An Assessment of Alternatives for Utilization of Forest Biomass and Wood Waste from Wood Products Manufacturing

Funding Provided by

The United States Forest Service Southern Region
Arkansas Forestry Commission
Economic Action Programs – Community Assistance
2001 Fire Plan Implementation Program

In Cooperation with

The Arkansas Wood Manufacturers Association

July 2002

Prepared by

Engineering, Compliance & Construction, Inc.
415 North McKinley, Suite 1180 • Little Rock, Arkansas 72205
Telephone: (501) 663-8247 • Facsimile: (501) 664-5005 • www.ecci.com

ACKNOWLEDGEMENTS

Special thanks to the U.S. Forest Service and the Arkansas Forestry Commission for providing the funding for this project. The project technical advisory committee was critical in helping maintain focus towards reasonably achievable alternatives, and those efforts deserve recognition. Multiple industrial and manufacturing facility plant managers are commended for taking time to review and evaluate opportunities to utilize wood wastes in their processes. Lastly, the AWMA staff helped gather data, arrange advisory committee meetings and contacts for meetings with plant managers of potential biomass energy users, and provided the AWMA annual convention as a public workshop for use as a forum to present the project findings to a broad base of government agencies and industries.

Table of Contents

I. BACKGROUND

Arkansas has one of the most active wood manufacturing industries in the U.S. The abundant supply of forests, both hard and soft woods, and the relatively rural setting are factors that help support wood products manufacturing.

In product manufacturing, using wood is a significant advantage over many other feedstock because the wood is a renewable resource. Historically, a large volume of wood wastes remain after products have been completed. Until fairly recently, large wood waste piles were common in rural areas and inefficient wood waste burners operated in more populated areas. Over the last thirty years however, such dumping and marginally controlled burning have become unacceptable disposal methods resulting in large volumes of wood wastes often being buried in landfills.

Abundant forests also mean abundant wood waste is created in forested areas by major ice storms, tornados or windstorms, and by many logging practices. The volumes of wood wastes potentially recoverable from forested areas are far larger than the amount of wood wastes generated by wood product manufacturers.

In 2001, the Arkansas Wood Manufacturers Association was able to obtain USDA Rural Development funding, through a Rural Business Opportunity Grant, to assess whether a project was feasible to recovery energy wood wastes and cost effectively generate steam or electricity. The Fort Smith area was used to develop a pilot model. That assessment also reviewed alternative wood waste utilization approaches including composting and manufacturing fuel pellets. Results from that 2001 Fort Smith area pilot project confirmed that, due to marketing constraints, there was too much wood waste in the Fort Smith area to be utilized as compost and there was enough to operate a conventional wood waste boiler to generate steam.

An economic assessment was completed, as part of the Phase I Fort Smith area study, to document the costs to build and operate such a conventional wood waste boiler facility selling process steam to an area industrial steam user. The annualized costs to construct and operate the wood waste facility were very similar to the costs of operating a similar sized existing natural gas fired boiler with natural gas prices at that time near $4.00 per million BTUs. Unfortunately even though the annualized costs were close, there are other factors associated with the wood waste boiler operation, including increased truck traffic for wood waste delivery and ash removal, air pollution control equipment with regular maintenance needs, and a much larger foot print for the boiler operation due to storage and preparation of the wood waste as a fuel. Consequently, even though cooperative waste generators and an interested steam purchaser were available in 2001, the project economics and physical limitations were such that progress halted.

As the AWMA Fort Smith pilot project was progressing, the U.S. Forest Service was seeking alternatives to recover usable wood or energy from ice storm damaged trees resulting from a huge Arkansas ice storm. One of the conclusions in the AWMA study was that a larger energy recovery operation would have resulted in economics that would show a healthy return on investments. Recognizing the AWMA need for additional wood waste volumes and the U.S. Forest Services desire to evaluate utilization of large in forest wood waste volumes, this assessment of the utilization of forest biomass along with wood wastes from wood products manufacturing resulted.

ECCI, an Arkansas based industrial and environmental engineering firm, was selected to complete this study due to significant experience and expertise in areas involving wastes and thermal processes. ECCI’s familiarity with Fort Smith area industries and familiarity with large forest product industries throughout Arkansas was also considered a beneficial factor in the selection of ECCI as the project-engineering firm.

II. Study Introduction

The forest products industry is unique in that it is both a major energy user and the largest producer of self-generated electricity in America's manufacturing sector. Fifty-seven percent (57%) of the industry's energy requirements are satisfied with biomass fuels from wood chips, bark, sawdust, and other manufacturing by-products. The burning of this renewable, sustainable, biomass fuel displaces the use of more than 250 million barrels of oil each year.[1]

But those wood waste amounts only include wastes from wood manufacturing. It is a hardwood industry generalization that half of the wood in a tree is left in the forest as logging residue, half of the log becomes mill residue, and half of the lumber becomes machinery residue (Figure 1).[2]

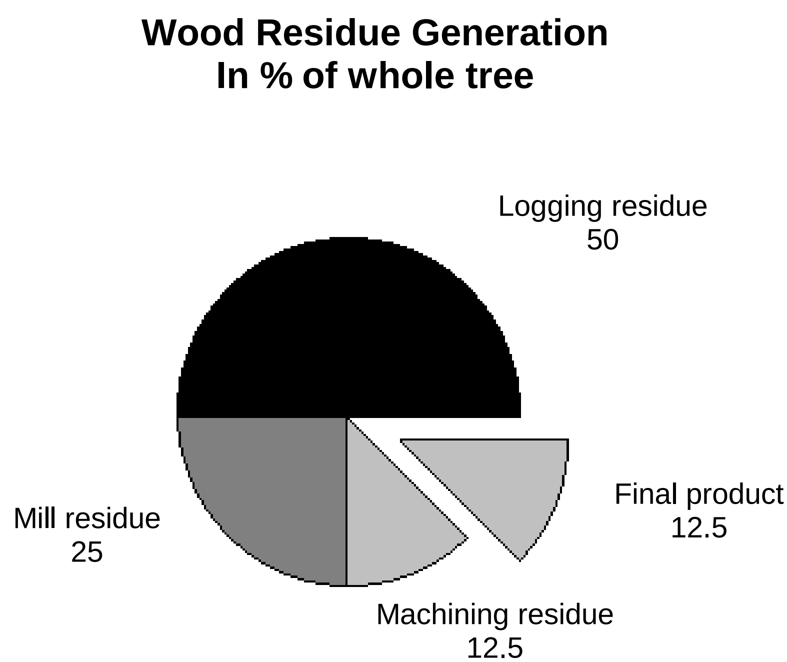


Figure 1. Generalized relationship between residue and product volume in converting trees to final product.

This project was to complete a technical evaluation of small technically reliable and affordable biomass-fueled co-generation power plants and traditional wood waste boiler technology. A number of developments contributed to the specific direction and scope of the project.

- EPA and the U.S. Department of Energy have endorsed gasification as a clean energy technology due to newer and better methods of extracting fuel value from organic containing materials and new efficient turbines to utilize the clean burning fuel;[3]

- Gasification equipment vendors such as Cratech, show a higher percentage of energy recovered through gasification than through using conventional wood waste boilers;

- Gasification technology can handle a larger range of feed material (biomass) than conventional wood waste boilers allowing the ability to utilize forest biomass;

- The project included a screening process of industrial facilities to provide an opportunity to locate a facility expansion or modification with the potential to utilize the energy from wood wastes rather than more traditional fuels such as natural gas;

- The additional forest biomass provided an opportunity to increase the size of a project to provide a better economy of scale to better compete with current fossil fuel prices;

- A facility was located that could benefit from incorporating a biomass fired furnace into a natural gas fired drying process.

III. Project Scope

The project's primary objectives included the components below:

- Assessment of using additional biomass including forest waste to allow better project economics;

- Evaluation of new gasification technology and a conventional wood waste boiler to recovery energy from the biomass;

- Evaluation of incorporating a natural gas fired furnace with a biomass furnace;

- Complete Phase II of a study on a cooperative group of secondary wood product manufacturers utilizing biomass for producing steam or electricity for sale;

- Complete financial and economic analysis of the co-generation systems and the hot air furnace system from the buyer's perspective;

- Disseminate useful information developed during the project.

IV. The Approach

The first task was to form a technical advisory committee, brief them on the project scope, utilize comments, and adjust directions according to the useful industry knowledge on the committee.

AWMA Wood Waste Technical Advisory Committee (AWWTAC)

Calvin Alley	*Alley & Associates*
Lonnie Clark	*AWMA*
Mike Cotriss	*ECCI*
Joe Craig	*Cratech*
Randy Cutting	*Fort Smith Rim & Bow*
Trip Gentry	*ECCI*
Vic Hicks	*Hardwoods Unlimited*
Linda Hixson	*AWMA*
Stan Jorgensen	*ECCI*
Harry Meyer	*Oak Mountain, Inc.*
Annett Pagan	*AWMA*
Daniel Reikes	*City of Fort Smith*
Andrew Rike	*ECCI*
Larry Sanford	*Capital Structures*
Mike Scarsdale	*Arkansas Products*
Mark Spradlin	*Capital Structures*
Richard J. "Dick" Udouj	*Fort Smith Field Office, Winrock International*
Phil White	*General Pallets, Inc*.
Garnett Wise	*River City Environmental Association*
Chris Witt	*Riverside Furniture Company*

Based upon recommendations from the Technical Advisory Committee we determined:

- We would focus on energy recovery since composting and pelletizing had not worked out during our Phase I study.

- We would attempt to identify industrial facilities, with expansion or modifications planned, where energy would be required.

- Forest biomass would be factored in as gasification fuel to scale up projects as necessary to hopefully achieve an acceptable cost/benefit.

- We would especially review energy needs at companies already generating wood wastes to evaluate those facilities as markets for the recovered energy, and we would add forest biomass as needed to fuel the energy generating unit.

- We would utilize the best identified alternatives to complete financial and economic analyses as model demonstrations which could be utilized in similar situations elsewhere.

V. Wood Waste Volumes and Characteristics

Based upon surveys and research conducted during the Phase I Fort Smith area study, we knew there were over six-thousand (6,000) tons per year of wood wastes generated within a fifty (50) mile radius of Fort Smith. For purposes of forest waste biomass, over 20 million tons of timber were removed from Arkansas forests in 2000.[4] This represents a potentially huge volume of forest biomass remaining which potentially could be utilized as fuel for a gasification or conventional boiler project in all forested areas of the state.

VI. Selected Scenarios

The project team focused on identification of actual energy needs to utilize these fuels effectively. Due to the cooperation already in place from current wood waste generators, those facilities were reviewed first for potential projects. One facility, which already generates a large volume of wood waste, was identified as representing an energy use potential. That scenario is represented as scenario 1 (see Scenario 1 narrative and tables). The total wood waste/ fuel necessary for the project is available from local wood product manufacturers.

Scenario 2 represents a larger energy recovery operation supplemented by 20% forest biomass. This scenario is developed as a model scenario which could be duplicated in any community with a significant size wood product manufacturer. The Gasifier technology is critical to this type of waste feed due to a large potential that soil/rock contamination will often be included in forest biomass delivered to the facility.

Scenario 3 represents a very late development during the project which arose during plant manager interviews. One facility operates a 12.5 MMBTU/hr dryer which utilizes natural gas as the fuel. A preliminary cost estimate for this scenario presents the implications offsetting natural gas with biomass to fuel the dryer. Certain modifications would be necessary; however, the capital costs are fairly low.

Conventional wood waste boiler technology was also evaluated under scenario 1 and scenario 2; however, the financial analysis presents unacceptable results. Those cost estimate and results from those financial assessments are presented in Appendix B.

Scenario 1

This scenario generates electrical power for the main complex at the Riverside Furniture plant using a biomass gasification process to turn a combustion turbine generator. Currently the cost of the plant's electrical usage totals about $475,000.00 per year. Based on wood waste production estimates collected from a survey of wood waste producers, Riverside could utilize 8420 tons of biomass per year to offset power costs. This amount of biomass would fuel a 22 MMBTU/hr gasifier, assuming the plant was run only on weekdays.

The wood waste would be delivered by the waste producer, and dumped into a bulk feed hopper with a live bottom. The bulk feed hopper would feed the waste into a hogging machine, reducing the size of the individual wood chips. The biomass would then be conveyed to a silo that would have a five-day storage capacity. The biomass would be pneumatically conveyed from the silo to the gasifier for processing. The biomass gasification process produces a gas used to fuel a gas turbine genset, producing 1300 KW of electricity. Exhaust gases will flow through a stack.

When the plant is in full operation, the gasifier would partially reduce the amount electricity used. During the second and third shifts, Riverside would have the capability of selling electricity back to the power company at a price about 1/3 of the wholesale energy price. This operation would save Riverside $275,000.00 a year on electricity. The wood waste producers would also save about $300,000.00 a year on disposal costs of the wood waste.

The following table presents the estimated capital costs, annual operation and maintenance costs, and annual savings associated with Scenario 1:

Table 1: Capital costs, annual operation and maintenance costs, and annual savings

Estimated Capital Costs...$ 2,744,000.00

Estimated Annual Operation and Maintenance Costs.....................$ 234,000.00

<u>Estimated Annual Savings on Electricity $ 275,000.00</u>

<u>Estimated Annual Savings on Wood Disposal Costs $ 300,000.00</u>

Assuming an interest rate of 8%, an equipment life of 10 years, and a salvage value of 20% of the real equipment cost, a 12-year payback with an internal rate of return of 6.1% can be expected.

SCENARIO 1
22 MMBTU GASIFIER FOR RIVERSIDE
1300 kWe NET
2700 LB/HOUR WOOD WASTE
6240 HOURS/YEAR

REAL EQUIPMENT	
Gasifier and Turbine Genset, Includes the Following:	$ 2,185,000.00
Gasifier	
Gas Turbine Genset	
Exhaust Stack	
Biomass Surge Bin	
Radiator	
Ash Storage	
Control Room	
Switchgear	
Fuel Storage	
Bulk Feed Hopper	
Hog	
Installation for above items	
Power Plant Building	
Concrete Slab	
Access Road	$ 5,000.00
SUB-TOTAL	**$ 2,190,000.00**
OTHER EQUIPMENT	
Installation of Utilities	$ 8,000.00
Tools	$ 2,000.00
Site Fencing	$ 25,000.00
Signs	$ 2,000.00
Landscaping	$ 5,000.00
SUB-TOTAL	**$ 42,000.00**

SCENARIO 1 (CONTINUED)

ESTIMATED CAPITAL COSTS

Real Equipment	$ 2,190,000.00
Land (1/3 Acre)	$ 3,400.00
Site Preparation	$ 1,000.00
Start up and working capital	$ 50,000.00
Other Equipment	$ 42,000.00
Financing and Legal	$ 20,000.00
Construction Otherwise Not Noted	$ 50,000.00
Professional Services	$ 30,000.00
Design (10% Capital)	$ 238,640.00
Contingencies (5% Capital)	$ 119,320.00
SUB-TOTAL	**$ 2,744,360.00**

ESTIMATED ANNUAL OPERATION AND MAINTENANCE COSTS

Salaries (2 hours/shift Operator) with Benefits	$ 66,300.00
Electricity	$ 22,557.60
Maintenance Costs, Gasifier	$ 73,008.00
Residue Removal and Disposal	$ 20,000.00
Other Overhead	$ 17,000.00
Taxes and Liscenses	$ 5,000.00
Insurance	$ 29,000.00
Water	$ 1,000.00
SUB-TOTAL	**$ 233,865.60**

CURRENT ELECTRICITY COSTS

First Shift	$ 380,133.00
Second Shift	$ 94,980.60
Third Shift	$ -
Weekends	$ -
SUB-TOTAL	**$ 475,113.60**

ESTIMATED ELECTRICITY COSTS WITH GASIFIER

First Shift	$ 243,243.00
Second Shift	$ (13,969.80)
Third Shift	$ (30,420.00)
Weekends	$ 561.60
SUB-TOTAL	**$ 199,414.80**

SCENARIO 1 (CONTINUED)

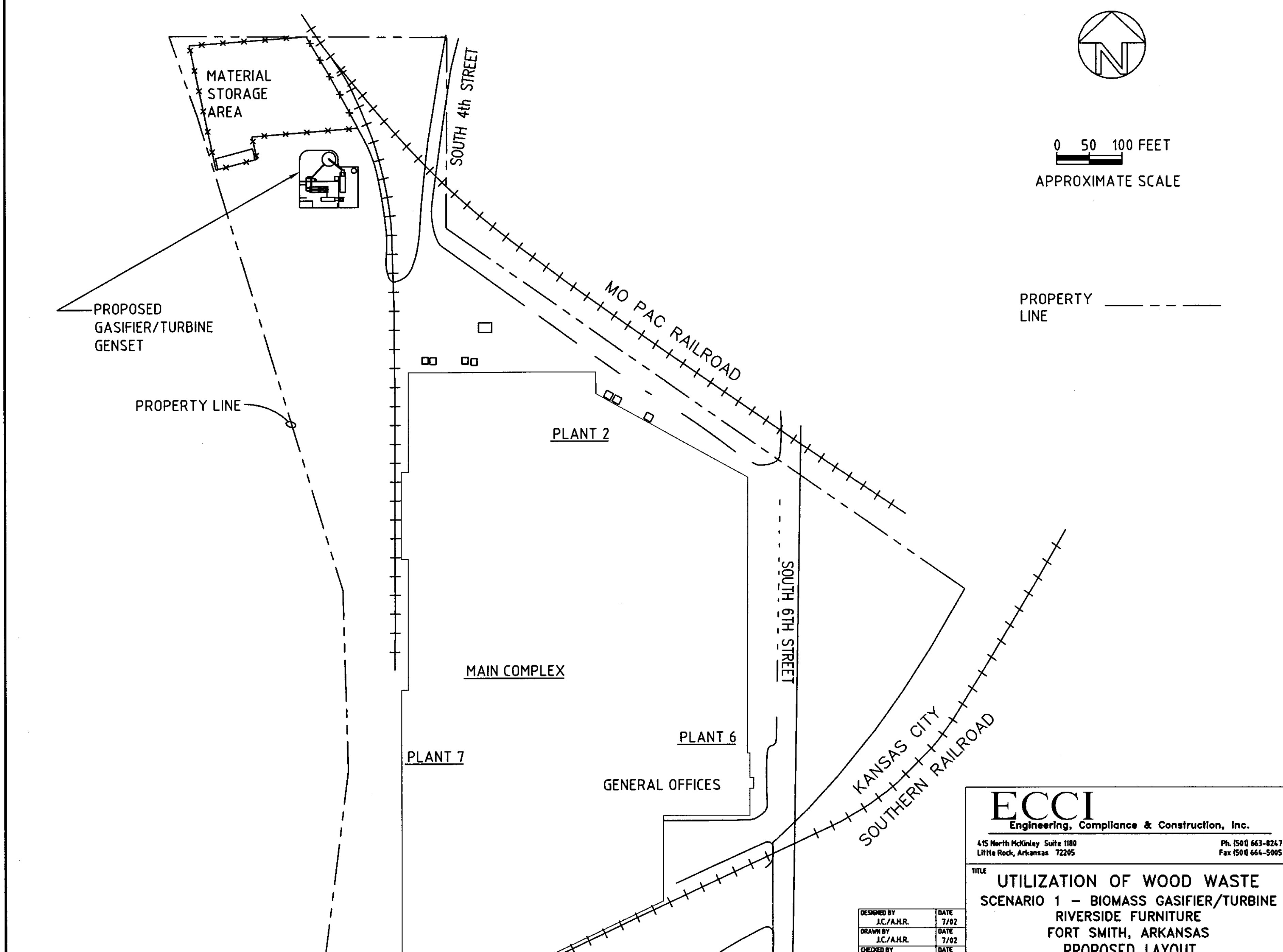
SAVINGS ON ELECTRICITY	$	275,698.80
SAVINGS ON WOOD DISPOSAL COSTS	$	300,000.00
TOTAL SAVINGS	$	575,698.80
SALVAGE VALUE (20% AFTER 10 YEARS)	$	438,000.00
A/P		0.134

Assuming an interest rate of 8%, there will be a 12-year pay back.

PRO FORMA INCOME STATEMENT
RIVERSIDE FURNITURE
1300 KW GASIFIER

Plant annual hours operation		6240
Plant net output	kWe	1300
Fuel input	lbs/hr	2700
price for electricity	$/kWh	0.045
sell power to grid	$/kWh	0.015
Plant total initial investment		$ 2,744,360.00

Year	1	2	3	4	5	6	7	8	9	10
Income										
Electricity Sales	$ 275,698.80	$ 275,698.80	$ 275,698.80	$ 275,698.80	$ 275,698.80	$ 275,698.80	$ 275,698.80	$ 275,698.80	$ 275,698.80	$ 275,698.80
Steam Sales	0	0	0	0	0	0	0	0	0	0
Char-ash Sales	0	0	0	0	0	0	0	0	0	0
Tipping Fees	$ 300,000.00	$ 300,000.00	$ 300,000.00	$ 300,000.00	$ 300,000.00	$ 300,000.00	$ 300,000.00	$ 300,000.00	$ 300,000.00	$ 300,000.00
Total	$ 575,698.80	$ 575,698.80	$ 575,698.80	$ 575,698.80	$ 575,698.80	$ 575,698.80	$ 575,698.80	$ 575,698.80	$ 575,698.80	$ 575,698.80
Expenses										
Operators	$ 66,300.00	$ 66,300.00	$ 66,300.00	$ 66,300.00	$ 66,300.00	$ 66,300.00	$ 66,300.00	$ 66,300.00	$ 66,300.00	$ 66,300.00
Maintenance	$ 73,008.00	$ 73,008.00	$ 73,008.00	$ 73,008.00	$ 73,008.00	$ 73,008.00	$ 73,008.00	$ 73,008.00	$ 73,008.00	$ 73,008.00
Biomass Fuel	0	0	0	0	0	0	0	0	0	0
Electricity	$ 22,557.60	$ 22,557.60	$ 22,557.60	$ 22,557.60	$ 22,557.60	$ 22,557.60	$ 22,557.60	$ 22,557.60	$ 22,557.60	$ 22,557.60
Depreciation	$ 219,548.80	$ 219,548.80	$ 219,548.80	$ 219,548.80	$ 219,548.80	$ 219,548.80	$ 219,548.80	$ 219,548.80	$ 219,548.80	$ 219,548.80
Insurance	$ 29,000.00	$ 29,000.00	$ 29,000.00	$ 29,000.00	$ 29,000.00	$ 29,000.00	$ 29,000.00	$ 29,000.00	$ 29,000.00	$ 29,000.00
Other	$ 43,000.00	$ 43,000.00	$ 43,000.00	$ 43,000.00	$ 43,000.00	$ 43,000.00	$ 43,000.00	$ 43,000.00	$ 43,000.00	$ 43,000.00
Total	$ 453,414.40	$ 453,414.40	$ 453,414.40	$ 453,414.40	$ 453,414.40	$ 453,414.40	$ 453,414.40	$ 453,414.40	$ 453,414.40	$ 453,414.40
EBIT	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40
Interest Expense	0	0	0	0	0	0	0	0	0	0
Earnings before Taxes	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40
Taxes	0	0	0	0	0	0	0	0	0	0
Fuel Tax Cedit	0	0	0	0	0	0	0	0	0	0
Net Taxes	0	0	0	0	0	0	0	0	0	0
Net Income	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40
Cash Flow										
Net Income	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40	$ 122,284.40
Depreciation	$ 219,548.80	$ 219,548.80	$ 219,548.80	$ 219,548.80	$ 219,548.80	$ 219,548.80	$ 219,548.80	$ 219,548.80	$ 219,548.80	$ 219,548.80
salvage value										$ 438,000.00
less										
Debt Retirement	0	0	0	0	0	0	0	0	0	0
Net Cash Flow	$ 341,833.20	$ 341,833.20	$ 341,833.20	$ 341,833.20	$ 341,833.20	$ 341,833.20	$ 341,833.20	$ 341,833.20	$ 341,833.20	$ 779,833.20
IRR of Net Cash Flow		**6.11%**								



ECCI
Engineering, Compliance & Construction, Inc.

415 North McKinley Suite 1180
Little Rock, Arkansas 72205
Ph. (501) 663-8247
Fax (501) 664-5005

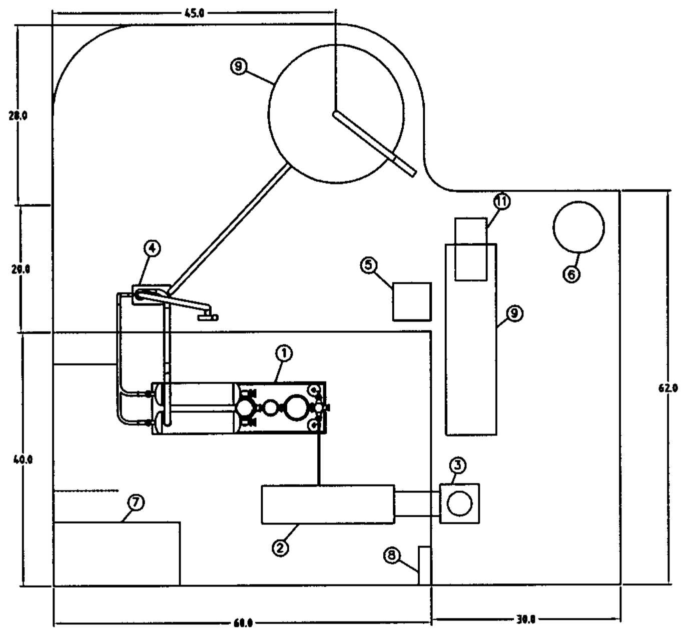
TITLE

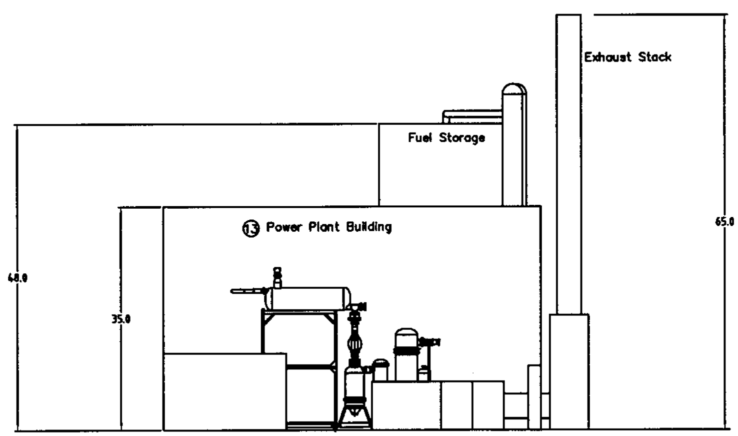
UTILIZATION OF WOOD WASTE
SCENARIO 1 – BIOMASS GASIFIER/TURBINE
RIVERSIDE FURNITURE
FORT SMITH, ARKANSAS
PROPOSED LAYOUT

DESIGNED BY J.C./A.H.R.	DATE 7/02
DRAWN BY J.C./A.H.R.	DATE 7/02
CHECKED BY S.J.	DATE 7/02
APPROVED BY S.J.	DATE 7/02

PROJECT NO.	APPROX. SCALE	DRAWING NO.	REV.
4167-3004	AS SHOWN	4167-3004-001	B

ITEM		DESCRIPTION
1		Gasifier
2		Gas Turbine Genset
3		Exhaust Stack
4		Biomass Surge Bin
5		Radiator
6		Ash Conveying and Storage
7		Control Room
8		Switchgear
9		Fuel Storage
10		Bulk Feed Hopper
11		Hog
12		–
13		Power Plant Building
14		–
15		–





CRATECH
P.O. BOX 70 TAHOKA, TEXAS 79373

Dimensions shown are in feet

CHG	DATE
1	8 JUL 02
0	MAY 25 02

DRAWN BY
APPROVED BY

DESCRIPTION
ECCI 1300 kWe Plant

1C0049 | SHEET OF | SCALE: 1" = 30' | D

Scenario 2

This scenario is similar to Scenario 1 in that it generates electrical power for the main complex at the Riverside Furniture plant using a biomass gasification process to turn a combustion turbine generator. However in this scenario, Riverside could utilize 8420 tons of biomass per year from wood manufacturers and increase the tonnage by 30% using forestry biomass to offset power costs. This amount of biomass would fuel a 28 MMBTU/hr gasifier, assuming the plant was run only on weekdays.

As with Scenario 1 the kiln dried wood waste would be delivered by the waste producer, and dumped into a bulk feed hopper with a live bottom. The forestry wood waste would also need to be delivered to the bulk feed hopper. The logistics of collecting and transporting the forestry wood waste to the gasifier are not addressed in this report. The bulk feed hopper would feed the waste into a hogging machine, reducing the size of the individual wood chips. The biomass would then be conveyed to a silo that would have a five-day storage capacity. The biomass would be pneumatically conveyed from the silo to the gasifier for processing. The biomass gasification process produces a gas used to fuel a gas turbine genset, producing 1800 KW of electricity. Exhaust gases will flow through a stack.

When the plant is in full operation, the gasifier would partially reduce the amount electricity used. During the second and third shifts, Riverside would have the capability of selling electricity back to the power company at a price about 1/3 of the wholesale energy price. This operation would save Riverside $358,000.00 a year on electricity. The wood waste producers would also save about $300,000.00 a year on disposal costs of the wood waste.

The following table presents the estimated capital costs, annual operation and maintenance costs, and annual savings associated with Scenario 2:

Table 2: Capital costs, annual operation and maintenance costs, and annual savings

Estimated Capital Costs...$ 3,558,000.00

Estimated Annual Operation and Maintenance Costs......................$ 280,000.00

<u>Estimated Annual Savings on Electricity $ 358,000.00</u>

<u>Estimated Annual Savings on Wood Disposal Costs $ 300,000.00</u>

Assuming an interest rate of 8%, an equipment life of 10 years, and a salvage value of 20% of the real equipment cost, a 15-year payback with an internal rate of return of 3.4% can be expected.

SCENARIO 2
28 MMBTU GASIFIER FOR RIVERSIDE
1800 kWe NET
3500 LB/HOUR WOOD WASTE
(80% INDUSTRY WOOD WASTE, 20% FORESTRY WOOD WASTE)
6240 HOURS/YEAR

<u>REAL EQUIPMENT</u>	
Gasifier and Turbine Genset, Includes the Following:	$ 2,860,000.00
Gasifier	
Gas Turbine Genset	
Exhaust Stack	
Biomass Surge Bin	
Radiator	
Ash Storage	
Control Room	
Switchgear	
Dryer	
Fuel Storage	
Bulk Feed Hopper	
Hog	
Installation for above items	
Power Plant Building	
Concrete Slab	
Access Road	$ 5,000.00
SUB-TOTAL	**$ 2,865,000.00**

<u>OTHER EQUIPMENT</u>	
Installation of Utilities	$ 8,000.00
Tools	$ 2,000.00
Site Fencing	$ 25,000.00
Signs	$ 2,000.00
Landscaping	$ 5,000.00
SUB-TOTAL	**$ 42,000.00**

SCENARIO 2 (CONTINUED)

ESTIMATED CAPITAL COSTS

Real Equipment	$ 2,865,000.00
Land (1 Acre)	$ 10,000.00
Site Preparation	$ 2,000.00
Other Equipment	$ 42,000.00
Start-Up and Working Capital	$ 75,000.00
Financing and Legal	$ 20,000.00
Construction Otherwise Not Noted	$ 50,000.00
Professional Services	$ 30,000.00
Design (10% Capital)	$ 309,400.00
Contingencies (5% Capital)	$ 154,700.00
SUB-TOTAL	**$ 3,558,100.00**

ESTIMATED ANNUAL OPERATION AND MAINTENANCE COSTS

Salaries (2 hours/shift Operator) with Benefits	$ 66,300.00
Electricity	$ 31,017.60
Maintenance Costs, Gasifier	$ 101,088.00
Residue Removal and Disposal	$ 20,000.00
Other Overhead	$ 17,000.00
Taxes and Liscenses	$ 5,000.00
Insurance	$ 39,000.00
Water	$ 1,000.00
SUB-TOTAL	**$ 280,405.60**

CURRENT ELECTRICITY COSTS

First Shift	$ 380,133.00
Second Shift	$ 94,980.60
Third Shift	$ -
Weekends	$ -
SUB-TOTAL	**$ 475,113.60**

ESTIMATED ELECTRICITY COSTS WITH GASIFIER

First Shift	$ 190,593.00
Second Shift	$ (31,519.80)
Third Shift	$ (42,120.00)
Weekends	$ 561.60
SUB-TOTAL	**$ 117,514.80**

SCENARIO 2 (CONTINUED)

SAVINGS ON ELECTRICITY	**$ 357,598.80**
SAVINGS ON WOOD DISPOSAL COSTS	**$ 300,000.00**
TOTAL SAVINGS	**$ 657,598.80**
SALVAGE VALUE (20% AFTER 10 YEARS)	**$ 573,000.00**
A/P	**0.116**

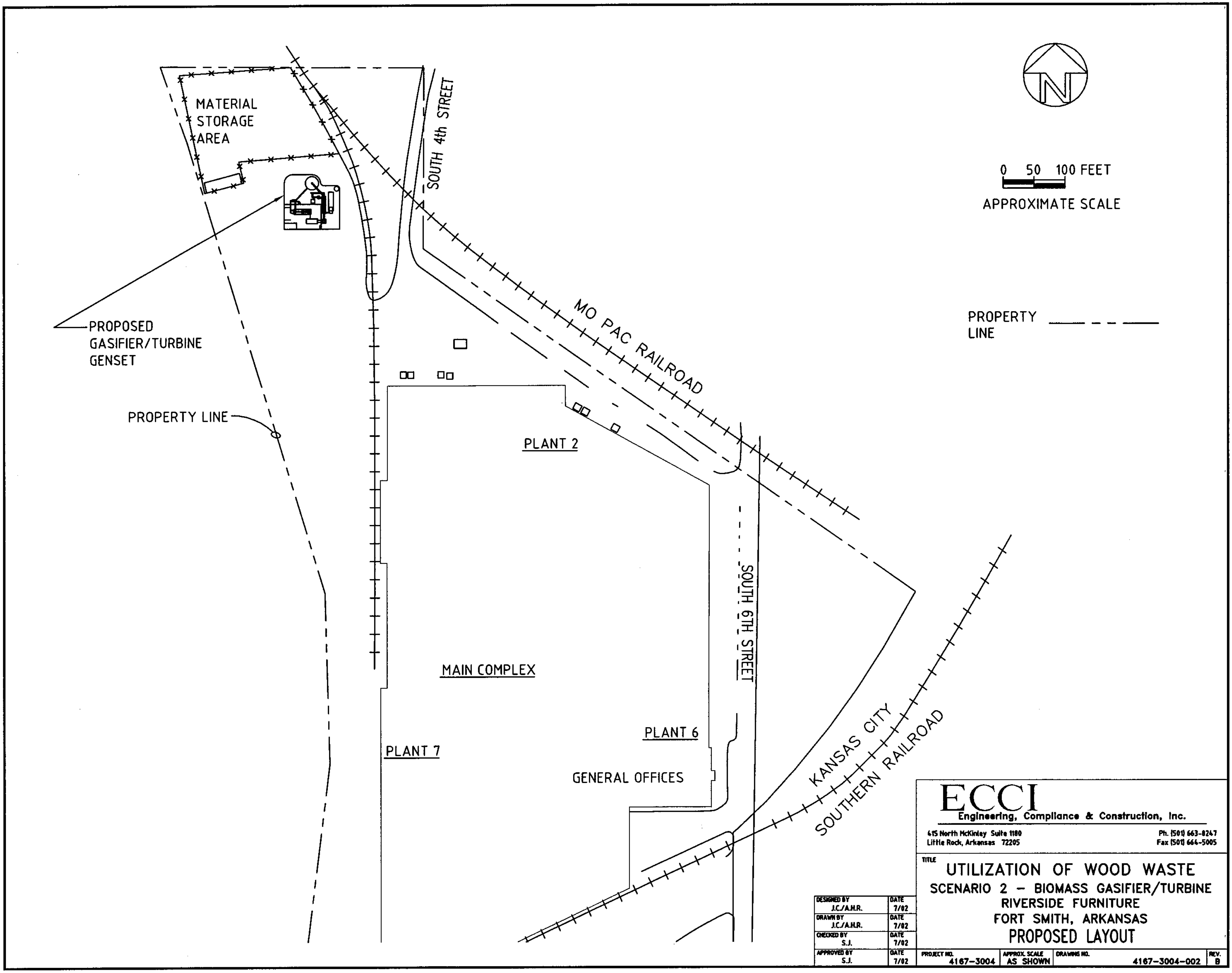
Assuming an interest rate of 8%, there will be a 15-year pay back.

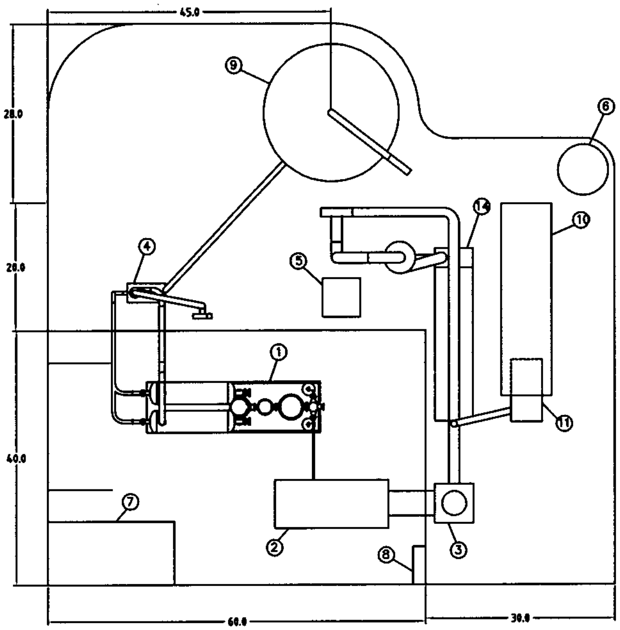
PRO FORMA INCOME STATEMENT
RIVERSIDE FURNITURE
1800 KW GASIFIER

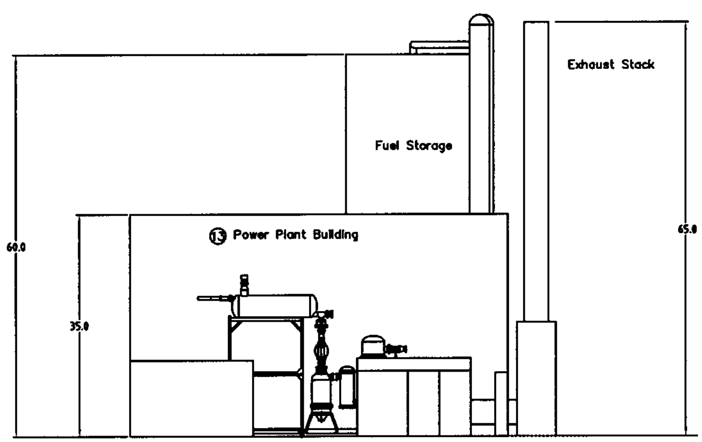
Plant annual hours operation		6240
Plant net output	kWe	1800
Fuel input	lbs/hr	3500
price for electricity	$/kWh	0.045
tipping fee	$/ton	30

Plant total initial investment $ 3,558,100.00

Year	1	2	3	4	5	6	7	8	9	10
Income										
Electricity Sales	$ 357,598.80	$ 357,598.80	$ 357,598.80	$ 357,598.80	$ 357,598.80	$ 357,598.80	$ 357,598.80	$ 357,598.80	$ 357,598.80	$ 357,598.80
Steam Sales	0	0	0	0	0	0	0	0	0	0
Char-ash Sales	0	0	0	0	0	0	0	0	0	0
Tipping Fees	$ 300,000.00	$ 300,000.00	$ 300,000.00	$ 300,000.00	$ 300,000.00	$ 300,000.00	$ 300,000.00	$ 300,000.00	$ 300,000.00	$ 300,000.00
Total	$ 657,598.80	$ 657,598.80	$ 657,598.80	$ 657,598.80	$ 657,598.80	$ 657,598.80	$ 657,598.80	$ 657,598.80	$ 657,598.80	$ 657,598.80
Expenses										
Operators	$ 66,300.00	$ 66,300.00	$ 66,300.00	$ 66,300.00	$ 66,300.00	$ 66,300.00	$ 66,300.00	$ 66,300.00	$ 66,300.00	$ 66,300.00
Maintenance	$ 101,088.00	$ 101,088.00	$ 101,088.00	$ 101,088.00	$ 101,088.00	$ 101,088.00	$ 101,088.00	$ 101,088.00	$ 101,088.00	$ 101,088.00
Biomass Fuel	0	0	0	0	0	0	0	0	0	0
Electricity	$ 31,017.60	$ 31,017.60	$ 31,017.60	$ 31,017.60	$ 31,017.60	$ 31,017.60	$ 31,017.60	$ 31,017.60	$ 31,017.60	$ 31,017.60
Depreciation	$ 284,648.00	$ 284,648.00	$ 284,648.00	$ 284,648.00	$ 284,648.00	$ 284,648.00	$ 284,648.00	$ 284,648.00	$ 284,648.00	$ 284,648.00
Insurance	$ 39,000.00	$ 39,000.00	$ 39,000.00	$ 39,000.00	$ 39,000.00	$ 39,000.00	$ 39,000.00	$ 39,000.00	$ 39,000.00	$ 39,000.00
Other	$ 43,000.00	$ 43,000.00	$ 43,000.00	$ 43,000.00	$ 43,000.00	$ 43,000.00	$ 43,000.00	$ 43,000.00	$ 43,000.00	$ 43,000.00
Total	$ 565,053.60	$ 565,053.60	$ 565,053.60	$ 565,053.60	$ 565,053.60	$ 565,053.60	$ 565,053.60	$ 565,053.60	$ 565,053.60	$ 565,053.60
EBIT	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20
Interest Expense	0	0	0	0	0	0	0	0	0	0
Earnings before Taxes	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20
Taxes	0	0	0	0	0	0	0	0	0	0
Fuel Tax Cedit	0	0	0	0	0	0	0	0	0	0
Net Taxes	0	0	0	0	0	0	0	0	0	0
Net Income	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20
Cash Flow										
Net Income	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20	$ 92,545.20
Depreciation	$ 284,648.00	$ 284,648.00	$ 284,648.00	$ 284,648.00	$ 284,648.00	$ 284,648.00	$ 284,648.00	$ 284,648.00	$ 284,648.00	$ 284,648.00
salvage value										$ 573,000.00
less										
Debt Retirement	0	0	0	0	0	0	0	0	0	0
Net Cash Flow	$ 377,193.20	$ 377,193.20	$ 377,193.20	$ 377,193.20	$ 377,193.20	$ 377,193.20	$ 377,193.20	$ 377,193.20	$ 377,193.20	$ 950,193.20
IRR of Net Cash Flow		**3.42%**								


MATERIAL
STORAGE
AREA
PROPOSED
GASIFIER/TURBINE
GENSET
PROPERTY LINE
SOUTH 4th STREET
MO PAC RAILROAD
PLANT 2
MAIN COMPLEX
PLANT 7
PLANT 6
GENERAL OFFICES
SOUTH 6TH STREET
KANSAS CITY
SOUTHERN RAILROAD
0 50 100 FEET
APPROXIMATE SCALE
PROPERTY
LINE
ECCI
Engineering, Compliance & Construction, Inc.
415 North McKinley Suite 1180
Little Rock, Arkansas 72205
Ph. (501) 663-8247
Fax (501) 664-5005
TITLE
UTILIZATION OF WOOD WASTE
SCENARIO 2 – BIOMASS GASIFIER/TURBINE
RIVERSIDE FURNITURE
FORT SMITH, ARKANSAS
PROPOSED LAYOUT
DESIGNED BY J.C./A.H.R.
DATE 7/02
DRAWN BY J.C./A.H.R.
DATE 7/02
CHECKED BY S.J.
DATE 7/02
APPROVED BY S.J.
DATE 7/02
PROJECT NO. 4167-3004
APPROX. SCALE AS SHOWN
DRAWING NO. 4167-3004-002
REV. B





COMPONENTS

ITEM		DESCRIPTION
1		Gasifier
2		Gas Turbine Genset
3		Exhaust Stack
4		Biomass Surge Bin
5		Radiator
6		Ash Storage
7		Control Room
8		Switchgear
9		Fuel Storage
10		Bulk Feed Hopper
11		Hog
12		—
13		Power Plant Building
14		Dryer
15		—

CRATECH
P.O. BOX 70 TAHOKA, TEXAS 79373

Dimensions shown are in feet

CHG	DATE
2	8 JUL 02
1	MAY 30 02
0	MAY 15 02

DRAWN BY
APPROVED BY

DESCRIPTION
ECCI 1800 kWe Plant + Dryer

1C0048 | SHEET OF | SCALE 1" = 30' | D

Scenario 3

This scenario utilizes the integration of a new biomass furnace with an existing natural gas fired furnace at a manufacturing plant. Currently the plant drives off moisture from products using a series of drying chambers heated to a temperature of 300° F. These drying chambers are heated by a natural gas fired hot air furnace that consumes 17 MMBTU/hr of gas on the average. The cost of gas to operate in this manner is approximately $600,000.00 per year. A biomass hot air furnace could be integrated with this system to reduce natural gas consumption.

Three large wood waste generators in the Fort Smith area produce about 6,190 tons of kiln dried wood waste each year. Assuming 90% of this amount was available from year to year, the production of wood waste would total 5,570 tons per year. This amount of wood waste would generate an average of 10 MMBTU/hr in a hot air furnace, assuming the furnace was run 50 weeks out of the year. Thinking conservatively, this amount of heat production would reduce the consumption of natural gas by half.

The wood waste would be processed and delivered by the furniture manufacturers to the manufacturer, ensuring the wood was less than 2" in size and less than 10% in moisture content. The waste would then be dumped into a ground level dump bin with a live bottom. The waste would be conveyed from the bin to a 15,405 cubic foot silo that would allow for three days of storage. The waste would then be conveyed to a feed bin and then to the furnace. The combustion air from the biomass furnace would be treated in a multiclone unit, and would then tie back into the existing natural gas firebox.

The following table presents the estimated capital costs, annual operation and maintenance costs, and annual savings associated with Scenario 3:

Table 3: Capital costs, annual operation and maintenance costs, and annual savings

Estimated Capital Costs	*$ 507,150.00*
Estimated Annual Operation and Maintenance Costs	*$ 120,000.00*
Estimated Annual Savings on Natural Gas	$ 300,000.00

Assuming an interest rate of 8%, an equipment life of 10 years, and a salvage value of 20% of the real equipment cost, a 3½-year payback with an internal rate of return of 33.1% can be expected.

SCENARIO 3
10 MMBTU HOT AIR FURNACE FOR BRICK MANUFACTURER
200° F TO 300° F
1320 LB/HOUR WOOD WASTE
(100% INDUSTRY WOOD WASTE)
8242 HOURS/YEAR

<u>REAL EQUIPMENT</u>		
Direct Fired Furnace System, Includes the Following:	$	450,000.00
Mechanical Components of Direct Fire System:		
Automatic fire box ash clean out and collection to central point		
2-8" stokers with rotary air locks and electrical and mechanical burn back protection		
Heavy duty precast fire box with 3100° F refractory and a generous gasification area		
Exhaust breeching		
High efficiency 48 tube particulate collector system		
Exhaust stub stack		
High efficiency induced draft fan assembly		
High efficiency tertiary blend air fan assembly		
Over fire gasification fan assembly		
Under fire fan assembly		
Complete PLC-based control panel with patent pending IBI combustion control suite		
Desktop PC with monitor for boiler system monitoring		
Fuel Supply and Storage System:		
Steel silo with 3 days storage (15405 cf storage)		
5" severe duty IBI wood waste unloader		
9" fuel transfer auger (unloader to stoker airlock)		
Concrete foundation for firebox and silo		
Bucket elevator system complete with truck dump hopper bin, erection, and assembly		
Installation of the Above Listed Components		
10' X 10' Control Room Building	$	3,000.00
Electrical	$	25,000.00
SUB-TOTAL	**$**	**478,000.00**

SCENARIO 3 (CONTINUED)

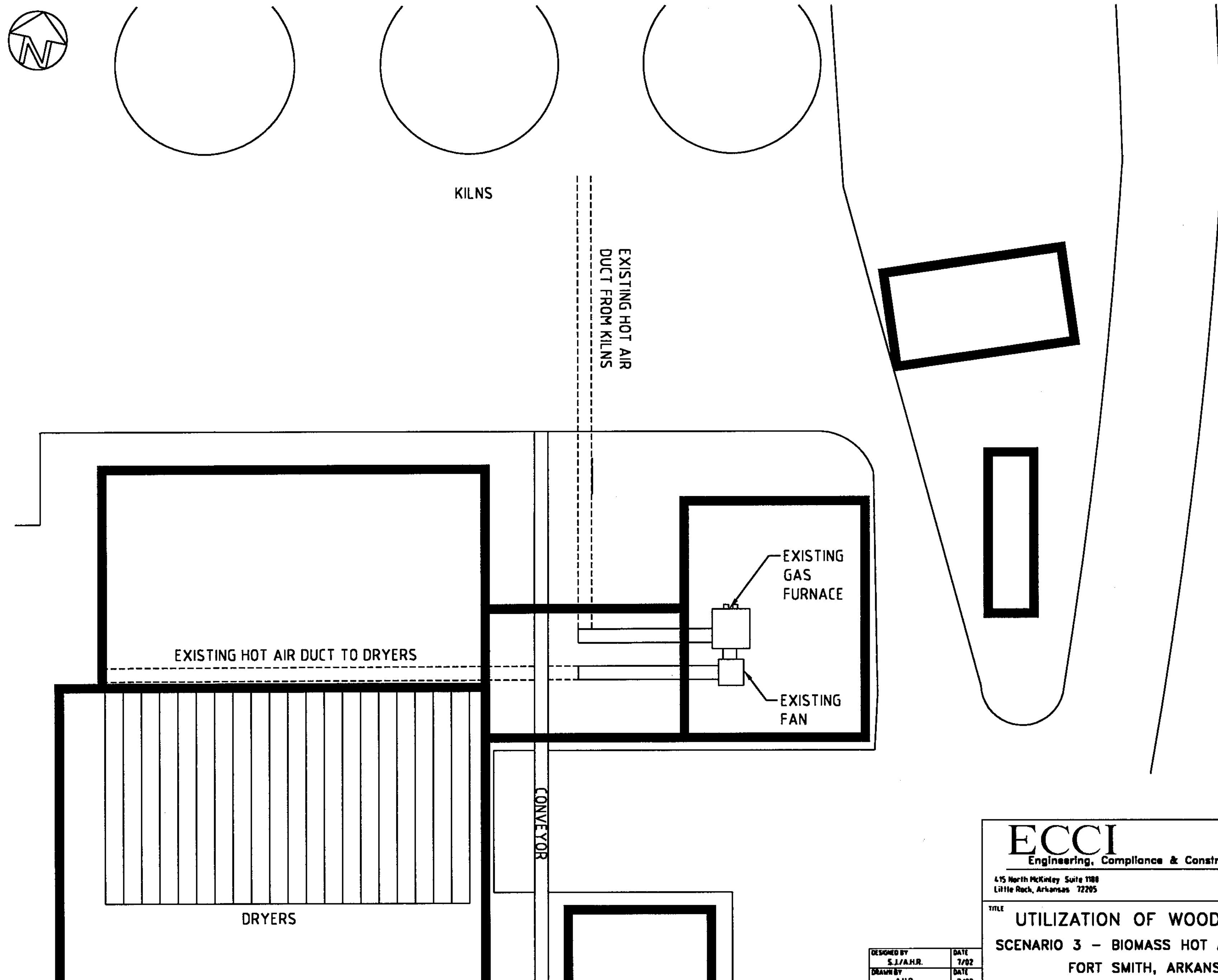
OTHER EQUIPMENT		
Installation of Utilities	$	8,000.00
Tools	$	2,000.00
SUB-TOTAL	**$**	**10,000.00**
ESTIMATED CAPITAL COSTS		
Real Equipment	$	478,000.00
Professional Services	$	5,000.00
Contingencies (5% Capital)	$	24,150.00
SUB-TOTAL	**$**	**507,150.00**
ESTIMATED ANNUAL OPERATION AND MAINTENANCE COSTS		
Salaries (1 Additional Operator)	$	40,000.00
Employee Benefits (35% Salaries)	$	14,000.00
Electricity	$	10,000.00
Maintenance Costs	$	20,000.00
Residue Removal and Disposal	$	20,000.00
Other Overhead	$	5,000.00
Taxes and Liscenses	$	5,000.00
Insurance	$	5,000.00
Water	$	1,000.00
SUB-TOTAL	**$**	**120,000.00**
CURRENT GAS COSTS	**$**	**600,000.00**
ESTIMATED GAS COSTS WITH BIOMASS FURNACE	**$**	**300,000.00**
SAVINGS ON GAS	**$**	**300,000.00**
SALVAGE VALUE (20% AFTER 10 YEARS)	**$**	**95,600.00**
A/P		**0.366**

Assuming an interest rate of 8%, there will be a 3 1/2-year pay back.

PRO FORMA INCOME STATEMENT
ACME BRICK
BIOMASS HOT AIR FURNACE

Plant total initial investment $ 507,150.00

Year	1	2	3	4	5	6	7	8	9	10
Income										
Natural Gas Saving	$300,000.00	$ 300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$ 300,000.00
Total	$300,000.00	$ 300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$300,000.00	$ 300,000.00
Expenses										
Operators	$ 54,000.00	$ 55,080.00	$ 56,181.60	$ 57,305.23	$ 58,451.34	$ 59,620.36	$ 60,812.77	$ 62,029.03	$ 63,269.61	$ 64,535.00
Maintenance	$ 20,000.00	$ 20,400.00	$ 20,808.00	$ 21,224.16	$ 21,648.64	$ 22,081.62	$ 22,523.25	$ 22,973.71	$ 23,433.19	$ 23,901.85
Biomass Fuel	0	0	0	0	0	0	0	0	0	0
Electricity	$ 10,000.00	$ 10,000.00	$ 10,000.00	$ 10,000.00	$ 10,000.00	$ 10,000.00	$ 10,000.00	$ 10,000.00	$ 10,000.00	$ 10,000.00
Depreciation	$ 40,572.00	$ 40,572.00	$ 40,572.00	$ 40,572.00	$ 40,572.00	$ 40,572.00	$ 40,572.00	$ 40,572.00	$ 40,572.00	$ 40,572.00
Insurance	$ 5,000.00	$ 5,000.00	$ 5,000.00	$ 5,000.00	$ 5,000.00	$ 5,000.00	$ 5,000.00	$ 5,000.00	$ 5,000.00	$ 5,000.00
Other	$ 31,000.00	$ 31,000.00	$ 31,000.00	$ 31,000.00	$ 31,000.00	$ 31,000.00	$ 31,000.00	$ 31,000.00	$ 31,000.00	$ 31,000.00
Total	$160,572.00	$ 162,052.00	$163,561.60	$165,101.39	$166,671.98	$168,273.98	$169,908.02	$171,574.74	$173,274.79	$ 175,008.85
EBIT	$139,428.00	$ 137,948.00	$136,438.40	$134,898.61	$133,328.02	$131,726.02	$130,091.98	$128,425.26	$126,725.21	$ 124,991.15
Interest Expense	0	0	0	0	0	0	0	0	0	0
Earnings before Taxes	$139,428.00	$ 137,948.00	$136,438.40	$134,898.61	$133,328.02	$131,726.02	$130,091.98	$128,425.26	$126,725.21	$ 124,991.15
Taxes	0	0	0	0	0	0	0	0	0	0
Fuel Tax Cedit	0	0	0	0	0	0	0	0	0	0
Net Taxes	0	0	0	0	0	0	0	0	0	0
Net Income	$139,428.00	$ 137,948.00	$136,438.40	$134,898.61	$133,328.02	$131,726.02	$130,091.98	$128,425.26	$126,725.21	$ 124,991.15
Cash Flow										
Net Income	$139,428.00	$ 137,948.00	$136,438.40	$134,898.61	$133,328.02	$131,726.02	$130,091.98	$128,425.26	$126,725.21	$ 124,991.15
Depreciation	$ 40,572.00	$ 40,572.00	$ 40,572.00	$ 40,572.00	$ 40,572.00	$ 40,572.00	$ 40,572.00	$ 40,572.00	$ 40,572.00	$ 40,572.00
salvage value										$ 95,600.00
less										
Debt Retirement	0	0	0	0	0	0	0	0	0	0
Net Cash Flow	$180,000.00	$ 178,520.00	$177,010.40	$175,470.61	$173,900.02	$172,298.02	$170,663.98	$168,997.26	$167,297.21	$ 261,163.15
IRR of Net Cash Flow		**33.1%**								

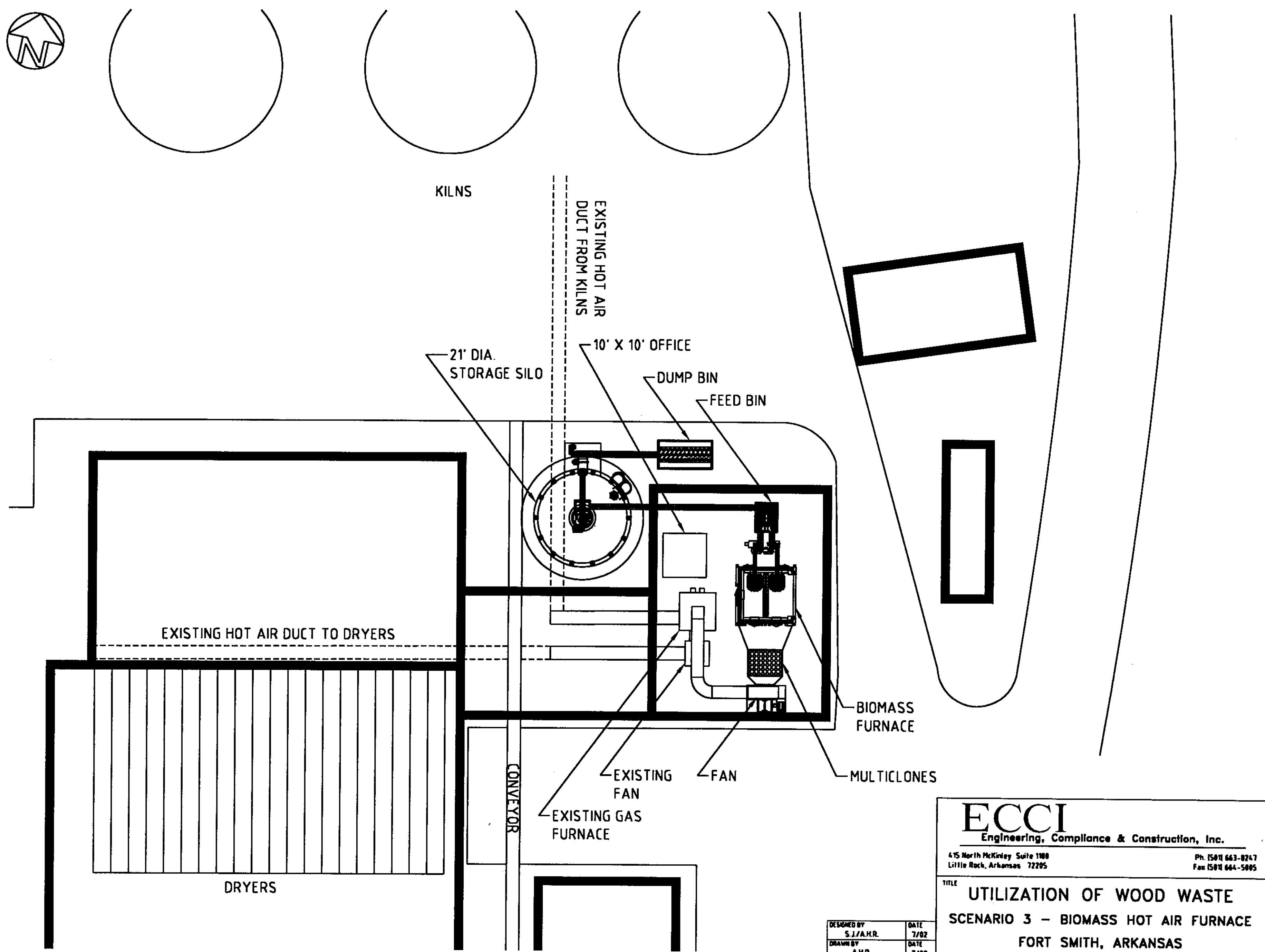


ECCI
Engineering, Compliance & Construction, Inc.
415 North McKinley Suite 1180
Little Rock, Arkansas 72205
Ph. (501) 663-8247
Fax (501) 664-5005

TITLE
UTILIZATION OF WOOD WASTE
SCENARIO 3 – BIOMASS HOT AIR FURNACE
FORT SMITH, ARKANSAS
EXISTING LAYOUT – PLAN VIEW

DESIGNED BY S.J./A.H.R.	DATE 7/02
DRAWN BY A.H.R.	DATE 7/02
CHECKED BY S.J.	DATE 7/02
APPROVED BY S.J.	DATE 7/02

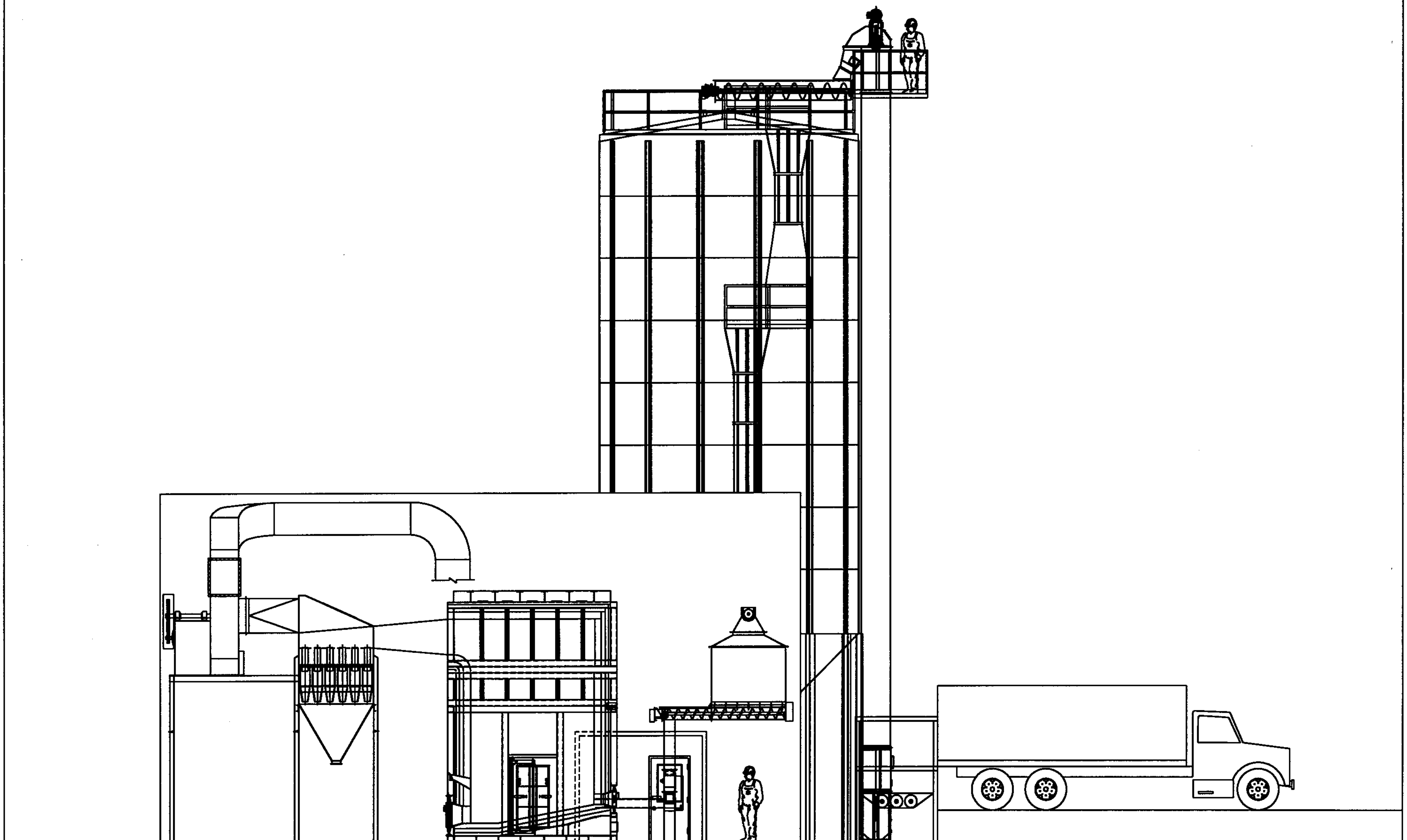
PROJECT NO.	APPROX. SCALE	DRAWING NO.	REV.
4167-3004	1" = 30'	4167-3004-003	A



ECCI
Engineering, Compliance & Construction, Inc.
415 North McKinley Suite 1100
Little Rock, Arkansas 72205
Ph. (501) 663-0247
Fax (501) 664-5005

TITLE
UTILIZATION OF WOOD WASTE
SCENARIO 3 – BIOMASS HOT AIR FURNACE
FORT SMITH, ARKANSAS
PROPOSED LAYOUT – PLAN VIEW

DESIGNED BY S.J./A.H.R.	DATE 7/02			
DRAWN BY A.H.R.	DATE 7/02			
CHECKED BY S.J.	DATE 7/02			
APPROVED BY S.J.	DATE 7/02	PROJECT NO. 4167-3004	APPROX. SCALE 1" = 30'	DRAWING NO. 4167-3004-004	REV. A



Sheet 1 of 1

MATERIAL	QTY./UNIT
As Noted	X

DESCRIPTION: Concept Elevation

TOLERANCES UNLESS OTHERWISE SPECIFIED

X DECIMAL	+/- .030	FRACTIONAL +/-
XX DECIMAL	+/- .015	.0625
XXX DECIMAL	+/- .005	125

INDUSTRIAL BIOMASS, INC.
Wood Waste to Energy
8800 South State Route 251
Rochelle, Illinois 61068
Phone: (815) 562-6400
Fax: (815) 562-6441

DRN. RLC
CHKD.
DATE 07-08-08

DWG. NO. Concept

VII. Environmental Impacts

The combustion technologies for recovering energy from wood biomass evaluated in this study all have either very low environmental impacts and utilize proven pollution control equipment to reduce potential environmental impacts.

Biomass Gasification is a process with small negative environmental impacts while reducing fossil fuel usage and reducing the need for land filling forest biomass or wood wastes from manufacturing. Total air emissions calculated for gasification processes described in this study were all below significant levels. The most significant emission products were carbon monoxide (CO) and oxides of nitrogen (NO_x). The largest gasifier process evaluated (28 MMBTU/hr) produces only 20.8 tons per year of CO and 19.6 tons per year of NO_x operating at full capacity.

Conventional Wood Waste Boilers create more air emissions, however air pollution control systems are required by EPA New Source Performance Standards which result in projected emissions near those predicted from gasification processes (again mostly CO and NO_x)

Hot Air Furnace technology is a relatively new application of conventional technologies to allow energy recovery to provide heat for operation of industrial dryers. The air emissions predicted from these systems are controlled to remove particulates. Resulting carbon monoxide and nitrogen oxide emissions are similar to the levels expected from gasification, although the hot air furnace scenario evaluated is less than half the capacity of the other systems and emissions decrease proportionately.

VIII. Financial Results

The financial analysis of the selected scenarios demonstrate the chances of actual project implementation. Utilization of gasification technology has potential to include recovery of forest biomass and is unique in ability to handle this fuel while successfully managing complications from more moisture as well as probable fuel contamination by soils during collection and handling. The economics of collection of biomass fuel from forests was beyond the scope of this study, however, there is a logical handling distance beyond which transportation of the biomass utilizes more energy than is available for recovery.

The size of gasification systems is limited by the amount of biomass or wood waste fuels available within a range of approximately fifty (50) miles. The flexibility of the gasification system to produce location specific mixtures of steam and/or electricity is an extremely positive characteristic which will result in increased utilization of this technology in the event that fossil fuel prices increase. The model gasification system costs for the 22 MMBTU/hr and 28 MMBTU/hr systems will allow an expedient assessment of the potential success of their systems for utilization at any location where wood wastes and forest biomass are readily available. The use of such model system costs and cash flow analysis should encourage decision makers to evaluate the potential systems benefits versus overall capital and operational costs. This should provide opportunities for saving energy and reducing overall costs while reducing disposal of wood related biomass.

For very large volumes of forest biomass or wood industry related wastes, conventional wood waste boiler technology is already broadly utilized (in the 250 MMBTU/hr range). These large utility type operations can produce large volumes of high quality process steam and often utilize conventional steam turbines to generate electricity to power large facilities. Scaling these conventional systems down to size to handle local wood product wastes is a challenge and forest biomass fuel can cause operational problems with slagging in the combustion zone from silica in soil and cause difficulties with ash removal systems.

Hot air furnaces are proving to be useful in industrial dryer applications. These systems are relatively straightforward with low maintenance costs. The preparation of the fuel is critical for successful system performance. Fuels must be sized to burn easily in the combustion zone and non-biomass fuel contaminants (such as trash, containers, or soils) must be minimized.

IX. Keys to Successful Implementation

This study is unique in the evaluation of utilization of biomass fuels from multiple sources being utilized by an individual industrial facility. In order for the industrial facility to be willing to invest the capital costs associated with construction of the appropriate technology, the facility must be confident in the availability of long term quality biomass fuel source. This will be a key factor in retiring the capital debt. There are numerous alternative approaches to achieve success where the industrial facility can reduce fuel costs, and the biomass waste generators can obtain secure long term alternatives to disposal and also reduce costs.

Several key arrangements must be negotiated:

- There must be a shared risk for capital investment costs. Waste biomass generators must either assist with capital investment in exchange for long term low costs outlets for the waste or provide guarantees of adequate quality biomass fuels long term. These contract arrangements can be tied to natural gas prices and allow a sharing of savings by the waste generator if natural gas prices increase significantly.

- Contracts should include provisions for fuel quality to prevent later misunderstandings. Generally, for smaller projects such as hot air furnaces, fuel should be prepared to an agreed size (<2 inches) and stored in covered vans or trailers to minimize moisture accumulation. Specifications should be established for both sizing and moisture, and the fuel user should be able to reject shipments failing the specification.

- Put-or-pay and take-or-pay provisions should be used to assure the fuel user will have adequate quality fuel and the biomass waste generator will have long term commitments for use of the fuel. Generally, the waste generator will agree to provide a minimum amount of fuel over a specific time period. Failure to provide the guaranteed minimum would result in the biomass generator sharing costs for alternative fuel as a way to help assure debt retirement. Likewise, the fuel user may be required to help the biomass fuel generator pay for landfill costs when the industrial facility is unable or unwilling to accept the minimum amount of quality prepared biomass fuel.

X. Conclusions

Several conclusions became available during this project:

- Many industrial facility managers are unaware of the availability of alternative sources of potentially cost-effective fuels which especially should be considered for process expansions or modifications.

- Gasification technology provides a process which is adaptable to a wide range of fuel characteristics and provides multiple products such as steam and/or electricity. This technology is expected to grow especially with any fossil fuel price increases. Wider use of the technology will educate decision makers to the wide potential uses for the technology.

- Unique opportunities exist for utilization of biomass as fuel or feed stocks at numerous industrial facilities; however, the knowledge of the availability is not wide spread. Effective communication of such availability to industrial managers would result in significant increases of use of materials previously handled as wastes.

Bibliography

1. Moore, W. Henson. “America’s Future Depends on New Energy Technologies.” Pulp and Paper. August 2001: 60.

2. Patterson, David W. and Gary W. Zinn. “Wood Residues as an Energy Resource.” West Virginia University Agricultural and Forestry Experiment Station, Bulletin 703. June, 1990: 1-2.

3. United States Environmental Protection Agency. “Regulation of Hazardous Oil-Bearing Secondary Materials in a Gasification System to Produce Synthesis Gas.” Federal Register. March 25, 2002: 13686.

4. Levins, Robert. “Timber Production in Arkansas- 1997 through 2001.” Arkansas Forestry Commission. “Personal Communication.” June 24, 2002.

Appendix A

Additional Cost Estimates and Financial Analysis

22 MMBTU BOILER FOR RIVERSIDE
1500 kWe
2700 LB/HOUR WOOD WASTE
(100% INDUSTRY WOOD WASTE)
6240 HOURS/YEAR

<u>REAL EQUIPMENT</u>

Boiler System with Electrical Generation, Includes the Following:	$ 4,300,000.00

- Fuel Storage and Handling System:
  - Fuel Storage Bin
  - Fuel Handling Conveyor (Storage Bin to Surge Bin)
- Watertube Boiler System:
  - Boiler Pressure Vessel
  - Boiler Casing and Insulation
  - Boiler Accessories
  - Sootblowers
  - Feedwater Control System
  - Supporting Structure
- Furnace System:
  - One Cell Furnace System
  - Metering Surge Bins
  - Furnace Fuel Feed Screws
  - Self-Cleaning Rotary Grates
- Combustion Air Handling System:
  - Forced Draft Fan
  - Ducting and Insulation
- Exhaust Gas Handling System:
  - Combustion Air Preheater
  - Multiple Cone Collector
  - Ducting and Insulation
  - Induced Draft Fan
  - Electrostatic Precipitator
- Computerized Control System:
  - Computer Equipment and Peripherals
  - Proprietary Software

REAL EQUIPMENT (Continued)

Supplemental Equipment:

- Electric Motors
- Motor Control Centers
- Boiler System Piping
- Blowdown Heat Exchanger
- Water Treatment Equipment
- Feedwater and Deaeration System
- Boiler Feedwater Pumps
- Boiler Gratewater Pumps
- Ash Handling
- Ash Receiver
- Opacity Monitor
- Boiler Walkways, Stairs, and Decks
- Boiler and Turbine-Generator Building

Electrical Generation System:

- Refurbished Steam Turbine/Generator Sets
- Condenser
- Air Injector
- Condensate Pumps
- Cooling Tower
- Circulating Pumps
- Switchgear
- DC Power System
- Electric Motors
- Motor Control Centers
- Control Panels
- Switchyard Equipment
- Protective Relaying and Metering
- Grounding Grid
- Utility Interface

REAL EQUIPMENT (Continued)

Project Services:
- System Design and Engineering
- Foundation Design (No Pilings)
- Foundation Construction (No Pilings)
- Grounding Grid Design
- Installation Drawings
- Mechanical Installation
- Electrical Installation
- Start-up and Training
- Operation and Maintenance Manuals
- Recommended Spare Parts List
- Freight to Site

Installation of the Above Listed Components

SUB-TOTAL	**$ 4,300,000.00**

OTHER EQUIPMENT

Installation of Utilities	$ 8,000.00
Tools	$ 2,000.00
Site Fencing	$ 25,000.00
Signs	$ 2,000.00
Landscaping	$ 5,000.00
SUB-TOTAL	**$ 42,000.00**

ESTIMATED CAPITAL COSTS

Real Equipment	$ 4,300,000.00
Land (1 Acre)	$ 10,000.00
Site Preparation	$ 2,000.00
Other Equipment	$ 42,000.00
Start-Up and Working Capital	$ 100,000.00
Financing and Legal	$ 20,000.00
Construction Otherwise Not Noted	$ 50,000.00
Professional Services	$ 30,000.00
Contingencies (5% Capital)	$ 227,700.00
SUB-TOTAL	**$ 4,781,700.00**

<u>ESTIMATED ANNUAL OPERATION AND MAINTENANCE COSTS</u>

Salaries (7 Operators)	$	210,000.00
Employee Benefits (35% Salaries)	$	73,500.00
Air Pollution Control Chemicals	$	-
Electricity	$	25,941.60
Maintenance Costs	$	100,000.00
Residue Removal and Disposal	$	20,000.00
Other Overhead	$	17,000.00
Taxes and Liscenses	$	5,000.00
Insurance	$	39,000.00
Water Treatment and Chemicals	$	20,000.00
Water	$	1,000.00
SUB-TOTAL	**$**	**511,441.60**

<u>CURRENT ELECTRICITY COSTS</u>

First Shift	$	380,133.00
Second Shift	$	94,980.60
Third Shift	$	-
Weekends	$	-
SUB-TOTAL	**$**	**475,113.60**

<u>ESTIMATED ELECTRICITY COSTS WITH GASIFIER</u>

First Shift	$	237,978.00
Second Shift	$	59,441.85
Third Shift	$	(7,897.50)
Weekends	$	-
SUB-TOTAL	**$**	**289,522.35**

SAVINGS ON ELECTRICITY	**$**	**185,591.25**
SAVINGS ON WOOD DISPOSAL COSTS	**$**	**251,000.00**
TOTAL SAVINGS	**$**	**436,591.25**
SALVAGE VALUE (20% AFTER 10 YEARS)	**$**	**860,000.00**
A/P		**-0.005**

Assuming an interest rate of 8%, there will never be a pay back.

28 MMBTU BOILER FOR RIVERSIDE
3500 kWe
3500 LB/HOUR WOOD WASTE
(80% INDUSTRY WOOD WASTE, 20% FORESTRY WOOD WASTE)
6240 HOURS/YEAR

REAL EQUIPMENT

Boiler System with Electrical Generation, Includes the Following: $ 7,740,000.00

- Fuel Storage and Handling System:
  - Fuel Storage Bin
  - Fuel Handling Conveyor (Storage Bin to Surge Bin)
- Watertube Boiler System:
  - Boiler Pressure Vessel
  - Boiler Casing and Insulation
  - Boiler Accessories
  - Sootblowers
  - Feedwater Control System
  - Supporting Structure
- Furnace System:
  - One Cell Furnace System
  - Metering Surge Bins
  - Furnace Fuel Feed Screws
  - Self-Cleaning Rotary Grates
- Combustion Air Handling System:
  - Forced Draft Fan
  - Ducting and Insulation
- Exhaust Gas Handling System:
  - Combustion Air Preheater
  - Multiple Cone Collector
  - Ducting and Insulation
  - Induced Draft Fan
  - Electrostatic Precipitator
- Computerized Control System:
  - Computer Equipment and Peripherals
  - Proprietary Software

REAL EQUIPMENT (Continued)

Supplemental Equipment:
- Electric Motors
- Motor Control Centers
- Boiler System Piping
- Blowdown Heat Exchanger
- Water Treatment Equipment
- Feedwater and Deaeration System
- Boiler Feedwater Pumps
- Boiler Gratewater Pumps
- Ash Handling
- Ash Receiver
- Opacity Monitor
- Boiler Walkways, Stairs, and Decks
- Boiler and Turbine-Generator Building

Electrical Generation System:
- Refurbished Steam Turbine/Generator Sets
- Condenser
- Air Injector
- Condensate Pumps
- Cooling Tower
- Circulating Pumps
- Switchgear
- DC Power System
- Electric Motors
- Motor Control Centers
- Control Panels
- Switchyard Equipment
- Protective Relaying and Metering
- Grounding Grid
- Utility Interface

REAL EQUIPMENT (Continued)

Project Services:

System Design and Engineering
Foundation Design (No Pilings)
Foundation Construction (No Pilings)
Grounding Grid Design
Installation Drawings
Mechanical Installation
Electrical Installation
Start-up and Training
Operation and Maintenance Manuals
Recommended Spare Parts List
Freight to Site

Installation of the Above Listed Components

SUB-TOTAL	**$ 7,740,000.00**

OTHER EQUIPMENT

Installation of Utilities	$ 8,000.00
Tools	$ 2,000.00
Site Fencing	$ 25,000.00
Signs	$ 2,000.00
Landscaping	$ 5,000.00
SUB-TOTAL	**$ 42,000.00**

ESTIMATED CAPITAL COSTS

Real Equipment	$ 7,740,000.00
Land (1 Acre)	$ 10,000.00
Site Preparation	$ 2,000.00
Other Equipment	$ 42,000.00
Start-Up and Working Capital	$ 100,000.00
Financing and Legal	$ 20,000.00
Construction Otherwise Not Noted	$ 50,000.00
Professional Services	$ 30,000.00
Contingencies (5% Capital)	$ 399,700.00
SUB-TOTAL	**$ 8,393,700.00**

ESTIMATED ANNUAL OPERATION AND MAINTENANCE COSTS		
Salaries (7 Operators)	$	210,000.00
Employee Benefits (35% Salaries)	$	73,500.00
Air Pollution Control Chemicals	$	-
Electricity	$	25,941.60
Maintenance Costs	$	100,000.00
Maintenance Costs, Loader		
Residue Removal and Disposal	$	20,000.00
Other Overhead	$	17,000.00
Taxes and Liscenses	$	5,000.00
Insurance	$	39,000.00
Water Treatment and Chemicals	$	20,000.00
Water	$	1,000.00
SUB-TOTAL	**$**	**511,441.60**

CURRENT ELECTRICITY COSTS		
First Shift	$	380,133.00
Second Shift	$	94,980.60
Third Shift	$	-
Weekends	$	-
SUB-TOTAL	**$**	**475,113.60**

ESTIMATED ELECTRICITY COSTS WITH GASIFIER		
First Shift	$	48,438.00
Second Shift	$	12,056.85
Third Shift	$	(18,427.50)
Weekends	$	-
SUB-TOTAL	**$**	**42,067.35**

SAVINGS ON ELECTRICITY	**$**	**433,046.25**
SAVINGS ON WOOD DISPOSAL COSTS	**$**	**300,000.00**
TOTAL SAVINGS	**$**	**733,046.25**
SALVAGE VALUE (20% AFTER 10 YEARS)	**$**	**1,548,000.00**
A/P		**0.037**

Assuming an interest rate of 8%, there will never be a pay back.