Biomass at Hannaford Career Center

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Introduction:

Since July 2003, the Town of Middlebury has been a member of the ICLEI-Local Governments for Sustainability (ICLEI) Cities for Climate Protection (CCP) Campaign. This program provides the town with a means of calculating greenhouse gas (GHG) emissions from various sectors including residential, commercial, industrial, transportation, solid waste, and municipal. ICLEI is an international association of local governments, but is comprised of 160 U.S. municipalities and 43 New England cities. According to the 2006 Middlebury Area Climate Action Plan, the town's greenhouse gas emissions have increased annually, rising from 109,075 tons of carbon dioxide in 2002 to 116,900 tons of carbon dioxide in 2005.[1] Due to this distinct increase of GHG emissions, by 2005 Middlebury incorporated climate change goals into the Middlebury Town Plan, making explicit recommendations for future reductions.

Though the transportation sector is responsible for the largest percentage of town GHG emissions (about half), commercial and residential sectors contribute 26 and 24 percent respectively. Municipal sources like town departments, boards, schools, and facility managers comprise only about 1 percent of total town emissions, but do provide an excellent opportunity to set good examples for other sectors.[2] The project work of our Spring 2007 Environmental Economics (ECON0265) group has thus provided recommendations for this sector through assessment of biomass feasibility at the Patricia A. Hannaford Career Center (HCC) in Middlebury, Vermont.

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[1] Town of Middlebury. "Middlebury Area Climate Action Plan: A Plan to Save Energy and Reduce Greenhouse Gas Emissions." July 2006.
[2] Ibid.

Despite its rise in GHG emissions, it is important to first note the Town of Middlebury's current efforts to reduce local energy consumption. Most recently, the non-profit organization Efficiency Vermont has helped the town with the construction of the new Police Station. The new station will eventually consume a fraction of the energy it would have under normal conditions.

Buildings are responsible for over half of the emission of the Town of Middlebury's municipal operations.[3] The three sources of these emissions are electricity, heating oil, and propane used to provide power and heat to the buildings. Even combined with improved efficiency through communication networks and EnergyStar approved appliances, however, municipalities alone create approximately 775 tons of carbon dioxide equivalents a year.[4] This being said, there are distinct ways to cost effectively cut municipal GHG emissions, a concept our group explores for the Middlebury HCC.

The Patricia A. Hannaford Career Center (called the Hannaford Career Center) provides educational programs to local students from Middlebury, Mount Abraham, and Vergennes Union High Schools. The Hannaford Career Center offers fourteen technical and six foundational programs divided into the subcategories of Agriculture, Technology, Arts & Humanities and Business Programs. The Center itself is comprised of a North Campus and Charles Avenue Campus, both standing at 18,000 and 60,000 square feet respectively.[5]

Though the original project called for renewable energy feasibility assessments for Middlebury Union High and Middle Schools, due to time constraints our group chose to focus solely on the HCC site. Consistent with the reduction goals of the Town's

[3] John Hanley. "Middlebury Municipalities and their Energy Consumption." 2004. p.2.
[4] Ibid
[5] Nancy Cobden, anecdotal.

Climate Action Plan, the Hannaford Career Center approached our ECON0265 group in hopes of reducing its own GHG emissions through some use of on site renewable energy.

Vermont is the national leader in research, development and commercialization of wood energy. The clean combustion of wood chips for heat and electricity has been particularly attractive in the state given its plentiful natural resources. The State Department of Public Service along with the Department of Forests, Parks and Recreation (FPR) avidly promote various applications of wood chip energy including Biomass District Energy, industrial and commercial applications, the Vermont Gasification Project, and woodchip heating in Vermont schools.[6]

Biomass refers to any biological material that, upon combustion, can be used as fuel to produce heat, electricity, or both. Wood chips and low grade wood wastes are the most common type of biomass fuel, but other common fuels include agricultural crop residues and farm animal wastes. There are currently hundreds of biomass fuel systems in effect around the United States, heating schools, government buildings, and cities to produce renewable energy. [7]

Biomass is a renewable fuel that can be sustainably produced. It makes sense to use biomass in place of conventional fuel for several reasons. Firstly, biomass fuel is a local product. In contrast to coal or petroleum-based fuel, biomass is grown and harvested on local and regional forests and farms. Energy dollars spent on biomass fuel stay in the regional economy, creating jobs and supporting forestry and agriculture. Another advantage of using biomass is that, compared to fossil fuels, biomass fuels are

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[6] "The DPS and Biomass Development." http://publicservice.vermont.gov/energy-efficiency/ee_files/biomass/ee18a.htm (May 22, 2007).
[7] Biomass Energy Resource Center. 2006. http://www.biomasscenter.org/ (May 21, 2007).

historically lower-priced with prices only increasing about 1 percent a year over the last two decades. Lastly, biomass is good for the environment. Using biomass in place of fossil fuel reduces GHGs like carbon dioxide and sulfur dioxide which cause climate change and acid rain. Biomass energy systems also help to keep forests healthy by providing a market for low-grade "cull" wood, whose removal improves the value of commercial trees and health of local forests. [8]

There are now 28 Vermont schools that heat with clean, efficient wood chip systems.[9] The concept of using biomass heating systems is no new endeavor for the state, however, and systems have been installed selectively throughout the past 20 years. In Vermont, school wood energy systems burn approximately 7,500 tons of green chipped wood annually, displacing 450,000 gallons of fuel oil. School biomass systems reduce net carbon dioxide emissions by 4,000 tons and sulfur dioxide emissions by 2,000 pounds annually, compared to the oil they replace.[10] Due to its increasing potential, Vermont school districts have recently passed votes for the installation 14 new wood chip systems.[11] Wood, with its low cost, is a local source of renewable energy whose supply is not disrupted by embargoes, high transportation costs or tariffs. Automated, wood-fired heating systems are often a school's least expensive heating alternative over the long term.

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[8] BERC, 2006.
[9] Vermont Department of Education School Construction Program. 2007. http://www.biomasscenter.org/pdfs/School_Construction_Program.pdf (May 20, 2007).
[10] T.Maker. Heating Schools with Biomass: Fifteen Years of Success in Vermont. http://www.localenergy.org/pdfs/Document%20Library/Heating%20Schools%20with%20Biomass%20in%20Vermont.pdf (May 20, 2007).
[11] 2007 Annual Biomass Heating Conference Report. 2007. http://www.biomasscenter.org/biomassconf.html (May 20, 2007)

Due to the precedent set by the Biomass Energy Resource Center, the Vermont Fuels for Schools Program, and various statewide initiatives, installation of a biomass facility was the most viable option for Hannaford Career Center. Though wind power was mentioned as a potential resource in initial discussions with the HCC, constraints on space, altitude of the wind turbine, and capital made the possibility of wind power highly unlikely. Installation of a mini-hydro system was also suggested for the Middlebury Union High School site, but was dropped after our group decided to focus feasibility efforts on Hannaford Career Center.

In an attempt to encourage the Hannaford Career Center to move forward with a biomass facility on site, this project will:

1) Explore the existing renewable energy programs currently available for Vermont schools
2) Perform a basic cost-benefit analysis on the potential for an on site biomass facility at the Hannaford Career Center
3) Delve into the differential economic and environmental impacts of various wood chip fuel sources
4) Explore the political processes and grants necessary for successful facility construction.

Public policy, however, cannot be divorced from economics. Despite the various statewide programs and local school models, funding for these biomass projects became a primary factor in determining overall feasibility. Due to various economic, political, and social factors, however, we recommend that the HCC further pursue the adoption of a biomass system for its energy needs.

Biomass Basics:

Biomass facilities are currently heating over twenty percent of Vermont students in their respective schools. A statewide initiative to promote and encourage the use of a renewable, local and natural resource to provide heat for Vermont schools describes the mission statement of the Vermont Fuels for Schools (VFFS) program. This initiative is one headed by the Biomass Energy Resource Center who work in collaboration with The Vermont Superintendents Association School Energy Management Program, with cooperation from VT Department of Forests, Parks and Recreation, VT Department of Education, VT Department of Pubic Services and funding from the U.S. Department of Energy, through the support of Senator Patrick Leahy. Evident from the vested interests in the VFFS program, support is widespread. The program seeks to provide schools with the information and logistical support necessary to evaluate and implement woodchip and biomass heating systems across the state.

What makes this program so attractive for Vermonters lies in the fact that energy supplies come from a local, sustainable, inexpensive source, which is wood from Vermont forests. Since 1986, biomass heat in Vermont has been at least 30 percent less expensive than oil and 75 percent less expensive than electricity. Heating costs of oil, propane and natural gas are roughly two-to-three times as much as biomass fuel resources. Over the last fifteen years 31 schools have installed woodchip facilities. Addison County is not new to biomass facilities, Mount Abraham High School in Bristol in fact, worked to get a boiler installed in their school and now is successfully using woodchips to supply its students with heat energy.[12] Due to the success seen across the

[12] Biomass Energy Resource Center. Website: http://www.biomasscenter.org/

state with the implementation of biomass burners in several schools we highly recommend Hannaford Career Center to move forward and implement a program for biomass in their school.

In addition, several state agencies support the development of biomass as a fuel source for Vermont. Among those that support this fuel supply are the Department of Public Service (DPS) and the Department of Forests, Parks and Recreation (FPR), who together have a shared staff position working as a wood energy expert, who has worked for more than a dozen years. FPR and DPS has made significant developments in four applications of biomass, which include the VFFS program. Other forms of biomass projects they work on involve Biomass District Energy, industrial and commercial applications and the Vermont Gasification Project, which is located at the McNeil Plant in Burlington.[13] In cooperation with the Public Service Board, the Energy Efficiency Division of Vermont (EED) and serves as the state office for the U.S. Department of Energy State Energy Program. EED woks on many state energy initiatives but specific to biomass they are involved with the development of programs and policies that encourage renewable energy development. They also work with many state entities, including schools, to further development and use of renewable energy production. Moreover, they serve as an advocate for energy efficiency and renewable energy in local, state, regional and national forums.[14] Due to state-wide agency support a further study of biomass feasibility should be conducted by the Hannaford Career Center

[13] The DPS and Biomass Development. http://publicservice.vermont.gov/energy-efficiency/ee_files/biomass/ee18a.htm
[14] Vermont Department of Public Service. *Energy Efficiency Division.* http://publicservice.vermont.gov/divisions/energy-efficiency.html

Economic Analysis:

Based on a strictly economic analysis, the project is marginal with a very large error margin. The dozens of inputs into the financial model are mostly extrapolated from non-site specific data and do not represent actionable numbers. The biggest example of this is the size of the plant. The power usage of the Middlebury school system ranges roughly from a continuous average of 10-150 kW depending on what facilities are included and time of day usage concerns, but in an effort to ballpark feasibility and use reliable numbers the model has been set up for a 25MW plant, a major commercial power plant for which it would be impossible to secure funds and/or supply inputs given our situation. This bigger 'ideal' plant is theoretically more efficient than one of the appropriate size, but the margin of error in other inputs such as initial costs, fuel, fixed and variable annual costs, government support etc., more than compensates for this.

The fact that a business plan has not been enacted and actual suppliers have not given quotes raises the valid question of what at all makes this model site specific. Woodchip prices of roughly $40/ton are New England specific, but the most important site specific input is the 10.32 cents/kW hour that Green Mountain Power charges for electricity. Even though HCC currently uses a good deal of fuel oil, buying power at this price is roughly their alternative to building a bioelectric plant. This is also similar to the "avoided cost" (statutorily defined with complex formulas) at which the power company would have to reimburse HCC for extra capacity. HCC would likely want to produce excess capacity for energy sustainability, security, and a chance at greater efficiency. Despite the community heavy rhetoric of the project, there is no way to complete this

project in isolation. The schools must still be hooked up to the grid and may need a legal contract with a corporate entity to realize the benefits of accelerated tax depreciation.

The Model

The model is sent as a separate excel file because it would be essentially useless as a printout. It is simple in that it assumes that the school district only uses electricity and only buys electricity. It has dozens of inputs, marked by blue text, and multiple tabs showing additional data and an interactive cash flow chart program that will put out a cash flow and a discounted cash flow for any set of inputs and any discount rate. The basic output of the model in the IRR, and is it higher than the discount rate. Basically the question it answers is whether a firm would build a power plant here. A decision made largely as a result of the relative prices of different commodities, the rest being specific environmental factors, and quotes from suppliers. All of these variables are extended for 20 years and distinct for each year. The period of 20 years was used because that is the maximum amount of time for which the town can enter a bond, but there is a good chance a properly maintained burner will not need to be completely rebuilt within 20 years and could continue to produce for longer than that. The model will be more complicated when it is adjusted for fuel oil tradeoffs and electricity sold on the market versus electricity consumed internally, but it is doable. It needs to be determined whether the proposed boiler would produce only heat or heat and electricity. A plant also producing electricity is much preferred because it could effectively provide stable electricity prices for the whole school district and some of the town.

The most important inputs are the expected price schedules of electricity and woodchips. Woodchip price currently around 35 dollars a ton, but their future prices are

uncertain. The college businessmen who are working on the Middlebury burner stressed the importance of getting long-term contracts to avoid crunches in the market. Electricity prices are also uncertain as they of course based on the marginal price of the marginal unit of production. If wood burners produce electricity at a cost lower than Vermont market prices, (or the slightly different avoided cost) it will be sold at a profit. Likewise, is wood is at any time the most inefficient marginal fuel, it will draw the regional electricity price higher, putting an implicit tax on the town that has the effect of making the school district poorer even if it is selling the electricity at the same high price. In other words, the larger of a plant you built the bigger gamble you are making about future price schedules, which proportionality higher returns but also greater consequences for a misstep. Until oil and natural gas are no longer the dominant electricity generating substances it is assumed that electricity prices and expenditures will rise as a percentage of income. So a major question become whether or not the United States can use its wood resources sustainably in the future without wood prices skyrocketing or wood supplies becoming inconsistent. If firms can trust that government to properly manage wood resources, it would thus seem logical to assume that electricity prices will rise faster than wood prices in the next 20 years, but who knows. What must be done is to plug in various plausibly extremes in the model and observe the corresponding rates of return. It is an inexact science.

How much does the fuel cost to produce 1MWhr of electricity?

40 dollars/ ton of wood
8,000,000 BTUs of energy realized from said ton
It requires 14,500,000 BTUs of energy to produce 1MWhr
Therefore before time specific inflation it costs $72.50/MWhr for woodchips, a significant portion of the $103.2/MWhr at which the electricity can be sold on the open market.

*numbers are ball parked from a variety of internet sources

Wood Chip Options & Environmental Analysis:

Choosing the fuel is a very important process for biomass implementation. Reliability of supply and consistency of the fuel rather than just having a lowest cost is essential, because it minimizes maintenance and optimizes system performance, which ultimately leads to the lower cost. No biomass currently handles widely varying fuel types at the same time. Although a system can be re-calibrated for a different fuel type, the most practical approach is to stick with one fuel type. Therefore, the fuel type needs to be part of the combustion system design process. Also in this part, we will explore the environmental effect of the woodchip biomass energy, and whether it is a good choice of energy for the sustainable future.

The main types of wood chips produced around Addison County are the chips made from sawmill residue and whole-tree, as shown in the Table 1.[15] The sawmill chips are made from slabs and edges that cannot be made into marketable lumber at sawmills, and the whole-tree chips come from harvest residue of low-grade trees that are obtained directly from the log landing of timber harvest sites.

Table 1. Woodchips in Vermont

	% wood chip production in Addison and Rutland counties (year 2001)	Cost/ton (year 2007)
Sawmill chip	85%	$33-36
Whole-tree chip	15%	$28-$36
Bole-tree chip	0%	$48-$56

[15] "*Biomass Fuel Assessment for Middlebury College,*" Vermont Family Forests. VT, 2004.

The current prices of the chips, according to the Biomass Energy Resource Center (BERC), are shown on Table 1. [16] The price of sawmill chip and whole-tree chip are about the same. The price of the whole tree chip consists of the price of harvest and chipping costs and transportation costs, and the price fluctuates depending on the supplier.[17] The price of the whole-tree chip may be cheaper than the sawmill chip, but the sawmill chip has a consistent price, which is very important because this tells us that the market is stable, and has a reliable supply of chips. There is another type of harvest residue other than the whole-tree chip, which is called a bole chip. They are made from a stems of the trees and large branches, as part of a timber harvesting operation. Bole chip is expensive compared to other two chips, but from the information obtained through the interview with BERC, increasing number of newer schools in VT are burning bole chips, due to the limited supply of sawmill chips. Very few schools are currently burning whole-tree chips.

Bark, Sawdust, and Shavings are not a good option for fuels, because they are expensive, and also because they cause routine maintenance problems that is very costly compared to the sawmill chips and the whole tree chips.[18]

The comparison among a sawmill chip, a whole-tree chip, and a bole chip is helpful in order to decide which type of wood chip is the most suitable for the Hannaford Career Center to use, and that would affect the type of the boiler they need and the annual fuel cost.

The chip made from the sawmill residue is considered the highest quality, due to its small possibility of jamming as it is bark-free with few pieces or branches.[19]

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[16] Adam Sherman, Biomass Energy Resource Center.
[17] "*Biomass Fuel Assessment for Middlebury College,*" Vermont Family Forests. VT, 2004.
[18] "*Preliminary Biomass Heating Analysis*," Richmond Energy Associate. VT, 2007.

However, the amount of sawmill residue is limited, so as the demand goes up in the future, the price is likely to rise. The price of the sawmill chip was $30 in 2003, and current price is $33-36, showing that the price of the sawmill chip is already rising.[20]

Whole-tree chips tend to be dirtier fuel than the sawmill chips, and might produce indoor pollution. They may contain small branches, barks, twigs and leaves, which can jam the relatively small augers system. Also, because they produce more ash than the sawmill chips, the cost of daily maintenance would increase. However, ashes are recycled back to the forest as nutrients, so the cost of disposal treatment can be neglected. Currently, the low-grade wood costs very little and only about 50% of logging operations in VT involve professional foresters who can layout roads, trails, and log landings. If the value of the wood rises, management of the logging operations may become more professional, and it improves the conservation of soils, nutrients, and water in the forest area. Also, using the whole-tree chips help to keep the forests healthy because the woods that used are crooked, diseased, or low-value boles, that are otherwise left on the site because of their very low price. There is, however, a debate on up to how much removal would be considered healthy.

Bole chips are quite similar to whole tree chips, but the tops and branches are left in the forest, so they tend to have far fewer twigs and long stringers than the whole tree chips. It is likely to have more oversized chips than the sawmill chips, which makes the bole tree chips' overall quality in between the whole-tree chips and the sawmill chips. However, the size of the chip depends on the careful operation and the maintenance of chipping equipment in the woods, so the quality can be improved. As from the aspect of

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[19] Ibid.
[20] "*Biomass Fuel Assessment for Middlebury College,*" Vermont Family Forests. VT, 2004.

forest preservation, tops and branches that are left at the forest contain most of the important soil nutrients in trees; branches contain 34-52 percent of the nutrient stock in a tree.[21] The removal of those branches will increase erosion and elevate the levels of nutrients leached by stream waters, so from this aspect, bole tree chips are better for the environment than that of the whole tree chips. However, the price of the bole chip is very expensive compared to sawmill chip and whole-tree chip. Additionally, in 2003 the bole-tree chip was very little or not at all produced in the Addison County and Rutland area (Table 1), so it is not only expensive, but it may be hard to find the supplier locally.

Currently, sawmill chips is the best option for the Hannaford Career Center when considering the cost of chips and the temporary maintenance fee. However, the price of the sawmill chip has been rising and it is likely to rise in the future as the biomass fuel becomes more popular in this region.[22] It would be a good idea for Hannaford Career Center to keep track of those three wood chips prices, and change the fuel type in the future if necessary. For Addison County as a whole, it is likely that use of at least either bole tree chip or whole tree chip will be necessary in the future if the biomass energy continues to replace the fossil fuel energy because sawmill chip would not be enough to supply every household.

Questioning the sustainability of biomass energy should not be neglected as well. Even though Vermont has abundant forest resources, if the wood chip biomass spreads in Addison County, the environmental consequences on the local forests may occur; this could possibly change the forest structure and microclimate. Bole-tree harvesting leaves the branches at the site, but coarse woody debris serve as seed

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[21] "*Preliminary Biomass Heating Analysis*," Richmond Energy Associate. VT, 2007.
[22] "*Vermont Fuels For Schools*," Biomass Energy Resource Center. http://www.biomasscenter.org/upcoming.html

germination sites, reservoirs of moisture, and habitat for numerous species of fungi, invertebrates, and vertebrates. It also plays a role in nutrient conservation and cycling, so even though they are low- grade trees, they play a role in the forest ecosystem, and exceeding proper harvesting amounts may have a substantial impact on the forest. Although the annual growth of low-quality wood exceeds demand, the available supply is less than annual growth because many landowners are reluctant to cut trees on their land. Middlebury College calculated how much net low-quality wood is available, after the college began to use biomass fuel and residential use of firewood increasing to replace 50% of residential fuel oil.[23] The results showed a trend of negative 33,814 tons (considering 75% of the landowners willing to sell their trees). From this calculation, in the long-run, there will not be enough wood chips to replace all the fossil fuel in the County. Considering the environmental impact and the supply of woodchips, Addison County needs to incorporate several different renewable energy resources rather than focus solely on biomass. For Hannaford Career Center, however, it would be wise to become independent from oil, and because biomass systems are relatively easy to convert to other fuels, it offers great flexibility for a future of uncertain energy supply.

[23] "*Biomass Fuel Assessment for Middlebury College*." Vermont Family Forests. VT, 2004.

Necessary Grants and Political Processes:

Making a switch to Biomass will not be cheap, and thus sources of funding need to be explored. There are many problems at the moment however, that face schools in terms of looking for funds. On the federal level, there are mixed messages being presented on funding, presumably because many of these programs are just emerging. According to the office of Senator Bernie Sanders, a project like this could receive a "grant that covers up to 25 percent of eligible project costs up to $500,000 per project; or you can apply for a guaranteed loan that covers up to 50 percent of project costs, up to $10 million" through the USDA Renewable Energy Systems and Energy Efficiency Improvements Program.[24] According to the office of Congressman Peter Welch, however, as a school, and more importantly a non-profit, Hannaford would be ineligible for federal funding on this project[25], meaning that all additional funding would have to come from state and local sources. Currently, alternative energy projects in Vermont public schools are eligible to receive seventy-five percent of their qualifying costs (costs that only apply directly to the boiler construction, such as handling, the boiler, and the building it is in) to be paid for by the state, through the Vermont Fuels for Schools Initiative.[26] To qualify for state aid, a Life Cycle Cost Analysis would need to undertaken to determine the project's feasibility over a thirty-year period.[27] An item on Vermont's legislative agenda for this session however, is looking to eliminate that funding. As of this publication, the bill has not made its way completely through the legislature. For Hannaford Career Center, this may not be a problem, because of the fact that there is

[24] Seth Engel, Legislative Correspondant for the Office of US Senator Bernie Sanders
[25] Mary L. Sprayregen, Business Liasion, Office of Congressman Peter Welch
[26] Paul Frederick, State Parks and Recreation
[27] Paul Frederick, State Parks and Recreation

some gray area to whether this could be considered a public school or not. If this funding is eliminated, however, there is still another way in which Hannaford can receive funding. Building projects outside of energy are eligible to receive thirty percent funding from the state for public schools and up to fifty percent for technical career centers such as Hannaford. Any other funding towards the project would have to come from the taxpayers themselves through the Center's taking out of loans and/or bonds.[28] Fortunately here, the taxpayer base has been a friendly one that has continued to support Hannaford, through the years and through its recent building expansion.[29] If this healthy relationship can be maintained, the overall costs (and thus overall benefits) can be distributed throughout the three-school region of Middlebury, Mount Abraham, and Vergennes. Other possibilities include securing private funding from environmental organizations, or even trying to solicit some of the power to other entities that desire to advertise themselves as "Green," which Middlebury College is considering with some off-campus projects. There is also the Middlebury College Environmental Grant program, which gives grants to proposals from students, faculty, and staff who present ideas on how to better the school and/or surrounding community. This cooperative project between Environmental Economics 265 and the Hannaford Career Center may be enough to apply for such funding, however, these grants only tend to range from fifty to fifteen-hundred dollars. Small monetary contributions, however, can help in funding for total costs not necessarily associated with just the burner, but also permits and other governmental fees.

[28] Kamalesh Doshi, Program Director of the Biomass Energy Resource Center
[29] Nancy Cobden

While there are numerous permits that will need to be applied and paid for, such as those dealing with building, occupancy, fire, and others, these would be dealt with by project engineers and architects. The major permits that would need to be undertaken however, would require more study. Hannaford Career Center is under the jurisdiction of Vermont Act 250, which requires the Center as well as other interested parties to complete a state environmental impact statement. This statement explores the following ten criteria for the project: that it "Will not result in undue water or air pollution"; "Has sufficient water available for the needs of the subdivision or development"; "Will not unreasonable burden any existing water supply"; "Will not cause unreasonable soil erosion or affect the capacity of the land to hold water"; "Will not cause unreasonably dangerous or congested conditions with respect to highways or other means of transportation"; "Will not create an unreasonable burden on the educational facilities of the municipality"; "Will not create an unreasonable burden on the municipality in providing governmental services"; "Will not have an undue adverse effect on aesthetics, scenic beauty, historic sites or natural areas, and...will not imperil necessary wildlife habitat or endangered species in the immediate area"; "Conforms with the Capability and Development Plan which includes the following considerations: (A) The impact the project will have on the growth of the town or region: (B) Primary agricultural soils; (C) Productive forest soils; (D) Earth resources; (E) Extraction of earth resources; (F) Energy conservation; (G) Private utility services; (H) Costs of scattered developments; (J) Public utility services; (K) Development affecting public investments; and (L) Rural growth areas"; "Is in conformance with any local or regional plan or capital facilities program."[30]

[30] State of Vermont Natural Resources Board—District Commissions "Act 250" http://www.nrb.state.vt.us/lup/publications/nrb1.pdf

While many of these criteria do not seem to apply to the project, since any construction will take place adjacent to an existing building, those in regards to aesthetics, water, and air quality may be a concern. An additional air quality test may be required, depending on the size of the burner. Should the decision be made to purchase a burner with a heat exchange of over ninety boiler horsepower, an air quality test will need to be undertaken.[31] However, all other local and state permits, as stated before, would be handled by architects and engineers involved in the project.

[31] Paul Frederick

Conclusions and Further Research:

While time constraints limited our ability to conduct more extensive analysis, there are other possibilities that can be looked into with this project to reduce costs and also further community involvement. We were not able to look into the idea of cogeneration with biomass, whereby the waste heat from the burner could be used to heat the building.

Further analysis can also look into the school's production of its own fuels. Currently Hannaford Career Center's North Campus sits efforts are made to convert these grasses to switch grass, the center may be able to reduce transportation costs of pellets by producing some of its own fuel. Biomass is a unique fuel source that may be used anywhere because it is not dependent on outside variables, such as sun, wind, or water to generate electricity, albeit for the growing process of organic matter. This convenience allowed us to conduct the biomass feasibility study over a relatively short period of time. If Hannaford Career Center and the Middlebury Union High School wish to look into the possibilities of investing in renewable hydropower, solar power, or even wind power, extensive study needs to be conducted. Many of these studies can incorporate student involvement. Measuring stream depth and flow in the nearby river over the course of determine if hydropower is feasible. Solar and wind can be looked into by students in terms of measuring daily wind and sunlight totals. Overall, we are excited about the possibility of a biomass burner being installed at the Hannaford Career Center in the future.

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This project was able to reach completion through the help of many people, including Bruce MacIntyre (an original community partner--even though we were not able to help him out with the Middlebury High School); Nancy Cobden (our community partner at the Hannaford Center); Seth Engel (our contact at Senator Bernie Sanders' office); State Representative Betty Nuovo of Middlebury; Nancy Sprayregen (our contact at Congressman Peter Welch's office); Norm Etkin (our contact at the Vermont Superintendents Association); Kamalesh Doshi and Adam Sherman (our contacts at BERC); Jeff Forward (our contact at Richmond Energy Associates); Paul Frederick (our contact at the Vermont State Parks and Recreation Department); as well as from the continuous help and support from Professor Jon Isham.

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