Preliminary Feasibility Report

Pittsfield School District

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Report Prepared for NH WEC by:

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The NH Wood Energy Council is coordinated by North Country Resource Conservation & Development and funded through a grant from the USDA Forest Service State & Private Forestry. North Country RC&D, coordinator of the NH Wood Energy Council, complies with federal nondiscrimination policy and is an equal opportunity provider.

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I. Executive Summary and Recommendations

The NH Wood Energy Council (NH WEC) www.nhwoodenergycouncil.org, with funding through a grant from the USDA Forest Service, funded this preliminary feasibility study for the Pittsfield School District in order to determine if switching from fossil fuel to wood fuel for heating is feasible and warranted. Jeff Forward of Forward Thinking Consultants, LLC was hired by NH WEC to complete this “Coaching” assignment and is the author of this report.

The Pittsfield Elementary School is a 52,480 square foot building. It is heated by two 1.477 mmBtu HB Smith cast iron fuel oil boilers that were installed in 1968. The boilers are in fair condition, but they are at the end of their design lives.

The Middle/High School is 80,000 square feet and was originally built in the 1950s. Since then it has had several additions added. It is heated with two 1.477 Weill McLain boilers that were installed in 2001 and are in fair to good condition.

The district reported that it used a five-year average of 12,617 gallons of fuel oil per year at the Elementary School and 24,549 gallons of fuel oil at the Middle/High School. Over this same period they paid an average of $3.03 per gallon.

This prefeasibility study examines four different scenarios to switch from fuel oil to predominately biomass heating.

- Scenario 1 analyzes the costs and saving from adding a pellet boiler system to the Elementary School.
- Scenario 2 analyzes a central district heating system that would link both schools fueled by green woodchips
- Scenario 3 analyzes a central district heating system that would link both schools fueled by semi-dry woodchips
- Scenario 4 analyzes a central district heating system that would link both schools fueled by wood pellets.

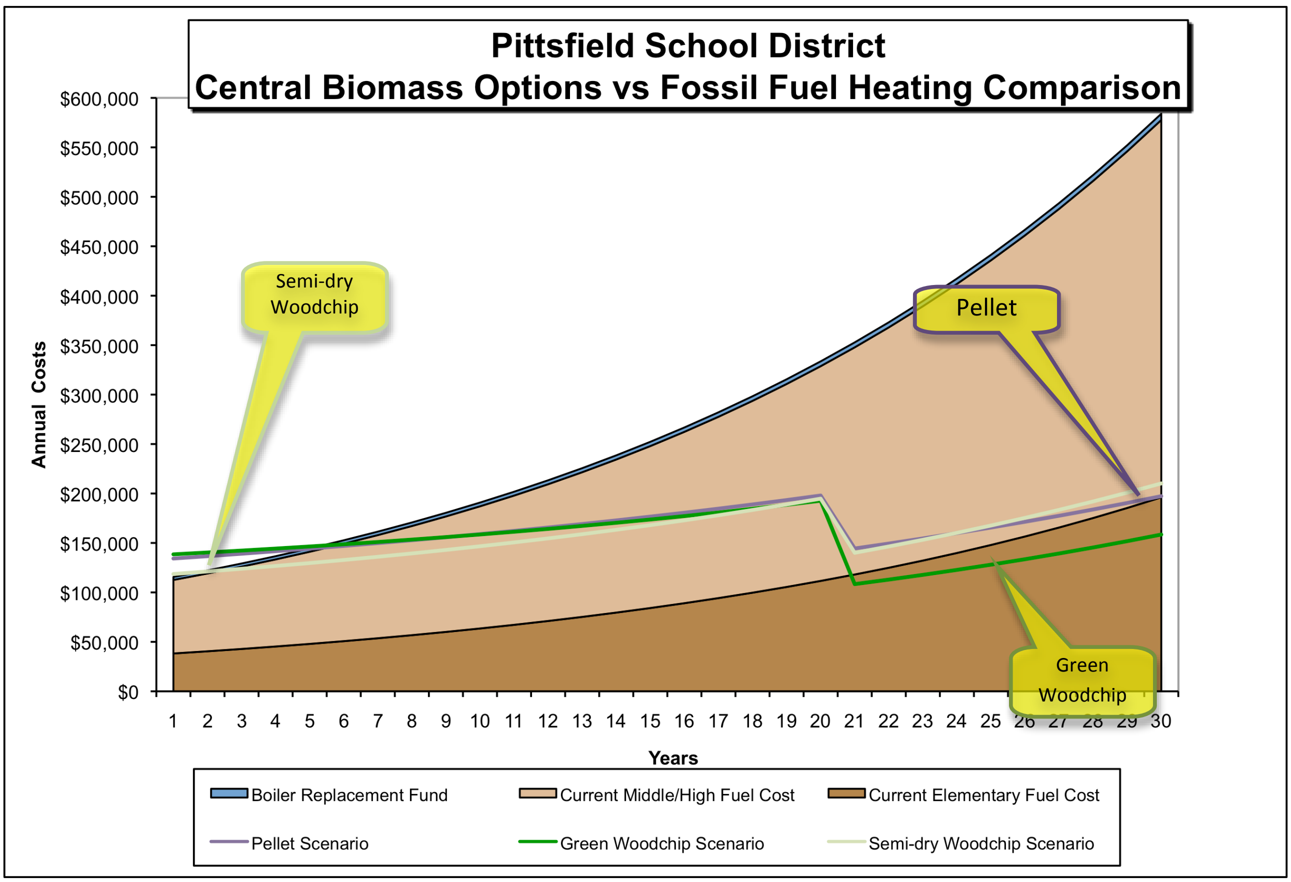
Life-cycle cost analyses for all four scenarios are presented in this report. All of the analyses are based on average fuel prices over the past five years. No one knows for sure what future fuel prices will be but history indicates that fuel oil prices will rise again in the future and an investment in biomass, especially with the generous incentives for biomass equipment that are available in New Hampshire, will reduce the current and future risk.

All four scenarios use life-cycle assessment tools. Capital cost estimates were based on estimates provided by a local biomass vendor and our experience with similar installations. Should the Pittsfield School District move forward with a new wood boiler system, it should be designed/configured to work in tandem with the fossil fuel fired boiler systems to ensure it meets peak capacity requirements and to provide back up for the biomass boiler system.

It was assumed that the district would be eligible for a New Hampshire Public Utilities Commission grant for biomass boilers. More grant funding would of course improve that return on investment. It was then assumed that the entire net cost of each project was financed at 4% interest over 20 years.

In addition to the economic analysis that is included in the body of this report, there are also sensitivity analyses in the appendix that compare the return on investment based on different fuel costs and system costs.

Figure 1: Biomass vs. Fossil Fuel Heating Comparison



Based on the analysis performed for this report, it appears that all four scenarios are cost effective. The semi-dry woodchip boiler scenario has the best return on investment, while the pellet system has the lowest capital cost for the central district heating scenarios.

Table 1: Summary Findings of Biomass Analysis for the Pittsfield School District

Scenario	Current Annual fuel oil (gallons)	Projected Annual Fuel Bill*	Net Estimated Project Costs after NH PUC Grant	Annual Tons of Woodchips / pellets	Annual Tons of Carbon Offset by woodchips/ pellets	Return on Investment	Net 1st Year Fuel Savings	Total 30 Year NPV Cumulative Savings
Elementary Only	12,717	$38,230	$341,030	83	127	4.4%	$14,854	$290,212
Green Woodchip	37,166	$112,613	$1,160,288	428	349	6.0%	$69,197	$1,623,031
Dry Woodchip	37,166	$112,613	$828,134	343	371	7.0%	$57,951	$1,590,479
Central Pellet	37,166	$112,613	$748,128	257	371	5.3%	$39,720	$1,484,969

We recommend the District take the following steps to further investigate the feasibility of a wood boiler heating system:

1. **Hire an engineering firm**[1] to help refine the project concept and to obtain firm local estimates on project costs. An important issue for the project engineers to consider is thermal storage. Biomass heating systems, including wood chip systems but especially pellet boiler systems, operate significantly more efficiently and effectively (improving cost savings) if thermal storage is designed into the overall system. With thermal storage, a biomass boiler can quickly ramp up to high fire and will shut down when the thermal storage has reached its optimum temperature, this type of system can supply a greater portion of the annual heating load and will therefore provide greater savings. We recommend that any pellet boiler system that is specified for this project include thermal storage as a component of the overall design and wood chip systems may also benefit from thermal storage.
2. **A mechanical analysis that provides an independent assessment of how to improve efficiencies and the operations and maintenance of the existing boiler equipment, ventilation equipment and controls** should be performed before investing in any new boiler system. Upgrades could include outdoor temperature reset, DDC controls for ventilation systems and improved boiler controls. Both schools have oil fired domestic hot water heaters. The District should instruct the engineering team to evaluate creating a zone off the main boiler system with a highly insulated storage tank for domestic hot water or other domestic hot water heating strategies. A mechanical evaluation will more than

[1] The District may be able to reduce costs by hiring a biomass boiler vendor directly to design/build whichever system the district decides to move forward with, thereby saving on design fees and general contracting costs.

likely pay for itself many times over regardless of whether or not the District moves forward with a biomass system.

3. **Propane should be used for back-up boiler systems if possible.** This would eliminate the need for an underground fuel oil storage tank, which can be a significant liability. If the District decides on the pellet boiler option for just the Elementary School, it should consider converting the existing boilers to propane and removing the underground fuel storage tank for that school. If the District decides to go with one of the central district heating options, careful consideration should be given to which heating systems should be retained for back-up and supplemental heat. It is likely that the boilers at the Middle/High school could serve as back-up for a central wood system and the boilers at the Elementary School could be removed or mothballed.

4. The District should consider other **energy efficiency improvements** simultaneously with boiler upgrades. The efficiency of the building envelope and ventilation equipment need to be considered when sizing new boiler equipment. It is our understanding that the District has commissioned an energy audit for both schools simultaneously with this biomass study. The District should evaluate the efficiency opportunities from those audits and consider combining energy efficiency measures with biomass boiler upgrades at one or both schools. The District may want to consider presenting this package of measures as a comprehensive energy improvement bond to voters. The value of investing in efficiency and biomass is that the long-term return on investment will be considerably better than continuing business as usual. Voters in school districts understand this dynamic and have shown their willingness, time and time again, to spend money to save money when it comes to energy improvements.

5. In order to effectively measure progress toward energy efficiency goals **historical energy consumption data should be collected and updated frequently**. There are many tools that could help the District accomplish this task. One such tool is the EPA Energy Star *Portfolio Manager* software. It is free public domain software that helps facility managers track energy and water use and provides useful reports and graphs. This software can be downloaded at:
   http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager

6. The District should **contact multiple wood fuel providers to get delivery quotes** and identify the lowest cost supplier. A list of biomass boiler vendors is included in the appendices to this report and a pellet fuel supplier list can be obtained from NH WEC. It is important to keep in mind that while price is important, ultimately the performance of any

wood heating system will depend on fuel quality. The Windham Wood Heat Initiative in Windham County, Vermont is working on a performance specification for pellet fuel. The Biomass Energy Resource Center has a performance specification for green wood chips. These are good tools for getting competitive bids that take fuel quality into consideration.

II. Introduction

There is a significant volume of low-grade biomass in the United States that represents a valuable economic and environmental opportunity if it can be constructively used to produce thermal energy. Commercially available biomass heating systems can provide heat cleanly and efficiently in many commercial applications. Biomass heating technologies (including woodchips and pellets) are being used quite successfully in nearly two-dozen New Hampshire schools. Good candidate facilities for biomass energy systems include those that have high heating bills, those that have hot water heating distribution systems and those that have ready access to reasonably priced biomass fuel.

In addition to the potential financial benefits of installing a biomass energy system, a biomass system would utilize locally grown and harvested wood (keeping energy dollars in the local economy); and it would reduce the District's carbon footprint (by replacing fossil fuel with a renewable fuel source). This analysis indicates that the Pittsfield School District could offset up to 371 tons of CO_2 annually by installing a wood boiler system.

Opportunities to use wood energy to replace fossil fuels can provide increased economic benefits to all residents and businesses in New Hampshire and help move the State towards the State's goal of using 25% Renewable Energy by 2025.

Nationally, the U.S. Department of Agriculture has directed the Forest Service to increase its wood to energy efforts as part of that Agency's continuing focus on building a forest restoration economy connected to the management of all lands. By placing a strong emphasis on developing renewable wood energy while restoring the nation's forests, USDA strives to create and retain sustainable rural jobs, conserve forests, and address societal needs.

For these reasons the State Forester and the U.S. Forest Service created the New Hampshire Wood Energy Council. The NH Wood Energy Council (NH WEC) includes individuals, organizations, NH businesses, industry associations and non-profits interested in the sustainable use of forest resources, development of renewable energy alternatives - from regional and community agencies sustaining local economies and meeting social needs, and from State and Federal agencies interested in maintaining and expanding the economic benefits from the State's forest resources. The NH WEC serves as a national pilot, testing and refining tools to encourage more use of wood for energy and methods.

The USDA Forest Service has provided financial and technical resources to support the work of the NH WEC. The North Country Resource Conservation and Development (RC&D) Area Council facilitates the organization and work of the Council.

A key component of the NH WEC's work is to provide direct technical assistance to public, institutional and private facility managers to encourage switching to modern, efficient wood-fueled heating systems. This preliminary feasibility study is a key method to deliver those technical services where needed.

An application for assistance, submitted by Superintendent John Freeman, was selected by the NH WEC as a site for a preliminary feasibility study conducted to assess the potential to convert from a fossil-fuel based heating system to a wood biomass based heating system.

This report is a pre-feasibility assessment specifically tailored to the Pittsfield School District outlining whether or not a biomass heating system makes economic sense for Pittsfield School District from a practical perspective.   In May of 2016 Jeff Forward from Forward Thinking Consultants, LLC traveled to Pittsfield to tour the two schools and collect information and data for this study. This assessment includes site-specific fuel savings projections based on historic fuel consumption for Pittsfield School District, and provides facility decision-makers suggestions and recommendations on next steps.

III. Existing Facilities and Heating Systems

Two 1.477 mmBtu/hr H.B. Smith cast iron hot water boilers were installed in 2001 at the Pittsfield Middle/High School. There is also one smaller 277,000 Btu/hr. Burnham fuel oil water heater that is used exclusively for domestic hot water at the Middle/High School.

Figure 2 Middle/High School 2001 2 - HB Smith Boilers on left, Burnham boiler on right

Figure 3 Elementary School Boilers and oil fired water heater

The Elementary School has two 1.47 mmBtu/hr Weil McLane boilers that were installed in the Elementary School in 1968. These boilers at the Elementary School are only in fair condition and are nearing the end of their design life[2]. The Elementary School also has an oil fired domestic hot water heater.

The boilers at the Middle/High School could be used for back-up and supplemental heat if a wood boiler system is installed. With proper controls, the lives of the oil boilers can be extended if they are only used for backup and supplemental heat because they would be used so little. During the fall and spring, facility operators with wood boilers often use fossil fuel boilers, as they are easier to start up and turn down. However, the utilization can be about 85% with a woodchip system and as much as 90%- 100% with pellet or semi-dry woodchip boilers because these boilers can include self-igniting and thermal storage systems, which allow them to operate throughout the shoulder seasons.

IV. Life Cycle Cost and Analysis Assumptions

Decision makers need practical methods for evaluating the economic performance of alternative choices for any given purchasing decision. When making a choice between mutually exclusive capital investments, it is prudent to compare all equipment and operating costs spent over the life of the longest-lived alternative in order to determine the true least cost choice. The total cost of acquisition, fuel costs, operation and maintenance of an item throughout its useful life is known as its “life cycle cost.” Life cycle costs that should be considered in a life cycle cost analysis include:

[2] The District should be considering replacement options for the oil boilers at the Elementary School if they decide not to install a new wood boiler system. For this reason, a boiler replacement fund starting at $3,000 per year was incorporated into each analysis to take into account the avoided cost of replacing the existing boilers at the Elementary School. This cost was then inflated at the general inflation rate.

- Capital costs for purchasing and installing equipment
- Fuel costs
- Inflation for fuels, operational labor and major repairs
- Annual operation and maintenance costs including scheduled major repairs
- Avoided future capital costs for replacement or overhaul of current system.

It is also useful for decision makers to consider the impact of debt service if the project is to be financed in order to get a clearer picture of how a project might affect annual budgets. When viewed in this light, equipment with significant capital costs may still be the least-cost alternative. A significant capital investment may actually lower annual expenses, if there are sufficient fuel savings to offset debt service and any incremental increases in operation and maintenance costs.

Fuel Oil Assumptions including inflation

Based on fuel deliveries from 2011- 2016 we assumed an average annual fuel use at 12,617 gallons for the Elementary School and 24,549 gallons for the Middle/High School for a combined total of 37,166 gallons of fuel oil for heating. The Middle/High school also has 3 propane fired air handlers. These were not inspected during the site visit and it is unknown whether those could be converted to hot water from the boiler system. But if they can be converted, it may be worth investigating during design. In general, with biomass heating systems, bigger is better. The larger the fuel bill the greater the savings.

Table 2 Annual Fuel Purchases and Price per Gallon[3]

Elementary School		
2015-2016	11,300	$2.21
2014-2015	11,812	$2.97
2013-2014	13,450	$3.20
2012-2013	14,186	$3.30
2011-2012	12,339	$3.28
Average	12,617	$3.03

Middle/High School		
2015-2016	21,606	$2.21
2014-2015	29,120	$3.05
2013-2014	22,142	$3.20
2012-2013	24,539	$3.30
2011-2012	25,338	$3.28
Average	24,549	$3.03

Fuel oil prices are at historic lows right now. However, 2 years ago they were nearly 50% higher than they were this year. For the purposes of this study $3.03 was used as the starting price for fuel oil in the analysis based on the 5 years of fuel oil pricing that the district has paid for these schools. Fuel oil prices may be lower than that today but it is more appropriate to look at a multi-year average in any projection. Sensitivity analyses in the appendix also look at other fuel price scenarios but we believe the 5-year average is the best estimate for the analysis.

In this pre-feasibility study it was assumed that the price of fuel, (heating oil, woodchips and wood pellets) would increase over time. Using US Energy Information Administration (EIA) data for residential fuel oil prices from 1995 – 2015 in New Hampshire, the last full year of data, the average inflation for fuel oil was 5.8% per year. This was the inflation rate that was used for fuel

[3] Information provided by the Pittsfield School District

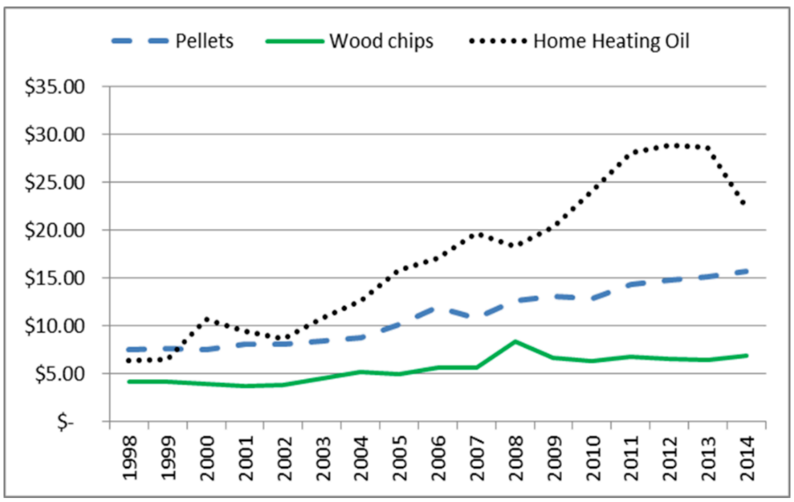
oil in the analysis. The average general inflation rate over that same period of time has been 2.6% based on US Bureau of Labor and Statistics data.

Wood Pellet Assumptions including inflation

EIA does not track pellet fuel data, but it is reasonable to assume that bulk pellet fuel inflation might be higher than general inflation because it requires energy to produce pellet fuel. By the same token it is reasonable to assume that bulk pellet fuel inflation will be lower than fuel oil inflation because pellet fuel prices historically have not been as volatile as fossil fuels prices. In addition, since pellet fuel is produced relatively locally it has considerably less exposure to global politics than fossil fuels. For the purposes of this analysis, an inflation rate of 4.25% was used for wood pellets, which is about half way between fuel oil and general inflation.

Figure 4 shows historical data for pricing of wood pellets and heating fuel oil.

Figure 4 Fuel Cost per MMBTU in NH, 1998 – 2014[4]



A temporary or seasonal price increase or decrease may occur but in general we believe these historical price trends will continue. For the purposes of this study, a current price for wood pellets delivered in bulk form at $235/ton[5] is used. This is equivalent to approximately $1.97/gallon fuel oil. It was assumed that a pellet boiler system would be able to provide 90% of the seasonal heating needs of the school.

Woodchip Fuel Cost Assumptions including inflation

We are projecting a first year cost of $60 per ton for green woodchips, which is equivalent to about $1.03 per gallon of fuel oil. In the green woodchip scenario, it is assumed that 85% of the seasonal heating needs of the school will be covered by woodchips (this is the typical usage reported by Vermont schools). The remaining 15% of the heating needs were assumed to be provided by fuel oil, using approximately 5,854 gallons of fuel oil each year including 5% line losses from piping. The cost for supplemental fuel oil is then adjusted for inflation each year over the 30-year horizon.

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[4] Source NH OEP, Innovative Natural Resource Solutions, LLC

[5] Froling Energy, Peterborough, NH

The cost of green woodchips used for heating fuel tends to increase more slowly and has historically been much more stable in price over the past two decades than fossil fuels. In Vermont for example, the statewide average woodchip fuel price for institutional biomass heating systems rose from $25/ton to $65/ton in the period between 1994 and 2014. The average annual increase during this period was about 3.6% annually[6] with the greatest increases happening recently. Because green woodchip fuel is locally produced from what is generally considered a waste product from some other forest product business, it does not have the same geopolitical pressures that fossil fuels have. Over the past twenty years, woodchip fuel costs have been far less volatile than fossil fuels.

While semi-dry woodchips are commonly used in Europe they are relatively new to the New England area. There are two suppliers of semi-dry woodchips in southern New Hampshire, Froling Energy and Innovative Wood Fuels, LLC. These chips are screened for consistent size and are dried to moisture content of 25-30%. Froling Energy was contacted and gave a price of $125/ton for semi-dry chips. Innovative Wood Fuels, LLC just signed a contract to deliver semi-dry wood chips to Plymouth High School in NH for the 2016-17 heating season for $105/ton delivered. To be conservative, $125/semi-dry ton delivered was the price that was used in the analysis. This price was then inflated at the same inflation rate as pellet fuel or 4.25% per year.

Table 3: Current Fuel Pricing and Cost per mmBtu

Fuel Type	Unit	Cost per Unit	Cost per MMBtu Delivered	Average Seasonal Efficiency	Cost per MMBtu After Combustion
#2 Oil	gallon	$3.03	$21.96	70%	$31.37
Wood Chips	ton	$60	$6.01	75%	$8.01
Semi-dry Woodchips	ton	$125	$10.10	80%	$12.63
Wood Pellets	ton	$235	$15.15	85%	$17.83

* Assumes 40% moisture content
** Assumes 25% moisture content
*** Assumes 6% moisture content

Capital Cost Estimates

It is not the intent of this project, nor was it in the scope of work, to develop detailed engineering cost estimates for a biomass energy project. The capital costs used for the biomass scenario are based on cost estimates provided by a biomass boiler vendor and generic estimates based on experience with similar scale projects.

The scenarios that were analyzed included purchase and installation of wood boiler systems including wood fuel storage; thermal storage for modulating heat delivery; an allowance for

[6] Extrapolated from Vermont Superintendent Association School Energy Management Program data. Woodchip price history is taken from Vermont because this State has the longest and best recorded, woodchip pricing history.

interconnecting with the existing boiler system; and standard design fees, contractor mark-up and contingency[7].

A $55,000 grant from the NH Public Utilities Commission[8] was subtracted from all scenarios' capital costs because these projects appear to be eligible for this grant and it is the intent of this study to analyze school district costs and savings, particularly as to how they relate to annual budgets.

It is recommended that the District hire a qualified design team to refine the project concept and to develop firm local cost estimates. We believe that the price estimates used for this report are within + or – 10%.

Table 4 Assumptions used for Scenario 1, Elementary School only

Pittsfield Elementary School **Pellet Scenario**	
Capital Cost Assumptions	
One 600,000 Btu pellet hot water boiler system including installation into existing boiler room	$250,000
Retrofit storage room to use as pellet storage silo	$20,000
Thermal Storage 600 gallon	$12,000
Interconnect to existing boiler system	$25,000
GC markup at 10%	$30,700
Construction contingency at 10%	$33,770
Design at 8%	$24,560
Total estimated project costs	$396,030
Boiler Replacement Fund	*$3,000*
NH PUC Incentive	$55,000
Total Local Share	**$341,030**
Financing Costs	
Financing, annual interest rate	4.0%
Finance term (years)	20
1st full year debt service	$25,094
Fuel Cost Assumptions	
Current annual fuel oil use (gal)	12,617
Assumed fuel oil price in 1st year	$3.03
Projected annual fuel oil bill if annual heating is entirely from fuel oil	$38,230
Percent pellet fuel utilization	90%
Fuel oil (gal)/ton ratio	136
Projected annual pellet fuel consumption in tons	83
Assumed pellet price in 1st year (per ton)	$235
Projected 1st year pellet fuel bill	$19,553
Projected 1st year supplemental fuel oil bill	$3,823
Inflation Assumptions	
General inflation rate (twenty year average CPI)	2.6%
Fuel oil inflation rate (twenty year average EIA)	5.8%
Pellet inflation rate (Biomass Energy Resource Center)	4.25%
O&M Assumptions	
Annual pellet O&M cost, including electricity for additional pumps and motors and staff time for daily and yearly maintenance	$2,000
Major repairs (annualized)	$1,000
Savings	
Return on Investment	**4.4%**
Net 1st year fuel savings	**$14,854**
Total 30 year NPV cumulative savings	**$290,212**

[7] The District may be able to reduce costs by hiring a biomass boiler vendor directly to design/build whichever system the district decides to move forward with, thereby saving on design fees and general contracting costs.
[8] The NH-PUC is currently reviewing this program and is considering increasing incentives significantly.

Table 5 Assumptions used for central district heating scenarios

Pittsfield School District Central District Energy Scenarios					Green Woodchip	Semi-Dry Woodchip	Pellet
Capital Cost Assumptions							
Biomass hot water boiler system including installation					$400,000	$350,000	$350,000
Pollution control equipment					$50,000	NA	NA
Pellet storage silo					NA	NA	$28,000
Green woodchip boilerhouse and chip storage building	2,500	SF	$150	/SF	$375,000		NA
Semi-Dry woodchip boilerhouse and chip storage building	1,500	SF	$100	/SF	NA	$150,000	NA
Pellet boilerhouse	1,000	SF	$100	/SF			$100,000
Underground insulated hot water piping from boiler house to school	764	LF	$150	/LF	$114,600	$114,600	$114,600
Thermal storage					$20,000	$20,000	$20,000
Interconnection to existing boiler rooms					$50,000	$50,000	$50,000
GC markup at 10%					$100,960	$68,460	$66,260
Construction contingency at 10%					$100,960	$75,306	$66,260
Design at 8%					$80,768	$54,768	$53,008
Total estimated project costs					$1,292,288	$883,134	$848,128
Boiler Replacement Fund					*$3,000*	*$3,000*	*$3,000*
NH PUC Incentive					$55,000	$55,000	$55,000
Total Local Share					**$1,237,288**	**$828,134**	**$793,128**
Financing Costs							
Financing, annual interest rate					4.0%	4.0%	4.0%
Finance term (years)					20	20	20
1st full year debt service					$91,042	$60,936	$58,360
Fuel Cost Assumptions							
Average annual fuel oil use in gallons for both schools					37,166	37,166	37,166
Assumed fuel oil price in 1st year					$3.03	$3.03	$3.03
Projected annual fuel oil bill if annual heating is entirely from fuel oil					$112,613	$112,613	$112,613
Percentage of wood utilization					85%	90%	90%
Fuel oil (gal)/ton ratio					78	102	136
Projected biomass use in tons (includes 5% line loss from piping)					428	343	257
Assumed wood price in 1st year (per ton)					$60	$125	$235
Projected 1st year wood fuel bill					$25,679	$42,838	$60,477
Projected 1st year supplemental fuel oil bill					$17,737	$11,824	$12,416
Inflation Assumptions							
General inflation rate (twenty year average CPI)					2.6%	2.6%	2.6%
Fuel oil inflation rate (twenty year average EIA)					5.8%	5.8%	5.8%
Wood inflation rate (20-year average extrapolated from Vermont Superintendents Assoc. data for green woodchips)					3.60%	4.25%	4.25%
O&M Assumptions							
Annual Wood O&M cost					$4,400	$2,000	$2,000
Major repairs (annualized)					$2,000	$1,000	$1,000
Savings							
Return on Investment from fuel savings					**5.6%**	**7.0%**	**5.0%**
Net 1st year fuel savings					**$69,197**	**$57,951**	**$39,720**
Total 30 year NPV cumulative savings					**$1,546,031**	**$1,590,479**	**$1,439,969**

Operation and maintenance assumptions

Pellet boiler and semi-dry woodchip scenarios

Many boilers that burn pellets will also burn semi-dry woodchips. It most cases it only requires some minor adjustments. Because wood pellets and semi-dry woodchips are generally uniform in size, shape, moisture and energy content, fuel handling is very straightforward. Nevertheless, there are some ongoing maintenance requirements for these systems. A wood pellet or wood chip boiler will take more time to maintain and operate than a traditional gas, oil, or electric heating system. At the institutional or commercial scale, however, many of the maintenance activities can be cost-effectively automated by installing off-the-shelf equipment such as soot blowers or automatic ash removal systems. Some of the typical maintenance activities required for wood pellet systems are:

Weekly

- Emptying ash collection containers
- Monitoring control devices to check combustion temperature, stack temperature, fuel consumption, and boiler operation
- Checking boiler settings and alarms, such as those that alert to a problem with soot buildup

Annually

- Greasing augers, gear boxes, and other moving parts as recommended by the manufacturer
- Checking for wear on conveyors, augers, motors, or gear boxes
- Cleaning of boiler tubes to reduce soot and improve efficiency

When considered on a weekly basis, the total time required for maintaining the wood pellet boiler system equates to roughly 1 – 1 ½ hours per week over the entire heating season but maintenance is not required every day during the heating season.

For the purposes of this analysis, it was assumed that on-site staff would spend approximately 100 hours per year on routine maintenance with a loaded labor rate of $20/hr for a total of $2,000 per year in year 1.

An assumption of $1,000 was included in the annual O&M costs for additional electricity costs for pumps and motors needed to operate the pellet boiler system.

Woodchip Scenario

Green woodchips are not as consistent as pellets or semi-dry woodchips. Therefore the fuel handling equipment is more robust than for pellets and semi-dry woodchips and the boilers require a little more attention. It is typical for operators of fully automated green woodchip heating systems to spend 15-30 minutes per day to clean ashes and to check on pumps, motors and controls. For the woodchip scenario, it was assumed that existing on-site staff would spend on average approximately one half hour per day in addition to their current boiler maintenance for 160 days per year and 40 hours during the summer months for routine maintenance. At a loaded labor rate of $20/hr, this equals $2,400 annually. An additional $2,000 in annual operational costs is assumed for electricity to run pumps, motors and pollution control equipment.

Scheduled Maintenance for All Scenarios

Another operations and maintenance cost that is included in both of the analyses is periodic repair or replacement of major items on the boilers such as the furnace refractory. It is reasonable to anticipate these types of costs on a 10-15 year cycle. Analyses for the woodchip scenario include $20,000 of scheduled maintenance anticipated in years 10, 20 and 30 and then annualized at $2,000 per year to simulate a sinking fund for major repairs. The $2,000 annual payments were inflated at the general annual inflation rate. Pellet boiler systems have fewer moving parts and should not require as much scheduled maintenance as a woodchip system. An annualized scheduled maintenance cost of $1,000 per year was included in the pellet scenario analyses for each boiler system and then inflated at the general inflation rate.

Under any biomass scenario, the existing oil heating units will require less maintenance and will likely last considerably longer since they will only be used for a small portion of the heating season. However, all heating equipment should be serviced at least annually no matter how much it is used. For these reasons, no additional annual maintenance for the existing fuel oil boilers were taken into consideration as these are considered costs that the District would have paid anyway. It was assumed that all costs for the operation and maintenance of a biomass boiler are incremental additional costs.

In all scenarios, the business as usual case anticipates the replacement of the existing fuel oil boilers sometime during the 30-year horizon of the analysis. To simulate this replacement cost a $3,000 per year replacement fund is added to the business as usual base case and is inflated at the standard inflation rate per year.

Financing Assumptions

Financing costs were included in the analysis to give facility decision makers a sense of how this project may impact their annual budget. This analysis assumes that the District will finance the entire net cost of the biomass project after subtracting a $55,000 NH Public Utilities Commission rebate. A 4% loan interest rate was used and the principal and interest payments were assumed to remain fixed over the life of the loan. At this time the analysis does not take into account any other grants, lease arrangements or the impact of financing only a portion of the project cost. Other financing plans could create more favorable cash flows depending on how much of the project costs are financed and how the remaining costs are financed. See the section in this report on Project Funding Opportunities to learn about alternative funding and financing options.

Sensitivity analyses are included in the appendices that show the relative life cycle cost savings under various financing and fuel price scenarios. If the District would like to see other cash flows using different financing schemes, Forward Thinking can provide additional analysis.

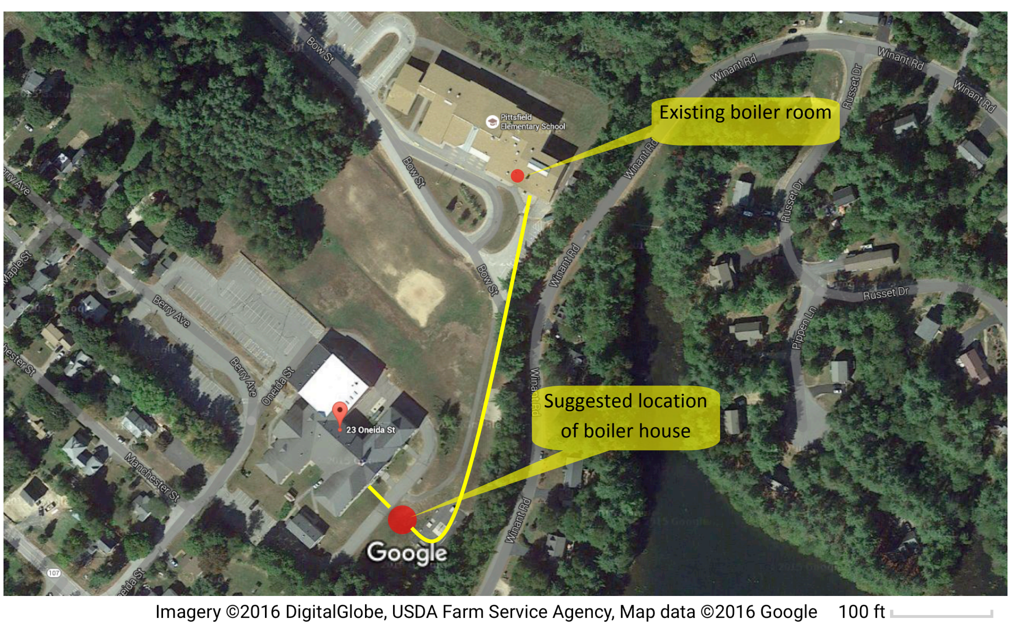
V. Analysis Results

The analysis performed for this facility compares two wood heat scenarios against a base case scenario over a 30-year horizon and takes into consideration life cycle cost factors. A 30-year time frame is used because it is the expected life of a new boiler. The analysis projects current and future annual heating bills, essentially business as usual, and compares that cost against the cost of operating a biomass system. Savings are presented in today's dollars using a net present value calculation. Net present value (NPV) is defined as the present dollar value of net cash flows over time. This is a standard method for using the time value of money to compare the cost effectiveness of long-term projects.

The central district heating scenarios envision building a boiler house southeast of the Middle/High School, because there appears to be good truck access at this location. Existing heating equipment would still be used to provide supplemental heat during the coldest days of the year if necessary and potentially for the warmer shoulder season months when buildings only require minimal heating during chilly weather.

All of the scenarios include design fees, general contracting costs and a 10% contingency fee for unexpected expenses.

Figure 5 Proposed central boiler house location



Scenario 1, Pellet Boiler at the Elementary School Only

For scenario 1, it was assumed that a new pellet boiler could be installed in the existing boiler room at the Elementary School and an adjacent storage room could be converted into a pellet storage bin. Alternately, a silo could be placed out behind the school to store pellets. The analysis includes construction costs for installation, fuel storage retrofit, ancillary equipment and interconnection costs.

Figure 6 Bulk Pellet Storage and Delivery[9]

One of the overlooked issues with pellet systems is the oversight of the volume of pellets in the storage bin. A bin with some type of gauge is required for quick line of sight of the need to order and refill the bin. This will depend on the size of the bin and the use. Pellet deliveries can be simplified and costs reduced in bulk delivery by increasing the size of the bin. In this analysis we have assumed a 36-ton bin that can accept a full truck load 25 tons of pellets per delivery.

[9] Photo of NH pellet storage at an institution in New Hampshire taken from the *Wood Pellet Heating Guidebook* published by Massachusetts Division of Energy Resources.

Figure 7 Pellet 30-year Life Cycle Cost Spreadsheet Analysis

Pittsfield Elementary School — **Preliminary Life Cycle Cost Estimate** — ***Pellets - Heat Only***

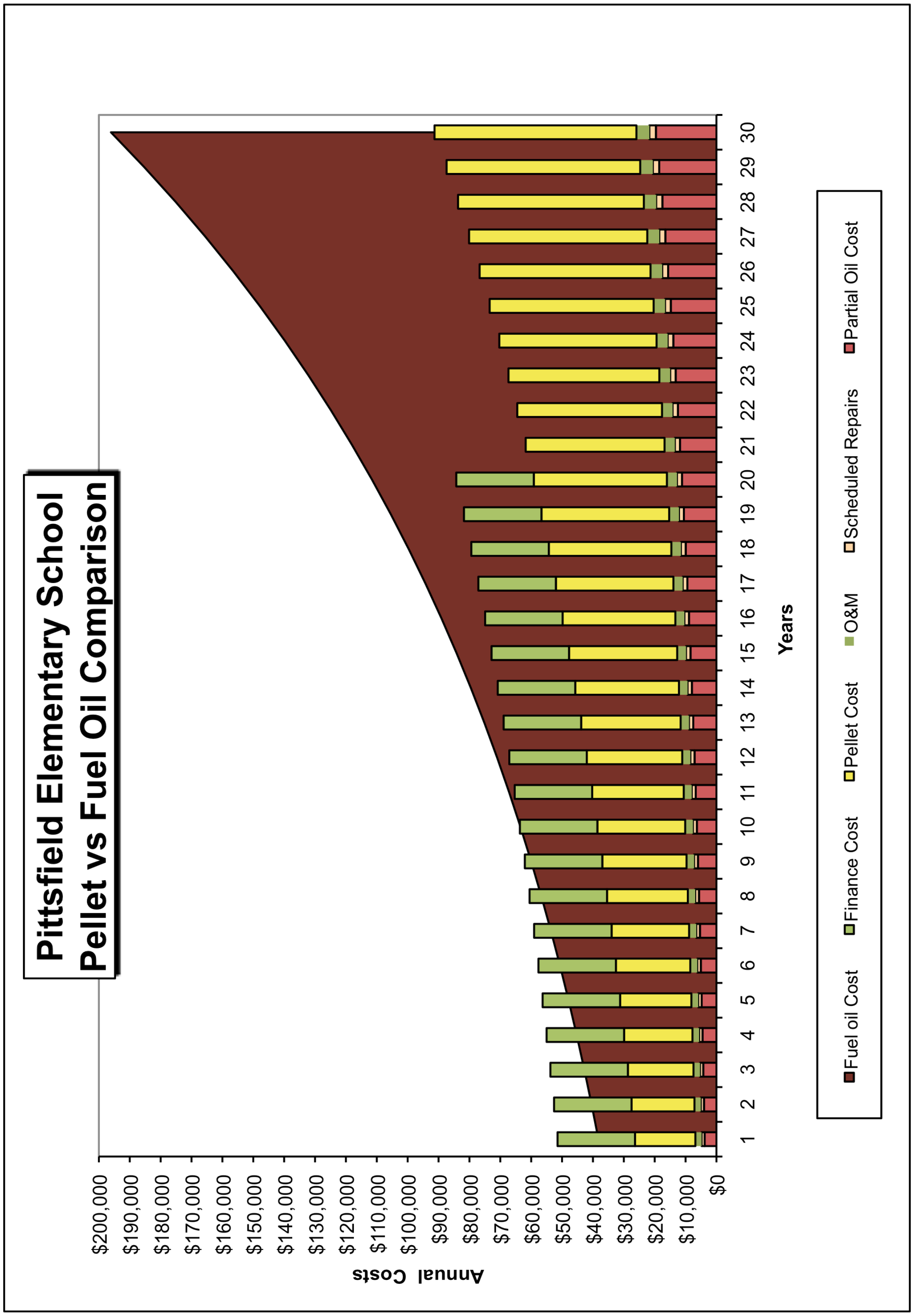
Pellet Scenario

Total estimated construction costs	***$341,030***					
Financing:	**4.0%**	*Bond interest rate*				
Oil heat consumption	**12,617**	Includes pellet BTUs	10%	Load covered by Fuel oil =	1,262 gallons	136 gal. / ton of pellets
Oil heat price	**$3.03**					
Oil heat cost	**$38,230**		92	tons if 100% pellets for oil		
Estimated pellet utilization	**90%**					
Projected pellet consumption	**83**	tons				
Estimated 1st year pellet price	**$235**	/ ton Year 1				
Projected 1st year pellet cost	**$19,553**					
Projected 1st year partial fuel oil cost	**$3,823**					
General Inflation:	**2.6%**	**annually**	*Twenty year average annual US Labor Dept. Consumer Price Index increases*			
Oil Inflation	**5.80%**		*20 year average increase for NH (US EIA)*			
Pellet Inflation:	**4.25%**	**annually**	*Estimate from Biomass Energy Resource Center*			
O & M.:	**$2,000**	**in Year 1 $**	*Estimate of additional electricity for feed system motors and additional maintenance staff time*			
Major Repairs:	**$1,000**		*Contingency for major repair (e.g. refractory replacement) at Years 10, 20 and 30 annualized*			

Yr.	Current Fuel oil Cost	Boiler Replacement Fund	Finance Cost For Entire Project	Pellet Cost	Partial Fuel oil Cost	O&M	Scheduled Repairs	Total Costs	Annual Fuel Savings	Annual Cashflow	Cumulative Cashflow
1	$38,230	$3,000	$25,094	$19,553	$3,823	$2,000	$1,000	$51,470	$14,854	-$13,240	-$13,240
2	$40,447	$3,078	$25,094	$20,384	$4,045	$2,052	$1,026	$52,600	$16,018	-$12,153	-$25,393
3	$42,793	$3,158	$25,094	$21,250	$4,279	$2,105	$1,053	$53,781	$17,263	-$10,988	-$36,382
4	$45,275	$3,240	$25,094	$22,153	$4,527	$2,160	$1,080	$55,015	$18,594	-$9,740	-$46,122
5	$47,901	$3,324	$25,094	$23,095	$4,790	$2,216	$1,108	$56,303	$20,016	-$8,402	-$54,524
6	$50,679	$3,411	$25,094	$24,076	$5,068	$2,274	$1,137	$57,649	$21,535	-$6,970	-$61,494
7	$53,618	$3,499	$25,094	$25,100	$5,362	$2,333	$1,166	$59,055	$23,157	-$5,436	-$66,930
8	$56,728	$3,590	$25,094	$26,166	$5,673	$2,394	$1,197	$60,523	$24,889	-$3,795	-$70,726
9	$60,018	$3,684	$25,094	$27,279	$6,002	$2,456	$1,228	$62,058	$26,738	-$2,039	-$72,765
10	$63,499	$3,780	$25,094	$28,438	$6,350	$2,520	$1,260	$63,661	$28,712	-$162	-$72,927
11	$67,182	$3,878	$25,094	$29,647	$6,718	$2,585	$1,293	$65,336	$30,818	$1,846	-$71,080
12	$71,079	$3,979	$25,094	$30,906	$7,108	$2,652	$1,326	$67,087	$33,065	$3,992	-$67,088
13	$75,202	$4,082	$25,094	$32,220	$7,520	$2,721	$1,361	$68,916	$35,461	$6,286	-$60,803
14	$79,563	$4,188	$25,094	$33,589	$7,956	$2,792	$1,396	$70,828	$38,018	$8,736	-$52,067
15	$84,178	$4,297	$25,094	$35,017	$8,418	$2,865	$1,432	$72,825	$40,743	$11,352	-$40,714
16	$89,060	$4,409	$25,094	$36,505	$8,906	$2,939	$1,470	$74,914	$43,649	$14,147	-$26,568
17	$94,226	$4,524	$25,094	$38,057	$9,423	$3,016	$1,508	$77,096	$46,747	$17,129	-$9,438
18	$99,691	$4,641	$25,094	$39,674	$9,969	$3,094	$1,547	$79,378	$50,048	$20,313	$10,875
19	$105,473	$4,762	$25,094	$41,360	$10,547	$3,175	$1,587	$81,763	$53,565	$23,710	$34,585
20	$111,590	$4,886	$25,094	$43,118	$11,159	$3,257	$1,629	$84,256	$57,313	$27,334	$61,919
21	$118,063	$5,013		$44,950	$11,806	$3,342	$1,671	$61,769	$61,306	$56,293	$118,212
22	$124,910	$5,143		$46,861	$12,491	$3,429	$1,714	$64,495	$65,558	$60,415	$178,627
23	$132,155	$5,277		$48,852	$13,215	$3,518	$1,759	$67,345	$70,087	$64,810	$243,437
24	$139,820	$5,414		$50,929	$13,982	$3,609	$1,805	$70,325	$74,909	$69,495	$312,933
25	$147,929	$5,555		$53,093	$14,793	$3,703	$1,852	$73,441	$80,043	$74,489	$387,421
26	$156,509	$5,699		$55,350	$15,651	$3,799	$1,900	$76,700	$85,509	$79,810	$467,231
27	$165,587	$5,847		$57,702	$16,559	$3,898	$1,949	$80,108	$91,326	$85,479	$552,710
28	$175,191	$5,999		$60,154	$17,519	$4,000	$2,000	$83,673	$97,518	$91,518	$644,228
29	$185,352	$6,155		$62,711	$18,535	$4,104	$2,052	$87,401	$104,106	$97,951	$742,179
30	$196,102	$6,315		$65,376	$19,610	$4,210	$2,105	$91,302	$111,116	$104,801	$846,980
Totals	$2,918,050	$133,827	$501,872	$1,143,566	$291,805	$89,218	$44,609	$2,071,070	$1,482,679	$846,980	
	30 Yr. NPV at		Discount Rate 4.0%								
	$1,429,964	$71,589	$341,030	$584,136	$142,996	$47,726	$23,863	$1,139,752	$702,831	$290,212	

Total Annual Heating Costs	Pellet Fuel First year	Partial Fossil Fuel First Year	Pellet System O&M /yr	Scheduled Repair Allowance / Year	Pellet + Fossil Fuel + O&M + Sheduled Repair	Annual Fuel Cost Savings	Total Project Cost	Simple Payback (yrs)	30 Yr. NPV Savings	Return on Investment
$38,230	$19,553	$3,823	$2,000	$1,000	$51,470	$14,854	$341,030	23.0	$290,212	4.4%

Figure 8 Pellet Life Cycle Cost Graph



CENTRAL DISTRICT HEAT SCENARIOS

All of the central district heating scenarios envision building a stand-alone boiler house. The green chip scenario and the semi-dry chip scenario include chip storage in the building. The central pellet boiler scenario includes a 36 ton silo for pellet storage which allows for a smaller building.

Figure 9 Williamstown, VT Middle/High School Woodchip boilerhouse

A woodchip boiler house will take considerably more space than a pellet boiler house because green chip storage requires more volume. It was assumed for this study that a 2,500 square foot chip storage and boiler room building would need to be built for a green woodchip system Below grade storage of woodchips is the preferable approach as it makes chip unloading easier and below grade storage is less likely to freeze. Only 1,500 square feet would be required for a semi-dry chip boiler house and 1,000 square feet for a central pellet boiler plant along with a pellet storage silo.

Scenario 2, Green Woodchip Central Heating Plant

Figure 10 Green Woodchip 30-year Life Cycle Cost Spreadsheet Analysis

Pittsfield School District | **Preliminary Life Cycle Cost Assessment** | ***Woodchips - District Energy***

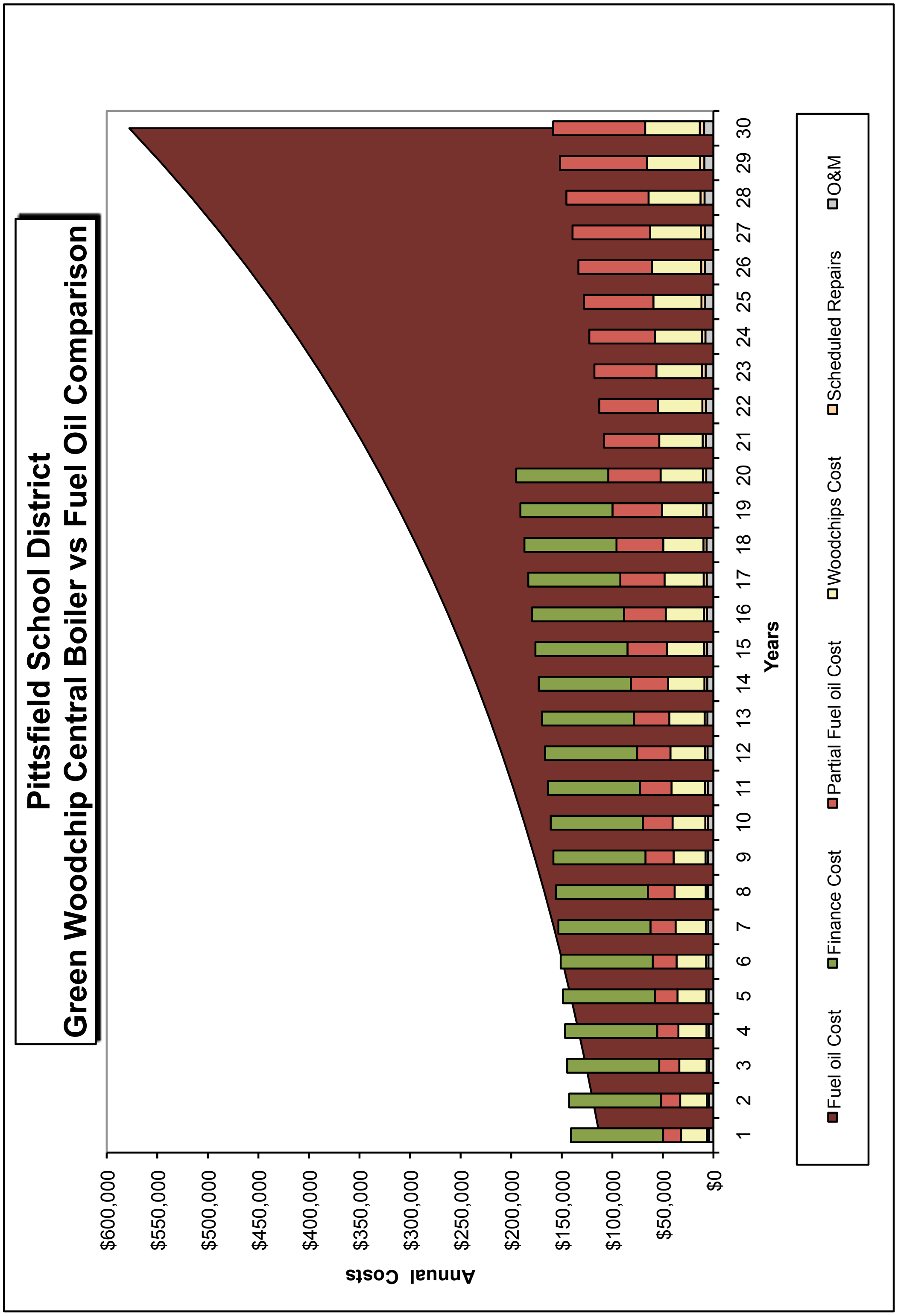
Green Woodchip District Energy Scenario

Total estimated construction costs	***$1,237,288***	*Conceptual project cost, Woodchips system, building and associated costs.*				
Financing:	**4.0%**	*Assumed loan interest*	20	Term of loan		
Fuel oil consumption	**37,166**	gallons/year	15%	Load covered by Fuel oil =	5,854 gallons	78 gallons/ton
Fuel oil heat price	**$3.03**	/gallon in year 1				
Fuel oil heat cost	**$112,613**		480	tons if 100% Woodchips		
Estimated Woodchips utilization	**85%**					
Projected Woodchips consumption	**428**	tons				
Estimated 1st year Woodchips price	**$60.00**	/ton				
Projected 1st year Woodchips cost	**$25,679**					
Projected 1st year partial fuel oil cost	**$17,737**					
General Inflation:	**2.6%**	**annually**	*Twenty year average annual US Labor Dept. Consumer Price Index increases*			
Fuel oil inflation:	**5.8%**	**annually**	*20 year average increase for NH (US EIA)*			
Woodchips Inflation:	**3.6%**	**annually**	*20 year average increase for Vermont Schools (VSA SEMP)*			
O & M.:	**$4,400**	**in Year 1 $**	*Estimate of additional maintenance staff time*			
Major Repairs:	**$2,000**		*Contingency for major repair (e.g. refractory replacement) at Years 10 and 20 annualized*			

Yr.	**Fuel oil Cost**	**Boiler Replacement Fund**	Finance Cost For Entire Project	Woodchips Cost	Partial Fuel oil Cost	O&M	Scheduled Repairs	Total Costs	Annual Fuel Savings	Annual Cashflow	Cumulative Cashflow
1	$112,613	$3,000	$91,042	$25,679	$17,737	$4,400	$2,000	$140,858	$69,197	-$28,245	-$28,245
2	$119,145	$3,078	$91,042	$26,347	$18,765	$4,514	$2,052	$142,720	$74,032	-$23,576	-$51,820
3	$126,055	$3,158	$91,042	$27,032	$19,854	$4,632	$2,105	$144,664	$79,169	-$18,610	-$70,430
4	$133,366	$3,240	$91,042	$27,735	$21,005	$4,752	$2,160	$146,694	$84,626	-$13,328	-$83,758
5	$141,101	$3,324	$91,042	$28,456	$22,223	$4,876	$2,216	$148,813	$90,422	-$7,712	-$91,470
6	$149,285	$3,411	$91,042	$29,196	$23,512	$5,003	$2,274	$151,026	$96,577	-$1,741	-$93,211
7	$157,944	$3,499	$91,042	$29,955	$24,876	$5,133	$2,333	$153,338	$103,113	$4,605	-$88,605
8	$167,104	$3,590	$91,042	$30,734	$26,319	$5,266	$2,394	$155,754	$110,052	$11,350	-$77,255
9	$176,797	$3,684	$91,042	$31,533	$27,845	$5,403	$2,456	$158,279	$117,418	$18,518	-$58,737
10	$187,051	$3,780	$91,042	$32,353	$29,460	$5,543	$2,520	$160,918	$125,238	$26,133	-$32,604
11	$197,900	$3,878	$91,042	$33,194	$31,169	$5,688	$2,585	$163,678	$133,537	$34,222	$1,618
12	$209,378	$3,979	$91,042	$34,057	$32,977	$5,835	$2,652	$166,563	$142,344	$42,814	$44,432
13	$221,522	$4,082	$91,042	$34,942	$34,890	$5,987	$2,721	$169,582	$151,690	$51,939	$96,372
14	$234,370	$4,188	$91,042	$35,851	$36,913	$6,143	$2,792	$172,741	$161,606	$61,629	$158,001
15	$247,964	$4,297	$91,042	$36,783	$39,054	$6,303	$2,865	$176,046	$172,126	$71,917	$229,918
16	$262,345	$4,409	$91,042	$37,739	$41,319	$6,466	$2,939	$179,506	$183,287	$82,839	$312,758
17	$277,561	$4,524	$91,042	$38,720	$43,716	$6,635	$3,016	$183,128	$195,125	$94,433	$407,191
18	$293,660	$4,641	$91,042	$39,727	$46,251	$6,807	$3,094	$186,922	$207,681	$106,738	$513,929
19	$310,692	$4,762	$91,042	$40,760	$48,934	$6,984	$3,175	$190,894	$220,998	$119,798	$633,727
20	$328,712	$4,886	$91,042	$41,820	$51,772	$7,166	$3,257	$195,056	$235,120	$133,656	$767,383
21	$347,778	$5,013	$0	$42,907	$54,775	$7,352	$3,342	$108,376	$250,096	$239,402	$1,006,785
22	$367,949	$5,143	$0	$44,023	$57,952	$7,543	$3,429	$112,946	$265,974	$255,003	$1,261,787
23	$389,290	$5,277	$0	$45,167	$61,313	$7,739	$3,518	$117,737	$282,809	$271,553	$1,533,340
24	$411,869	$5,414	$0	$46,342	$64,869	$7,940	$3,609	$122,761	$300,658	$289,108	$1,822,448
25	$435,757	$5,555	$0	$47,546	$68,632	$8,147	$3,703	$128,028	$319,579	$307,729	$2,130,177
26	$461,031	$5,699	$0	$48,783	$72,612	$8,359	$3,799	$133,553	$339,636	$327,478	$2,457,655
27	$487,771	$5,847	$0	$50,051	$76,824	$8,576	$3,898	$139,349	$360,896	$348,422	$2,806,077
28	$516,062	$5,999	$0	$51,352	$81,280	$8,799	$4,000	$145,431	$383,429	$370,631	$3,176,708
29	$545,993	$6,155	$0	$52,688	$85,994	$9,028	$4,104	$151,813	$407,312	$394,180	$3,570,888
30	$577,661	$6,315	$0	$54,057	$90,982	$9,262	$4,210	$158,512	$432,622	$419,149	$3,990,037
Totals	$8,595,725	$133,827	$1,820,836	$662,610	$638,594	$113,535	$51,607	$3,287,182	$6,096,371	$3,990,037	
	30 Yr. NPV		Discount Rate 4%								
	$4,212,256	$71,589	$1,237,288	$612,784	$663,430	$104,997	$47,726	$2,666,225	$2,936,042	$1,546,031	

Total Annual Heating Costs	Woodchips 1st year cost	Fuel oil 1st year	Woodchips System O&M /Year	Scheduled Repair Allowance / Year	Woodchips + Fuel + O&M + Contingency	Annual Fuel Cost Savings	Total Project Cost	Simple Payback (yrs)	30 Yr. NPV Savings	Return on Investment
$112,613	$25,679	$17,737	$4,400	$2,000	$24,137	$69,197	$1,237,288	17.9	$1,546,031	5.6%

Figure 11 Green Woodchip Life Cycle Cost Graph



Scenario 3, Semi-Dry Woodchip Central Heating Plant

Figure 12 Semi-Dry Woodchip 30-year Life Cycle Cost Spreadsheet Analysis

Pittsfield School District — **Preliminary Life Cycle Cost Estimate** — ***Dry Chips***

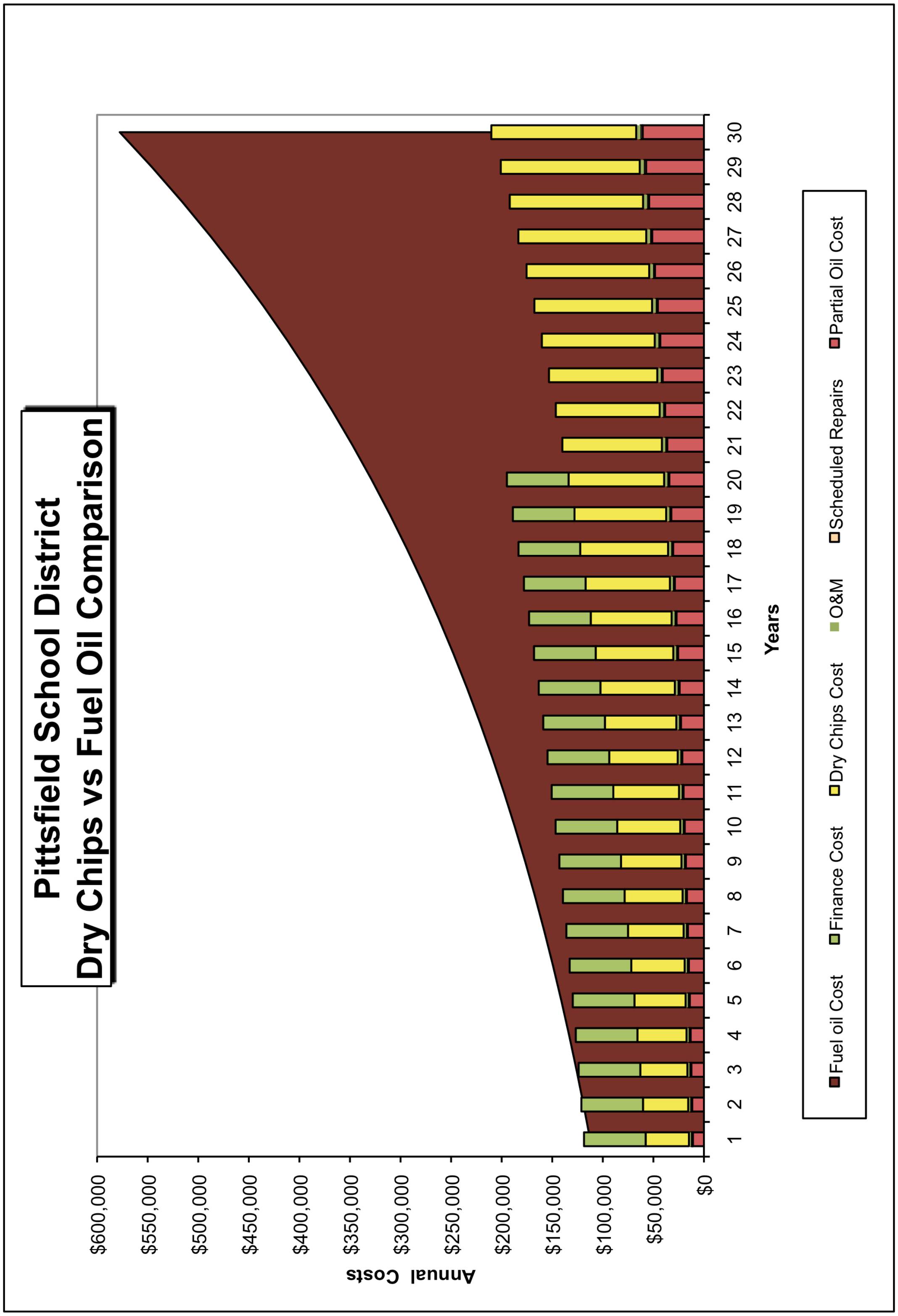
Semi-dry Woodchip District Energy Scenario

Total estimated construction costs	***$828,134***		
Financing:	**4.0%**	*Bond interest rate*	
Oil heat consumption	**37,166**	Includes Dry Chips BTUs	10% Load covered by Fuel oil = 3,902 gallons; 102 gal. / ton of chips
Oil heat price	**$3.03**		
Oil heat cost	**$112,613**		363 tons if 100% Dry Chips for oil
Estimated Dry Chips utilization	**90%**		
Projected Dry Chips consumption	**343**	tons	
Estimated 1st year Dry Chips price	**$125**	/ ton Year 1	
Projected 1st year Dry Chips cost	**$42,838**		
Projected 1st year partial fuel oil cost	**$11,824**		
General Inflation:	**2.6%**	**annually**	*Twenty year average annual US Labor Dept. Consumer Price Index increases*
Oil Inflation	**5.80%**		*20 year average increase for NH (US EIA)*
Dry Chips Inflation:	**4.25%**	**annually**	*Estimate from Biomass Energy Resource Center*
O & M.:	**$2,000**	**in Year 1 $**	*Estimate of additional electricity for feed system motors and additional maintenance staff time*
Major Repairs:	**$1,000**		*Contingency for major repair (e.g. refractory replacement) at Years 10, 20 and 30 annualized*

Yr.	Current Fuel oil Cost	Boiler Replacement Fund	Finance Cost For Entire Project	Dry Chips Cost	Partial Fuel oil Cost	O&M	Scheduled Repairs	Total Costs	Annual Fuel Savings	Annual Cashflow	Cumulative Cashflow
1	$112,613	$3,000	$60,936	$42,838	$11,824	$2,000	$1,000	$118,598	$57,951	-$5,985	-$5,985
2	$119,145	$3,078	$60,936	$44,659	$12,510	$2,052	$1,026	$121,182	$61,976	-$2,038	-$8,023
3	$126,055	$3,158	$60,936	$46,557	$13,236	$2,105	$1,053	$123,886	$66,263	$2,169	-$5,854
4	$133,366	$3,240	$60,936	$48,535	$14,003	$2,160	$1,080	$126,714	$70,827	$6,652	$798
5	$141,101	$3,324	$60,936	$50,598	$14,816	$2,216	$1,108	$129,674	$75,688	$11,428	$12,225
6	$149,285	$3,411	$60,936	$52,748	$15,675	$2,274	$1,137	$132,770	$80,862	$16,515	$28,741
7	$157,944	$3,499	$60,936	$54,990	$16,584	$2,333	$1,166	$136,009	$86,369	$21,934	$50,675
8	$167,104	$3,590	$60,936	$57,327	$17,546	$2,394	$1,197	$139,399	$92,231	$27,705	$78,380
9	$176,797	$3,684	$60,936	$59,764	$18,564	$2,456	$1,228	$142,947	$98,469	$33,850	$112,230
10	$187,051	$3,780	$60,936	$62,304	$19,640	$2,520	$1,260	$146,659	$105,107	$40,392	$152,622
11	$197,900	$3,878	$60,936	$64,952	$20,779	$2,585	$1,293	$150,545	$112,169	$47,355	$199,977
12	$209,378	$3,979	$60,936	$67,712	$21,985	$2,652	$1,326	$154,611	$119,681	$54,767	$254,744
13	$221,522	$4,082	$60,936	$70,590	$23,260	$2,721	$1,361	$158,867	$127,672	$62,654	$317,398
14	$234,370	$4,188	$60,936	$73,590	$24,609	$2,792	$1,396	$163,323	$136,171	$71,047	$388,445
15	$247,964	$4,297	$60,936	$76,718	$26,036	$2,865	$1,432	$167,986	$145,210	$79,977	$468,423
16	$262,345	$4,409	$60,936	$79,978	$27,546	$2,939	$1,470	$172,869	$154,821	$89,477	$557,899
17	$277,561	$4,524	$60,936	$83,377	$29,144	$3,016	$1,508	$177,980	$165,040	$99,581	$657,481
18	$293,660	$4,641	$60,936	$86,921	$30,834	$3,094	$1,547	$183,332	$175,905	$110,328	$767,809
19	$310,692	$4,762	$60,936	$90,615	$32,623	$3,175	$1,587	$188,935	$187,455	$121,758	$889,567
20	$328,712	$4,886	$60,936	$94,466	$34,515	$3,257	$1,629	$194,802	$199,732	$133,911	$1,023,477
21	$347,778	$5,013		$98,481	$36,517	$3,342	$1,671	$140,010	$212,780	$207,768	$1,231,245
22	$367,949	$5,143		$102,666	$38,635	$3,429	$1,714	$146,444	$226,648	$221,505	$1,452,750
23	$389,290	$5,277		$107,029	$40,875	$3,518	$1,759	$153,182	$241,385	$236,108	$1,688,858
24	$411,869	$5,414		$111,578	$43,246	$3,609	$1,805	$160,238	$257,044	$251,630	$1,940,489
25	$435,757	$5,555		$116,320	$45,754	$3,703	$1,852	$167,629	$273,682	$268,128	$2,208,617
26	$461,031	$5,699		$121,264	$48,408	$3,799	$1,900	$175,371	$291,359	$285,660	$2,494,277
27	$487,771	$5,847		$126,418	$51,216	$3,898	$1,949	$183,481	$310,137	$304,290	$2,798,567
28	$516,062	$5,999		$131,790	$54,186	$4,000	$2,000	$191,976	$330,085	$324,086	$3,122,652
29	$545,993	$6,155		$137,391	$57,329	$4,104	$2,052	$200,876	$351,272	$345,117	$3,467,769
30	$577,661	$6,315		$143,230	$60,654	$4,210	$2,105	$210,200	$373,776	$367,461	$3,835,230
Totals	$8,595,725	$133,827	$1,218,711	$2,505,405	$902,551	$89,218	$44,609	$4,760,495	$5,187,768	$3,835,230	
	30 Yr. NPV at $4,212,256	$71,589	Discount Rate 4.0% $828,134	$1,279,767	$442,287	$47,726	$23,863	$2,621,776	$2,490,202	$1,590,479	

Total Annual Heating Costs	Dry Chips Fuel First year	Partial Fossil Fuel First Year	Dry Chips System O&M /yr	Scheduled Repair Allowance / Year	Dry Chips + Fossil Fuel + O&M + Sheduled Repair	Annual Fuel Cost Savings	Total Project Cost	Simple Payback (yrs)	30 Yr. NPV Savings	Return on Investment
$112,613	$42,838	$11,824	$2,000	$1,000	$118,598	$57,951	$828,134	14.3	$1,590,479	7.0%

Figure 13 Semi-Dry Woodchip Life Cycle Cost Graph



Scenario 4, Pellet Central Heating Plant

Figure 14 Pellet Central Heating 30-year Life Cycle Cost Spreadsheet Analysis

Pittsfield School District | **Preliminary Life Cycle Cost Assessment** | ***Pellet - District Energy***

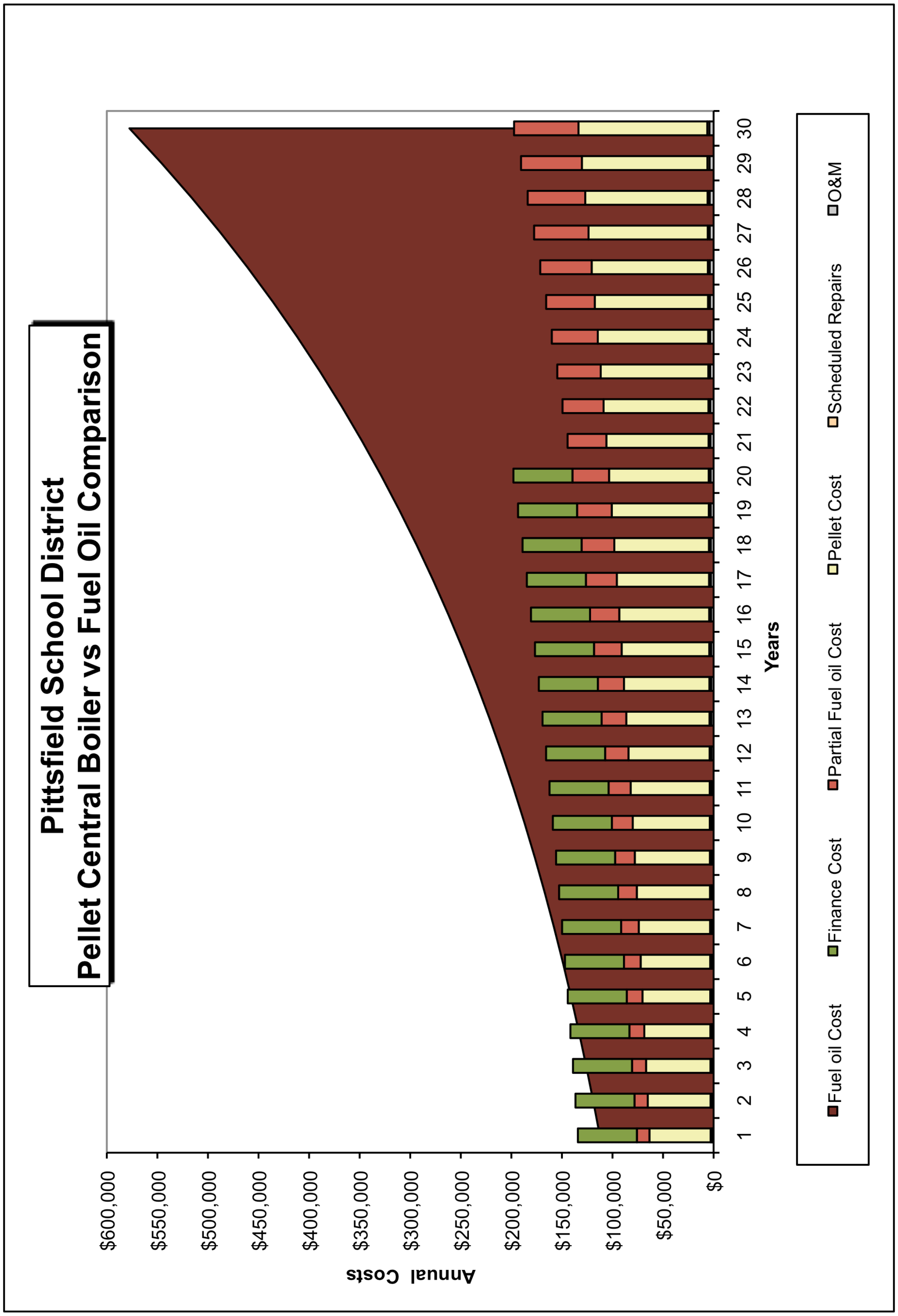
Central Pellet Boiler Scenario

Total estimated construction costs	***$793,128***	*Conceptual project cost, pellet system, building and associated costs.*
Financing:	**4.0%**	*Assumed loan interest*; 20 Term of loan
Fuel oil consumption	**37,166**	gallons/year; 10% Load covered by Fuel oil = 3,902 gallons; 136 gallons/ton
Fuel oil heat price	**$3.03**	/gallon in year 1
Fuel oil heat cost	**$112,613**	272 tons if 100% Pellets
Estimated pellet utilization	**90%**	
Projected pellet consumption	**257**	tons
Estimated 1st year pellet price	**$235**	/ton
Projected 1st year pellet cost	**$60,477**	
Projected 1st year partial fuel oil cost	**$12,416**	
General Inflation:	**2.6% annually**	*Twenty year average annual US Labor Dept. Consumer Price Index increases*
Fuel oil inflation:	**5.8% annually**	*20 year average increase for NH (US EIA)*
Pellet Inflation:	**4.25% annually**	*Estimate from Biomass Energy Resource Center*
O & M.:	**$2,000 in Year 1 $**	*Estimate of additional maintenance staff time*
Major Repairs:	**$1,000**	*Contingency for major repair (e.g. refractory replacement) at Years 10 and 20 annualized*

Yr.	Fuel oil Cost	Boiler Replacement Fund	Finance Cost For Entire Project	Pellet Cost	Partial Fuel oil Cost	O&M	Scheduled Repairs	Total Costs	Annual Fuel Savings	Annual Cashflow	Cumulative Cashflow
1	$112,613	$3,000	$58,360	$60,477	$12,416	$2,000	$1,000	$134,253	$39,720	-$21,640	-$21,640
2	$119,145	$3,078	$58,360	$62,050	$13,136	$2,052	$1,026	$136,623	$43,959	-$17,479	-$39,118
3	$126,055	$3,158	$58,360	$63,663	$13,898	$2,105	$1,053	$139,078	$48,494	-$13,023	-$52,141
4	$133,366	$3,240	$58,360	$65,318	$14,704	$2,160	$1,080	$141,622	$53,344	-$8,256	-$60,397
5	$141,101	$3,324	$58,360	$67,016	$15,556	$2,216	$1,108	$144,257	$58,528	-$3,156	-$63,553
6	$149,285	$3,411	$58,360	$68,759	$16,459	$2,274	$1,137	$146,988	$64,068	$2,297	-$61,256
7	$157,944	$3,499	$58,360	$70,547	$17,413	$2,333	$1,166	$149,819	$69,984	$8,125	-$53,131
8	$167,104	$3,590	$58,360	$72,381	$18,423	$2,394	$1,197	$152,754	$76,300	$14,350	-$38,781
9	$176,797	$3,684	$58,360	$74,263	$19,492	$2,456	$1,228	$155,798	$83,042	$20,998	-$17,782
10	$187,051	$3,780	$58,360	$76,194	$20,622	$2,520	$1,260	$158,955	$90,235	$28,096	$10,313
11	$197,900	$3,878	$58,360	$78,175	$21,818	$2,585	$1,293	$162,231	$97,907	$35,669	$45,982
12	$209,378	$3,979	$58,360	$80,207	$23,084	$2,652	$1,326	$165,629	$106,087	$43,748	$89,731
13	$221,522	$4,082	$58,360	$82,292	$24,423	$2,721	$1,361	$169,157	$114,807	$52,365	$142,095
14	$234,370	$4,188	$58,360	$84,432	$25,839	$2,792	$1,396	$172,819	$124,099	$61,551	$203,646
15	$247,964	$4,297	$58,360	$86,627	$27,338	$2,865	$1,432	$176,622	$133,998	$71,341	$274,987
16	$262,345	$4,409	$58,360	$88,880	$28,924	$2,939	$1,470	$180,572	$144,542	$81,774	$356,761
17	$277,561	$4,524	$58,360	$91,191	$30,601	$3,016	$1,508	$184,675	$155,770	$92,886	$449,647
18	$293,660	$4,641	$58,360	$93,561	$32,376	$3,094	$1,547	$188,938	$167,723	$104,722	$554,369
19	$310,692	$4,762	$58,360	$95,994	$34,254	$3,175	$1,587	$193,369	$180,444	$117,323	$671,692
20	$328,712	$4,886	$58,360	$98,490	$36,241	$3,257	$1,629	$197,976	$193,982	$130,737	$802,428
21	$347,778	$5,013	$0	$101,051	$38,342	$3,342	$1,671	$144,406	$208,385	$203,372	$1,005,800
22	$367,949	$5,143	$0	$103,678	$40,566	$3,429	$1,714	$149,387	$223,705	$218,562	$1,224,362
23	$389,290	$5,277	$0	$106,374	$42,919	$3,518	$1,759	$154,570	$239,997	$234,720	$1,459,082
24	$411,869	$5,414	$0	$109,139	$45,409	$3,609	$1,805	$159,962	$257,321	$251,907	$1,710,989
25	$435,757	$5,555	$0	$111,977	$48,042	$3,703	$1,852	$165,574	$275,738	$270,183	$1,981,172
26	$461,031	$5,699	$0	$114,888	$50,829	$3,799	$1,900	$171,416	$295,314	$289,615	$2,270,787
27	$487,771	$5,847	$0	$117,875	$53,777	$3,898	$1,949	$177,499	$316,119	$310,271	$2,581,059
28	$516,062	$5,999	$0	$120,940	$56,896	$4,000	$2,000	$183,835	$338,226	$332,226	$2,913,285
29	$545,993	$6,155	$0	$124,085	$60,196	$4,104	$2,052	$190,436	$361,713	$355,557	$3,268,842
30	$577,661	$6,315	$0	$127,311	$63,687	$4,210	$2,105	$197,313	$386,663	$380,347	$3,649,190
Totals	$8,595,725	$133,827	$1,167,195	$1,560,516	$447,016	$51,607	$25,803	$3,252,137	$4,950,212	$3,649,190	
	30 Yr. NPV $4,212,256	$71,589	Discount Rate 4% $793,128	$1,443,169	$464,401	$47,726	$23,863	$2,772,287	$2,304,686	$1,439,969	

Total Annual Heating Costs	Pellet Fuel First year	Partial Fossil Fuel First Year	Pellets System O&M /Year	Scheduled Repair Allowance / Year	Pellets + Fuel + O&M + Contingency	Annual Fuel Cost Savings	Total Project Cost	Simple Payback (yrs)	30 Yr. NPV Savings	Return on Investment
$112,613	$60,477	$12,416	$2,000	$1,000	$15,416	$39,720	$793,128	20.0	$1,439,969	5.0%

Figure 15   Pellet Central Heating Life Cycle Cost Graph



VI. Project Conclusions and Recommendations

Based on the analysis performed for this report, it appears that all four scenarios are cost effective. The semi-dry woodchip boiler scenario has the best return of investment while the pellet scenario has the lowest capital cost for the central district heating scenarios.

We recommend the District take the following steps to further investigate the feasibility of a wood boiler heating system:

1. **Hire an engineering firm**[10] to help refine the project concept and to obtain firm local estimates on project costs. An important issue for the project engineers to consider is thermal storage. Biomass heating systems, including wood chip systems but especially pellet boiler systems, operate significantly more efficiently and effectively (improving cost savings) if thermal storage is designed into the overall system. With thermal storage, a biomass boiler can quickly ramp up to high fire and will shut down when the thermal storage has reached its optimum temperature, this type of system can supply a greater portion of the annual heating load and will therefore provide greater savings. We recommend that any pellet boiler system that is specified for this project include thermal storage as a component of the overall design and wood chip systems may also benefit from thermal storage.
2. **A mechanical analysis that provides an independent assessment of how to improve efficiencies and the operations and maintenance of the existing boiler equipment, ventilation equipment and controls** should be performed before investing in any new boiler system. Upgrades could include outdoor temperature reset, DDC controls for ventilation systems and improved boiler controls. Both schools have oil fired domestic hot water heaters. The District should instruct the engineering team to evaluate creating a zone off the main boiler system with a highly insulated storage tank for domestic hot water or other domestic hot water heating strategies. A mechanical evaluation will more than likely pay for itself many times over regardless of whether or not the District moves forward with a biomass system.
3. **Propane should be used for back-up boiler systems if possible.** This would eliminate the need for an underground fuel oil storage tank, which can be a significant liability. If the District decides on the pellet boiler option for just the Elementary School, it should

[10] The District may be able to reduce costs by hiring a biomass boiler vendor directly to design/build whichever system the district decides to move forward with, thereby saving on design fees and general contracting costs.

consider converting the existing boilers to propane and removing the underground fuel storage tank for that school. If the District decides to go with one of the central district heating options, careful consideration should be given to which heating systems should be retained for back-up and supplemental heat. It is likely that the boilers at the Middle/High school could serve as back-up for a central wood system and the boilers at the Elementary School could be removed or mothballed.

4. The District should consider other **energy efficiency improvements** simultaneously with boiler upgrades. The efficiency of the building envelope and ventilation equipment need to be considered when sizing new boiler equipment. It is our understanding that the District has commissioned an energy audit for both schools simultaneously with this biomass study. The District should evaluate the efficiency opportunities from those audits and consider combining energy efficiency measures with biomass boiler upgrades at one or both schools. The District may want to consider presenting this package of measures as a comprehensive energy improvement bond to voters. The value of investing in efficiency and biomass is that the long-term return on investment will be considerably better than continuing business as usual. Voters in school districts understand this dynamic and have shown their willingness, time and time again, to spend money to save money when it comes to energy improvements.

5. In order to effectively measure progress toward energy efficiency goals **historical energy consumption data should be collected and updated frequently**. There are many tools that could help the District accomplish this task. One such tool is the EPA Energy Star *Portfolio Manager* software. It is free public domain software that helps facility managers track energy and water use and provides useful reports and graphs. This software can be downloaded at:
   http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager

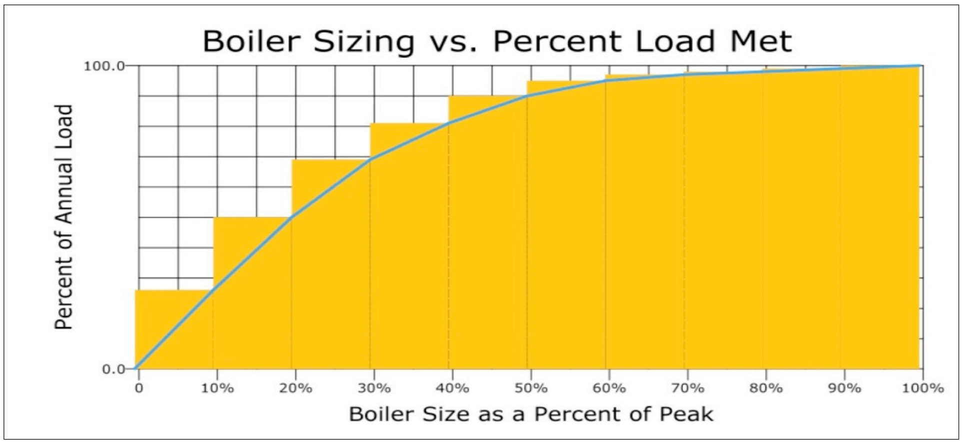
6. The District should **contact multiple wood fuel providers to get delivery quotes** and identify the lowest cost supplier. A list of biomass boiler vendors is included in the appendices to this report and a pellet fuel supplier list can be obtained from NH WEC. It is important to keep in mind that while price is important, ultimately the performance of any wood heating system will depend on fuel quality. The Windham Wood Heat Initiative in Windham County, Vermont is working on a performance specification for pellet fuel. The Biomass Energy Resource Center has a performance specification for green wood chips. These are good tools for getting competitive bids that take fuel quality into consideration.

VII. Additional Issues to Consider

Boiler Equipment Sizing

Biomass boilers are not sized the same as fossil fueled boilers. Biomass boilers, because of the nature of the fuel and their operation, need to be sized to consistently operate within their most efficient operating range. This range is typically near 100% of their rated capacity.

Figure 16 Boiler Sizing compared to peak demand[11]



When using a fossil fuel boiler for peak loads and backup, the biomass boiler can be sized using the "50/90" rule. The rule is a general guiding principle based upon peak versus annual heating loads. Data has shown that sizing boilers to 50 percent of the peak heating load results in meeting 90 percent of the annual heating needs (see figure above). The existing fossil fuel boiler can meet the final 10 percent of the annual heat load. This configuration can also provide the added benefit of providing redundant boiler capacity that can be used in the unlikely event of an outage of the biomass boiler system.

Thermal storage should be incorporated to help reduce short cycling and provide for short-term peaks in demand. Proper sizing and thermal storage improve overall performance and efficiency.

Thermal Storage (TS)

A thermal storage tank or tanks are used to store heat from the boiler in an insulated hot water tank, from which hot water is then distributed as the building calls for heat. This allows an appropriately sized biomass boiler to operate in a high fire state, at peak efficiency, and then be turned off or to go into a stand-by mode where a minimal amount of fuel is being burned.

[11] Wood Boiler Sizing – Partial Bin Analysis, Adam Kohler, E.I.T.

Thermal storage is widely recognized as an important efficiency investment that optimizes system performance and aids in controlling air emissions and environmental conditions. In the analysis it was assumed that with thermal storage the pellet boiler would supply 90% of the annual heating requirement for both buildings. Thermal storage also provides additional benefits including faster response time to calls for heat in the building and greater overall efficiency of the system and increased boiler life.

Emissions and Permitting

Based on current NH air emissions standards and the estimates and assumptions made in this Pre-Feasibility Report this project will not require air emissions permitting in New Hampshire for installation. Emissions such as NOx, SOx and volatile organic compounds from pellet and wood chip burning equipment are, in general, very low in comparison to other forms of combustion heating. Automated, commercial-sized woodchip and pellet systems burn much cleaner than even the most modern home wood or pellet stove. The current practice to properly size the wood pellet boiler with added thermal storage contributes to increased efficiency in the operation of the system and lower emissions. Wood chip boilers are somewhat larger and best practice is to include pollution control equipment in order to reduce emissions. An allowance of $50,000 was included in the analysis for pollution control equipment for the woodchip scenario. It is recommended that the Pittsfield School District check with local officials to determine what building permits or other local permitting is required if a wood-fueled system is installed.

Wood Ash

One by-product of burning wood pellets is ash, a non-combustible residue. While the ash produced by burning wood pellets can be automatically removed from the boiler in the systems of many manufacturers, the container in which the ash is collected must periodically be emptied and disposed of manually.

The ash volume produced depends on the fuel burned. Ash content is measured as a percentage of weight and should be at most 1% for wood pellets available for New Hampshire use. A ton of wood pellets burned will produce approximately 20 pounds (about 2 gallons of volume) of ash. The boiler system for the Elementary School only system are estimated to use 83 tons of pellets annually and generate approximately 1,600 pounds of ash annually (considerably less than 1 cubic yard). The central district heating plant is projected to burn about 428 tons of green woodchips or about 17 truckloads of chips. Each truckload produces the equivalent of a small garbage can of ash depending on the quality of the fuel. For a semi-dry chip system, 343 tons, 14 truckloads and for pellets about 10 truckloads. All will have about the same volume of ash. The primary difference between green woodchips, semi-dry woodchips and pellets is the moisture content and the energy density of the fuel. The drier the fuel, the more energy that can be delivered per ton.

While many wood boiler operators use their ash as fertilizer for lawns or athletic fields, there are other useful ways to handle wood ash material, such as composting and amending soil. The ash is not known to adversely affect humans or plant and animal life when dispersed in this way, although, it may over time lead to increased nutrient runoff into streams, rivers, wetlands and other water bodies if not disposed of properly so care is needed in disposal or re-use. This ash can also be disposed of at any state landfill or other permitted solid waste management facility.

There are regulations in NH for wood ash disposal. Historically, all non-household wood ash is captured under Env-Ws 1700 of Solid Waste Rules from the NH Department of Environmental Services (DES), including the large biomass plants and the small and mid-sized commercial boilers. NH-DES does not have staff or resources to implement this regulation for all the new boiler installations.

Effective February 11, 2014, emergency rules are now in effect that exempt from the requirements of Env-Sw 1700 generators and brokers who distribute 500 tons per year or less of wood ash from the combustion of clean wood for agronomic use (spreading on ag lands). This emergency rule has been filed to address the concerns that the Department received at the public hearing and subsequently about the difficulty that the requirements of Env-Sw 1700 has on small boiler operators.

What this means for the ash disposal from this project is that there are no state regulations and oversight for the disposal of the ash from the estimated wood burned in the proposed biomass system for this project, but it must be actively managed and beneficially used in agricultural applications. Wood ash needs to be managed sustainably in order to be environmentally responsible, cost effective and socially beneficial. According to DES recommendations, an operator of a commercial scale wood boiler should:

- Protect the asset by knowing the quality of the wood ash before distribution
- Develop a program for managing wood ash responsibly
- Keep records documenting distribution practices
- Partner with an end user that will benefit
- Educate the public about its win-win program

See posting on: http://des.nh.gov/organization/commissioner/legal/rulemaking/index.htm

VIII. Financing Opportunities

Purchase and installation of a wood biomass heating system represents a significant capital cost. The following are financial assistance programs that can offset some of those capital costs. Each of the programs listed below have eligibility requirements and may or may not be available to the District depending on the program requirements.

State

NH Public Utilities Commission Commercial Wood Pellet Boiler Rebate Program

This program offers a rebate payment of 30% of the heating appliance(s) and installation cost, up to a maximum of $50,000[12], for investments in non-residential bulk-fuel fed wood pellet boilers and furnaces of 2.5 million BTU or less. Additionally, a rebate of 30% up to $5,000 is available for thermal storage tanks and related components. This grant was included in the financial assessment contained in this report. For complete program details, please refer to http://www.puc.state.nh.us/sustainable%20Energy/RenewableEnergyRebates-CI-BFWP.html or contact Barbara Bernstein, barbara.bernstein@puc.nh.gov.

NH Thermal Renewable Energy Certificates

NH has a first-in-the-nation law that allows for generation of Renewable Energy Certificates from wood-fueled thermal projects. It is possible that specialized organizations may be formed that would provide payments to the District in exchange for the thermal RECs that are generated. Go to the New Hampshire T-RECs Enterprise Fund at http://www.t-recsfund.org/ to learn more about this special REC fund set up to assist with capital costs. The process to generate thermal RECs is new and the impact of RECs on the project was not calculated for this report. For more information go to: http://www.puc.state.nh.us/sustainable%20Energy/Class%20I%20Thermal%20Renewable%20Energy.html.

NH Public Utility Commission Competitive Grants

Various competitive grants for wood biomass thermal systems have been available in recent years. Check at: http://www.puc.state.nh.us/sustainable%20Energy/RFPs.htm to see current availability as these opportunities are changing regularly.

Federal

U.S. Department of Agriculture Community Facilities Program

The U.S. Department of Agriculture administers a small number of programs that provide incentives for renewable energy. One USDA program that could be applied is the Community Facilities Loan Grant Program. The program is very competitive for grants but does provide attractive fixed interest rates for financing. The program is primarily used to finance large community facility projects and as such has significant regulatory and reporting requirements that could be costly to administer.

[12] This program is currently under review and incentives could go up significantly.

Contact information for USDA Community Facilities Program in New Hampshire:

Anne Getchell
The Grindle Center
78 Main Street – P O Box 1020
Conway, NH 03818
603-447-3318 x 202
Anne.getchell@nh.usda.gov

Other/Private

Energy Service Companies (ESCOs)

Energy Performance Contracting is a creative approach to financing energy investments whereby a 3rd party energy services company (ESCO) provides the upfront capital, which is then paid off from annual energy costs savings over a period of years. During this time the end use entity is guaranteed a discounted energy cost relative to their current costs. ESCO's have high overhead costs and choose their projects carefully for large cash flows and very attractive returns on investment, which generally means very large projects. While it would be unusual for an ESCO to fund only the installation of a biomass pellet boiler, it may be worth contacting a few to see if they might be interested. Any ESCO would like to include a menu of energy measures along with the boiler in order to increase the project budget and increase savings.

An example of an ESCO in New Hampshire that might be interested in a project of this type and scale is:

Energy Efficient Investments, Inc.
26A Columbia Circle
Merrimack, NH 03054
Ph: 603 423-6000

Another New Hampshire company has developed a business model whereby they install, own and maintain advanced wood boiler equipment and charge their customers an annual fee just for the heat. The name of the company is:

Xylogen
www.xylogen.net
Facebook.com/XylogenLLC
Twitter.com/Xylogen_LLC
603.924.1001

Municipal Lease Purchase

As a public entity, the Pittsfield School District may be eligible for a municipal lease/purchase arrangement to finance the anticipated project costs for a biomass heating system. A municipal lease is a contract that has many of the characteristics of a standard commercial lease, with at least two primary differences:

- In a municipal lease, the intent of the lessee is to purchase and take title to the equipment. The financing is a full payout contract with no significant residual or balloon payments at the end of the lease term.
- The lease payments include the return of principal and interest, with the interest being exempt from Federal income taxation to the recipient. Because the interest is exempt from federal tax, a tax-exempt lease offers the lessee a significant cost savings when compared to conventional leasing.

There are a number of companies that provide municipal leases to school districts in New Hampshire.

Northern Forest Center

The Northern Forest Center is actively promoting the use of advanced wood heating systems in New Hampshire. They currently do not likely have grant money available for commercial scale biomass heating systems. However, they are knowledgeable about other grant programs that might help fund these kinds of systems. They may be able to help with identifying grant sources and perhaps even grant writing. The Center is always looking for high-visibility projects and owners who are willing to share their stories and open their businesses to tours. For more information contact Maura Adams, Northern Forest Center: madams@northernforest.org

IX. Appendices

Sensitivity Analysis

Fuel prices have a significant impact on cost effectiveness within the analysis. While wood fuel prices are relatively stable, fuel oil prices are volatile and unpredictable. As recently as 2014, fuel oil prices were more than double what they are today.

Table 6 through

Table 9 compare annual fuel savings from the installation of a biomass boiler based on varying prices for fuel oil and wood fuel for all three district energy scenarios. All of the other assumptions stay the same. For example, in Table 6 if the price of fuel oil goes up to $4.00 per gallon and the District is able to purchase pellets for $220 per ton, the annual fuel savings will be $27,116.

Table 6: Annual fuel savings when pellet and fuel oil prices vary for Elementary School only scenario

Pellet Cost per ton	# 2 Fuel Oil per Gallon				
	$2.50	**$3.00**	**$3.50**	**$4.00**	**$4.50**
$180	$13,412	$19,089	$24,767	$30,444	$36,122
$200	$11,747	$17,425	$23,103	$28,780	$34,458
$220	$10,083	$15,761	$21,439	$27,116	$32,794
$240	$8,419	$14,097	$19,775	$25,452	$31,130
$260	$6,755	$12,433	$18,110	$23,788	$29,466

Table 7: Annual fuel savings when green woodchip and fuel oil prices vary

Woodchip $/ton	Fuel Oil $ / Gallon				
	$2.50	**$3.00**	**$3.50**	**$4.00**	**$4.50**
$50	$56,882	$72,538	$88,194	$103,850	$119,506
$55	$54,742	$70,398	$86,054	$101,710	$117,366
$60	$52,602	$68,258	$83,914	$99,570	$115,226
$65	$50,462	$66,118	$81,774	$97,430	$113,086
$70	$48,322	$63,978	$79,634	$95,290	$110,947

Table 8: Annual fuel savings when semi-dry woodchips and fuel oil prices vary

semi-dry woodchips	# 2 Fuel Oil per Gallon				
	$2.50	$3.00	$3.50	$4.00	$4.50
$105	$47,175	$63,807	$80,439	$97,070	$113,702
$115	$43,748	$60,380	$77,011	$93,643	$110,275
$125	$40,321	$56,953	$73,584	$90,216	$106,848
$135	$36,894	$53,526	$70,157	$86,789	$103,421
$145	$33,467	$50,099	$66,730	$83,362	$99,994

Table 9 Annual fuel savings when pellet and fuel oil prices vary for central pellet scenario

Pellets $/ton	Fuel Oil $ / Gallon				
	$2.50	$3.00	$3.50	$4.00	$4.50
$180	$36,348	$52,882	$69,417	$85,951	$102,485
$200	$31,201	$47,735	$64,270	$80,804	$97,338
$220	$26,054	$42,588	$59,123	$75,657	$92,191
$240	$20,907	$37,441	$53,976	$70,510	$87,044
$260	$15,760	$32,294	$48,829	$65,363	$81,897

Table 10 through Table 12 show the first year cash flow and the thirty year Net Present Value (NPV) savings from the installation of a central wood system if the District is able to obtain grant funding for the project. All of the other assumptions remain constant. The only change is a reduction in the capital cost based on grant funding. For example, Table 10 shows that if the District were able to obtain a $75,000 grant for a pellet boiler project, the 30-year NPV for the pellet project would increase to $1,459,969. Table 11 and Table 12 show the same relationship between cash flow and NPV savings with green woodchips and dry woodchips.

Table 10: 1st year cash flow and 30-year NPV savings with grant funding - central pellet

	Project Costs (Capital – Grant)	1st Year Cash Flow	30-Year NPV
No grant funding	$848,128	($25,687)	$1,384,969
$55,000 Grant	$793,128	($21,640)	$1,439,969
$75,000 Grant	$773,128	($20,168)	$1,459,969
$100,000 Grant	$748,128	($18,328)	$1,484,969

Table 11 1st year cash flow and 30 year NPV savings with grant funding - green woodchips

	Project Costs (Capital – Grant)	1st Year Cash Flow	30-Year NPV
No grant funding	$1,260,288	($29,937)	$1,523,031
$55,000 Grant	$1,205,288	($25,890)	$1,578,031
$75,000 Grant	$1,185,288	($24,418)	$1,598,031
$100,000 Grant	$1,160,288	($22,579)	$1,623,031

Table 12: 1st year cash flow and 30-year NPV savings with grant funding- dry woodchips

	Project Costs (Capital – Grant)	1st Year Cash Flow	30-Year NPV
No grant funding	$883,134	($10,032)	$1,535,479
$55,000 Grant	$828,134	($5,985)	$1,590,479
$75,000 Grant	$808,134	($4,513)	$1,610,479
$100,000 Grant	$783,134	($2,674)	$1,635,479

Semi-dry Wood Chips

Semi-dry wood chips are a newer fuel in the U.S. although they have been used in Western Europe for over a decade. There are now a handful of semi-dry wood chip fuel users in New Hampshire and so could be contemplated for Pittsfield. Further information about this newer wood chip fuel follows.

In the United States, small commercial and community-scale biomass units have traditionally used one of two wood fuels:

- Wood pellets – a refined, standardized wood fuel that is force dried to about 4-8% moisture and pelletized; or
- Green wood chips, with a moisture content "as found" in the field, generally varying from 40% to 55% moisture, depending upon the species, time of year and other factors.

Wood chips that meet the specifications of a typical biomass thermal user (e.g., <2.5" in two directions, no sticks and branches, live floor delivery, etc.) cost roughly $45 - 60 per green ton, delivered. Assuming a 45% average moisture content, this means that users of a wood chip system are often paying +/- $5.50 per MMBTU of fuel.

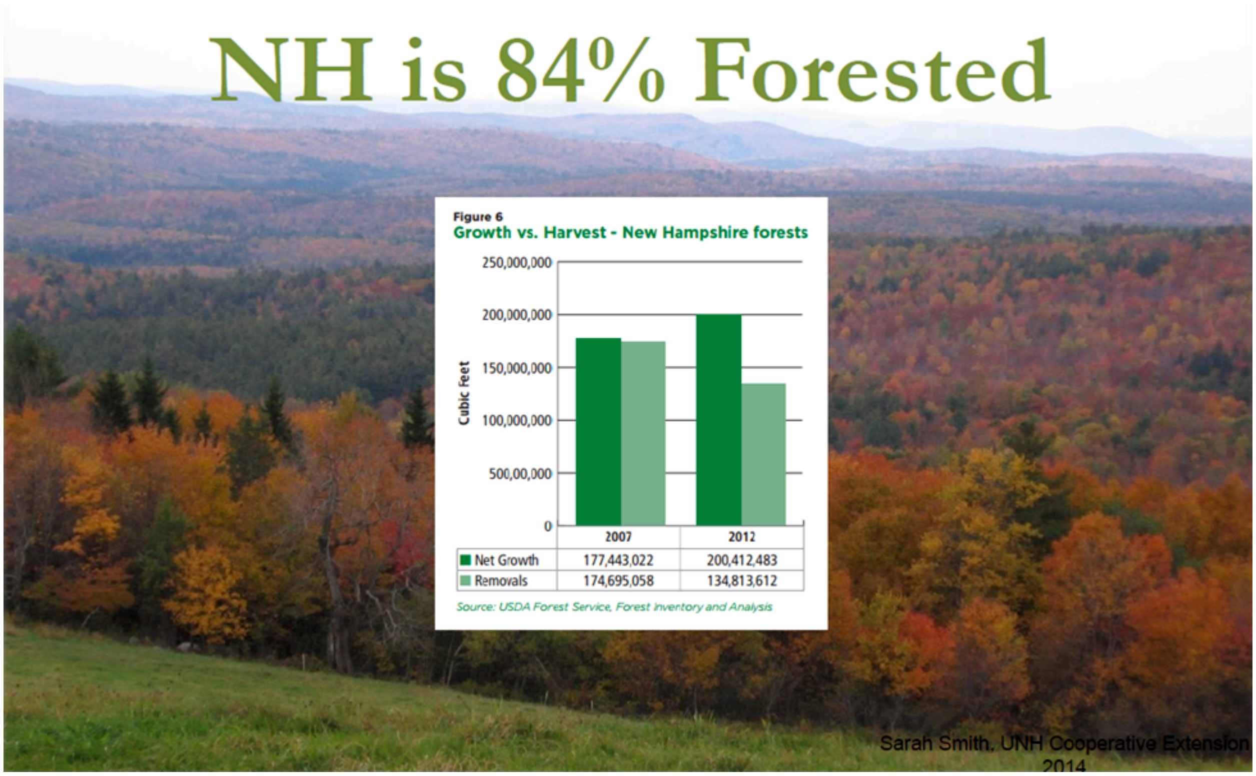
Wood pellets are more expensive, given the processing and handling needed to manufacture a standardized and refined fuel. Bulk wood pellets at $250 / ton, delivered, with 4% moisture content, have wood pellet users paying +/- $13.00 per MMBTU. Wood pellets are in some cases the fuel of choice, despite the higher cost per MMBTU than green wood chips, because of the smaller installation footprint, lower capital cost, operating efficiencies, and easier fuel handling characteristics.

In Europe, where biomass thermal applications are more common and the industry more mature, a fuel exists between these two, and, as a result, specifically designed biomass boilers are now available that use a pellet or a semi-dry wood chip fuel boiler while enjoying a fuel price closer to green biomass chips. These systems also operate at higher output efficiencies than green chip boilers, and can achieve lower overall air emissions than conventional green chip boilers with less investment in back-end emission controls. Some mid-size boilers designed to burn wood pellets, and sold as such in the United States, have the ability to burn low-moisture wood chips as well. Semi-dry hardwood wood chips cost approximately $ 105-140/ton delivered or +/- $10.00 per MMBTU and semi-dry softwood (pine) wood chips are approximately $90-100/ton delivered.

Wood Fuel Availability and Forest Sustainability Issues

New Hampshire is the second most forested state in the U.S. in terms of percentage of land area (Maine is first). New Hampshire's forests are also adding wood volume every year because wood growth on our trees exceeds the amount harvested for various products plus the volume of trees dying each year. Our forests are in good shape and can easily handle additional wood use for thermal purposes.

Figure 17 The NH Supply of Wood for Energy



Where Does the Wood Come From for Heating?

Wood used to make wood pellets and chips is low-grade material, harvested during forestry operations or produced as a by-product of lumber and wood product manufacturing (e.g., sawdust). Manufacturers of wood pellets often seek sawdust, shavings and other residue from lumber and wood product manufacturing because it is already debarked, sized, and uniform in species. Wood also comes from low-grade wood harvested during logging operations – the relatively low value that wood chip users and wood pellet manufacturers can pay for material means that wood chip use and wood pellet manufacturing does not compete with lumber manufacturing and other higher value uses of wood that is so important to the region's forest economy. In fact, these uses are complimentary to higher value wood uses.

In New England, we are growing significantly more wood than is being used for a range of products, including paper manufacturing, biomass energy, home heating, lumber and other wood products. On private forestland in New England, we currently grow 1.6 times the amount of wood harvested.

Where Are Wood Pellets Made?

Wood pellets are made at dedicated wood pellet mills, which are located to access a sustainable and reliable supply of low-grade wood to use as a feedstock. There is currently one wood pellet manufacturing facility located in New Hampshire, New England Wood Pellet (Jaffrey). The New Hampshire market is also supplied by wood pellet manufacturers in nearby Vermont, Maine, Quebec and New York.

The purchase of wood pellets manufactured in the region helps support the forest economy, keeps dollars spent on heating circulating in New England, and creates jobs for your neighbors in the harvesting, manufacturing and delivery of a locally produced fuel.

Commissioning

Building, or systems, commissioning is a process that verifies that a facility and/or system is functioning properly. The commissioning process takes place at all phases of construction, from planning to operation, to confirm that facilities and systems are performing as specified. Commissioning of a new system provides quality assurance, identifies potential equipment problems early on and provides financial savings on utility and maintenance costs during system operations. A recent study of 224 buildings found that the energy savings from commissioning new buildings had a payback period of less than five years. Additional benefits of commissioning include: improved indoor air quality, fewer deficiencies and increased system reliability. We recommend that the Pittsfield School District work with an independent, third-party, commissioning agent during the design and construction of a biomass heating system.

Woodchip and Pellet Boiler Vendors in the Northeast

Wood Pellet/Chip Boiler Vendors in Northeast U.S.

P – pellet
C – chip
1 – Residential
2 – Commercial/Institutional
3 – Industrial

Maine Energy Systems P - 1, 2
Dr. Harry "Dutch" Dresser
Dutch@maineenergysystems.com
www.maineenergysystems.com
8 Airport Road, P.O. Box 547
Bethel, Maine 04217
Office: 207.824.NRGY (6749)

Pellergy LLC P - 1, 2
Andy Boutin
andy.boutin@pellergy.com
www.pellergy.com
104 East State Street
Montpelier, VT 05602
802-477-3224

Froling Energy Systems P/C - 1, 2, 3
Mark Froling
mark@frolingllc.com
www.frolingenergy.com
19 Grove Street
PO Box 178
Peterborough, NH 03458
603-924-1001

The Sandri Companies P - 1, 2
Jake Goodyear
jgoodyear@sandri.com
http://www.sandri.com/renewable-energy/
400 Chapman Street
Greenfield, MA 01301
413-223-1115
800-628-1900

Tarm Biomass P/C - 1, 2
Scott Nichols
scott@tarmusa.com
www.woodboilers.com

WeBiomass Inc. P – 1,2
16 Washington St.
Rutland, VT 05701
802-772-7563
info@webiomass.com

Interphase Energy
4 Britton Lane
P.O. Box 285
Lyme, NH 03768
800.782.9927

Lyme Green Heat P - 1, 2
Morton Bailey
morton@lymegreenheat.com
www.lymegreenheat.com
302 Orford Road
Lyme, NH 03768
603-353-9404

Bioenergy Project Partners P/C - 2, 3
David Dungate
New York-based
Toll Free: 888-583-5852
Email: info@bioenergybox.com
Web: www.bioenergybox.com

Woodmaster P/C - 1, 2, 3
Gust Freeman
Bowman Stoves
www.woodmaster.com/index.php
1727 US Highway 11
Castle Creek NY 13744
bowmanstoves@gmail.com
607-692-2595

Caluwe Inc./Windhager/Heizomat, P/C - 1, 2
Marc Caluwe
marc@hydro-to-heat-convertor.com
www.hydro-to-heat-convertor.com/pelletboilers.html
83 Alexander Road
Billerica MA 01821
781-308-8583

Viessmann P/C - 2, 3
Bede Wellford
wefb@viessmann.com
www.viessmann.ca

(207) 212-2052

Troy Boiler Works/Evotherm P - 1, 2
Lou Okonski
lokonski@troyboilerworks.com
www.troyboilerworks.coml
2800 7th Ave.
Troy NY 12180
518-274-2650

Thayer Corporation P/C - 2, 3
Dan Thayer
info@thayercorp.com
www.thayercorp.com
1400 Hotel Road
Auburn, ME 04210
207-782-4197

Sunwood Systems P – 1, 2
David Frank
124 Fiddlers Green, Waitsfield, VT 05673
(802) 583-9300

Better World Energy/Messersmith C – 2, 3
Barry Bernstein
1237 Bliss Road
Marshfield VT 05658
802-477-3993
bbearvt@myfairpoint.net

Gazogen
Carl Bielenberg
Tel 802-522-8584
GazogenVIP@gmail.com
330 Industrial Drive
P.O. Box 346
Bradford, VT 05033

AFS Energy Systems C – 2, 3
418 Oak Street
P.O. Box 170
Lemoyne, PA 17043
717.763.0286
info@afsenergy.com