Vermonters today, and a respect for future generations who will call our state home, that this study is conducted."

Tom Tailer, VSHI

Biomass Energy Resource Center (BERC)

BERC is an independent, national nonprofit organization located in Montpelier, Vermont with a Midwest office in Madison, Wisconsin. BERC assists communities, colleges and universities, state and local governments, businesses, utilities, schools, and others in making the most of their local energy resources. BERC's mission is to achieve a healthier environment, strengthen local economies, and increase energy security across the United States through the development of sustainable biomass energy systems at the community level.

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EXECUTIVE SUMMARY

The Vermont Sustainable Heating Initiative (VSHI) engaged the Biomass Energy Resource Center (BERC) to study the overall feasibility of a conceptual pellet mill located in Chittenden County, Vermont.

PROJECT BACKGROUND

The Vermont Sustainable Heating Initiative (VSHI) engaged the Biomass Energy Resource Center (BERC) to study the overall feasibility of a conceptual pellet mill located in Chittenden County, Vermont. This material is based upon work supported by the Department of Energy under Award Number DE-RW0000259. The scope of work for this assessment included:

- A regional assessment of the available biomass feedstocks
- Development of recommendations on operational processes and economic viability
- A survey of the current pellet fuel market and estimations for future growth
- Outreach to the community to assess interest and support
- An assessment of possible business models

METHODS AND APPROACH

This assessment considered three potential mill sizes: 3, 6, and 12 tons per hour (TPH). The mill proposed here would produce 19,440-77,760 tons of pellets per year at full capacity, depending on the mill size. It was assumed here that wood feedstocks would be green, at 50 percent moisture content, and required in a 2:1 ratio of feedstock to produced pellets. Therefore, the mill would consume between 38,880 and 155,520 green tons of woody feedstocks per year.

The feedstock availability assessment considered both woody and agricultural feedstocks, including dedicated energy crops within the likely wood basket surrounding the proposed mill. The primary woody feedstocks were sawmill residues such as sawdust and wood shavings, which were not recommended due to competition with farmers, and harvested low-grade wood. Harvested low-grade wood will be the primary source of feedstock for the proposed mill, irrespective of mill size, and it was found to be available in more than sufficient quantities for the 3 and 6 TPH mill options and in sufficient quantities for the 12 TPH mill, although the largest mill option would consume about half of the low-grade wood available in this region.

WOODY BIOMASS FEEDSTOCK AVAILABILITY

Geographic Information System (GIS) analysis was conducted to determine the forested footprint within the wood basket considered here that is physically accessible and ecologically appropriate for harvesting. National Woodland Ownership survey data was used to evaluate the likelihood of active management (including periodic harvesting) on this forestland. Current data from the US Forest Service Forest Inventory and Analysis (FIA) program was used to calculate the current availability of low-grade wood growing on the forested footprint in

Annual Wood Feedstock Consumption and Pellet Production Volumes for Each Mill Size in Tons per Hour (TPH)

	3 TPH Mill	6 TPH Mill	12 TPH Mill
Annual Consumption of Green Low-Grade Wood (green tons)	38,880	77,760	155,520
Annual Pellet Production (dry tons)	19,440	38,880	77,760

the wood basket that is physically accessible, ecologically appropriate, and actively managed for periodic harvesting. While there are nearly a half million green tons of low-grade wood growing annually, current demands for this material consume roughly half of this quantity annually; therefore, the total available low-grade wood is more than 345,000 green tons per year.

We recommend that any new pellet mill focus solely on higher-quality feedstocks—that is, low-grade wood—to produce a Premium and/or Super Premium pellet in the first years of operation. Once the mill is successful and the product and brand are well established within the market, other lower-quality pellet fuel products could be produced using feedstocks such as agricultural residues and dedicated energy crops. It is important to note that these are lower-quality feedstocks and will produce a lower-quality pellet, likely meeting specifications for Standard grade. The success of utilizing these alternative feedstocks will therefore depend also on the development of a market for Standard-grade pellets.

ALTERNATIVE BIOMASS FEEDSTOCKS

The availability of some alternative pellet feedstocks was also examined here. Agricultural residues are largely unavailable in Vermont, with the exception of spoiled hay—also known as mulch hay—which is available in varying quantities inconsistently from year to year depending on the growing season's conditions; however, dedicated energy crops grown on marginal agricultural lands do show promise. There is the potential to grow 20,000-30,000 dry tons of grasses on marginal agricultural lands in Chittenden County. The recommended species are Switchgrass and, to a lesser extent, Reed Canarygrass, since this particular species is not native to Vermont and produces a lower-quality pellet than Switchgrass. Mulch hay could also be sourced in years when it is available in sufficient quantities. This quantity of grass fiber could help supplement wood fibers to produce a lower-quality pellet fuel that meets quality requirements for a Standard-grade pellet.

MILL LAYOUT

Again, the mill should be designed at the outset to source 100 percent wood feedstocks (any experimentation with alternative feedstocks should be conducted only after the Premium or Super Premium product is well established in the market). The recommended mill layout is a centralized plant including an ample wood storage yard for sourcing roundwood; however, the mill design should also include the capacity to directly receive woodchips. The facility design should include all necessary equipment for weighing and unloading roundwood trucks, moving material (both roundwood and chips) onsite, and de-barking and chipping roundwood onsite. The additional capability of handling woodchips will mean that a bucket loader, with both bucket and grapple attachments, and covered storage be included at the mill. The pellet mill itself would include a feedstock drier, fueled by a biomass boiler using bark removed from the roundwood, a hammermill for grinding feedstocks, pelletizer(s), screening and cooling equipment, bulk pellet storage, and bagging and packaging line equipment.

BUSINESS STRUCTURE

There are several possible business structures for a new pellet mill. VSHI chose to assess the viability of a cooperative that aims to meet objectives for a strong commitment to social justice and environmental responsibility. This model included livable wages for staff, responsibly harvested wood feedstocks (with the exclusion of tops and limbs), and five percent of pellets donated

There are several possible business structures for a new pellet mill. VSHI chose to assess the viability of a cooperative that aims to meet objectives for a strong commitment to social justice and environmental responsibility.

EXECUTIVE SUMMARY *(cont'd)*

The financial viability of this business structure was assessed at three different mill capacities: 3, 6, and 12 tons per hour (TPH), equivalent to roughly 20,000, 40,000, and 75,000 tons per year, respectively.

to low-income Vermonters. Conceptually, member shares in the coop would be equivalent to one ton of pellets, giving the member control over the tonnage equivalent to their level of buy in. Members would be free to buy, sell, or donate their respective tonnages. VSHI's goal is to sell about 40 percent of product on the open market to retailers, 50 percent direct sales to coop share holders, and 5 percent would be donated; the remainder was assumed to be lost inventory due to damage, sales, marketing promotions, or other reasons.

FINANCIAL VIABILITY

The financial viability of this business structure was assessed at three different mill capacities: 3, 6, and 12 TPH, equivalent to roughly 20,000, 40,000, and 75,000 tons per year, respectively. Assuming a 2:1 ratio of feedstock to product, these mills would source about twice as much feedstock as their respective outputs; all consumption rates are within the current availability of wood feedstocks in this region. The table below shows annual pellet production, feedstock consumption, and available low-grade wood for each of the mill capacities assessed here.

Using a set of conservative assumptions, only the 12 TPH mill was found to be a viable business, from a traditional financial perspective. This business would produce positive cash flow from the start, positive net income, a reasonable payback, and an internal rate of return that is better than current interest rates on more traditional investments. This is partly because a bigger mill can produce pellets for a lower cost than can smaller mills. These results are, of course, also dependent on the assumptions used here for numerous factors such as construction costs, staff wages, and utility prices, to name a few.

There is a fairly high degree of uncertainty in each of these. For example, the cost of building a brand new pellet mill on undeveloped land in Chittenden County is quite different from that of utilizing a developed site's infrastructure or siting the mill in a county adjacent to Chittenden where property prices may be more reasonable. Some sensitivity analysis was conducted around the capital cost of constructing the mill, and it was found that if actual development costs could be lowered, a smaller pellet mill could prove financially viable.

Annual Pellet Production, Feedstock Consumption, and Available Wood Feedstock

	3 TPH Mill	6 TPH Mill	12 TPH Mill
Annual Pellet Production (dry tons)	19,440	38,880	77,760
Annual Consumption of Green Low-Grade Wood (green tons)	38,880	77,760	155,520
Annual available Feedstock (green tons)	345,864 *(irrespective of mill size)*		

POTENTIAL MILL SITES

Several potential sites for a pellet mill were identified in Chittenden County, and details on these are included in that chapter of the report. These potential sites were limited to those parcels of land and existing facilities that are currently listed for sale.

Certainly, numerous other potential sites exist in Chittenden County; however, without the landowner's permission, it would be inappropriate to list these properties in this report. Existing and former sawmill sites are a top choice.

CONCLUSIONS AND RECOMMENDATIONS

Overall, there appear to be positive results for both the 6 and 12 TPH wood pellet mill sited in Chittenden County. While the 6 TPH mill modeled here was not financially viable, lowering the capital costs would help towards viability. The 3 TPH mill was not found to be viable from a financial perspective, though other metrics were favorable (feedstock availability and market size, for example). The table above right shows the overall results of this analysis.

VSHI should continue to focus on further assessment of the cooperative business model, paying particular attention to the anticipated level of membership sales. The focus should be on building a mill in the 6 or 12 TPH size range.

As the project concept is developed, an important next step will be to investigate the level of cooperative membership that can realistically be expected for this business. It was assumed here that 20 percent of the capital budget would be raised through membership sales. Whether this is actually possible will remain to be seen. One next step could be to look at the level of membership at some of Vermont's top cooperatives such as Mad River Glen, Onion River Food Cooperative, or Cabot Creamery, the latter of which is owned by the Massachusetts-based cooperative Agri-Mark. While none of these cooperatives focus on energy products, looking at their levels of membership would help VSHI to gain a better understanding of the realistic potential for buy-in to a pellet fuel cooperative.

Overall Feasibility Results

	3 TPH Mill	6 TPH Mill	12 TPH Mill
Feedstock Availability	√	√	×
Current Market	√	√	×
Potential Future Market	×	√	×
Site Locations	√	√	√
Financial Feasibility	×	×	√

Overall, there appears to be positive results for both the 6 and 12 TPH wood pellet mill sited in Chittenden County.

NEXT STEPS

- Ongoing investigation and monitoring of suitable and available sites for the pellet mill
- Collecting actual capital costs and developing a construction-ready budget (those presented here were theoretical and highly variable)
- Revisiting the financial viability assessment with more accurate figures to ensure the business will be financially sustainable
- Continued investigation into the business structure and viability, including a detailed survey of the potential for the cooperative model
- Pursuit of potential grants, investors, or other possible funding mechanisms for which a cooperative would be eligible

I. INTRODUCTION

The Vermont Sustainable Heating Initiative (VSHI) works to establish affordability and sustainability in Vermont's home heating economy, striving for state energy independence in the home heating sector. As part of its work, VSHI is transitioning low-income households to pellet heating.

A. PROJECT BACKGROUND

The Vermont Sustainable Heating Initiative (VSHI) works to establish affordability and sustainability in Vermont's home heating economy, striving for state energy independence in the home heating sector. As part of its work, VSHI is transitioning low-income households to pellet heating. At this time, wood pellets are the primary pellet fuel available to Vermont residents. VSHI believes, however, that Vermont has enough agricultural land that is both underutilized and unsuitable for food production to sustainably support the bulk of the state's home heating needs with grass-derived pellet fuels.

VSHI's goals for pellet production and use in Chittenden County and northwestern Vermont are to:

- establish a pellet production facility in Chittenden County with a production capacity of 60,000-70,000 tons per year
- work with the State of Vermont to increase the use of pellets as an affordable heating fuel for residential and commercial applications. The specifics are to create demand for over 60,000 tons of pellet fuel in Chittenden and adjacent counties
- work with towns and other groups to increase the use of land management plans that support sustainable local biomass feedstock harvesting, processing, and development
- work with Vermont's universities and colleges to monitor the sustainability and other scientific issues related to pellet feedstock procurement, pelletization, distribution, and combustion of the fuel
- research new uses and technologies for pellet fuels
- work with the state's fuel assistance program to install pellet heating systems in 500 clients' homes each year over the course of two years; the total 1,000 homes will then be provided with pellet fuel at no cost to the state when the local facility reaches its production capacity

VSHI contracted with the Biomass Energy Resource Center (BERC) to assess whether local pellet production would be logistically and financially viable, with the ultimate goal of establishing a local pellet production facility. BERC's sustainable fuel supply team has extensive experience in assessing the availability, reliability, and sustainability of biomass fuels and pellet manufacturing businesses. As a partner in the Vermont Grass Energy Partnership, BERC also has experience with growing, harvesting, processing, and combusting grass as boiler fuel.

B. SCOPE OF WORK

VSHI was awarded a grant from the Chittenden County Regional Planning Commission (CCRPC) to conduct a preliminary feasibility study to evaluate the potential of developing a pellet plant in the county using feedstock from Chittenden and adjacent counties. BERC was hired to perform tasks 1, 2, 3, and 5, below; VSHI conducted task 4.

Following are the details on each of the study components.

1. **Regional Assessment of Available and Potential Bio-Fuel Feedstocks.** Current data was collected, reviewed and analyzed to assess the regional availability of wood by-products, harvested low-grade wood, agricultural by-products, and dedicated energy crops. Presented here are average annual volumes, current pricing, the present demand, and availability of these materials.

2. **Development of Recommendations on Operational Processes and Economic Viability.** Recommendations were developed on the collection, transport, processing, and storage of each feedstock and of the final pellet product using the information collected in the review of availability and viability of each potential feedstock. Preliminary capital costs and a pro forma financial assessment were developed for a 3, 6, and 12 tons per hour (TPH) capacity central pellet plant business model. Several potential sites in Chittenden County were identified as potential locations for a pellet mill based on their matching a set of criteria.

3. **Survey of Potential Pellet Fuel Market.** A survey of current, existing markets for pellet fuel was conducted as part of an assessment of the potential market volume and specific needs for pellet fuels. The current wholesale and retail demand for bulk and bagged pellet fuels was assessed through research and by contacting distributors of pellet fuels, including both local suppliers and more distant export markets. A rough estimation of the potential for expanded future local demand for pellets was also assessed.

4. **Community Outreach and Assessment of Interest.** Online, telephone, and personal communications were used to assess the community's interest in supporting a local pellet fuel business. Data was also collected on the characteristics of the business that were most appealing, such as sustainability and local economic development.

5. **Assessment and Recommendations for Business Models.** All possible business structures were reviewed including sole proprietorship, S and C Corporations, LLC, cooperative, not for profit, and L3C. A cooperative was modeled here in more detail.

This report summarizes this work and provides the conclusions and recommendations developed through conducting this study. Also included is an overview of pellet fuels and current pellet fuel markets.

VSHI was awarded a grant from the Chittenden County Regional Planning Commission (CCRPC) to conduct a preliminary feasibility study to evaluate the potential of developing a pellet plant in the county using feedstock from Chittenden and adjacent counties.

II. PELLET FUEL OVERVIEW

A. PELLET HEATING OVERVIEW

History and Benefits of Wood Heating and Pellet Fuels in Vermont

Wood for heating is not a new concept; burning wood for heat has been common in homes and the wood products industry for many years. The technology is well proven and cost effective, and many are looking to wood to heat their homes, businesses, facilities, and communities. In addition to a long history of heating homes with wood, Vermont has a 25-year history of using wood as a heating fuel in public buildings and institutions.

In general, wood fuel has the benefits of lower costs, increased energy security, retention of energy dollars in the local economy, support of community jobs, and mitigation of several environmental issues such as minimized contribution to acid rain and the potential for reduced impact on atmospheric levels of carbon, when compared to traditional fossil heating fuels.

More specifically, wood pellets have gained increased popularity in the recent decade as a more convenient means to heat with wood, compared to cordwood in homes or woodchips in larger facilities.

Pellets are more uniform in shape, size, energy content, and moisture than either cordwood or woodchips, making them easier to transport, store, and convey when compared to other wood fuels. Their high energy density means they have more energy by volume than cordwood or woodchips; for the building owner, this translates to smaller storage space requirements.

Additionally, the equipment to combust pellets is more highly automated than some other wood-fueled systems. The combustion equipment is also highly efficient when compared to other biomass-fueled systems.

Right: Wood pellets are consistent in shape, size, and moisture content and can be more convenient to use than other forms of woody biomass like cordwood or woodchips.

Current Markets for Pellet Fuels

Current markets for wood pellet fuels include residential customers, who are typically heating several rooms with a stove or their house with a centralized boiler system. These customers are buying pellets in 40-pound bags. Often these bags are packaged by the pallet or by the ton. One-ton bags are also available for some applications. Residential customers may use one-half to several tons of pellets per heating season to heat their homes.

These pellets are manufactured regionally and shipped to distribution centers and stores, such as local home & garden or feed & supply stores. Customers buy their pellets from the manufacturer, distributor, or store, and typically pick them up and bring them to their home where they are stored for the upcoming heating season. Residential pellet customers will manually unload their bags of pellets one bag at a time into a day bin, or hopper, from where the pellets are automatically conveyed into their appliance.

Increasingly, many larger community-scale buildings such as schools and businesses are looking to pellets as a fuel in their centralized boiler systems. These are called bulk customers since they buy pellets in bulk quantities, requiring several to several hundred tons of pellets per year. These customers buy pellets by the truck load, and the pellets are delivered into an on-site storage bin such as a silo (the same type of silo used in standard farm applications).

The size of the silo will match the particular application, but it could range from a 5- to 30-ton silo, from which the pellets are automatically fed into the combustion system. For more detailed information on using wood pellets to provide heat at the community, institutional, or small commercial scale, please see the BERC publication *Wood Pellet Heating: A Reference on Wood Pellet Fuels and Technology for Small Commercial & Institutional Heating* (www.biomasscenter.org/resources/publications.html). The Pellet Fuels Institute (PFI) is also a resource on pellet fuel standards, manufacturers and suppliers, and other information (www.pelletheat.org).

Left: Wood pellets delivered in bulk quantities are conveyed from the delivery truck into an onsite storage silo. Much of the infrastructure for conveying and storing wood pellets is identical to that used for grain in farming applications.

II. PELLET FUEL OVERVIEW *(cont'd)*

Alternative Feedstocks for Pellet Manufacturing

Recently, interest has also turned to pelletizing feedstocks other than wood; researchers and others are investigating pellets made from grass, waste paper, manure, and agricultural residues, among other things. For the purpose of heating fuel in the northeast, feedstocks such as grass and fast-growing willow show the most promise, with much recent work being focused on grass.

The recently produced *Technical Assessment of Grass as Boiler Fuel in Vermont* (www.biomasscenter.org/resources/publications.html) by the Vermont Grass Energy Partnership summarizes several years of research and trials in growing, pelletizing, and test-burning grass pellets. The partnership continues to monitor developments in this field, including the development and small-scale demonstration of mobile grass pelletizers that can be brought onsite via flatbed truck. Some information on the lessons learned from this work is included in this report, but for more details contact BERC or the Vermont Sustainable Jobs Fund.

Right: Grass has shown promise as a dedicated energy crop that can be grown on marginal agricultural lands in Vermont; however, higher nutrient content in grass means more ash is produced during combustion, leading to some challenges with using grass as a boiler fuel. Blending grass feedstocks with wood is one way to overcome these challenges.

B. PELLET FUEL QUALITY

Pellets are a manufactured biomass fuel, and pellet fuel quality can range widely depending on the source materials and manufacturing process. There are many different species and sources of feedstock and many ways in which the material can be harvested, processed, loaded, transported, and received, all of which can impact the overall quality of the pellet and thereby the successful operation of the pellet heating system.

Today's pellet marketplace includes customers that expect high-quality fuel. Ensuring that pellet fuel is up to certain standards means fewer mechanical jams, less ash produced (and therefore less time spent on removing ash), and longer periods of maintenance-free burn time. The performance of pellet heating systems is optimized by using a high-quality fuel designed for the heating equipment. The following chart details the parameters affecting the quality of a fuel pellet.

PARAMETERS AFFECTING OVERALL QUALITY OF A FUEL PELLET
SIZE. Fuel pellets are of uniform size and shape (between 1 or 1 ½ inches in length by approximately ¼ - 5/16 inches in diameter), making them easy to store and use in fuel auguring systems. Pellets also take up much less space in storage than other biomass fuels because they are relatively dry and densified compared to other biomass fuels such as woodchips.
MOISTURE CONTENT. Pellets typically have moisture content between four and six percent, though this can range depending on the quality of pellet. All pellets should have a moisture content less than 10 percent. If pellets are stored improperly and are remoistened, many issues are created.
ENERGY CONTENT (BTU[1] VALUE). Pellets have a higher energy content by weight (roughly 8,084 Btu per pound at six percent moisture content) than woodchips (roughly 4,500 – 5,000 Btu per lb at 50 percent moisture) and other non-densified biomass fuels. Pellets should contain a minimum of 8,000 Btu per dry pound.
ASH CONTENT AND MINERAL COMPOSITION. Ash content is perhaps the greatest distinguishing parameter among the four grades of pellet fuels. Super Premium pellets have less than 0.5 percent ash content; Premium pellets, less than one percent; Standard pellets, between one and two percent; and Utility or Industrial pellets have two to six percent. The amount and composition of minerals in the fuel will determine the amount of ash produced and to what extent these minerals will fuse or melt together, forming clinkers during combustion at standard combustion temperatures.[2]
DENSITY. Pellets have consistent hardness and energy content (minimum 40 pounds/cubic foot for Premium or Super Premium). Density is a key factor in pellet fuel quality. Less dense pellets will burn less efficiently and deliver less heat. Less dense pellets are also less durable and often degrade into fines prematurely.
FINES. Pellets commonly break down into a small amount of fines or dust due to wear and tear in handling and shipping. Excessive fines content can cause material bridging in the fuel hopper; minimizing the amount of fines content avoids fairly serious problems with the fuel feeding systems. The amount of fine dust passing through 1/8-inch screen should be no more than 0.5 percent by weight.
CHLORIDES. There should be limited salt content (no more than 300 parts per million) in pellets. When pellets are burned, chloride gases are extremely corrosive to metal and excessive levels can cause significant damage to heat exchange and exhaust venting systems.

II. PELLET FUEL OVERVIEW *(cont'd)*

The industry standard for delineating levels of pellet quality is the set of specifications put forth and maintained by the Pellet Fuels Institute, and include Utility (or Industrial), Standard, Premium, and Super Premium.

The industry standard for delineating levels of pellet quality is the set of specifications put forth and maintained by the Pellet Fuels Institute. These standards include Utility (or Industrial), Standard, Premium, and Super Premium, in order from lowest to highest quality. Table 1 on the the following page summarizes these quality standards for each grade of pellet fuel.

For residential and small commercial heating, pellets should be of Premium or Super Premium quality. These pellets will be the most convenient and reliable for these customers.

Some larger facilities may choose to source Standard pellets, since larger pellet systems may have automatic ash removal systems that are capable of handling the larger volumes of ash produced by these lower-quality pellets.

Utility-grade pellets would be appropriate only in large, industrial applications.

Since the residential, small-commercial, and community-scale markets represent the greatest proportion of pellet customers in the region and also the focus group for both project partners, any pellets manufactured in Vermont, and specifically in Chittenden County, should match the standards for Premium or Super Premium grade. The characteristics of the pellets produced by the Chittenden County pellet mill can be periodically lab-tested to verify that certain standards are met and to include the Premium or Super Premium label on any packaging or marketing materials.

TABLE 1. PFI Pellet Quality Standards

	Likely Source Materials	Size	Moisture Content	Btu Value	Ash Content	Bulk Density	Fines Content
Super Premium	Wood fiber	6-8mm	<6%	>8,000 Btu/lb	<0.5%	40-46lbs/ft3	<0.5%
Premium	Wood fiber	6-8mm	<8%	>8,000 Btu/lb	<1.0%	40-46lbs/ft3	<0.5%
Standard	Primarily wood fiber with possibly a small percent of other ag fiber	6-8mm	<8%	>8,000 Btu/lb	<2.0%	38-46lbs/ft3	<0.5%
Utility or Industrial	Wood fiber, bark, grass, other	6-8mm & larger	<10%	>8,000 Btu/lb	<6.0%	38-46lbs/ft3	<0.5%

Table 1: Voluntary pellet fuel quality standards are maintained by the Pellet Fuels Institute. These standards regulate the pellet fuel market and provide assurance to customers that they are buying a grade of pellet that matches their appliance.

III. RESOURCE ASSESSMENT OF AVAILABLE AND POTENTIAL FEEDSTOCKS

By producing pellets in Chittenden County from locally and sustainably procured forest and agricultural feedstocks, greater energy security and self-sufficiency can be achieved while simultaneously creating a market that helps sustain the working landscape in Vermont.

A. RESOURCE ASSESSMENT OVERVIEW

An important first step in exploring the viability of a pellet mill in Chittenden County is an assessment of the available feedstock for making pellets. This is the foundation for a successful wood pelletizing business.

The benefits of heating with any biomass fuel, pellets included, are best achieved when the feedstock is sourced locally and sustainably. By producing pellets in Chittenden County from locally and sustainably procured forest and agricultural feedstocks, greater energy security and self-sufficiency can be achieved while simultaneously creating a market that helps sustain the working landscape in Vermont. The first question to answer here is: Are there sufficient feedstocks to produce pellets sustainably?

As was discussed earlier in the overview of pellet fuels section, wood pellet feedstocks can include woodchips, sawdust, and other wood wastes, though there have also been recent achievements in developing grass pellet fuel. For grass pellets, the feedstock would be spoiled hay or one of several grass species grown and harvested for the sole purpose of making pellet fuel. For this assessment, the partners agreed to put emphasis on wood pellets, since these are well known and established, while keeping an eye ahead on future developments in the grass pellet fuel market. Here, the primary focus was the current availability of woody biomass feedstocks (and, later, the operations and financial feasibility of making wood pellets) and the potential for growing grass or other dedicated energy crops in the future is also discussed.

B. WOOD FEEDSTOCK ASSESSMENT

In the assessment of woody feedstock availability, the following sources were considered:

- Wood processing and manufacturing residues
- Harvested low-grade wood
- Wood wastes from community wood recycling

(Note: Woody crops like willow are discussed later in the report within the section on dedicated energy crops.)

The study area for this assessment was defined by the likely distance that wood feedstocks can be cost-effectively transported from point of origin (or point of sale or harvest) to the consumer. The consumer in this case is a theoretical pellet mill in Chittenden County. Typically this cost-effective transport distance is somewhere between 60 and 90 minutes of drive time for low-grade green wood; after this amount of time, transporting the material can become more expensive than the wood is worth. Since an exact pellet mill location is currently unknown (though several potential sites are identified later in this report), a 60-minute drive time zone was drawn from the borders of Chittenden County to make up the “wood basket” from which wood feedstocks could be sourced cost-effectively.

The data used to estimate the availability of these feedstock sources are available largely on the county level. Therefore, for this assessment, the five counties falling largely within the 60-minute drive time zone comprised the study area. These are: Addison, Chittenden, Franklin, Lamoille, and Washington.

Above left: The study area for the wood feedstock assessment was comprised of the five counties falling within the radius of cost-effective feedstock delivery.

Above right: The primary source of biomass fuel and feedstocks in Vermont has been sawdust and wood shavings generated at sawmills when making round logs into square boards.

Wood Processing and Manufacturing Residues

The optimal source of wood feedstocks for making pellets will be sawdust and wood shavings purchased from sawmills and other mills that are already processing wood in the Chittenden County area. These materials are the by-products of sawing logs into lumber, and further, from processing lumber into wood products. Because this feedstock source represents the use of a waste stream, this is the most economic (in other words, affordable) choice. Often these materials are clean, screened, dried, and ideally suited for making wood pellets.

However, while residues from these industries are an optimal fuel source, they are not going to be available in sufficient quantities or in a reliable way. The availability of these materials is dependent on a vibrant wood products industry.

Unfortunately, this industry has been on the decline due to decreased demand for paper and wood products and increased production of these products in other countries. In addition to limited availability of these wood sources due to an economic downturn, there is increasingly less waste produced by this industry as it evolves to incorporate more efficient equipment and methods. As this industry strives to improve efficiency, lower volumes of by-products are being produced.

In addition to the general issue of availability, in the case of sawdust, there is a conflict between pellet producers and farmers: Sawdust produced from wood processing has historically been sold, or given for free, to farmers for use as animal bedding, particularly for cows on dairy farms, which are known to be struggling in Vermont. Pellet mills have the potential to both eat up the supply of sawdust and drive up the price of sawdust, both of which will impact area farmers.

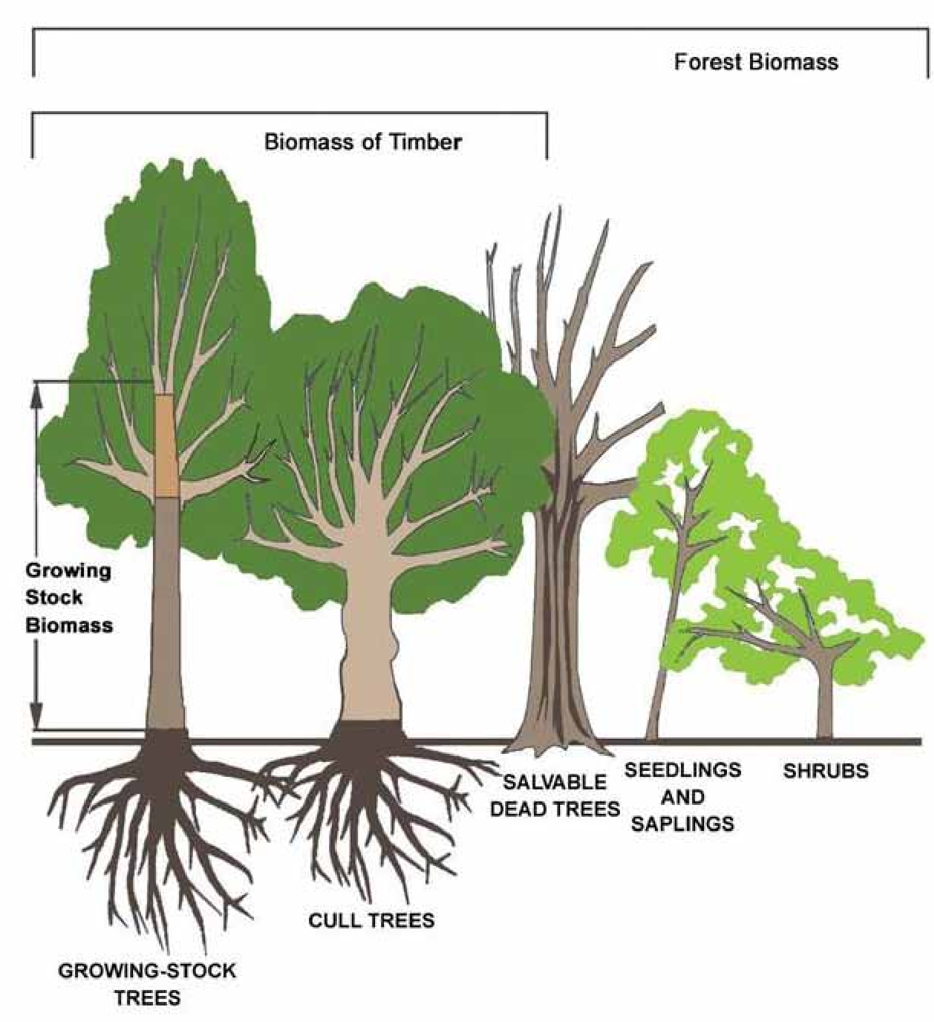
III. RESOURCE ASSESSMENT OF AVAILABLE AND POTENTIAL FEEDSTOCKS (*cont'd*)

Already, many farmers have turned to using sand, a poor substitute, because sawdust is largely unavailable or just too expensive due to the shortage. Any further competition for sawdust would only exacerbate the problem. This would be a public relations issue for any mill, but more importantly, would also go against the partners' decision to avoid competition between food production and biomass fuel production. For this reason, a pellet mill in Chittenden County may want to avoid purchasing sawdust as a feedstock for making wood pellets; wood wastes from sawmills are not recommended as a source of feedstock for this proposed pellet mill.

Harvested Low-Grade Wood

Despite the downturn in by-product supply of woodchips described in the previous section, logging contractors have encouragingly responded to the recent upswing in demand for wood fuels and feedstocks by producing these commodities as a primary product, something that loggers are particularly interested in after the loss of the pulpwood market. Low-grade logs or roundwood that historically would have gone to regional pulpmills now is a major source of wood fuel and feedstocks for pellets. The primary wood feedstock for a mill in Chittenden County will be low-grade wood from integrated harvesting that is currently taking place within the wood basket. These feedstocks come from the lower-valued trees being cut during harvesting jobs that are already happening in the area.

Right: Biomass fuel and feedstock can be sourced from harvesting that is already happening. Low-grade wood that has little to no value in other markets can be used to make roundwood or woodchips for pellet production or fuel.



Left: An integrated harvest will include removal of many qualities of trees including higher-value growing stock trees and lower-value cull trees. This analysis quantifies the low-grade wood from both growing stock and cull tree categories.

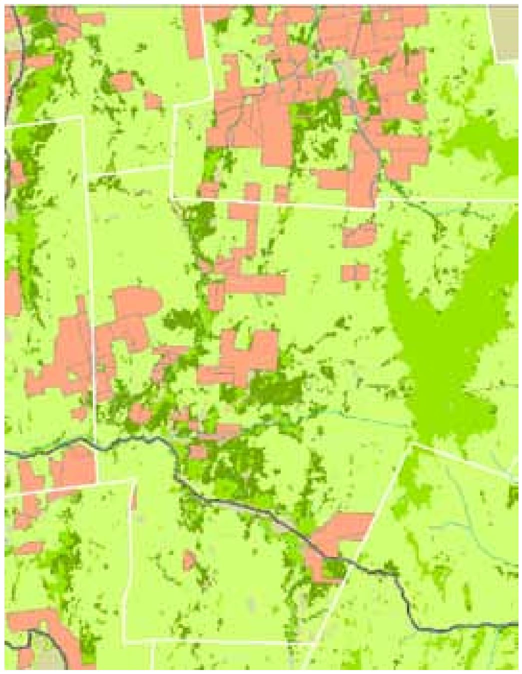
Because wood is not infinite in its supply, careful attention must be paid in this scenario to the sustainable availability of this material; otherwise we run the risk of growing our wood fuel demand beyond our forests' capacity to supply. In an effort to better understand the potential capacity of the region's forests to provide low-grade wood for fuel and feedstock, the forestland within the wood basket, or procurement area described above (Addison, Chittenden, Franklin, Lamoille, and Washington counties), was identified and the current inventory of wood on this forestland was estimated.

To do this, the following steps were taken:

1. Identify and examine accessible and managed forestland area
2. Examine the current inventory of wood on the forestland area
3. Understand the rate of forest growth, building upon existing inventory
4. Quantify the existing market demand for low-grade wood
5. Determine any additional forest capacity for increased demand for low-grade wood

III. RESOURCE ASSESSMENT OF AVAILABLE AND POTENTIAL FEEDSTOCKS (*cont'd*)

Right: A Geographic Information System (GIS) was used to determine the forested footprint that was physically accessible and ecologically appropriate for harvesting.



In the five-county study area considered here, there are more than 1.2 million acres of forestland. But not all of this forestland is physically accessible to harvesting due to factors like slope, elevation, or buffers that are to be maintained around roads, streams, and water bodies.

Further, not all of the forestland is ecologically appropriate for harvesting due to wildlife habitat, preservations, or other sensitivities. Using US Forest Service Forest Inventory and Analysis (USFS FIA) data and spatial analysis, it was estimated here that this five-county study area contains just over 894,000 acres of forestland that are both physically accessible and ecologically appropriate for management, including periodic harvesting.

Still, only some portion of these 894,000 acres of accessible and appropriate forestland is likely to be managed in a way that calls for periodic harvesting. The National Woodland Owner Survey, a part of the USFS FIA program, provides data on the amount of forestland, by county, that is managed for harvesting. Using this data, we found that there are approximately 563,000 acres of forestland in this five-county study area that are accessible, appropriate, and actively managed for harvesting (Table 2).

Table 2: The first step in calculating the availability of low-grade wood was determining the footprint from which this material can be harvested. This five-county study area contains more than 563,000 acres of forestland that are physically accessible, ecologically appropriate, and actively managed (and therefore are periodically harvested).

TABLE 2. Forestland that is Accessible, Appropriate, and Actively Managed for Harvesting (Acres)

County	Total Forest Area	Accessible and Appropriate Forest Area	Total Accessible, Appropriate, and Managed
Addison	249,203	192,242	107,530
Chittenden	209,963	133,560	83,272
Franklin	233,102	175,238	119,666
Lamoille	241,275	161,454	105,289
Washington	362,212	232,488	147,607
TOTAL	1,295,755	894,982	563,365

TABLE 3. Forest Inventory on Harvestable Forestland (Acres)

County	Total Managed & Harvestable Forestland	Growing-Stock (GS) Wood (Green Tons)			Cull Wood (Green Tons)		
		Bole	Tops & Limbs	Total	Bole	Tops & Limbs	Total
Addison	107,530	7,937,548	1,934,100	9,871,648	1,381,750	328,415	1,710,165
Chittenden	83,272	6,683,633	1,639,436	8,323,069	1,036,122	242,845	1,278,967
Franklin	119,666	8,956,502	2,239,755	11,196,257	1,490,763	333,253	1,824,015
Lamoille	105,289	8,612,535	2,130,280	10,742,814	1,382,504	319,690	1,702,193
Washington	147,607	11,452,267	2,824,006	14,276,273	1,879,457	435,630	2,315,087
TOTAL	563,365	43,642,484	10,767,578	54,410,062	7,170,595	1,659,833	8,830,428

Once the footprint of potential source forestland has been determined, the quantity of wood that is available from that footprint can be calculated. The USFS FIA program collects data on the volume and health of trees on US forestland. On this accessible, appropriate, and managed forestland in the five-county study area, there are more than 63.2 million green tons of standing inventory in both the growing stock (merchantable) and cull (non-merchantable) categories, according to data from the FIA program (Table 3).

Each year, new growth is added to this standing inventory—some stands grow quickly, others more slowly. Using an average annual growth rate of 2.1 percent, there are more than 1.3 million green tons of wood added annually to the current standing inventory on the forestland in this study area that is accessible, appropriate, and managed for harvesting (Table 4). This new growth can be considered analogous to interest earned on a principal investment. Just as wise investors will only spend the interest earned on their investment, only the portion of new wood growing each year should be harvested, thereby sustaining the forest resource over time.

Of this new annual growth, only the portion that is low-grade wood (not merchantable in any other market) is going to become wood fuel or feedstocks for pellets. This material is a high-quality pellet feedstock, but is too poor of a quality to be marketable for higher-value wood products like lumber or furniture. Further, only bole wood, or the main stem portion of the tree, was considered as feedstock in this assessment; tops and limbs of harvested trees were not counted here. While the tops and limbs can be marketable portions of the harvested tree (they are often chipped for fuel), this wood makes a poor quality pellet due to a higher ratio of bark to white wood. Bark will produce more ash than white wood during combustion; therefore, bark content should be minimized when making higher quality pellets that meet Premium or Super Premium standards. Additionally, tops and limbs can be left on the forest floor to decay, returning nutrients to the forest ecosystem.

Table 3: There are more than 63.2 million green tons of live standing trees on the harvestable forestland in this five-county study area (this is total growing stock wood and total cull wood in both bole and tops and limbs, combined).

III. RESOURCE ASSESSMENT OF AVAILABLE AND POTENTIAL FEEDSTOCKS (*cont'd*)

TABLE 4. Net Annual Forest Growth (Assuming a 2.10% Growth Rate)

County	Growing-Stock Wood (Green Tons)			Cull Wood (Green Tons)			
	Bole	Tops & Limbs	Total	Bole	Tops & Limbs	Total	Grand Total
Addison	166,689	40,616	207,305	29,017	6,897	35,913	243,218
Chittenden	140,356	34,428	174,784	21,759	5,100	26,858	201,643
Franklin	188,087	47,035	235,121	31,306	6,998	38,304	273,426
Lamoille	180,863	44,736	225,599	29,033	6,713	35,746	261,345
Washington	240,498	59,304	299,802	39,469	9,148	48,617	348,419
TOTAL	916,492	226,119	1,142,611	150,583	34,856	185,439	1,328,050

Table 4: There are more than 1.3 million new green tons of total wood added per year to the standing inventory on the harvestable forestland in this five-county study area.

Assuming that 60 percent of the growing stock bole wood and 80 percent of the cull bole wood on this forestland was low-grade, there are approximately 670,000 green tons of low-grade bole wood growing annually on the forestland considered here (Table 5). It is important to note that this low-grade material is removed as part of harvesting that is already happening; these figures are not meant to represent actual harvesting of low-grade wood annually, but rather the potential for this low-grade wood to be available while sustaining the forest resource.

While there are about 670,000 green tons of low-grade wood available annually to become wood fuel or feedstocks, there are existing demands for this wood, including firewood for home heating, pulpwood for pulp and paper, and woodchips for electric production at McNeil Generating Station in Burlington. Firewood and pulpwood come from harvested bole wood; woodchips (for the McNeil Station) predominantly come mainly from tops and limbs. These existing demands were found to consume about 335,000 green tons of low-grade wood collectively, including the top and limb wood that is made into chips. Of the bole wood portion of this low-grade wood, there are more than 345,000 green tons that could be available annually for making wood pellets at this proposed mill (Table 6). A full copy of this assessment is included at the end of this report as Appendix A.

TABLE 5. Portion of Net Annual Growth that is Low Grade and Harvestable

County	Growing Stock and Cull Wood Combined (Green Tons)		
	Bole	Tops & Limbs	Total
Addison	123,226.50	-	123,226.50
Chittenden	101,620.63	-	101,620.63
Franklin	137,896.73	-	137,896.73
Lamoille	131,744.00	-	131,744.00
Washington	175,873.45	-	175,873.45
TOTAL	670,361	0	670,361

Table 5: About 670,000 green tons of low-grade bole wood, a high-quality pellet feedstock, are growing annually on the harvestable footprint in this five-county study area. Tops and limbs were not considered here because these feedstocks reduce the overall quality of wood pellets; additionally, this material can be left in the forest to retain nutrients in the forest ecosystem.

This low-grade wood can be purchased as chips or roundwood (logs) from local logging and chipping contractors, from regional chip brokers, or from more distant chip mills. We recommend that this pellet mill source roundwood almost entirely. This roundwood can be piled and stored in lots surrounding the pellet mill and then chipped onsite as needed. This will ensure a reliable supply of wood feedstocks and will be more economical than purchasing woodchips.

Note: Other proposed competing new demands for this wood could affect the availability and pricing of this material in the future; these proposed consumers are discussed later in this report.

TABLE 6. Net Available Low-Grade Wood

County	Annual Harvest of Low-Grade Wood (Green Tons)			Net Available Low-Grade Wood (Green Tons)		
	Firewood	Pulp	Chips	Bole	Tops & Limbs	Total
Addison	35,026	3,600	1,141	84,601	-	84,601
Chittenden	56,196	3,706	19,397	41,718	-	41,718
Franklin	54,890	15,045	14,263	67,962	-	67,962
Lamoille	53,434	5,934	7,650	72,376	-	72,376
Washington	80,640	16,027	12,058	79,206	-	79,206
TOTAL	280,186	44,312	54,510	345,864	0	345,864

Table 6: While there are about 670,000 green tons of low-grade wood growing annually on the harvestable footprint within the five-county study area considered here, nearly half of this wood is already in demand for firewood, pulp, chipped fuel, and other uses. After accounting for these current demands, more than 345,000 green tons of new low-grade wood are available annually for use as biomass fuel or feedstock.

III. RESOURCE ASSESSMENT OF AVAILABLE AND POTENTIAL FEEDSTOCKS (*cont'd*)

Right, top: Clean community wood wastes can be collected at a central yard and chipped for fuel or feedstock. Careful attention must be paid to keeping this feedstock free of contaminants.

Right, bottom: Woodchips from clean community wood wastes are often the lowest quality because they are inconsistent in shape and size, contain a higher percentage of bark and foliage, and have a greater risk for being contaminated by dirt, debris, or chemicals.

Wood Wastes from Community Wood Recycling

In addition to the primary wood feedstock sources of processing residues and harvested low-grade wood, this pellet mill could source clean community wood wastes. These include urban tree trimmings, wastes from residential tree care, and other wood wastes like pallets, Christmas trees, and untreated and unpainted construction materials. It is highly important that this material be clean and free of chemicals or other contaminants. It can be collected in a central location like a wood recycling yard co-located at the mill, and a contractor can be brought in periodically to grind the material (alternatively, onsite chipping equipment can be used, if chosen to be included in the mill layout).

Additionally, the mill could be set up to accept dump truck loads of chipped tree trimmings from local arborists. Again, the material must be free of metal, plastics, or other foreign objects as well as paint, chemicals, or other treatments that can be toxic when combusted.

In Chittenden County, many tons of clean wood wastes are generated every year, with about 6,800 tons of this material collected annually by Chittenden Solid Waste District (CSWD) and McNeil Generating Station. Chittenden County already does a significant job of collecting and using these materials. CSWD maintains several drop-off points for any clean wood waste, and in addition, the McNeil Generating Station operates a Wood and Yard Waste Depot adjacent to their power plant where residents can drop off uncontaminated material free of charge. Wood wastes are ground onsite and burned in the wood-fired power plant.

Still, this material could be used just as any other wood feedstock (again, as long as it is kept clean), and there is the potential to collect these materials for a pellet mill in Chittenden County. The method recommended here would be to incorporate a wood waste depot into the woodyard at the pellet mill, where community members can drop off clean wood wastes. These materials would need to be inspected prior to drop off to ensure they are free of contaminants, and they can be stockpiled and ground by a hired third-party contractor as needed. The annual volumes that could be collected are difficult to estimate, and it should be noted that any attempt to source this material from within Chittenden County may be viewed by McNeil Generating Station as direct competition for this resource on which they rely.

Wood Feedstock Availability Conclusions and Recommendations

We have shown that sawmill residue wood will be limited in availability and will not be a primary feedstock source for a pellet mill in Chittenden County. The most likely and readily available source of wood feedstock for this mill will be harvested low-grade wood; this material appears to be available sustainably in sufficient quantities within the wood basket considered here. It is recommended that this feedstock be purchased as roundwood (the model assumed in the economic analyses presented later in this report). This roundwood can be stockpiled in the wood yard at the pellet mill and can be chipped as needed. Roundwood has a longer "shelf life" than woodchips and this will be a more reliable and economical option for the mill. An additional benefit of sourcing roundwood is better quality control. Buying roundwood and, under controlled processes, debarking, chipping and regrinding the wood on site allows for close monitoring to produce the highest quality pellet feedstock. Buying woodchips from someone else gives less control over the quality of the feedstock material.

Additionally, these feedstocks could be supplemented with woodchips from clean community wood wastes. A wood recycling yard could be co-located at the mill to collect these materials; a staff person will be required to inspect incoming material to be sure it is free of contaminants that would pose problems when the pellets are burned. Additionally, the mill could be set up to receive dump truck loads of chipped tree trimmings from local arborists. The inclusion of clean community wood wastes is appealing from the waste utilization perspective, but this is optional and should not be considered a primary source of feedstock since the potential volumes are low and unpredictable, the feedstock quality is poor, and the utilization of this material will require additional labor for quality control.

C. AGRICULTURAL FEEDSTOCKS

In this assessment of agricultural feedstocks, the following potential sources were considered:

- Agricultural residues
- Dedicated energy crops

The study area for this part of the feedstock assessment was Chittenden County only (not the five-county area used in the woody feedstock assessment on the previous pages).

Agricultural Residues

Generally in farming, there are harvestable residues left in the field after the primary crop has been harvested. Primary crops can be food (for humans) or feed (food for other animals). Corn stover is a good example of an agricultural residue. After the desirable portion of the corn plant is harvested, the parts remaining in the field, called stover, can be harvested. Corn stover can be ground up and made into pellets for fuel. The majority of crops grown in Vermont, however, are feed crops for livestock, mostly dairy cows. In other parts of the country the stover is left in the field and a second harvest collects that material which can be used as a fuel or pellet feedstock; in Vermont, all of the corn plant is harvested and used as feed for the animals, so stover is not an available feedstock in Vermont.

Below: Agricultural residues are a common form of biomass in some parts of the country; however, in Vermont, they are largely not available.

III. RESOURCE ASSESSMENT OF AVAILABLE AND POTENTIAL FEEDSTOCKS (*cont'd*)

There are two main types of energy crops that can be grown in Vermont and that have already been somewhat proven to at least show promise, if not yet to be successful options: woody energy crops and grasses.

As with corn, any residues from oil seed crops are also highly valuable as animal feed—probably more valuable as feed than fuel. Agricultural residues are often simply not available in Vermont, and when they are, there is likely a use already in place that presents either an economic or societal barrier to their use for making pellet fuel.

One potential crop residue that is available in Vermont and without food conflicts is waste hay, which is of poorer quality than feed-quality hay. This waste hay, also called mulch hay, could be used to make pellets, though it would need to be blended with wood to achieve a desired product quality. The Vermont Grass Energy Partnership found that only pellets made from a 6-12 percent mulch hay feedstock were acceptable as boiler fuel, meeting Premium quality pellet fuel standards.

It is difficult, however, to quantify the volume of waste hay that could be available annually. This is because in good years most of the hay grown will be feed hay; in wetter, poorer growing conditions, the yield will be made up of proportionally more waste hay. This lack of predictability will make waste hay a highly unreliable feedstock. Yet waste hay could be sourced when it is available, and a blended wood pellet could be made using 6-12 percent waste hay. In this case, the pellet mill being considered here would need to include some additional equipment to accept waste hay as a feedstock. (Equipment and operations are discussed in greater detail later in this report).

Dedicated Energy Crops

There are two main types of energy crops that can be grown in Vermont and that have already been somewhat proven to at least show promise, if not yet to be successful options: woody energy crops and grasses.

Woody Energy Crops. Woody plants like willow and poplar coppice are becoming a proven energy crop in the northeast. Middlebury College is currently test-growing about six acres of willow. The first harvest of willow woodchips was made there at the start of the 2010-11 winter season, and is further being tested as boiler fuel in the college's woodchip combined heat and power plant.

While willow chips can make a sufficient if not good boiler fuel, chipped willow is not an ideal pellet feedstock. Growing willow coppice involves cutting plantings within their first two years of growth to encourage them to grow into bushy plants with many small stems, rather than one main stem. Because of this growth pattern and the plant's relatively young age when it is harvested, these multiple stems are only about 1 to 2 inches in diameter and often smaller. This means that the ratio of bark to inner "white wood" is very high and it would be nearly impossible to de-bark these small-diameter stems. Therefore, the bark content of willow feedstocks is going to be too high and will impact negatively the resulting pellet fuel's characteristics and further the ability to match pellet fuel quality standards. Due to this, BERC recommends that VSHI not consider willow or poplar coppice as a potential feedstock for making pellet fuel in Chittenden County, Vermont. Because this feedstock is not recommended, this assessment did not go into detail on the potential volumes of willow that could be available.

Grasses. Grasses have been grown and pelletized in Vermont with some success and show the most promise among dedicated energy crops. Two varieties, Switchgrass (*Panicum virgatum*) and Reed Canarygrass (*Phalaris arundinacea*), are best for Vermont's climate and growing season. Switchgrass is not commonly found in Vermont, though it grows well here and has been shown in other parts of the country to be a good biomass crop; Reed Canarygrass is common in Vermont, is highly adaptive, and does well in wet and/or marginal growing conditions, thereby meeting the partners' objectives to consider only marginal agricultural land for growing dedicated energy crops. Reed Canarygrass, however, is not native to Vermont and produces a lower-quality pellet; Switchgrass would be the better species with which to work.

While grass can easily be planted and grown in Vermont, pelletizing and combusting grass can prove challenging. As the Vermont Grass Energy Partnership found, the grass fibers do not flow well and tend to bridge and ball up very easily as they are prepared for pellet manufacturing. Additionally, 100 percent grass pellets do not make good boiler fuel for small- to medium-sized stoves and boilers, though they could be used in some larger applications. This is because they produce a large volume of ash that fuses at relatively low temperatures, and the fused ash, commonly referred to as "clinkers," can cause difficulties. Also, the combustion gases are highly corrosive to heating equipment, due to higher concentrations of salts present in grass. These operating and maintenance problems will take time and money to resolve. The two challenges can be mitigated, however, by blending grass fibers with wood at a ratio of 10-20 percent grass to 80-90 percent wood. The blended pellets were easier to produce and burn, and better met quality standards for Standard or, in some cases where white wood content was highest, Premium pellets.

Above, left to right: A willow plantation at Middlebury College, Middlebury, Vermont.

At a young age, willow plantations are cut back to encourage multiple stems to regenerate, thereby producing a greater yield of willow.

A pile of willow chips to be test-burned in Middlebury College's biomass-fired combined heat and power plant.

Left: Grass pellets are not an ideal fuel because they produce high quantities of ash that can be difficult for today's systems to handle. Grasses can be mixed with wood feedstocks, however, to make a blended pellet that more easily meets Standard pellet fuel quality standards.

III. RESOURCE ASSESSMENT OF AVAILABLE AND POTENTIAL FEEDSTOCKS (*cont'd*)

To assess the acreage of marginal agricultural lands that could be appropriate for energy crops, BERC reviewed spatial data from the University of Vermont that categorizes agricultural lands into those primarily planted with corn, other crops, or hay as well as those lands that are fallow, developed, idle, or currently pasture. In total, there are 316,000 acres of agricultural land represented in this data. To determine the area within this total that could be converted to dedicated energy crops, the following was assumed:

- none of the land currently planted with corn, nor land that is developed, nor pasture land would be converted to energy crops
- about 20 percent of the land that is currently idle would be converted to dedicated energy crops
- about 10 percent each of the agricultural acreage that is planted with other crops or that is fallow would be converted to dedicated energy crops
- about 5 percent of the land that is currently planted with hay would be converted to energy crops

Considering these assumptions, there are approximately 11,200 acres of marginal agricultural land in Chittenden County that could be appropriate for growing energy crops (Table 7).

Once the available footprint of growing space is known, the potential volume of grass that can be grown annually is estimated using average per-acre yields of these crops. Per-acre yields of grasses were provided by Dr. Sid Bosworth at the University of Vermont; his work has shown that the average yield of grasses for energy is eight 900-pound bales per acre. Roughly translated, Switchgrass has an average yield of 2-3.5 dry tons per acre; Reed Canarygrass yields just under 3 dry tons per acre.

Table 7: There are approximately 11,200 acres of marginal agricultural land in Chittenden County that could be converted to dedicated energy crops without presenting a conflict for food production.

TABLE 7. Area for Energy Crop Production Based on Study Assumptions (Acres)

County	Corn	Other Crops	Hay	Fallow	Developed	Pasture	Idle	Total Area Under Crop Production
Total Agricultural Acreage in Chittenden County	50,000	2,000	170,000	13,000	30,000	45,000	6,000	316,000
Percent that is Marginal	0%	10%	5%	10%	0%	0%	20%	
Marginal Agricultural Land in Chittenden County	-	200	8,500	1,300	-	-	1,200	11,200

If the 11,200 acres in Chittenden County that could be planted with energy crops were planted entirely with either of these two grasses, the yield of Switchgrass would be about 28,000 dry tons per year; for Reed Canarygrass it would be slightly higher at about 30,000 dry tons per year. There appears to be sufficient marginal agricultural land in Chittenden County to experiment with growing grasses and sourcing this material to try a grass-wood blended pellet that meets Standard pellet fuel quality standards. This full assessment is included at the end of this report as Appendix B.

It is important to note that is was assumed in this assessment that 100 percent of the marginal agricultural lands deemed appropriate for conversion to energy crops would be planted with Switchgrass or Reed Canarygrass to achieve these volumes. In reality, this may not be the case. First of all, in a free market, landowners are free to plant their acreage with whatever crop they decide is likely to be the most profitable. Also, it will take a significant amount of work to collectively convince landowners to plant their acreages with this crop, and further, it will take a significant amount of work to plant, grow, harvest, and prepare the crop. While there is potential here, it may take years to ratchet up to full-scale production of a grass-wood blended pellet.

Agricultural Feedstock Availability Conclusions and Recommendations

It was found here that agricultural residues are largely unavailable in Vermont, particularly without presenting a conflict for food production. Yet, waste hay (or mulch hay) can be available, albeit unreliably. Depending on the growing season there may be more or less mulch hay produced. Still, this feedstock could be sourced if and when the pellet mill adds grass processing capabilities. Further, there is potential in Chittenden County to plant marginal agricultural lands with dedicated energy crops. For making pellets, the best options are such grasses as Switchgrass or Reed Canarygrass. Again, these materials could only be sourced as pellet feedstocks if and when the pellet mill adds grass processing capabilities; these grasses would then be blended with wood to make pellets that meet Standard pellet fuel quality standards. For now, it is recommended that the pellet mill be designed to source 100 percent wood feedstocks while keeping an eye towards adding the capability to source grass in the future. It will be a considerable effort to ratchet up the total acreage planted with grasses, and the success of marketing this blended pellet will rely on the emergence and growth of a demand for Standard-grade pellet fuel.

For now, it is recommended that the pellet mill be designed to source 100 percent wood feedstocks while keeping an eye towards adding the capability to source grass in the future.

III. RESOURCE ASSESSMENT OF AVAILABLE AND POTENTIAL FEEDSTOCKS (*cont'd*)

In the Northeast, wood residues and wood wastes are generally declining in availability, due both to the downturn in the forest products industry and improving efficiency of processing equipment.

D. FEEDSTOCK PRICING

The purchase price of these previously mentioned potential feedstocks is an important consideration in both the availability of the feedstocks and the financial feasibility of a pellet mill. For example, a feedstock may be technically available, but its limited supply and high demand may drive prices far out of reach. And the total expenditure on feedstocks is an important part of overall cash flow of the business.

In the Northeast, wood residues and wood wastes are generally declining in availability, due both to the downturn in the forest products industry and improving efficiency of processing equipment. There is simply less waste wood being produced than there was 10 years ago. Still, as was noted above, these feedstocks should be sourced when they are available, with a careful eye towards avoiding competition with other important users, like farmers who are dependent on sawdust for animal bedding. Residue woodchips from sawmills will likely cost $30-50 per green ton (at 50 percent moisture content), including transportation over a reasonable distance.

As residue wood becomes scarcer, the fuel market is switching focus to chipped bole wood, or bole chips, as a commodity source of wood fuels and feedstocks. This wood is more marketable, has a higher value, and has to pay its own way out of the woods. Therefore, this feedstock will be a little more expensive to purchase, but in exchange it will be more reliable. It can be purchased as roundwood or chipped wood. Again, it is advised here that the pellet mill source roundwood which can be stored in the wood yard at the pellet mill and chipped on site. This wood will cost $28 to $32 per green ton, including transportation over a reasonable distance.

As discussed in the previous section, agricultural residues will either be limited in availability or not generally recommended for use; therefore, prices for these materials are not given here. One possible exception, however, is waste hay, which will be available in differing quantities from year to year, depending on growing conditions each season. When waste hay is available, it can typically be purchased for $75-$100 per ton.

Also shown in the previous section was the potential for growing grasses on marginal agricultural land as a dedicated energy crop. The cost to grow this crop has been characterized by Dr. Sid Bosworth at UVM to be about $250 per acre. With typical per-acre yields of eight 900-pound bales, this translates to roughly $70 per dry ton, not including transportation. Transportation within Chittenden County may add another $10 per ton to the cost, bringing the cost to produce and transport grass energy crops to about $80 per dry ton. In general, adding grass feedstocks will increase the cost of making pellets. Further detailed market analysis would need to determine if this would be profitable.

E. FUEL SUPPLY CONCLUSIONS / RECOMMENDATIONS

In summary, residue materials, either woody or agricultural, will be challenging to come by. While wood residues are an optimal feedstock and economical choice for making pellets, sawdust should be avoided due to the potential for conflict with farmers. Harvested low-grade wood will be the primary wood feedstock and should be purchased as roundwood. Additionally, clean community wood wastes could be collected at the pellet mill by co-locating a wood recycling yard or accepting chipped tree trimmings from local arborists; these residues have the benefit of utilizing a waste stream, but this is optional and very much supplemental and runs the risk of upsetting another consumer of this material in Chittenden County, McNeil Generating Station.

Agricultural residues are largely unavailable in Vermont, with the exception of mulch hay which will be available in differing quantities from year to year, depending on the growing season. In general, agricultural materials present potential issues like the need to avoid competition between fuel and food. A conscious decision was made by the project partners to avoid consideration of growing dedicated energy crops of prime agricultural land; therefore, this analysis considered only the potential for growing these crops on marginal agricultural land. Dedicated energy crops like willow and poplar coppice can be grown in Vermont and have great potential as boiler fuel, but do not make quality pellet feedstock due to the increase in ash content caused by a higher volume of bark.

Grass is a potential pellet feedstock that can be grown in Vermont, specifically in Chittenden County. It seems that blending grass and wood could be supported by the annual volumes of both grass and wood feedstocks that are available in and to Chittenden County. It is recommended and assumed here, however, that the pellet mill source 100 percent roundwood at the outset, though equipment can be added in the future to handle grass feedstocks or community wood wastes. Since grasses and community wood wastes will produce a lower-quality pellet—even when blended with higher-quality wood feedstocks—the viability of adding these feedstocks will depend on the success of making a quality pellet from these materials and the growth of markets for lower-quality pellets. From a cost perspective, wood will be more economical for making pellets because dedicated energy crops like grasses may increase the overall feedstock cost; this would need to be assessed more closely in a detailed market assessment. The pellet mill should conduct this detailed assessment—and consider all other factors—prior to making the decision to produce a grass-wood blended pellet.

In general, any new pellet mill in Chittenden County should first focus on low-grade wood from integrated harvesting as the primary feedstock. The mill should be designed at the outset to source, store, and process this material. Then, as markets for lower-grade pellets develop, the mill could incorporate other supplemental materials like grasses or clean community wood wastes. These would at first be experimental and could then be phased in based on the success of using these new materials.

Dedicated energy crops like willow and poplar coppice can be grown in Vermont and have great potential as boiler fuel, but do not make quality pellet feedstock due to the increase in ash content caused by a higher volume of bark.

IV. OPERATIONAL PROCESSES AND ECONOMIC VIABILITIY

A. CONCEPTUAL OVERVIEW OF PELLET MANUFACTURING

In general, making pellets requires the acquisition of feedstock (wood, grass, or agricultural residues, for example) in large enough quantities to produce the desired output. A sufficient amount of space is required to store that raw material, as it is typically a 2:1 ratio of input to output. From there, the material is dried and processed into an even-sized mixture of particles that presses easily into the pelletizer.

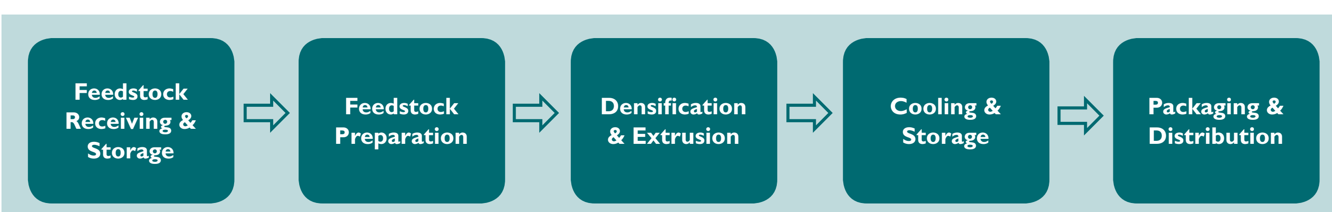
The high amounts of pressure and heat created in the process help the material to bind into pellets. For wood pellets or other materials blended with wood, lignin naturally present in the material holds the pellets together; no additional binders are required. For other materials that are lower in lignin content, an additive like wax, vegetable oil, starch, or clay can enhance the binding of the material into a durable pellet. Once the pellets are made, they are spread out to cool. When cooled, they are moved to storage from where they are distributed for use.

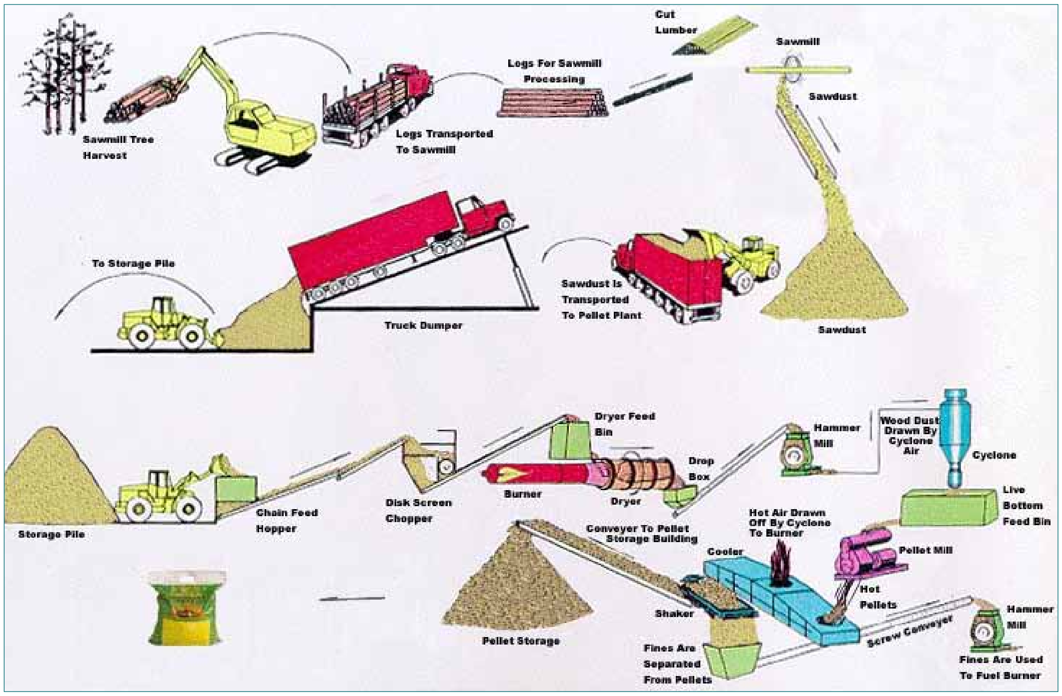
Pellets can be sold in bulk quantities (one ton or more), in which case a truck would deliver loads of pellets directly to the customer. Pellets also can be bagged for retail sale, in which case a bagging machine and storage space for bagged inventory would be required. The flow chart below summarizes the overall pellet-making process.

A pellet mill can be a stationary, centralized plant or it can be a mobile unit mounted onto a flatbread trailer that can be brought to the feedstock harvesting site. The benefit of a mobile plant is that it is transportable, but generally the scale and efficiency of these mobile pelletizers are smaller and lower, respectively, than a stationary facility. At this time, they currently make the most sense in on-farm applications such as grass pelletizing, where the farmer has grass or other feedstocks available, plus time to assist with the process and a market for 1-ton bags of grass pellets in place.

The centralized plant concept is well-established and is best for utilizing wood feedstocks; thus, this is the type of layout recommended and considered in this assessment. Within the centralized plant concept, there are numerous options for equipment and design.

Below: This flow-chart provides an overview of the necessary steps in making pellet fuels.





Left: This diagram gives a conceptual overview of a pellet plant, including the harvesting and delivery of wood feedstocks. Note that this image is included to show the general concept and includes sawdust as the pellet-making feedstock. Sawdust, however, is not recommended as a feedstock for this proposed pellet mill. Image source: Energex (www.energex.com).

Centralized Plant Details

Above is a generalized diagram of a centralized plant; beyond that, there is a general overview of each component and discussion of equipment options. Note that this image is included to show the general concept and includes sawdust as the pellet- making feedstock. Sawdust, however, is not recommended as a feedstock for this proposed pellet mill.

Feedstock Receiving and Storage. The first step in making pellets, once the plant is set up and ready to go, is procuring and receiving shipments of feedstock. These feedstocks can include woodchips, sawdust, other wood wastes like slabs and off-cuts from mills, or roundwood, in the case of wood pellets. It was recommended here that roundwood be the primary feedstock for this proposed mill; however, space and equipment for handling woodchips should be included as well.

During the development of the plant, suppliers of these feedstocks will be identified and contracted with to supply certain volumes of feedstock at agreed-upon prices. Typically, a bidding process is recommended for contracting with suppliers. At the plant, suppliers will deliver feedstock material by the truckload. This means there will need to be space for in-bound and out-bound trucks, plus space and equipment for unloading trucks, plus ample space for storing these feedstocks.

IV. OPERATIONAL PROCESSES AND ECONOMIC VIABILITIY (*cont'd*)

Above, left to right: Two examples of pellet feedstocks are woodchips and roundwood.

Since these feedstocks are sold and purchased on a weight basis (typically by the green ton in the case of wood) all deliveries will need to be weighed. A scale ticket will need to be submitted by the supplier to verify the amount of feedstock in each delivery. Payment will be made to the supplier based on the quantity delivered, so this scale ticket becomes the basis for billing for each feedstock delivery. To obtain the scale ticket, a supplier can go to a weigh station before and after the delivery or a truck scale can be installed at the pellet plant. While there is a greater cost for the latter option, it will be off-set by the greater ease of deliveries, since truckers will no longer need to drive out of their way to a weigh station; the use of weigh stations could also mean more expensive trucking costs. In either case, the delivered feedstock weight will equal the net difference in weight between the loaded and unloaded truck.

It is very important to engage suppliers early on in the conceptual phases of pellet mill development, since local delivery methods, equipment, and preferences will all impact the overall design of the feedstock receiving and storage area.

The type of delivery truck, and therefore the process for unloading it, will be different for each of the feedstocks. For example, roundwood will be delivered in a log truck, which is unloaded either by a grapple arm mounted on the truck or by on-site machinery. Woodchips will come in either a walking-floor or standard box trailer. Walking-floor, or moving grate, trailers are automatic in their unloading; a standard box trailer will require a truck tipper for unloading, which is an additional piece of equipment that would be installed for this option.

An essential piece of equipment for the pellet mill is a bucket loader for moving both roundwood and woodchips around the pellet mill, utilizing a grapple attachment to lift and move roundwood and bucket to scoop and move woodchips.

Each of these feedstocks should be delivered directly into their respective storage space to avoid re-handling the material. Roundwood can be stacked out in the open and chipped using either onsite chipping equipment or a contractor with mobile chipping equipment. Woodchips, on the other hand, should be stored under cover and they are not to be stored for longer than three months. Stockpiles of woodchips will eventually begin to ferment and rot. In some extreme situations, large chip piles have been known to spontaneously combust. Though it may not be a likely source, any sawdust and wood shavings should also be stored under cover to avoid taking up more moisture, only to have to re-dry the material—an energy-intensive process.

If a woody dedicated energy crop, such as willow, is sourced for feedstock, it can be treated similarly to the primary wood feedstocks. Willow is more likely to be delivered as chips via dump truck, since harvesters typically blow willow chips into a wagon or truck, and these chips should be stored under cover for no longer than three months at a time.

Other energy crops, like grasses, or agricultural residues would be received as they are harvested. For example, grasses would most likely be delivered as bales by truck. Covered storage space should be allocated for these materials as well. Hay bales should not be wrapped in plastic while in storage.

Feedstock Preparation. Any feedstock received at the pellet mill will need to be prepared and conditioned for pelletizing. Roundwood will need to be de-barked (the bark content in pellets should be minimized to produce Premium or Super Premium pellets) and chipped. To de-bark and chip the roundwood, onsite equipment can be installed, though it can be rather expensive. Another option is to hire a contractor to come onsite with mobile equipment to do the chipping, though de-barking equipment is not typically available from a mobile third-party contractor; thus de-barking equipment should be installed regardless of whether on-site or third-party chipping is done. Larger pellet mills will be able to afford the cost of additional equipment, while it may be more viable for smaller pellet mills to contract out this work. Any removed bark can either be sold as mulch or can become fuel for drying the feedstock; either way, the bark represents a valued product.

When all materials are reduced to at least woodchip size, they are then further ground into finer particles for blending. This grinding is typically done with a stationary electric-powered hammermill.

Once ground, a majority of feedstocks also need to be dried to reduce the moisture content. This is typically done using a rotary drum dryer. Materials are conveyed into and through the dryer, and come out the other end dried to a uniform and consistent moisture content. Since these dryers run on fuel to create warm air for drying, it is possible to have a wood-fired dryer at a pellet mill, even using bark from de-barked roundwood feedstocks purchased by the mill. Alternatively, woodchips or wood wastes can be purchased for boiler fuel in addition to wood feedstocks for making pellets.

An essential piece of equipment for the pellet mill is a bucket loader for moving both roundwood and woodchips around the pellet mill,utilizing a grapple attachment to lift and move roundwood and bucket to scoop and move woodchips.

IV. OPERATIONAL PROCESSES AND ECONOMIC VIABILITIY (*cont'd*)

Densification and Extrusion. Once the material is sufficiently ground and dried it is fed to the pelletizer(s). There are two main types of pelletizers: flat-die mills and ring-die mills. They differ in the exact configuration of the mechanism through which feedstock is passed to be shaped into pellets.

The flat die type has a circular perforated disk on which two or more rollers rotate and extrude the material through the holes.

The ring die press features a rotating perforated ring on which rollers press the material to the outer perimeter. The feedstocks are pushed through the holes in the die with a ram piston or roller, depending on which type of equipment is used, and knives cut the extruded material to the desired length. The high heat and pressure created in this process melt the lignin, a substance found naturally in wood that holds wood pellets in shape. In feedstocks that lack lignin or sufficient quantities of it, additives like distilled lignin, starch, or wax can be added to hold the pellet together.

Cooling and Storage. When the pellets are made, they are spread out to cool, which sets the lignin (or other binding material, if used). Once cool, they are then screened to remove fines that can be created by the breakdown of pellets. These fines can be re-circulated back to the beginning of the process to be re-made into pellets. The resulting screened pellets are then moved to storage, which is typically a large-capacity silo, from where they can be sold to bulk distributors or bagged for retail sale. For bagging and packaging, an additional line of equipment is added to automate this process. Depending on the size of the pellet mill, different levels of automation for bagging and packaging can be achieved. Smaller pellet mills tend to rely on manual labor to operate bagging and sealing equipment and then stack filled bags on 1-ton pallets by hand, while larger pellet mills will use equipment to completely automate this process.

Right: There are two types of pelletizers: (left image) a flat die mill, a flat perforated disc over which rollers rotate pushing the material into pellets, and (right image) a ring die mill, a circular perforated disc on which rollers press to push the material through.

Left, clockwise: Once the pellets are made they are cooled and then screened to remove any fine material that would lower the quality of the pellet fuel.

Pellets can be stored at the mill in storage silos and later fed into bagging equipment or directly into delivery trucks for bulk sales.

Pellets are bagged for the residential market and can be sold by the bag or the pallet.

Packaging and Distribution. Bulk pellets are typically sold by the ton and delivered by truck. For this, pellets will be conveyed, either pneumatically or by auger, from the storage silo into the truck and brought to the customer who typically also has a storage silo onsite. Bagged pellets are bagged at the mill, and the process can be either low-tech and slow, or high-tech and able to produce hundreds of bags per hour. In either case, bagged pellets are stacked 50 bags per pallet to make one-ton pallets; the entire pallet is wrapped in plastic stretch-wrap for distribution. Another option that is gaining popularity is the one-ton bulk bag. Either way, bagged pellets can be picked up directly by customers at the mill—often for a better price than retail—or they are bought by distributors and delivered to retail stores or customers by truck. Distributors sell the pellets by the ton or bag.

IV. OPERATIONAL PROCESSES AND ECONOMIC VIABILITIY (*cont'd*)

Three possible mill sizes were considered here: 3, 6, and 12 tons-per-hour (TPH).

Conceptual Plant Recommendations

The following characteristics of the pellet mill are recommended and assumed here:

- Low-grade wood from integrated harvesting should be the primary feed-stock and the mill will produce, in its first years of operation, a 100 percent wood pellet meeting Premium quality standards or better
- The incorporation of alternative feed-stocks should be experimented with only after the mill is well established and a market for Standard pellets has emerged and grown
- A truck scale will be installed at the plant to avoid the use of third party weigh stations
- A bucket loader will be used to unload roundwood from delivery trucks (if they cannot self unload), to move roundwood around the wood yard, and to move chips around the yard
- Roundwood will be the primary feedstock and the mill design will include ample space for a wood storage yard
- Roundwood will be stored in the open (without cover)
- The mill should have ample storage space for a minimum three-month supply of wood feedstocks
- De-barking, chipping, and re-grinding equipment will be installed, as opposed to bringing in a third-party contractor to do the processing and chipping
- A rotary drum drier will be installed and fueled by a biomass boiler using bark from the de-barked logs (chips can also be purchased to supplement, if needed) and using an electrostatic precipitator or cyclone/baghouse combination to minimize particulate emissions
- Bulk storage silos and bagging equipment will be included

The above assumptions represent the conceptual plant modeled here. Following is more detailed discussion on mill capacity options and business structure. Together, these make up the full set of assumptions used to characterize and study the viability of this proposed pellet mill.

B. MILL CAPACITY

Three possible mill sizes were considered here: 3, 6, and 12 TPH. These mill sizes would be capable of producing approximately 19,440, 38,880, and 77,760 tons of pellets per year (TPY), respectively, when at full capacity.[3]

Each of these mill size options could have the same equipment installed, though larger capacity mills have more redundancy; these are made up of several lines of smaller equipment working in parallel. Smaller mills, in the 3-6 TPH size range, also may not warrant some of the more expensive components like truck scales and tippers or de-barking and chipping equipment that can be afforded at larger mills, as explained in the pellet manufacturing overview section. Each of these mill sizes requires a correspondingly larger footprint in terms of acreage and building size. Also, a larger mill will both receive and initiate more in-bound truck deliveries and out-bound product shipments.

C. BUSINESS STRUCTURE

Overview of Business Structure Options

There are a variety of business structures that may be appropriate for a mission-driven pellet manufacturing business; however, it is highly unlikely that any one approach will present the "perfect" model. It is therefore important to understand the options and weigh their respective advantages and disadvantages relative to the goals of the business. Below, the options available to Vermont businesses are presented and compared.

When considering business models, it is often helpful to identify the objectives for the attributes that come with business ownership. These attributes include the ability to partake in profits (or obligations associated with losses), governance and management of the operation, access to use of the business' products or services, and tax implications. In many cases, the goals concerning one attribute may be much more critical than other attributes.

Businesses can be organized as sole proprietorships, partnerships, or as corporations. Corporations are often the preferred structure for ownership of a business. In effect, the company is recognized by the state to have a distinct legal personality. Corporate status legally separates the company and its liabilities and interests from those of its owners or shareholders. This means the liability of any one owner is limited to their investment in the company; owners are not individually liable for the corporation's total obligations. As a result, incorporation makes it easier for a company to raise investment capital. Other attributes of a corporation are the ability to transfer ownership interests or shares as well as management and governance using a board structure.

There are a variety of business structures that may be appropriate for a mission-driven pellet manufacturing business; however, it is highly unlikely that any one approach will present the "perfect" model.

IV. OPERATIONAL PROCESSES AND ECONOMIC VIABILITIY (*cont'd*)

Vermont law allows for the following types of business structures:

- **For-profit (a standard C corporation or an S corporation)**
- **Nonprofit corporation**
- **Cooperative corporation**
- **Limited liability company (LLC)**
- **L3C or low-profit limited liability company**

Business organization is typically governed by state enabling laws and federal tax regulations. In addition to sole proprietors and partnerships, Vermont law allows for the following types of business structures:

- For-profit business corporations, which may elect for tax purposes, to be either a standard C corporation or an S corporation
- Nonprofit corporation
- Cooperative corporation
- Limited liability company (LLC)
- L3C or low-profit limited liability company

Standard Business or C Corporations

This is the standard structure for most major for-profit companies in the United States. These companies are typically created to provide wealth and other benefits for their owners. C Corporations are taxed on their corporate income and again on dividends at the shareholder level. This is often described as double taxation.

Subchapter S Corporations

S corporations are for-profit businesses that have elected (typically upon their incorporation) to be taxed according to Subsection S of Chapter 1 of the Internal Revenue Code (IRC). In these companies, taxation does not occur at the corporate level—profits or losses are passed through to the shareholders and reported on their individual tax returns. S corporations are often smaller companies due to various IRC requirements including only one class of shares and no more than 100 stockholders, all of whom must be natural persons (i.e., not corporations or partnerships) and American residents or citizens.

Nonprofit Corporations

Nonprofit corporations are created to benefit the greater good—they are not permitted to benefit individual owners, unless they are a support corporation formed by one or more nonprofits. Typically, nonprofits exist to meet charitable, cultural, educational, religious, scientific, or social purposes. Although controlled by members and/or boards, nonprofits have no private owners, no transfer of shares, and no financial benefit accruing to their directors or officers. Nonprofits may submit an application to the Internal Revenue Service (IRS) seeking 501(c)(3) status. This designation, which can take a year or longer to achieve, enables them to receive tax-exempt gifts from individuals and corporations. A wood pellet manufacturing facility, even one that targeted its benefits as environmental and / or its service to low-income people, would probably find it challenging to qualify as a 501(c)(3).

Cooperative Corporations

Cooperatives are corporations that are jointly owned and equally governed (one share = one vote) for the benefit of their members. Members typically produce or consume the product or service the cooperative sells. Vermont statutes proscribe strict requirements related to cooperatives including limits on the amount of interest that can be earned on capital stock, establishment and maintenance of capital reserve funds, distribution of dividends and limitations on ownership. There are also specific requirements that apply to agricultural marketing cooperatives which would impact a wood pellet manufacturing facility if the cooperative's owners were the source of the biomass for the pellets.

A consumer cooperative would not be impacted by these requirements. Many supporters of cooperatives and cooperative principles consider Vermont's co-op statutes as dated and overly-cumbersome. As a result, the state has seen other types of corporations that operate using cooperative principles.

Limited Liability Company (LLC)

LLCs combine attributes of partnerships and corporations. LLCs maintain the limited liability attributes of corporations, even though they are not incorporated. From a tax perspective, LLCs are typically treated as pass-through corporations, although they can elect to be treated as C or S corporations or partnerships. The advantage of LLCs is the amount of flexibility they offer for establishing different classes of members or owners, including varied financial and governance rights.

Low Profit Limited Liability Company (L3C)

Vermont was the first and is one of only eight states that have enabled these unique companies. L3Cs combine attributes of nonprofits and LLCs. Like nonprofits, L3Cs must be formed for charitable or educational purposes; however, unlike nonprofits, they are permitted to make profits that can be shared with their owners. L3Cs were created as a way to allow foundations to make program-related investments (PRIs) that support their missions and make some financial return on their investments. PRIs are recognized by the IRS as legitimate ways for a foundation to spend the required five percent of their net asset value each year. L3Cs can use these foundation investments to leverage more conventional capital, often at more favorable rates or terms. If the corporation is not likely to attract foundation investments, it makes no sense to form an L3C.

Table 8 on the following page is an abbreviated comparison of several of the business structure options presented in this report, compared here across several key parameters. A full table, including all of the business structure options presented here, and more detailed comparison can be found at the end of this report as Appendix C.

IV. OPERATIONAL PROCESSES AND ECONOMIC VIABILITIY (*cont'd*)

TABLE 8. Overview and Comparison of Business Structure Options

Ownership	C Corporation	S Corporation	Nonprofit	Cooperative	LLC	L3C
Limitations on who can own or create	Few, if any	No more than 35 owners; owners must be persons & US citizens or residents	Must be for nonprofit purpose	Only members who use (if consumer co-op) or supply (if marketing co-op) the cooperative	After start-up, new owners must be approved by existing owners	After start-up, new owners must be approved by existing owners
Governance						
Voting Power	Proportional to ownership, typically one vote per share	Typically one vote per share–can vary voting rights	One vote per member	One vote per member	Allows for differences in ownership classes and voting rights.	Typically proportional to investment
Earnings (Losses)						
Distributed as	Dividends	Earnings	NA	Patronage dividends (may be paper not cash transaction)	Earnings	Earnings
Start-Up Concerns						
Legal and admin costs	Most complicated and costly	Moderate	Can be costly if charitable purpose raises concerns at IRS	Can be costly due to lack of familiarity with co-op structure	Relatively easy	Slightly more difficult than LLC due to relative newness
Financing						
Sources of equity	Private capital markets	Friends and family	Foundation and government grants	Members	Friends and family	Foundations, friends, and family
Summary						
Advantages	Most familiar form for conventional investors	Tax advantages for the owners	Community benefits and is able to secure grants for social mission	Governance structure based on equality: one member = one vote	Great flexibility in ownership classes, no limitations on who can own. Less complex	Access to foundation PRIs, flexibility
Disadvantages	Complexity & double taxation	Limitations on ownership	No wealth creation and often not appropriate for profit-making entity	Often difficult to get 3rd party investments; VT law is cumbersome	Less known in some places–relatively well-understood in VT	Lack of familiarity (you pay for the learning curve)

An important note: In May of 2011, Vermont passed legislation (S.263) in support of Benefit, or B, Corporations. According to the website www.bcorporation.net, "B-Corporations are a new class of corporation that are required to create a material positive impact on society and the environment and to meet higher standards of accountability and transparency." Additionally, B-Corps require consideration of non-financial interests when making a decision and they are required to report on overall social and environmental performance using recognized third party standards. This business structure is relatively new to Vermont with little collective experience as of yet with developing these businesses in the State of Vermont. It is recommended here that VSHI consider this business structure as a possibility and continue to learn about its characteristics and merits.

Business Structure Conclusions and Assumptions

VSHI developed a business model that met the group's objectives for environmental and social sustainability and justice. Incorporated were characteristics like livable wages, donations of product to low-income Vermonters, and close consideration of public acceptance of certain models and practices. An important component was community involvement. Therefore, modeled here was a cooperative in which members will buy shares equivalent to the control of one ton of pellets, giving members the right to buy, sell, or donate their share of pellets. However, two other possible business structures that might be of interest to VSHI are an L3C or B-Corporation; these should also be considered as VSHI continues to pursue the development of this mill.

D. FINANCIAL VIABILITY OF A COOPERATIVE PELLET MILL

Modeling Assumptions

This assessment included the following assumptions:

- Owner equity will be 25 percent of the capital cost for the 3 TPH mill and 20 percent for the 6 and 12 TPH mills
- Shares will be $200 each, equivalent to one ton of pellets
- There were no other sources of funding such as grants or investments
- Fifty percent of the product will be sold on the retail market, 40-42 percent will be sold as shares, 5 percent will be donated to low-income Vermonters, and 3-5 percent will be unsold due to waste and marketing or other reasons
- The total land requirement is 6, 8, and 12 acres and land will cost $25,000 per acre
- The land is purchased outright (meaning it is not financed)
- There are no structures or existing infrastructure on the site
- The constructed space will be 11,000, 15,000, and 20,000 square feet and will cost $140 per constructed square foot
- The overall cost contingency was 15 percent
- Seventy-five percent of the capital cost of the 3 TPH mill is financed and 80 percent of the 6 and 12 TPH mills' capital cost is financed
- The loan term is 10 years and the financing rate is 6.5 percent
- The depreciation value for land is 7 years and for equipment is 30 years
- Roundwood from area harvesting will be the sole feedstock for making pellets

IV. OPERATIONAL PROCESSES AND ECONOMIC VIABILITIY (*cont'd*)

The capital cost estimated for each of the mill capacities being considered includes the purchase of the land, site work, building construction, setting up a wood yard, building and outfitting the mill itself, and other work like utilities, permitting, design and general contractor fees, and a contingency.

- Roundwood will be de-barked and chipped onsite and the bark will be used as boiler fuel for the feedstock dryers in the pellet mill
- In year 1, roundwood will cost $28-$32 per green ton (depending on the mill capacity and total volume purchased) and the price will escalate at the rate of general inflation, assumed here to be 3.5 percent per year
- In the first year of operation, pellets will sell for $220 retail and $190 wholesale (for more details on these markets and the differences between them, please see the Assessment of Pellet Fuel Markets section on page 50)
- The discount rate (used to calculate net present dollar values) is 7 percent

As part of this assessment, a spreadsheet-based tool was created to model the business and evaluate certain financial metrics. These were capital cost, profit and loss, 10-year pro forma financial assessment, simple payback, net present value, and internal rate of return. The model was set up for this study using the assumptions above, but these can be changed as the project concept develops or to assess sensitivities to changes in a given parameter. As a final product of this study, VSHI will receive a copy of this tool to continue to evaluate the potential success of this business as the concept is developed. In the interim, the above assumptions were used to achieve the set of results presented here, and discussed in more detail below.

Capital Cost

The total cost to develop a pellet mill will depend largely on the characteristics of the chosen site. If the site is already developed, with some buildings and infrastructure, the conversion to a pellet mill can be easier and less costly. If the site is undeveloped, the costs to construct a pellet mill will be greater. There are also the costs to prepare the site, construct space, purchase and install equipment, and other work.

The capital cost estimated for each of the mill capacities being considered includes the purchase of the land, site work, building construction, setting up a wood yard, building and outfitting the mill itself, and other work like utilities, permitting, design and general contractor fees, and a contingency. Again, certain assumptions were used (listed above) to characterize the capital cost of constructing a pellet mill at each of the three capacities being considered here.

Based on these assumptions, a 3 TPH pellet mill will cost $7.68 million; a 6 TPH pellet mill will cost $8.69 million; and a 12 TPH pellet mill will cost $12.66 million. Table 9 on the following page shows the total capital cost, the portion of capital raised through member share sales, and the remaining portion of the capital assumed here to be financed; a full itemized list of capital costs can be found in Appendix D at the end of this report.

TABLE 9. Pellet Mill Capital Costs			
	3 TPH	6 TPH	12 TPH
Capital Cost	$7,681,750	$8,694,250	$12,661,000
Cash from Share Sales	$1,920,438	$1,738,850	$2,532,200
Financed Amount	$5,761,313	$6,955,400	$10,128,800

Table 9: Shown here are the capital costs of a 3, 6, and 12 TPH pellet mill, based on the assumptions outlined in this report. Also shown are the portions of the capital cost covered by the sale of cooperative member shares and the remaining amount to be financed, as assumed in this analysis.

TABLE 10. Profit and Loss Assessment Results			
	3 TPH	6 TPH	12 TPH
First-Year Net Income 80% Operational Capacity)	$ -231,485	$73,817	$666,255
Second-Year Net Income (90% Operational Capacity)	$ -207,885	$111,187	$1,260,270

Table 10: First-year and second-year cash flow were found to be negative for the 3 TPH pellet mill modeled here and positive for the 6 and 12 TPH mills modeled here. It was assumed here that in the first year the mill will run at 80 percent operational capacity; in the second year, operational capacity was assumed to be 90 percent. These percentages account for some downtime at the pellet mill due to maintenance, breakdowns, or other causes.

It is important to note that a portion of this capital cost is working capital, or cash reserves to have in the bank for on-going expenses, such as purchasing feedstocks, cutting paychecks, and dealing with unexpected start-up expenses. This portion of the capital cost can be financed, even though it does not go directly to purchasing or installing equipment or infrastructure.

Profit and Loss

The capital costs explained above were used as one input into the economic analysis of the proposed pellet mill at each of the capacities being considered here. The first measure of economic feasibility assessed here is profit and loss (P&L); this measures the ability of a business to generate revenue.

Table 10 above shows net income for the first year (at 80 percent operational capacity) and second year (at 90 percent operational capacity). As discussed earlier, full operational capacity was assumed to be 90 percent, to account for losses in inventory and downtime at the mill caused by maintenance or breakdowns.

The results illustrate unfavorable economics for the 3 TPH mill; for the 6 TPH mill, cash flow is positive and there is even a first-year profit after taxes; the 12 TPH mill has the greatest net income. A full-page copy of this assessment can be found in Appendix E.

10-Year Pro Forma Financial Assessment

In addition to examining P&L, a 10-year projection was also conducted to determine the longer-term financial performance of each of the mill capacities considered here. This 10-year pro forma financial assessment examines performance on a cash accrual basis accounting for non-cash expenses, such as depreciation. This analysis builds on the assumptions above, and extrapolates them over a 10-year period, comparing annual net income against the initial capital investment.

IV. OPERATIONAL PROCESSES AND ECONOMIC VIABILITIY (*cont'd*)

Table 11:The 10-year cumulative profit was negative for the 3 and 6 TPH mills modeled here and positive for the 12 TPH mill. A negative result indicates a business that does not generate enough net income within the ten-year period to be profitable; a positive result represents a business that profits over the initial investment.

TABLE 11. 10-Year Pro Forma Financial Assessment Results

	3 TPH	6 TPH	12 TPH
10-Year Cumulative Profit	$ -617,827	$ -314,187	$ 1,015,261

A negative number as the result indicates a business that loses money over time; in other words, the net income is not enough within this 10-year period to offset the initial investment. A positive result indicates a business that makes money over the 10-year period; in other words, it pays back the initial investment and then continues to net profits. Table 11 above shows cumulative profit over the 10-year period considered here. A full pro forma financial assessment is included as Appendix F at the end of this report.

As can be seen above, the cumulative profit (after taxes) was greatest for the 12 TPH mill, at more than $1 million. The cumulative profit was negative at the end of the 10-year period for both the 3 and 6 TPH mill options. Again, it is important to note here that this pro forma financial assessment considers also the depreciation of equipment and infrastructure, which contributes to the negative result for the 3 and 6 TPH mills.

Other Financial Metrics

Simple payback is the first year profit, before taxes, divided into the total capital invested. While simple payback is a frequently cited measure of economic success, it does not take into account the changing annual performance of a business. For this reason, two other measures were examined; both are better metrics of a business's overall financial performance.

In general terms, ***Net Present Value (NPV)*** measures the value of an investment over time; in specific terms, it is the total cost to install and operate the pellet mill plus the profit gained from the mill over the 10-year analysis period considered here. The resulting value is given in today's dollar value for comparison, since these calculations take into account the inflating value of the dollar over time.

Internal Rate of Return (IRR) is based on NPV, but relates more to the actual financial performance of the investment, in this case the pellet mills being considered here. IRR translates the financial performance of the mills into a rate of return, analogous to an interest rate for earnings on an investment.

TABLE 12. Other Financial Results

	3 TPH	6 TPH	12 TPH
Simple Payback (years)	n/a	17	11
NPV of Investment	$542,704	$4,071,195	$12,599,890
IRR on Investment	n/a	-11%	7%

Table 12: Simple payback, net present value, and internal rate of return are shown here for each mill size option. The 12 TPH mill shows the best financial performance according to these metrics. The 3 TPH mill would be a poor investment with a net loss of money and an incomprehensible payback period and IRR on investment.

Ideally, the IRR of a business should be greater than the interest rate earning from investments in stocks or other financial packages to warrant the investment in the financially riskier business, compared to more traditional forms of investments. Table 12 above shows the results of each of these analyses.

Under the assumptions and scenarios considered here, the simple payback, NPV, and IRR were unfavorable for the 3 TPH mill with incomprehensible results for simple payback and IRR. In the case of NPV, while the result is a positive number, it shows an overall loss of money when compared to the initial capital cost of the 3 TPH mill. This result is like taking $7.68 million and investing it today, only to have $542,704 in 10 years (this value is in 2011 dollars, thereby accounting for inflation). This would be a poor investment that would continue to lose money.

The 12 TPH mill shows the most favorable simple payback, NPV, and IRR. Still, the NPV result shows a loss of money over the 10-year period ($12.66 million invested in capital today compared to a $12.6 million value at the end of the 10-year period, 2011 dollars). IRR for the 12 TPH mill is better than most current interest rates on traditional investments, but it is still low.

IV. OPERATIONAL PROCESSES AND ECONOMIC VIABILITIY (*cont'd*)

Table 13: Results of the financial analysis for each mill size option are shown here. Overall, the 12 TPH mill was the best option, from a financial perspective.

TABLE 13. Overview of Financial Feasibility Assessment

	3 TPH	6 TPH	12 TPH
Capital Cost	$7,681,750	$8,694,250	$12,661,000
Cash from Share Sales	$1,920,438	$1,738,850	$2,532,200
Financed Amount	$5,761,313	$6,955,400	$10,128,800
First-Year Net Income (80% Operational Capacity)	$ - 262,905	$73,817	$666,255
Second-Year Net Income (90% Operational Capacity)	$ -231,920	$111,187	$1,260,270
10-Year Cumulative Profit	$ -617,827	$ -314,187	$1,015,261
Simple Payback (years)	n/a	17	11
NPV of Investment	$542,704	$4,071,195	$12,599,890
IRR on Investment	n/a	-11%	7%
Overall Result	Negative	Negative	Marginally Positive

E. BUSINESS STRUCTURE AND FINANCIAL VIABILITY CONCLUSIONS AND RECOMMENDATIONS

VSHI favors a cooperative as the business structure. Using the assumptions considered here, only the 12 TPH mill is financially viable. Even still, this will be a low profit-generating venture. While both the 6 and 12 TPH mills would generate net income annually, when the depreciation of infrastructure and equipment is accounted for, as in the P&L and NPV assessments, the 6 TPH mill will lose money. In the case of the 12 TPH mill, the NPV results were not entirely favorable, but they were not terrible, and other financial metrics, like first-year cash flow, P&L, simple payback, and IRR were positive.

To summarize, the full set of results are compared in Table 13 above.

TABLE 14. Sensitivity of Financial Feasibility to Changes in Capital Cost at the 6 TPH Mill

Mill Size	6 TPH	6 TPH	6 TPH
CAPITAL COST	$8,694,250	$5,000,000	$3,500,000
10-Year Cumulative Profit	$ 1,415,169	$2,690,579	$3,168,309
Simple Payback (years)	17	9	6
NPV of Investment	$4,071,195	$4,855,047	$5,151,490
IRR on Investment	-11%	6%	18%
CAPITAL COST	Negative	Marginally Positive / Break Even	Positive

Table 14: The sensitivity of these financial results to changes in capital cost was tested for the 6 TPH mill option by reducing the capital cost first to $5 million and then to $3.5 million. While the 6 TPH mill was found not to be financially viable under the assumptions considered here (assuming an $8.69 million capital budget), reducing the capital budget to $5 million would make the 6 TPH mill financially viable and a capital budget of $3.5 million would be even more viable.

Another way to look at the financial viability of these mill options is to consider what capital budget could be afforded at each mill size while still yielding positive economic results. For the 3 TPH mill size, it seems that a budget of $2.5 to $3 million would yield positive results (compared to the $7.68 million capital cost considered here); for the 6 TPH mill, a budget of $3.5 to $5 million would be more viable (compared to $8.69 million considered here). And, while the results were positive for the 12 TPH mill as modeled here, they were marginal; the viability of the 12 TPH mill would be greatly improved by bringing the capital budget down from $12.66 million (considered here) to about $9.5 or $10 million. Conversely, a capital budget of $13.5-$14 million for the 12 TPH mill could tip the scales towards less viability. This emphasizes the importance of revisiting these economics as the project and its budget are developed.

Results of this sensitivity analysis for the 6 TPH mill option are shown in Table 14 above.

It is important to remind that these results are dependent on the assumptions used, including capital costs and business structure. These assumptions include a specific business structure, membership sales, an undeveloped site, and donations of product. A different scenario could yield quite different results.

V. ASSESSMENT OF PELLET FUEL MARKETS

A. OVERVIEW OF PELLET FUEL MARKETS

There are two main markets for pellet fuel: residential and commercial.

For the ***residential market***, wood pellets are sold in 40-pound bags at farm or building supply stores. These bags of pellets can be sold directly from the mill to customers at a discounted price, though customers would be responsible for their own delivery of the pellets, or the pellets can be sold to distributors who will offer the bags at a retail price. At home, the bags of pellets are manually emptied into a holding bin, from which the pellets are conveyed automatically into the heating appliance.

Small commercial- or institutional-scale applications require larger quantities of pellets because these facilities tend to be larger in size and have a higher heating load. For such applications, the 40-pound bag would be far too cumbersome and laborious; therefore, bulk delivery and onsite storage are essential for small commercial- or institutional-scale pellet heating systems. Bulk pellets will be sold at a lower wholesale price than bagged pellets. They can be sold to a trucking company, which then sells the pellets to its delivery customers. Another option is for the mill to sell bulk pellets at a wholesale price directly to customers.

TABLE 15. Comparison of Heating Fuel Costs

	Price Per Unit	Btu Per Unit (dry)	Moisture Content (%)	Average Seasonal Equipment Efficiency (%)	MMBtu[4] Per Unit After Combustion	Cost per MMBtu (after combustion)
Oil (gallon)	$3.55	138,000	0%	75%	0.104	$34.30
Propane (gallon)	$3.45	92,000	0%	80%	0.074	$46.88
Electric (kWh)	$0.12	3,412	0%	100%	0.003	$35.17
Natural Gas (ccf)	$14.04	1,000,000	0%	80%	0.800	$17.55
Cordwood (cord)	$200	seasoned		60%	13.2	$15.15
Pellets (ton)	$230	16,500,000	6%	80%	12.41	$18.54

Table 15: A comparison of heating fuel costs shows that pellets can be 10-25 percent less expensive to heat with than traditional fossil heating fuels like oil or propane.

With bulk delivery, the customer is charged per ton delivered, the price typically including a per-load fee scaled to the distance of the delivery. The pellets are conveyed from the delivery truck to the on-site storage, typically a silo identical to those used for grain, from which the pellets are fed into the boiler.

A pellet manufacturing business will sell pellets to both markets, offering a wholesale price for each. The wholesale price for residential pellet sales will be higher than for bulk due to added equipment, materials, and labor costs associated with bagging pellets.

The price of pellet fuels will impact the customer's decision to install a new wood pellet heating system. On average, heating with wood pellets will save 10-25 percent over fossil fuels, with the exception of natural gas: pellet fuels are often not cost competitive with natural gas.

As can be seen in Table 15 on the previous page, real dollar savings can be achieved when home or business owners offset some of their propane or oil use by installing a pellet heating system. Often these savings need to be significant enough to warrant the purchase and installation of a new appliance, though some homeowners cite other benefits to heating with wood as well.

The impact of market pellet prices on these savings should be kept in mind as the economics of the pellet mill are considered, since pellet sales, and their marketability, will be the driver behind cash flow at the mill.

B. DISTRIBUTION AREA

The distribution area for pellet sales will be the area within a cost-effective transport distance, just as was the case for the wood feedstocks. For this study it was assumed that pellets would be distributed within a 120 minute drive time radius from the proposed pellet plant, which is assumed here to be located at the center of Chittenden County. This radius is about two-times larger than the feedstock procurement area, a 60-minute drive time radius. In the case of pellet fuels, which are densified, there is far more value per ton of material transported, so it can be economical to transport pellets over a farther distance than for green wood feedstocks. The distribution area considered here also represents a balance between transportation economics and reaching a majority of the market in a largely rural area with low population density. As with the feedstock assessment, data is most often compiled and most easily calculated at the county level, so the distribution area comprises the following counties:

Vermont
Addison
Caledonia
Chittenden
Franklin
Grand Isle
Lamoille
Orange
Orleans
Rutland
Washington
New York
Clinton
Essex

In the case of pellet fuels, which are densified, there is far more value per ton of material transported, so it can be economical to transport pellets over a farther distance than for green wood feedstocks.

V. ASSESSMENT OF PELLET FUEL MARKETS (*cont'd*)

C. CURRENT PELLET FUEL MARKETS

Residential Market

Below: Pellets are a dry, densified, and value-added product that can be transported economically over greater distances than green wood. This map shows the distribution area assuming a 120 minute drive time distribution radius.

At present, there is limited data on the number of residences heated with wood pellets, but there are ways to estimate this number. The State of Vermont does survey home heating fuel use, and so a known average rate of pellet use can be applied. To do this, we looked here at the total heated residential area in the distribution area to estimate the portion of heating covered by wood pellets and therefore the current demand for wood pellets.

According to US census data (2000), there are 215,879 households within the distribution area being considered here. Assuming an average home is 2,000 square feet, this equates to about 431.758 million square feet of heated space. A Macro International study[5] conducted for the State of Vermont found that 2.79 percent of the homes in Vermont are heated, at least partially, with pellets. Using this figure, and extrapolating it also to the adjoining counties in New York, it is estimated here that approximately 12 million square feet of residential space, or about 6,000 homes (12 million divided by the average 2,000 SF house size) within this distribution area are currently heated by pellets, at least some of the time. BERC's extensive experience with woody biomass heating has shown that approximately 0.003 tons of pellets are consumed per year to heat one square foot of residential space; therefore, these pellet-heated homes within this distribution area might consume about 36,000 tons of pellets annually. Table 14 on the facing page shows these results by county and by state.

These estimated results indicate that there is a strong current market for wood pellets used for home heating within the distribution area being considered here, comprised of northern Vermont and northeastern New York. It is important to note that some of western New Hampshire may also fall within the distribution area, given the shorter drive times allowed by using Interstate 89, further increasing the size of the potential current market.

TABLE 16. Estimated Current Residential Pellet Demand

County	Number of Households (2000 Census)	Estimated Total Residential Area (SF)	Estimated Pellet Heated Area (SF)	Estimated Pellet Demand (tons/yr)
Vermont				
Addison	13,068	26,136,000	729,194	2,188
Caledonia	11,663	23,326,000	650,795	1,952
Chittenden	56,452	112,904,000	3,150,022	9,450
Franklin	16,765	33,530,000	935,487	2,806
Grand Isle	2,761	5,522,000	154,064	462
Orange	10,936	21,872,000	610,229	1,831
Orleans	10,446	20,892,000	582,887	1,749
Rutland	25,678	51,356,000	1,432,832	4,298
Washington	23,659	47,318,000	1,320,172	3,961
Vermont Total	171,428	342,856,000	9,565,682	28,697
New York				
Clinton	29,423	58,846,000	1,641,803	4,925
Essex	15,028	30,056,000	838,562	2,516
New York Total	44,451	88,902,000	2,480,366	7,441
Grand Total	**215,879**	**431,758,000**	**12,046,048**	**36,138**

Table 16: The total estimated current pellet demand for residential heating in northern Vermont and northeastern New York is more than 36,000 tons of pellets per year.

V. ASSESSMENT OF PELLET FUEL MARKETS (*cont'd*)

Payback periods (for new pellet installations) are closely linked to fossil fuel costs and are most favorable when average oil prices rise to $3.00 per gallon or more, while the cost of pellets and pellet heating systems remain stable.

Commercial Market

Currently, several schools and community buildings within this distribution area heat with wood pellets supplied in bulk, such as the Interfaith Center in Shelburne, NRG Systems in Hinesburg, People's Academy in Morrisville, and Craftsbury Academy in Craftsbury, among others. Just over the Vermont border into New Hampshire is Dartmouth College in Hanover, where the Sachem Village student housing community is heated with a centralized wood pellet district heating system. Collectively, these commercial customers represent a relatively small market, purchasing only about 3,000 to 5,000 tons of pellets per year. However, indications are that this market will continue to grow as more owners of facilities in this size range consider alternative heating options. More information on small commercial biomass heating systems can be found in the national database of community-scale biomass energy projects housed on the BERC website.[6]

D. POTENTIAL GROWTH OF PELLET FUEL MARKETS

In both the residential and commercial markets, new pellet heating systems are installed every year. According to the national trade association Hearth, Patio, and Barbeque, annual sales of wood pellet stoves in the US has increased by nearly 300 percent in the past 10 years. These appliances can be stoves that heat a room or two, boilers that heat and provide hot water to homes, schools, or small commercial or institutional buildings, or centralized energy plants that pipe heat to multiple buildings and users. The continued growth of this market depends on the success of appliance vendors in selling these systems to Vermont customers, thereby creating the demand for pellet fuel.

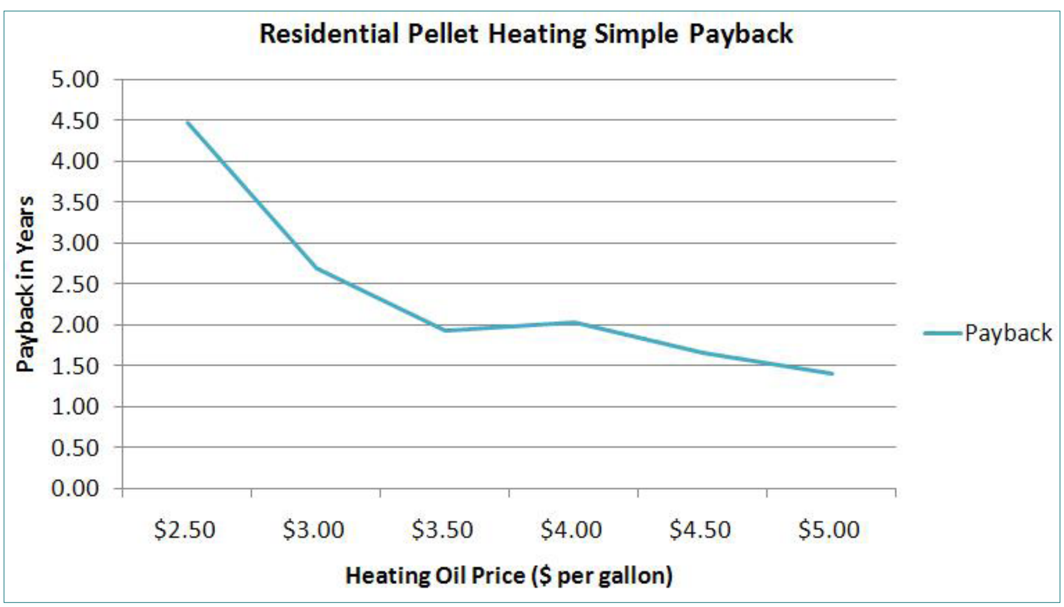
Of course the rate of new installations is very hard to predict, but previous research by BERC has shown an important link between the likelihood of installing a pellet system and the length of the payback period on that new energy system. Home and business owners are typically looking for a payback period within a few years; communities and municipalities prefer a payback within 10 years. This payback period is closely linked to fossil fuel costs. Payback periods are most favorable when average oil prices rise to $3.00 per gallon or more, while the cost of pellets and pellet heating systems remain stable.

In general, the sale and installation of centralized wood pellet boilers will see the most rapid growth within the overall pellet heating industry as these systems become more well-known and gain popularity. In Vermont, Governor Shumlin has recently mandated Efficiency Vermont to develop a biomass boiler incentive program that will apply only to the purchase of new biomass boilers—the incentive will not apply to new stoves.[7] This will likely make the growth of this market more rapid, particularly if increases in oil prices align with the availability of this incentive, making payback periods even more attractive.

Residential Market

Residential Stove and Boiler Sales. This pool of customers will continue to grow as fossil heating fuels rise and technology costs decrease. It is relatively easy for homeowners to purchase and install a new pellet stove; they have lower capital costs, and installation is simple with direct venting through the nearest wall. Pellet boilers are still not widely perceived as being an option due to an overall lack of a robust sales and service market for these systems, but as this changes, they will be more often considered for central home boiler systems. The recently developed incentive program offered through Efficiency Vermont will provide home and business owners rebates on a newly installed high-efficiency pellet boiler.

As discussed earlier, residents will be largely driven by economics and, in particular, payback period, which is affected in part by increasing fossil fuel cost. Previous work by BERC has shown that homeowners were most likely to install a pellet heating system if the payback period was within three years; less likely with a payback within five years; and least likely if the payback was five to seven years. For the payback period to be less than three years for the typical home installation, average oil prices would need to be $3.00 per gallon or more. The figure below shows the relationship between increasing oil prices and the payback period on installing a residential pellet heating system, assuming that the price of pellets and the cost to install the system are the same.



Left: As oil prices increase, the payback period becomes shorter, assuming that pellet prices and pellet heating system installation costs remain the same.

V. ASSESSMENT OF PELLET FUEL MARKETS (*cont'd*)

For the purpose of illustration, we estimate here that new pellet heating systems are installed to heat 2.5 percent of the residential space not currently heated with pellets within the distribution area, a relatively conservative estimate overall. In this case, the residential market alone would grow by nearly 32,000 tons of pellets annually, bringing the total annual residential demand for pellets within the distribution area considered here to about 67,000 tons per year. Table 17 below shows the calculations done to estimate the potential new growth in the residential pellet heating market.

Table 17: Estimated potential growth of the residential pellet fuel market in northern Vermont and northeastern New York could increase annual pellet demand by nearly 32,000 tons per year.

TABLE 17. Estimated Potential Growth in Pellet Demand

County	Total Residential Area Not Currently Heated by Pellets (SF)	New Pellet Heated Area (SF)	Estimated New Pellet Demand (tons/yr)
Vermont			
Addison	25,406,806	635,170	1,906
Caledonia	22,675,205	566,880	1,701
Chittenden	109,753,978	2,743,849	8,232
Franklin	32,594,513	814,863	2,445
Grand Isle	5,367,936	134,198	403
Orange	21,261,771	531,544	1,595
Orleans	20,309,113	507,728	1,523
Rutland	49,923,168	1,248,079	3,744
Washington	45,997,828	1,149,946	3,450
Vermont Total	266,883	7,446	24,997
New York			
Clinton	57,204,197	1,430,105	4,290
Essex	29,217,438	730,436	2,516
New York Total	86,421,634	2,160,541	6,806
Grand Total	**86,688,517**	**2,167,987**	**31,803**

TABLE 18. Annual Business Donations to Low-Income Vermonters (tons donated per year) *These donation levels represent 5 percent of the total annual pellet production.*

Mill Size	3 TPH	6 TPH	12 TPH
Total Pellet Production (tons per year)	19,440	38,880	77,760
Total Pellet Donations (tons per year)	972	1,944	3,888

Table 18: VSHI's business model includes donation of 5 percent of the annual product to low-income Vermonters participating in VSHI's home pellet heating assistance program. The total annual demand for pellet fuels from these customers could be 4,500 tons, while the volume of donations would range from 972 to 3,888 tons per year at the mill sizes considered here. The business's donations would likely need to be supplemented by other donations or programs.

Low-Income Heating Assistance Programs. In the 2010-2011 heating season, over 40,000 Vermont households requested fuel assistance; of these, roughly 36,000 households received some level of assistance. VSHI has the goal of adding 1,000 more low-income Vermont homes to a heating assistance program that provides leased pellet stoves at a nominal fee and donated or discount pellet fuel. To estimate the total square footage that could be converted to pellet heating through this program, we assumed that each house is 2,000 square feet on average, meaning 2 million square feet of new pellet heated space would be added. On average, it takes 0.003 tons of pellets per year to heat one square foot of residential space; thus, the total demand for pellets created by this program would be 4,500 tons per year.

VSHI's current business model requires 5 percent of the product be donated to low-income heating programs. A 3 TPH mill producing 19,440 tons of pellets per year would donate 972 tons annually, while a 12 TPH mill producing 77,760 tons of pellets per year would donate 3,888 tons, plus any additional tonnages donated by co-operative shareholders (who also are free to donate any portion of their shares). A low-income heating program aiming to add 1,000 additional low-income Vermont homes could not be entirely supported through 5 percent donations from any of these mill size options, but donations could come from cooperative members or other campaigns. Table 18 above shows the business's annual donations for each mill size option considered here.

Commercial Market

The small commercial and institutional scale market will also be interested in the payback period of new pellet heating systems. Businesses need to present this as a fiscally smart opportunity to their management, while community buildings often depend on voter approval for financing. A critical element of these decisions is the impact on the bottom line.

It is difficult to assess the growth in the bulk pellet fuel market that these new systems can represent; though it is safe to say that energy prices will continue to rise and building owners will be looking for ways to save on heating costs. There are several small commercial and institutional buildings within the distribution area considered here that already have pellet heating systems and indications are this market is poised to take off. For the purpose of illustration, it was assumed here that 2,000-5,000 tons of new pellet demand could be added by new small commercial and institutional installations in this distribution area in the next few years. The potential for growth in this market is significant, particularly in small commercial or institutional settings larger than residential buildings but that do not have the heating demand to warrant a larger woodchip heating system. Additionally, the Efficiency Vermont biomass boiler incentive program (described in the previous section) will apply to these facilities as well.

V. ASSESSMENT OF PELLET FUEL MARKETS (*cont'd*)

E. COMPETING PELLET MILLS

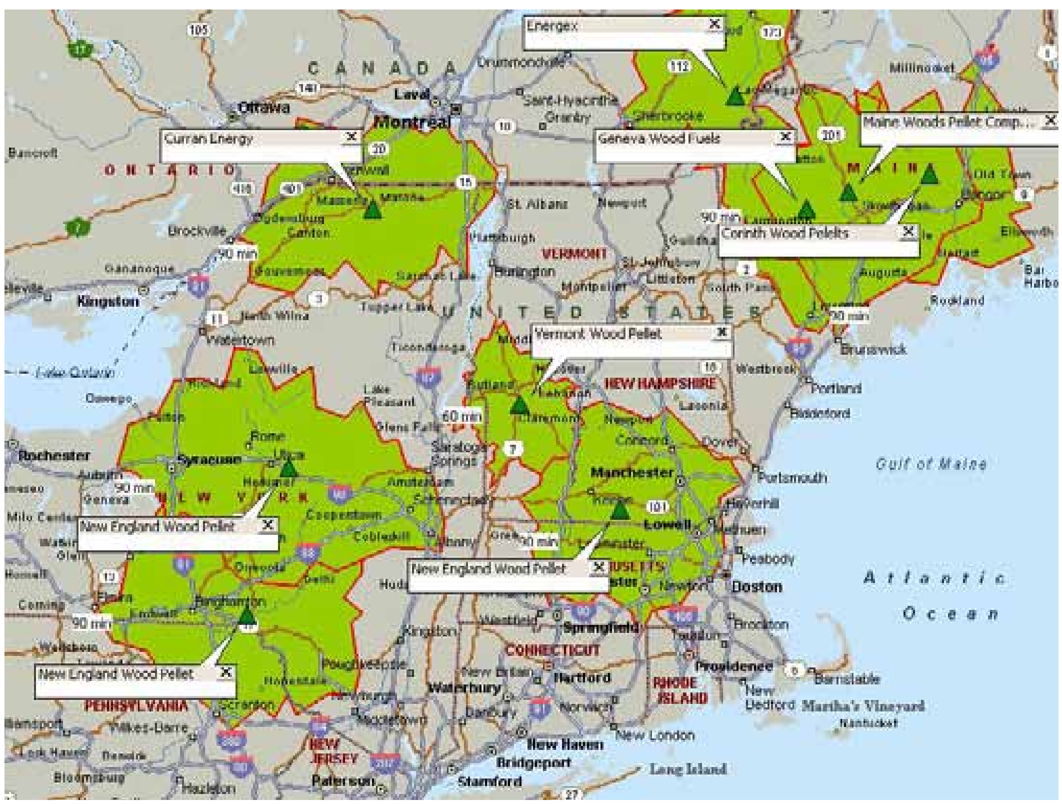
Existing Mills

Below are descriptions of the existing pellet mills within the distribution area considered here and the distance, in both miles and drive time, between the competing mill and the location of the pellet mill proposed here (assumed to be the center of Chittenden County).

Vermont Wood Pellet Company LLC (VWP) www.vermontwoodpellet.com

VWP began commercial production of pellets in September 2009 in a converted pallet mill in North Clarendon, Vermont. VWP purchases pine pulpwood as its main fiber and produces about 10,000 tons of pellets per year sold in bulk and 40-pound bags. VWP has bulk distribution representation in Addison County via Bordeau Brothers and a retail relationship with the Addison County Relocalization Network (ACORN) for bagged product distribution.

Right: There are several pellet mills in Vermont, New York, New Hampshire, Maine, and Quebec that could be competitors for this proposed mill; however, there is minimal overlap among the distribution areas of these mills, so competition will not be strong.



This mill is located about 96 miles or a two-hour drive from the center of Chittenden County. There is minimal overlap between the distribution areas of these two mills, thus VWP does not represent major competition.

Curran Renewable Energy LLC
www.curranpellets.com

When at full capacity, this mill can produce 100,000 tons of finished pellets annually. Currently, the mill is operating at less than full capacity. Curran Energy uses paper grade woodchips from its own harvesting operations. This mill is located in Massena, NY approximately 130 miles or a three-hour drive from Chittenden County. There is minimal overlap between the distribution areas of these mills, thus this mill does not represent a major competitor.

New England Wood Pellet (NEWP)
www.pelletheat.com

NEWP owns and operates two existing pellet mills and has a third under development. Its flagship facility is located in Jaffrey, New Hampshire, 130 miles from Chittenden County. Its recently completed second mill, located in Schuyler, New York, is 170 miles or three hours away from Chittenden County. Its Deposit, New York facility is about 270 miles or five hours away from Chittenden County. In addition to the three pellet mills, NEWP operates a pellet distribution center located in Palmer, Massachusetts that is far outside of the distribution area for the mill being proposed here. None of these mills represent major competition for the mill proposed here for Chittenden County, since there is minimal overlap in their distribution areas. NEWP will, however, be a strong competitor in New Hampshire or southern Vermont.

Energex
www.energex.com

Energex operates two pellet mills in the region—the first in Mifflintown, Pennsylvania and the second in Lac-Megantic, Quebec. The Quebec mill is 175 miles or four hours from the center of Chittenden County; there is minimal overlap in the distribution area. The Pennsylvania mill is too far away to effectively compete with a mill in Chittenden County.

Maine Woods Pellet Company
www.mainewoodspelletco.com

This recently completed pellet mill is located in Athens, Maine. This pellet mill can produce up to 100,000 tons of pellets annually and distribute both bulk and bags. This mill is well outside the distribution area for the mill being proposed here; however, potential customers in northern and central New Hampshire will have several competing mills to choose from: Maine Woods Pellet, New England Wood Pellet, Corinth Wood Pellets (below), and the mill being proposed here. There could be the potential for strong competition in the northern New Hampshire market.

Corinth Wood Pellets
www.corinthwoodpellets.com

Corinth Wood Pellets is a new pellet mill in central Maine that produces hardwood pellets and distributes bulk and bagged product. Again, while this mill does not present a major competitor since it is far from Chittenden County, Vermont, there will be strong competition in the northern New Hampshire market as these customers will have several options from which to choose.

V. ASSESSMENT OF PELLET FUEL MARKETS (*cont'd*)

Proposed Mills

The following is a description of one known proposal for a new pellet mill in Vermont. While this project is currently under development and is moving forward, there is no certainty at this time that it will be built.

Beaver Wood Energy, LLC

There is currently a proposal for a biomass electric generation station in Pownal, Vermont. The proposal includes the co-location of a pellet mill to utilize the waste heat from electric generation. If built, this mill could present a major competitor both for feedstock, in the case of roundwood, and in product sales in the case of pellets. Pownal, Vermont is more than 140 miles or a three-hour drive from Chittenden County.

TABLE 19. Market Assessment Results

Market Sector	Estimated Annual Demand (tons)
Current Residential	36,138
Current Commercial/Bulk	5,000
Total Current Demand	41,138
New Residential – private	31,803
New Residential – public assistance program	4,500
New Commercial	5,000
Total New Potential Demand	41,303
Grand Total	82,441

Table 19: Total current pellet demand is estimated to be more than 40,000 tons per year in northern Vermont and northeastern New York including both the residential and small commercial/institutional markets. This demand could grow to more than 80,000 tons per year as fossil fuel prices increase and with the help of incentive programs that encourage the installation of pellet heating systems.

F. MARKET ASSESSMENT CONCLUSIONS AND RECOMMENDATIONS

From the data and estimations presented here, it appears that there is currently an annual demand for about 41,000 tons of pellets per year. However, with the growth of the market through increased demand from residences, low-income fuel assistance programs, and community scale applications, the annual demand could potentially grow to about 82,400 tons per year. It would take several years to ratchet up to this level, but this potential market could support the proposed pellet mill, even at the largest 12 TPH capacity.

Such growth in these markets will be encouraged and made more rapid with targeted programs and campaigns, more advertising and dissemination of good information on pellet heating, and joint efforts between pellet system vendors and pellet fuel manufacturers. To recap on the assessments shown above, Table 19 on the previous page summarizes the current and potential future markets as estimated here.

While there are several other pellet mills within Vermont, New York, and New Hampshire, there is not significant overlap among distribution areas. Northern Vermont has been without a local pellet production facility for some time, and current pellet customers have expressed interest in a more local option. The greatest level of competition could come from the proposed Beaver Wood Energy electric generating and pellet manufacturing plant in Pownal, Vermont. Because this electric plant and pellet mill will potentially be a very large wood consumer, it will have a correspondingly large procurement radius that could overlap with the proposed mill in Chittenden County.

As for product sales, this mill would be best suited for distributing product throughout southern New England, but the distribution area will also overlap with the mill proposed here. Any other proposed plants located in northwestern Vermont or northeastern New York could be strong competitors. However, the Beaver Wood Energy plant is not currently under construction and is not yet a certainty.

It is important to note the difference between current market demand and the annual output of the three pellet mill sizes outlined here. The 3 TPH mill will meet only about half of the current market demand, producing just less than 19,440 tons of pellets per year. The 6 TPH mill will not quite meet the current annual market demand, either, producing 38,880 tons of pellets per year. The 12 TPH mill, however, will produce nearly two times as much product as is currently in demand—77,760 tons per year.

Of course, no one mill can be guaranteed the full share of the current or potential future pellet fuel markets. For illustrative purposes, if only 10 percent of the market demand was met by this proposed pellet mill, this would equate to an annual demand of only 4,100 tons of pellets—hardly enough to support any of these pellet mill size options. Three-quarters of the current market demand would be 30,000 tons of pellets, which would more than support the 3 TPH mill and would match well with the 6 TPH mill, with some room for growth in the market. The 12 TPH mill will produce far more pellets than can be consumed by the current market, but the output is well matched to the potential future market as demand for pellets grows in the coming years.

While there are several other pellet mills within Vermont, New York, and New Hampshire, there is not significant overlap among distribution areas.

VI. COMMUNITY SUPPORT

***Disclaimer:** This section of the report was drafted by VSHI board members and edited by BERC staff.*

A. METHODS FOR ASSESSING COMMUNITY SUPPORT

Several approaches were used to assess community interest in and general support of a pellet manufacturing business located in Chittenden County. Careful attention was paid to land use, sustainability and harvesting, and pellet demand. VSHI board members conducted this outreach to select boards, planning and zoning officials, and community members through conversations and a survey.

B. TOWN OFFICE SUPPORT

In talking with town officials, all towns were interested in job creation and generating revenue for landowners; most planning officials were excited about the potential to site this facility and expressed a willingness to work towards that goal. Some towns, however, presented permitting and public acceptance issues such as noise, dust, truck traffic, and a history of permitting complications. One example is Burlington, where the population density and land use patterns may not align well with the development of a pellet mill. Others, like Essex and Richmond, have large landholdings and areas zoned appropriately for this type of development.

C. COMMUNITY SUPPORT

Engaging the Public

It was important to VSHI to engage the public from the beginning, as board members felt that the community's participation and support would depend largely on their opinions of the mill, the business, and the methods and practices employed by both. For example, reliably sourcing pellet feedstocks can depend on the public's perception of logging, agriculture, and woody biomass energy. Two examples of areas that are perceived by VSHI to be affected by community involvement are:

Reliable Supply of High Quality Feedstock. This will include public and municipal support of the local sourcing of biomass feedstocks including woody residues from mills, responsibly harvested wood from area forests, and possibly clean community wood wastes and dedicated energy crops like grasses. These feedstocks can come from privately owned lands or municipal or state lands; in either case, support from landowners and town officials is imperative.

Public Acceptance of Feedstock Harvesting and Pellet Use. It will take the involvement of town energy committees and local environmental groups to ensure that both the production and use of pellet fuel is kept in line with the community's standards for environmental safety and responsibility. It is feared that, if these groups perceive that the pellet facility is not being run to high environmental standards, there will be considerable opposition to the operations of the mill.

Additionally, conversations with community members yielded a sense of general support for the following practices, which could be supported by the pellet mill proposed here.

- Maintaining biodiversity
- Reclaiming overgrown pasture land
- Increasing the value of our forests
- Harvesting invasive species and grasses as feedstock

It is vital to recognize all of the above issues in establishing a pellet production facility so that the diverse communities within the county will support the long-term sustainability of the business. These are opportunities for public education and areas to continually monitor as VSHI gauges public support for this proposed pellet mill.

Survey Results

Community interest in the development of a local pellet mill was assessed by VSHI through attending functions in several towns and talking with community members. Additionally, an online survey was developed by VSHI to evaluate public interest and concerns related to a wood pellet facility in the county. Community members were invited to take this survey, located at https://www.surveymonkey.com/s/3V58PGL. As of June 16th, 2011, there were 112 responses; the questions and results are given on pages 64-67.

Question 1 evaluated the diverse reasons community members were interested in local pellet production. Its intention was to decipher whether savings on fuel cost were the primary driver or if there were other concerns, such as environmental responsibility, when the public considered heating with wood pellets. The response shows that there are multiple considerations taken into account when choosing pellet fuels. It is important to recognize that there are informed members of the local community and that, while savings on heating costs are important, there are other critical environmental issues being considered as well.

Question 2 shows interest in production of a high quality pellet. This is in agreement with other relatively small pellet producers. Low-quality pellet production over time is not supported by a local market.

In ***Question 3***, the majority of respondents thought that a higher level of environmental protection than required by the state was important.

Question 4 responses show clear interest in business models other than only a for-profit corporation.

Question 5 results showed deep support for both social and educational functions of local pelletization.

Responses to ***Question 6*** show significant interest in a co-operative business model.

Question 7 shows the feasibility of raising capital to form a co-operative pellet corporation at a level of $200 per member share.

The tables on the following pages detail the compiled survey results of questions 1 through 7.

VI. COMMUNITY SUPPORT *(cont'd)*

The survey was designed by VSHI and the comments, opinions, and perspectives presented here are those of VSHI board members and survey respondents;The views and opinions expressed in this section do not represent evidence, research, or results of any analysis conducted or presented by BERC.

QUESTION 1. Wood pellet heating has several advantages over other types of fuels. My primary interest in pellet fuel is because...

		Response Percent	Response Count
Pellets are less expensive than other fuels.		3.7%	4
Pellets are part of the short term carbon cycle and thus do not contribute to climate change green house gases.		9.2%	10
Pellets can be produced locally and thus will create jobs and keep money in the local economy.		11.9%	13
Pellets are cleaner burning than cord wood fuel.		2.8%	3
All of the above reasons are important.		72.5%	79
	answered question		109
	skipped question		3

QUESTION 2. There is a significant difference in the quality of pellets that are available on the market. Price is not always related to quality. These differences are a function of ash content, moisture content, dust that can clog your stove and large size pellets that can block your stove. The highest quality pellets also have a very high energy content per ton of fuel. If a local pellet mill is established it should...

		Response Percent	Response Count
Produce pellets at as low a cost as possible; quality is a secondary concern.		0.9%	1
Produce "functional" pellets at a low price.		40.0%	44
Produce only the highest quality pellets at a reasonable price.		59.1%	65
	answered question		110
	skipped question		2

QUESTION 3. There are many environmental issues related to local pellet manufacturing practices. Some of the issues are soil conservation, sustainable logging practices, wild life habitat preservation, biodiversity management, and air quality from both producing and burning the pellets. What level of environmental protection should be used in the local production of pellets?

		Response Percent	Response Count
The goal should be to produce pellets at as low a cost as possible, thus the less environmental regulation, the better.		2.8%	3
The existing state and local environmental regulations are sufficient.		42.2%	46
Local pellet production should be managed for higher levels of environmental protection than required by the state, even if that increases the cost and decreases to total amount of wood pellet fuel that can be produced.		55.0%	60
	answered question		109
	skipped question		3

QUESTION 4. There are many types of business models that can be used to set up a local wood pellet mill. Given the goals of being economically viable as a business and addressing environmental concerns, what type of business model do you think would work the best?

		Response Percent	Response Count
A for profit business. This would allow market forces to establish prices and quality. Investors should benefit.		12.3%	13
A Non-Profit company set up to serve the interests of the community. Profit should not be the goal of a bio fuel industry in Chittenden County.		3.8%	4
A Co-Op model where the Co-Op members are the investors and owners of the pellet production facility. This should allow the members to maintain high quality pellets and local protection of our environment.		13.2%	14
An L3C. This is a type of corporation in Vermont that has a limited liability and a limited profit that can be made. An L3C can be set up with an environmental and social justice mandate in its charter.		11.3%	12
A hybrid corporation that is both a Co-Op and an L3C. This would allow both ownership by the Co-op members and the strong protection of both environmental and social justice statements in a corporate charter.[8]		21.7%	23
A hybrid corporation as mentioned above that directly donates a percentage, say 5% of the pellet production to the Vermont fuel assistance program for low income families at no cost to the state or families. The idea of this model is that the natural resources of the state must be used to provide for the most needy in our communities. (A separate program would provide the pellet stoves to the fuel assistance clients.)		37.7%	40
	answered question		110
	skipped question		2

VI. COMMUNITY SUPPORT *(cont'd)*

QUESTION 5. Should a wood pellet operation in Chittenden County have social justice and/or educational functions as part of its charter? Which of the following do you think should be part of a local pellet mill's operation? Please include all that you think are appropriate.

		Response Percent	Response Count
There should be no social component of local biomass production.		5.6%	6
Assistance to local low income families at 2% of total production.		22.2%	24
Assistance to local low income families at 5% of total production.		54.6%	59
There should be no educational component of local biomass production.		1.9%	2
Educational connection to local colleges for research on the sustainability of the pellet mill.		82.4%	89
Educational connection with local schools.		73.1%	79
Educational connection for using biomass harvesting to promote biodiversity in our local ecosystem.		67.6%	73
Research on different feed stocks including grasses and other non-woody forms of biomass.		66.7%	72
Research on uses and technology for pellet biomass fuels.		75.9%	82
	answered question		108
	skipped question		4

QUESTION 6. If a pellet production facility is established in Chittenden County it will have many benefits. A facility that produced 28,000 tons of pellets a year would have a significant economic impact. This would replace roughly 3.3 million gallons of fuel oil. 85% of money spent on fuel oil leaves the local economy. 85% of money spent on locally produced pellets would stay in the local economy. As this money circulates through our local business it would have at least a $20 million local stimulus. I am interested in...

		Response Percent	Response Count
investing in a privately owned, for profit company.		8.3%	9
investing in a non-profit.		10.2%	11
investing in a co-op where each share will allow me to purchase one ton of pellets a year at cost.		45.4%	49
not investing.		36.1%	39
	answered question		108
	skipped question		4

QUESTION 7. To raise capital to establish a non profit or co-op, shares could be sold for $100 each. If 28,000 shares were sold this would raise $2.8 million. More money would then have to be borrowed to set up the co-op production facility. If shares were sold for $200 each then less money would have to be borrowed. Each share would allow the owner to purchase one ton of pellets a year at member prices. They could use their pellets, donate them to the fuel assistance program, or have the business sell them on the open market to make money for the member. What price should the shares that control one ton of pellet production be set at?

		Response Percent	Response Count
$100 per share. This raises $2.8 million and $2.8 million is borrowed.		26.1%	24
$150 per share. This raises $4.2 million and $1.4 million is borrowed.		30.4%	28
$200 per share. This raises $5.6 million and no additional money will need to be borrowed.		43.5%	40
	answered question		92
	skipped question		20

QUESTION 8. I am interested in further information regarding local pellet production. If a non profit or co-op model is established I would be interested in being a member of such an organization. Members would have a voice in controlling the operation of the facility, its harvesting practices and mission statement. You do not need to live in Chittenden County to be part of this organization.

		Response Percent	Response Count
Name:		94.6%	35
Company:		10.8%	4
Address:		83.8%	31
Address 2:		2.7%	1
City/Town:		91.9%	34
State:		97.3%	36
ZIP:		86.5%	32
Country:		59.5%	22
Email Address:		97.3%	36
Phone Number:		73.0%	27
	answered question		37
	skipped question		75

VI. COMMUNITY SUPPORT *(cont'd)*

This information was collected mainly to keep interested community members informed as the proposed pellet mill is developed. The results, however, are interesting because they indicate the percentage of respondents who were interested enough to give full contact information. Thirty-seven of the 112 respondents surveyed as of June 16, 2011 were interested in staying informed and shared their contact information.

The survey is only a preliminary indication of the type of interest in local pellet production. The sample size is small and biased, however, it can be used to support continued development of a co-operative model.

D. COMMUNITY SUPPORT CONCLUSIONS AND RECOMMENDATIONS

Through VSHI's conversations with community groups and from the results from the on-line survey, it appears that VSHI will find support in Chittenden County for the pellet mill proposed here. In particular, there is strong support for careful attention to be paid to the issues that matter to community members, municipalities, and town offices. Largely, this support is conditional as to the extent that sustainable practices are used. Still, an important point is whether this support will actually come in the form of member shares purchased, and to what level. Whether 20 to 25 percent of the capital cost can realistically be raised through member sales remains to be seen.

Results of the on-line survey indicate that there could be support for a local pellet industry if it is run as a non-profit, an L3C, a benefit corporation, or a co-operative. There is a long history of such corporations in Vermont for energy, agricultural, and other industries.

One of the public's concerns regarding a for-profit business model is that the long-term goal will be to make a profit and will come at the expense of not caring for the forest resources of the state for the long-term. This is less of a concern for alternative business models as shown in the survey results.In order to be successful, a biofuels processing pellet facility in Chittenden County will need to establish a balance between diverse community goals such as:

- Job creation
- Long-term sustainability
- Deep commitment to the local environment
- Development of local "green" fuels
- Use of the resources in our community and a need to be efficient in our use of resources
- Retention of fuel dollars in the local economy
- Appreciation that high fuel costs are causing a crisis for our lowest-income neighbors

A business model that takes these diverse community needs into account should garner community support. This is important both in the permitting process, the procurement of feedstock, and the sale of the pellet fuel.

VII. IDENTIFICATION OF POTENTIAL MILL SITES

The project partners agreed that brownfields, or sites that have already been developed, should be prioritized over greenfields, or sites that are currently undeveloped.

A. SITE REQUIREMENTS

Part of the work undertaken in this assessment was to identify suitable sites in Chittenden County for a pellet mill. The project partners agreed that brownfields, or sites that have already been developed, should be prioritized over greenfields, or sites that are currently undeveloped.

To identify the full pool of candidate sites, project partners talked with town planners and real estate agents to identify parcels that could be available or are for sale. This total pool was then narrowed down to those that met criteria for being a good site for a pellet mill. Criteria for these sites included:

- Industrial or commercial equivalent zoning
- Parcel size greater than 5 acres
- Sufficient truck access (what type of road, weight limits?)
- Potential access to three-phase power
- Proximity to a rail spur
- Acceptable distance from residential areas, limiting exposure of residents to noise and dust
- Overall compatibility with current or historic use
- Landowner's interest and willingness to be considered as a potential site

Zoning and parcel size data were collected from the Chittenden County Regional Planning Commission. Truck and rail access were reviewed using satellite imagery; neighboring residential areas were also identified using maps and satellite images. Access to three-phase power was determined by conversations with the utility. Information on current use was often collected from town planners, real estate companies, or the landowners themselves, where it wasn't immediately known by the project partners. Landowner's willingness was determined by talking to them directly.

B. LIST OF POTENTIAL SITES FOR A PELLET MILL IN CHITTENDEN COUNTY

The following table shows the potential sites within Chittenden County that meet the above criteria. These sites are either listed as being for sale or were known by town officials to be available for this type of development. Additional information such as parcel size, list price, and any other notes were also included.

There is not a large pool of candidate sites in Chittenden County that is industrially zoned and undeveloped; this is already the most developed county in the state.

In general, when looking for sites, it is recommended here to consider sites listed for sale as first options. A second approach is to pursue other ideal sites meeting the above criteria that are not currently listed as being for sale. A third approach could be to consider sites outside of Chittenden County. Neighboring counties will have a higher frequency of industrially zoned parcels and these will be more economical options as well.

TABLE 19. Potential Mill Sites

Site	Address	Town	Acres	For Sale	List price	Notes
Livak Sandpit	Kenyon Road	Richmond	~28	By owner	$800,000	Active sand pit with existing Act 250 permit. Site has steep topography. Major upgrades to Kenyon Road would be needed for year round truck access. No rail spur or access to 3-phase power.
Marcelino	260 Governor Peck Road	Richmond	35	Via Broker	$1.4 Million	Inactive sandpit. Industrial zoning. Possible to subdivide a smaller parcel. Close to Interstate. Close access to 3-phase. Great site.
Sunderland Hollow	Sunderland Hollow Industrial Park	Colchester	18	Via Broker	$810,000	Located near I-89. Access to 3-phase power.

Table19: Potential sites for a wood pellet mill in Chittenden County,Vermont.

VIII. CONCLUSIONS AND RECOMMENDATIONS

This assessment finds the proposed pellet mill for Chittenden County to be feasible overall considering the availability and pricing of feedstocks, the availability of potential sites, the likelihood of community support, and the current and potential new markets for pellet fuel.

Low-grade wood from current area harvesting is the best option for making high-quality pellets. It was shown here that more than 345,000 green tons of low-grade wood could be available annually from forestland that is physically accessible and ecologically appropriate for harvesting and that is managed to include periodic harvesting, after accounting for current demands for this material.

Compared to the consumption rates shown in Table 20 below, this low-grade wood appears to be sustainably available in sufficient quantities within the 5-county wood basket considered here to support the proposed pellet mill at any of the sizes modeled in this assessment. The 12 TPH mill option, however, would consume a significant portion of the available low-grade wood in the region. The 3 and 6 TPH mill size options are the better matches for the area's feedstock availability, using 5-12 percent of the area's available low-grade wood, while the 12 TPH mill would use more than 20 percent of this material.

Table 20: The annual rates of feedstock consumption (in green tons) were assumed here to be two times the annual pellet production (in dry tons), for a 2 to 1 ratio of feedstock to product. These annual consumption rates are all within the more than 345,000 green tons of low-grade wood shown here to be available annually within a five-county wood basket surrounding the proposed mill.

TABLE 20. Feedstock Availability Compared to Annual Consumption and Pellet Production

	3 TPH Mill	6 TPH Mill	12 TPH Mill
Annual Pellet Production (dry tons)	19,440	38,880	77,760
Annual Consumption of Green Low-Grade Wood (green tons)	38,880	77,760	155,520
Annual Available Feedstock (green tons)	345,864 *(this result is irrespective of mill size)*		

TABLE 21. Annual Pellet Production (tons per year)			
	3 TPH Mill	6 TPH Mill	12 TPH Mill
Annual Pellet Production (tons)	19,440	38,880	77,760
Annual Pellet Demand (tons per year)			
Total Current Demand	41,138		
Total New Potential Demand	41,303		
Grand Total	82,441		

Table 21: Annual pellet production at the 3 and 6 TPH mills will not be able to meet the total demand for pellet fuels in this region, though they will likely meet a realistic share of the current and future markets; the 12 TPH mill will meet 100 percent (and more) of the total current and potential future demand, but will likely be oversized given that this business will not own 100 percent of the market. Overall, the 6 TPH mill is best sized to meet today's demand, with room for meeting the demands of a growing market.

Encouragingly, the current market for Premium and Super Premium pellet fuels is established, at an estimated 41,000 tons of pellets per year in northern Vermont and northeastern New York. Further, there is the potential to grow this demand to more than 80,000 tons per year as new pellet heating systems are installed throughout the region in both homes and community buildings and businesses. It will take several years for this market to see that kind of growth, but there is good potential for the demand for pellets in the region to be well aligned with the output from this proposed mill and the portion of the total market that this proposed mill could likely claim.

Neither the 3 nor 6 TPH mill options would meet the total current demand for pellet fuels, but in reality, no single business can claim 100 percent of its market. The 3 TPH mill could be a good match for a portion of the current pellet fuel market, but this mill size could be too small to meet the potential future market demand for pellet fuels; a 6 TPH mill would be better sized to be both supported by the current market demand for pellet fuels and capable of meeting the potential growth in demand for pellets.

While the 6 TPH mill would not be able to meet 100 percent of the demand for pellet fuels in this region, it would be able to provide a realistic market share. The 12 TPH mill would be oversized for both the current and potential future demand for pellet fuels, a situation that could force the business to export its product over greater distances, in turn detracting from some of the project's objectives such as retaining money in the local economy and minimizing environmental impacts. Overall, the 6 TPH mill will be the best match for meeting a substantial share of the current total annual pellet demand, with room to grow to meet increases in this demand. Table 21 above shows the annual pellet production at each mill size option compared to the total current demand for pellet fuels and the estimated potential growth in the pellet fuel market.

The 12 TPH mill option was the only economically viable option among the three mill sizes considered here. This is likely due in part to the economy of scale: In manufacturing, businesses with larger output capacities are able to produce products at a lower cost than smaller businesses.

VIII. CONCLUSIONS AND RECOMMENDATIONS *(cont'd)*

The results presented here are also dependent on the assumptions used in this analysis, one of which was the utilization of a "greenfield" (in other words, undeveloped) site located in Chittenden County. This portion of the capital budget is quite high since land is expensive in this part of Vermont and because the mill would be built from the ground up. If, instead, a site could be found with some existing infrastructure that could be utilized, such as an abandoned mill or other industrial site, or a parcel outside of Chittenden County was chosen, the capital budget for this mill could be lowered. Sensitivity analysis conducted here showed that a budget of less than $5 million could result in the 6 TPH mill option being economically viable.

Overall, the results of this assessment are nuanced. While the 12 TPH mill appears to be the best option financially, it does not appear to be the best match when compared to the availability of feedstock, and it will be oversized compared to both the current and potential future markets for pellet fuels. The 6 TPH mill would be the best option and is the size recommended here for VSHI to pursue. The 6 TPH mill would use less than a third of the region's available low-grade wood and will match well with both the current and potential future pellet fuel markets. While the economic analysis results were poor for this mill size option, careful attention to keeping the construction budget less than $5 million could make the 6 TPH mill a viable business (Table 22).

Table 22: Several key financial metrics can be compared across the mill size options considered here to show that the 12 TPH mill was the only economically feasible option, with the exception of the 6 TPH mill, if capital costs can be lowered to $5 million or less.

TABLE 22. Overview of Financial Feasibility Assessment

	3 TPH	6 TPH	6 TPH	12 TPH
Capital Cost	$7,681,750	$8,694,250	$5,000,000	$12,661,000
10-Year Cumulative Profit	$ - 2,099,661	$ 1,415,169	$2,690,579	$11,889,342
Simple Payback (years)	(106)	17	9	11
NPV of Investment	$542,704	$4,071,195	$4,855,047	$12,599,890
IRR on Investment	n/a	-11%	6%	7%
Overall Result	Negative	Negative	[Marginally] Positive / Break Even	[Marginally] Positive

TABLE 23. Overall Feasibility Results

	3 TPH Mill	6 TPH Mill	12 TPH Mill
Feedstock Availability	√	√	×
Current Market	√	√	×
Potential Future Market	×	√	×
Site Locations	√	√	√
Financial Feasibility	×	×	√

Table 23: A simplified summary of the results of this assessment, where "x" indicates a negative result and "√" represents a positive finding, shows the 6 TPH mill to be the best option among those modeled here as long as the capital budget can be kept to $5 million or less.

Whether this capital budget can be attained should be the focus of continued research into developing this business. Table 23 above gives a summary of the results of the full assessment in an attempt to clarify which mill size options considered here are worth further consideration.

It is recommended that VSHI pursue developing a 6 TPH pellet mill and that the proposed mill be designed as a centralized plant sourcing 100 percent wood feedstock. This low-grade wood should be sourced as roundwood, though the mill should be capable of sourcing woodchips as well. In its first years, the mill should focus solely on producing a quality wood pellet product meeting Premium or Super Premium grade standards. Once this product is well established within the market, the mill could choose to experiment with alternative feedstock sources such as grasses or clean community wood wastes to produce a blended wood pellet that will be of lower quality, most likely meeting the specifications for Standard grade. As these alternative feedstock sources become available and markets for Standard grade pellets emerge and grow, the equipment and infrastructure to use these feedstocks can be added to the mill.

The financial viability of sourcing alternative feedstocks should be revisited prior to adding these capabilities, since there will also be a substantial investment in new equipment. The success of using these alternative, lower-quality feedstocks will hinge on the presence of a market for Standard grade pellets.

There is the potential for strong support for this business from communities and municipalities, and community members have shown particular interest in the business being structured as a cooperative. Nevertheless, whether 20 percent of the capital cost can actually be raised through membership sales will remain to be seen. The potential for this should be another primary focus of further assessment of this business model. One next step could be an investigation into the level of membership at some of Vermont's top cooperatives such as Mad River Glen, Onion River Food Cooperative, or Cabot Creamery to gain a better understanding of the realistic potential for buy-in to a pellet fuel cooperative. Other possible structures that might be of interest to VSHI include an L3C and a Benefit, or B, Corporation.

VIII. CONCLUSIONS AND RECOMMENDATIONS *(cont'd)*

Next steps for VSHI include:

- Ongoing investigation and monitoring of suitable and available sites for the pellet mill
- Collecting actual capital costs and developing a construction-ready budget (those presented here were theoretical and highly variable)
- Continuing to assess the best business structure and, in the case of a cooperative, whether the goals for member buy-in are realistic
- Revisiting the financial viability assessment with more accurate figures to ensure the business will be financially sustainable
- Continued investigation into the business structure and viability, including a detailed survey of the potential for the cooperative model
- Pursuit of potential grants, investors, or other possible funding mechanisms for which a cooperative would be eligible

END NOTES

[1] Btu (British thermal unit) is a standard unit of energy equal to the heat required to raise the temperature of one pound of water one degree Fahrenheit.

[2] Source: http://www.pelletheat.org/3/industry/index.html.

[3] It was assumed here that full capacity is 90 percent operational capacity to account for downtime due to delays, breakdowns, maintenance, or other issues. Full capacity was assumed to be reached in year 2 of operation, as year 1 would include a learning curve. Here, the operational capacity in year 1 was assumed to be 80 percent.

[4] MMBtu is a standard unit of energy equal to one million Btu (each M represents 1,000).

[5] Source: Vermont Residential Wood Fuel Assessment, 1997-1998.

[6] Source: www.biomasscenter.org/database.html.

[7] For more information on Efficiency Vermont's centralized biomass boiler incentive program, visit http://www.efficiencyvermont.com/for_my_business/ways-to-save-and-rebates/hvac/rebates/wood_biomass.aspx.

[8] It was found in the assessment of business structures conducted as part of this feasibility study that a hybrid cooperative and L3C business are not legally possible. While an L3C can be structured as a cooperative , it cannot legally be called a cooperative in the State of Vermont. This detail was not yet clear to the project partners at the time that the survey was developed and distributed. A cooperative business structure was modeled for this assessment.

A Feasibility Study of Pellet Manufacturing in Chittenden County, Vermont

APPENDICES

A. Net Available Low-Grade Wood Full Assessment

B. Dedicated Energy Crop Potential Full Assessment

C. Overview and Comparison of Business Structure Options

D. Itemized Mill Capital Cost Estimates

E. Profit and Loss Full Assessment

F. Full 10-Year Pro Forma Financial Assessment

APPENDIX A. NET AVAILABLE LOW-GRADE WOOD FULL ASSESSMENT

Management of Forestland that is Physcially Accessible & Ecologically Appropriate for Harvesting

			Managed Forestland by Ownership Category (Acres)										
County	Total Forest Area (Acres)	Accessible and Appropriate Forest Area (Acres)	National Forest	State	Municipal	Forest Industry	Farmer	Corporate	Indiv <50 acres	Indiv >50 acres	Other	Total Managed (Acres)	Total Unmanaged (Acres)
Addison	249,203	192,242	35,321	6,613	6,613	16,883	10,581	13,226	27,619	69,631	5,755	107,530	84,712
Chittenden	209,963	133,560	0	26,226	-	4,478	-	8,699	25,596	64,531	4,030	83,272	50,288
Franklin	233,102	175,238	0	3,916	-	23,192	27,650	7,349	32,129	81,001	-	119,666	55,572
Lamoille	241,275	161,454	0	18,784	-	14,014	5,665	12,299	31,437	79,256	-	105,289	56,165
Washington	362,212	232,488	3,634	38,120	-	-	5,759	40,931	40,909	103,136	-	147,607	84,882
TOTAL	**1,295,755**	**894,982**	**38,955**	**93,658**	**6,613**	**58,566**	**49,655**	**82,504**	**157,689**	**397,556**	**9,785**	**563,365**	**331,618**

Forest Inventory on Forestland that is Accessible, Ecologically Appropriate, and Actively Managed for Periodic Harvesting

		Forest Inventory on Harvestable Forestland					
		Growing-Stock (GS) Wood (Green Tons)			Cull Wood & Non Commercial Species (Green Tons)		
County	Total Managed (Acres)	Bole	Tops & Limbs	Total	Bole	Tops & Limbs	Total
Addison	107,530	7,937,548	1,934,100	9,871,648	1,381,750	328,415	1,710,165
Chittenden	83,272	6,683,633	1,639,436	8,323,069	1,036,122	242,845	1,278,967
Franklin	119,666	8,956,502	2,239,755	11,196,257	1,490,763	333,253	1,824,015
Lamoille	105,289	8,612,535	2,130,280	10,742,814	1,382,504	319,690	1,702,193
Washington	147,607	11,452,267	2,824,006	14,276,273	1,879,457	435,630	2,315,087
TOTAL	**563,365**	**43,642,484**	**10,767,578**	**54,410,062**	**7,170,595**	**1,659,833**	**8,830,428**

Net Annual Growth of ALL Wood on Forestland that is Accessible, Appropriate, and Managed

		Net Annual Forest Growth on Harvestable Forestland						
		Growing Stock (GS) Wood (Green Tons)			Cull Wood & Non Commercial Species (Green Tons)			
County	Net Annual Growth Rate	Bole	Tops & Limbs	Total	Bole	Tops & Limbs	Total	GRAND TOTAL
Addison	**2.10%**	166,689	40,616	207,305	29,017	6,897	35,913	243,218
Chittenden	**2.10%**	140,356	34,428	174,784	21,759	5,100	26,858	201,643
Franklin	**2.10%**	188,087	47,035	235,121	31,306	6,998	38,304	273,426
Lamoille	**2.10%**	180,863	44,736	225,599	29,033	6,713	35,746	261,345
Washington	**2.10%**	240,498	59,304	299,802	39,469	9,148	48,617	348,419
TOTAL		**916,492**	**226,119**	**1,142,611**	**150,583**	**34,856**	**185,439**	**1,328,050**

Net Annual Growth and Availability of Low-Grade Wood on Forestland that is Accessible, Appropriate, and Actively Managed

	Portion of Net Annual Growth that is Low Grade and Harvestable*		
	Growing Stock and Cull Wood Combined (Green Tons)		
County	Bole	Tops & Limbs	Total
Addison	123,226.50	-	123,226.50
Chittenden	101,620.63	-	101,620.63
Franklin	137,896.73	-	137,896.73
Lamoille	131,744.00	-	131,744.00
Washington	175,873.45	-	175,873.45
TOTAL	**670,361**	**0**	**670,361**

	Net Available Low-Grade Wood					
	Annual Harvest of Low-Grade Wood (Green Tons)			Net Available Low-Grade Wood (Green Tons)		
County	Firewood	Pulp	Chips	Bole	Tops & Limbs	Total
Addison	35,026	3,600	1,141	84,601		84,601
Chittenden	56,196	3,706	19,397	41,718		41,718
Franklin	54,890	15,045	14,263	67,962		67,962
Lamoille	53,434	5,934	7,650	72,376		72,376
Washington	80,640	16,027	12,058	79,206		79,206
TOTAL	**280,186**	**44,312**	**54,510**	**345,864**	**0**	**345,864**

* Note: For the purspose of this assessment, it was assumed that top & limb wood was not harvestable.

APPENDIX B. DEDICATED ENERGY CROP POTENTIAL FULL ASSESSMENT

Potential Availability of Agricultural Lands

		Agricultural Land Area by Crop / Category (Acres)							
County	**Total Land Area (Acres)**	**Corn**	**Other Crops**	**Hay**	**Fallow**	**Developed**	**Pasture**	**Idle**	**Total Agricultural Area (Acres)**
Chittenden	344,960	50,000	2,000	170,000	13,000	30,000	45,000	6,000	316,000
TOTAL									

Area Potentially Available for Energy Crop Production

	Area for Energy Crop Production Based on Study Assumptions (Acres)							
County	**Corn**	**Other Crops**	**Hay**	**Fallow**	**Developed**	**Pasture**	**Idle**	**Total Area Under Crop Production (Acres)**
Chittenden	-	200.0	8,500.00	1,300.0	-	-	1,200	11,200
TOTAL								

Potential Energy Crop Yields on Areas That Could be Available for Energy Crop Production

	Potential Crop Yields				
County	**Switchgrass (dry tons)**	**Reed Canarygrass (dry tons)**			
Chittenden	28,000	30,800			
TOTAL					

Appendix C. Overview and Comparison of Business Structure Options

Overview and Comparison of Business Structure Options						
	C Corporation	S Corporation	Nonprofit	Cooperative	LLC	L3C
Ownership						
Owners called	Shareholders	Shareholders	Typically not "owned"; may have members or a Board which serves as members	Member	Member	Member
Limitations on who can own or create	Few, if any	No more than 35 owners; Owners must be persons & US citizen or resident	Must be for nonprofit purpose	Only members who use (if consumer co-op) or supply (if marketing co-op) the cooperative	After start-up, new owners must be approved by existing owners	After start-up, new owners must be approved by existing owners
Restrictions		May not own a subsidiary	No benefits to Board or members	No more than 10% owned by any one member (11 VSA §981)		
Governance						
Voting Power	Proportional to ownership, typically one vote per share	Typically one vote per share – can vary voting rights	One vote per member	One vote per member	Allows for differences in ownership classes and voting rights.	Typically proportional to investment
Decision-making body	Board of Directors, elected by shareholders	Board of Directors, elected by shareholders	Board of Directors, either elected by members or self-perpetuating	Board of Directors elected by members	The members as a whole – typically less formal and more flexible.	The members as a whole – typically less formal and more flexible.
Day to day management	Board typically hires manager.	Collectively by owners or hired management	Board typically hires manager.	Board typically hires manager.	Collectively by owners or hired management	Collectively by owners or hired management
Earnings (Losses)						
Distributed as	Dividends	Earnings	NA	Patronage dividends (may be paper not cash transaction)	Earnings	Earnings
Limitations (if any)				Must set aside at least 10% of profits until reserve = 50% of paid up capital stock; No more than 6% dividend on stock per year (11 VSA §981)		
Taxation						
Pass-through income	No	Yes	NA	Yes	Yes	Yes
Basis adjustments						
Capital gains concerns	Taxable gains can be recognized at the individual and corporate level	Less onerous than C corps	NA	Taxable gains can be recognized at the individual and corporate level	Appreciated assets can be distributed to original contributors without recognizing gains	
Start-up Concerns						
Organizing Documents needed	Articles of Association & By-laws	Articles of Association & By-laws	Articles of Association & By-laws	Articles of Association, By-laws, subscription agreement	Operating Agreement	Operating Agreement
Legal and admin costs	Most Complicated and costly	Moderate	Can be costly if charitable purpose raises concerns at IRS	Can be costly due to lack of familiarity with co-op structure	Relatively easy	Slightly more difficult than LLC due to relative newness

Overview and Comparison of Business Structure Options						
	C Corporation	S Corporation	Nonprofit	Cooperative	LLC	L3C
Lawyers, CPAs and funders familiar with structure?	Extensive	Extensive	Extensive	Not extensive in Vermont	Moderate	Very new concept – expect a learning curve
Financing						
Sources of equity	Private capital markets	Friends and family	Foundation and government grants	Members	Friends and family	Foundations, friends and family
Sources of loans	Banks, VEDA, government guarantees	Banks, VEDA, government guarantees	Banks, VEDA, government guarantees	Banks, VEDA, government guarantees	Banks, VEDA, government guarantees	Banks, VEDA, foundations
Summary						
Advantages	Most familiar form for conventional investors	Tax advantages for the owners	Community benefits and is able to secure grants for social mission	Governance structure based on equality: one member = one vote	Great flexibility in ownership classes, no limitations on who can own. Less complex	Access to foundation PRIs, flexibility
Disadvantages	Complexity & double taxation	Limitations on ownership	No wealth creation and often not appropriate for profit-making entity	Often difficult to get 3rd party investments; Vt law is cumbersome	Less known in some places – relatively well-understood in VT	Lack of familiarity (you pay for the learning curve)

APPENDIX D. ITEMIZED MILL CAPITAL COST ESTIMATES

Item	3 TPH	6 TPH	12 TPH
Land Purchase	$375,000	$560,000	$780,000
Site work	$100,000	$150,000	$200,000
Building Construction	$1,925,000	$2,400,000	$3,000,000
Wood Yard			
Receiving (scales, etc.)	$30,000	$50,000	$70,000
Storage	$30,000	$40,000	$50,000
Processing (debarking, chipping, regrinding)	$500,000	$750,000	$950,000
Pellet Mill			
Conveyors	$50,000	$65,000	$70,000
Driers + Boiler	$500,000	$700,000	$1,000,000
Pelletizer(s)	$400,000	$800,000	$1,400,000
Cooling	$50,000	$70,000	$90,000
Bulk Storage (overhead bins)	$50,000	$100,000	$150,000
Bagging	$75,000	$120,000	$150,000
Bag Storage (warehouse space)	$0	$0	$0
Electric Hookup	$25,000	$25,000	$25,000
Water/Sewer	$10,000	$10,000	$10,000
Design	$50,000	$60,000	$70,000
Permitting	$25,000	$25,000	$25,000
GC mark-up	$50,000	$70,000	$100,000
Working Capital	$2,800,000	$1,800,000	$3,300,000
Contingency (15%)	$636,750	$899,250	$1,221,000
TOTAL	**$7,681,750**	**$8,694,250**	**$12,661,000**
TOTAL (less working capital)	**$ 4,881,750**	**$ 6,894,250**	**$ 9,361,000**

APPENDIX E. PROFIT-AND-LOSS FULL ASSESSMENT

P&L - at Projected Year 1

			80%			75%			70%
PROFIT & LOSS	**3 ton per hour capacity**			**6 ton per hour capacity**			**12 ton per hour capacity**		
Annual Production (tons)	17,280			32,400			60,480		
	Volume	**Rate**	**$ Amount**	**Volume**	**Rate**	**$ Amount**	**Volume**	**Rate**	**$ Amount**
Revenue									
Direct to Coop Member Sales	8,640	$ 220	$ 1,900,800	16,200	$ 210	$ 3,402,000	30,240	$ 200	$ 6,048,000
Wholesale Sales	6,912	$ 190	$ 1,313,280	13,284	$ 190	$ 2,523,960	25,402	$ 190	$ 4,826,304
TOTAL SALES	**15,552**		**3,214,080**	**29,484**		**5,925,960**	**55,642**		**10,874,304**
Cost of Goods Sold									
Fiber purchased	34,560	$ 32	$ 1,105,920	64,800	$ 30	$ 1,944,000	120,960	$ 28	$ 3,386,880
Production Labor	5	$ 17	$ 475,200	9	$ 18	$ 874,800	15	$ 20	$ 1,512,000
Benefits, fringe (25% of Labor)		25%	$ 118,800		25%	$ 218,700		25%	$ 378,000
Dryer Fuel	1,728	$ 3.69	$ 6,376	3,240	$ 3.69	$ 11,956	6,048	$ 3.69	$ 22,317
Electric	2,640,000	$ 0.12	$ 316,800	4,950,000	$ 0.12	$ 594,000	8,400,000	$ 0.12	$ 1,008,000
Equipment Maint & Repairs			$ 80,000			$ 75,000			$ 70,000
Printed Bags & Packaging Supplies	432,000	$ 0.35	$ 151,200	810,000	$ 0.35	$ 283,500	1,512,000	$ 0.32	$ 483,840
Supplies & Misc			$ 40,000			$ 37,500			$ 35,000
Sub-total Cost of Goods Sold			**$ 2,294,296**			**$ 4,039,456**			**$ 6,896,037**
COGS/Sales	71%			68%			63%		
Cost/Ton	$ 132.77			$ 124.67			$ 114.02		
Gross Profit			**$ 919,784**			**$ 1,886,504**			**$ 3,978,267**
Product Distribution	15,552	$ 15.00	$ 233,280	29,484	$ 15.00	$ 442,260	55,642	$ 15.00	$ 834,624
Management Personnel			$ 100,000			$ 168,750			$ 250,000
Real estate taxes		$ 2.50	$ 122,044		$ 2.50	$ 172,356		$ 2.50	$ 234,025
Insurance			$ 35,000			$ 60,000			$ 100,000
Advertising			$ 35,000			$ 50,000			$ 85,000
Professional Fees			$ 20,000			$ 25,000			$ 30,000
Office and Admin			$ 20,000			$ 35,000			$ 50,000
Testing & Certification			$ 10,000			$ 15,000			$ 20,000
Sub-total - other expenses			$ 575,324			$ 968,366			$ 1,603,649
EBITDA (Earnings before Interest,			$ 344,460			$ 918,138			$ 2,374,618
Interest - Year 1			$ 330,612			$ 437,066			$ 636,477
Depreciation			$ 245,333			$ 387,357			$ 562,690
Taxes - State & Federal			$ -			$ 19,898			$ 509,196
Net Income		**$ -**	**$ (231,485)**		**$ -**	**$ 73,817**		**$ -**	**$ 666,255**

ANNUAL P&L - at full capacity

PROFIT & LOSS	**3 ton per hour capacity**			**6 ton per hour capacity**			**12 ton per hour capacity**		
Annual Production (tons)	19,440			38,880			77,760		
	Volume	**Rate**	**$ Amount**	**Volume**	**Rate**	**$ Amount**	**Volume**	**Rate**	**$ Amount**
Revenue									
Direct to Coop Member Sales	9,720	$ 220	$ 2,138,400	19,440	$ 210	$ 4,082,400	38,880	$ 200	$ 7,776,000
Wholesale Sales	7,776	$ 190	$ 1,477,440	15,941	$ 190	$ 3,028,752	32,659	$ 190	$ 6,205,248
TOTAL SALES	**17,496**		**3,615,840**	**35,381**		**7,111,152**	**71,539**		**13,981,248**
Cost of Goods Sold									
Fiber purchased	38,880	$ 32	$ 1,244,160	77,760	$ 30	$ 2,332,800	155,520	$ 28	$ 4,354,560
Production Labor	5	$ 17	$ 594,000	9	$ 18	$ 1,166,400	15	$ 20	$ 2,160,000
Benefits, fringe (25% of Labor)		25%	$ 148,500		25%	$ 291,600		25%	$ 540,000
Dryer Fuel	1,944	$ 3.69	$ 7,173	3,888	$ 3.69	$ 14,347	7,776	$ 3.69	$ 28,693
Electric	3,300,000	$ 0.12	$ 396,000	6,600,000	$ 0.12	$ 792,000	12,000,000	$ 0.12	$ 1,440,000
Equipment Maint & Repairs			$ 100,000			$ 100,000			$ 100,000
Printed Bags & Packaging Supplies	486,000	$ 0.35	$ 170,100	972,000	$ 0.35	$ 340,200	1,944,000	$ 0.32	$ 622,080
Supplies & Misc			$ 50,000			$ 50,000			$ 50,000
Sub-total Cost of Goods Sold			$ 2,709,933			$ 5,087,347			$ 9,295,333
COGS/Sales	75%			72%			66%		
Cost/Ton	$ 139.40			$ 130.85			$ 119.54		
Gross Profit			**$ 905,907**			**$ 2,023,805**			**$ 4,685,915**
Product Distribution	17,496	$ 15.00	$ 262,440	35,381	$ 15.00	$ 530,712	71,539	$ 15.00	$ 1,073,088
Management Personnel			$ 100,000			$ 168,750			$ 250,000
Real estate taxes		$ 2.50	$ 122,044		$ 2.50	$ 172,356		$ 2.50	$ 234,025
Insurance			$ 35,000			$ 60,000			$ 100,000
Advertising			$ 35,000			$ 50,000			$ 85,000
Professional Fees			$ 20,000			$ 25,000			$ 30,000
Office and Admin			$ 20,000			$ 35,000			$ 50,000
Testing & Certification			$ 10,000			$ 15,000			$ 20,000
Sub-total - other expenses			$ 604,484			$ 1,056,818			$ 1,842,113
EBITDA (Earnings before Interest, Taxes			$ 301,423			$ 966,987			$ 2,843,802
Interest - Year 1			$ 330,612			$ 437,066			$ 636,477
Depreciation			$ 245,333			$ 387,357			$ 562,690
Taxes - State & Federal			$ (66,638)			$ 31,378			$ 384,364
Net Income		**$ -**	**$ (207,885)**		**$ -**	**$ 111,187**		**$ -**	**$ 1,260,270**

APPENDIX F. FULL 10-YEAR PRO FORMA FINANCIAL ASSESSMENT

3 TPH Option		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production Capacity		80%	90%	90%	95%	95%	95%	95%	95%	95%	95%
Tons Produced		15,552	17,496	17,496	18,468	18,468	18,468	18,468	18,468	18,468	18,468
Revenue											
Direct to Coop Member Sales		$ 1,710,720	$ 1,991,920	$ 2,059,279	$ 2,244,785	$ 2,315,887	$ 2,386,989	$ 2,458,091	$ 2,529,193	$ 2,600,294	$ 2,671,396
Wholesale Sales		$ 1,181,952	$ 1,376,235	$ 1,422,775	$ 1,550,943	$ 1,600,068	$ 1,649,192	$ 1,698,317	$ 1,747,442	$ 1,796,567	$ 1,845,692
TOTAL REVENUE		**$ 2,892,672**	**$ 3,368,155**	**$ 3,482,054**	**$ 3,795,728**	**$ 3,915,955**	**$ 4,036,181**	**$ 4,156,408**	**$ 4,276,635**	**$ 4,396,861**	**$ 4,517,088**
Expenses											
COGS		$ 2,167,947	$ 2,524,303	$ 2,609,666	$ 2,844,753	$ 2,934,858	$ 3,024,963	$ 3,115,068	$ 3,205,174	$ 3,295,279	$ 3,385,384
Gross Profit		**$ 724,725**	**$ 843,852**	**$ 872,388**	**$ 950,975**	**$ 981,097**	**$ 1,011,218**	**$ 1,041,340**	**$ 1,071,461**	**$ 1,101,582**	**$ 1,131,704**
Product Distribution		$ 209,952	$ 244,463	$ 252,730	$ 275,496	$ 284,223	$ 292,949	$ 301,675	$ 310,401	$ 319,127	$ 327,853
Depreciation		$ 245,333	$ 245,333	$ 245,333	$ 245,333	$ 245,333	$ 245,333	$ 245,333	$ 245,333	$ 245,333	$ 245,333
Other Expenses		$ 342,044	$ 354,015	$ 378,796	$ 418,570	$ 477,170	$ 560,674	$ 678,416	$ 844,628	$ 1,081,124	$ 1,421,678
TOTAL EXPENSE		**$ 2,965,276**	**$ 3,368,114**	**$ 3,486,525**	**$ 3,784,152**	**$ 3,941,583**	**$ 4,123,920**	**$ 4,340,493**	**$ 4,605,536**	**$ 4,940,863**	**$ 5,380,249**
PROFIT/(Loss) Before Taxes		**$ (72,604)**	**$ 41**	**$ (4,471)**	**$ 11,576**	**$ (25,629)**	**$ (87,738)**	**$ (184,085)**	**$ (328,901)**	**$ (544,002)**	**$ (863,161)**
Taxes (Federal & Vermont)		$ -	$ (2,108)	$ -	$ 2,795	$ -	$ -	$ -	$ -	$ -	$ -
Profit/(Loss) After Taxes		$ (72,604)	$ 2,148	$ (4,471)	$ 8,781	$ (25,629)	$ (87,738)	$ (184,085)	$ (328,901)	$ (544,002)	$ (863,161)
Cummulative		$ (72,604)	$ (70,455)	$ (74,927)	$ (66,146)	$ (91,774)	$ (179,513)	$ (363,597)	$ (692,498)	$ (1,236,500)	$ (2,099,661)
Net Cash from Operations	**($7,681,750)**	$ 172,730	$ 247,482	$ 240,862	$ 254,114	$ 219,705	$ 157,595	$ 61,249	$ (83,568)	$ (298,668)	$ (617,827)

6 TPH Option		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production Capacity		75%	90%	90%	95%	95%	95%	95%	95%	95%	95%
Tons Produced		29,160	34,992	34,992	36,936	36,936	36,936	36,936	36,936	36,936	36,936
Revenue											
Direct to Coop Member Sales		$ 3,061,800	$ 3,802,756	$ 3,931,351	$ 4,285,499	$ 4,421,239	$ 4,556,979	$ 4,692,719	$ 4,828,459	$ 4,964,198	$ 5,099,938
Wholesale Sales		$ 2,271,564	$ 2,821,282	$ 2,916,688	$ 3,179,432	$ 3,280,138	$ 3,380,844	$ 3,481,550	$ 3,582,256	$ 3,682,962	$ 3,783,668
TOTAL REVENUE		**$ 5,333,364**	**$ 6,624,038**	**$ 6,848,039**	**$ 7,464,932**	**$ 7,701,378**	**$ 7,937,823**	**$ 8,174,269**	**$ 8,410,715**	**$ 8,647,161**	**$ 8,883,607**
Expenses											
COGS		$ 3,815,510	$ 3,949,053	$ 4,899,115	$ 5,059,366	$ 5,509,596	$ 5,678,751	$ 5,847,905	$ 6,017,059	$ 6,186,214	$ 6,355,368
Gross Profit		**$ 1,517,854**	**$ 2,674,985**	**$ 1,948,924**	**$ 2,405,565**	**$ 2,191,781**	**$ 2,259,073**	**$ 2,326,364**	**$ 2,393,656**	**$ 2,460,947**	**$ 2,528,239**
Product Distribution		$ 393,660	$ 488,926	$ 505,459	$ 550,993	$ 568,445	$ 585,897	$ 603,350	$ 620,802	$ 638,254	$ 655,706
Depreciation		$ 387,357	$ 387,357	$ 387,357	$ 387,357	$ 387,357	$ 387,357	$ 387,357	$ 387,357	$ 387,357	$ 387,357
Other Expenses		$ 526,106	$ 544,520	$ 582,636	$ 643,813	$ 733,947	$ 862,388	$ 1,043,489	$ 1,299,144	$ 1,662,904	$ 2,186,719
TOTAL EXPENSE		**$ 5,122,633**	**$ 5,369,856**	**$ 6,374,568**	**$ 6,641,529**	**$ 7,199,346**	**$ 7,514,393**	**$ 7,882,101**	**$ 8,324,362**	**$ 8,874,729**	**$ 9,585,151**
PROFIT/(Loss) Before Taxes		**$ 210,731**	**$ 1,254,182**	**$ 473,472**	**$ 823,402**	**$ 502,032**	**$ 423,430**	**$ 292,168**	**$ 86,353**	**$ (227,568)**	**$ (701,544)**
Taxes (Federal & Vermont)		$ 97,972	$ 530,903	$ 199,100	$ 347,821	$ 211,239	$ 177,833	$ 122,047	$ 34,575	$ -	$ -
Profit/(Loss) After Taxes		$ 112,759	$ 723,280	$ 274,371	$ 475,581	$ 290,793	$ 245,598	$ 170,122	$ 51,778	$ (227,568)	$ (701,544)
Cummulative		$ 112,759	$ 836,038	$ 1,110,410	$ 1,585,991	$ 1,876,784	$ 2,122,382	$ 2,292,504	$ 2,344,281	$ 2,116,713	$ 1,415,169
Net Cash from Operations	**($8,694,250)**	$ 500,116	$ 1,110,637	$ 661,728	$ 862,939	$ 678,150	$ 632,955	$ 557,479	$ 439,135	$ 159,789	$ (314,187)

12 TPH Option		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production Capacity		70%	90%	90%	95%	95%	95%	95%	95%	95%	95%
Tons Produced		54,432	69,984	69,984	73,872	73,872	73,872	73,872	73,872	73,872	73,872
Revenue											
Direct to Coop Member Sales		$ 5,443,200	$ 7,243,344	$ 7,488,288	$ 8,162,856	$ 8,421,408	$ 8,679,960	$ 8,938,512	$ 9,197,064	$ 9,455,616	$ 9,714,168
Wholesale Sales		$ 4,343,674	$ 5,780,189	$ 5,975,654	$ 6,513,959	$ 6,720,284	$ 6,926,608	$ 7,132,933	$ 7,339,257	$ 7,545,582	$ 7,751,906
TOTAL REVENUE		**$ 9,786,874**	**$ 13,023,533**	**$ 13,463,942**	**$ 14,676,815**	**$ 15,141,692**	**$ 15,606,568**	**$ 16,071,445**	**$ 16,536,321**	**$ 17,001,198**	**$ 17,466,074**
Expenses											
COGS		$ 6,506,733	$ 6,734,469	$ 8,951,406	$ 9,244,209	$ 10,066,846	$ 10,375,916	$ 10,684,986	$ 10,994,056	$ 11,303,125	$ 11,612,195
Gross Profit		**$ 3,280,140**	**$ 6,289,063**	**$ 4,512,536**	**$ 5,432,606**	**$ 5,074,845**	**$ 5,230,652**	**$ 5,386,459**	**$ 5,542,265**	**$ 5,698,072**	**$ 5,853,879**
Product Distribution		$ 751,162	$ 977,851	$ 1,010,919	$ 1,101,986	$ 1,136,890	$ 1,171,795	$ 1,206,699	$ 1,241,604	$ 1,276,508	$ 1,311,413
Depreciation		$ 562,690	$ 562,690	$ 562,690	$ 562,690	$ 562,690	$ 562,690	$ 562,690	$ 562,690	$ 562,690	$ 562,690
Other Expenses		$ 769,025	$ 795,941	$ 851,657	$ 941,081	$ 1,072,832	$ 1,260,578	$ 1,525,299	$ 1,898,997	$ 2,430,716	$ 3,196,392
TOTAL EXPENSE		**$ 8,589,610**	**$ 9,070,952**	**$ 11,376,672**	**$ 11,849,966**	**$ 12,839,259**	**$ 13,370,979**	**$ 13,979,674**	**$ 14,697,347**	**$ 15,573,040**	**$ 16,682,690**
PROFIT/(Loss) Before Taxes		**$ 1,197,263**	**$ 3,952,581**	**$ 2,087,270**	**$ 2,826,849**	**$ 2,302,433**	**$ 2,235,589**	**$ 2,091,770**	**$ 1,838,974**	**$ 1,428,157**	**$ 783,384**
Taxes (Federal & Vermont)		$ 566,575	$ 1,677,722	$ 884,965	$ 1,199,286	$ 976,409	$ 948,001	$ 886,877	$ 779,439	$ 604,842	$ 330,813
Profit/(Loss) After Taxes		$ 630,688	$ 2,274,859	$ 1,202,305	$ 1,627,563	$ 1,326,024	$ 1,287,589	$ 1,204,893	$ 1,059,535	$ 823,315	$ 452,571
Cummulative		$ 630,688	$ 2,905,547	$ 4,107,852	$ 5,735,415	$ 7,061,439	$ 8,349,028	$ 9,553,921	$ 10,613,456	$ 11,436,772	$ 11,889,342
Net Cash from Operations	**($12,661,000)**	$ 1,193,379	$ 2,837,549	$ 1,764,996	$ 2,190,254	$ 1,888,714	$ 1,850,279	$ 1,767,583	$ 1,622,226	$ 1,386,006	$ 1,015,261

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