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State and Private Forestry

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Preliminary Feasibility Report

Biomass Heating Analysis for Jersey Shore Area School District

Jersey Shore, Pennsylvania

December 2011

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EXECUTIVE SUMMARY

The Jersey Shore Area School District serves grades K-12 in one administration building, four elementary schools, one middle school and one high school. This report outlines the potential for using biomass energy at one of the elementary schools, the middle school and the high school. These three buildings serve 3,000 students and are in relatively close proximity to one another. The 81,000 square foot Elementary School, serving grades K-5, is primarily heated by electricity, with hot water and some space heating provided by natural gas. Approximately 350 feet north of the Elementary School, the Junior High / Middle School (112,450 square feet) serves grades 6-8 and is heated with natural gas hot water boilers. And 1,500 feet southwest of the Elementary School, the Jersey Shore High School serves grades 9-12 in 184,000 square feet. This facility is also heated by its own natural gas hot water boilers.

These three buildings currently consume approximately 843,600 kWh of electricity and 12,729 dekatherms of natural gas for heat and hot water each year. At the average price paid over the past two years of $0.10 per kWh and $10.26 per dekatherm, the District can expect to pay more than $210,190 to provide heat and hot water for these buildings in the coming year.

This study analyzes three different biomass scenarios, 1) A biomass system that serves the High School only; 2) a biomass system that serves the Elementary School and Junior High / Middle School; and 3) a biomass system that serves all three buildings. If the Elementary School is tied into a biomass system with the Middle School or the Middle and High Schools, then purchasing a separate, replacement, boiler (as planned) can be avoided. While all three scenarios would provide the District with annual fuel savings (ranging from $33,644 with a system for the high school only to $135,931 for a system that served all three schools), these savings do not likely justify the capital costs required (ranging from $1.48 million with a system for the high school only to $2.5 million for a system that served all three schools) to install a woodchip system.

This report analyzes the opportunity to utilize wood energy at Jersey Shore Area School District. While investing in a woodchip system is not practical at this time due to the current price of natural gas. As natural gas prices increase or if substantial grant funding is obtained, installation of a woodchip system may become a better investment for the District.

Table 1: Summary Findings of Analyses

	Capital Cost	1st Year Debt Service	1st Year Annual Fuel Savings	30 Year NPV Cumulative Savings
Scenario 1 (High School Only)	$1.48 million	$132,931	$33,644	($696,360)
Scenario 2 (Elementary and Middle Schools)	$1.8 million	$163,215	$99,749	$43,307
Scenario 3 (All 3 schools)	$2.5 million	$221,374	$135,931	$469,281

Regardless of whether or not Jersey Shore Area School District moves forward with a biomass project, we recommend the District consider the following:

1. The District should replace the aging electric heating system at the Elementary School with a hot water boiler and hydronic heating distribution system. The existing system is reaching the end of its useful life and electricity is the most expensive fuel for heating by far. A new hydronic heating system will serve this school well for many, many years and likely pay for itself in fuel cost savings no matter which fuel is used for the boilers.
2. In order to effectively measure progress toward energy efficiency goals historical energy consumption data should be collected and updated frequently. There are many tools to help the District accomplish this. 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. This software can be downloaded at:
   http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager
3. The District should also consider the addition of solar hot water generation sized to heat the swimming pool during the summer months at the time of a boiler upgrade. Solar hot water is one of the most cost effective renewable energy technologies, particularly for facilities with a substantial summer heat load such as a heated swimming pool.

If the District does decide to move forward with a biomass project we also recommend taking the following steps:

1. Hire an engineering firm to help refine the project concept and to obtain firm local estimates on project costs. The US Forest Service may be able to provide some technical assistance from an engineering team with biomass experience. If the District moves forward with this project, they should contact Lew McCreery, the US Forest Service Biomass Coordinator for the Northeastern Area to see what assistance can be provided. Contact Lew at (304)285-1538 or lmccreery@fs.fed.us
2. The District should identify any heating system improvements it plans to undertake and include those projects with the biomass project. It is more cost effective to implement boiler room upgrades and heating distribution improvements at the same time a new boiler system is installed.
3. Concurrent with the design of the project, the District should cultivate potential biomass fuel suppliers. District staff should work with Mike Palko, Biomass Energy Specialist with the PA DCNR Bureau of Forestry, to identify potential Pennsylvania woodchip suppliers. Mike can be reached at (570)326-6020 or mipalko@state.pa.us.

This preliminary feasibility study was prepared by Yellow Wood Associates in collaboration with Richmond Energy Associates for the Jersey Shore Area School District. Both Yellow Wood and Richmond Energy have extensive community economic development experience and Richmond Energy specializes in biomass energy projects. This study was funded by the Wood Education and Resource Center, Northeastern Area State and Private Forestry, U.S. Department of Agriculture.

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 energy. Commercially available biomass heating systems can provide heat cleanly and efficiently in many commercial applications. Biomass heating technologies are being used quite successfully in over 45 public schools in Vermont and ten in Pennsylvania. The concept of heating institutions with wood is catching on in several other areas of the United States and Canada. Good candidate facilities for biomass energy systems include those that have high heating bills, those that have either steam or 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 dollar in the local economy); reduce the School's carbon footprint (by replacing fossil fuel with a renewable fuel source); and reduce dependence on fossil fuel, helping the State to achieve targets for renewable energy use.

This report is a pre-feasibility assessment specifically tailored to the Jersey Shore Area School District outlining whether or not a biomass heating system makes sense for the District from a practical perspective. In June 2011, staff from Yellow Wood Associates traveled to Jersey Shore to tour these three buildings. (Nippenose Elementary was also visited on this tour, but that facility is not included in this analysis.) This report includes site specific fuel savings projections based on historic fuel consumption, and provides facility decision-makers suggestions and recommendations on next steps.

The study was funded by the U.S. Department of Agriculture Wood Education and Resource Center.

This preliminary feasibility study was prepared by Yellow Wood Associates and Richmond Energy Associates, LLC.

DESCRIPTION OF THE EXISTING HEATING SYSTEMS

ELEMENTARY SCHOOL

The Elementary School, located on School Road in Jersey Shore, was built in 1971. The 81,000 square foot school building is served primarily by electric Univent heaters – installed when the school was built – located in individual classrooms. In addition to the electric heaters, the Elementary School has four rooftop natural gas units to heat the gym and cafeteria. Hot water is provided by a natural gas boiler. The gas units were installed in 2005 and all heating units are reported to be in good condition by the school Buildings and Grounds supervisor. The natural gas usage at the elementary school is not included in the analyses in this report, as it is likely the existing natural gas units in the elementary school will continue to be used.

MIDDLE / JUNIOR HIGH SCHOOL

The Middle School, located between Thompson and Locust Streets, was built in 1959. The 112,450 square foot building is heated by two Clever Brooks hot water boilers that were installed in 2001, and are in good condition. An additional natural gas boiler, installed in 2009, provides domestic hot water for the school. The Middle School uses an average of 5,703 dekatherms of natural gas for heat and hot water each year.

HIGH SCHOOL

The High School is both the newest and largest of the three buildings, located on Cemetery Street. Built in 1983, the 183,946 square foot High School is heated primarily by three 3.2 mmBtu Kewanee boilers that were converted from coal to natural gas in 2002. The High School has an additional 2.1 mmBtu natural gas boiler that heats the gym and the pool (installed in 1999) and a 540,000 Btu boiler for domestic hot water. All together, the school uses an average of 6,533 dekatherms of natural gas for heat and hot water each year.

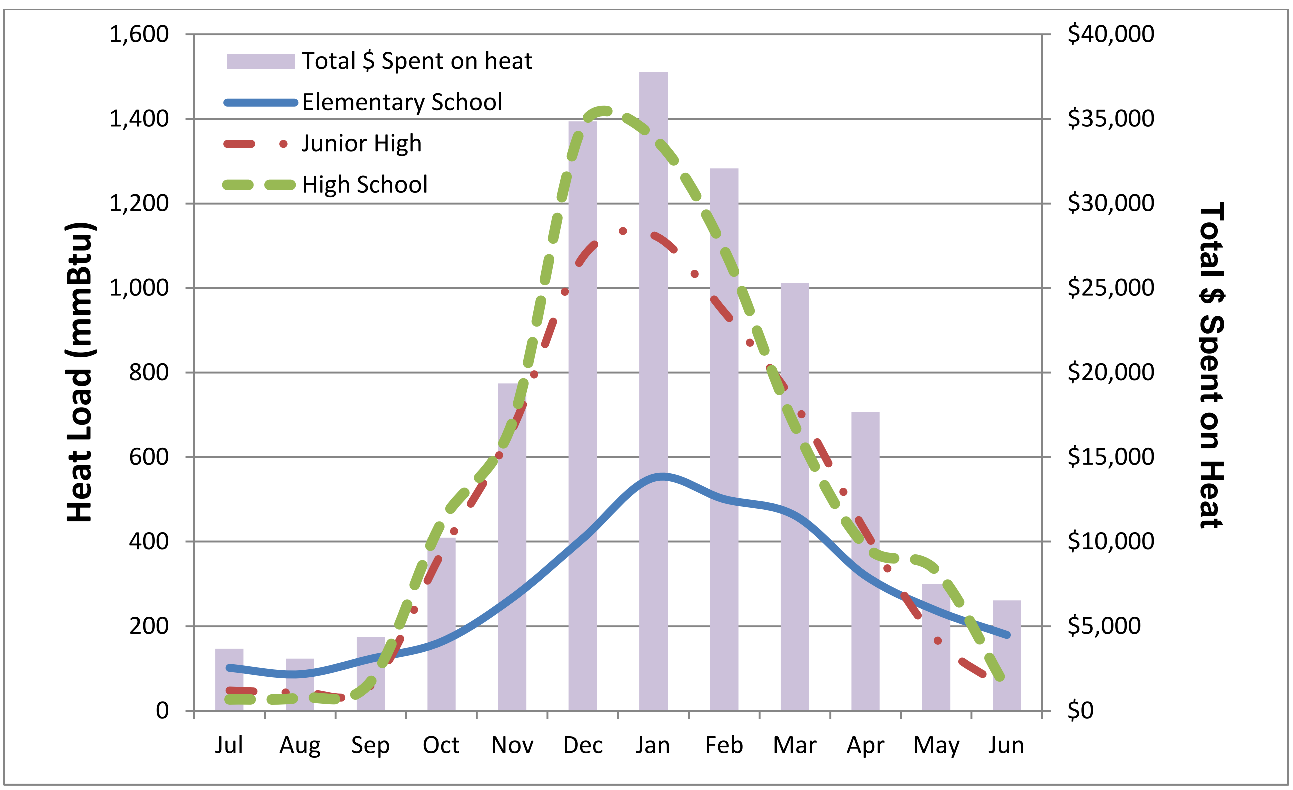
EXISTING FUEL USAGE

The Jersey Shore Area School District currently spends over $200,000 each year on natural gas and electricity to heat the Elementary School, Middle School and High School. The table below shows the average annual usage of electricity and natural gas for each school. The last row in this table shows the cost the District pays per square foot to heat these buildings, highlighting the expense of using electricity for heat. With biomass, the District can expect to pay approximately $.22 per square foot.

Table 2: Existing Fuel Usage and Cost by School

	Elementary School	Middle School	High School	Total
Natural Gas Usage (Dth)	493	5,703	6,533	12,729
Natural Gas Cost	$8,707	$58,332	$63,593	$130,632
Electricity Usage (kWh, Heat Only)	843,600	NA	NA	843,600
Electricity Cost (Heat Only)	$82,249	NA	NA	$82,249
$ spent per SF	**$1.12**	**$0.52**	**$0.35**	**$1.95**

Figure 1: Annual Heating Usage



ANALYSIS ASSUMPTIONS

LIFE CYCLE COST METHODOLOGY

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:

- 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
- Salvage costs of equipment and buildings at the end of the analysis period

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. In some cases, 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.

The analysis performed for this facility compares different scenarios 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 alternative biomass scenarios envision installing a new woodchip heating system that would serve different combinations of Jersey Shore Area School District buildings. While the scenarios include all ancillary equipment and interconnection costs, they do not include the cost of converting the Elementary School to hot water heat. This cost is not included because this is a conversion the District is planning on making regardless of the type of heating system installed. Under the biomass scenarios, the existing hot water boilers 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.

The analysis projects current and future annual heating bills 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.

It is not the intent of this project, nor was it in the scope of work, to develop detailed cost estimates for a biomass system. It is recommended that for a project of this scale, the District hire a qualified design team to refine the project concept and to develop firm local cost estimates. Therefore the capital costs used for the biomass scenario are generic estimates based on our experience with similar scale projects.

ELECTRICITY COST ASSUMPTIONS

During the past two years, the Jersey Shore Elementary School used an average of 843,600 kWh of electricity to heat the school. This is the amount of electricity used for heat identified by the District. The total of 843,600 kWh was the assumed annual electricity consumption used for the base case in the analysis. The average price paid for electricity over the past two years was $0.10 per kWh according to billing history. (This cost includes delivery charge. The average delivery charge over the past 18 months was $0.06.) At $0.10 per kWh, the District will spend more than $82,000 to heat the Elementary School next year. Electricity usage for the Middle School and High School were not analyzed because neither of these buildings uses electricity for heat or hot water.

NATURAL GAS COST ASSUMPTIONS

During the past two years the Elementary School, Middle School and High School used an average of 12,729 dekatherms of natural gas for heat and hot water. The average price paid for natural gas over the past two years was $10.63 per dekatherm, according to billing history provided by the District. 12,729 dekatherms at $10.63 per dekatherm were the consumption and price used for the base case in the analysis. At this price the District will pay more than $135,000 for natural gas in the coming year.

WOODCHIP FUEL COST ASSUMPTIONS

Frequently, operators of institutional woodchip systems don't fire up their biomass boilers until there is constant demand for building heat. During the fall and spring, fossil fuel boilers are often used as they are easier to start up and turn down. Woodchip boilers are then typically used in place of fossil fuel boilers for the bulk of the winter heating season. In Vermont where there are well over 40 schools that heat with wood, the average annual wood utilization is about 85%.

After consulting with other woodchip users in the region, we are projecting a first year cost of $40 per ton for woodchips which is equivalent to about $4.50 per Dth of natural gas and $0.02 per kWh of electricity. The remaining 15% of the heating needs were then assumed to be provided by the existing natural gas boilers. The cost for supplemental natural gas is adjusted for inflation each year over the 30-year horizon.

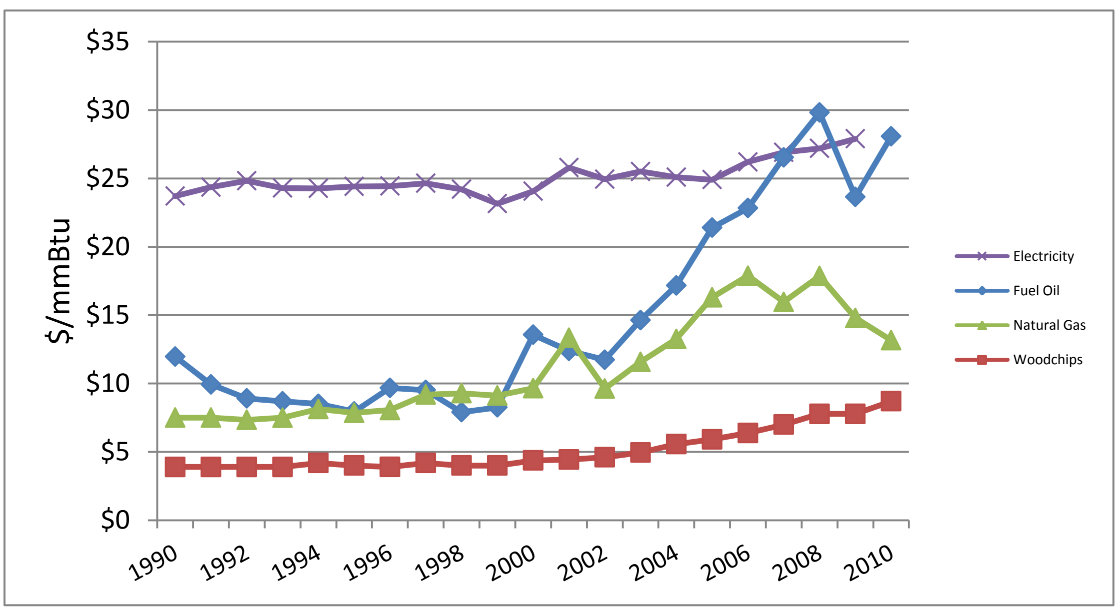
INFLATION ASSUMPTIONS

Estimating future fuel costs over time is difficult at best. Over the past few years it has become even more difficult as fuel prices have fluctuated dramatically. Nevertheless, in order to more accurately reflect future costs in a thirty-year analysis, some rate of inflation needs to be applied to future fuel costs.

We looked retrospectively over the last 20 years (1990 – 2010) using US Energy Information Agency data and found that the average annual increase for natural gas in Pennsylvania was 4.04% per year and 0.9% per year for electricity. The analysis projects these average inflation rates for natural gas and electricity forward over the thirty-year analysis period. The District's electricity rate of $0.10 per kWh and natural gas rate of $10.26 per Dth was used for the first year of the analysis and then inflated each year at 0.9% and 4.0% respectively.

The cost of 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 $56/ton in the period between 1990 and 2010. The average annual increase during this period was about 3.6% annually[1] with the greatest increases happening recently. Because 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.

Figure 2: Pennsylvania Fossil Fuel Price History vs. Vermont Woodchip Price History[1]



[1] 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.

The overall Consumer Price Index for the period between 1990 and 2009, the last year for which full data is available, increased an average of 2.7% annually. This is the annual inflation rate that was used in projecting all future labor costs, operations and maintenance costs and scheduled major repair costs for the biomass scenario.

OPERATION AND MAINTENANCE ASSUMPTIONS

It is typical for operators of fully automated woodchip heating systems of the sizes analyzed in this report to spend 15-30 minutes per day to clean ashes[2] and to check on pumps, motors and controls. For all three of the woodchip scenarios, 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 150 days per year and 20 hours during the summer months for routine maintenance. At a loaded labor rate of $25/hr, this equals $2,375 annually. An additional $6,000 in annual operational costs is assumed for electricity to run pumps, motors and pollution control equipment. These operations and maintenance costs were assumed to be the same across all three biomass scenarios.

Another operations and maintenance cost that is included in the analyses is periodic repair or replacement of major items on the boiler such as the furnace refractory. It is reasonable to anticipate these types of costs on a 10-15 year cycle. For the analysis in scenario one, $15,000 of scheduled maintenance was anticipated in years 10, 20 and 30 and then annualized at $1,500 per year to simulate a sinking fund for major repairs for scenario one. Similarly for scenario two, $3,000 per year was assumed for scheduled maintenance and $4,000 per year was assumed for scenario three. These scheduled maintenance costs were then inflated at the general annual inflation rate.

Under any biomass scenario, a case could be made that the existing heating units will require less maintenance and may last 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. Additionally it is very difficult to estimate how long the replacement of the existing units might be delayed. For these reasons, no additional annual maintenance, scheduled repair or planned replacement costs for the existing natural gas 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.

[2] Wood ash is generally not considered a hazardous material in most states and can be landfilled or land applied as a soil amendment by farmers or on-site maintenance staff.

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 cost of the biomass project with a low interest 4% loan. At this time the analysis does not take into account any potential grants or lower interest loans. Other financing schedules 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.

BIOMASS SCENARIOS

This report analyzes three different biomass scenarios. The first scenario is a biomass boiler that serves the High School only. The second scenario analyzes a biomass boiler that serves the Elementary School and Middle School (but not the High School). And the third scenario analyzes a system that serves all three schools. In all three of the biomass scenarios, costs for a tall stack were included to ensure good emissions dispersal. A pollution control system may be required by state air quality regulators for a system this size. Included in the analysis is an allowance for pollution control equipment. The District should direct its design engineers to investigate appropriate pollution control strategies to determine which will work best for this site and project.

Costs for an underground woodchip storage bin were included, as below grade chip storage bins are less likely to freeze in the coldest winter weather, and chip delivery using self unloading trailers into below grade bins is fast and easy.

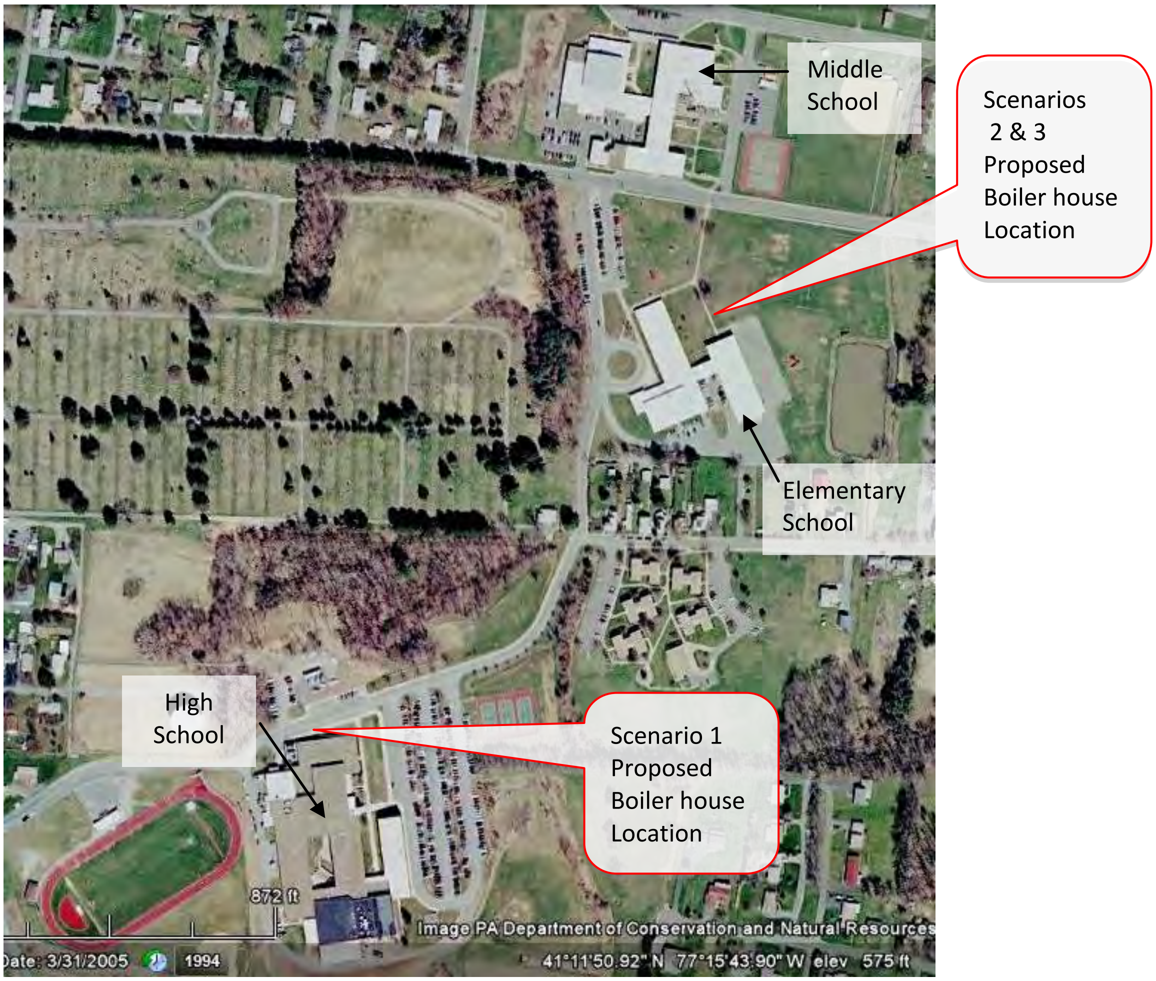
A thermal storage system is included in the capital cost estimates for this study. In this case the thermal storage system includes a large, insulated hot water tank and ancillary piping and pumps that connect the insulated storage tank to the wood fired boiler and to the building heating system. Heat from the wood boiler is stored in the water in the insulated tank until needed by the building system. This allows the 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.

The improved efficiency from thermal storage means fuel savings and reduced emissions. A thermal storage system also allows peak load shaving and, as a result, a smaller combustion system can be installed. The stored energy in the tank provides a buffer for peak loads during the day. The boiler loads energy into the tank during periods of low demand. When periods of peak demand occur, the energy stored in the tank responds immediately to the buildings' demand while the wood-fired boiler is reaching a "high fire" state. Then the boiler can provide the additional energy required to meet the peak demand. In commercial or school settings, these peak demand periods are often periods of maximum air exchange with the outdoors.

Additional benefits of the thermal storage system include the ability to extend the operation of the wood combustion system during warmer spring and fall periods, and in some cases, to address summer domestic hot water needs. Additionally solar thermal energy systems can be connected to the storage tank. In fact such combination systems are often used in Europe to meet summer domestic hot water needs and increase overall system efficiency.

A healthy construction contingency, standard general contractor mark-up and professional design fees were also included.

Figure 3: Site Plan



BIOMASS SCENARIO ONE ANALYSIS

The first scenario proposes a biomass heating system for the High School. This scenario includes building a 2,500 sf stand-alone boiler house and chip storage facility that would house a 4.2 mmBtu woodchip hot water boiler, woodchip fuel storage and fuel handling equipment to feed the boiler automatically. Hot water from the woodchip boiler house would be tied into the existing HVAC systems via approximately 250 feet of underground insulated piping. The scenario assumes the existing natural gas boilers would remain to provide back-up heat for the shoulder seasons and supplemental heat during the coldest days of the year if necessary.

Table 3: Biomass Scenario 1 Analysis Assumptions

Jersey Shore - Scenario One - Woodchip boiler system for Senior High Analysis Assumptions					
Capital Cost Assumptions					
One 4.2 mmBtu biomass boiler installed in new boilerhouse					$450,000
70 ft stack					$35,000
Pollution control equipment					$100,000
Biomass boiler house	2,500	SF	$150	/SF	$375,000
Underground insulated piping	250	LF	$150	LF	$37,500
Thermal storage 2,000 gallon					$20,000
Interconnection to existing boiler room					$25,000
GC markup at 10%					$104,250
Construction contingency at 15%					$172,013
Design at 12%					$158,252
Total estimated project costs					$1,477,014
Finance Assumptions					
Assumed Interest Rate					4%
First year debt service					$132,931
Fuel Cost Assumptions					
Current annual natural gas use in Dekatherms (Dkth)					6,533
Assumed natural gas price in 1st year (per Dkth)					$10.63
Projected annual natural gas bill					$69,446
Assumed wood price in 1st year (per ton)					$40
Projected 1st year wood fuel bill					$25,385
Projected 1st year supplemental natural gas bill					$10,417
Inflation Assumptions					
General inflation rate (twenty year average CPI)					2.7%
Natural gas inflation rate (twenty year average EIA)					4.0%
Wood inflation rate (average increase in VT from 1990 - 2010)					3.6%
O&M Assumptions					
Annual Wood O&M cost, including electricity for additional pumps and motors and staff time for daily and yearly maintenance					$8,375
Major repairs (annualized)					$1,500
Savings					
Return on Investment					**2.3%**
Net 1st year fuel savings					**$33,644**
Total 30 year NPV cumulative savings					**($696,360)**

Figure 4: Annual Cash Flow Graph for Biomass Scenario 1

This graph shows the projected cash flow over the 30 year life-cycle of the biomass boiler. The graph takes into account projected heating fuel savings (cost of woodchips versus the cost of natural gas), projected revenue and projected debt service.

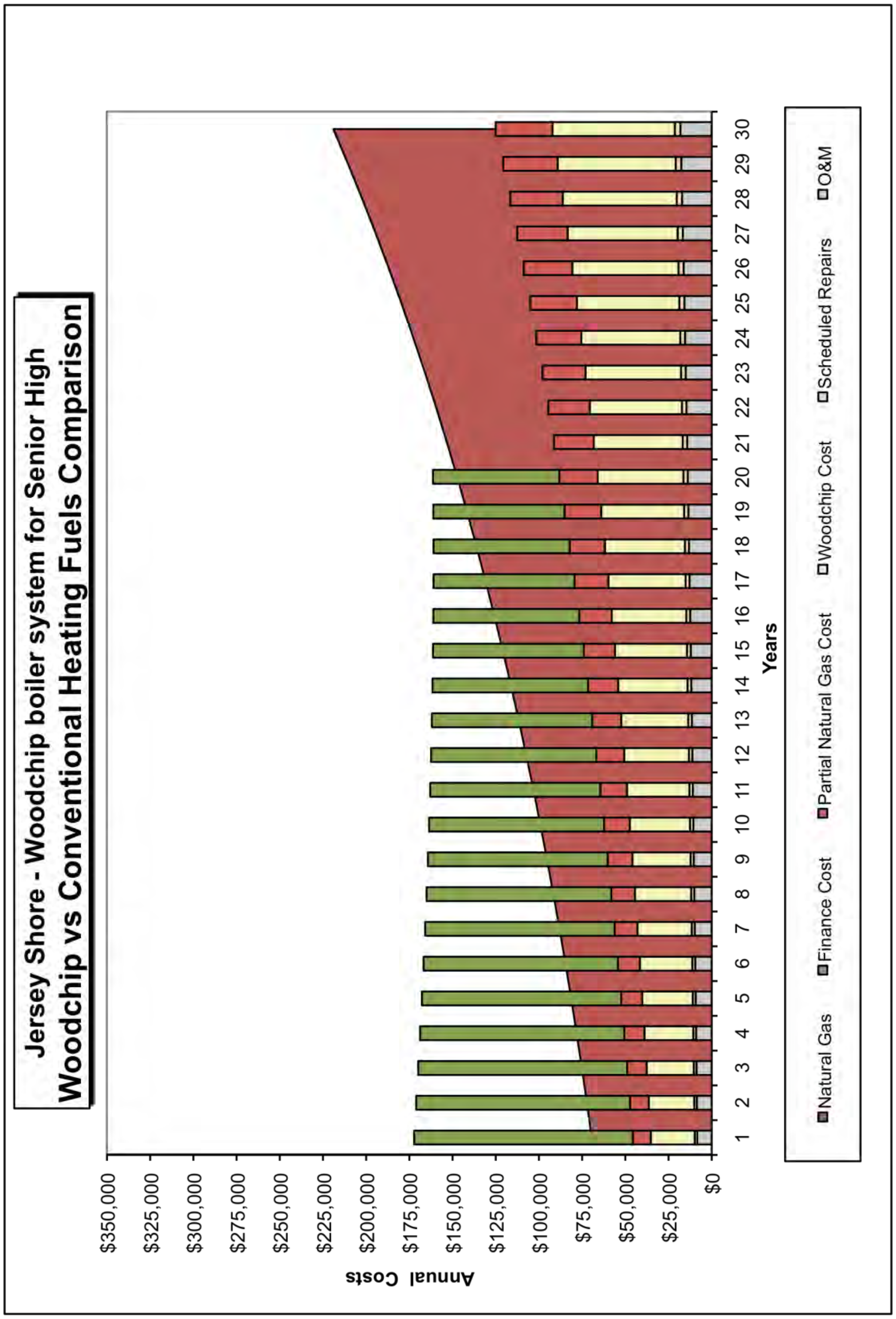


Table 4: 30-Year Life Cycle Analysis Spreadsheet for Biomass Scenario 1

Jersey Shore - Scenario One - Woodchip boiler system for Senior High — **Preliminary Life Cycle Cost Estimate**

Total estimated construction costs	***$1,477,014***		
Financing:	**4.0%**	*Assumed interest rate each year, 20 years*	
Natural Gas consumption	**6,533**	Dkth/year	15% Natural Gas = 980 Dkth; 9 Dkth / ton of woodchips
Natural Gas price	**$10.63**	/gallon in year 1	
Natural Gas cost	**$69,446**		747 tons if 100% woodchips for Natural Gas
Estimated woodchip utilization	**85%**		
Projected woodchip consumption	**635**	tons	
Estimated 1st year woodchip price	**$40**	/ ton Year 1	
Projected 1st year woodchip cost	**$25,385**		
General Inflation:	**2.7%**	**annually**	*Twenty year average annual US Labor Dept. Consumer Price Index increases*
Natural Gas inflation:	**4.0%**	**annually**	*Average increase for Commercial Natural Gas in PA from 1990 - 2010 (US EIA)*
Woodchip Inflation:	**3.6%**	**annually**	*Average increase for woodchips for schools in Vermont from 1990 - 2010 is 3.6%. (VSA)*
O & M.:	**$8,375**	**in Year 1 $**	*Estimate of additional electricity for feed system motors and additional maintenance staff time*
Major Repairs:	**$1,500**		*Contingency for major repair (e.g. refractory replacement) at Years 10, 20 and 30 annualized*

Yr.	Natural Gas Cost	Finance Cost	Woodchip Cost	Partial Natural Gas Cost	O&M	Scheduled Repairs	Total Costs	Annual Cashflow	Cumulative Cashflow
1	$69,446	$132,931	$25,385	$10,417	$8,375	$1,500	$178,608	-$109,163	-$109,163
2	$72,251	$129,977	$26,299	$10,838	$8,601	$1,541	$177,256	-$105,004	-$323,330
3	$75,170	$127,023	$27,246	$11,276	$8,833	$1,582	$175,960	-$100,790	-$638,287
4	$78,207	$124,069	$28,227	$11,731	$9,072	$1,625	$174,724	-$96,517	-$1,049,760
5	$81,367	$121,115	$29,243	$12,205	$9,317	$1,669	$173,549	-$92,182	-$1,553,416
6	$84,654	$118,161	$30,296	$12,698	$9,568	$1,714	$172,437	-$87,783	-$2,144,854
7	$88,074	$115,207	$31,386	$13,211	$9,827	$1,760	$171,391	-$83,317	-$2,819,610
8	$91,632	$112,253	$32,516	$13,745	$10,092	$1,808	$170,414	-$78,782	-$3,573,147
9	$95,334	$109,299	$33,687	$14,300	$10,365	$1,856	$169,507	-$74,173	-$4,400,857
10	$99,186	$106,345	$34,900	$14,878	$10,644	$1,906	$168,673	-$69,488	-$5,298,055
11	$103,193	$103,391	$36,156	$15,479	$10,932	$1,958	$167,916	-$64,723	-$6,259,976
12	$107,362	$100,437	$37,458	$16,104	$11,227	$2,011	$167,237	-$59,875	-$7,281,771
13	$111,699	$97,483	$38,806	$16,755	$11,530	$2,065	$166,639	-$54,940	-$8,358,506
14	$116,212	$94,529	$40,203	$17,432	$11,841	$2,121	$166,126	-$49,914	-$9,485,156
15	$120,907	$91,575	$41,650	$18,136	$12,161	$2,178	$165,701	-$44,794	-$10,656,599
16	$125,791	$88,621	$43,150	$18,869	$12,489	$2,237	$165,366	-$39,574	-$11,867,616
17	$130,873	$85,667	$44,703	$19,631	$12,827	$2,297	$165,125	-$34,252	-$13,112,885
18	$136,161	$82,713	$46,313	$20,424	$13,173	$2,359	$164,982	-$28,821	-$14,386,975
19	$141,662	$79,759	$47,980	$21,249	$13,529	$2,423	$164,940	-$23,278	-$15,684,343
20	$147,385	$76,805	$49,707	$22,108	$13,894	$2,488	$165,002	-$17,617	-$16,999,329
21	$153,339		$51,497	$23,001	$14,269	$2,556	$91,322	$62,017	-$18,252,297
22	$159,534		$53,350	$23,930	$14,654	$2,625	$94,559	$64,974	-$19,440,291
23	$165,979		$55,271	$24,897	$15,050	$2,696	$97,913	$68,066	-$20,560,219
24	$172,685		$57,261	$25,903	$15,456	$2,768	$101,388	$71,297	-$21,608,850
25	$179,661		$59,322	$26,949	$15,874	$2,843	$104,988	$74,673	-$22,582,809
26	$186,919		$61,458	$28,038	$16,302	$2,920	$108,718	$78,202	-$23,478,566
27	$194,471		$63,670	$29,171	$16,742	$2,999	$112,582	$81,889	-$24,292,433
28	$202,328		$65,962	$30,349	$17,194	$3,080	$116,586	$85,742	-$25,020,559
29	$210,502		$68,337	$31,575	$17,659	$3,163	$120,734	$89,768	-$25,658,917
30	$219,006		$70,797	$32,851	$18,135	$3,248	$125,032	$93,974	-$26,203,301
Totals	$3,920,990	$2,097,360	$1,332,239	$588,148	$379,633	$67,994	$4,465,373	-$544,384	
	Discount Rate	4%							
	$2,014,456	$1,477,014	$692,861	$302,168	$202,503	$36,269	$2,710,816	-$696,360	

Total Annual Heating Costs	Natural Gas + Woodchips	Woodchip System O&M /Year	Scheduled Repair Allowance / Year	Woodchip + Fuel + O&M + Contingency	Annual Fuel Cost Savings	Total Project Cost	Simple Payback (yrs)	30 Yr. NPV Savings	Return on Investment
$69,446	$35,802	$8,375	$1,500	$45,677	$33,644	$1,477,014	44	($696,360)	2.3%

BIOMASS SCENARIO TWO ANALYSIS

The second scenario proposes a biomass heating system for the Elementary School and Middle School only. This scenario includes building a 2,500 sf stand-alone boiler house and chip storage facility that would house two 4.2 mmBtu woodchip hot water boilers, woodchip fuel storage and fuel handling equipment to feed the boiler automatically. Hot water from the woodchip boiler house would be tied into the existing HVAC system of the Middle School and a new hot water distribution system in the Elementary School via approximately 500 feet of underground insulated piping. The scenario assumes the existing natural gas boilers at the Middle School would remain to provide back-up heat for the shoulder seasons and supplemental heat during the coldest days of the year if necessary. No additional heating equipment for the Elementary School would be required.

Table 5: Biomass Scenario 2 Analysis Assumptions

Jersey Shore - Scenario Two - Woodchip boiler system for Elementary and Jr. High
Analysis Assumptions

Capital Cost Assumptions					
Two 4.2 mmBtu biomass boilers installed in new boilerhouse					$700,000
70 ft stack					$35,000
Pollution control equipment					$50,000
Biomass boiler house	2,500	SF	$150	/SF	$375,000
Underground insulated piping	500	LF	$150	LF	$75,000
Thermal storage 2,000 gallon					$20,000
Interconnection to existing boiler rooms					$25,000
GC markup at 10%					$128,000
Construction contingency at 15%					$211,200
Design at 12%					$194,304
Total estimated project costs					$1,813,504
Finance Assumptions					
Assumed Interest Rate					4%
First year debt service					$163,215
Fuel Cost Assumptions					
Average electric heat consumption in kWh for last two years					843,600
Assumed electric heat cost/kWh					$0.10
Projected annual electric heat bill					$84,360
Current annual natural gas use in Dekatherms (Dkth)					5,703
Assumed natural gas price in 1st year (per Dkth)					$10.63
Projected annual natural gas bill					$60,623
Assumed wood price in 1st year (per ton)					$40
Projected 1st year wood fuel bill					$36,141
Projected 1st year supplemental natural gas bill					$9,093
Inflation Assumptions					
General inflation rate (twenty year average CPI)					2.7%
Natural gas inflation rate (twenty year average EIA)					4.0%
Electric inflation rate (twenty year average EIA)					0.9%
Wood inflation rate (average increase in VT from 1990 - 2010)					3.6%
O&M Assumptions					
Annual Wood O&M cost, including electricity for additional pumps and motors and staff time for daily and yearly maintenance					$8,375
Major repairs (annualized)					$3,000
Savings					
Return on Investment					**5.5%**
Net 1st year fuel savings					**$99,749**
Total 30 year NPV cumulative savings					**$43,307**

Figure 5: Annual Cash Flow Graph for Biomass Scenario 2

This graph shows the projected cash flow over the 30 year life-cycle of the biomass boiler. The graph takes into account projected heating fuel savings (cost of woodchips versus the cost of natural gas and electricity), projected revenue and projected debt service.

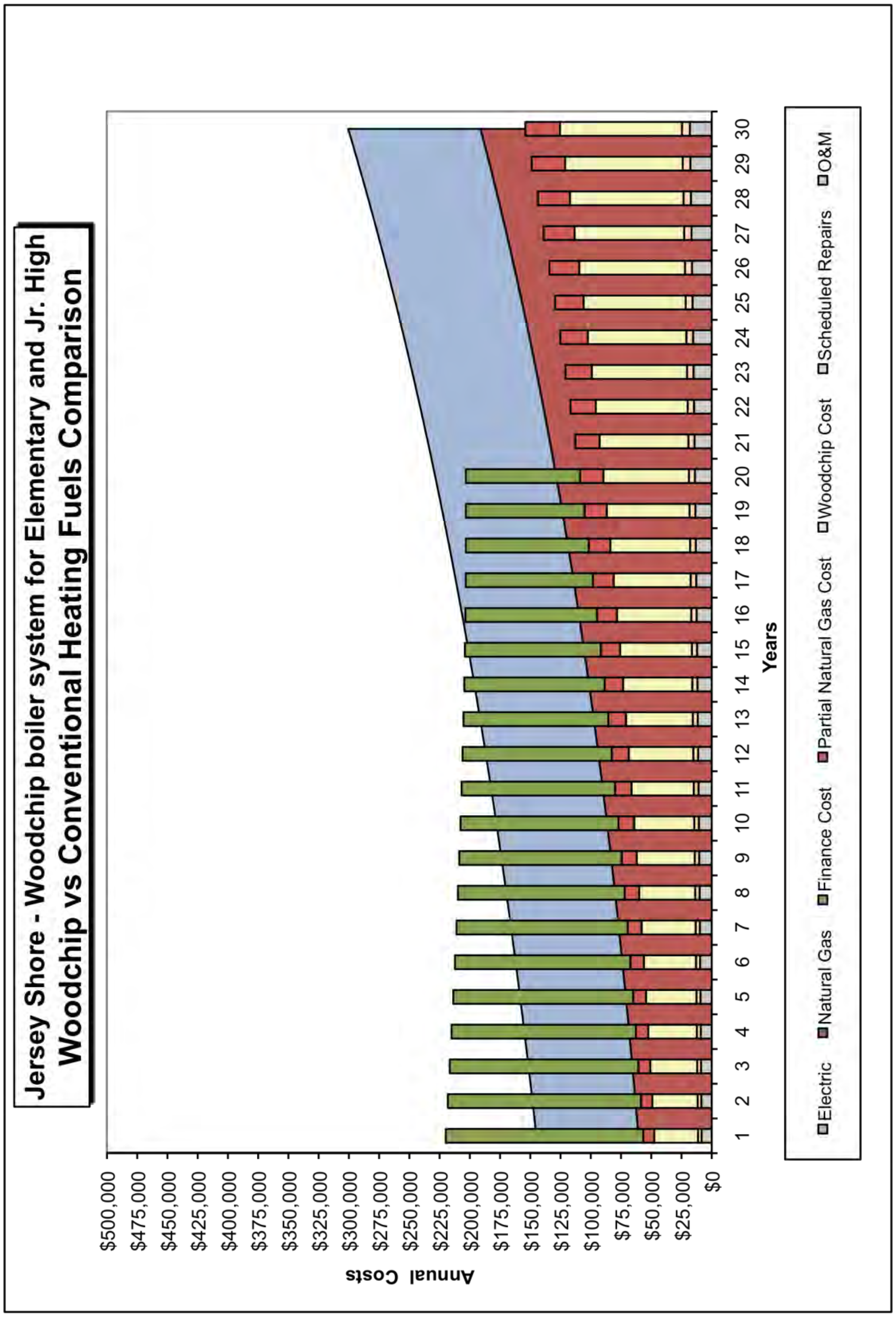


Table 6: 30-Year Life Cycle Analysis Spreadsheet for Biomass Scenario 2

Jersey Shore - Scenario Two - Woodchip boiler system for Elementary and Jr. High — **Preliminary Life Cycle Cost Estimate**

Total estimated construction costs	$2,167,704					
Financing:	4.0%	*Assumed interest rate each year, 20 years*				
Electric heat consumption	843,600	kWh/year	411	tons if 100% woodchips for electricity	2,052	kWh/ton of woodchips
Electric heat price	$0.10	/kWh in year 1				
Electric heat cost	$84,360					
Natural Gas consumption	5,703	Dkth/year	15%	Natural Gas = 855 Dkth	9	Dkth / ton of woodchips
Natural Gas price	$10.63	/gallon in year 1				
Natural Gas cost	$60,623		652	tons if 100% woodchips for Natural Gas		
Estimated woodchip utilization	85%					
Projected woodchip consumption	904	tons				
Estimated 1st year woodchip price	$40	/ ton Year 1				
Projected 1st year woodchip cost	$36,141					
General Inflation:	2.7%	annually	*Twenty year average annual US Labor Dept. Consumer Price Index increases*			
Electricity inflation	0.9%	annually	*Twenty year averagein PA (US EIA)*			
Natural Gas inflation:	4.0%	annually	*Average increase for Commercial Natural Gas in PA from 1990 - 2010 (US EIA)*			
Woodchip Inflation:	3.6%	annually	*Average increase for woodchips for schools in Vermont from 1990 - 2010 is 3.6%. (VSA)*			
O & M.:	$8,375	in Year 1 $	*Estimate of additional electricity for feed system motors and additional maintenance staff time*			
Major Repairs:	$3,000		*Contingency for major repair (e.g. refractory replacement) at Years 10, 20 and 30 annualized*			

Yr.	Electric Cost	Natural Gas Cost	Total	Finance Cost	Woodchip Cost	Partial Natural Gas Cost	O&M	Scheduled Repairs	Electricity Savings	Total Costs	Annual Cashflow	Cumulative Cashflow
1	$84,360	$60,623	$144,983	$195,093	$36,141	$9,093	$8,375	$3,000	$84,360	$251,703	-$106,720	-$106,720
2	$85,119	$63,072	$148,191	$190,758	$37,442	$9,461	$8,601	$3,081	$86,638	$249,343	-$101,152	-$207,871
3	$85,885	$65,620	$151,505	$186,423	$38,790	$9,843	$8,833	$3,164	$88,977	$247,053	-$95,547	-$303,419
4	$86,658	$68,271	$154,930	$182,087	$40,186	$10,241	$9,072	$3,250	$91,379	$244,836	-$89,906	-$393,325
5	$87,438	$71,029	$158,468	$177,752	$41,633	$10,654	$9,317	$3,337	$93,847	$242,693	-$84,226	-$477,550
6	$88,225	$73,899	$162,124	$173,416	$43,132	$11,085	$9,568	$3,427	$96,380	$240,629	-$78,505	-$556,055
7	$89,019	$76,884	$165,904	$169,081	$44,684	$11,533	$9,827	$3,520	$98,983	$238,645	-$72,741	-$628,796
8	$89,820	$79,991	$169,811	$164,746	$46,293	$11,999	$10,092	$3,615	$101,655	$236,744	-$66,933	-$695,730
9	$90,629	$83,222	$173,851	$160,410	$47,960	$12,483	$10,365	$3,713	$104,400	$234,930	-$61,079	-$756,809
10	$91,444	$86,584	$178,029	$156,075	$49,686	$12,988	$10,644	$3,813	$107,219	$233,206	-$55,177	-$811,986
11	$92,267	$90,082	$182,350	$151,739	$51,475	$13,512	$10,932	$3,916	$110,114	$231,574	-$49,224	-$861,210
12	$93,098	$93,722	$186,820	$147,404	$53,328	$14,058	$11,227	$4,022	$113,087	$230,039	-$43,219	-$904,429
13	$93,936	$97,508	$191,444	$143,068	$55,248	$14,626	$11,530	$4,130	$116,140	$228,603	-$37,159	-$941,588
14	$94,781	$101,447	$196,229	$138,733	$57,237	$15,217	$11,841	$4,242	$119,276	$227,270	-$31,041	-$972,630
15	$95,634	$105,546	$201,180	$134,398	$59,297	$15,832	$12,161	$4,356	$122,496	$226,044	-$24,864	-$997,494
16	$96,495	$109,810	$206,305	$130,062	$61,432	$16,471	$12,489	$4,474	$125,804	$224,929	-$18,624	-$1,016,118
17	$97,363	$114,246	$211,610	$125,727	$63,644	$17,137	$12,827	$4,595	$129,200	$223,929	-$12,319	-$1,028,437
18	$98,240	$118,862	$217,101	$121,391	$65,935	$17,829	$13,173	$4,719	$132,689	$223,047	-$5,946	-$1,034,382
19	$99,124	$123,664	$222,788	$117,056	$68,308	$18,550	$13,529	$4,846	$136,271	$222,289	$499	-$1,033,884
20	$100,016	$128,660	$228,676	$112,721	$70,767	$19,299	$13,894	$4,977	$139,951	$221,658	$7,018	-$1,026,866
21	$100,916	$133,858	$234,774		$73,315	$20,079	$14,269	$5,111	$143,729	$112,774	$122,000	-$904,866
22	$101,824	$139,266	$241,090		$75,954	$20,890	$14,654	$5,249	$147,610	$116,748	$124,342	-$780,524
23	$102,741	$144,892	$247,633		$78,689	$21,734	$15,050	$5,391	$151,596	$120,864	$126,769	-$653,755
24	$103,665	$150,746	$254,411		$81,522	$22,612	$15,456	$5,537	$155,689	$125,126	$129,285	-$524,470
25	$104,598	$156,836	$261,434		$84,456	$23,525	$15,874	$5,686	$159,892	$129,541	$131,893	-$392,578
26	$105,540	$163,172	$268,712		$87,497	$24,476	$16,302	$5,840	$164,209	$134,114	$134,597	-$257,981
27	$106,490	$169,764	$276,254		$90,647	$25,465	$16,742	$5,997	$168,643	$138,851	$137,403	-$120,578
28	$107,448	$176,622	$284,070		$93,910	$26,493	$17,194	$6,159	$173,196	$143,757	$140,313	$19,735
29	$108,415	$183,758	$292,173		$97,291	$27,564	$17,659	$6,325	$177,873	$148,839	$143,334	$163,070
30	$109,391	$191,182	$300,573		$100,793	$28,677	$18,135	$6,496	$182,675	$154,102	$146,470	$309,540
Totals	$2,890,579	$3,422,839	$6,313,418	$3,078,140	$1,896,692	$513,426	$379,633	$135,988	$3,823,976	$6,003,878	$309,540	
	Discount Rate	4%	$3,382,049	$2,167,704	$986,418	$263,779	$202,503	$72,538	$2,039,781	$3,692,942	-$310,893	

Total Annual Heating Costs	Natural Gas + Woodchips	Woodchip System O&M /Year	Scheduled Repair Allowance / Year	Woodchip + Fuel + O&M + Contingency	Annual Fuel Cost Savings	Total Project Cost	Simple Payback (yrs)	30 Yr. NPV Savings	Return on Investment
$144,983	$45,234	$8,375	$3,000	$56,609	$99,749	$2,167,704	21.7	($310,893)	4.6%

BIOMASS SCENARIO THREE ANALYSIS

The third scenario proposes a biomass heating system for all three schools. This scenario includes building a 3,000 sf stand-alone boiler house and chip storage facility that would house three 4.2 mmBtu woodchip hot water boilers, woodchip fuel storage and fuel handling equipment to feed the boiler automatically. Hot water from the woodchip boiler house would be tied into the existing HVAC systems of the Middle School and High School and a new hot water distribution system in the Elementary School via approximately 1,500 feet of underground insulated piping. The scenario assumes the existing natural gas boilers at the Middle School and High School would remain to provide back-up heat for the shoulder seasons and supplemental heat during the coldest days of the year if necessary. No additional heating equipment for the Elementary School would be required.

Table 7: Biomass Scenario 3 Analysis Assumptions

Jersey Shore - Scenario Three - Woodchip boiler system for all three schools
Analysis Assumptions

Capital Cost Assumptions					
Three 4.2 mmBtu biomass boilers installed in new boilerhouse					$900,000
70 ft stack					$35,000
Pollution control equipment					$50,000
Biomass boiler house	3,000	SF	$150	/SF	$450,000
Pex Pipe (Combination of 4" and 6" supply and return)	1,474	LF	$150	LF	$221,100
Thermal storage 3,000 gallon					$30,000
Interconnection to 2 existing boiler rooms at $25,000 each					$50,000
GC markup at 10%					$173,610
Construction contingency at 15%					$286,457
Design at 12%					$263,540
Total estimated project costs					$2,459,706
Finance Assumptions					
Assumed Interest Rate					4%
First year debt service					$221,374
Fuel Cost Assumptions					
Average electric heat consumption in kWh for last two years					843,600
Assumed electric heat cost/kWh					$0.10
Projected annual electric heat bill					$84,360
Current annual natural gas use in Dekatherms (Dkth)					12,729
Assumed natural gas price in 1st year (per Dkth)					$10.63
Projected annual natural gas bill					$135,309
Assumed wood price in 1st year (per ton)					$40
Projected 1st year wood fuel bill					$63,442
Projected 1st year supplemental natural gas bill					$20,296
Inflation Assumptions					
General inflation rate (twenty year average CPI)					2.7%
Natural gas inflation rate (twenty year average EIA)					4.0%
Electric inflation rate (twenty year average EIA)					0.9%
Wood inflation rate (average increase in VT from 1990 - 2010)					3.6%
O&M Assumptions					
Annual Wood O&M cost, including electricity for additional pumps and motors and staff time for daily and yearly maintenance					$8,375
Major repairs (annualized)					$4,000
Savings					
Return on Investment					**5.5%**
Net 1st year fuel savings					**$135,931**
Total 30 year NPV cumulative savings					**$469,281**

Figure 6: Annual Cash Flow Graph for Biomass Scenario 3

This graph shows the projected cash flow over the 30 year life-cycle of the biomass boiler. The graph takes into account projected heating fuel savings (cost of woodchips versus the cost of natural gas and electricity), projected revenue and projected debt service.

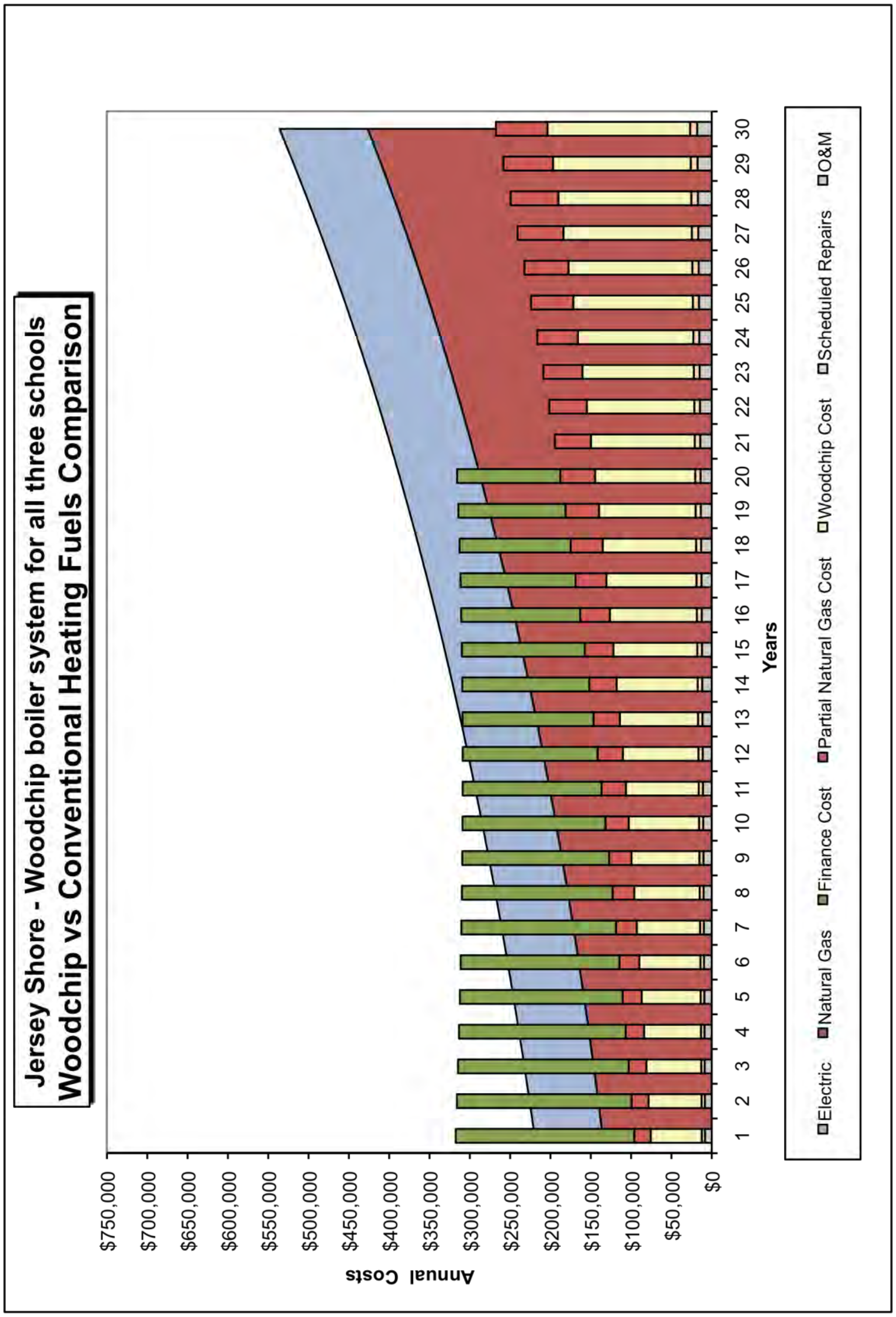


Table 8: 30-Year Life Cycle Analysis Spreadsheet for Biomass Scenario 3

Jersey Shore - Scenario Three - Woodchip boiler system for all three schools — **Preliminary Life Cycle Cost Estimate**

Total estimated construction costs	***$2,459,706***					
Financing:	**4.0%**	*Assumed interest rate each year, 20 years*				
Electric heat consumption	**843,600**	kWh/year	411	tons if 100% woodchips for electricity	2,052	kWh/ton of woodchips
Electric heat price	**$0.10**	/kWh in year 1				
Electric heat cost	**$84,360**					
Natural Gas consumption	**12,729**	Dkth/year	15%	Natural Gas = 1,909 Dkth	9	Dkth / ton of woodchips
Natural Gas price	**$10.63**	/gallon in year 1				
Natural Gas cost	**$135,309**		1,455	tons if 100% woodchips for Natural Gas		
Estimated woodchip utilization	**85%**					
Projected woodchip consumption	**1,586**	tons				
Estimated 1st year woodchip price	**$40**	/ ton Year 1				
Projected 1st year woodchip cost	**$63,442**					
General Inflation:	**2.7%**	**annually**	*Twenty year average annual US Labor Dept. Consumer Price Index increases*			
Electricity inflation	**0.9%**	**annually**	*Twenty year averagein PA (US EIA)*			
Natural Gas inflation:	**4.0%**	**annually**	*Average increase for Commercial Natural Gas in PA from 1990 - 2010 (US EIA)*			
Woodchip Inflation:	**3.6%**	**annually**	*Average increase for woodchips for schools in Vermont from 1990 - 2010 is 3.6%. (VSA)*			
O & M.:	**$8,375**	**in Year 1 $**	*Estimate of additional electricity for feed system motors and additional maintenance staff time*			
Major Repairs:	**$4,000**		*Contingency for major repair (e.g. refractory replacement) at Years 10, 20 and 30 annualized*			

Yr.	Electric Cost	Natural Gas Cost	Total	Finance Cost	Woodchip Cost	Partial Natural Gas Cost	O&M	Scheduled Repairs	Electricity Savings	Total Costs	Annual Cashflow	Cumulative Cashflow
1	$84,360	$135,309	$219,669	$221,374	$63,442	$20,296	$8,375	$4,000	$84,360	$317,487	-$97,818	-$97,818
2	$85,119	$140,776	$225,895	$216,454	$65,726	$21,116	$8,601	$4,108	$86,638	$316,005	-$90,110	-$187,928
3	$85,885	$146,463	$232,348	$211,535	$68,092	$21,969	$8,833	$4,219	$88,977	$314,648	-$82,300	-$270,228
4	$86,658	$152,380	$239,038	$206,615	$70,543	$22,857	$9,072	$4,333	$91,379	$313,420	-$74,382	-$344,610
5	$87,438	$158,536	$245,975	$201,696	$73,083	$23,780	$9,317	$4,450	$93,847	$312,326	-$66,351	-$410,961
6	$88,225	$164,941	$253,166	$196,777	$75,714	$24,741	$9,568	$4,570	$96,380	$311,370	-$58,203	-$469,164
7	$89,019	$171,605	$260,624	$191,857	$78,439	$25,741	$9,827	$4,693	$98,983	$310,557	-$49,933	-$519,098
8	$89,820	$178,538	$268,358	$186,938	$81,263	$26,781	$10,092	$4,820	$101,655	$309,894	-$41,536	-$560,633
9	$90,629	$185,751	$276,379	$182,018	$84,189	$27,863	$10,365	$4,950	$104,400	$309,384	-$33,005	-$593,638
10	$91,444	$193,255	$284,699	$177,099	$87,220	$28,988	$10,644	$5,084	$107,219	$309,035	-$24,336	-$617,974
11	$92,267	$201,062	$293,330	$172,179	$90,359	$30,159	$10,932	$5,221	$110,114	$308,851	-$15,521	-$633,495
12	$93,098	$209,185	$302,283	$167,260	$93,612	$31,378	$11,227	$5,362	$113,087	$308,839	-$6,556	-$640,051
13	$93,936	$217,636	$311,572	$162,341	$96,982	$32,645	$11,530	$5,507	$116,140	$309,005	$2,567	-$637,484
14	$94,781	$226,429	$321,210	$157,421	$100,474	$33,964	$11,841	$5,656	$119,276	$309,356	$11,854	-$625,631
15	$95,634	$235,577	$331,211	$152,502	$104,091	$35,337	$12,161	$5,808	$122,496	$309,898	$21,312	-$604,318
16	$96,495	$245,094	$341,589	$147,582	$107,838	$36,764	$12,489	$5,965	$125,804	$310,639	$30,950	-$573,369
17	$97,363	$254,996	$352,359	$142,663	$111,720	$38,249	$12,827	$6,126	$129,200	$311,585	$40,774	-$532,595
18	$98,240	$265,298	$363,537	$137,744	$115,742	$39,795	$13,173	$6,292	$132,689	$312,745	$50,792	-$481,803
19	$99,124	$276,016	$375,139	$132,824	$119,909	$41,402	$13,529	$6,461	$136,271	$314,125	$61,014	-$420,789
20	$100,016	$287,167	$387,183	$127,905	$124,226	$43,075	$13,894	$6,636	$139,951	$315,735	$71,447	-$349,341
21	$100,916	$298,768	$399,684		$128,698	$44,815	$14,269	$6,815	$143,729	$194,597	$205,087	-$144,254
22	$101,824	$310,838	$412,663		$133,331	$46,626	$14,654	$6,999	$147,610	$201,610	$211,053	$66,798
23	$102,741	$323,396	$426,137		$138,131	$48,509	$15,050	$7,188	$151,596	$208,878	$217,259	$284,057
24	$103,665	$336,462	$440,127		$143,104	$50,469	$15,456	$7,382	$155,689	$216,411	$223,716	$507,773
25	$104,598	$350,055	$454,653		$148,255	$52,508	$15,874	$7,581	$159,892	$224,218	$230,434	$738,207
26	$105,540	$364,197	$469,736		$153,592	$54,630	$16,302	$7,786	$164,209	$232,310	$237,426	$975,633
27	$106,490	$378,910	$485,400		$159,122	$56,837	$16,742	$7,996	$168,643	$240,697	$244,703	$1,220,336
28	$107,448	$394,218	$501,666		$164,850	$59,133	$17,194	$8,212	$173,196	$249,390	$252,277	$1,472,613
29	$108,415	$410,145	$518,560		$170,785	$61,522	$17,659	$8,434	$177,873	$258,399	$260,161	$1,732,774
30	$109,391	$426,715	$536,105		$176,933	$64,007	$18,135	$8,662	$182,675	$267,737	$268,368	$2,001,142
Totals	$2,890,579	$7,639,718	$10,530,297	$3,492,783	$3,329,465	$1,145,958	$379,633	$181,317	$3,823,976	$8,529,156	$2,001,142	
Discount Rate		4%										
			$5,548,522	$2,459,706	$1,731,564	$588,750	$202,503	$96,718	$2,039,781	$5,079,241	$469,281	

Total Annual Heating Costs	Natural Gas + Woodchips	Woodchip System O&M /Year	Scheduled Repair Allowance / Year	Woodchip + Fuel + O&M + Contingency	Annual Fuel Cost Savings	Total Project Cost	Simple Payback (yrs)	30 Yr. NPV Savings	Return on Investment
$219,669	$83,738	$8,375	$4,000	$96,113	$135,931	$2,459,706	18.1	$469,281	5.5%

ADDITIONAL ISSUES TO CONSIDER

ENERGY MANAGEMENT

In order to effectively manage energy use and to identify efficiency opportunities in buildings it is very important to track energy usage. Unless energy consumption is measured over time, it is difficult or impossible to know the impact of efficiency improvements or renewable energy investments. The Environmental Protection Agency has developed a public domain software program called Portfolio Manager that can track and assess energy and water consumption across an entire portfolio of buildings. Portfolio Manager can help set efficiency priorities, identify under-performing buildings, verify efficiency improvements, and receive EPA recognition for superior energy performance. Yellow Wood recommends that the District input several years' worth of energy and water use data for each school into *Portfolio Manager* as soon as it can. The EPA *Portfolio Manager* software can be downloaded at the following address: http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager

ENERGY EFFICIENCY

Whether the District converts to biomass or stays with natural gas and electricity, the facility should use its energy efficiently. PPL Electric Utilities, Jersey Shore's electricity provider, has a number of energy efficiency programs with rebates, incentives and tools to address energy efficiency through its E-Power program. One service, school benchmarking, includes a free energy analysis to provide benchmarking for schools and identification of potential energy savings opportunities. Another, custom, incentive offers an incentive of $0.10 per kWh saved. To learn about all of PPL's efficiency programs and incentive, visit their website at: http://www.pplelectric.com/e-power.

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 strongly recommend that the District work with an independent, third-party, commissioning agent during the design and construction of a biomass heating system. See the *Biomass and Green Building Resources* binder for more information on commissioning.

PROJECT FUNDING POSSIBILITIES

PENNSYLVANIA ALTERNATIVE AND CLEAN ENERGY PROGRAM

The Pennsylvania Alternative and Clean Energy Program provides grants and loans to be used for the development of alternative and clean energy projects in Pennsylvania. Businesses, economic development organizations and municipalities, counties and school districts are all eligible to apply for loans. Grants up to $2 million and loan guarantees up to $5 million are available for clean energy projects (including the purchase and installation of a biomass boiler to provide heat). There is a $1 to $1 matching requirement for both loans and grant funding. More information about the program is available at:
http://www.newpa.com/find-and-apply-for-funding/funding-and-program-finder/alternative-and-clean-energy-program

You can apply for funding through this program through the *Single Application for Assistance* at: http://www.newpa.com/what-can-pa-do-for-you/single-application

Or through the *Customer Service Center*: http://www.newpa.com/contact-us

PENNSYLVANIA ENERGY DEVELOPMENT AUTHORITY (PEDA) GRANTS

PEDA grants provide financial assistance for alternative energy projects including biomass and energy efficiency. Funding can be used for capital costs such as construction and equipment purchase. Funding requires the project to have a research component and have a measureable environmental benefit for the commonwealth. The most recent round of PEDA grants closed in June. You can access more information on PEDA grants and sign up to be notified when the next PEDA round opens at:
http://www.portal.state.pa.us/portal/server.pt/community/peda-move_to_grants/10496

PENNSYLVANIA GREEN ENERGY LOAN FUND (GELF)

The GELF energy loans provide low interest financing (3.5%) for building energy efficiency retrofits and high-perofmance energy systems that result in a 25% reduction in energy consumption. The GELF accepts loan applications on a rolling basis. For more information about the program and to download an application, go to:
http://www.trfund.com/financing/energy/pagelf.html

WOODY BIOMASS UTILIZATION GRANT PROGRAM

The woody biomass utilization grant program, administered by the Department of Agriculture, provides grant funding for wood energy projects requiring engineering services. The woody biomass shall be used in a bioenergy facility that uses commercially proven technologies to produce thermal, electrical, or liquid/gaseous bioenergy. The funds from the Woody Biomass Utilization Grant program (WBU) must be used to further the planning of such facilities by funding the engineering services necessary for final design and cost analysis. This program is aimed at helping applicants complete the necessary design work needed to secure public and/or private investment for construction. In particular, USDA Rural Development has established grants and loan programs that might help fund construction of such facilities.

Applications for 2011 funding were due on March 1st, 2011. A new announcement for a 2012 round of funding has not yet been made. For more information on the grant program, contact:

Lew R. McCreery, Biomass Coordinator
USFS Northeastern Area
180 Canfield St.
Morgantown, WV 26505
(304) 285-1538
lmccreery@fs.fed.us

To see last year's request for proposals go to:
http://www.grants.gov/search/search.do?mode=VIEW&oppId=58881.

USDA FUNDING OPPORTUNITIES

2008 Farm Bill

The 2008 Farm Bill has a number of provisions that may help rural communities consider and implement renewable energy and energy efficiency projects.

- **Section 9009** provides grants for the purpose of enabling rural communities to increase their energy self-sufficiency.
- **Section 9013** provides grants to state and local governments to acquire wood energy systems.

These grants and loan guarantee programs are competitive. The District should check with the local USDA office to express interest and to get program updates.

Rural Community Facilities Grant and Loan Program

The USDA provides grants and loans to assist the development of essential community facilities. Grants can be used to construct, enlarge or improve community facilities for health care, public safety and other community and public services. The amount of grant assistance depends on the median household income and the population of the community where the project is located.

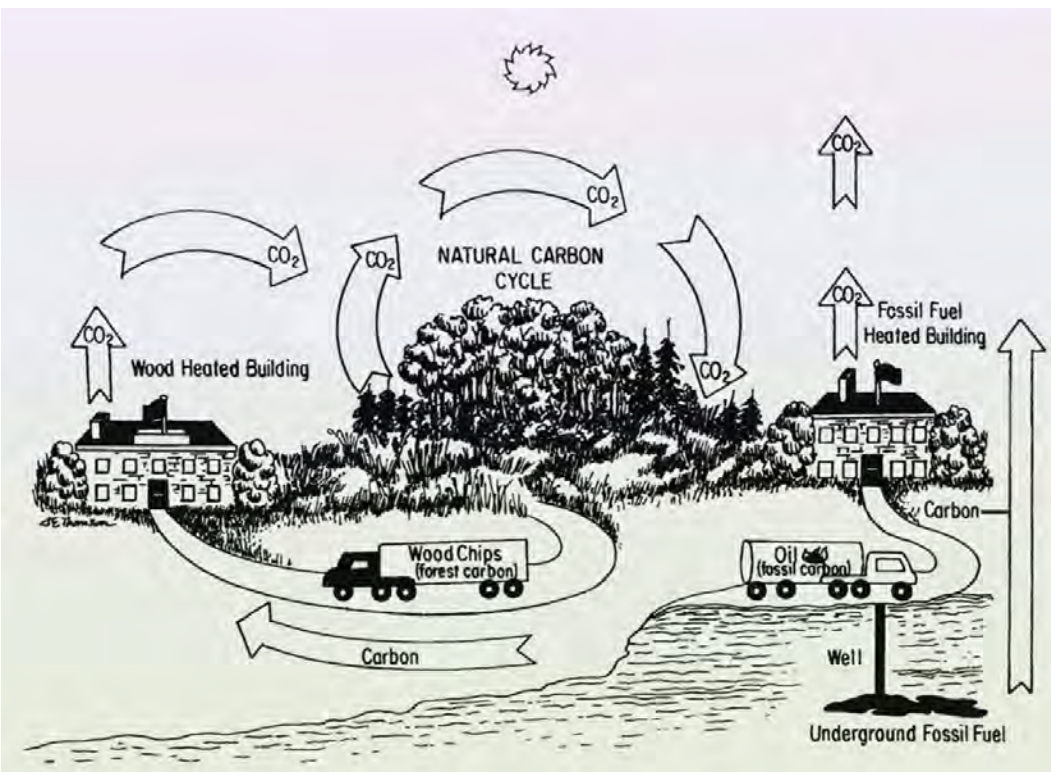
These grants and loans are also competitive. Highest priority projects are those that serve small communities, those that serve low-income communities and those that are highly leveraged with other loan and grant awards.

For more information about USDA programs and services, contact your local USDA office. Information on programs and contact information is provided in the *Biomass and Green Building Resources* Binder.

CARBON OFFSETS

While fossil fuels introduce carbon that has been sequestered for millions of years into the atmosphere, the carbon dioxide emitted from burning biomass comes from carbon that is already above the ground and in the carbon cycle. Biomass fuels typically come from the waste of some other industrial activity such as a logging operation or from sawmill production. The carbon from this waste would soon wind up in the atmosphere whether it was left to decompose or it was burned as slash. Jersey Shore Area School District could reduce its carbon footprint by switching their heating fuel use from natural gas and electricity to a biomass fuel.

Figure 7: Carbon Cycle Illustration[3]



[3] Illustration taken from a handout produced by the Biomass Energy Resource Center

Carbon offsets help fund projects that reduce greenhouse gases emissions. Carbon offset providers sell the greenhouse gas reductions associated with projects like wind farms or biomass projects to customers who want to offset the emissions they caused by flying, driving, or using electricity. Selling offsets is a way for some renewable energy projects to become more financially viable. Buying offsets is a way for companies and individuals to compensate for the CO_2 pollution they create.

For a biomass heat-only project, a Btu-for-Btu displacement of heating fuel (based on historic purchase records) by biomass is assumed over the project's predicted operating life. CO_2 avoidance is based on the emissions profile (Lbs. CO_2 /Btu) of the displaced fuel. The US EPA calculates that 11.7 lbs. of CO_2 is produced from each therm of natural gas consumed and 1.31 pounds per kWh of electricity. In the scenario that includes all three schools (scenario 3), it is projected that the Jersey Shore Area School District can offset approximately 109,000 therms of Natural Gas and 843,600 kWh of electricity per year by replacing that heat using biomass. This is equivalent to about 1,190 tons of CO_2 annually. The market value of this type of offset is between $3/ton and $5/ton. These offsets can be negotiated as either a lump sum offset for up to 10 years or can be paid out as an annual payment. This could mean annual payments of $3,570 - $5,950 or a lump sum up front payment of as much as $59,500

There are a number of companies that are interested in contributing to the construction of new sources of clean and renewable energy through carbon offsets. Information about carbon offsets is included in the _Biomass and Green Building Resources Binder_ accompanying this report.

PERMITTING

Modern biomass boiler technology is both clean and efficient. Controls moderate both the biomass fuel and air to create either a small hot fire or a large hot fire depending on heat demand from the building. Under full load, modern woodchip boilers routinely operate at steady state efficiencies of 70% – 75%. Operating temperatures in commercial scale biomass boilers can reach up to 2,000 degrees and more, completely eliminating creosote and the need to clean stacks. The amount of ash produced from a 25 ton tractor trailer load of green hardwood chips can fit in a 25 gallon trash can, is not considered a hazardous waste and can be used as a soil amendment on lawns, gardens and playing fields.

However, as with any combustion process, there are emissions from biomass boilers. There is no question that natural gas is the cleanest fuel used for heating. However, biomass compares favorably with fuel oil and modern commercial scale biomass boilers with the appropriate pollution control devices can burn very cleanly and efficiently.

Table 9: Comparison of Boiler Emissions Fired by Wood, Distillate Oil, Natural Gas and Propane[4]

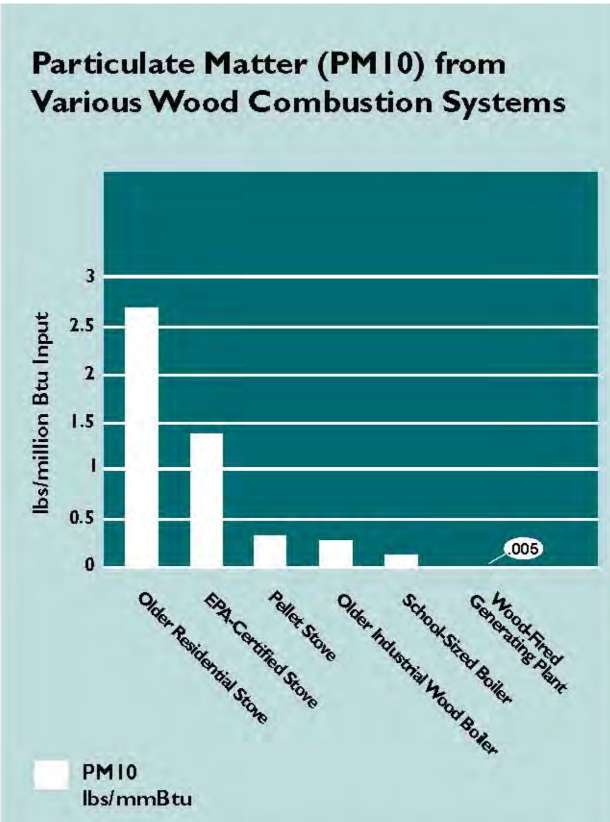
(Pounds per million Btu output)				
	Wood	Distillate Oil	Natural Gas	Propane
PM_{10}	0.1000	0.0140	0.007	0.004
NO_X	0.1650	0.1430	0.09	0.154
CO	0.7300	0.0350	0.08	0.021
SO_2	0.0082	0.5000	0.0005	0.016
TOC	0.0242	0.0039	0.01	0.005
CO_2	gross 220 (net 0)	159	118	137

The pollutant of greatest concern with biomass is particulates (PM_{10}). Biomass boilers clearly generate more particulates than fuel oil or gas boilers. That is why it is important to install appropriate pollution control equipment. Many modern types of emission control equipment, capable of reducing particulate matter emissions from 50-99 percent, are commercially available in the US. The most common emission control equipment technologies are baghouses, cyclones, multi-cyclones, electrostatic precipitators, and wet scrubbers. Appropriate emission control equipment technologies should be identified in consultation with local air quality regulators. The emissions from a modern woodchip boiler are much less than most people think.

[4] Data excerpted from the paper *An Evaluation of Air Pollution Control Technologies for Small Wood-Fired Boilers* prepared by Resource Systems Group, Inc. White River Jct., VT, for the New York Department of Public Service and others, Revised September 2001.

One of the most common misconceptions about institutional/commercial biomass energy systems comes from the experience people have with residential wood stoves and outdoor wood boilers. In general, an institutional/commercial-scale wood energy system emits only one fifteenth (seven percent) the PM_{10} of the average wood stove on a Btu basis. Over the course of a year, a large, woodchip heated school in a climate like Vermont may have the same particulate emissions as four or five houses heated with wood stoves.

Figure 8: Particulate Emissions[5]



This chart shows the PM10 emission rates for the same energy input comparing a number of wood-energy technologies, ranging from common wood stoves to a clean-burning wood-fired power plant. In general, a school wood-energy system emits only 1/15 (7%) the PM10 of the average wood stove in use today for the same level of fuel energy input. Over the course of a year, a large, wood-heated high school (150-200,000 square feet) may have the same particulate emissions as four or five houses heated with wood stoves.

New EPA Regulations

On February 21, 2011, the Environmental Protection Agency (EPA) issued a final rule that will reduce emissions of toxic air pollutants (including mercury, metals and organic air toxics, including dioxins) from existing and new industrial, commercial and institutional boilers. For area source boilers (those that emit less than 10 tons per year (tpy) of any single air toxic or less than 25 tpy of any combination of air toxics) the EPA is issuing regulations based on boiler design. Biomass boilers with heat input equal to or greater than 10 million Btu per hour must meet emission limits for particulate matter (PM) only. Biomass boilers with heat input less than 10 million Btu must perform a boiler tune-up every two years.

The EPA has also issued regulations based on boiler size for major source facilities (those that emit or has the potential to emit 10 or more tpy of any single air toxic or 25 tpy or more of any combination of air toxics). For large boilers, those with a heat input capacity equal to, or greater than, 10 mmBtu/hr, the EPA establishes numeric emission limits for mercury, dioxin, particulate matter, hydrogen chloride and carbon monoxide. In addition, the EPA will require monitoring to assure the boiler and pollution controls

[5] Excerpted from Air Emissions From Modern Wood Energy Systems, Biomass Energy Resource Center.

are operating properly and compliant with emission requirements. For all new biomass boilers at major source facilities with a heat capacity of less than 10 mmBtu/hr, the EPA has established a "work practice rule" instead of numeric emission limits.

The boilers analyzed in this report are smaller than 10 million Btu – under the new regulations Jersey Shore would be required to perform a boiler tune-up every two years on the biomass boiler. The EPA requires an *Area Source Notification Form* for new boilers 120 days after the startup of the new boiler. To access the notification form with instructions, go to: www.epa.gov/ttn/atw/boiler/area_**initial_notification**.doc.
Up-to-date information on EPA emission requirements is available at:
www.epa.gov/airquality/combustion/

In order to install a new woodchip boiler, it is often necessary to obtain an air quality permit or an amendment to an existing permit. For a woodchip boiler, the permit would likely include requirements for pollution control equipment along with a requirement for a tall stack to help with dispersion. Costs for pollution control equipment are included in the cost estimates for all of the woodchip scenarios analyzed in this report. Other permit conditions might include testing for emissions and efficiency, keeping records of fuel consumption and test results and making periodic submittals to regulatory agencies.

CONCLUSIONS AND RECOMMENDATIONS

Regardless of whether or not Jersey Shore Area School District moves forward with a biomass project, we recommend the District consider the following:

1. The District should replace the aging electric heating system at the Elementary School with a hot water boiler and hydronic heating distribution system. The existing system is reaching the end of its useful life and electricity is the most expensive fuel for heating by far. A new hydronic heating system will serve this school well for many, many years and likely pay for itself in fuel cost savings no matter what fuel is used for the boilers.
2. In order to effectively measure progress toward energy efficiency goals historical energy consumption data should be collected and updated frequently. There are many tools to help the District accomplish this. 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. This software can be downloaded at:
   http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager
3. The District should also consider the addition of solar hot water generation sized to heat the swimming pool during the summer months at the time of the boiler upgrade. Solar hot water is one of the most cost effective renewable energy technologies, particularly for facilities with a substantial summer heat load such as a heated swimming pool.

If the District does decide to move forward with a biomass project we also recommend taking the following steps:

1. Hire an engineering firm to help refine the project concept and to obtain firm local estimates on project costs. The US Forest Service may be able to provide some technical assistance from an engineering team with biomass experience. If the District moves forward with this project, they should contact Lew McCreery, the US Forest Service Biomass Coordinator for the Northeastern Area to see what assistance can be provided. Contact Lew at (304)285-1538 or lmccreery@fs.fed.us
2. The District should identify any heating system improvements it plans to undertake and include those projects with the biomass project. It is more cost effective to implement boiler room upgrades and heating distribution improvements at the same time a new boiler system is installed.
3. Concurrent with the design of the project, the District should cultivate potential biomass fuel suppliers. District staff should work with Mike Palko, Biomass Energy Specialist with the PA DCNR Bureau of Forestry, to identify potential Pennsylvani woodchip suppliers. Mike can be reached at (570)326-6020 or mipalko@state.pa.us.

WHO WE ARE

Yellow Wood Associates

Yellow Wood Associates (Yellow Wood) is a woman-owned small business specializing in rural community economic development since 1985. Yellow Wood has experience in green infrastructure, program evaluation, business development, market research, business plans, feasibility studies, and strategic planning for rural communities. Yellow Wood provides a range of services that include measurement training, facilitation, research, and program management.

Richmond Energy Associates

Richmond Energy Associates was created in 1997 to provide consulting services to business and organizations on energy efficiency and renewable energy program design and implementation. Richmond Energy has extensive experience in wood energy systems. Jeff Forward provides analysis and project management on specific biomass projects and works with state, regional and federal agencies to develop initiatives to promote biomass utilization around the country. In addition to his own consulting business, he is also a Senior Associate with Yellow Wood.

APPENDICES

SENSITIVITY ANALYSIS

Table 10 is a sensitivity analysis comparing annual fuel savings from the installation of a woodchip heating system for the Elementary School, Middle School / Junior High and High School based on varying prices for wood and natural gas. In this analysis the assumed loan interest rate of 4% and the inflation rates outlined in the assumptions are held constant. For example, if the price of Natural Gas goes up to $15 a dekatherm, and woodchip prices stay at $40 per ton, the District could save $183,213

Table 10: Annual Fuel Savings for Scenario 3 When Wood and Natural Gas Prices Vary

Woodchip $/ton	Natural Gas $/Dth			
	$5.00	**$10.00**	**$15.00**	**$20.00**
$35	$82,947	$137,045	$191,143	$245,241
$40	$75,016	$129,115	$183,213	$237,311
$45	$67,086	$121,184	$175,283	$229,381
$50	$59,156	$113,254	$167,352	$221,451
$55	$51,226	$105,324	$159,422	$213,520

Table 11 is a sensitivity analysis showing the first year cash flow and net present value (NPV) of the installation of a woodchip heating system for all three schools (biomass scenario 3) based on varying rates of grant funding. In this analysis all of the assumptions presented in Table 7 are held constant. For example, if the Jersey School Area School District were able to get $500,000 in grant funding for the biomass project, the first year cash flow would be negative $52,818 and the 30 year NPV would rise to $969,281 (the annual fuel savings would be unchanged).

Table 11: 30-Year Net Present Value (NPV) for Scenario 3 when Grant Funding is available

	Project Costs (Capital – Grant)	1st Year Cash Flow	30-Year NPV
No grant funding	$2,459,706	($97,818)	$469,281
$250,000 grant	$2,209,706	($75,318)	$719,281
$500,000 Grant	$1,959,706	($52,818)	$969,281
$750,000 Grant	$1,709,706	($30,318)	$1,219,281
$1,000,000 Grant	$1,459,706	($7,818)	$1,469,281

JERSEY SHORE FUEL HISTORY

The tables below summarize fuel history provided by the Jersey Shore Area School District as part of the application for a biomass pre-feasibility study.

Table 12: Electricity Usage for Heat – Elementary School

	2010-2011		2009-2010		2008-2009	
	kWh	$	kWh	$	kWh	$
Jul	25,200	$3,182	27,600	$2,598	28,800	$2,634
Aug	23,400	$2,628	22,800	$1,944	22,200	$2,162
Sep	28,800	$4,042	31,200	$2,901	32,400	$2,914
Oct	40,800	$5,060	43,200	$3,828	39,000	$3,403
Nov	58,200	$5,758	70,800	$6,144	63,000	$5,433
Dec	85,800	$7,543	79,800	$6,755	98,400	$8,179
Jan	138,000	$12,593	127,800	$11,253	139,800	$11,410
Feb	126,000	$12,565	118,200	$10,076	135,000	$11,224
Mar	118,800	$10,452	123,000	$11,032	123,600	$10,354
Apr	97,800	$8,515	80,400	$8,202	89,400	$7,712
May	66,600	$6,417	60,000	$5,859	70,800	$6,047
Jun	43,200	$4,448	49,800	$5,321	49,800	$4,440
Total	852,600	$83,202	834,600	$75,913	892,200	$75,913

Table 13: Natural Gas Usage – Middle School / Junior High

	2010-2011				2009-2010				2008-2009			
		Cost				Cost				Cost		
	Dth	Dist.	Volume	Total	Dth	Dist.	Volume	Total	Dth	Dist.	Volume	Total
Jul	28.6	$242	$223	$464	70.4	$292	$416	$708	84.7	$316	$1,371	$1,686
Aug	35.3	$266	$214	$480	55.7	$272	$244	$516	86.4	$319	$1,062	$1,380
Sep	50.1	$285	$280	$565	73.1	$331	$323	$653	147.0	$419	$1,685	$2,104
Oct	422.1	$1,030	$2,421	$3,451	346.7	$881	$1,958	$2,839	503.0	$1,007	$5,302	$6,309
Nov	700.8	$1,642	$4,778	$6,420	668.7	$1,528	$5,465	$6,993	801.5	$1,500	$7,644	$9,144
Dec	1088.7	$2,387	$7,985	$10,372	1113.4	$2,417	$8,411	$10,828	1261.1	$2,261	$12,556	$14,817
Jan	1116.8	$2,443	$8,135	$10,578	1192.8	$2,577	$10,594	$13,171	1503.8	$2,662	$13,841	$16,503
Feb	967.7	$2,263	$7,284	$9,547	968.8	$2,128	$8,102	$10,230	1082.9	$1,966	$8,169	$10,136
Mar	859.0	$1,921	$5,936	$7,857	632.6	$1,454	$5,472	$6,926	828.1	$1,545	$5,899	$7,444
Apr	547.3	$1,384	$4,056	$5,441	321.4	$829	$2,757	$3,586	470.4	$954	$3,151	$4,105
May	119.0	$421	$886	$1,307	232.5	$649	$1,706	$2,355	248.3	$587	$1,587	$2,173
Jun	47.9	$279	$345	$624	58.1	$332	$420	$752	125.5	$383	$684	$1,067
Total	5983	$14,563	$42,544	$57,107	5734	$13,689	$45,868	$59,557	7143	$13,918	$62,951	$76,868

Table 14: Natural Gas Usage – High School

	2010-2011				2009-2010				2008-2009			
		Cost				Cost				Cost		
	Dth	Dist.	Volume	Total	Dth	Dist.	Volume	Total	Dth	Dist.	Volume	Total
Jul	15.3	$215	$119	$334	40.1	$242	$237	$479	95.8	$334	$1,550	$1,884
Aug	24.0	$242	$145	$388	39.8	$245	$174	$419	41.3	$244	$508	$752
Sep	57.9	$300	$324	$624	85.4	$355	$377	$733	86.7	$319	$994	$1,313
Oct	317.1	$821	$1,819	$2,640	599.8	$1,389	$3,387	$4,777	765.4	$743	$8,068	$8,811
Nov	655.2	$1,541	$4,468	$6,008	747.9	$1,687	$6,113	$7,800	1,363.6	$1,324	$13,005	$14,329
Dec	1,395.5	$3,008	$10,236	$13,243	1,449.5	$3,092	$10,949	$14,041	1,914.7	$1,861	$19,063	$20,924
Jan	1,363.6	$2,943	$9,933	$12,876	1,421.7	$3,036	$12,627	$15,663	2,284.4	$2,220	$21,025	$23,246
Feb	1,022.2	$2,400	$7,695	$10,095	1,217.3	$2,626	$10,180	$12,807	1,670.0	$1,623	$12,598	$14,221
Mar	697.6	$1,595	$4,821	$6,415	687.1	$1,561	$5,943	$7,504	1,309.1	$1,272	$9,326	$10,598
Apr	497.3	$1,266	$3,686	$4,952	301.7	$790	$2,587	$3,377	731.0	$711	$4,897	$5,608
May	144.4	$141	$1,075	$1,216	195.9	$577	$1,438	$2,014	265.8	$258	$1,698	$1,956
Jun	72.8	$328	$524	$852	32.8	$279	$237	$516	72.6	$71	$396	$466
Total	6,263	$14,799	$44,845	$59,643	6,819	$15,879	$54,251	$70,130	10,600	$10,981	$93,127	$104,108

DISCUSSION OF BIOMASS FUELS

Purchasing wood fuel is a different exercise than purchasing fossil fuels. While conventional fuels are delivered to the site with little interaction from facility managers, biomass fuel suppliers will need to be cultivated and educated about the type of fuel needed, its characteristics and the frequency of deliveries. Concurrently with designing a wood-energy system, Jersey Shore Area School District should also be cultivating potential biomass fuel suppliers.

Potential wood fuel suppliers include sawmills, loggers, chip brokers and large industrial users such as paper mills or power plants. Many of these forest products producers already make woodchips for pulp and to reduce waste, but may not have much experience dealing with the needs of smaller volume customers. Woodchips produced for institutional/commercial biomass boilers have more stringent specifications than those produced for large industrial customers. And woodchip fuel may need to be delivered in different trailers.

When talking to potential woodchip fuel suppliers, it is important to have the wood fuel specification in mind. A one to three inch square chip is ideal. If possible, woodchips for institutional/commercial biomass systems will come from logs that are debarked prior to chipping because bark produces more ash which translates into a little more daily maintenance. Pieces or small branches that are six inches or longer can jam augers and conveyors which will interrupt the operation of automated fuel handling equipment. Institutional/commercial scale biomass boiler systems in the Northeast are typically designed to operate with wood fuel that is within a 35% to 45% range for moisture content.

Typically institutional/commercial biomass systems of this scale have limited chip storage capacity which means they may need deliveries on relatively short notice. Woodchip fuel suppliers will need to be within a 100 to 150 mile radius or so of the user, the closer the better, as transportation costs will affect price. Chip deliveries are typically made in "live bottom" trailers that will self unload into below-grade chip storage bins. Therefore, potential suppliers must have access to a self-unloading trailer for deliveries.

It is possible to design a wood-energy system that uses any one of a variety of biomass fuels, but green hardwood chips make the best fuel. If it is readily available, it should be the fuel of choice. In addition, users should focus on reliability of supply and consistency of the fuel rather than just lowest cost. The goal should be to minimize maintenance and optimize system performance.

Whichever fuel is used, the fuel type needs to be part of the combustion system design process, and the wood system should be operated using the fuel it is set up to use. Ideally, sample fuel chips should be sent to the manufacturer of the biomass heating equipment so that they can design the fuel handling equipment around the type of fuel and calibrate the system properly when setting the system up. No system handles widely varying fuel types at the same time very well. A system can be re-calibrated for a different fuel type, but the most practical approach is to stick with one fuel type, at least for a given heating season. If, for some reason, that fuel type becomes unavailable, the manufacturer of the equipment should be consulted to help reconfigure or retune the system for another fuel.

It is best to try to locate several potential suppliers. By doing so, Jersey Shore will have the security of knowing there will be back-up in case of an interruption from their primary supplier. This will also generate some competition. Contact Mike Palko, Biomass Energy Specialist for a list of local suppliers.

Michael T. Palko, Biomass Energy Specialist
PA Department of Conservation & Natural Resources
Bureau of Forestry
330 Pine Street, Suite 200
Williamsport, PA 17701
Phone: 570.326.6020
Fax: 570.322.2914
E-mail: mipalko@state.pa.us

The bottom line is that both Jersey Shore and fuel suppliers need to clearly understand the characteristics of fuel needed for their particular system. Consistent particle size and moisture content is particularly important for institutional/commercial customers, and Jersey Shore should insist on the quality of the chip. A sample fuel specification is included in the *Biomass and Green Building Resources Binder* to give an idea of the types of characteristics to look for in woodchip fuel. Below is a description of the advantages and disadvantages of different types of biomass fuels in order of preference.

Green Hardwood Chips

A consistent green hardwood chip is the easiest fuel for institutional/commercial scale automated biomass heating systems to handle. Rarely will they jam an auger or conveyor. Green chips burn somewhat cooler than most other biomass fuels making it easier to control the combustion. With proper controls, they burn very cleanly with minimal particulate emissions and little ash. They have less dust than other biomass fuels so they are less messy and safer to handle. Ideally moisture content will be between 35% and 45% on a wet basis. Green hardwood chips can come from sawmill residues or timber harvest operations.

Mill Residues vs. Harvest Residues

Woodchips can be produced at sawmills or other primary wood products industrial sites as part of their waste wood disposal process. Mill residues are typically the most desirable source of fuel woodchips. Mills can produce a bark-free chip with few long pieces or branches that can jam augers and fuel conveyors. A mill supplier can easily calculate trucking costs and can negotiate dependable delivery at a consistent price.

Another potential type of wood fuel is whole tree chips which are produced as part of tree harvesting. Whole tree chips tend to be a dirtier fuel than sawmill residues and may contain small branches, bark, twigs and leaves. The longer pieces can jam the relatively small augers of an institutional/commercial scale biomass system and can add to the daily maintenance because they produce more ash.

The bole of a tree is the de-limbed trunk or stem. Chips made from boles are in-between the quality of a sawmill chip and a whole tree chip. Bole-tree chips tend to have fewer twigs and long stringers than whole tree chips. Both bole-chips and whole-tree chips can be potentially good sources for biomass fuels, although they have a greater likelihood of including oversized chips and they will produce somewhat more ash, compared to mill residues.

Softwood Chips

Green softwood chips will generally have less energy and more water content per truckload, and therefore they will be more expensive to transport than hardwood chips. As long as the combustion and fuel handling equipment is properly calibrated for softwood chips, an automated woodchip heating system can operate satisfactorily with softwood chips. Softwoods tend to have higher moisture contents and can range up to 60% moisture on a wet basis. The best biomass fuel will have less than 50% moisture. One species to avoid altogether is white pine. It has a very high moisture content and therefore relatively low bulk density. The experience in Vermont schools with white pine is that it is a poor biomass fuel for institutional/commercial-scale woodchip systems.

Dry Chips vs. Green Chips

Dry chips (less than 20% moisture on a wet basis) burn considerably hotter than green chips and typically have more dust. The increased operating temperature can deteriorate furnace refractory faster increasing maintenance costs slightly. The dust can make for a somewhat dirtier boiler room which will be a problem for some maintenance staff. Dry chips are also easier to accidentally ignite in the fuel storage bin or fuel handling system. If dry chips are used, the combustion equipment needs to be carefully calibrated to handle these higher temperatures. Dry chips are not generally recommended for institutional/commercial settings.

Bark

Bark has a high energy value, but it also comes with significant maintenance costs. It produces a considerable amount of ash that needs disposal; it can create more smoke than green chips; and it can cause other routine maintenance problems such as frequent jamming of augers from rocks. Bark can be an inexpensive fuel, but the additional maintenance costs make it unattractive for institutional/commercial biomass systems.

Sawdust and Shavings

Sawdust and shavings should ordinarily be ruled out for the institutional/commercial wood heating market. Dry sawdust can be dusty to handle and raises fire safety and explosion issues. Shavings are also dusty and easily ignited and are difficult to handle with typical fuel handling equipment. This fuel type can work fine in an industrial setting, but institutions typically do not have the maintenance staff that can provide the supervision that these fuels need.

Ground or "Hog" Fuel

Ground or "Hog" fuel is common in the logging industry. It is typically made by grinding any manner of woody material by using a "tub grinder". Hog fuel does not typically make good wood fuel for institutional scale biomass energy systems. The fuel is "dirty" meaning there are many contaminants such as bark, dirt, gravel and foreign objects. The material is typically rough and is irregularly shaped making it difficult to handle in the relatively small augers and conveyors of institutional scale wood fuel handling equipment. Additionally, since the fuel might come from a variety of sources, hog fuel can have a wider range of moisture content than wood chip fuel. Hog fuel can work well in industrial biomass energy systems, but institutions typically do not have the maintenance staff that can deal with these kinds of fuels.

BIOMASS AND GREEN BUILDING RESOURCES BINDER

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WERC

Wood Education and Resource Center

The Wood Education and Resource Center is located in Princeton, W.Va., and administered by the Northeastern Area State and Private Forestry unit of the U.S. Department of Agriculture Forest Service. The Center's mission is to work with the forest products industry toward sustainable forest products production for the eastern hardwood forest region. It provides state-of-the-art training, technology transfer, networking opportunities, applied research, and information. Visit www.na.fs.fed.us/werc for more information about the Center.