U.S. Department of Agriculture
Northeastern Area
State and Private Forestry

WERC
Wood Education and Resource Center
310 Hardwood Lane
Princeton, WV 24740
304-487-1510
www.na.fs.fed.us/werc

Preliminary Feasibility Report

Biomass Heating Analysis for Southern Fulton Elementary School

Warfordsburg, Pennsylvania

December 2011

Prepared by:
YELLOW WOOD associates, inc.
228 North Main Street
St. Albans, VT 05478
Phone: (802)524-6141
www.yellowwood.org

Richmond Energy Associates, LLC
2899 Hinesburg Road
Richmond, VT 05477
Phone: (802) 434-3770

TABLE OF CONTENTS

EXECUTIVE SUMMARY **1**
INTRODUCTION **4**
ANALYSIS ASSUMPTIONS **5**
DESCRIPTION OF THE EXISTING HEATING SYSTEMS 5
LIFE CYCLE COST METHODOLOGY 5
FUEL OIL COST ASSUMPTIONS 6
WOODCHIP FUEL COST ASSUMPTIONS 7
WOOD PELLET FUEL COST ASSUMPTIONS 7
INFLATION ASSUMPTIONS 7
OPERATION AND MAINTENANCE ASSUMPTIONS 9
FINANCING ASSUMPTIONS 10
BIOMASS SCENARIO ANALYSIS **11**
BIOMASS PELLET SCENARIO 12
BIOMASS WOODCHIP SCENARIO 16
ADDITIONAL ISSUES TO CONSIDER **20**
ENERGY MANAGEMENT 20
ENERGY EFFICIENCY 20
COMMISSIONING 20
SEMI-AUTOMATED SYSTEMS 21
PROJECT FUNDING POSSIBILITIES **23**
PENNSYLVANIA ALTERNATIVE AND CLEAN ENERGY PROGRAM 23
WEST PENN POWER SUSTAINABLE ENERGY FUND 23
PENNSYLVANIA ENERGY DEVELOPMENT AUTHORITY (PEDA) GRANTS 23
PENNSYLVANIA GREEN ENERGY LOAN FUND (GELF) 24
WOODY BIOMASS UTILIZATION GRANT PROGRAM 24
USDA FUNDING OPPORTUNITIES 24
CARBON OFFSETS 25
PERMITTING **27**
CONCLUSIONS AND RECOMMENDATIONS **30**
APPENDICES **33**
PELLET SENSITIVITY ANALYSIS 33
WOODCHIP SENSITIVITY ANALYSIS 34
SOUTHERN FULTON ELEMENTARY SCHOOL FUEL HISTORY 36
WOOD PELLET FUEL 37
WOODCHIP FUEL 39
BIOMASS AND GREEN BUILDING RESOURCES BINDER 43

LIST OF FIGURES

Figure 1: Fuel Oil, Woodchip and Pellet Fuel Annual Cost Comparison ... 2
Figure 2: Average Annual Fuel Oil Usage ... 5
Figure 3: Woodchip and Pennsylvania Fossil Fuel Inflation ... 8
Figure 4: Site Plan ... 11
Figure 5: Annual Cash Flow Graph for Pellet Scenario ... 14
Figure 6: Underground Insulated Piping ... 16
Figure 7: Annual Cash Flow Graph for Woodchip Scenario ... 18
Figure 8: Schematic Floorplan of a Semi-Automated Biomass Boiler House ... 21
Figure 9: Carbon Cycle Illustration ... 25
Figure 10: Particulate Emissions ... 28
Figure 11: Typical Bulk Pellet Fuel Storage and Delivery ... 37
Figure 12: PA Pellet Manufacturers providing bulk delivery ... 38

List of Tables

Table 1: Pellet Scenario Analysis Assumptions ... 13
Table 2: 30-Year Life Cycle Analysis Spreadsheet for Pellet Scenario ... 15
Table 3: Woodchip Scenario Analysis Assumptions ... 17
Table 4: 30-Year Life Cycle Analysis Spreadsheet for woodchip Scenario ... 19
Table 5: Characteristics of Semi-Automated Woodchip Heating Systems ... 22
Table 6: Comparison of Boiler Emissions Fired by Wood, Distillate Oil, Natural Gas and Propane ... 27
Table 7: Annual Fuel Savings When Pellet and Fuel Oil Prices Vary ... 33
Table 8: 30-Year Net Present Value (NPV) when Interest and Fuel Oil Inflation Vary ... 33
Table 9: 30-Year Net Present Value (NPV) when Grant Funding is available ... 34
Table 10: Annual Fuel Savings When Woodchip and Fuel Oil Prices Vary ... 34
Table 11: 30-Year Net Present Value (NPV) when Interest and Fuel Oil Inflation Vary ... 35
Table 12: 30-Year Net Present Value (NPV) when Grant Funding is available ... 35
Table 13: Fuel Oil Usage 2008 - 2011 ... 36

EXECUTIVE SUMMARY

The Southern Fulton Elementary School serves approximately 500 students in grades K-6. The 80,000 square foot facility is heated primarily with two hot water boilers that run on fuel oil. The Southern Fulton School District is currently going through the Planning and Construction (PlanCon) process and is working with an architect on their capital plan. This is an ideal time to consider converting to a biomass heating system and the architect is supportive of a biomass heating project.

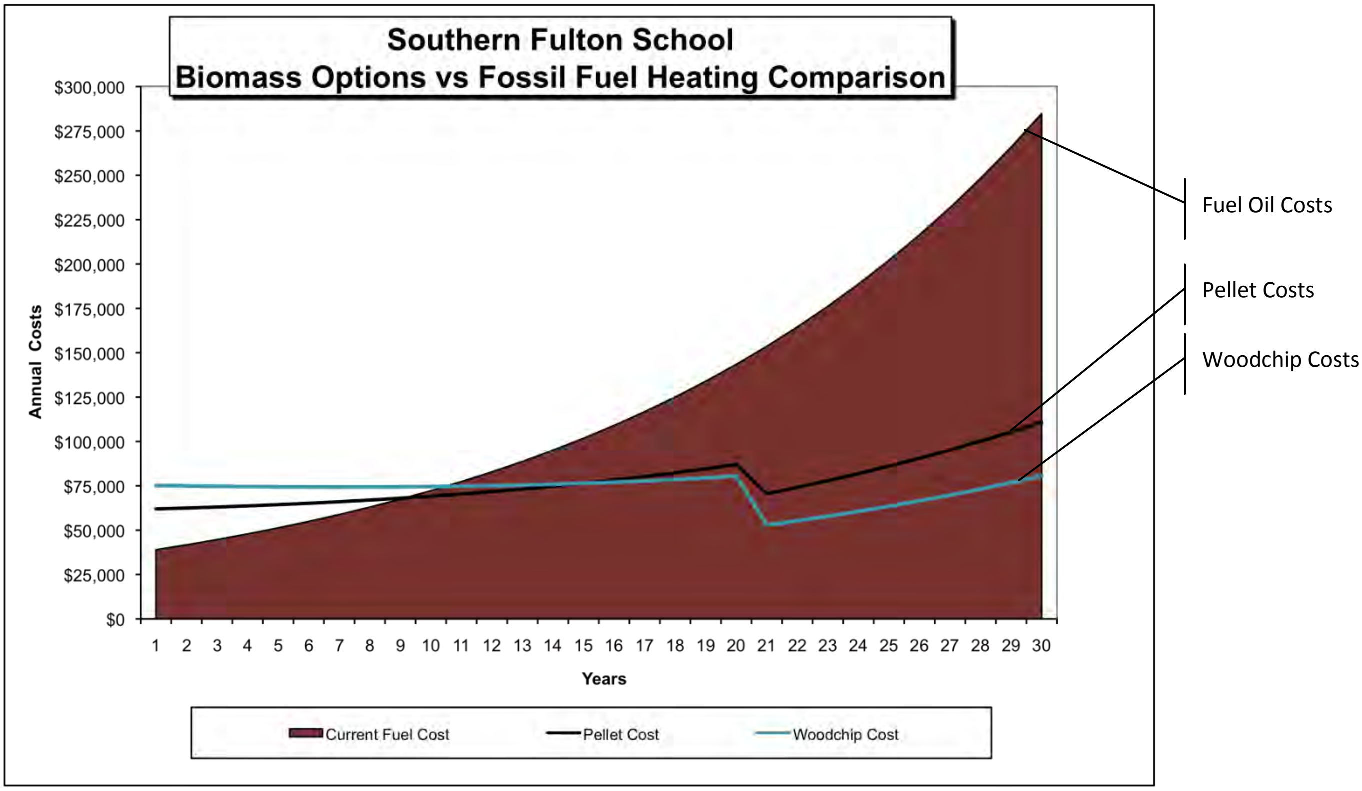
The School currently uses approximately 14,000 gallons of fuel oil each year. The average price paid by the School over the past three years was $2.65 per gallon. At that price Southern Fulton will spend approximately $37,300 on fuel oil this coming year.

This study analyzes two different biomass scenarios for heating the Southern Fulton Elementary School. One scenario analyzes the installation of a wood pellet boiler while the other scenario analyzes the installation of a semi-automated woodchip system. Both analyses show moderate savings with a fairly long payback period and modest return on investment. The wood pellet scenario requires less of a capital investment but provides smaller annual fuel savings, while a woodchip system provides higher annual fuel savings and requires a larger capital expenditure. For Southern Fulton the analysis shows savings of just over $500,000 for either a pellet system or a woodchip system, in operating costs over 30 years in today's dollars even when the cost of financing is included.

The analysis shows that Southern Fulton Elementary School would need to spend approximately $390,000 for a pellet system and the required infrastructure (versus $575,000 for a woodchip system) and the School would save $14,500 on fuel in the first year with a pellet system versus $25,500 with a woodchip system.

The Chart below compares annual heating costs over the next 30 years for Southern Fulton Elementary School with the existing heating system, a wood pellet system and a semi-automated woodchip system. As you can see, the analysis predicts that both biomass systems will provide savings over the existing fuel oil system. The pellet and woodchip systems have similar annual costs because the larger fuel savings provided by the woodchip system are partly consumed by the debt of the capital expenditure.

Figure 1: Fuel Oil, Woodchip and Pellet Fuel Annual Cost Comparison



We recommend further investigation of a biomass project if Southern Fulton Elementary School is able to obtain funding through the PlanCon process or other grant opportunities. If Southern Fulton moves forward with a biomass project we recommend the School take the following steps to investigate this opportunity further.

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 School decides to move forward with a biomass project, decision-makers 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 School should consider a biomass project as part of the PlanCon process and speak with their PlanCon architect about the addition of a biomass project to current plans. In addition, the School should identify any additional heating system improvements it plans to undertake at this facility and consider including those projects with the biomass project. It will be more cost effective to implement boiler room upgrades and heating distribution improvements at the same time a new boiler system is installed than it would be to postpone those improvements for a later time.

3. The School should consider 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. This should be done regardless of whether or not the School moves ahead with a biomass project at this time. Information on energy efficiency programs and incentives are included in the *Biomass and Green Building Resources* binder accompanying this report. At minimum the School should replace all T-12 light fixtures with higher efficiency fixtures.

4. 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 School 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

5. The School should consider managing the 100 acre site for stand improvement that could supply some woodchip fuel and/or timber sales in the future. The School should contact Mike Palko, Biomass Energy Specialist with the PA DCNR Bureau of Forestry, to schedule a time for a service forester to visit the site and provide a forest management plan.
   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@pa.gov
   www.dcnr.state.pa.us

6. The School should also work with Mike Palko to cultivate other potential biomass fuel suppliers concurrent with the design of the biomass system.

This preliminary feasibility study was prepared by Yellow Wood Associates in collaboration with Richmond Energy Associates for Southern Fulton Elementary School. 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 District'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 Southern Fulton Elementary School outlining whether or not a biomass heating project makes sense for this facility from a practical perspective. In June, staff from Yellow Wood Associates traveled to Warfordsburg to tour the Southern Fulton Elementary School. This assessment 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.

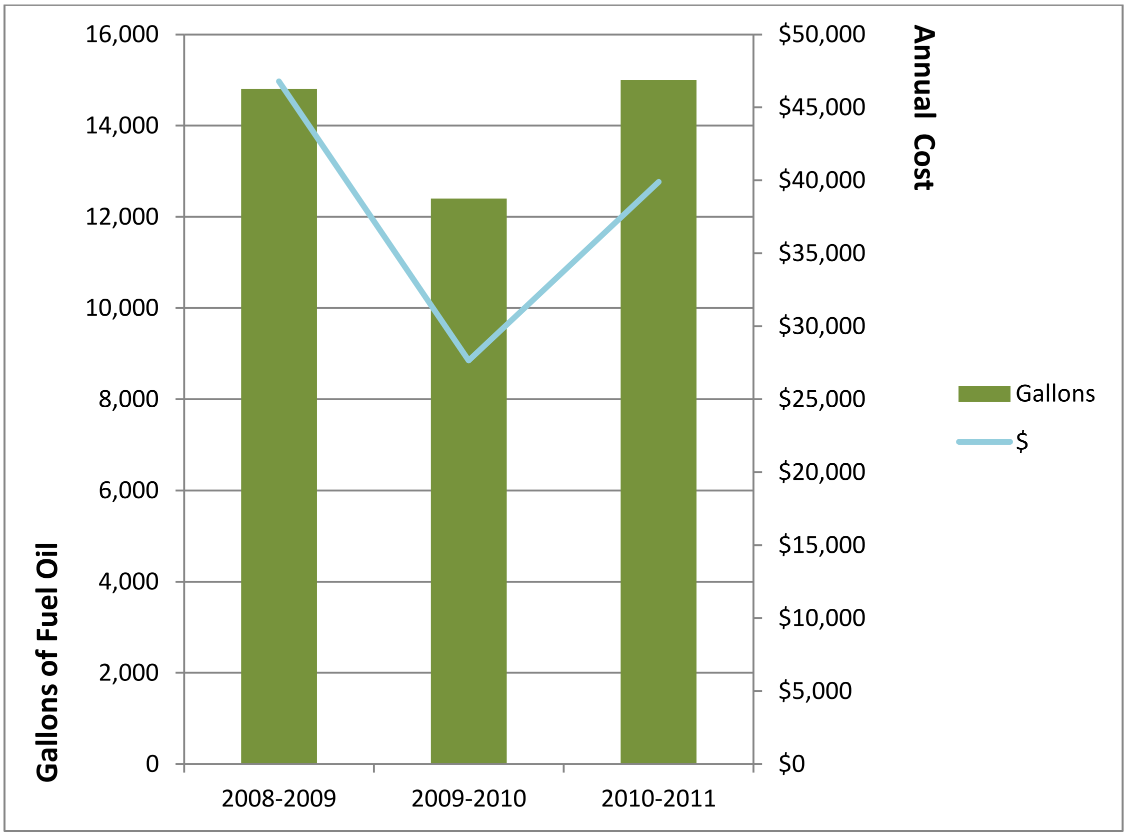
This preliminary feasibility study was prepared by Yellow Wood Associates and Richmond Energy Associates, LLC.

ANALYSIS ASSUMPTIONS

DESCRIPTION OF THE EXISTING HEATING SYSTEMS

The Southern Fulton Elementary School is currently served by two 2898 MBH hot water boilers that were installed in 1993. The boilers are in good condition and are well maintained.

Figure 2: Average Annual Fuel Oil Usage



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 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 biomass heating system that would serve the Southern Fulton Elementary School. The scenarios include all ancillary equipment and interconnection costs. Under the biomass scenarios, the 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.

The analyses project current and future annual heating bills and compare 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 heating system. It is recommended that for a project of this scale, the School 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 scenarios are generic estimates based on our experience with similar scale projects.

FUEL OIL COST ASSUMPTIONS

During the past three years the School used an average of 14,067 gallons of fuel oil to heat the school. The total of 14,067 gallons was the assumed annual fuel consumption used for the base case in the analysis. The average price paid for fuel oil over the past three years was $2.65 per gallon according to School records. As fuel oil prices are rising at an average of 7.1% annually, the analyses in this report use the most recent price paid by Southern Fulton, $2.77 per gallon, as the base price. At that price, Southern Fulton will spend close to $39,000 to heat the elementary school next 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 45 schools that heat with wood, the average annual wood utilization is about 85%. The woodchip analysis in this report estimates 85% utilization.

After consulting with woodchip suppliers in the region, we are projecting a first year cost of $40 per ton for woodchips which is equivalent to about $0.60 per gallon of fuel oil. The remaining 15% of the heating needs were then assumed to be provided by the existing fuel oil boilers consuming about 2,110 gallons of fuel oil. The cost for supplemental fuel oil is then adjusted for inflation each year over the 30-year horizon.

WOOD PELLET FUEL COST ASSUMPTIONS

Pellet fuel is a manufactured product that competes directly with fossil fuels. Consequently pellet fuel prices track more closely to fossil fuels than other biomass fuel. Pellets prices also fluctuate more dramatically than woodchip prices. However, pellets are still a relatively local product so they won't likely have the same geopolitical pressures as fossil fuels. After consulting with several pellet manufacturers in Pennsylvania, we are projecting a first year cost of $185 per ton for pellets, which is equivalent to about $1.56 per gallon for fuel oil.

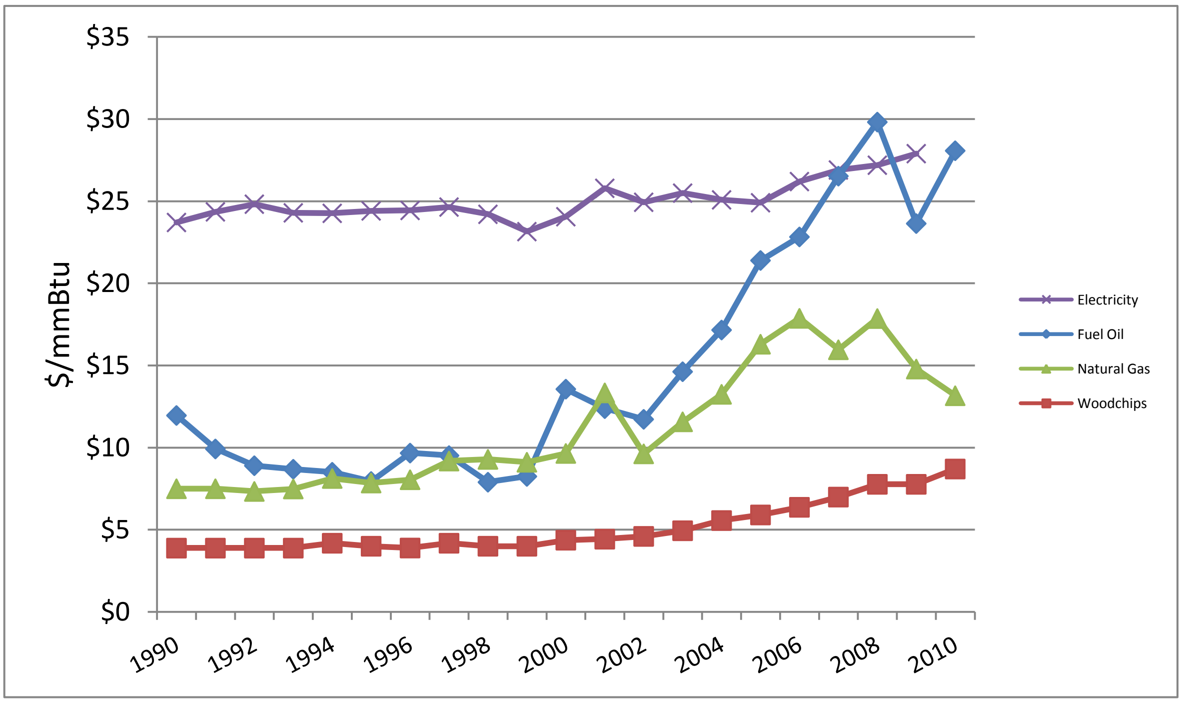
The pellet scenario assumes the facility will meet 85% of its winter heating needs with pellets and therefore consume 100 tons of pellets per year at $185 per ton in the first year. The remaining 15% of the heating needs were then assumed to be provided by fuel oil, consuming about 2,110 gallons of fuel oil per year. The costs for supplemental fuel oil and pellets are then adjusted for inflation each year over the thirty-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 fuel oil in Pennsylvania was 7.1% per year. The analysis projects this average inflation rate for fuel oil forward over the thirty-year analysis period. Southern Fulton's fuel rate of $2.77 per gallon was used for the first year of the analysis and then inflated each year at 7.1%.

Figure 3: Woodchip and Pennsylvania Fossil Fuel Inflation



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.

---

[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.

There is not good historical data on pellet prices. Anecdotal evidence suggests that pellet prices are more volatile than woodchips, but less so than fossil fuels. For the purposes of this analysis, it was assumed that pellet fuel will inflate at a higher rate than general inflation and less than the projected inflation rate for propane. A pellet fuel price inflation rate of 4.25% is halfway between the twenty year average Consumer Price Index and the twenty year average fuel oil price inflation. A 4.25% annual inflation rate was applied to all future pellet fuel costs in the pellet analysis.

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 semi-automated woodchip heating systems of this size to spend up to one hour per day to load fuel, clean ashes[2] 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 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 $4,250 annually. An additional $4,125 in annual operational costs is assumed for electricity to run pumps and motors.

Pellet boilers require very little maintenance in comparison to woodchip boilers. For the pellet scenario, it was assumed that existing on-site staff would spend on average approximately one hour per week in addition to their current boiler maintenance for 30 weeks per year and 10 hours during the summer months for routine maintenance. At a loaded labor rate of $25/hr this equals $1,000 annually. An additional $1,000 in annual operational costs is assumed for electricity to run pumps and motors.

Another operations and maintenance cost that is included in both 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. Analysis for the woodchip scenario included $15,000 of scheduled maintenance anticipated in years 10, 20 and 30 and then annualized at $1,500 per year to simulate a sinking fund for major repairs. The $1,500 annual payments were inflated at the general annual inflation rate. Pellet boiler systems have fewer moving parts and should not require as much

[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 by on-site maintenance staff.

scheduled maintenance as a woodchip system. An annualized maintenance cost of $1,000 per year was included in the pellet scenario analysis and then inflated at the general 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 fuel oil boilers were taken into consideration as these are considered costs that the School would have paid anyway. It was assumed that all costs for the operation and maintenance of a biomass boiler are incremental additional costs.

FINANCING ASSUMPTIONS

Financing costs were included in the analyses to give facility decision makers a sense of how a biomass project may impact their annual budget. This analysis assumes that the School will finance the entire cost of the biomass project with a low interest 4% bond. At this time the analysis does not take into account any potential tax credits, 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.

A sensitivity analysis is included in the appendices to this report that show the relative life cycle cost savings under various financing scenarios. If the School would like to see other cash flows using different financing schemes, Yellow Wood can provide additional analysis.

BIOMASS SCENARIO ANALYSIS

Figure 4: Site Plan

This report analyzes two different biomass scenarios, the first includes a pellet boiler and the second a semi-automated woodchip boiler. It appears that Southern Fulton has enough space in the existing boiler room to accommodate a pellet boiler. The woodchip scenario requires the construction of a boiler house and chip storage building.

BIOMASS PELLET SCENARIO

The pellet scenario that was analyzed for this facility envisions adding a 1.7 mmBtu wood pellet boiler to the School's existing heating system. The boiler would be housed in the existing boiler room and a 40-ton pellet silo, for pellet storage, would be placed outside the boiler room, allowing for bulk delivery of pellets and automatic feeding of the pellet boiler. Costs for 2,000 gallons of thermal storage and an allowance for interconnecting to the existing heating distribution systems are included in the proposed capital costs. The scenario assumes the existing fuel oil boilers would remain to provide back-up heat for the shoulder seasons and supplemental heat during the coldest days of the year if necessary.

Thermal storage is included in both of 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.

The analysis of the biomass pellet scenario shows that the Southern Fulton Elementary School could save more than $500,000 in today's dollars in operating costs over the next 30 years by installing a pellet heating system, even including debt service on the cost of the system. Annual fuel savings alone are projected to be more than $14,600 per year in the first year and should increase over time as fossil fuel prices continue to climb. This project would have a positive annual cash flow within 10 years.

Table 1: Pellet Scenario Analysis Assumptions

Southern Fulton Elementary School
Pellet Scenario

Capital Cost Assumptions	
One 1.7 mmBtu pellet hot water boiler systems including installation	$200,000
40 ton pellet storage silo	$30,000
Thermal Storage 2,000 gallon	$20,000
Interconnect to existing boiler system	$25,000
GC markup at 10%	$27,500
Construction contingency at 15%	$45,375
Design at 12%	$41,745
Total estimated project costs	$389,620
Financing Costs	
Financing, annual interest rate	4.0%
Finance term (years)	20
1st full year debt service	$34,676
Fuel Cost Assumptions	
Current annual fuel oil use (gal)	14,067
Assumed fuel oil price in 1st year	$2.77
Projected annual fuel oil bill	$38,966
Percent pellet fuel utilization	85%
Assumed pellet price in 1st year (per ton)	$185
Projected 1st year pellet fuel bill	$18,451
Projected 1st year supplemental fuel oil bill	$5,845
Inflation Assumptions	
General inflation rate (twenty year average CPI)	2.7%
Fuel oil inflation rate (twenty year EIA average for Pennsylvania)	7.1%
Pellet inflation rate (estimate from 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	**3.8%**
Net 1st year fuel savings	**$14,669**
Total 30 year NPV cumulative savings	**$502,325**

Figure 5: Annual Cash Flow Graph for Pellet Scenario

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

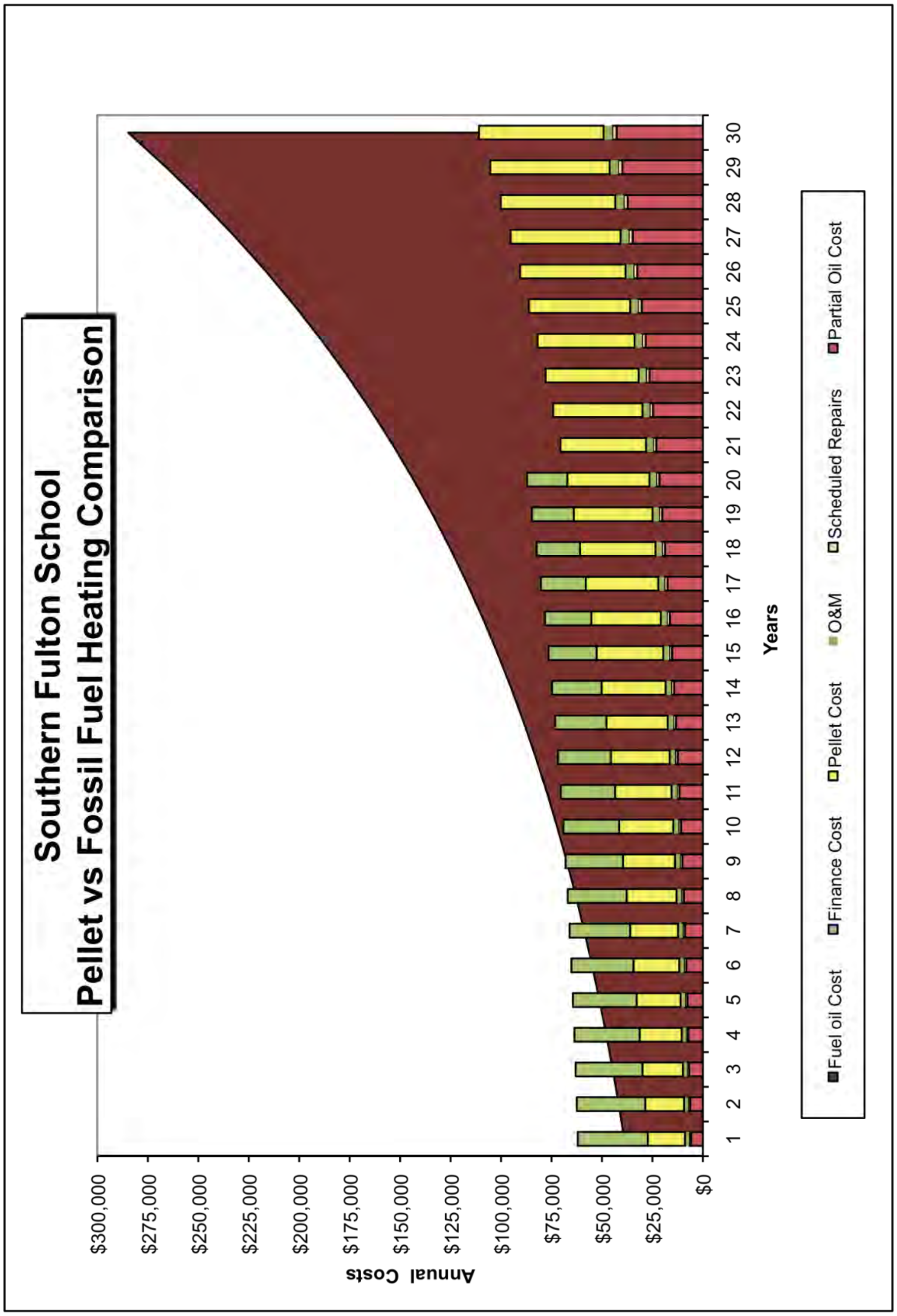


Table 2: 30-Year Life Cycle Analysis Spreadsheet for Pellet Scenario

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

Total estimated construction costs	***$389,620***			
Financing:	4.0%	*Bond interest rate*	20 Term of bond	
Oil heat consumption	14,067		15% Load covered by Fuel oil =	2,110 gallons; 120 gal. / ton of pellets
Oil heat price	$2.77			
Oil heat cost	$38,966		117 tons if 100% pellets for oil	
Estimated pellet utilization	85%			
Projected pellet consumption	100	tons		
Estimated 1st year pellet price	$185	/ ton Year 1		
Projected 1st year pellet cost	$18,451			
Projected 1st year partial fuel oil cost	$5,845			
General Inflation:	2.7%	annually	*Twenty year average annual US Labor Dept. Consumer Price Index increases*	
Oil Inflation	7.1%		*Average increase for Penmnsylvania Commercial Fuel Oil from 1990 - 2010 (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	Finance Cost For Entire Project	Pellet Cost	Partial Fuel oil Cost	O&M	Scheduled Repairs	Total Costs	Annual Cashflow	Cumulative Cashflow
1	$38,966	$34,676	$18,451	$5,845	$2,000	$1,000	$61,972	-$23,007	-$23,007
2	$41,732	$33,897	$19,236	$6,260	$2,054	$1,027	$62,473	-$20,741	-$43,748
3	$44,695	$33,118	$20,053	$6,704	$2,109	$1,055	$63,039	-$18,344	-$62,092
4	$47,868	$32,338	$20,905	$7,180	$2,166	$1,083	$63,674	-$15,805	-$77,898
5	$51,267	$31,559	$21,794	$7,690	$2,225	$1,112	$64,381	-$13,113	-$91,011
6	$54,907	$30,780	$22,720	$8,236	$2,285	$1,142	$65,164	-$10,257	-$101,268
7	$58,806	$30,001	$23,686	$8,821	$2,347	$1,173	$66,027	-$7,222	-$108,489
8	$62,981	$29,222	$24,692	$9,447	$2,410	$1,205	$66,976	-$3,995	-$112,485
9	$67,452	$28,442	$25,742	$10,118	$2,475	$1,238	$68,015	-$562	-$113,047
10	$72,241	$27,663	$26,836	$10,836	$2,542	$1,271	$69,148	$3,093	-$109,953
11	$77,371	$26,884	$27,976	$11,606	$2,611	$1,305	$70,382	$6,989	-$102,964
12	$82,864	$26,105	$29,165	$12,430	$2,681	$1,341	$71,721	$11,143	-$91,822
13	$88,747	$25,325	$30,405	$13,312	$2,753	$1,377	$73,172	$15,575	-$76,247
14	$95,048	$24,546	$31,697	$14,257	$2,828	$1,414	$74,742	$20,306	-$55,941
15	$101,797	$23,767	$33,044	$15,270	$2,904	$1,452	$76,437	$25,360	-$30,581
16	$109,024	$22,988	$34,449	$16,354	$2,983	$1,491	$78,264	$30,761	$180
17	$116,765	$22,208	$35,913	$17,515	$3,063	$1,532	$80,230	$36,535	$36,715
18	$125,055	$21,429	$37,439	$18,758	$3,146	$1,573	$82,345	$42,710	$79,425
19	$133,934	$20,650	$39,030	$20,090	$3,231	$1,615	$84,616	$49,318	$128,743
20	$143,444	$19,871	$40,689	$21,517	$3,318	$1,659	$87,053	$56,391	$185,134
21	$153,628		$42,418	$23,044	$3,408	$1,704	$70,574	$83,054	$268,188
22	$164,536		$44,221	$24,680	$3,500	$1,750	$74,151	$90,385	$358,573
23	$176,218		$46,100	$26,433	$3,594	$1,797	$77,924	$98,294	$456,867
24	$188,729		$48,060	$28,309	$3,691	$1,846	$81,906	$106,824	$563,691
25	$202,129		$50,102	$30,319	$3,791	$1,895	$86,108	$116,021	$679,712
26	$216,480		$52,231	$32,472	$3,893	$1,947	$90,543	$125,937	$805,649
27	$231,850		$54,451	$34,778	$3,998	$1,999	$95,226	$136,624	$942,273
28	$248,312		$56,765	$37,247	$4,106	$2,053	$100,171	$148,140	$1,090,413
29	$265,942		$59,178	$39,891	$4,217	$2,108	$105,395	$160,547	$1,250,960
30	$284,824		$61,693	$42,724	$4,331	$2,165	$110,913	$173,911	$1,424,871
Totals	$3,747,612	$545,468	$1,079,143	$562,142	$90,659	$45,329	$2,322,741	$1,424,871	
	30 Yr. NPV at	Discount Rate 4.0%							
	$1,776,961	$384,325	$551,229	$266,544	$48,359	$24,179	$1,274,636	$502,325	

Total Annual Heating Costs	Pellet Fuel + 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
$38,966	$24,296	$2,000	$1,000	$61,972	$14,669	$389,620	26.6	$502,325	3.8%

BIOMASS WOODCHIP SCENARIO

The second scenario analyzes the installation of a semi-automated woodchip boiler. The woodchip biomass scenario envisions building a 1,000 square foot stand-alone boiler house and chip storage facility which would house a 2.0 mmBtu semi-automated woodchip boiler, thermal storage and woodchip fuel storage. This type of system requires the operator to spend approximately one hour per day for fuel handling and basic maintenance, but requires a much lower capital cost investment than a fully automated system.

For a semi-automated woodchip system, chips are unloaded into a chip storage building at grade and then loaded into a day-bin hopper with a bucket loader. This requires more effort on the part of the operator than a fully automated system, but the building that stores the chips is considerably less expensive to build and the smaller chip handling system is also less expensive. See the section on semi-automated system in *Additional Issues to Consider* for an explanation on how this type of system works.

Figure 6: Underground Insulated Piping

Hot water from the woodchip boiler would be tied into the exiting HVAC systems via approximately 100 feet of underground insulated piping. This scenario assumes the existing fuel oil boilers would remain to provide back-up heat for the shoulder seasons and supplemental heat during the coldest days of the year if necessary.

Costs for a tall stack were included to ensure good emissions dispersal. An allowance for pollution control equipment was also included.

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

Table 3: Woodchip Scenario Analysis Assumptions

Southern Fulton Elementary School
Woodchip Scenario

Capital Cost Assumptions					
2.0 mmBtu woodchip hot water boiler system including installation					$200,000
50 ft stack					$35,000
Pollution control equipment					$50,000
Woodchip boilerhouse and chip storage building	1,000	SF	$100	/SF	$100,000
Underground insulated hot water piping from boiler house to school	100	LF	$150	/LF	$15,000
Thermal storage 2,000 gallon					$20,000
Interconnection to existing boiler rooms					$25,000
Cost of Skid Steer					$20,000
GC markup at 10%					$44,500
Construction contingency at 15%					$66,750
Design at 12%					$53,400
Total estimated project costs					$576,250
Financing Costs					
Financing, annual interest rate					4.0%
Finance term (years)					20
1st full year debt service					$51,863
Fuel Cost Assumptions					
Current annual fuel oil use (gal)					14,067
Assumed fuel oil price in 1st year					$2.77
Projected annual fuel oil bill					$38,966
Percentage of wood utilization					85%
Fuel oil (gal)/ton ratio					63
Assumed wood price in 1st year (per ton)					$40
Projected 1st year wood fuel bill					$7,629
Projected 1st year supplemental fuel oil bill					$5,845
Inflation Assumptions					
General inflation rate (twenty year average CPI)					2.7%
Fuel oil inflation rate (twenty year average EIA)					7.1%
Wood inflation rate (twenty year average extrapolated from Vermont Superintendents Assoc. data)					3.6%
O&M Assumptions					
Annual Wood O&M cost					$8,375
Major repairs (annualized)					$1,500
Savings					
Return on Investment from fuel savings					**4.4%**
Net 1st year fuel savings					**$25,492**
Total 30 year NPV cumulative savings					**$510,929**

Figure 7: Annual Cash Flow Graph for Woodchip Scenario

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

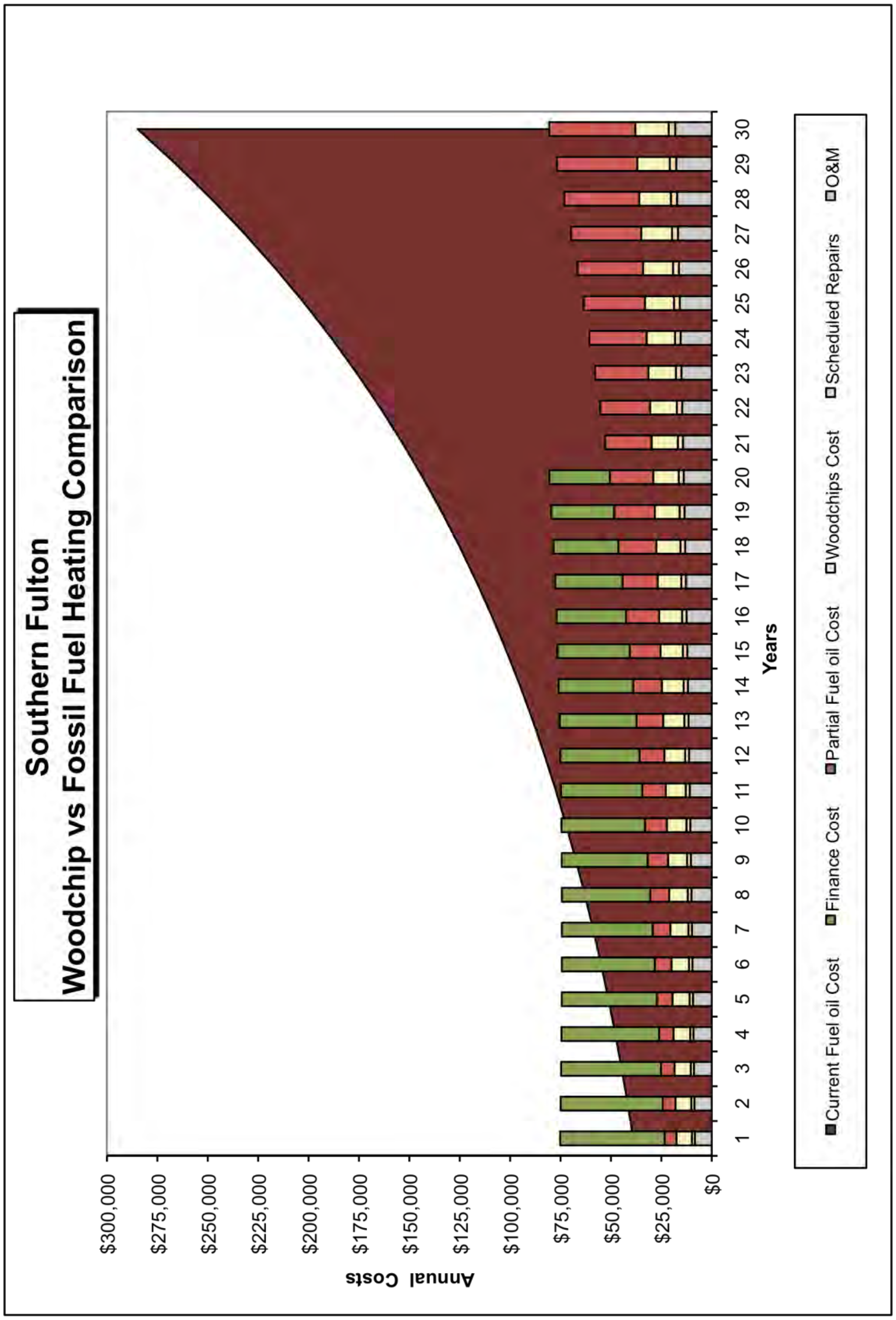


Table 4: 30-Year Life Cycle Analysis Spreadsheet for woodchip Scenario

Southern Fulton Elementary School — **Preliminary Life Cycle Cost Assessment** — ***Woodchips - Heat Only***

Total estimated construction costs	*$576,250*	*Conceptual project cost, Woodchips system, building and associated costs.*		
Financing:	4.0%	*Assumed bond interest*	20 Term of bond	
Fuel oil consumption	14,067	gallons/year	15% Load covered by Fuel ı 2,110 gallons	63 gallons/ton
Fuel oil heat price	$2.77	/gallon in year 1		
Fuel oil heat cost	$38,966		224 tons if 100% Woodchips	
Estimated Woodchips utilization	85%			
Projected Woodchips consumption	191	tons		
Estimated 1st year Woodchips price	$40.00	/ton		
Projected 1st year Woodchips cost	$7,629			
General Inflation:	2.7%	annually	*Twenty year average annual US Labor Dept. Consumer Price Index increases*	
Fuel oil inflation:	7.1%	annually	*Average increase for Penmnsylvania Commercial Fuel Oil from 1990 - 2010 (US EIA)*	
Woodchips Inflation:	3.6%	annually	*Average increase for Vermont Schools 1990 - 2010 (VSA SEMP)*	
O & M.:	$8,375	in Year 1 $	*Estimate of additional maintenance staff time*	
Major Repairs:	$1,500		*Contingency for major repair (e.g. refractory replacement) at Years 10 and 20 annualized*	

Yr.	Current Fuel oil Cost	Finance Cost For Entire Project	Woodchips Cost	Partial Fuel oil Cost	O&M	Scheduled Repairs	Total Costs	Annual Cashflow	Cumulative Cashflow
1	$38,966	$51,863	$7,629	$5,845	$8,375	$1,500	$75,211	-$36,246	-$36,246
2	$41,732	$50,710	$7,835	$6,260	$8,601	$1,541	$74,946	-$33,214	-$69,460
3	$44,695	$49,558	$8,047	$6,704	$8,833	$1,582	$74,724	-$30,029	-$99,489
4	$47,868	$48,405	$8,264	$7,180	$9,072	$1,625	$74,546	-$26,677	-$126,166
5	$51,267	$47,253	$8,487	$7,690	$9,317	$1,669	$74,415	-$23,148	-$149,314
6	$54,907	$46,100	$8,716	$8,236	$9,568	$1,714	$74,334	-$19,427	-$168,741
7	$58,806	$44,948	$8,951	$8,821	$9,827	$1,760	$74,306	-$15,501	-$184,242
8	$62,981	$43,795	$9,193	$9,447	$10,092	$1,808	$74,335	-$11,354	-$195,596
9	$67,452	$42,643	$9,441	$10,118	$10,365	$1,856	$74,422	-$6,970	-$202,566
10	$72,241	$41,490	$9,696	$10,836	$10,644	$1,906	$74,573	-$2,332	-$204,898
11	$77,371	$40,338	$9,958	$11,606	$10,932	$1,958	$74,791	$2,580	-$202,318
12	$82,864	$39,185	$10,227	$12,430	$11,227	$2,011	$75,079	$7,785	-$194,533
13	$88,747	$38,033	$10,503	$13,312	$11,530	$2,065	$75,443	$13,305	-$181,228
14	$95,048	$36,880	$10,787	$14,257	$11,841	$2,121	$75,886	$19,162	-$162,066
15	$101,797	$35,728	$11,078	$15,270	$12,161	$2,178	$76,414	$25,383	-$136,683
16	$109,024	$34,575	$11,377	$16,354	$12,489	$2,237	$77,032	$31,992	-$104,691
17	$116,765	$33,423	$11,684	$17,515	$12,827	$2,297	$77,745	$39,020	-$65,671
18	$125,055	$32,270	$12,000	$18,758	$13,173	$2,359	$78,560	$46,495	-$19,176
19	$133,934	$31,118	$12,324	$20,090	$13,529	$2,423	$79,483	$54,451	$35,275
20	$143,444	$29,965	$12,656	$21,517	$13,894	$2,488	$80,520	$62,923	$98,199
21	$153,628	$0	$12,998	$23,044	$14,269	$2,556	$52,867	$100,761	$198,960
22	$164,536	$0	$13,349	$24,680	$14,654	$2,625	$55,308	$109,227	$308,188
23	$176,218	$0	$13,709	$26,433	$15,050	$2,696	$57,887	$118,330	$426,518
24	$188,729	$0	$14,080	$28,309	$15,456	$2,768	$60,613	$128,116	$554,634
25	$202,129	$0	$14,460	$30,319	$15,874	$2,843	$63,496	$138,633	$693,267
26	$216,480	$0	$14,850	$32,472	$16,302	$2,920	$66,544	$149,936	$843,203
27	$231,850	$0	$15,251	$34,778	$16,742	$2,999	$69,770	$162,081	$1,005,284
28	$248,312	$0	$15,663	$37,247	$17,194	$3,080	$73,184	$175,128	$1,180,412
29	$265,942	$0	$16,086	$39,891	$17,659	$3,163	$76,798	$189,143	$1,369,555
30	$284,824	$0	$16,520	$42,724	$18,135	$3,248	$80,627	$204,196	$1,573,751
Totals	$1,614,965	$818,275	$198,852	$242,245	$218,296	$39,098	$1,516,766	$98,199	
	30 Yr. NPV	Discount Rate 4%							
	$1,776,961	$576,250	$184,465	$266,544	$202,503	$36,269	$1,266,032	$510,929	

Total Annual Heating Costs	Fuel oil + Woodchips	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
$38,966	$13,474	$8,375	$1,500	$23,349	$25,492	$576,250	22.6	$510,929	4.4%

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 School input several years' worth of energy and water use data 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 Southern Fulton Elementary School converts to biomass or stays with fuel oil, the facility should use its heating fuel efficiently. If the School decides to move forward with a biomass energy project, it should work with an efficiency program to identify other efficiency projects that could be completed at the same time.

General information on efficiency programs in are included in the *Biomass and Green Building Resources Binder* accompanying this report.

COMMISSIONING

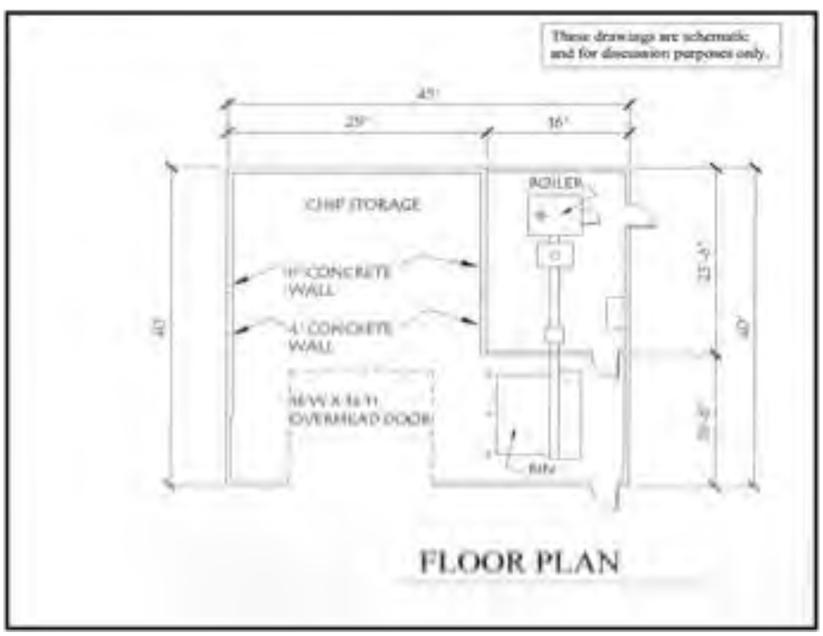
Building, or systems, commissioning is a process that verifies that a facility and/or system is functioning properly. The commissioning process takes place at all phases of construction, from planning to operation, to confirm that facilities and systems are performing as specified. Commissioning of a 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 Southern Fulton Elementary School 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.

SEMI-AUTOMATED SYSTEMS

Semi-automated biomass systems[3] are a cost efficient alternative to fully automated systems. The semi-automated system is typically installed in an on-grade slab building that includes both a boiler room and chip storage. The system also includes a day bin fuel hopper to supply the boiler automatically for one-to-two days without reloading. The day bin of a semi-automated woodchip system is loaded by an operator using a small tractor with a front end bucket or skid steer. Semi-automated systems have automated controls to manage fuel supply and combustion air, although the controls are simpler than those in a fully automated system.

The attraction of a semi-automated system is that both the building that houses the system and the vendor equipment are less expensive than a fully automated system. The system takes the operator up to one hour per day over the typical operation and maintenance time required for a fully automated system; this additional time is for loading the day bin. The semi-automated woodchip system is a good match for a smaller rural school or office building where the additional time in fuel handling is not a significant burden to maintenance staff.

Figure 8: Schematic Floorplan of a Semi-Automated Biomass Boiler House
(Drawing Courtesy of the Biomass Energy Resource Center (BERC))



[3]Excerpted from a handout produced by the Biomass Energy Resource Center:
http://www.biomasscenter.org/resources/technology/heating-systems-semiautomated.html

Table 5: Characteristics of Semi-Automated Woodchip Heating Systems

CHARACTERISTICS OF SEMI-AUTOMATED WOODCHIP HEATING SYSTEMS	
Primary Fuel:	Green wood chips (mill or forest residue, 25%-50% mc)
Energy Output:	Hot water or steam (boiler system)
Size (Boiler Output):	0.5 – 2.0 Btu/hour (or larger)
Fuel Storage:	Slab-on-grade building (overhead door delivery)
Fuel Handling:	Tractor with front-end bucket, from pile to day bin (performed by operator, once or twice daily) Automated from day bin to combustion chamber (no operator labor)
Operator Work Load:	Up to 1 hour daily
Combustion Control:	Electronic control panel (minimum) On-off firing rate (minimum) Automated, tuned control of fuel and combustion air "Idle" or flame maintenance mode
Stack Emission Control Device:	None required (unless required by state regulations) Must meet applicable state regulations, if any
Ash Removal:	Manual or automated
Vendor-Supplied Equipment:	Boiler with standard controls Combustion chamber Day bin with automated fuel reclaim in bottom Automated fuel handling system (day bin to boiler) Control Panel Wood system wiring (from system control panel) Breaching (from boiler to stack)
Vendor Responsibilities:	All installation Coordination with General Contractor Warranty Service Capability (limited) (Plumbing connection by others) (Building construction by others) (Tractors by others) (Bonding generally not required)

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

WEST PENN POWER SUSTAINABLE ENERGY FUND

The West Penn Power Sustainable Energy Fund provides grants for renewable energy projects. While the fund is not currently accepting new proposals, they are in the process of developing a program that would provide funding for school biomass, and other demonstration, projects. For more information, contact:

Joel L. Morrison
WPPSEF Program Administrator
814-865-4802
wppsef@ems.psu.edu
http://www.wppsef.org

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-performance 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 announced. 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.

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

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

<u>Rural Community Facilities Grant and Loan Program</u>

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.

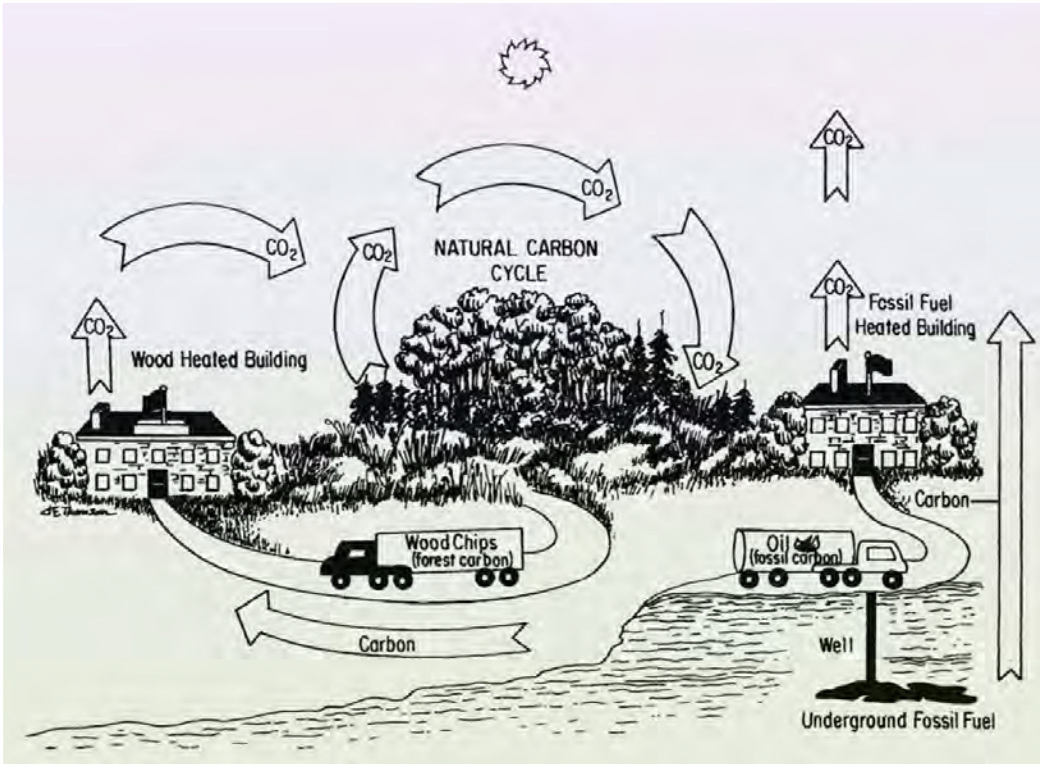
For more information about USDA programs and services, contact your local USDA office. Information on programs and contact information is provided in the <u>*Biomass and Green Building Resources Binder.*</u>

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. There are few measures Southern Fulton Elementary School could undertake that would reduce its carbon footprint more than switching their heating fuel use from fuel oil to a biomass fuel.

Figure 9: Carbon Cycle Illustration[4]

[4] 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 22.2 lbs. of CO_2 is produced from each gallon of fuel oil consumed. It is projected that the Southern Fulton can offset approximately 12,000 gallons of fuel oil per year by replacing that heat using biomass. This is equivalent to about 266,400 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 \$400 - \$665 or a lump sum up front payment of as much as \$6,650.

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.

Pellet boilers have not had as much emissions testing as woodchip boilers in the United States so there is less concrete data about performance and emissions. However, pellet fuel boilers are much more common in Europe and testing there indicates that pellet boilers have fewer lbs/mBtu of particulate emissions than woodchip boilers.

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 6: Comparison of Boiler Emissions Fired by Wood, Distillate Oil, Natural Gas and Propane[5]

(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

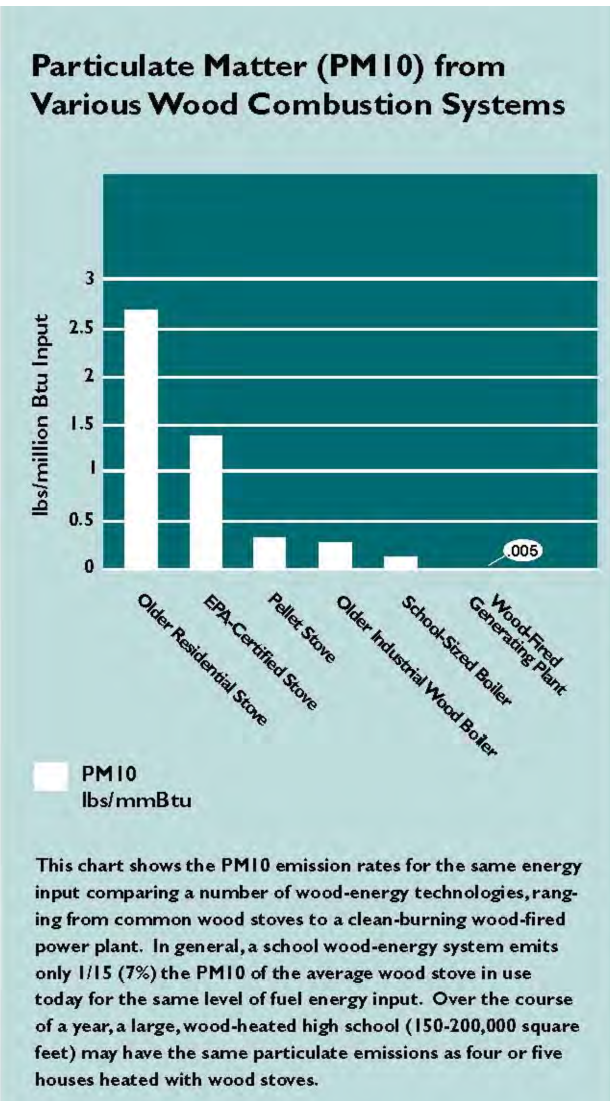
The pollutant of greatest concern with biomass is particulates (PM_{10}). Biomass boilers clearly generate more particulates than fuel oil or gas boilers. That is why it is important to install appropriate pollution control equipment. Many modern types of emission control equipment, capable of reducing particulate matter emissions from 50-99 percent, are commercially available in the US. The most common emission control equipment technologies are

[5] 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.

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.

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 10: Particulate Emissions[6]



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 boiler analyzed in this report is smaller than 10 million Btu – under the new regulations Southern Fulton Elementary School would be required to perform a boiler tune-up every two years on the biomass boiler. Starting on September 17, 2011 the

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

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 the woodchip scenario analysis 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

Southern Fulton Elementary School appears to be a good candidate for a biomass heating system. We recommend the School take the following steps to investigate this opportunity further.

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 School decides to move forward with a biomass project, decision-makers 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 School should consider a biomass project as part of the PlanCon process and speak with their PlanCon architect about addition a biomass project to current plans. In addition, the School should identify any additional heating system improvements it plans to undertake at this facility and consider including those projects with the biomass project. It will be more cost effective to implement boiler room upgrades and heating distribution improvements at the same time a new boiler system is installed than it would be to postpone those improvements for a later time.

3. The School should consider 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. This should be done regardless of whether or not the School moves ahead with a biomass project at this time. Information on energy efficiency programs and incentives are included in the *Biomass and Green Building Resources* binder accompanying this report. At minimum the School should replace all T-12 light fixtures with higher efficiency fixtures.

4. 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 School 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

5. The School should consider managing the 100 acre site for stand improvement that could supply some woodchip fuel and/or timber sales in the future. The School should contact Mike Palko, Biomass Energy Specialist with the PA DCNR Bureau of Forestry, to schedule a time for a service forester to visit the site and provide a forest management plan.
   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@pa.gov
www.dcnr.state.pa.us

6. The School should also work with Mike Palko to cultivate other potential biomass fuel suppliers concurrent with the design of the biomass system.

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

PELLET SENSITIVITY ANALYSIS

Table 7 is a sensitivity analysis comparing annual fuel savings from the installation of a pellet system based on varying prices for pellets and fuel oil. In this analysis, the assumed loan interest rate of 4.0% and the inflation rates outlined in the assumptions are held constant. For example, if Southern Fulton were able to get pellets for $180 per ton ($175 per ton was the lowest estimated pellet price) and was paying $3.00 per gallon of fuel oil, the annual fuel savings would be $17,918.

Table 7: Annual Fuel Savings When Pellet and Fuel Oil Prices Vary

Pellet Cost per ton	# 2 Fuel Oil per Gallon				
	$2.50	$3.00	$3.50	$4.00	$4.50
$180	$11,940	$17,918	$23,897	$29,875	$35,854
$200	$9,945	$15,923	$21,902	$27,880	$33,859
$220	$7,950	$13,929	$19,907	$25,886	$31,864
$240	$5,955	$11,934	$17,912	$23,891	$29,869
$260	$3,961	$9,939	$15,918	$21,896	$27,874

Table 8 is a sensitivity analysis showing the Net Present Value (NPV) of the installation of a pellet system based on varying financing interest rates and fuel inflation rates. In this analysis the cost of wood pellets (at $185 per ton) and the General inflation rate of 2.7% are held constant. For example, if the District is able to get a loan for the project at 3.0% and the fuel oil inflation rate was at 7.0%, the NPV for the system would be $656,072.

Table 8: 30-Year Net Present Value (NPV) when Interest and Fuel Oil Inflation Vary

Interest Rate	30 year NPV Relative to Fuel Oil Inflation Rate				
	4.0%	5.0%	6.0%	7.0%	8.0%
3.0%	$943	$179,976	$395,667	$656,072	$971,048
4.0%	($52,686)	$93,290	$268,424	$479,030	$732,821
5.0%	($96,392)	$23,384	$166,466	$337,825	$543,522
6.0%	($132,255)	($33,356)	$84,265	$224,538	$392,243
7.0%	($161,885)	($79,708)	$17,583	$133,107	$270,653

*7.1% is the average rate of fuel oil inflation in Pennsylvania over the past 20 years.

Table 9 is a sensitivity analysis showing the first year cash flow and net present value (NPV) of the installation of a wood pellet heating system based on varying rates of grant funding. In this analysis all of the assumptions presented in Table 1 are held constant. For example, if Southern Fulton Elementary School were able to get $300,000 in grant funding for the pellet project, the first year cash flow would be $3,693 and the 30 year NPV would rise to $798,248 (the annual fuel savings would be unchanged).

Table 9: 30-Year Net Present Value (NPV) when Grant Funding is available

	Project Costs (Capital – Grant)	1st Year Cash Flow	30-Year NPV
No grant funding	$389,620	($23,007)	$502,325
$100,000 grant	$289,620	($14,107)	$600,966
$200,000 Grant	$189,620	($5,207)	$699,607
$300,000 Grant	$89,620	$3,693	$798,248

WOODCHIP SENSITIVITY ANALYSIS

Table 10 is a sensitivity analysis comparing annual fuel savings from the installation of a woodchip system based on varying prices for woodchips and fuel oil. In this analysis, the assumed loan interest rate of 4.0% and the inflation rates outlined in the assumptions are held constant. For example, if woodchips cost $50 per ton and fuel oil climbed to $4.50 per gallon, then the annual fuel savings would be $38,292.

Table 10: Annual Fuel Savings When Woodchip and Fuel Oil Prices Vary

Woodchip $/ton	*Fuel Oil $ / Gallon*				
	$2.50	**$3.00**	**$3.50**	**$4.00**	**$4.50**
$35	$23,217	$29,195	$35,174	$41,152	$47,131
$40	$22,263	$28,242	$34,220	$40,199	$46,177
$45	$21,310	$27,288	$33,267	$39,245	$45,224
$50	$20,356	$26,335	$32,313	$38,292	$44,270
$55	$19,402	$25,381	$31,359	$37,338	$43,316

Table 11 is a sensitivity analysis showing the Net Present Value (NPV) of the installation of a woodchip system based on varying financing interest rates and fuel inflation rates. In this analysis the cost of woodchips (at $40 per ton) and the General inflation rate of 2.7% are held constant. For example, if the District is able to get a loan for the project at 3.0% and the fuel oil inflation rate was at 7.0%, the 30 year NPV for the system would be $703,653.

Table 11: 30-Year Net Present Value (NPV) when Interest and Fuel Oil Inflation Vary

Interest Rate	Fuel Oil Inflation Rate				
	4.0%	5.0%	6.0%	7.0%*	8.0%
3.0%	$48,524	$227,557	$443,248	$703,653	$1,018,629
4.0%	($44,081)	$101,895	$277,028	$487,634	$741,426
5.0%	($119,161)	$615	$143,696	$315,056	$520,753
6.0%	($180,434)	($81,535)	$36,087	$176,359	$344,064
7.0%	($230,769)	($148,592)	($51,301)	$64,223	$201,768

*7.1% is the average rate of fuel oil inflation in Pennsylvania over the past 20 years.

Table 12 is a sensitivity analysis showing the first year cash flow and net present value (NPV) of the installation of a woodchip heating system based on varying rates of grant funding. In this analysis all of the assumptions presented in Table 3 are held constant. For example, if Southern Fulton Elementary School were able to get $300,000 in grant funding for the woodchip project, the first year cash flow would be negative $9,246 and the 30 year NPV would rise to $810,929 (the annual fuel savings would be unchanged).

Table 12: 30-Year Net Present Value (NPV) when Grant Funding is available

	Project Costs (Capital – Grant)	1st Year Cash Flow	30-Year NPV
No grant funding	$576,250	($36,246)	$510,929
$100,000 grant	$476,250	($27,246)	$610,929
$200,000 Grant	$376,250	($18,246)	$710,929
$300,000 Grant	$276,250	($9,246)	$810,929

SOUTHERN FULTON ELEMENTARY SCHOOL FUEL HISTORY

Fuel oil is the primary heat source for the Southern Fulton Elementary School. The table below summarizes fuel history provided by the Southern Fulton Elementary School as part of the application for a biomass pre-feasibility study.

Table 13: Fuel Oil Usage 2008 - 2011

	2008-2009			2009-2010			2010-2011		
	gallons	**$/gal**	**total $**	**gallons**	**$/gal**	**total $**	**gallons**	**$/gal**	**total $**
Dec	7,500	$2.55	$19,125	-	-	-	-	-	-
Jan	7,500	$2.77	$20,771	7,499	$2.25	$16,869	7,721	$3.16	$24,369
Mar	-	-	-	4,900	$2.20	$10,780	7,082	$3.17	$22,421
Total	**15,000**	**$2.66**	**$39,896**	**12,399**	**$2.22**	**$27,649**	**14,803**	**$3.16**	**$46,790**

WOOD PELLET FUEL

Wood pellets are made from wood waste materials that are compressed into pellets under heat and pressure. Natural plant lignin holds the pellets together without glues or additives. Wood pellets are of uniform size, shape and composition making them easy to store and to burn.

Much of the pellet fuel market is geared toward supplying 40 pound bags for residential scale pellet stoves and boilers. Commercial scale systems typically have bulk storage of pellet fuel that can then be fed into the boiler automatically. Therefore pellet fuel suppliers for a commercial scale system need to have the ability to deliver in self unloading trucks. Commercial scale pellet consumers should identify several pellet fuel manufacturers within a 200 mile radius that have the capability to deliver pellet fuel in bulk.

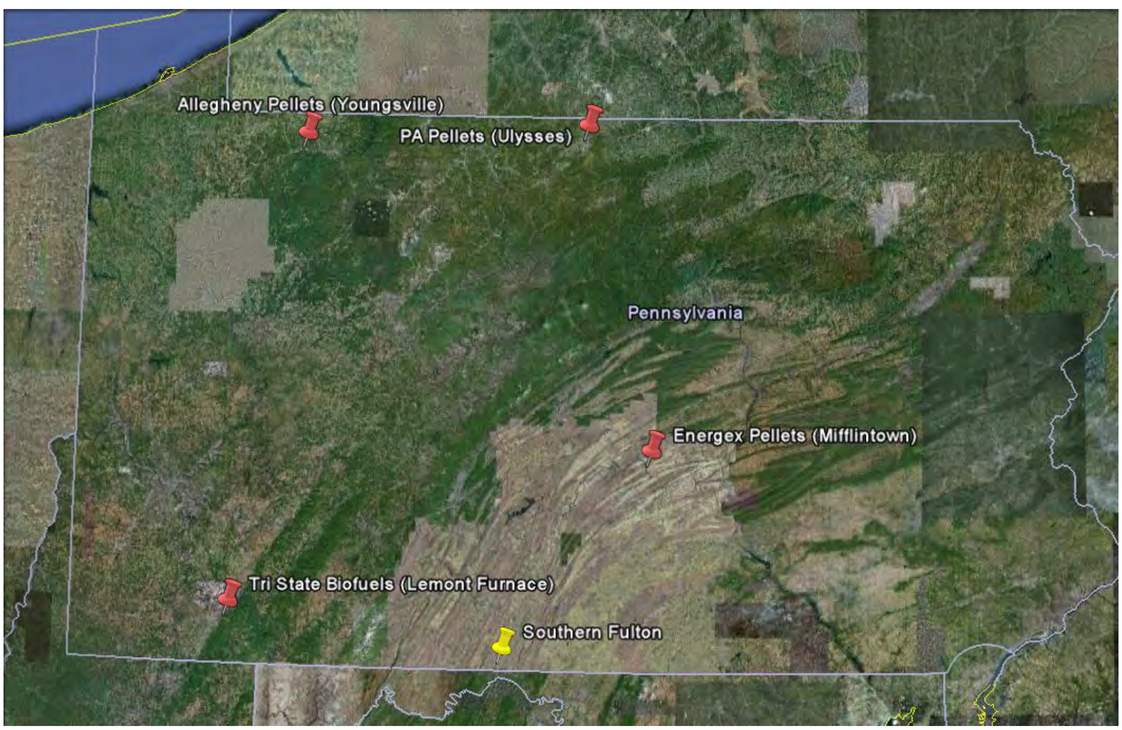
Figure 11: Typical Bulk Pellet Fuel Storage and Delivery[7]

[7] Photo taken from the *Wood Pellet Heating Guidebook* published by Massachusetts Division of Energy Resources.

It is best to secure a supplier that will guarantee supply for at least a complete heating season. Distance from the manufacturer will affect cost so generally the closer the supplier, the better the delivered price. There are several wood pellet manufacturers in Pennsylvania that provide bulk delivery. If the School decides to move forward with a wood pellet project they should contact each manufacturer for pricing and delivery information or work with Mike Palko to gather this information.

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@pa.gov
www.dcnr.state.pa.us

Figure 12: PA Pellet Manufacturers providing bulk delivery



WOODCHIP FUEL

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, Southern Fulton Elementary School 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, Southern Fulton 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 the Mike Palko 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@pa.gov
www.dcnr.state.pa.us

The bottom line is that both Southern Fulton Elementary School 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 Southern Fulton 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

TABLE OF CONTENTS

- **Financing Resources**
  - EPA Innovative Financing Solutions
  - *Financing Energy Efficiency Projects* – Zobler & Hatcher, Government Finance Review
  - USDA Community Facility Grants
  - USDA Rural Energy For America Program (REAP)
  - USDA Loan and Grant Programs
  - National Clearinghouse for Educational Facilities Stimulus Funding and Tax Credit Bonds for School Construction
  - *Native*Energy (Carbon Offsetting)
  - 3Degrees (Carbon Offsetting)
  - The Climate Trust (Carbon Offsetting)
  - US DOE EnergySmart Schools Solutions (ON ENCLOSED CD)
- **Efficiency Resources**
  - Reference Guide for EPA Portfolio Manager software
  - US Department of Energy Reduce Operating Costs with an EnergySmart School Project
  - U-32 Junior Senior High School Energy Efficiency Case Study
  - Advanced Energy Design Guide Information
  - Collaborative for High Performance Schools and Green Schools Resources (ON ENCLOSED CD)
  - EPA Indoor Air Quality Tools for Schools Reference Guide (ON ENCLOSED CD)
- **Biomass Equipment Vendors**

<u>Woodchip Boiler Manufacturers</u>

ACT Bioenergy
Advanced Recycling
AFS Energy Systems
Alternative Energy Solutions (AESI)
Biofuel Boiler Technologies
Biomass Combustion Systems
Biomax Commercial Boilers
Chiptec
Decton
Hurst Boiler
King Coal Furnace Corporation
Messersmith Manufacturing
Moss
Total Energy Solutions
Viessman / KOB / Mawera
Wellons FEI

<u>Pellet Boiler Manufacturers</u>

ACT Bioenergy
Okofen
Solagen
SWEBO
TARM Biomass
Viessman / KOB

- Biomass Energy Resources
  - Carbon Dioxide and Biomass Energy
  - Air Emissions from Modern Wood Energy Systems
  - EPA Institutional Boilers Fact Sheet
  - Particulate Matter Emissions-Control Options for Wood Boiler Systems
  - Woodchip Heating Fuel Specifications
  - North America's Wood Pellet Sector - USDA
  - Pellet Fuel – Pellet Fuels Institute
  - The Wider World of Pellet Fuel – Pellet Fuels Institute
  - Pellet Fuel Standards – Pellet Fuels Institute
  - Demonstration and Public Education at the W!ld Center – NYSERDA
  - *Commercial-Scale Biomass Boilers Market Growing in the Northeast – David Dungate, Northeast Sun*
  - Wood Pellet Heating Guide Book (ON ENCLOSED CD)
  - Biomass Boiler and Furnace Emissions and Safety Regulations in the Northeast States (ON ENCLOSED CD)
  - Woodchip Heating Systems, *A Guide for Institutional and Commercial Installations* (ON ENCLOSED CD)

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.