Woody Biomass Technologies Assessment for Heat and/or Power

Bad River Band of Lake Superior Tribe of Chippewa Indians

Odanah, Wisconsin

SEH No. TRBRC 116118

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Executive Summary

The purpose of the assessment was to analyze the existing heat and power infrastructure of four buildings on the Bad River Band of Lake Superior Tribe of Chippewa Indians reservation and develop alternative heat and/or power alternatives. The **Lodge and Casino, Moccasin Trail Center, Tribal Elderly Center,** and new **Tribal Wellness Center** were assessed for their potential to integrate bioenergy into their heating and power needs. Four alternatives were developed including capital costs, estimated annual maintenance costs, a projection of annual heat and/or power savings, a benefit-cost comparison with alternative proposals, and a description of biomass feedstock requirements, and emissions. A brief description of each alternative and key findings are presented below.

Option #1) Casino/Motel Pool Heating (all year long)

- Balance of system located adjacent to casino/hotel complex
- Enclosed to limit dust, noise, and disturbance
- Steady, stable usage -0.4 MMBTU/hr
- Replace Natural Gas Heat ($37,000/yr)
- Capital costs $367,000
- Operational costs $28,000/yr
- Simple payback approx. 44 yrs. – with 35% funding assistance reduced to 29 years

Option #2) Pool Heating plus Electrical generation for use at Wellness Center (all year long)

- Balance of system located adjacent to casino/hotel complex
- Enclosed to limit dust, noise, and disturbance
- Steady, stable usage at pool - 0.4MMBTU/hr
- Electrical power routed to Wellness center
- Replace Natural Gas Heat and Electricity ($80,000/yr)
- Capital Costs $624,000
- Operations Costs $42,000/yr
- Simple Payback approx 17 years with 35% funding assistance reduced to 11 years

Option #3) Pool Heating Seasonal Heating of Wellness Center

- System co-located with Wood Receiving and Long Term Storage area
- Heat piped approx 600 ft to Wellness Center and 600 ft to casino/hotel complex
- Steady, stable usage at pool - 0.4 MMBTU/hr at low end with “turn-up” capacity to 1.0 MMBTU/hr to accommodate seasonal use of heat at Wellness center
- Replace Natural Gas Heat ($65,000/yr)
- Capital Costs $928,000
- Operational Costs $47,000/yr
- Simple payback approx 51 yrs - with 35% funding assistance reduced to 33 years

Option #4) Pool Heating Seasonal Heating of Wellness Center plus Electrical generation

- System co-located with Wood Receiving and Long Term Storage area
- Heat piped approx 600 ft to Wellness Center and 600 ft to casino/hotel complex
- Steady, stable usage at pool - 0.4 MMBTU/hr at low end with “turn-up” capacity to 1.5-MMBTU/hr to accommodate seasonal use of heat and power at Wellness center and other Buildings
- Replace Natural Gas Heat and Electricity ($165,000/yr)
- Capital Costs $1.3M
- Operational Costs $70,000/yr
- Simple payback approx 14 yrs - with 35% funding assistance reduced to 9 years

Table of Contents

Acknowledgements
Executive Summary
Table of Contents
Abbreviations

Page

1.0 Introduction 1
1.1 Scope of Services 1
2.0 Review of Existing Energy Infrastructure and Demand 1
3.0 Preliminary Design Consideration 2
3.1 Facility Components 2
3.2 Physical Site Requirements 3
3.2.1 Location 3
3.2.2 Size 3
3.2.3 Transportation Infrastructure 3
3.2.4 Fuel 3
3.2.5 Water 3
3.2.6 Wastewater 3
3.2.7 Waste Management 3
3.3 Permitting and Regulatory Considerations 3
3.3.1 Land Use and Construction Code 4
3.3.1.1 Traffic 4
3.3.1.2 Building and Construction Codes 4
3.3.2 Environmental Permits 4
3.3.2.1 National Environmental Policy Act (NEPA) 4
3.3.2.2 Air Emissions 5
3.3.2.3 Wetlands 5
3.3.2.4 Water Supply 5
3.3.2.5 Stormwater 5
3.3.2.6 Wastewater 5
3.3.2.7 Solid and Hazardous Wastes 5
4.0 Biomass for Heat and/or Power Options 5
4.1 Option #1 – Casino/Motel Pool Heating (all year long) 6
4.2 Option #2 – Pool Heating plus Electrical generation for use at Wellness Center (all year long) 6
4.3 Option #3 – Pool Heating plus Seasonal Heating of Wellness Center 7
4.4 Option #4 – Pool Heating plus Seasonal Heating and Electrical Generation for Wellness Center System and Other Buildings 8
5.0 Discussion 8
5.1 Job Creation and Training Opportunities 8
5.2 Air Quality 9
5.3 Cost Sensitivity 9

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Table of Contents (Continued)

5.4 Tribal Energy Plan 9
6.0 Resources 10

List of Appendices

Appendix A Wood Yard Location
Appendix B Cost Estimates
Appendix C FAQs on Wood Boiler Air Quality Issues

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Abbreviations

BIA	Bureau of Indian Affairs
Bad River	Bad River Band of Chippewa
BTU	British thermal unit
cft	cubic feet
CHP	combined heat and power
DOE	United States Department of Energy
dtpd	dry tons per day
EIA	Energy Information Administration
F	degrees Fahrenheit
FS	Feasibility Study
gpm	gallons per minute
gtpd	green tons per day
kwhr	kilowatt hour
lbs	pounds
MMBtu	Million British thermal units
MW	MegaWatt
NEPA	National Environmental Policy Act
NREL	National Renewable Energy Lab
SEH	Short Elliott Hendrickson Inc.
sft	square feet
State	State of Wisconsin
USDA	United States Department of Agriculture
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service

Woody Biomass Technologies Assessment for Heat and/or Power

Prepared for Bad River Band of Lake Superior Tribe of Chippewa Indians

1.0 Introduction

On behalf of the Bad River Band of Chippewa (Bad River) SEH has completed the woody biomass technology assessment, in accordance with our proposal dated January 17, 2011.

This project has focused on biomass to energy opportunities for the Bad River commercial complex on US Highway 2, which include:

- Lodge and Casino
- Moccasin Trail Center
- Tribal Elder Center
- New Health and Wellness Center (under construction)

1.1 Scope of Services

The following tasks were conducted to meet the objectives of the assessment:

- Review existing energy infrastructure and demand
- Conduct woody biomass technology assessment reviewing at least three options to provide heat and or power to one or a group of the buildings identified.
- Report preparation and meetings.

2.0 Review of Existing Energy Infrastructure and Demand

SEH conducted multiple site visits and meetings with the Bad River Energy Task Force to better understand the existing conditions at the site, energy costs, and to put the various background materials provided in to context.

It is our understanding that the Casino, Hotel, and Moccasin Trail Center are on interruptible power and that discount rates have been negotiated for electricity ($0.07/kwhr). The Elderly Center and Wellness Center have somewhat higher electricity rates ($0.11/kwhr). Natural gas rates are approximately $1.05/therm.

To gain an understanding of the heat and power demands of the four facilities we reviewed the:

- Energy Load Assessment Study Bad River Indian Reservation (Energy Center of Wisconsin, October 2010), and the
- Energy Cost Analysis of Bad River Health and Wellness Center (All Service Plumbing, June 2010)

In order to understand the infrastructure in place at the 4 buildings, we conducted a site visit after reviewing the construction drawings for the:

- Casino and Hotel (Dovolis Johnson and Ruggieri, August 18, 1995)
- Casino Addition & Remodel (TCI, December 2000)
- Elder Center Facility (Krech Ojard, July 2, 2008)
- Health and Wellness Center (dsgw, July 23, 2010)

In order to understand the potential to provide hot water to the existing boiler systems, we also obtained and reviewed the Maintenance Manuals for both the

- Munchkin Boiler (specified for Elder Center), and the
- Buderus Boiler, SB615 Series (specified for Wellness Center)

We reviewed the following reports to establish reasonable biomass harvest quantities that could be expected to provide fuel for the potential biomass to energy scenarios:

- Estimate of Biomass Yields from Bad River Trust Lands (BIA, June 2009 Update).
- Preliminary Assessment of Woody Biomass Resources on Bad River Reservation Trust Lands (BIA, August 2008)
- Assessment of Biomass Resources for Energy Generation at XceL Energy's Bay Front Generating Station in Ashland, WI (Energy Center of Wisconsin, April 2007) and the
- Integrated Resources Management Plan – Bad River Band of Lake Superior Tribe of Chippewa Indians (July 2001)

Finally, in order to better understand potential locations for a wood yard and central heating plant, we reviewed the "master plan" components of the report: Bad River Indian Reservation – A Study of American Indian Communities in Odanah, WI (Kathy Lewis, UW Madison, May 2010).

3.0 Preliminary Design Consideration

This section describes design, construction and permitting considerations for bio-mass heat and power systems. The NREL report Market Assessment of Biomass Gasification and Combustion Technology for Small- and Medium-Scale Applications, and USEPA report Biomass Combined Heat and Power Catalog of Technologies indicate that either direct combustion boilers or close-coupled gasifiers would be appropriate technologies for the scale of applications being considered.

3.1 Facility Components

The biomass to energy facility will include the following components

- Wood chip receiving and long term storage (14 days +)
- Short term storage for feed into energy system (minimum 3 days for holiday weekend)
- Feed system
- Combustion system & boiler
- Heat conveyance to user (pipes and pumps)
- Heat exchangers
- Power transmission
- Integration with existing infrastructure

- Ash handling
- Emissions control and stack

3.2 Physical Site Requirements

3.2.1 Location

The location of the wood storage area and biomass to energy system should be located as close to the buildings as is feasible and have enough room for

- Processing 1 to 3 tons green wood chips per day
- Minimum 14 days storage = 14 to 28 tons storage space (need minimum 500 sft area for storage, plus additional space for equipment, truck turn around, etc)
- Traffic Flow (2 to 3 truckloads of chips per month delivered to site)
- Space available allows for expanded storage if economic benefit
- Space for storing and chipping raw wood (roundwood, residuals, etc) if desired in future

Appendix A includes a sketch of one potential location that was discussed in a currently undeveloped area north of Moccasin Trail Center.

3.2.2 Size

The optimal site location would have approximately 2 acres of area to allow for the various system components, and potential future expansion.

3.2.3 Transportation Infrastructure

The site location should be adjacent to roads that can handle heavy traffic and loads from the biomass delivery and product shipping.

3.2.4 Fuel

Propane or natural gas is typically required for pilot ignition of heating system. Fuel oil may be used as start-up fuel for heating system.

3.2.5 Water

Water supply to the facility would be required for sanitary uses, drinking water, housekeeping operations, and for fire protection.

3.2.6 Wastewater

Wastewater disposal will primarily be for human sanitary uses and housekeeping. Human wastewater would be disposed in a local sewer or in an underground septic system. Wastewater generated from plant maintenance activities that may contain hazardous chemicals would be diverted to a temporary storage tank system for offsite disposal.

3.2.7 Waste Management

Waste containers would be required for waste generated during normal operations (administrative, housekeeping, empty containers).

3.3 Permitting and Regulatory Considerations

The Bad River Band of the Chippewa Tribe is a federally-recognized Indian Tribe responsible for regulation of activities which occur on its Reservation lands in cooperation with the requirements of the United States federal government. This section outlines various permitting and regulatory considerations when progressing with various components of the project.

3.3.1 Land Use and Construction Code

3.3.1.1 Traffic

A Traffic Plan may be required by the Bad River to establish traffic route patterns and operating restrictions for the truck traffic.

Seasonal limits restricting weight loads to prevent road damage during Spring thaw might limit the weight allowed for trucks. Lighter loads may be required to deliver the wood fuel to the site during the seasonal restrictions.

3.3.1.2 Building and Construction Codes

Construction of new facilities would be required to be designed and constructed in accordance with the following codes:

- International Building Code
- International Fire Code
- National Electrical Code
- International Plumbing Code
- International Mechanical Code
- International Fuel Gas Code
- International Energy Conservation Code
- American Petroleum Institute Design Code

3.3.2 Environmental Permits

The Bad River DNR is responsible for coordination of environmental permits in cooperation with the Federal regulatory agencies. The tribe is exempt from State and local laws, provided the activity occurs within the Reservation.

3.3.2.1 National Environmental Policy Act (NEPA)

The project will require federal permits and may also use federal funds, therefore a NEPA assessment will likely be required. The Bad River DNR has received training and has extensive experience with NEPA compliance and the environmental assessment (EA) process. The NEPA process will require consideration of the applicability of Executive Orders, Indian Treaties, and environmental laws such as the:

- Clean Air Act (CAA)
- Clean Water Act (CWA)
- Emergency Planning and Community Right-to-Know Act (EPCRA)
- Endangered Species Act
- Fish and Wildlife Conservation Act
- National Historic Preservation Act
- National Pollution Discharge Elimination System (NPDES)
- New Source Performance Standards (NSPS)
- Noise Control Act
- Occupational Safety and Health Act (OSHA)
- Pollution Prevention Act
- Prevention of Significant Deterioration Permit

- Resource Conservation and Recovery Act (RCRA)
- Safe Drinking Water Act (SDWA)

3.3.2.2 Air Emissions

Construction and Operating Air Permits would be required.

3.3.2.3 Wetlands

Permits for disturbing wetland areas may be required, dependant on site location.

3.3.2.4 Water Supply

Water supply to the facility would be required for sanitary uses, drinking water, housekeeping operations, and for fire protection.

3.3.2.5 Stormwater

Operators of construction sites larger than 1 acre may be required to obtain authorization to discharge stormwater under a NPDES stormwater permit (likely the USEPA Construction General Permit).

A Stormwater Pollution Prevention Plan (SWPP) may be required for construction and/or long term operations.

3.3.2.6 Wastewater

Wastewater disposal will primarily be for human sanitary uses and housekeeping. Wastewater would be disposed in a local sewer or in an underground septic system. A discharge permit would be required from the Bad River DNR.

3.3.2.7 Solid and Hazardous Wastes

The process does not create hazardous wastes, however small quantities of solvents may be required for plant maintenance. Spent solvents and/or other industrial wastes may require temporary storage on site.

Management of solid and hazardous wastes will be in accordance with the Bad River DNR policies and RCRA.

4.0 Biomass for Heat and/or Power Options

After reviewing several options and configurations, the following four options were selected for further evaluation:

- #1 – Casino/Motel Pool Heating (all year long)
- #2 – Pool Heating plus Electrical generation for use at Wellness Center (all year long)
- #3 – Pool Heating plus Seasonal Heating of Wellness Center
- #4 – Pool Heating plus Seasonal Heating and Electrical Generation for Wellness Center and other buildings

The following assumptions were held for all options:

- All systems sized base on heat load, rather than electrical power load.
- Hot water heat (instead of steam)
- Integrate heat system with existing equipment (use heat exchangers at existing facility boilers)

- Wood chip receiving and long term storage location in currently undeveloped area north of Moccasin Trail Center. See sketch in Appendix A.
- Natural Gas offset costs $1.05/therm
- Electricity offset costs at Wellness Center $0.11/kwhr
- Fuel supply = green wood chips @ $35/green ton
- Costs shown in Appendix B are only preliminary for comparison of options, and require refinement in subsequent engineering phases
- Capital costs shown do not include potential offsets from grants, so final payback analysis will probably be better than shown.

4.1 Option #1 – Casino/Motel Pool Heating (all year long)

The facility would be co-located with the Casino/Hotel complex and require a 40' x 50' enclosed area to limit dust, noise, and disturbance. The system would provide steady, stable usage of heat at the pool with 0.4 MMBTU/hr.

A simple financial evaluation (for comparison to other alternatives) concluded:

- Replace Natural Gas Heat ($37,000/yr @ $1.05/therm)
- Capital Costs $367,000
- Operation Costs $28,000/year
- Simple Payback approx 44 years. With 35% funding assistance, payback reduced to 29 years

Pros

- Simplest option
- Visibility may be positive benefit (green tourism)
- Lowest short term capital cost

Cons

- Potential disturbance to visitors
- Little room for future expansion
- Payback not as fast as Option 2

4.2 Option #2 – Pool Heating plus Electrical generation for use at Wellness Center (all year long)

The facility would be co-located with the Casino/Hotel complex and require a 40' x 50' enclosed area to limit dust, noise, and disturbance. The system would provide steady, stable usage of heat at the pool with 0.4 MMBTU/hr. Electricity would be conveyed (new underground lines) to the Wellness Center (due to higher electricity costs compared to casino.)

A simple financial evaluation (for comparison to other alternatives) concluded:

- 0.4 MMBTU/hr heat value to replace Natural Gas Heat ($37,000/yr @ $1.05/therm) savings
- 0.15 MMBTU/hr (40 KW) electricity ($42,000/yr @ $.11/kwhr) savings via net metering

- Capital Costs $624,000
- Operation Costs $42,000
- Simple payback approx 17 years with 35% funding assistance, payback reduced to 11 years

Pros

- Provides experience (and hedge) against both gas and electricity
- Visibility may be positive benefit (green tourism)
- Relatively Good Simple Payback Scenario

Cons

- Potential disturbance to visitors
- Little room for future expansion at this location
- Need to coordinate net metering with electrical utility

4.3 Option #3 – Pool Heating plus Seasonal Heating of Wellness Center

The facility would be co-located with Wood Receiving and Long Term Storage area. Heat would be piped approx 600 ft to the Wellness Center and 600 ft to the Casino/Hotel complex (@ approx $200/lf).

The system would include steady, stable usage of heat at the pool wit 0.4 MMBTU/hr heat at low end with "turn-up" capacity to 1.0 MMBTU/hr to accommodate seasonal use of heat and power at Wellness center and other buildings.

A simple financial evaluation (for comparison to other alternatives) concluded:

- Replace Natural Gas Heat ($65,000/yr @ $1.05/therm)
- Capital Costs $928,000
- Operation Costs $46,000
- Simple Payback approx 51 years with 35% funding assistance, payback reduced to 33 years

Pros

- Out of public view and traffic
- Provides experience with district heating concept
- Space for expansion of energy system
- Can extend heat lines to other facilities in future
- Possible modifications to add electricity generation in future

Cons

- Higher maintenance (heat lines, multiple boilers)
- More expensive than options 1 or 2
- Simple Payback not as fast as options 1 or 2
- May be wetland mitigation issue in this area, dependant on space requirements

4.4 Option #4 – Pool Heating plus Seasonal Heating and Electrical Generation for Wellness Center System and Other Buildings

The facility would be co-located with Wood Receiving and Long Term Storage area. Heat would be piped approx 600 ft to the Wellness Center and 600 ft to the Casino/Hotel complex (@ approx $200/lf). Electricity would be conveyed (new underground lines) to the Wellness Center (due to higher electricity costs compared to casino).

The system would include steady, stable usage of heat at the pool wit 0.4 MMBTU/hr heat at low end with "turn-up" capacity to 1.5 MMBTU/hr to accommodate seasonal use of heat and power at Wellness center and other buildings.

A simple financial evaluation (for comparison to other alternatives) concluded:

- Replace Natural Gas Heat ($65,000/yr @ $1.05/therm)
- Electricity ($99,000/yr @ $.11/kwhr) savings via net metering
- Capital Costs $1.3 M
- Operation Costs $69,000
- Simple Payback approx 14 years, with 35% funding assistance, payback reduced to 9 years

Pros

- Out of public view and traffic
- Provides experience with district heating concept
- Space for expansion of energy system
- Can extend heat lines to other facilities in future
- Best Simple Payback Scenario of the 4 options

Cons

- Higher maintenance (heat lines, multiple boilers)
- Most expensive capital cost
- May be wetland mitigation issue in this area, dependant on space requirements
- Need to coordinate net metering with electrical utility

5.0 Discussion

5.1 Job Creation and Training Opportunities

The Operation/Maintenance of the system and wood yard would likely require one to three part time positions.

Potential jobs associated with wood harvesting, chipping, and transport of 1 to 3 green tons wood per day is *not significant* if supplied by established forest products harvesters. However, harvest and supply may represent a training and business start-up opportunity for other forest product related business.

5.2 Air Quality

The Bad River DNR will be responsible for issuing and enforcing air quality regulations to limit potential issues with particulate matter from the wood energy system, and will likely require a pollution control devices and a computer based combustion control and monitoring system. Results are ultimately dependant on proper sizing, consistent fuel quality, operations and maintenance, and confirmation the installed system meets specification requirements.

Additional information and references are provided in Appendix C "FAQs on Wood Boiler Air Quality Issues."

5.3 Cost Sensitivity

The costs and simple payback analyses provided in this report are based on limited information and assumptions and were conducted for the purposes of comparing various options. A more detailed cost estimate should be performed if a decision is made to move forward with one of the options. The economics will be sensitive to severable variables including the cost of wood chips, and competing fuel costs (natural gas and electricity), interconnection costs, and availability of grants and/or low interest loans.

5.4 Tribal Energy Plan

The Tribal Energy Plan – Energy Efficiency and Conservation Strategy (SEH, January 26, 2012) discusses several other woody biomass to energy issues and options beyond the scope of this assessment including:

- Woody Biomass Resource Assessment
- Development of a Sustainable Biomass Supply
- Larger scale District Heating and Power scenario
- Clarification of Tribal Utility Rights and
- Next steps

MJB/AD

6.0 Resources

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Biomass Combined Heat and Power Catalog of Technologies. USEPA CHP Partnership. September 2007.

Biomass Energy Data Book, Edition 1. Prepared for USDOE by Oak Ridge National Laboratory, September 2006.

Biomass Harvesting Guidelines for Forestlands, Brushlands and Open Lands. MFRC. December 2007.

Biofuel Feasibility Study for Bois Forte Band of Chippewa. SEH, January 2009.

Community Roadmap to Renewable Woody Biomass Energy – A Step by Step Decision Making Tool for New Hampshire Communities. Yellow Wood Associates and the Biomass Energy Resources Center. September 2010.

Distributed Generation Renewable Energy Estimate of Costs and Useful Life, NREL, June 2011

EECBG – Renewable Energy for Tribal Community Development ,Green Bay Workshop proceedings, March 2011

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Harvesting Fuel: Cutting Costs and Reducing Forest Fire Hazards Through Biomass Harvest. Arnosti, Don, Dalia Abbas, Dean Current, and Michael Demchik, Institute for Agriculture and Trade Policy (IATP). June 2008.

Information on Air Pollution Control Technology for Woody Biomass Boilers USDA Forest Service, USEPA, Montana DNR, Washington Dept of Ecology, NESCAUM. March 2009

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Market Assessment of Biomass Gasification and Combustion Technology for Small- and Medium-Scale Applications, David Peterson and Scott Haase, NREL/TP-7A2-46190. July 2009.

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Wood Boiler Systems Overview. Biomass Energy Resource Center. 2011.

Wood-Chip Heating Systems, Timothy Maker and Biomass Energy Resource Center, 2004.

Wood Dust Exposure Hazards. Ohio State University Extension Fact Sheet. January 2006 (Revised).

Woody Biomass Feedstock Yard Business Development Guide. Federal Woody Biomass Utilization Group. 2010.

Woody Biomass Utilization Desk Guide. USDA Forest Service September 2007.

Appendix A

Wood Yard Location

Appendix B

Cost Estimates

System Components		Option 1	Option 2	Option 3	Option 4
wood yard prep - 1 acre (clear, grub, fill, grade)		$ 50,000.00	$ 50,000.00	$ 50,000.00	$ 50,000.00
biomass energy system site prep (utilities, etc)				$ 50,000.00	$ 50,000.00
0.4 mmbtu/hr heat system		$ 150,000.00			
0.6 mmbtu/hr CHP system (with 40 kw electricity)			$ 250,000.00		
1.0 mmbtu/hr heat system				$ 200,000.00	
1.5 mmbtu/hr heat system (with 100 kw electricity)					$ 400,000.00
buried electrical cost 1000 lf @ $50/lf			$ 50,000.00		$ 50,000.00
buried heat pipe 1200 lf @$200/lf				$ 240,000.00	$ 240,000.00
Misc piping & equip mods		$ 30,000.00	$ 30,000.00	$ 50,000.00	$ 50,000.00
Misc Electrical		$ 5,000.00	$ 20,000.00	$ 5,000.00	$ 20,000.00
subtotal		$ 235,000.00	$ 400,000.00	$ 595,000.00	$ 860,000.00
subtotal with contingency (20%)		$ 282,000.00	$ 480,000.00	$ 714,000.00	$ 1,032,000.00
Engineering & Permitting (15%)		$ 42,300.00	$ 72,000.00	$ 107,100.00	$ 154,800.00
Contractor Mob & Markup (15%)		$ 42,300.00	$ 72,000.00	$ 107,100.00	$ 154,800.00
Total Capital Costs		**$ 366,600.00**	**$ 624,000.00**	**$ 928,200.00**	**$ 1,341,600.00**
Savings					
NG savings ($1.05/therm)		$ 36,792.00	$ 36,792.00	$ 64,764.00	$ 64,764.00
Power savings ($0.11/kwhr)			$ 42,349.84		$ 99,396.43
Total energy savings		$ 36,792.00	$ 79,141.84	$ 64,764.00	$ 164,160.43
O&M Costs					
mmbtu/yr		*3504*	*4818*	*6168*	*9252*
tons of wood per year (@ 40% mc), 10.8 mmbtu/ton		*406*	*558*	*714*	*1071*
Wood Fuel $/ton, green	$ 35.00	$ 14,194.44	$ 19,517.36	$ 24,986.11	$ 37,479.17
Operator Labor		$ 10,000.00	$ 15,000.00	$ 15,000.00	$ 20,000.00
Maintenance Cost (annualized over 40 yr life)		$ 3,750.00	$ 6,250.00	$ 5,000.00	$ 10,000.00
Utilities & Chemical costs (estimated)		$ 500.00	$ 1,000.00	$ 1,500.00	$ 2,000.00
Total		$ 28,444.44	$ 41,767.36	$ 46,486.11	$ 69,479.17
Net Savings		**$ 8,347.56**	**$ 37,374.48**	**$ 18,277.89**	**$ 94,681.26**
Simple Payback (years)		**44**	**17**	**51**	**14**
Simple Payback if capital costs offset by 35% funding		*29*	*11*	*33*	*9*

Or- if looking at Cheaper Fuel Costs:

O&M Costs					
Wood Fuel $/ton, green	$ 20.00	$ 8,111.11	$ 11,152.78	$ 14,277.78	$ 21,416.67
Operator Labor		$ 10,000.00	$ 15,000.00	$ 20,000.00	$ 25,000.00
Maintenance Cost (annualized over 40 yr life)		$ 3,750.00	$ 6,250.00	$ 5,000.00	$ 10,000.00
Utilities costs (estimated)		$ 500.00	$ 500.00	$ 2,000.00	$ 2,000.00
Total		$ 22,361.11	$ 32,902.78	$ 41,277.78	$ 58,416.67
Net Savings		$ 14,430.89	$ 46,239.06	$ 23,486.22	$ 105,743.76
Simple Payback (years)		25	13	40	13
Simple Payback if capital costs offset by 35% funding		*17*	*9*	*26*	*8*

Appendix C

FAQs on Wood Boiler Air Quality Issues

This info.is from the Biomass Energy Resource Center http://www.biomasscenter.org/resources/faqs.html#20

Q: Will the wood smoke be an air-quality problem?

A: Automated, commercial-sized woodchip and pellet systems burn much cleaner than even the most modern home wood or pellet stove. They produce no creosote and practically no visual smoke or odor. Because the biomass fuel is green, or close to 50 percent water, however, in cold weather the chimney may show a plume of condensed water vapor. Interviews with dozens of system operators support the conclusion that odor generated by the fuel or the smoke is almost never a problem, and in most cases, both chip and pellet systems easily meet state air quality standards.

Q: Will the system produce airborne wood ash that will fall over the neighborhood?

A: No. A well-designed woodchip system burns at a high rate of efficiency, resulting in a small percentage of residual ash (about one percent of the original fuel volume). In addition, these systems require specific stack (chimney) heights that effectively disperse any emissions into the prevailing winds. BERC has not heard of this reported as a problem in the neighborhoods of institutional and commercial woodchip burners.

Q: Are the wood ashes toxic? Where and how are they disposed?

A: Wood ash from institutional and commercial heating plants is not toxic, in fact, it is an excellent soil additive for agricultural use. It can also be spread on athletic fields and gardens or disposed of at a landfill.

Additional information is available in the BERC pamphlet: **Particulate Matter Emissions-Control Options for Wood Boiler Systems.**