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

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Preliminary Feasibility Report

Biomass Heating Analysis for Burrows Paper

Lyons Falls, New York

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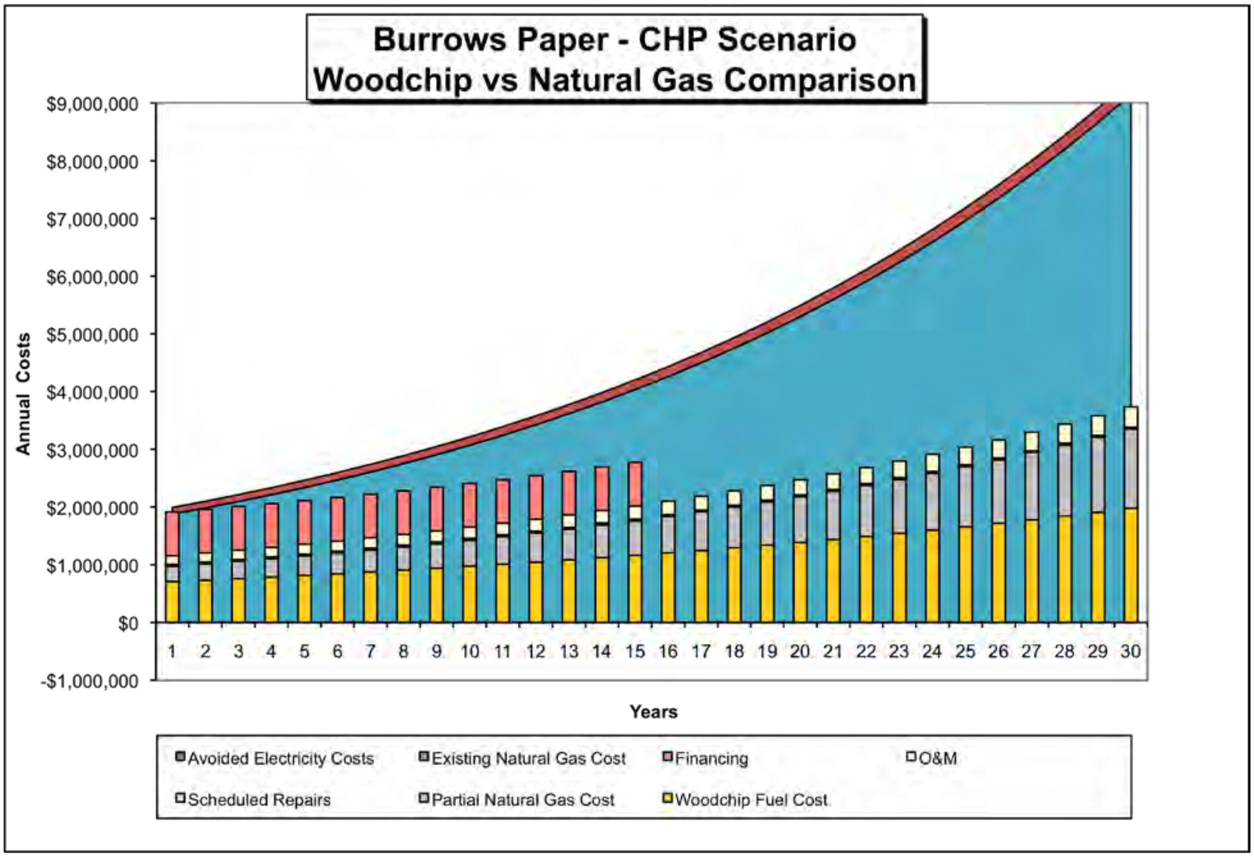
EXECUTIVE SUMMARY

The Burrows Paper mill analyzed for this study produces light weight specialty paper and packaging products. The facility has approximately 300,000 square feet of conditioned space and uses a combination of natural gas (supplied by one steam boiler) and purchased steam from Lyonsdale Biomass, a biomass power plant located across the street. The boiler at the mill is approximately 12 years old and in good condition.

The facility currently uses approximately 91,911 Dekatherms (Dth)[1] of natural gas each year and purchases an additional 60,293 k-lb of steam (equivalent to an additional 83,455 Dth of natural gas). Burrows paid an average of $10.72 per Dth of Natural Gas and $6.89 per k-lb of steam (equivalent to $4.85 per Dth). It was assumed that a biomass boiler installed at the mill would provide 85% of the entire annual heating needs for the mill replacing all of the steam purchased and most of the natural gas required for the operation of the mill. It was assumed the on-site natural gas boiler would provide the remaining 15% of the annual heat load.



While the mill currently purchases process steam from Lyonsdale Biomass, for the purposes of this analysis it was assumed that the on-site natural gas boiler provided the total annual heating needs. Therefore annual steam purchases were converted to a natural gas equivalent and then multiplied by the

[1] A Dekatherm = 1,000,000 Btus

$10.72 average natural gas price paid by the mill to evaluate current and projected costs. Based on these assumptions, Burrows Paper would spend more than $1.8 million on natural gas in the coming year. It appears that there is potential for a small biomass combined heat and power (CHP) project based on the consistency of demand for heat and the size of electrical load at this facility. Both a heat-only and a combined heat and power scenario are analyzed in this report.

For the heat only scenario, the analysis provided in this report indicates that this facility could save more than $15.4 million in operating costs over 30 years in today's dollars, even when the cost of financing is included. The analysis shows more than $900,000 in fuel savings in the first year alone. For the CHP scenario, the analysis shows that an additional $250,000 investment in a backpressure steam turbine to produce on-site electricity could provide a net benefit of approximately $85,000 in first year electricity cost offsets in addition to the same $900,000 in fuel savings. The 30-year life cycle cost savings for the CHP scenario are more than $16.5 million.

Burrows Paper appears to be an excellent candidate for a biomass energy system. Based on our site visit we believe there is enough space in the existing boiler room to install a woodchip steam boiler and a workable site for a woodchip storage building immediately outside the existing boiler room. The existing natural gas boiler system could work well to provide back-up and supplemental heat in combination with a wood-fired boiler. We recommend Burrows Paper takes the following steps to investigate this opportunity further:

1. This is only a preliminary feasibility study to explore the economics of investing in a biomass energy system. The next step should be to hire a qualified engineering firm to help refine the project concept and to obtain firm local estimates on project costs.
2. The US Forest Service may be able to provide some engineering technical assistance from an engineering team with biomass experience that is part of the program that funded this study. 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. His contact information is: 304-285-1538, lmccreery@fs.fed.us.
3. Emission regulations for the installation of commercial and industrial scale boilers will be changing in the near future. The EPA is undergoing a public review process for draft rules that could affect the type of equipment specified for a site like this. The engineers hired by the facility for a biomass project should carefully review the new rules and evaluate the best available technology options for pollution control devices when they are designing the project.
4. The New York State Energy Research and Development Authority (NYSERDA) has funding available to help cover the cost of detailed Combined Heat and Power studies. We recommend working with NYSERDA to take advantage of this opportunity.
5. Another potential resource for exploring CHP is the Northeast Combined Heat and Power Initiative. This group provides technical assistance for facilities considering CHP at little or no cost. For more information, visit: http://www.northeastchp.org/.

6. NYSERDA should also be engaged to develop comprehensive energy efficiency recommendations and proposals for incentives for efficiency upgrades. NYSERDA provides technical assistance and cash incentives for many energy efficiency improvements including building efficiency and industrial process efficiencies. Information on NYSERDA programs is included in the Resource Binder accompanying this report.
7. Concurrent with the design of a biomass project, Burrows Paper should investigate potential woodchip fuel providers. Contact the New York State Forest Utilization Program for a list of local suppliers.

This preliminary feasibility study was prepared by Yellow Wood Associates in collaboration with Richmond Energy Associates, LLC and Wilson Engineering Services, PC for the Burrows Paper Mill in Lyons Falls, NY. Both Yellow Wood and Richmond Energy have extensive community economic development experience and Richmond Energy specializes in biomass energy projects. Wilson Engineering Services is a multidisciplinary firm providing engineering and consulting services for a wide range of projects and programs. 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 40 public schools in Vermont alone and 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 boiler systems and those that have ready access to reasonably priced biomass fuel.

This report is a pre-feasibility assessment specifically tailored to Burrows Paper outlining whether or not biomass energy makes sense for this facility from a practical perspective. In June 2010, staff from Yellow Wood Associates traveled to Lyons Falls, NY to tour the facility. This assessment includes site specific fuel savings projections based on historic fuel consumption, and provides facility decision-makers suggestions and recommendations on next steps.

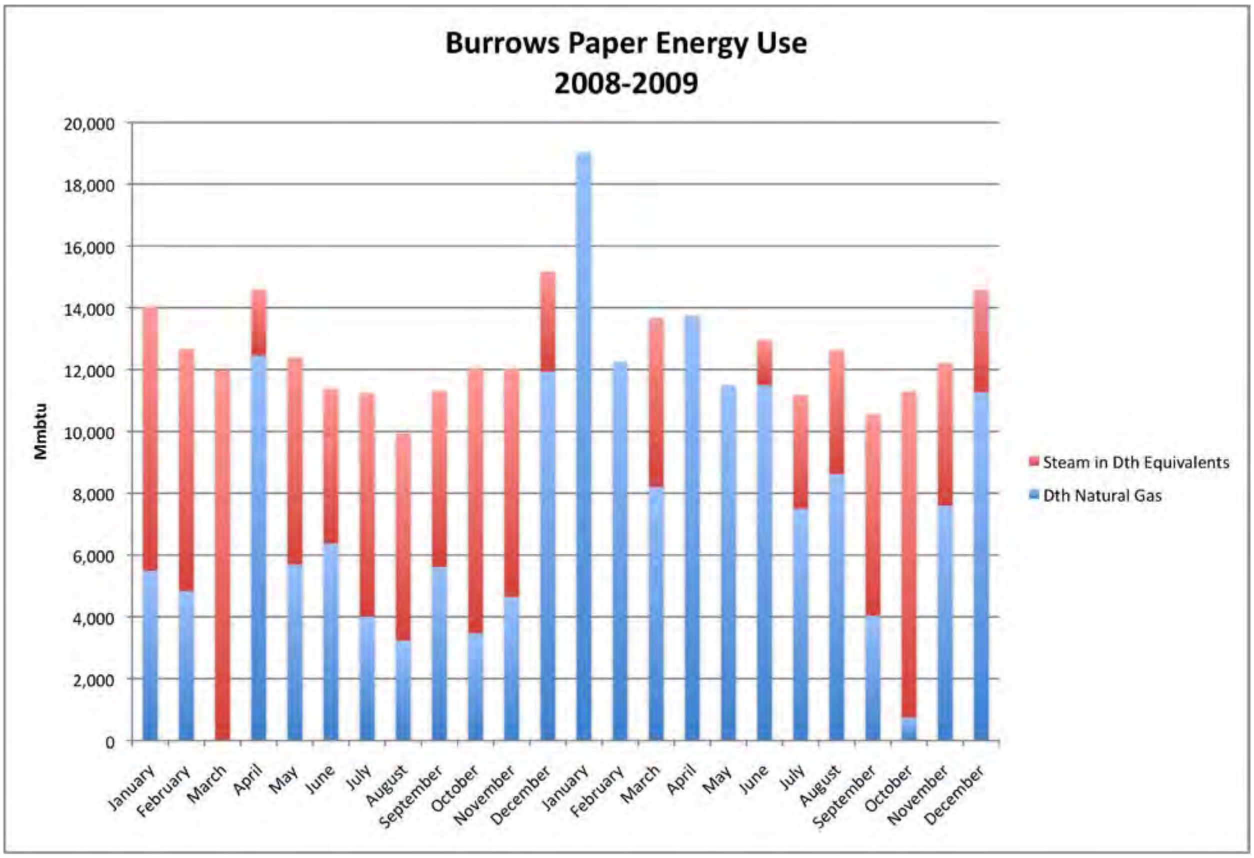
The U.S. Department of Agriculture Wood Education and Resource Center funded the study. This preliminary feasibility study was prepared by Yellow Wood Associates and Richmond Energy Associates, LLC with support from Wilson Engineering Services, PC.

ANALYSIS ASSUMPTIONS

DESCRIPTION OF THE EXISTING HEATING SYSTEM

Burrows Paper is a diversified specialty paper and specialty packaging producer located in Lyons Falls, NY. The 300,000 SF facility currently runs on one steam boiler and purchases steam from Lyonsdale Biomass. The majority of energy use for this facility is process steam for use in the mill's paper making process. Burrows Paper is considering installing a second boiler and terminating their contract with Lyonsdale. Over the past two years, the facility used approximately 91,911 Dekatherms (Dth) of natural gas each year and purchased an additional 60,293 k-lb of steam (equivalent to an additional 83,455 Dth of natural gas).

Table 1: Energy Use



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 two different biomass scenarios over a 30-year horizon and takes into consideration life cycle cost factors. The first scenario is a heat only option that would cover 85% of the current annual heat load for the entire facility (including space and process heat). The second scenario would add a backpressure steam turbine to the project and produce electricity for use on site. It was assumed that the electricity produced could be net metered and would directly offset a portion of the electricity currently purchased by Burrows Paper. It was assumed that the boiler could still provide 85% of the heat load for the facility and that the electricity production would require a minimal amount of additional biomass fuel. Both biomass scenarios include all ancillary equipment and interconnection costs. Under both biomass scenarios, the existing natural gas steam boiler would still be used to provide supplemental and back-up heat. Under both scenarios it was also assumed that Burrows would no longer purchase steam from Lyonsdale Biomass. A 30-year time frame is used for both scenarios because it is the expected life of a new boiler.

The analysis projects current and future annual natural gas 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 boiler facility. It is recommended that for a project of this scale, Burrows Paper 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 and information from Burrows.

NATURAL GAS COST ASSUMPTIONS

Fuel bills provided by Burrows Paper indicate that the facility uses an average of 91,911 Dth of natural gas per year and purchases an additional 60,293 k-lb (the equivalent of 83,455 Dth natural gas) of steam each year. For this study it is assumed that all future steam loads were to be produced on site using an on-site natural gas boiler. An average annual fuel consumption of 175,352 Dth (using the steam equivalent) is assumed for the base case in the analysis. Over the past two years, Burrows Paper paid an average of $10.72 per Dth of natural gas; both biomass scenarios in this study use this price for the first year of the analysis. At that price, Burrows Paper would spend more than $1,878,948 for natural gas at this facility next year.

ELECTRICAL COST ASSUMPTIONS

Bills provided by Burrows Paper indicate that the facility uses an average of 20,071,983 kWh of electricity each year. Over the past two years, Burrows Paper paid an average of $0.083 per kWh for electricity. The CHP scenario assumes the installation of a 200 kW backpressure steam turbine with an induction generator. We estimate that this turbine could produce as much as 1,350,000 kWh per year if the boilers were operated at 50% of capacity or more for 95% of the plant operation hours during the year. (It is our understanding that the plant operates 8760 hours per year.) We assumed that the facility would be able to use all of this electricity production on-site and therefore would be offsetting the retail rate of $0.083/kWh.

WOODCHIP FUEL COST ASSUMPTIONS

The woodchip heat only scenario in this study assumes the facility will meet 85% of the heat load for the facility with woodchips and therefore consume 17,064 tons of chips per year. 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. The remaining 15% of the heating needs were then assumed to be provided by the existing natural gas boiler consuming about 26,300 Dth of natural gas.

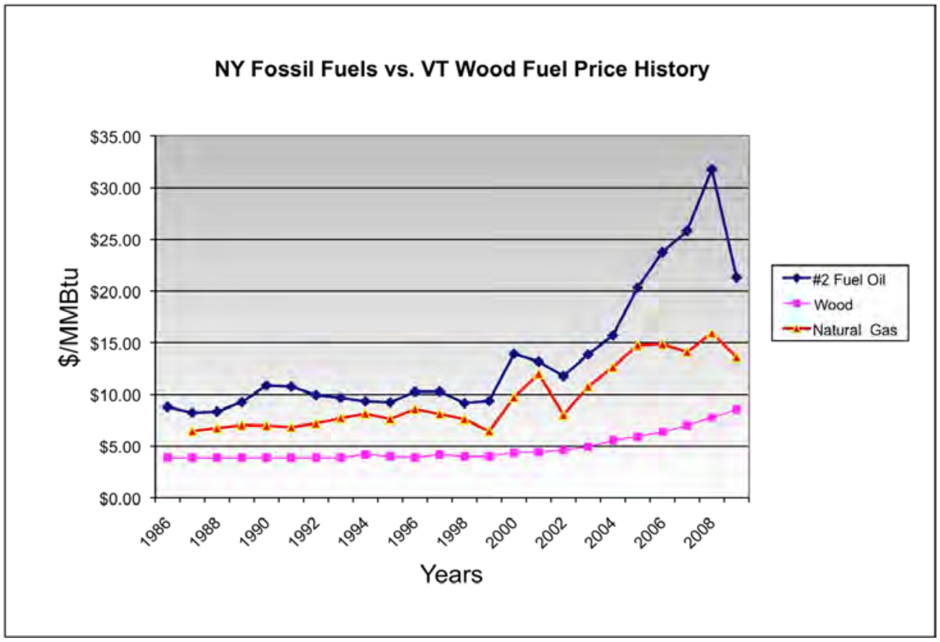
For the CHP scenario we assumed the woodchip boiler would still provide 85% of the heat load for the facility, but that it would take an additional 675 tons of woodchips to fuel the turbine annually. Therefore the total quantity of woodchips required for the CHP scenario was 17,739 tons. For the CHP scenario it was assumed that 26,300 Dth of natural gas would still be used to provide 15% of the heat load.

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 (1989 – 2009) using US Energy Information Agency data and found that the average annual commercial customer increase for Natural Gas in New York was 4.8% per year. The analysis projects this average inflation rate for natural gas forward over the thirty-year analysis period. Burrows Paper's fuel rate of $10.72/Dth was used for the first year of the analysis and then inflated each year at 4.8%.

Figure 1: Woodchip and Fossil Fuel Inflation



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 2.6% 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.

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 $55/ton in the period between 1990 and 2009. The average annual increase during this period was about 3.6% annually[2] 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. For the analysis in this report the cost of woodchip fuel was inflated 3.6% annually for the thirty years of the analysis.

[2] Extrapolated from Vermont Superintendent Association School Energy Management Program data. Vermont wood chip price history is used because it is one of the only states that has this historical data.

OPERATION AND MAINTENANCE ASSUMPTIONS

For this facility it was assumed that one additional full-time staff person would need to be hired to properly maintain the boiler and to supervise operation. At a loaded rate of $35/hr. it was assumed Burrows would need to spend $70,000 in labor costs for the operations and maintenance of a biomass boiler.

It was also assumed that the biomass boiler and fuel handling equipment would consume an additional 1 million kWh of electricity annually. At $0.083/kWh it was estimated that Burrows would spend another $83,000 in electricity to run the biomass boiler and ancillary equipment.

Another operations and maintenance cost that is included in the analysis 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 this analysis, $150,000 of scheduled maintenance was anticipated in years 10, 20 and 30 and then annualized at $15,000 per year to simulate a sinking fund for major repairs. This $15,000 was 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 boiler were taken into consideration as these are considered costs that Burrows Paper 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

This analysis assumes that Burrows Paper will finance the entire cost of the biomass project with a 7% loan. At this time the analysis does not take into account any potential tax credits, grants or low 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.

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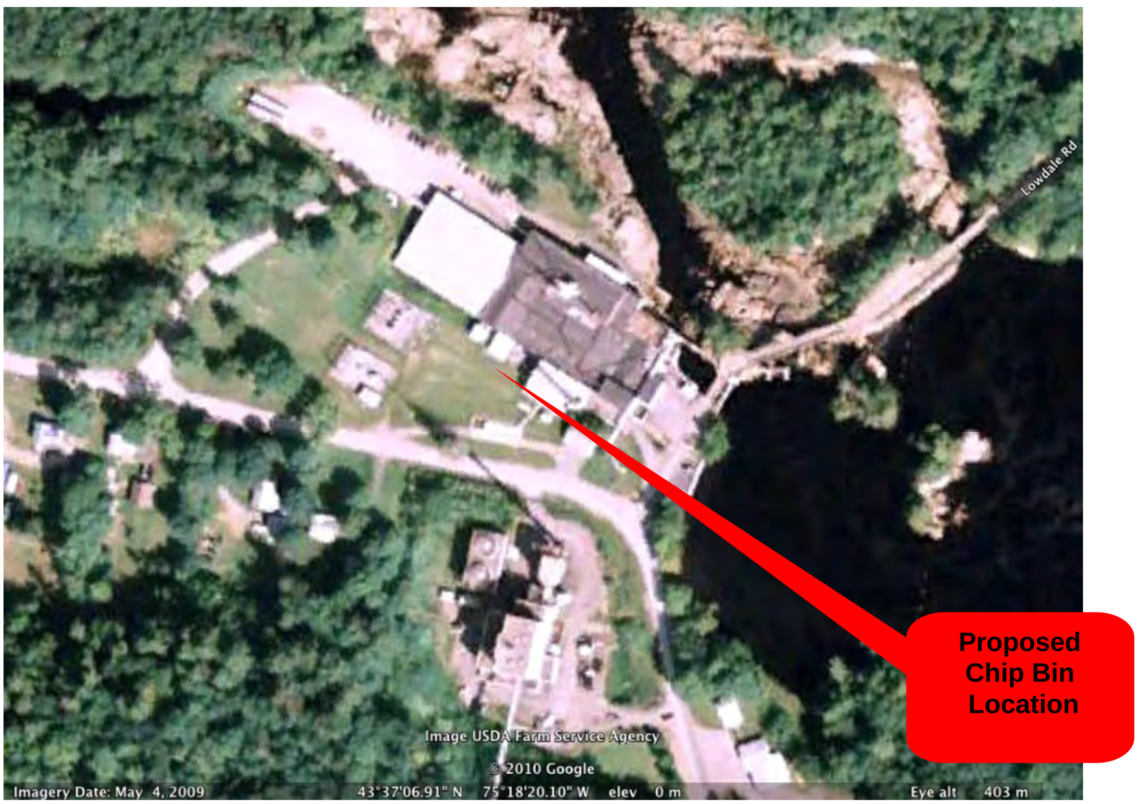
BIOMASS SCENARIOS

Two scenarios were analyzed for this study – one analyzes the addition of a woodchip boiler to provide heat only, replacing 85% the natural gas and 100% of the purchased steam. The second scenario investigates the feasibility of adding a steam backpressure turbine with an induction generator (creating a combined heat and power (CHP) biomass plant), which would offset some of the facility's electrical use as well. In both scenarios it is assumed that the existing boiler would remain to provide back-up and supplemental heat if necessary and that Burrows would no longer purchase steam from Lyonsdale Biomass.

Both biomass scenarios envisions adding a 20 mmBtu biomass steam boiler to the existing boiler room and building a chip storage bin adjacent to the boiler room. Construction costs were estimated assuming that a biomass boiler could be placed in the existing boiler room. The chip storage building would be a separate structure. Below is the suggested location for the woodchip storage bin.

Figure 2: Proposed Chip Bin Location



BIOMASS HEAT ONLY SCENARIO ANALYSIS RESULTS

Under the first biomass heat only scenario, steam from the woodchip boiler would be used for process heat, the same way it is being used now from the existing natural gas boiler. Costs for a tall stack are included to ensure good emissions dispersal. Costs for an underground woodchip storage bin are 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. Costs for interconnecting with the existing boiler equipment, a healthy construction contingency, standard general contractor mark-up and professional design fees were also included.

The analysis shows that Burrows Paper could save more than $15.4 million in today's dollars in operating costs over the next 30 years by installing a woodchip heating system, even including debt service on the cost of the system. Annual fuel savings alone are projected to be more than $900,000 per year in the first year and should increase over time as natural gas prices climb. If construction cost assumptions, finance cost assumptions and fuel price assumptions are correct, the project will have a positive annual cash flow from the first year.

Table 2: Biomass Heat Only Scenario Analysis Assumptions

Burrows Paper Biomass Heat Only Scenario			
Capital Cost Assumptions			
20 mmBtu biomass steam boiler system including installation			$3,000,000
Stack and breeching			$150,000
300 cubic yard chip storage building and chip storage bunker	4,000 SF	$150 /SF	$600,000
Pollution cotrol equipment			$600,000
Site preparation			$50,000
Biomass boiler room equipment			$100,000
Interconnection to existing systems			$100,000
GC markup at 10%			$460,000
Construction contingency at 15%			$759,000
Design at 12%			$698,280
Total estimated project costs			$6,517,280
State or Federal Grants			$0
Total Facility Share			$6,517,280
Financing Costs			
Financing, annual interest rate			7.0%
Finance term (years)			15
1st full year debt service			$782,074
Fuel Cost Assumptions			
Current annual natural gas use (Dth)			175,352
Assumed natural gas price in 1st year (Dth)			$10.72
Projected annual natural gas bill			$1,879,768
Assumed wood price in 1st year (per ton)			$40
Projected 1st year wood fuel bill			$682,560
Projected 1st year supplemental natural gas bill			$281,965
Inflation Assumptions			
General inflation rate (twenty year average CPI)			2.9%
Natural gas inflation rate (twenty year average EIA)			5.6%
Wood inflation rate (average increase in VT from 1988 - 2008 is 3.6%)			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			$153,000
Major repairs (annualized)			$15,000
Savings			
Net 1st year fuel savings			**$915,243**
Total 30 year NPV cumulative savings			**$15,449,907**

Figure 3: Annual Cash Flow Graph for Biomass Heat Only Scenario

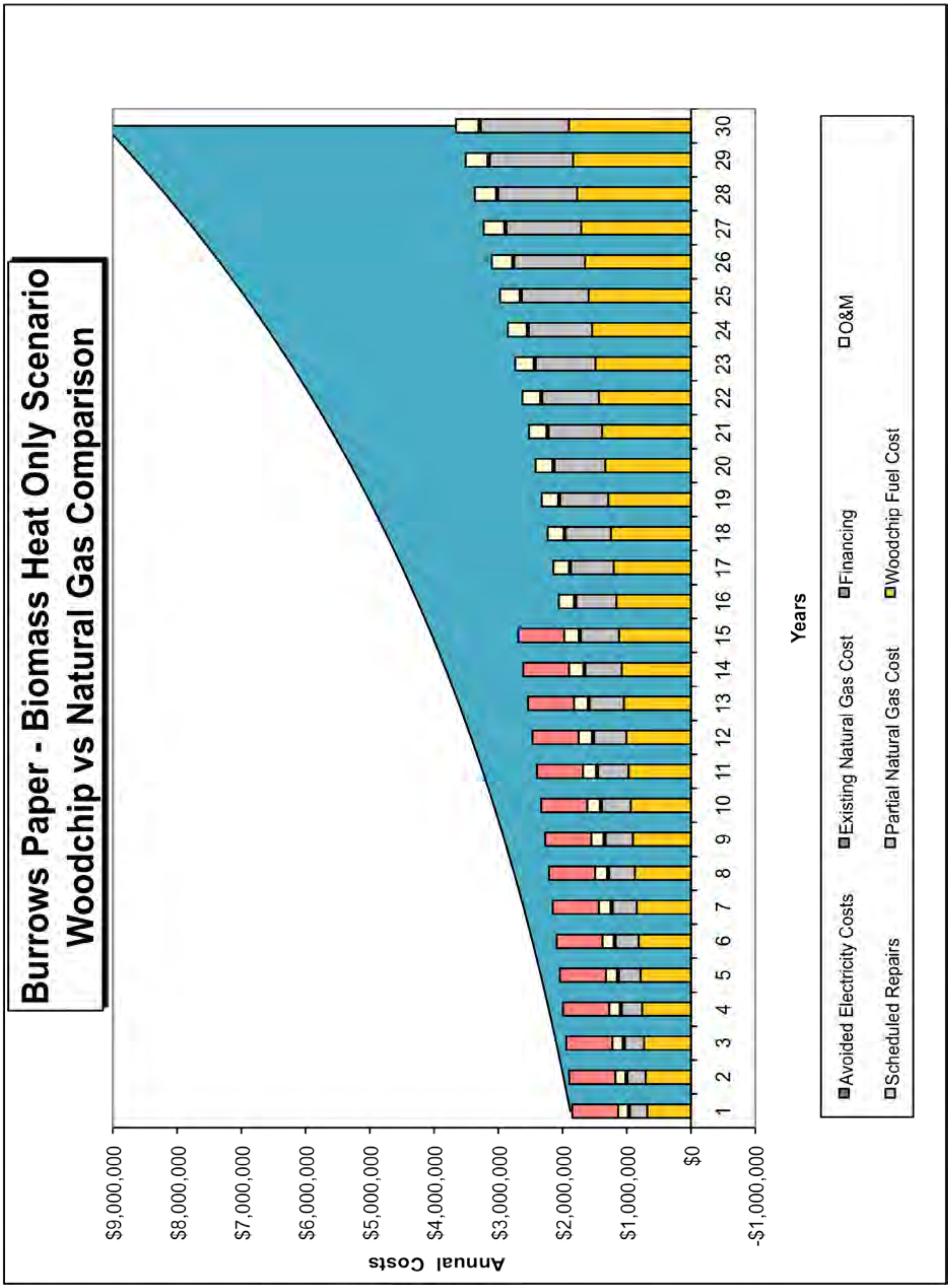


Table 3: 30-Year Life Cycle Analysis Spreadsheet for Biomass Heat Only Scenario

Burrows Paper — **Preliminary Life Cycle Cost Estimate** — ***Wood Chip - Heat Only***

Total estimated construction costs	$6,517,280		*Estimated state or federal grants* **$0**
Local Share:	$6,517,280		
Financing:	7.0%	*Assumed interest rate each year, 15 years*	
Natural Gas heat consumption	175,352	DThs/year	15% Natural Gas = 26,303 DThs; 20,075 tons if 100% woodchips for Natural Ga; 9 DTh / ton of woodchips
Natural Gas heat price	$10.72	/DTh in year 1	
Natural Gas heat cost	$1,879,768		
Estimated woodchip utilization	85%		
Projected woodchip consumption	17,064	tons	
Estimated 1st year woodchip price	$40	/ ton Year 1	
Projected 1st year woodchip cost	$682,560		
General Inflation:	2.9%	annually	*Twenty year average annual US Labor Dept. Consumer Price Index increases*
Natural Gas Inflation	5.6%	annually	*Average increase for New York Commercial NG users from 1991 - 2009 (US EIA)*
Woodchip Inflation:	3.6%	annually	*Average increase for wodchips for schools in Vermont from 1988 - 2008 is 3.6%. (VSA)*
O & M.:	$153,000	in Year 1 $	*Estimate of additional electricity for feed system motors and additional maintenance staff time*
Major Repairs:	$15,000		*Contingency for major repair (e.g. refractory replacement) at Years 10, 20 and 30 annualized*

Yr.	Natural Gas Cost	Financing	Woodchip Fuel Cost	Partial Natural Gas Cost	O&M	Scheduled Repairs	Total	Annual Cashflow	Cumulative Cashflow
1	$1,879,768	$715,562	$682,560	$281,965	$153,000	$15,000	$1,848,088	$31,680	$31,680
2	$1,985,035	$715,562	$707,132	$297,755	$157,437	$15,435	$1,893,322	$91,713	$123,393
3	$2,096,197	$715,562	$732,589	$314,430	$162,003	$15,883	$1,940,466	$155,731	$279,124
4	$2,213,584	$715,562	$758,962	$332,038	$166,701	$16,343	$1,989,606	$223,978	$503,102
5	$2,337,545	$715,562	$786,285	$350,632	$171,535	$16,817	$2,040,831	$296,713	$799,815
6	$2,468,447	$715,562	$814,591	$370,267	$176,510	$17,305	$2,094,235	$374,212	$1,174,027
7	$2,606,680	$715,562	$843,917	$391,002	$181,628	$17,807	$2,149,916	$456,764	$1,630,791
8	$2,752,654	$715,562	$874,298	$412,898	$186,896	$18,323	$2,207,977	$544,678	$2,175,469
9	$2,906,803	$715,562	$905,772	$436,020	$192,316	$18,854	$2,268,525	$638,278	$2,813,747
10	$3,069,584	$715,562	$938,380	$460,438	$197,893	$19,401	$2,331,674	$737,910	$3,551,657
11	$3,241,481	$715,562	$972,162	$486,222	$203,632	$19,964	$2,397,542	$843,939	$4,395,596
12	$3,423,004	$715,562	$1,007,160	$513,451	$209,537	$20,543	$2,466,252	$956,751	$5,352,347
13	$3,614,692	$715,562	$1,043,417	$542,204	$215,613	$21,139	$2,537,936	$1,076,756	$6,429,104
14	$3,817,115	$715,562	$1,080,980	$572,567	$221,866	$21,752	$2,612,728	$1,204,387	$7,633,491
15	$4,030,873	$715,562	$1,119,896	$604,631	$228,300	$22,382	$2,690,772	$1,340,101	$8,973,592
16	$4,256,602		$1,160,212	$638,490	$234,921	$23,031	$2,056,655	$2,199,947	$11,173,539
17	$4,494,972		$1,201,980	$674,246	$241,734	$23,699	$2,141,659	$2,353,313	$13,526,852
18	$4,746,690		$1,245,251	$712,004	$248,744	$24,387	$2,230,385	$2,516,305	$16,043,157
19	$5,012,505		$1,290,080	$751,876	$255,958	$25,094	$2,323,007	$2,689,498	$18,732,654
20	$5,293,205		$1,336,523	$793,981	$263,380	$25,822	$2,419,706	$2,873,499	$21,606,154
21	$5,589,625		$1,384,638	$838,444	$271,018	$26,570	$2,520,670	$3,068,954	$24,675,108
22	$5,902,643		$1,434,485	$885,397	$278,878	$27,341	$2,626,100	$3,276,543	$27,951,651
23	$6,233,192		$1,486,126	$934,979	$286,965	$28,134	$2,736,204	$3,496,987	$31,448,639
24	$6,582,250		$1,539,627	$987,338	$295,287	$28,950	$2,851,201	$3,731,049	$35,179,688
25	$6,950,856		$1,595,053	$1,042,628	$303,851	$29,789	$2,971,322	$3,979,535	$39,159,222
26	$7,340,104		$1,652,475	$1,101,016	$312,663	$30,653	$3,096,806	$4,243,298	$43,402,520
27	$7,751,150		$1,711,964	$1,162,673	$321,730	$31,542	$3,227,909	$4,523,242	$47,925,761
28	$8,185,214		$1,773,595	$1,227,782	$331,060	$32,457	$3,364,894	$4,820,321	$52,746,082
29	$8,643,586		$1,837,444	$1,296,538	$340,661	$33,398	$3,508,041	$5,135,545	$57,881,628
30	$9,127,627		$1,903,592	$1,369,144	$350,540	$34,367	$3,657,643	$5,469,984	$63,351,612
Totals	$138,553,685	$10,733,435	$35,821,147	$20,783,053	$7,162,256	$702,182	$75,202,073	$63,351,612	
30 Yr. NPV at 7% Discount Rate	$43,825,005	$6,517,280	$12,455,541	$6,573,751	$2,575,980	$252,547	$28,375,098	$15,449,907	

Total Annual Heating Costs	Natural Gas + Woodchips	Woodchip System O&M /Year	Contingency Allowance / Year	Woodchip + Partial NG + O&M + Contingency	Annual Fuel Cost Savings	Local Share Cost	Simple Payback (yrs)	30 Yr. NPV Savings	Annual Rate of Return
$1,879,768	$964,526	$153,000	$15,000	$1,132,526	$915,243	$6,517,280	7.1	$15,449,907	11.5%

BIOMASS CHP SCENARIO ANALYSIS RESULTS

The second biomass scenario envisions building a combined heat and power facility. All of the cost assumptions for the CHP scenario remain the same as in the biomass heat only scenario except there is an added cost of $250,000 for a back pressure steam turbine and induction generator and there are assumed electricity generation benefits.

The CHP analysis shows that Burrows could save more than $16.5 million in today's dollars in operating costs over the next 30 years by installing a woodchip heating system with a steam turbine for generating electricity, even including debt service on the cost of the system. Annual fuel savings alone are projected to be more than $1 million per year in the first year and should increase over time as natural gas and electricity prices continue to climb. If construction cost assumptions, finance cost assumptions and fuel price assumptions are correct, the CHP project will also have a positive annual cash flow from the first year.

Table 4: Biomass CHP Scenario Analysis Assumptions

Burrows Paper Biomass CHP Scenario					
Capital Cost Assumptions					
20 mmBtu biomass steam boiler system including installation					$3,000,000
200 kW steam turbine					$250,000
Stack and breeching					$150,000
300 cubic yard chip storage building and chip storage bunker	4,000	SF	$150	/SF	$600,000
Pollution control equipment					$600,000
Site preparation					$50,000
Biomass boiler room equipment					$100,000
Interconnection to existing systems					$100,000
GC markup at 10%					$485,000
Construction contingency at 15%					$800,250
Design at 12%					$736,230
Total estimated project costs					$6,871,480
State or Federal Grants					$0
Total Facility Share					$6,871,480
Financing Costs					
Financing, annual interest rate					7.0%
Finance term (years)					15
1st full year debt service					$824,578
Fuel Cost Assumptions					
Current electricity that could be replaced by a 200 kW steam turbine					1,350,000
Electric cost/kWh					$0.083
Projected annual electric bill displaced by steam turbine					$112,050
Current annual natural gas use (Dth)					175,352
Assumed natural gas price in 1st year (Dth)					$10.72
Projected annual natural gas bill					$1,879,768
Assumed wood price in 1st year (per ton)					$40
Projected 1st year wood fuel bill					$709,560
Projected 1st year supplemental natural gas bill					$281,965
Inflation Assumptions					
General inflation rate (twenty year average CPI)					2.9%
Natrual gas inflation rate (twenty year average EIA)					5.6%
Electric inflation rate					2.9%
Wood inflation rate (average increase in VT from 1988 - 2008 is 3.6%)					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					$153,000
Major repairs (annualized)					$15,000
Savings					
Net 1st year fuel savings					**$1,000,293**
Total 30 year NPV cumulative savings					**$16,529,907**

Figure 4: Annual Cash Flow Graph for Biomass CHP Scenario

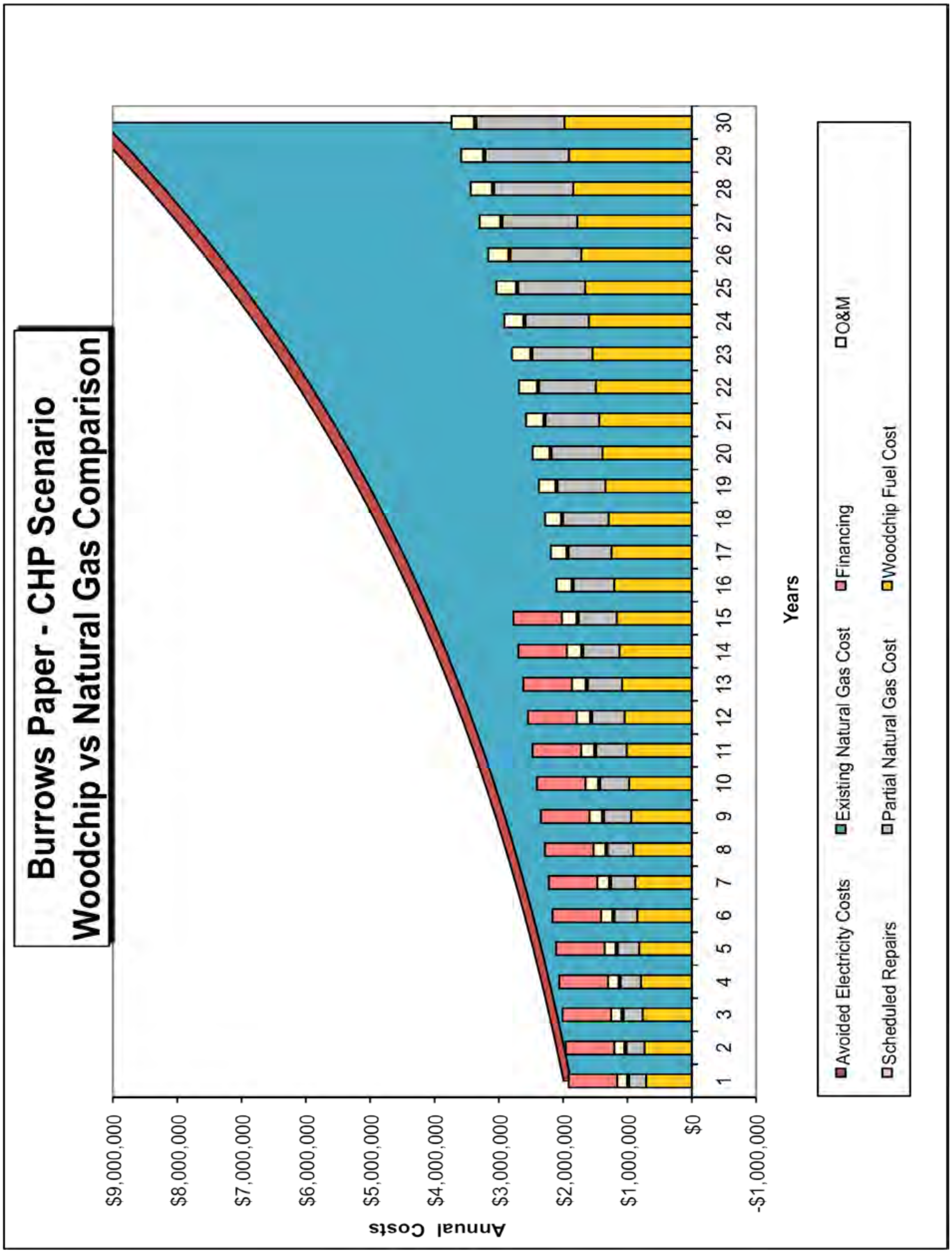


Table 5: 30-Year Life Cycle Analysis Spreadsheet for Biomass CHP Scenario

Burrows Paper — **Preliminary Life Cycle Cost Estimate** — ***Wood Chip - CHP***

Total estimated construction costs	***$6,871,480***		*Estimated state grant*	**$0**
Local Share:	**$6,871,480**			
Financing:	**7.0%**	*Assumed interest rate each year, 15 years*		
Electricity Generation Benefit	**1,350,000**	kWh/year	675	Tons of additional woodchip fuel to produce electricity
Electricity price	**$0.08**	/kWh in year 1		
Demand charge				
Total Electric Benefit in year 1	**$112,050**			
Natural Gas heat consumption	**175,352**	DThs/year	15% Natural Gas = 26,303 DThs	20,075 tons if 100% woodchips for Natural Ga; 9 DTh / ton of woodchips
Natural Gas heat price	**$10.72**	/DTh in year 1		
Natural Gas heat cost	**$1,879,768**			
Estimated woodchip utilization	**85%**			
Projected woodchip consumption	**17,739**	tons		
Estimated 1st year woodchip price	**$40**	/ ton Year 1		
Projected 1st year woodchip cost	**$709,560**			
General Inflation:	**2.9%**	**annually**	*Twenty year average annual US Labor Dept. Consumer Price Index increases*	
Natural Gas Inflation	**5.6%**	**annually**	*Average Increase for New York Commercial NG users from 1991 - 2009 (US EIA)*	
Woodchip Inflation:	**3.6%**	**annually**	*Average increase for wodchips for schools in Vermont from 1988 - 2008 is 3.6%. (VSA)*	
O & M.:	**$153,000**	**in Year 1 $**	*Estimate of additional electricity for feed system motors and additional maintenance staff time*	
Major Repairs:	**$15,000**		*Contingency for major repair (e.g. refractory replacement) at Years 10, 20 and 30 annualized*	

Yr.	Electric Cost	Natural Gas Cost	Total	Financing	Woodchip Fuel Cost	Partial atural Gas Cost	Electric Benefit	O&M	Scheduled Repairs	Total	Annual Cashflow	Cumulative Cashflow
1	$112,050	$1,879,768	$1,991,818	$754,452	$709,560	$281,965	$112,050	$153,000	$15,000	$1,913,977	$77,841	$77,841
2	$115,299	$1,985,194	$2,100,494	$754,452	$735,104	$297,779	$115,299	$157,437	$15,435	$1,960,207	$140,286	$218,127
3	$118,643	$2,096,533	$2,215,176	$754,452	$761,568	$314,480	$118,643	$162,003	$15,883	$2,008,385	$206,791	$424,919
4	$122,084	$2,214,116	$2,336,200	$754,452	$788,985	$332,117	$122,084	$166,701	$16,343	$2,058,598	$277,602	$702,521
5	$125,624	$2,338,294	$2,463,918	$754,452	$817,388	$350,744	$125,624	$171,535	$16,817	$2,110,936	$352,982	$1,055,503
6	$129,267	$2,469,437	$2,598,704	$754,452	$846,814	$370,415	$129,267	$176,510	$17,305	$2,165,496	$433,208	$1,488,711
7	$133,016	$2,607,934	$2,740,950	$754,452	$877,299	$391,190	$133,016	$181,628	$17,807	$2,222,376	$518,574	$2,007,285
8	$136,874	$2,754,199	$2,891,072	$754,452	$908,882	$413,130	$136,874	$186,896	$18,323	$2,281,682	$609,390	$2,616,676
9	$140,843	$2,908,667	$3,049,510	$754,452	$941,602	$436,300	$140,843	$192,316	$18,854	$2,343,524	$705,986	$3,322,662
10	$144,927	$3,071,799	$3,216,726	$754,452	$975,500	$460,770	$144,927	$197,893	$19,401	$2,408,015	$808,711	$4,131,373
11	$149,130	$3,244,079	$3,393,210	$754,452	$1,010,618	$486,612	$149,130	$203,632	$19,964	$2,475,277	$917,933	$5,049,306
12	$153,455	$3,426,022	$3,579,477	$754,452	$1,047,000	$513,903	$153,455	$209,537	$20,543	$2,545,435	$1,034,043	$6,083,349
13	$157,905	$3,618,169	$3,776,075	$754,452	$1,084,692	$542,725	$157,905	$215,613	$21,139	$2,618,621	$1,157,454	$7,240,802
14	$162,484	$3,821,093	$3,983,578	$754,452	$1,123,741	$573,164	$162,484	$221,866	$21,752	$2,694,974	$1,288,603	$8,529,406
15	$167,196	$4,035,398	$4,202,594	$754,452	$1,164,195	$605,310	$167,196	$228,300	$22,382	$2,774,639	$1,427,955	$9,957,360
16	$172,045	$4,261,721	$4,433,767		$1,206,106	$639,258	$172,045	$234,921	$23,031	$2,103,317	$2,330,449	$12,287,810
17	$177,034	$4,500,739	$4,677,773		$1,249,526	$675,111	$177,034	$241,734	$23,699	$2,190,070	$2,487,703	$14,775,513
18	$182,168	$4,753,161	$4,935,329		$1,294,509	$712,974	$182,168	$248,744	$24,387	$2,280,614	$2,654,715	$17,430,228
19	$187,451	$5,019,740	$5,207,191		$1,341,112	$752,961	$187,451	$255,958	$25,094	$2,375,124	$2,832,067	$20,262,295
20	$192,887	$5,301,270	$5,494,158		$1,389,392	$795,191	$192,887	$263,380	$25,822	$2,473,784	$3,020,373	$23,282,668
21	$198,481	$5,598,590	$5,797,071		$1,439,410	$839,788	$198,481	$271,018	$26,570	$2,576,787	$3,220,284	$26,502,952
22	$204,237	$5,912,585	$6,116,822		$1,491,228	$886,888	$204,237	$278,878	$27,341	$2,684,335	$3,432,487	$29,935,439
23	$210,160	$6,244,190	$6,454,350		$1,544,913	$936,628	$210,160	$286,965	$28,134	$2,796,641	$3,657,709	$33,593,149
24	$216,255	$6,594,393	$6,810,648		$1,600,530	$989,159	$216,255	$295,287	$28,950	$2,913,926	$3,896,722	$37,489,870
25	$222,526	$6,964,237	$7,186,763		$1,658,149	$1,044,636	$222,526	$303,851	$29,789	$3,036,424	$4,150,339	$41,640,209
26	$228,979	$7,354,824	$7,583,803		$1,717,842	$1,103,224	$228,979	$312,663	$30,653	$3,164,381	$4,419,422	$46,059,631
27	$235,620	$7,767,316	$8,002,936		$1,779,684	$1,165,097	$235,620	$321,730	$31,542	$3,298,054	$4,704,882	$50,764,513
28	$242,453	$8,202,943	$8,445,396		$1,843,753	$1,230,441	$242,453	$331,060	$32,457	$3,437,711	$5,007,685	$55,772,198
29	$249,484	$8,663,002	$8,912,486		$1,910,128	$1,299,450	$249,484	$340,661	$33,398	$3,583,637	$5,328,849	$61,101,047
30	$256,719	$9,148,863	$9,405,582		$1,978,893	$1,372,329	$256,719	$350,540	$34,367	$3,736,128	$5,669,454	$66,770,500
Totals	$5,245,299	$138,758,277	$144,003,576	$11,316,774	$37,238,122	$20,813,742	$5,245,299	$7,162,256	$702,182	$77,233,076	$66,770,500	
	30 Yr. NPV at	7%	Discount Rate									
	$1,886,526	$43,872,507	$45,759,033	$6,871,480	$12,948,244	$6,580,876	$1,886,526	$2,575,980	$252,547	$29,229,126	$16,529,907	

Total Annual Healing Costs	Natural Gas + Woodchips	Woodchip System O&M /Year	Contingency Allowance / Year	Woodchip + Fuel + O&M + Contingency	Electric Benefit	Annual Fuel Cost Savings	Local Share Cost	Simple Payback (yrs)	30 Yr. NPV Savings	Annual Rate of Return
$1,879,768	$991,526	$153,000	$15,000	$1,159,526	$112,050	$1,000,293	$6,871,480	6.9	$16,529,907	10.5%

ADDITONAL ISSUES TO CONSIDER

ENERGY EFFICIENCY

Whether Burrows Paper converts to biomass or stays with natural gas, the facility should use energy efficiently. The New York State Energy Research and Development Authority (NYSERDA) can help identify and prioritize appropriate energy efficiency projects that will improve the facility's infrastructure and save money. NYSERDA's Flextech contractors can help analyze the opportunity for CHP and they can help with the evaluation of energy efficiency opportunities. NYSERDA also provides financial incentives to upgrade and improve equipment efficiencies. If the facility decides to move forward with a biomass energy project, it should work with NYSERDA to identify other efficiency projects that could be completed at the same time.

General information on NYSERDA programs is included in the *Biomass and Green Building Resources* binder accompanying this report.

COMMISSIONING

Commissioning of a new system provides quality assurance, identifies potential equipment problems early on and provides financial savings on utility and maintenance costs during system operations. A recent study of 224 buildings found that the energy savings from commissioning new buildings had a payback period of less than five years. Additional benefits of commissioning include: improved indoor air quality, fewer deficiencies and increased system reliability. We recommend that Burrows Paper work with an independent, third-party, commissioning agent during the design and construction of a biomass energy system. See the *Biomass and Green Building Resources* binder for more information on commissioning.

COMBINED HEAT AND POWER (CHP)

With its consistent year-round steam load, Burrows Paper makes for a particularly attractive site for biomass combined heat and power (CHP). Adding the equipment to produce electricity will add less than 5% to project costs, but will provide a nearly 40% return on investment.

The Northeast CHP Application Center has a mission to help facilities understand their CHP opportunities. They often can provide technical assistance at little to no cost to the facility. If Burrows decides to move forward with a biomass energy project, we recommend contacting them for assistance. For more information, contact Beka Kosanovic, NAC Co-Director for Technical Assistance at:

Northeast CHP Application Center
(413) 545-0684
kosanovi@ecs.umass.edu
http://www.northeastchp.org/nac/

PROJECT FUNDING POSSIBILITIES

GRANTS/FINANCING OPPORTUNITIES

USDA Rural Energy for America Program (REAP)

To help agricultural producers and rural small businesses purchase and install RE systems and energy efficiency improvements.

Eligible Small Businesses are to be located in a rural area and can not exceed SBA size standards by NAICS code.
http://www.sba.gov/idc/groups/public/documents/sba_homepage/serv_sstd_tablepdf.pdf)

Eligible technologies include wind, solar, biomass, geothermal, hydrogen, small hydro and energy efficiency. The projects are limited to commercial and pre-commercial (no R&D). Residential property is not eligible for Rural Energy for America grants or loans.

Grant – The grant can cover up to 25% of eligible project costs with a minimum grant amount of $2,500 and a maximum grant amount of $500,000.

Guaranteed Loan – Guaranteed loans can be used for working capital, land acquisition and costs related to the Renewable Energy system. Loans can cover a maximum of 75% of project costs. The maximum loan amount is $25 million. Borrower equity of 15% is required for guaranteed loans less than $600,000 and 25% for guaranteed loans greater than $600,000 (some borrower equity can be covered by a REAP grant, see below).

Combination Grant/Guaranteed Loans – Combine Grant and Guaranteed Loans cannot exceed 75% of total project costs. The minimum combine funding level is $80,000 with the grant covering a minimum of $20,000. The grant amount contributes to the borrower equity percentage in the project.

USDA Business and Industry Guaranteed Loans (B&I)

The purpose of the B&I Guaranteed Loan Program is to improve, develop, or finance business, industry, and employment and improve the economic and environmental climate in rural communities. This purpose is achieved by bolstering the existing private credit structure through the guarantee of quality loans which will provide lasting community benefits. It is not intended that the guarantee authority will be used for marginal or substandard loans or for relief of lenders having such loans.

Eligible borrowers must be a cooperative organization, corporation, partnership, or other legal entity organized and operated on a profit or nonprofit basis. The borrower must be engaged in or proposing activities which improve the economic or environmental climate and/or reduce reliance on nonrenewable energy resources by encouraging the development and construction of solar energy systems and other renewable energy systems.

The maximum loan amount is $10 million. The maximum percentage of guarantee for the loan is 80% for loans of $5 million or less and 70% for loans between $5 million and $10 million. Machinery and equipment loans must be repaid in 7 years or less.

For more information on USDA grants and loans contact:
Karen McDonnell | Rural Business Cooperative Specialist
USDA Rural Development
315-4776426 | 315-477-6448 Fax
beverly.vonpless@ny.usda.gov

NYSERDA

NYSERDA's **FlexTech Program** provides New York State commercial, industrial, institutional, government, and not-for-profit sectors with objective and customized information to help customers make informed energy decisions. FlexTech's goal is to increase productivity and economic competitiveness of participating facilities by identifying and encouraging the implementation of cost-effective energy efficiency, carbon reduction measures, peak-load curtailment, and CHP and renewable generation projects. Facilities can apply for funding for Combined Heat & Power studies that will investigate the site-specific technical and economic feasibility of installing CHP. All projects must include cost-sharing in the form of matching cash support from the applicant. For most applications, NYSERDA will contribute fifty percent (50%) of the eligible study costs, up to the lesser of either $1,000,000 or ten percent (10%) of the applicant's annual energy costs, based on an approved Scope of Work. The full Program Opportunity Notice (PON), including an application, is available in the Biomass and Green Building Resource Binder or online at:
http://www.nyserda.org/Funding/1746pon.asp

There is a chance that NYSERDA will be announcing funding available for Biomass Combined Heat and Power projects this fall. It is proposed that the agency will have grants available for 30% of the project up to $2 million. Proposals will be due in early December (2010). For more information contact Jeff Peterson, Energy Resources Project Manager at:
NYSERDA
17 Columbia Circle
Albany, NY 12203
518-862-1090 x3288 | 518-862-1091 Fax
jmp@nyserda.org

FEDERAL TAX INCENTIVES

ELECTRICITY/ CHP

Business Energy Investment Tax Credit

This corporate tax credit is equal to 10% of Combined Heat and Power expenditures, with no maximum limit. Eligible CHP property generally includes systems up to 50 MW in capacity that exceed 60% energy efficiency, subject to certain limitations and reductions for large systems. The efficiency requirement does not apply to CHP systems that use biomass for at least 90% of the system's energy source, but the credit may be reduced for less-efficient systems.

MACRS Accelerated Deprecation

Under the federal Modified Accelerated Cost-Recovery System (MACRS), businesses may recover investments in certain property through depreciation deductions. The MACRS establishes a set of class lives for various types of property, ranging from three to 50 years, over which the property may be depreciated. For certain biomass property, the MACRS property class life is seven years. Eligible biomass property generally includes assets used in the conversion of biomass to heat or to a solid, liquid or gaseous fuel, and to equipment and structures used to receive, handle, collect and process biomass in a waterwall, combustion system, or refuse-derived fuel system to create hot water, gas, steam and electricity.

For more information on Federal tax incentives, see the Database of State Incentives for Renewable Energy Website at:
http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US06F&re=1&ee=1

THERMAL

At the time this report was written there were no tax credits available for commercial installation of thermal biomass heating systems. However there is legislation pending in Congress that could change this situation. The Biomass Thermal Energy Council (BTEC) does a good job of keeping up-to-date on all biomass-related legislation, including tax credits. You can visit their website for the most up-to-date information: http://www.biomassthermal.org/legislative/. The following bills are pending:

S. 3188 – American Renewable Biomass Heating Act of 2010

This bill would establish a corporate tax credit equal to 30% of the installed cost of biomass heating systems for commercial or industrial applications, with no maximum credit. To qualify for the credit, boilers and furnaces would be required to operate at greater than 75% efficiency and provide thermal energy for space heating, air conditioning, domestic hot water, or industrial process heat.

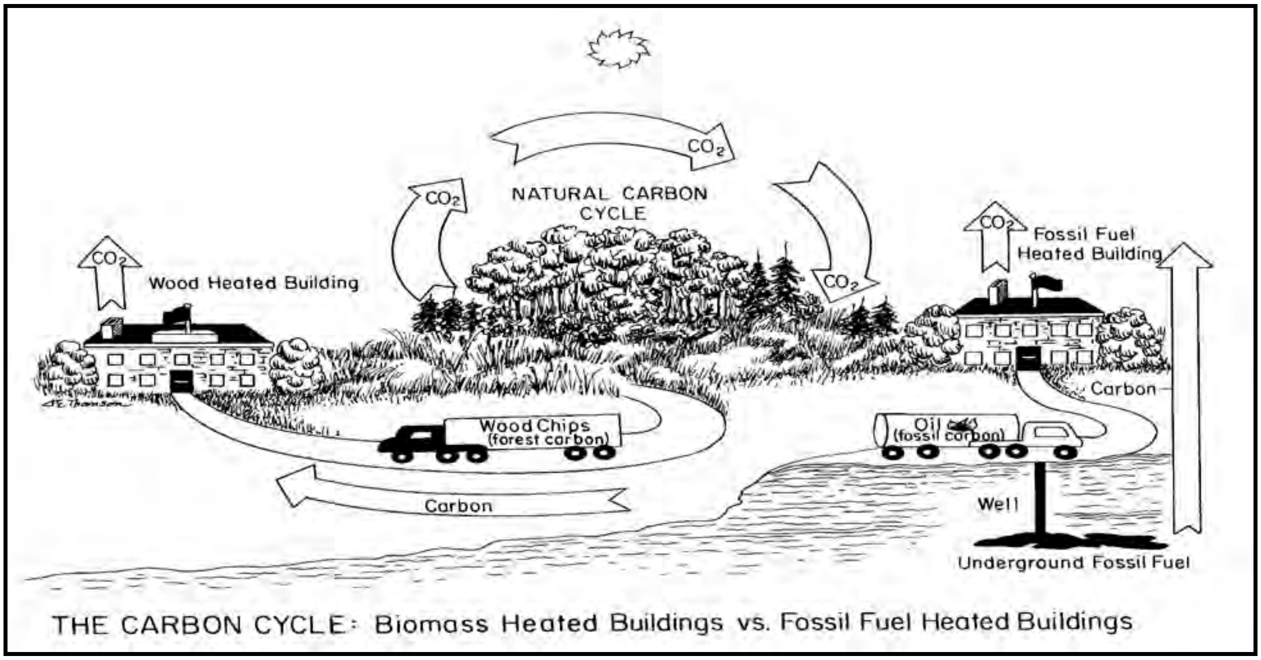
S. 1094 – REAP Act

This bill would amend the Renewable Energy Alternative Production (REAP) Act to include a credit for the production of non-electric renewable energy, including thermal energy.

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 Burrows Paper could undertake that would reduce its carbon footprint more than switching their heating fuel use from natural gas to a biomass fuel.

Figure 5: Carbon Cycle Illustration[3]



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 (equivalent to 117 lbs per Dth). It is projected that Burrows Paper can offset approximately 149,000 Dth of natural gas per year by replacing

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

that energy using biomass. This is equivalent to about 8,700 tons of CO_2. 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 $26,100 - $43,500 or a lump sum up front payment of as much as $261,000 to $435,000.

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

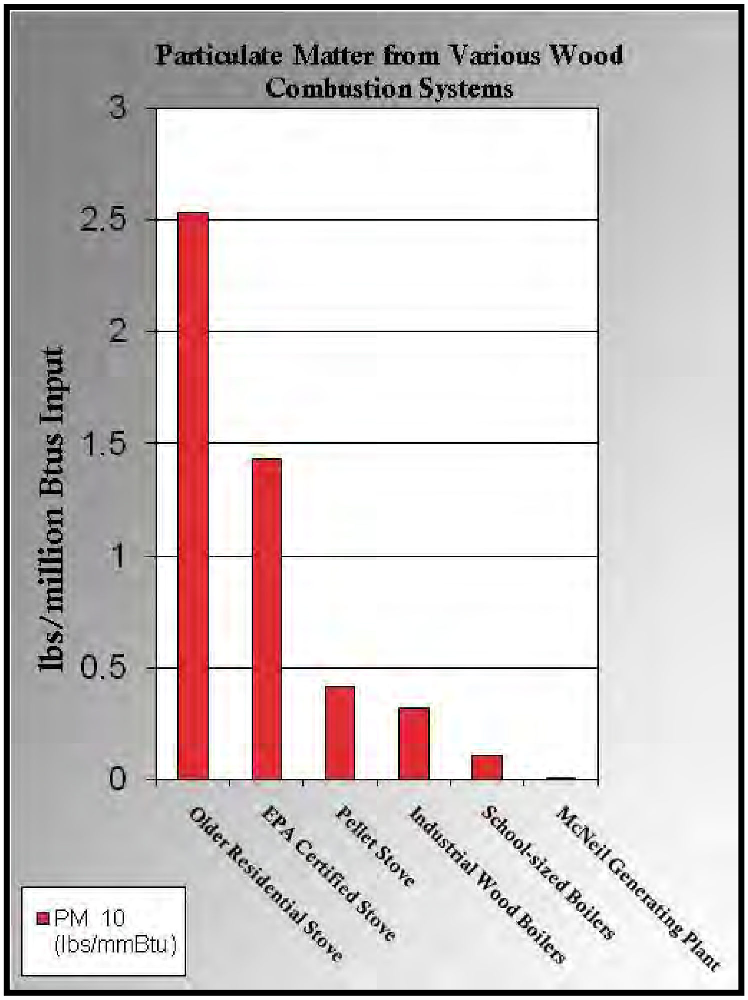
Modern biomass boiler technology is both clean and efficient. Controls moderate both the biomass fuel and air to create either a small hot fire or a large hot fire depending on heat demand from the building. Under full load, modern woodchip boilers routinely operate at steady state efficiencies of 70% – 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 boiler 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.

As with any combustion process, there are emissions from biomass boilers. The pollutant of greatest concern with biomass is particulates (PM_{10}). While biomass compares reasonably well with natural gas, biomass boilers clearly generate more particulates. 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.

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 6: Particulate Emissions[4]



New EPA Regulations

On April 29, 2010, the Environmental Protection Agency (EPA) issued a proposed rule that would reduce emissions of toxic air pollutants from existing and new industrial, commercial and institutional boilers located at area source or major source facilities. An area source facility emits or has the potential to 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 major source facility emits 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.

The proposal would set different requirements for large and small boilers at the area source facility. Large boilers have a heat input capacity equal to or greater than 10 mmBtu/hr and small boilers have a heat input capacity less than 10 mmBtu/hr. The biomass fired new boilers would need to meet limits for PM and CO. For the major source facility, EPA has identified 11 different subcategories of boilers and process heaters based on the design of the various types of units. The proposed rule would include specific requirements for each subcategory.

Details on the status of this proposal will be posted at www.epa.gov/airquality/combustion/

In order to install a new woodchip boiler, it is likely that the company will need 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, such as a bag house or an electrostatic precipitator along with a requirement for a tall stack to help with dispersion. Costs for pollution control equipment and a tall stack are included in the cost estimates for the woodchip scenario 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.

[4] Excerpted from a handout produced by the Biomass Energy Resource Center

CONCLUSIONS AND RECOMMENDATIONS

Burrows Paper appears to be an excellent candidate for a biomass energy system. Based on our site visit we believe there is enough space in the existing boiler room to install a woodchip steam boiler and a workable site for a woodchip storage building immediately outside the existing boiler room. The existing natural gas boiler system could work well to provide back-up and supplemental heat in combination with a wood-fired boiler. We recommend Burrows Paper takes the following steps to investigate this opportunity further:

1. This is only a preliminary feasibility study to explore the economics of investing in a biomass energy system. The next step should be to hire a qualified engineering firm to help refine the project concept and to obtain firm local estimates on project costs.
2. The US Forest Service may be able to provide some engineering technical assistance from an engineering team with biomass experience that is part of the program that funded this study. 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. His contact information is: 304-285-1538, lmccreery@fs.fed.us.
3. Emission regulations for the installation of commercial and industrial scale boilers will be changing in the near future. The EPA is undergoing a public review process for draft rules that could affect the type of equipment specified for a site like this. The engineers hired by the facility for a biomass project should carefully review the new rules and evaluate the best available technology options for pollution control devices when they are designing the project.
4. The New York State Energy Research and Development Authority (NYSERDA) has funding available to help cover the cost of detailed Combined Heat and Power studies. We recommend working with NYSERDA to take advantage of this opportunity.
5. Another potential resource for exploring CHP is the Northeast Combined Heat and Power Initiative. This group provides technical assistance for facilities considering CHP at little or no cost. For more information, visit: http://www.northeastchp.org/.
6. NYSERDA should also be engaged to develop comprehensive energy efficiency recommendations and proposals for incentives for efficiency upgrades. NYSERDA provides technical assistance and cash incentives for many energy efficiency improvements including building efficiency and industrial process efficiencies. Information on NYSERDA programs is included in the Resource Binder accompanying this report.
7. Concurrent with the design of a biomass project, Burrows Paper should investigate potential woodchip fuel providers. Contact the New York State Forest Utilization Program for a list of local suppliers.

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, LLC

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.

Wilson Engineering Services, PC

Wilson Engineering Services (WES) is a multidisciplinary firm providing engineering and consulting services for a wide range of projects and programs. WES combines extensive experience in the following areas to provide clients with sustainable solutions to energy and environmental related issues, including agri-business; application of technology projects related to energy production and distribution, waste handling and environmental remediation; and engineering consulting project and program management.

APPENDICES

DISCUSSION OF BIOMASS FUELS

Purchasing wood fuel is a different exercise than purchasing natural gas. While natural gas is 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, Burrows Paper 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, Burrows Paper 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 New York State Forest Utilization Program for a list of local suppliers.

The bottom line is that both Burrows Paper 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 Burrows Paper 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 longer 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.

POTENTIAL BIOMASS FUEL SUPPLIERS

Active providers of woodchip fuel change regularly. For the most up-to-date information on potential providers contact the New York State Forest Utilization Program:

Sloane Crawford
Program Leader
NYS Forest Utilization Program
625 Broadway
Albany, NY 12233-4253
Phone: (518) 402-9415
Fax: (518) 402-9028
sncrawfo@gw.dec.state.ny.us

310 Hardwood Lane
Princeton, WV 24720
(304) 487-1510

MEMORANDUM ON CHP POTENTIAL

DATE: **September 21, 2010**

TO: **Jeff Forward, Yellow Wood**

FROM: **Dan Wilson, PE; WES**

CC: **Lew McCreery, WERC**

RE: **Conceptual Estimate of Biomass Electric Generation Potential – Burrows Paper, Lyonsdale**

This memorandum provides the results of an evaluation done at the conceptual level. The goal of the evaluation is to assess the potential for Burrows Paper to generate low-cost electricity as part of a biomass project utilizing a 600-hp boiler to provide process steam. A site visit and detailed evaluation of operating processes at the Burrows Paper plant has not been conducted and would be required for a more detailed analysis. The following information has been provided to allow development of this analysis.

- 2008 and 2009 month natural gas and steam usage
- Daily natural gas and steam usage from 1999 – 2010
- Electric bills showing $0.084 cost of electric
- Spreadsheet showing hourly electric demand for 2009 and 2010 ranging from about 600 kW to 2,800 kW
- 235^{o}F boiler feed water
- 175 psig steam distribution pressure required for processes in plant
- 600-hp biomass boiler operating to provide offset of natural gas and backpressure steam electric generation as a secondary objective

Energy Use Profile

Daily records of natural gas and purchased steam usage for the plant were used to develop an average boiler output required for each day. These values were used to generate the load duration curves shown in Figures 1 and 2. Analysis of the curves shows that the plant has a load that is at or above 10 mmBtu/hr for over 95% of the time during plant operations.

The green hatching on the graph shows the load that could be covered by a 600 hp biomass boiler with a 4:1 turndown ratio. These graphs show that over 95% of the current fuel usage could be replaced by a 600-hp biomass boiler. This replacement estimate is based on a daily average output as opposed to actual hourly data, and should be verified through tracking of daily load fluctuations.

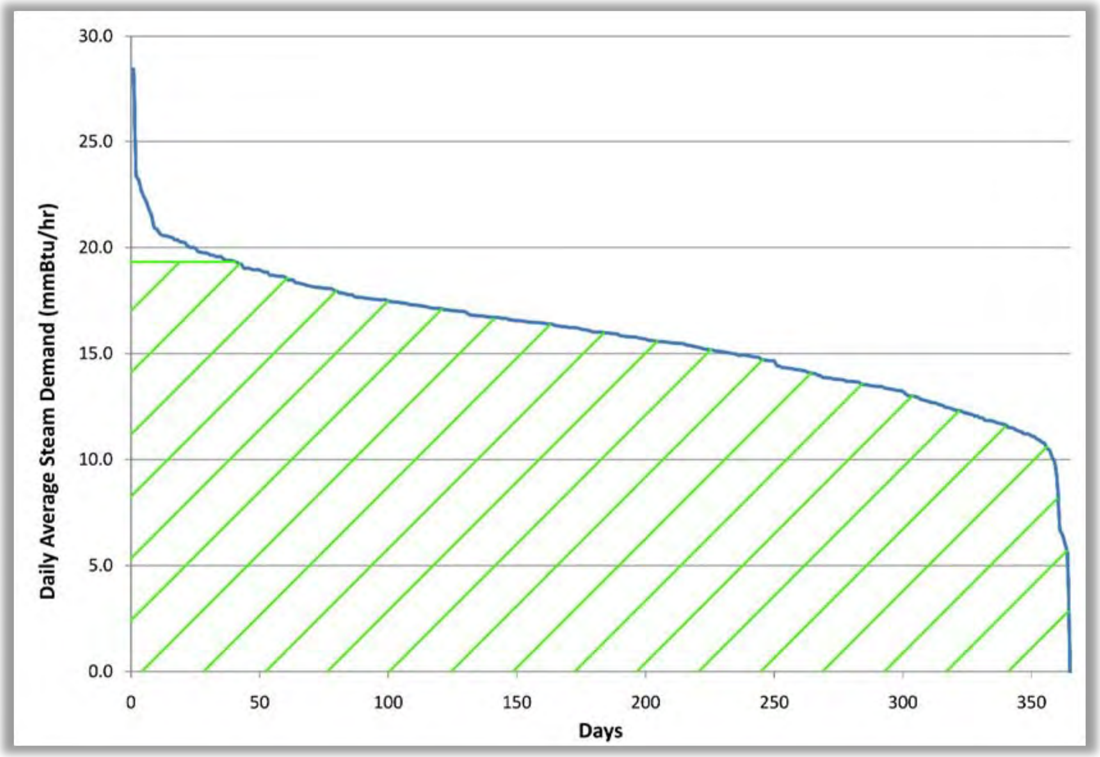


Figure 1 – 2008 Load Duration Curve, Daily Average Output

Note: Figure developed using daily fuel usage records.

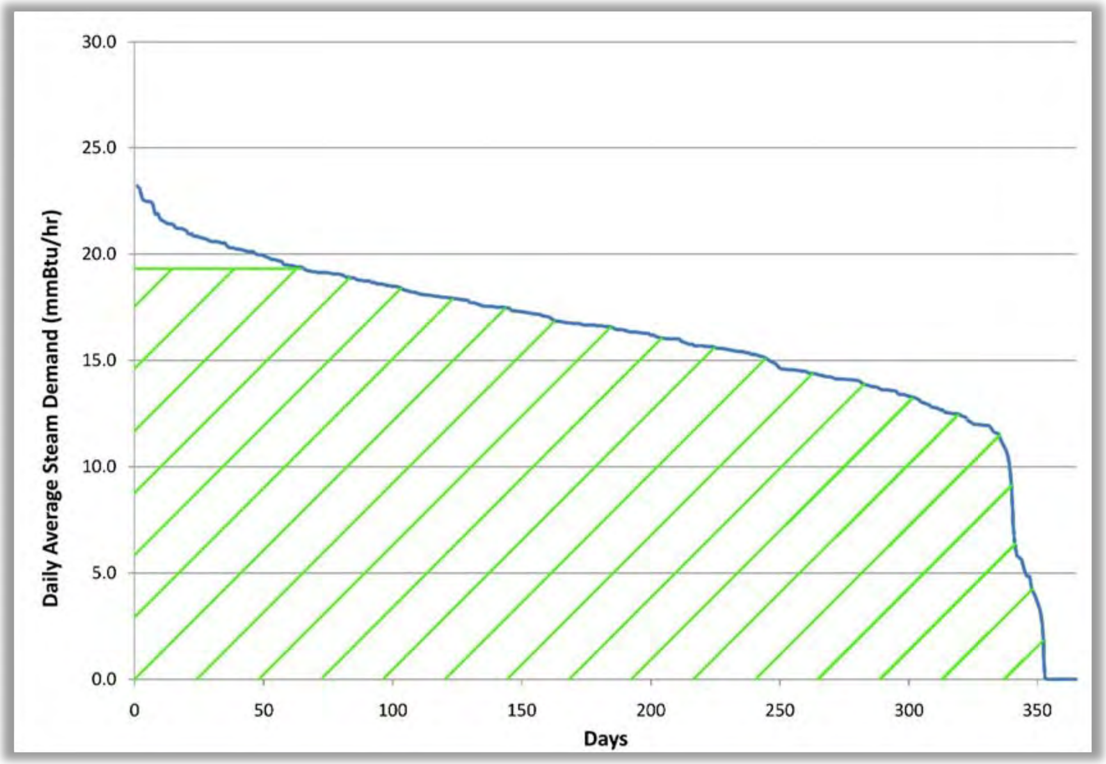


Figure 2 – 2009 Load Duration Curve, Daily Average Output

Note: Table developed using daily fuel usage records.

Biomass Potential (Thermal and Electrical Generation)

Table 1 shows the annual demand for 2008 and 2009. The gas usage value was obtained by subtracting the first meter reading of each year from the last meter reading of each year. The steam usage was obtained by totaling the daily records of steam usage for the year. Due to the distribution of steam demand, a 600-hp biomass boiler can provide about 95% of the annual steam demand for the plant. Table 1 also shows the potential annual electric generation with a 200 kW backpressure steam turbine.

Table 1 – Annual Steam Usage and Potential Replacement by Biomass, Electric Generation

Item	2008	2009
Gas Usage, mcf	65,701	113,130
Purchased Steam, k-lbs - 175 psig, sat	80,580	39,198
Gas Boiler Output, k-lbs - 175 psig, sat	57,915	99,723
Total Steam Demand, k-lbs - 175 psig, sat	138,495	138,922
Potential Demand Replaced by Biomass, k-lbs - 175 psig, sat	**132,874**	**132,314**
Electric Generation Potential from Biomass, kWh	**1,375,223**	**1,362,829**

Current electric charges are approximately $0.083/kWh. The installation of a backpressure steam turbine to be run on biomass fuel could produce electricity for $0.02/kWh in biomass fuel costs. Thus, the potential annual savings on electric costs would be approximately $85,000. [($0.084-$0.02)*1,350,000 kWh]

The following assumptions were used to estimate the replacement values and potential cost savings:

1) 85% efficiency of the current natural gas boiler
2) 1,030,000 Btu/mcf
3) Biomass boiler output of 425 psig, saturated steam
4) Backpressure steam turbine output of 175 psig, saturated steam
5) 200 kW backpressure steam turbine, 48% isentropic efficiency, output of 175 psig, saturated steam
6) $40/ton wood chips, 10 mmBtu/ton, 75% biomass boiler efficiency
7) Current electric cost of $0.083/kWh

Backpressure Steam Turbine System and Capital Costs

The system recommended would be a 200 kW backpressure steam turbine with an induction generator. All electricity generated would be utilized within the plant, and grid connection would not be required. The electric demand in the plant has been shown to always exceed 200 kW.

The capital cost for this system, installed, would be approximately $250,000. This includes the turbine, generator, controls, and switchgear. Depending on the onsite electrical distribution, a transformer may be required and would be additional cost.