

Alabama's Biomass Energy Program



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IV. Executive Summary

ADECA's Biomass Energy program promotes biomass systems in the State of Alabama. The University of Alabama in Huntsville is in charge of the daily operations of this program since its start in 1984. This research attempts to determine the success of the Biomass Energy Program in its current form. An overview of the current program is provided with the goals of the program. The methodology followed for the research is presented as well as the findings and recommendations.

The research points out that for every one dollar from ADECA, the timber industry saves \$59.50. The biomass program reduced the use of fossil fuels by 21.0 billion MMBTU since 1984. It has saved the wood industry approximately \$94.7 million since 1984, and it reduces the amount of solid wood waste disposed in landfills by 312,000 tons per year.

This report explains in detail how the calculations were done and a complete analysis of the data is available in the chapter "Research Results".

V. Introduction

Since 1984, the Alabama Department of Economic and Community Affairs – Energy Division (ADECA) has offered financial assistance for the installation of qualifying biomass energy systems in commercial, industrial, and institutional facilities. Assistance is provided in the form of an interest subsidy on loans used to finance the projects. The maximum amount of assistance for any one project is \$75,000. To be eligible for the financial aid, companies have to submit an application with a detailed description of the project. Next, the application is reviewed by engineering technical support to insure that the project qualifies according to the published guidelines. Once approved, each company is required to report energy consumption, wood used, production output, and operational data quarterly for the following three consecutive years after the installation of the biomass energy system. In most cases, after the reporting requirement ends, there is little or no data of how the biomass systems perform thereafter. Research is needed to know what happened to these wood-fired boilers once the company stops reporting. With this research, one will be able to answer many questions and give an evaluation of the biomass program.

VI. Alabama Biomass Energy Program

1) Description

ADECA offers financial assistance for the installation of qualifying biomass energy systems in commercial, industrial, and institutional facilities. Assistance is provided in the form of an interest subsidy on loans used to finance qualifying projects. The maximum amount of assistance for any one project is \$75,000. To be eligible for the financial aid, companies have to submit an application with a detailed description of the project.

Projects qualifying for the program typically include the installation of new or modified equipment for producing hot water, steam and/or hot air. Typically included are costs associated with the biomass fuel unloading system, storage, site preparation, and transporting equipment. Equipment controls, pollution controls, and building modifications incidental to the conversion to biomass energy are also eligible

components of a project. The system can operate on solid, liquid, or gaseous biomass fuel that may be derived from a variety of sources: landfills, logging waste, animal waste, and, waste from manufacturing processes involving forest or agricultural products.

The purpose of the Biomass Energy Program is to reduce the financial burden of converting to biomass and to demonstrate biomass as a viable alternative to natural gas. Through demonstration of successful systems, more people will adopt biomass, thereby reducing the use of fossil fuels and reducing the cost of energy used in the State of Alabama (State). The use of waste material from logging or manufacturing operations, agricultural and municipal wastes, and other biomass fuels can provide a significant economic benefit to the State as well as reduce pollution, create new jobs, and reduce the amount of solid waste going to landfills. Increased use of these waste materials for fuels will make Alabama more energy-independent and can make fuel-burning industries more profitable. This is especially true considering the potential for future price increases for conventional fuels. Demonstration of successful alternative energy technologies will encourage future consideration by property owners and remove concerns the financial community may have about their economic effectiveness.

2) The research objective

The objective of this research is it to answer one simple question:

“Is the current Biomass Energy Program a good program?”

To best answer this question, it is divided into four sub-questions:

1. What is the current Biomass Energy Program? (Chapter VI)
2. How did the Biomass Energy Program perform in the past? (Section 3)below)
3. How does the Biomass Energy Program compare to other similar programs? (Chapter IX)
 - a. What is the definition of a good program? Efficiently managing the budget. (Chapter IX)
 - b. Reaching the clients that are eligible for the grant. (Chapter VII)
 - c. Providing follow up to clients. (Chapter VI)
 - d. Achieving the goals mentioned at its conception. (See Below)

To evaluate the program, it has to be measured against its mission and stated goals. At its conception in 1984, the mission was to:

1. Reduce the use of fossil fuels (Chapter IX)
2. Reduce the cost of energy in the State of Alabama (Chapter IX)
3. Reduce the amount of solid waste that has to be disposed in the landfill (Chapter IX)
4. Reduce pollution (Chapter IX)

5. Make Alabama more energy independent (Chapter IX)
6. Make fuel burning industries more profitable (Chapter IX)
7. Create new jobs (Chapter IX)

Companies that entered the program were monitored via submitted reports for 3 years, but little data is available describing the performance of the biomass systems after that. Without this information, it is difficult to determine if the overall goals of the program have been attained. Research has been done for this reason, and will attempt to answer all the questions outlined above.

3) The past and present workflow

Companies participating in the program submit reports about their system to UA-Huntsville during the three-year reporting period. The information in the reports generally includes:

1. Energy consumed by the system
2. Amount and type of wood burned including the moisture content and cost
3. Production output
4. Operational data including maintenance and repairs

UA-Huntsville aggregates the reported information and includes it in quarterly and annual reports to ADECA. For this research, past quarterly reports were available for some years and were the starting point of this research. Although the quarterly and yearly reports have changed over time, they tend to have a standard layout and report the following information:

1. Overview of active companies reporting to UA-Huntsville
 - a. Amount paid by ADECA to each company
 - b. Energy produced
2. Balance of the current trust fund
3. New companies applying to the Biomass Energy Program and their situation
4. Special projects (conferences, promotions of the biomass program, biomass exchange database, etc.)
5. Description of on-site visits
6. A description of each company and data on the biomass systems operation including:

- a. Biomass tons used [Ton]
- b. Energy produced [MMBTU]
- c. Natural gas equivalents [kcf]
- d. Wood cost [\$]
- e. Natural gas cost [\$]
- f. Savings [\$]
- g. Data to calculate above variables
 - i. HHV [Btu per pound]
 - ii. Moisture content [%]
 - iii. Efficiency [%]

The balance of the current Trust Fund (Point 2) was done by UA-Huntsville for an extended period, but this is now maintained by ADECA. UA-Huntsville staff continues to perform site visits to verify information in the applications, to make post installation site visits for every new installation in the Biomass Energy Program, to verify the compliance of the company's installation, and to distribute literature about the existence of the Biomass Energy Program to companies in the state.

As mentioned earlier, once the three-year reporting requirement of the participating company expires, little is known about the installed systems. This leaves many unanswered questions about the installed systems. Is the company still doing business? Is the biomass system still in use? If not, why and when did it stop being used? Have there been technical modifications or problems with the system? Did they use more or less tons of wood in the biomass system to follow the production trend? How beneficial has the system been to the companies in the program, and how much money has the company saved as a result of the converting to burning biomass? This research will answer these questions and more about the projects in the biomass energy program.

VII. The Research Methodology

1) Overview

Below is a short overview of the research methodology.

1. Develop objectives -> answering the main question
2. Develop variables to answer the main question
3. Search for data
 - a. Company specific data:

- i. In existing files since 1984 (all companies that received a grant should have filed a standard application)
 - ii. By surveying the companies by phone, fax, e-mail and personal visits
 - b. Industry specific data (U.S. Department of Energy, Census, Energy Information Agency, etc.)
 - c. Other states' incentives
4. Compile the data -> MS Access database
 5. Calculate the variables to answer the main question
 6. Make conclusions

The research started by developing objectives based on the main question: "Is the current Biomass Energy Program a good program?" This question was decomposed into several different parts and analyzed individually.

The data in this research was gathered from the quarterly and annual reports made by the participating companies during their three-year reporting period. Information was also gathered from the companies' applications to the Biomass Energy Program. All of these files are stored at UA-Huntsville and ADECA. The applications include general information about each company, technical information on the project, and estimates of the financial viability of the future biomass system.


Data was also collected by attempting to contact each company to determine the outcome of its biomass system. Of the forty-four companies in the biomass program since 1984, twenty-seven were successfully surveyed. The surveying instrument covered three areas: financial, technical, and subjective. The financial part of the survey included the company's initial investment in the system and the loan the company took to finance the project. The technical area provided information about the energy contributed by the biomass system and the tons of wood consumed. The subjective component featured open-ended questions to determine the company's perception of the Biomass Energy Program and its effect on their company.

Each company was initially contacted by phone to explain the research and to obtain permission to send a survey to the company via email. The survey could then be filled out on the computer and returned. This approach was unsuccessful. It turned out that all companies had to be contacted by phone, fax, and/or in person to collect the needed information.

The information from various sources has been compiled in a Microsoft Access database. The database has been used to produce reports representing the overall Biomass Energy Program with different variables. Below are sample screenshots of the database representing all the information gathered for each company in the Biomass Energy Program.

2) Example file in the database: Bennett Lumber Company

a) General company information:

 Bennett Lumber Co	
Name:	Bennett Lumber Co
Address:	111 Old Ladiga Rd
City:	Piedmont
Zipcode:	36272
County:	Calhoun
Phone:	256 447 9663
Fax:	256 447 2178

b) Financial information:

Initial Investment:	\$550,000.00	Project's savings until today in \$:	\$28,192.75
Total Loan:	\$550,000.00	Avg Savings/Year of Conventional Fuel in \$:	\$231,277.10
Term Of Loan:	3	Wood Cost/ton:	\$23.00
Interest Rate:	8.50	Biomass cost/year:	\$82,800.00
Name Of Lender:		Amount Awarded:	\$75,000.00
		# Payback Years:	

c) Energetic information:

Energy Produced during project's lifetime in MMBTU :	80,607.00
Energy Contributed By System/Year in MMBTU :	32,242.68
Type Of Renewable Fuel:	Pine shavings
Moisture Content:	30.00
Tons Of Biomass Used /Year:	3,600.00
Type Of Conventional Fuel Displaced:	Natural Gas

d) General information:

Website:	www.bennettlumberco.com	Company has been surveyed	<input checked="" type="checkbox"/>
# Employees:	45	Still In Business?	Yes
Product:	Southern yellow pine	Why Out Of Business:	
Species:			
Facilities:	sawmill, drying kilns, planer operations		
Industry Type:	Sawmill	Year Biomass Program in operation:	2006
Biomass Description:	heating the boiler that provides steam to the dryer 250 hp - running 2 weeks/month only full dayshift	CBoilerStillInUse:	Yes
		# Years Of Biomass In Operation:	3
			3.00 <input type="button" value="Copy"/>
		Cumulative Gas Price:	29.34

If the boiler is still in operation today, this would be the number of years in operation:

e) Part of the questionnaire:

Any problems with the biomass system?	No
How would you rate the Biomass Program?	Good
How many jobs were created because of the biomass program?	2
Did you upgrade or change your system?	

f) Part of the call log:

CallDate	CallName	CallWay	C	CallNote
10/30/2008	James Bennett	Phone	Out	Answered all my questions, nice !
10/21/2008	James Bennett	Fax	Out	Form is send for a 3 time
10/14/2008	James Bennett	Email	Out	Form is sent a 2 time

VIII. Calculate the Variables

1) Defining variables

Each company burns a number of tons each year of wood waste with specific moisture content. Based on moisture content, these tonnages can be converted to energy. This value is called the **energy production per year** for the company. This energy production can be converted into the equivalent amount of cubic feet of natural gas needed to generate the same amount of energy. The energy production per year multiplied by the amount of years the company has the biomass system in service gives the total energy produced for a company over its lifetime. The equivalent cubic feet of natural gas used per year is determined by dividing the energy production per year by the net heating value of natural gas (for this report: 1004 BTU). The equivalent cubic feet of natural gas used per year multiplied by the average natural gas price for the duration of the project minus the wood cost over the years minus the initial investment is called the **total savings** of the project for a company. A sample calculation is presented later to illustrate. Savings during project lifetime are excluded of the state's \$75,000 awarded to the company. The equivalent natural gas price over the biomass system's life divided by the boiler's number of years in service is called the **savings on conventional fuel per year average**. These savings per year are difficult to due to the great volatility of the gas price from years to year. All previous calculations were at the company level. **Total savings** is the sum of all the total savings of all the individual companies.

2) Higher heating values

The amount of recoverable heat energy from wood fuel varies with moisture content, chemical composition, escaping heat, escaping fuel, quantity of excess air admitted to the furnace, temperature of stack gases beyond all heat recovery devices, and the air temperature entering the furnace. Conventional heat losses include heat losses resulting from incomplete combustion, thermal radiation, conduction, and convection of heat. Heat losses from such factors are described by Miller and Hansen¹ to be around 3% to 4 %. To estimate the recoverable heat, one needs to have information on all variables previously described. A schematic overview is provided in the Appendix. This information was not available for this research resulting in the need for assumptions. For this research, the following assumptions are made:

According to John W. Bartok² green sawdust has an energy content between 8 to 10 MMBTU per ton, bark has 9-10.5 MMBTU per ton, and chips with a moisture content of 45% have 7.6 MMBTU per ton. Many different higher heating values (HHVs) for the same material exist from different reputable sources. To create a consistent report, all the HHVs come from the U.S. Department of Agriculture (USDA) Forest Product Laboratory's Fuel Value Calculator published in July 2004. The complete table is in Appendix (See Chapter XIV).

TYPE OF FUEL	Wood			
	Green (50% MC) ^a	Semidried (30% MC) ^a	Air-dried (20% MC) ^a	Ovendried (0% MC)
GROSS HEATING VALUE	8,600,000 Btu/ton	12,040,000 Btu/ton	13,760,000 Btu/ton	17,200,000 Btu/ton
EFFICIENCY	67%	74%	77%	80%
NET HEATING VALUE	5,740,000 Btu/ton	8,950,000 Btu/ton	10,560,000 Btu/ton	13,800,000 Btu/ton

Figure 1 Heating Values for Wood with Different MC

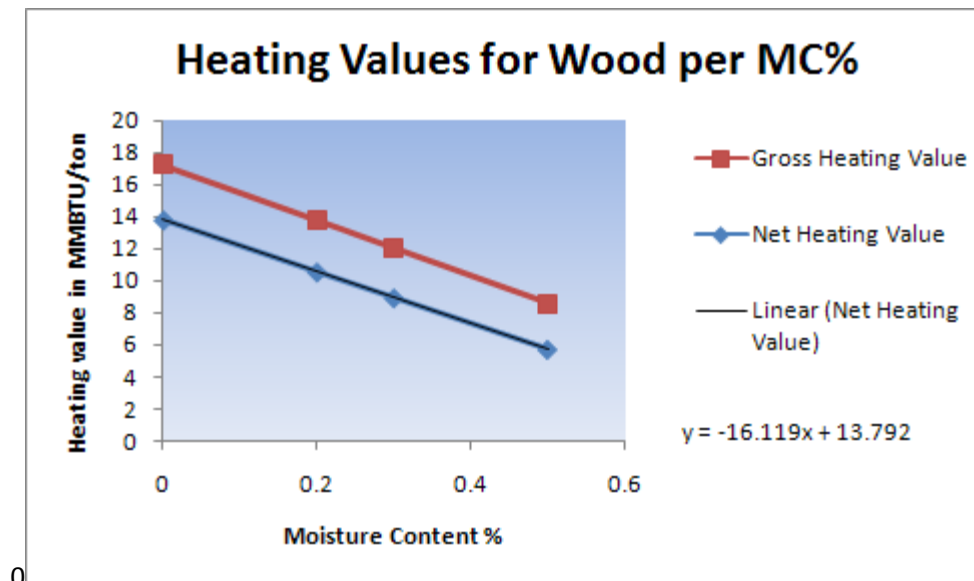
The moisture in wood absorbs energy during the combustion in the form of latent heat needed to vaporize the water. The maximum moisture content at which wood or bark can be burned in furnaces without auxiliary fuel is typically between 65% to 70% percent.⁴ One company is burning wood at 75% moisture content on a wet basis, however, they equipped their boiler specifically for this purpose and they represent the exception.

3) Net heating values per moisture content

The surveyed companies have moisture contents ranging from 7% to 75%. To find the appropriate net heating value at the corresponding moisture content, the net heating values and corresponding moisture content were plotted against each other in Figure 5. A linear trend line was found yielding the following equation:

$$y = -16.119x + 13.792 \text{ (Equation 1)}$$

Table 1 Heating Values for Wood per MC



Substituting the moisture content percentage into the above equation for x yields the heating value for a given ton of wood. For example, with an average moisture content of 35.34 % for the surveyed companies, the average net heating value is 8.095 MMBTU per ton. The number of tons of wood fuel burned is then multiplied by the net heating value to yield the MMBTUs generated by the biomass system that are used for heat generation in the boilers. Knowing the amount of energy generated that is used for heat generation, one can now determine the amount of natural gas that a natural gas system would require to produce an equivalent amount of energy. To remain consistent with the reporting of UA-Huntsville, a HHV for natural gas of 1004 BTU per ft³ is assumed. To convert from energy produced in BTU to natural gas equivalent in cubic feet, one multiplies the amount of energy produced in BTUs by 1/1004 or 0.996.

4) The equivalent gas price

To establish the price of natural gas over the years, the “industrial price” data is used from the Energy Information Administration (EIA). The Industrial Price is defined as “The price of natural gas used for heat, power, or chemical feedstock by manufacturing establishments or those engaged in mining or other mineral extraction as well as consumers in agriculture, forestry, fisheries and construction.”⁵ The EIA did not provide the industrial natural gas prices for Alabama for years before 1997. To estimate Alabama’s industrial natural gas price, the national wellhead price was used to generate an estimate. Working backwards from 1997, the percent change in the national wellhead price was applied to the Alabama industrial natural gas price. The results are displayed in Table 2. The data displays the estimated annual industrial natural gas price paid in dollars per 1000 ft³ for each year for the past 25 years in the state of Alabama.

Table 2 Alabama Annual Industrial Gas Price in dollars per 1000 cubic feet by Year

Estimated Average Alabama Industrial Gas Price in \$ per 1000 ft ³ by Year								
1984	1985	1986	1987	1988	1989	1990	1991	1992
5.10	5.07	3.95	4.06	3.62	3.72	3.76	3.19	3.13
1993	1994	1995	1996	1997	1998	1999	2000	2001
3.36	2.97	2.49	3.58	3.65	3.30	3.42	4.47	6.33
2002	2003	2004	2005	2006	2007	2008		
5.24	6.65	7.35	9.51	9.46	8.73	11.15		

Using the data in Table 2 and knowing the specific years the boilers were in operation, estimates were made as to how much money was saved by switching to biomass rather than continuing to burn natural gas. To do this, the natural gas equivalent in cubic feet calculated in the previous section is multiplied by the average price paid for natural gas over the life of the biomass boiler. For instance, if a boiler was requiring an average of 10,000 MMBTUs from biomass per year, then the system would require 9960 kcf of natural gas to produce an equivalent amount of BTUs. If the system operated from 1997 to 2000, then the average gas price from 1997 to 2000 would be calculated, and the result multiplied against the number of required kcf of natural gas to give the cost of natural gas displaced by biomass. The average

gas price from 1997 to 2000 is \$3.71 per kcf, so this is multiplied times 9960 kcf resulting in the amount that would have been paid in natural gas expense in each of the three years of the biomass system's operation to generate the needed 10,000MMBTUs. In this fictitious example, \$36,952 would have been avoided in natural gas expense each year. Note that this is the natural gas cost avoided, not to be confused with the total saving of the project. To determine the lifetime savings, the initial investment of the system and the price paid for biomass fuel are needed to subtract from the total natural gas cost avoided over the lifetime of the project to show the total savings of the project. This will be shown later.

5) Boiler prices

The boiler price is used to determine payback period and return on investment. When the initial boiler price is not known, one can make a rough estimate with the table below published in April 2004 from the University of Wisconsin. This table was rarely used because the original applications usually provided the necessary information.

Wood-Fired Boiler Sizes and Costs

Boiler Size (Boiler Horsepower)	Boiler Size (Million Btu per hour)	Boiler Size (Kilowatts)	GREEN Wood/ Bark Fuel	DRY Wood- Bark Fuel
<u>50</u>	<u>1,673,950</u>	<u>491</u>	\$ 182,500	\$ 175,000
<u>100</u>	<u>3,347,900</u>	<u>981</u>	\$ 237,500	\$ 225,000
<u>150</u>	<u>5,021,850</u>	<u>1,472</u>	\$ 395,000	\$ 370,000
<u>200</u>	<u>6,695,800</u>	<u>1,962</u>	\$ 555,000	\$ 515,000
<u>250</u>	<u>8,369,750</u>	<u>2,453</u>	\$ 675,000	\$ 625,000
<u>300</u>	<u>10,043,700</u>	<u>2,943</u>	\$ 745,000	\$ 685,000
<u>350</u>	<u>11,717,650</u>	<u>3,434</u>	\$ 810,000	\$ 745,000
<u>400</u>	<u>13,391,600</u>	<u>3,924</u>	\$ 875,000	\$ 805,000
<u>450</u>	<u>15,065,550</u>	<u>4,415</u>	\$ 900,000	\$ 830,000
<u>500</u>	<u>16,739,500</u>	<u>4,905</u>	\$ 940,000	\$ 865,000
<u>550</u>	<u>18,413,450</u>	<u>5,396</u>	\$ 975,000	\$ 900,000
<u>600</u>	<u>20,087,400</u>	<u>5,886</u>	\$ 1,010,000	\$ 935,000
<u>650</u>	<u>21,761,350</u>	<u>6,377</u>	\$ 1,050,000	\$ 970,000
<u>700</u>	<u>23,435,300</u>	<u>6,867</u>	\$ 1,090,000	\$ 1,005,000
<u>750</u>	<u>25,109,250</u>	<u>7,358</u>	\$ 1,135,000	\$ 1,050,000
<u>800</u>	<u>26,783,200</u>	<u>7,848</u>	\$ 1,170,000	\$ 1,080,000
<u>850</u>	<u>28,457,150</u>	<u>8,339</u>	\$ 1,200,000	\$ 1,110,000
<u>900</u>	<u>30,131,100</u>	<u>8,829</u>	\$ 1,230,000	\$ 1,140,000
<u>950</u>	<u>31,805,050</u>	<u>9,320</u>	\$ 1,265,000	\$ 1,170,000
<u>1000</u>	<u>33,479,000</u>	<u>9,810</u>	\$ 1,300,000	\$ 1,200,000

NOTE: The table above provides some ROUGH estimates of wood/bark fueled boiler system costs for various boiler sizes. This is a ROUGH estimation of what might be expected as an installed wood/bark fuel boiler system, to include the low pressure steam boiler, the fuel stoker and combustion device, flue gas cleaning system, steam piping with water side auxiliaries, assembly, installation, start-up and operator training. As a general rule of thumb, for each 50 horsepower of the boiler system, approximately a 2,000 cubic foot area is required for wood fuel receiving, metering and storage for a 3 day fuel supply.

THESE COST DATA ARE SUITABLE FOR ROUGH PRELIMINARY ESTIMATES ONLY!

Reference: Bob Govett (University of Wisconsin-Stevens Point)

6

6) Example calculation

Data from Bennett Lumber Company is used in the sample calculations that follow. Its data is displayed in the previous chapter.

Bennett Lumber Company uses 3,600 tons per year of biomass waste with a moisture content of 30%. Using equation 1 above, the amount of MMBTU per year generated by their biomass system can be determined:

$$3,600 \text{ tons/year} \times (-16.119 \times 0.3 + 13.792) \text{ MMBTU/ton}$$

$$=3,600 \text{ tons/year} \times 8.9563 \text{ MMBTU/ton}$$

$$= 32,242 \text{ MMBTU/Year}$$

With this number, the equivalent ft³ of natural gas necessary to produce the same amount of energy per year can be calculated. If this amount of energy would be delivered by a natural gas system, the equivalent amount of natural gas in ft³ necessary is equal it is:

$$[32,242.68 \text{ MMBTU/year}] / [1004 \text{ BTU/ ft}^3] = 32,114,223 \text{ ft}^3/\text{year}$$

Bennett Lumber Company's biomass system has been in operation since 2006. Since limited data exists for the exact month the system went on-line, it is assumed that the installation was complete on July 1st for each project. This will cause the savings calculated for the systems that were installed in January to be underestimated, and the systems installed in December to be overestimated. Making the assumption that the systems went on-line in July averages the over and underestimation, thus minimizing the effect. Since the average number of years that a system was in place is ten, the effect of the half year is greatly diminished. This is important because once the average MMBTUs per year is known, the number of years is later multiplied against it to determine lifetime savings. The longer the project runs, the more money is saved. By using the first year as six months, it gives a more conservative estimate as to the total gas savings. As Bennett Lumber Company entered the program in 2006, the assumption is made that the boiler has been in place since July 2006 until December 2008, and that the system has been in operation for 2.5 years.

The average price paid per year is calculated by summing the gas prices in Table 2 for the years 2006, 2007, and 2008 which are 9.46, 8.73, and 11.15, respectively. Next, divide by the number of years in the biomass program, which is 3. For the average price, the entire year was utilized for calculating the average gas price. This made the average gas price lower over the interval as gas prices tended to increase over time. By weighting the first year as heavily as the other years, it lowered the gas savings estimate, making the total savings calculation more conservative. For Bennett Lumber Company, the average price paid for natural gas during the 3 year period was:

$$(9.46 + 8.73 + 11.15) \$/1000 \text{ ft}^3 / 3 \text{ years} =$$

$$29.34 \$/1000 \text{ ft}^3 / 3 \text{ years} =$$

$$9.78 \$/1000 \text{ ft}^3$$

Now, the equivalent amount of natural gas required per year is multiplied by the average price paid for natural gas during the three year period, and multiplied by the number of years.

$$9.78 \$/1000 \text{ ft}^3 \times 32,114,223 \text{ ft}^3/\text{year} \times 2.5 \text{ years} = \$785,193$$

This is the amount of money that would have been spent on natural gas during the 2.5 year period to provide Bennett Lumber with the same amount of energy as the wood-fired system produced. From the natural gas equivalent price just calculated, the initial investment for the wood-fueled system and the cost of the biomass fuel consumed are subtracted to calculate the actual lifetime savings. In this case, the initial investment for the system is given in the original application to ADECA as \$550,000 (in other instances, an estimate was made as mentioned earlier). To determine the actual wood fuel cost, the number of tons burned annually as reported in the quarterly reports is multiplied by the cost per ton.

Of the 44 companies in the biomass program since 1984, only 27 companies produced information that is verifiable by surveys, annual report, company reports, and supporting documents. Some of the 27 companies have stopped using their wood-fired boiler for reasons to be described later. To calculate the savings of conventional fuel per year, only companies with operating boilers are counted in each year. If no data were available for a period, it was assumed that the biomass system was not being operated. Although it is likely the system was still being used for years after the reporting period ended, assuming that it was no longer being used kept the savings estimate conservative and verifiable. Below is an overview of the data that was used to perform the calculation.

a) The calculations with the 27 companies surveyed

Energy

- a. Total energy produced over the lifetime of the Biomass Energy Program
- b. Moisture content
- c. Total years of biomass system in operation

Finance

- a. Total savings
- b. Total initial investments made
- c. Total amount awarded by ADECA
- d. Total loans made for the biomass systems
- e. Term of loans
- f. Average wood cost per ton

b) The calculations with the 27 companies minus those without an operating boiler in' 2008

Energy

- a. Tons of biomass used per year
- b. Energy used per year in MMBTU per year

Finance

- a. Savings on conventional fuel per year average

IX. Research Results

Is the current Biomass Energy Program a good program? While this main question is rather short, the answer is a bit more complex.

The Biomass Energy Program covered 44 companies that had to be surveyed. From those 44 companies, 27 companies provided information that was verifiable by different sources and thus, only these 27

could be used in the research. From the 44 companies in the database, 21 of the projects are still in operation in 2008. Three companies submitted applications to join the program in 2008, one in 2007, and two in 2006.

From the sixteen companies we could not survey, five were confirmed to be out-of-business.

The following companies are not included in the calculations part of the research:

- Browder Veneer Co, Inc. has not installed their biomass system yet, so their information cannot be taken into account.
- Mars Pet Food was thinking about the installation of a biomass system in cooperation with Destin Energy, but it has not been finalized as of December 2008.
- Wootten Farms has not been approved or completed installation of its boilers as of December 2008.
- Ala-Tenn was not in any county's register and could therefore not be contacted for the survey. The date it went out of business is unknown.
- The last information about Creret Lumber is a court filing in 1995 about the malfunction of their biomass system.

Some companies that are still in business have been contacted, but it was not possible to find the right person with the correct information that the research needed, or the person with the right information was unavailable. Companies that fall in this category are Cahaba Pressure Treated and Crystal Lake Manufacturing.

The following companies could not be reached by phone or email: Ciba/Destin Energy; Hamilton Woods Veneer Company; McKinney Lumber Company, Inc.; Mobile Infirmary; Prime Pine International; Re'Vod Furniture, Inc.; Seaman Timber Company, Inc.; Southern Architect; Southern Wood Chips; Sumter Veneer Works; and Wellborn Cabinet, Inc.

A few of the surveyed companies gave reasons why they had stopped using or modified the equipment after installation.

Scotch Lumber in Fulton County generated electricity for the whole plant at about 500,365 MMBTU per year. After a fire in the generator room, they decided to no longer produce electricity. In 2008 the company switched to a single shift operation and they now produce 350,895.90 MMBTU per year for heating purposes only.

Lumber Remanufacturing Services switched back to gas after producing their steam from biomass for nine years. The company relocated and was offered a low initial investment cost for the natural gas at the time that natural gas was at \$2.19 per kcf. As they had little wood waste to burn at the time and with the natural gas being offered so cheaply, they decided to convert back to natural gas during the relocation.

Phenix Lumber used a direct-fired system which introduces the furnace gases directly in the kiln, rather than the more conventional system that uses a boiler to produce low pressure steam; this system then transfers the heat to the kiln indirectly through radiators. They stopped using their system after 15 years of operation, because they stated that the current process was damaging the lumber. On the

other hand, other companies like Freeman Patrick Lumber have no problem with the direct fire system, and highlighted the importance of proper engineering before installation.

Below is a summary of the most important numbers characterizing the biomass systems. Please check the previous chapter “Defining Variables” to have a full understanding of the variables and their meaning.

1) Energy

The total energy produced by companies that are part of the biomass program is nearly 21.0 million MMBTU since 1984. The average company in Alabama’s Biomass Energy Program produces on average 776,588 MMBTU with an average period of operation of approximately 10.52 years. The Biomass Energy Program has been in place since 1984, and some companies like Capital Veneer Works, Inc. and the Miller Company, Inc. are still using their boiler after 25 years of operation. There is also a special case in which the boiler for Buchanan Lumber Co. is specially designed to burn wood waste with a wet basis moisture content of 75%. Each year over 370,000 tons of wood are burned in the companies that have been surveyed and are currently in operation.

When wood is burned, it releases carbon dioxide previously stored in the wood. According to the International Panel on Climate Change (IPCC), the net release of carbon dioxide to the atmosphere is zero⁷ when it is domestically burned. The wood waste that is burned in the boilers is either the byproduct of the sawmill, or it is transported over a short distance; therefore it is domestically burned. When natural gas is burned, it releases 117 pounds of carbon dioxide gas per million BTU into the atmosphere.⁸

In Table 3 Fossil Fuel Emission Levels - Pounds per Billion Btu of Energy Input, we see that natural gas produces 117,000 of carbon dioxide per billion of BTUs of energy input. Using this information and converting the nearly 21 million MMBTU saved to CO₂, Alabama avoided producing 2.4 billion pounds of CO₂ or 1.2 million tons of CO₂ since 1984. Yearly, over 313,000 tons of carbon neutral biomass are burned under this program.

Table 3 Fossil Fuel Emission Levels - Pounds per Billion Btu of Energy Input

Pollutant	Natural Gas	Oil	Coal
Carbon Dioxide	117,000	164,000	208,000
Carbon Monoxide	40	33	208
Nitrogen Oxides	92	448	457
Sulfur Dioxide	1	1,122	2,591
Particulates	7	84	2,744
Mercury	0.000	0.007	0.016

2) Finance

The highest price paid for wood waste was \$30 per ton paid by Valley Lumber Co., Inc. The majority of the companies are sawmills, and they use the sawdust generated from their operations in their boiler. For companies reporting the purchase of wood waste, the average wood waste price is \$4.82 per ton. If Valley Lumber, who pays \$30 per ton is taken out of the calculation, the average cost for the fuel is \$3.79 per ton.

The total savings of the Biomass Energy Program amounts to nearly \$94.7 million since the beginning of the program. This takes the investments and the cost of wood fuel into account, but does not calculate with the time value of money. The state of Alabama invested approximately \$1.6 million in the 27 surveyed companies, indicating that for every \$1 of subsidy provided by ADECA, there was a saving of \$59.50 by a company in Alabama (\$94,658,130 /\$1,590,934). (See “Defining Variables” in Chapter VIII to review what the Total Savings are to the company.) The 27 companies surveyed together used the interest subsidy to make combined investments of \$32.6 million in biomass systems. This equates to every dollar that the state invested, the private sector invested \$20.46 (\$29,700,736/\$1,590,934).

Some of the companies in the study have a negative total savings. This is because they recently invested in the equipment and have not yet recouped the costs of their investments. One exception is Tolleson Lumber. It has a program value of -\$435,770.66. In 1990, they invested in a biomass system, but unfortunately the company burned to the ground that same year, so they were unable to recoup their investment in the biomass system.

One of the biggest successes has been Rock-Tenn Pulp & Paper (formerly Gulf-States Paper). This plant consumes the wood waste it generates (191,789 tons per year). This company biases the analysis somewhat. With them included in the report, the average tons of biomass per year consumed at each company is 15,345.11. When this company is removed, the average biomass consumed drops to 8,179.08 tons per year at each company. This demonstrates the major success this facility has experienced under the program. About 15 companies use the wood waste they created themselves. For those that purchase wood waste, the average price for one ton of wood waste is \$4.82, however it should be noted that the cost per ton has risen over time. One of the benefits noted, but not captured, is the avoidance in landfill disposal costs and transportation expenses. By burning their own wood waste, wood waste producers are able to avoid disposal and transportation charges, and save additional money that is not captured here. It is important to note that if the wood waste being consumed had gone to a landfill rather than being utilized under the program, the landfill tipping fees would have totaled over 88 million dollars. However, this is a dubious and unverifiable number as nearly all companies were giving away or selling the wood waste before converting to biomass.

3) Alabama compared to other states

As for how Alabama compares to other states, it has a generous package to help the companies that want to install a biomass system. Not many of the other states offer as many incentives as Alabama. An internet search was performed to identify state agencies in each state that have a similar role as ADECA-Energy Division. Each identified agency was emailed and faxed a questionnaire inquiring about the aspects of each state’s biomass program, and each was followed up with a phone call. The questionnaires asked the following questions.

- What is your yearly budget/resources?
- What are your yearly benefits and how do you measure these benefits?
- How many participants do you have in your program?
- When was your program created?
- What is the overall program goal?

- What is the popularity of the program?
- Where can I find more information on your program?

The following is the information obtained from each state:

Delaware

Delaware has a 'quasi' Biomass Utilization Program operating since the early 1990's. It is basically an information/education outreach effort partnership between the University of Delaware Cooperative Extension, Delaware State Energy Office and the Delaware Forest Service. The Delaware Bioenergy Consortium (previously the Biomass Utilization Working Group) helps with program direction. Funding to support state-wide bioenergy-related conferences, workshops, or travel and supplies has come from a federal DOE grant which is no longer available. This grant has also helped support a portion of salary for the state Biomass Utilization Forester's position. Currently, the only funding for a biomass program in Delaware comes from two sources. One, the Delaware Forest Service supplies a portion of their staff's time to the efforts. Two, the Federal RREA (Renewable Resources Extension Act) supports biomass program outreach efforts by supplementing a small portion of salary for the Delaware Cooperative Extension. There is no direct funding coming from our state to support a biomass program with a full-time staff assignment or grants to cover project implementation.

The first meeting of the Biomass Utilization Working Group took place in 1992. In 2000, that group was expanded to the current 24 members and renamed: the Delaware Bioenergy Consortium. This group has not met over the past few years due to its membership's involvement in crafting the Governor's Energy Task Force Report and State Energy Plan. There is no consolidated and specific "Biomass Program" for Delaware, so it is hard to determine just how many people around the state are working on various aspects of a biomass program.

Annual funding is based on the increased awareness of biomass-related options and opportunities created by personal contacts (i.e., one-on-one and group participation), along with the number of outreach activities provided (i.e., workshops, conferences, etc...). Funding is not dependent upon the number of projects installed.

Florida

The Biomass Project fostered development of biomass technology and increased the use of biomass energy. It provided for the education and promotion to the public of biomass energy as a reliable, market-ready alternative energy source that is available to all segments of society. It created resource maps of biomass and biofuels potential in Florida, developed a statewide biomass network to facilitate information sharing, and conducted continuing research and demonstration of biomass and biofuels technologies and practices.

Georgia

Biomass Sales and Use Tax Exemption:

Georgia enacted legislation in April 2006 (HB 1018) creating an exemption for biomass materials from the state's sales and use taxes. The term "biomass material" is defined as "organic matter, excluding fossil fuels, including agricultural crops, plants, trees, wood, wood wastes and residues, sawmill waste, sawdust, wood chips, bark chips, and forest thinning, harvesting, or clearing residues; wood waste from pallets or other wood demolition debris; peanut shells; pecan shells; cotton plants; corn stalks; and plant matter, including aquatic plants, grasses, stalks, vegetation, and residues, including hulls, shells, or cellulose containing fibers."

To qualify for the exemption, biomass material must be utilized in the production of energy, including the production of electricity, steam, or both electricity and steam. Pellets and fuels derived from biomass are generally eligible.

Indiana

Alternative Power & Energy Grant Program

The Alternative Power and Energy (APE) Grant Program provides a matching fund grant to non-profit, public and commercial entities to support the purchase and installation of alternative energy systems that offset fossil fuel usage and encourage public education. The 2008 solicitation of this program targets projects that use solar hot water systems, solar electric systems, wind power, and combined heat and power (CHP) projects using biogas and located at municipal wastewater treatment facilities.

An eligible entity may apply for a grant that uses one or more of the targeted alternative energy systems. Each project may receive up to \$25,000 for a grant, with different incentive amounts for the size and costs of the energy systems. Solar electric systems may receive funding for the first 5 kW of rated capacity; wind power systems may receive funding for the first 10 kW of rated capacity; and solar hot water and biogas CHP systems are eligible for an award of up to 50% of project costs. Larger systems are eligible for funding, but the additional capacity will not be subsidized. Grant applications will be reviewed based on the amount of fossil fueled energy that the project offsets, as well as the organization's plan to showcase the project as an educational tool. The program has a yearly budget of \$300,000 with each participant receiving a maximum of \$25,000.

Solar Water Heating: 50% of projects costs

Solar Electric: \$5 per watt DC

Wind Power: \$2.50 per watt DC

Biogas CHP: 50% of projects costs

Kentucky

It has a program called HB 1 that provides incentives for biofuels. Its purpose is similar, but it takes a difference approach to get there.

Louisiana

The Renewable Biomass Resources Program developed a comprehensive, interactive Web-based database that identifies, quantifies, and geographically locates all potential renewable energy resources in the state. The database also evaluates the economic development potential and the environmental impact of alternative farming and agricultural practices, as well as transportation costs in aggregating materials.

New Mexico

Provide help to woody biomass, algae, biomass, landfill gas, and manure biomass.

Note: They have also facilitated a dairy manure-to-energy loan fund project, with a state funded, low interest loan amount of \$2,000,000. They have a budget of \$1,552,731 for Woody Biomass. New Mexico's division has one partial FTE (70%) working on biomass. The Forestry Division in our Department has a Woody Biomass specialist at around 20%.

New York

NYSERDA does not have a "Biomass Energy" program. But they do have programs that biomass projects can participate in, such as the CHP Demonstration Program.

South Carolina

The Renewable Resource Use and Development and Utility Policy Development Program provided leadership and assistance in alliance/partnership creations that resulted in operational status for three South Carolina landfill gas conversion projects. They helped develop biomass energy projects through national and regional programs. They also promoted utility green power activities and awarded rebates for the EarthCraft solar program in residential homes. The program also identified other opportunities for renewable resource development and developed biomass partnerships in the areas of transportation, production, and consumption.

Wisconsin

The Focus on Energy Program has a budget of \$2,500,000 mainly used for converting old furnaces in schools to wood fuel. Schools report saving \$50,000 to \$100,000 per school on converting from fuel oil or natural gas to using wood for heat. Twelve schools have been converted so far. As many as 300 schools could benefit from this program. The program started in 2006 and has been highly popular. The

new program offers interested schools and communities pre-feasibility studies and feasibility studies at no cost, and up to \$250,000 toward the implementation of a biomass system.

The following states confirmed that they do not have a state sponsored biomass energy program or equivalent:

Arizona
Connecticut
Missouri
New Hampshire
South Dakota
Texas
West Virginia

The remaining states did not respond to the surveys or the appropriate person to contact could not be identified.

Comparing Alabama’s Biomass Energy Program to other states, Alabama compares quite favorably. Based upon the results of the survey performed, Alabama only trails Wisconsin in terms of funding per project.

4) Results from quarterly and yearly reports

The graphs below are created from data and comments from the quarterly and annual reports.

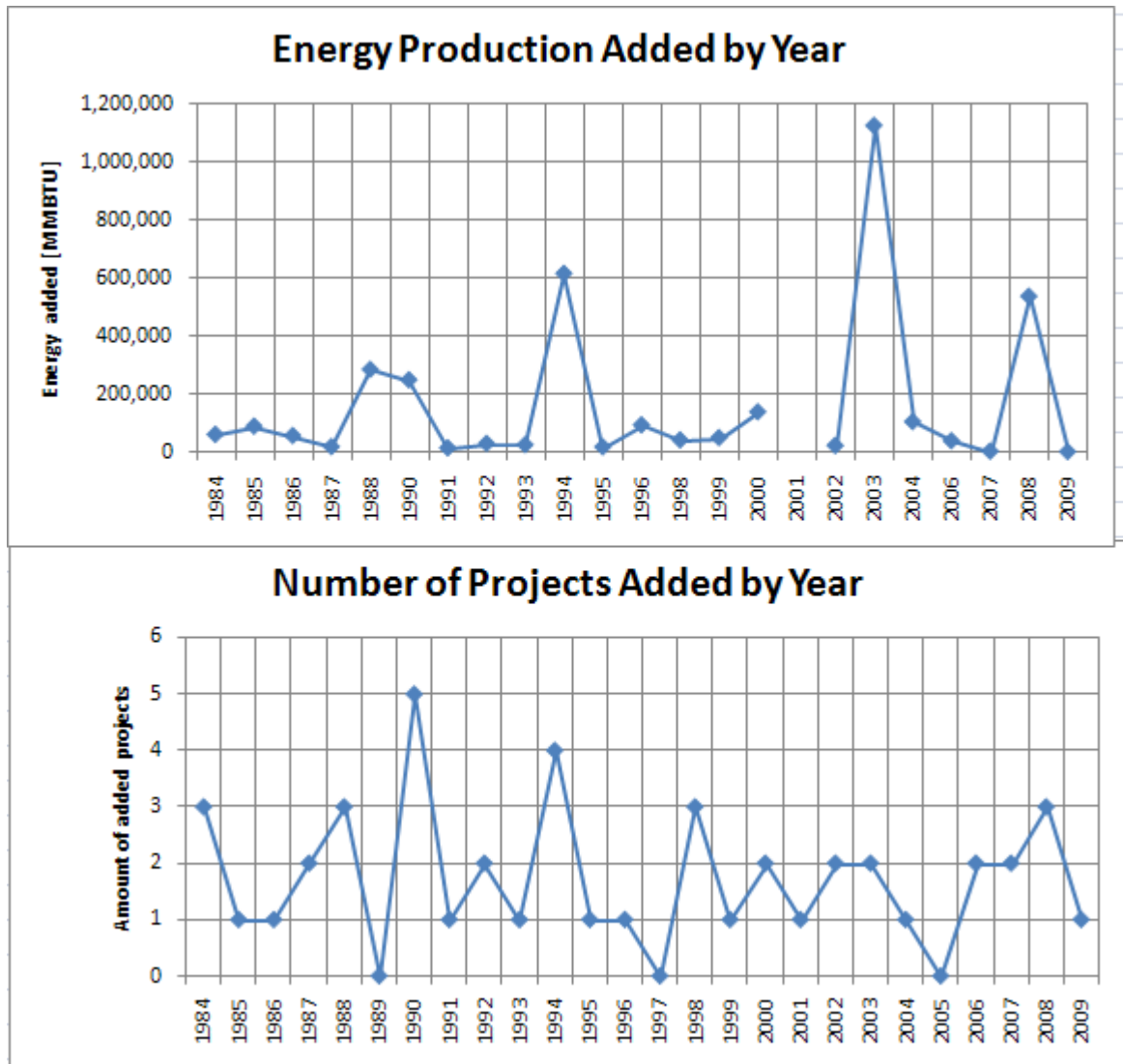


Figure 2 Energy and Number of Projects Added each Year

From the above figures, one can conclude that the most energy added in a specific year in the Biomass Energy Program does not necessarily coincide with the most number of projects added. The biggest gain in energy production is added in 2003 by only two new projects. The bulk of this gain is attributed by the project of the Rock-Tenn Pulp & Paper Company (formerly known as Gulf State Paper). They produced approximately 1 million MMBTU with the installed biomass system and averaged nearly 200,000 tons of wood waste per year. Contrasting, in 1990, five projects were added with only an additional 16,000 MMBTU being generated from biomass. Although approximately two companies are added to the biomass program each year, it can be concluded that the number of projects that are being added per year is not the key metric for success of the program. To best obtain the objectives of the program as stated in Chapter VI, when prioritizing who is awarded the subsidy, consideration should be given to the type of projects and the projected natural gas savings. In addition, marketing efforts in the future should target companies that have a potential to offset larger amounts of natural gas.

Although not a key metric, one has to question why only two companies per year join the program. The following are sample comments from the quarterly and annual reports on file:

Comments from 1986:

- ‘...too many people were reluctant about “free money from the state.”’
- “The program has some difficulties reaching out to the people. We feel like we cannot get the message across.”
- ‘The requirements to enter the program are high; a feasibility study is too complex for family owned businesses in Alabama where an investment is made because “it feels right.”’

Comments from 1991:

- “There are two weaknesses in the project financial planning. The first weakness is the failure to perform proper overall financial planning, including estimation of project opportunity cost. The second is failure to consider all practical alternatives, including that of used equipment, when selecting the most cost-effective equipment available. Personal experience gathered over more than 30 project applications indicates that these weaknesses in financial planning have probably resulted in rejection of projects that would be economically viable according to conventional business practices, even without the state interest subsidies.”

Comments from 1992:

- “The recession has caused a reduction in lumber sales and thus a reduction of wood burned. National and regional interest increases because of [the Clean] Air Act of 1990 with heightened public interest in solving the greenhouse gas problem. Wood residues cost more to dispose, because of increasing landfill fees [(See chart below)]. Therefore participation is expected to go up. Existing projects continue to save more than \$50 in avoided use of scarce energy for every \$1 spent in loan interest subsidies.”

From these comments, it can be concluded that over the years some issues stayed the same:

- Marketing the Biomass Energy Program and educating the public on the benefits of biomass continues to be a challenge.
- Small companies often lack the resources to perform the engineering analysis required.

5) Jobs created by the Biomass Energy Program

The creation of jobs is one of the goals of the Biomass Energy Program. This has been surveyed, but the results are not reliable because the data’s margin of error is too great. Most of the companies in the survey did not add personnel to operate the biomass systems. Many of the systems are automated and the work that is required can be handled by existing personnel. If a company added a person, the added job created was netted out by layoffs at other dates. Based on the surveys, the number of jobs created by the program cannot be determined.

The forest industry is the state’s largest manufacturing industry in Alabama, producing an estimated \$15.39 billion worth of products in 2005.¹⁰ There are approximately 850 active forest products manufacturing operations in the state. The program has helped 47 companies since 1984, all but one in the lumber industry. By these numbers, this program has only reached 5.6% of the industry.

At an average gas price in 2008 of \$11.15 per 1000 ft³, all the companies together made estimated savings in natural gas of \$22.5 million in 2008. The enormous increase in fuel cost is because of the drastic natural gas price increase in recent years.

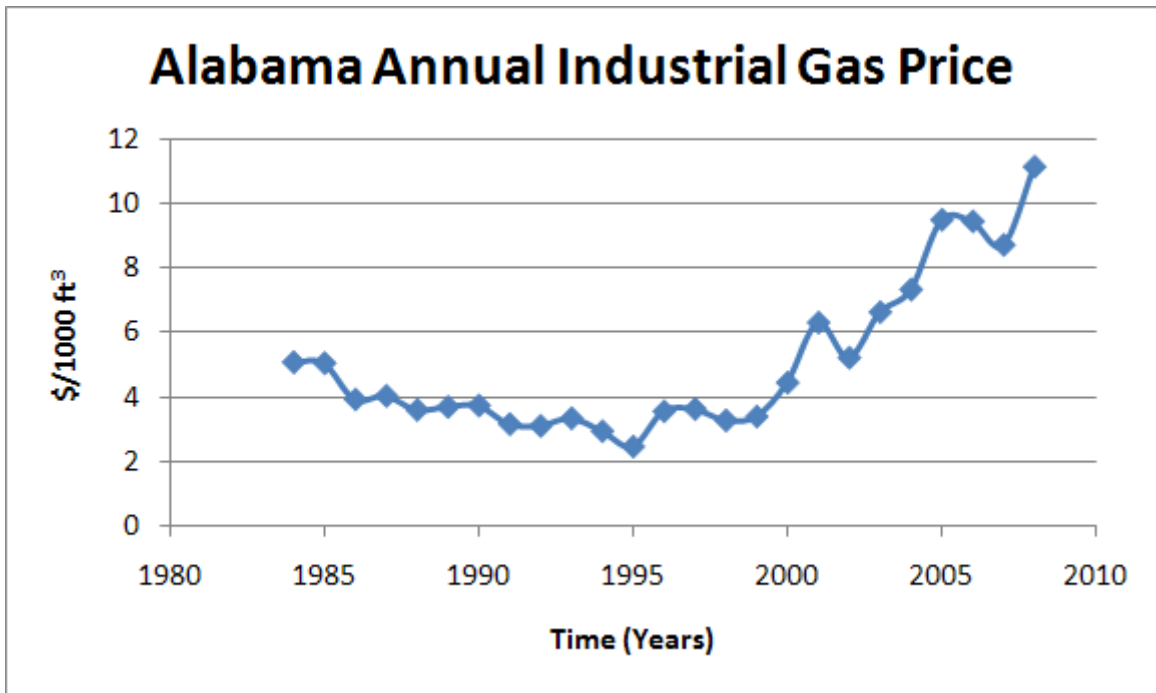


Figure 3: Annual Industrial Gas Price

Timberland in Alabama accounts for 69.3% of the total land area in the state (approximately 23 million out of 33 million acres¹¹) Non-industrial private landowners owned 78.7% of the timberland acreage in 2005.¹² Each year, approximately one billion ft³ of timber is harvested, creating over 2.7 million dry tons of logging-related wood waste. Wood manufacturing generates another 6.8 million dry tons of wood manufacturing waste¹³. Based on the verifiable data collected, 3.1 million tons of wood waste has been consumed by the companies participating in the biomass energy program since its inception. Companies with active boilers currently consume a total of 365,000 tons of wood waste each year. While this amount is considerable, it indicates that a substantial opportunity exists to utilize the wood waste being generated that is not being consumed.

X. Conclusion of the Research

The definition of a good project is defined in the introduction of this report. Below are the numeric answers to those questions.:

- Efficient budget management
 - \$1 from ADECA = \$59.50 in savings for a company in Alabama

According to these numbers, one can conclude that the budget is efficiently managed.

- Reaching the clients that are eligible for the grant?
 - Of 850 companies in the forest industry, approximately 5.6% of the companies have participated in the program.
 - The Biomass Program has a maximum of three new entries each year. Over a period of 25 years that would be 75 companies that benefitted from the Biomass Program. 44 companies have entered the program, which is 60% of the capacity.

The total number of companies in the timber industry is approximately 850. Some do not need a boiler at all. This 5.6% is just to give an idea of the spread of this program across the timber industry in Alabama.

- Providing follow up to the clients that received the grant
 - All companies reported for three years after installation as required.

The goal of the biomass program is outlined in the introduction of this report. Answers are given throughout the report, and below is each question with its answer. Goals of the biomass program:

- Reduce the use of fossil fuels
 - 21.0 billion MMBTU generated by biomass rather than fossil fuels since 1984
 - 2.7 million MMBTU per year from active companies in 2008
- Reduce the cost of energy in the State of Alabama
 - Total savings of nearly \$95 million since 1984
 - Savings of conventional fuel per year= \$17.3 million
- Reduce the amount of solid waste that has to be disposed in the landfill
 - Potential savings of 312,155 tons per year of wood waste
- Reduce pollution
 - 1.5 million tons of CO₂ saved since 1984
 - 135,000 tons of CO₂ saved each year
- Make Alabama more energy independent
 - Generated a total of 21.0 billion MMBTU with biomass
 - Displaced average of 2,719,659,000 ft³ per year of natural gas each year
- Make fuel burning industries more profitable

- Companies in the program have saved a combined total of \$94.7 million since 1984.
 - Active companies in the program saved approximately \$22,494,488 in 2008.
- Create new jobs
- Due to complexity in counting job creation and additional responsibilities, the actual number of jobs created by the program could not be determined with reasonable certainty. This question had never been addressed in previous reports.

XI. Recommendations

This research uncovered many findings of interest. It was found that the type of project greatly impacted the achievement of many of the goals of the program. While the funded lumber company projects provided savings, the largest savings and avoidance of waste material going to landfills was achieved at the Rock-Tenn facility project. It generated considerable savings for the company. As the program grows, priority should be given to projects that impact the goals of the Biomass Energy Program. To date, this has not been an issue.

Another finding is that although the program has been very successful in achieving its goals, it has not been well publicized. The companies participating in the program have traditionally been companies in the lumber industry, with some exceptions. The findings of this research demonstrate that companies that use natural gas for their processing can attain significant cost savings by converting to biomass. This shows that there is a large opportunity for other industries to convert from natural gas to biomass. Marketing efforts of the program need to target large natural gas consumers to have greater impact.

Based upon the number of companies in the program and the number of companies in the wood industry, there are many companies in the wood industry that are not participating in the biomass program. These companies could save substantially by converting to biomass systems for process heat and steam. Many companies are not aware of the Biomass Energy Program. Of the ones that are, the feasibility study for the project is a barrier to entry for many companies. Some issues raised by the participants are the competition for the fuel sources and the difficulty in locating wood waste producers. Unless a company is producing its own wood waste, without the biomass database in place, companies looking to get into the program may have difficulty locating an affordable fuel source. It is recommended that a list of available wood waste producers be compiled and the database be reinstated.

One observation is that the price for wood waste fuel is beginning to increase. It is not completely clear why this is occurring. One possibility is that with the recent economic slowdown, there is less wood waste being produced, hence a smaller supply. As biomass systems become more mainstream, competition for resources will drive cost for wood waste up. As the program grows, projects that create wood fuel for biomass systems may need to be undertaken to create an adequate and affordable supply of consistently-shaped wood chips.

Over the years, UA-Huntsville has been making reports for ADECA. It would be beneficial to revisit the report template so that all necessary information for evaluating the program is captured. Further, UA-

Huntsville should continue to contact the companies that are still using their boilers beyond the three year reporting period on an annual basis to more robustly track the cost savings by the companies, and by extension, success of the program.

To increase the marketing of the program, it would be beneficial to increase funds to UA-Huntsville specifically for marketing the Biomass Energy Program. Increased funds for holding promotional activities at conferences and trade shows, and for performing site visits to initiate discussions about converting to biomass would also be of use

XII. Case Studies

1) Lewis Brothers Lumber Company, Inc.

David Lewis is the general manager of Lewis Brothers Lumber, a family owned sawmill that has operated in Aliceville since 1954 with seventy employees. His father took over the company in the sixties, and David has been the head of the company since January 2007. They work with Sweetgum, Yellow Pine, and Poplar. They found a lucrative way to dispose of one third of the 3,000 tons of sawdust the sawmill produces by installing a wood-fired boiler in 1990 with an investment of \$147,600. The 400-hp boiler produces steam used to dry 20 million board feet annually with sales of approximately \$ 10 million each year. They burn about 1,000 tons of sawdust with 50% moisture



content. In the past, the biomass system also generated electricity with a 625 kVA steam turbine and generator set, but was stopped for financial and maintenance reasons. At the project's conception, the project was estimated to save 80,670 MMBTUs of energy at a value of \$463,703. Up to 2008, it has produced 125,000 MMBTU and saved approximately \$650,000, exceeding the company's expectations

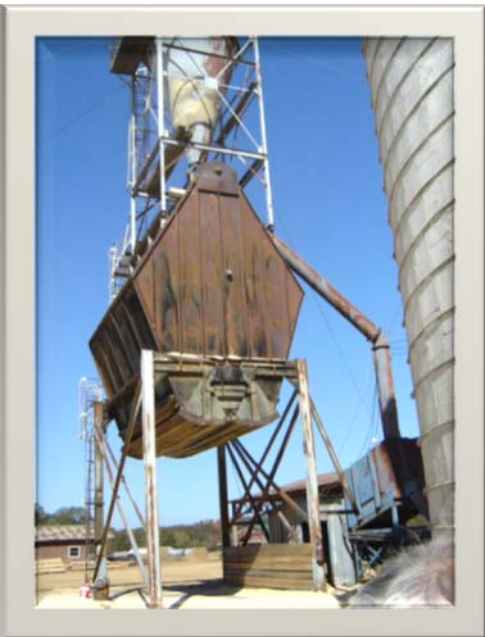
2) Buchanan Lumber

Buchanan Lumber works with White and Red Oak to produce hardwood flooring. The wood-fired boiler burns 8,486 tons of sawdust per year. It produces steam to heat kilns and runs a 550 KW turbine generator. In 2008, the biomass system was converted to run mostly off of wet sawdust as opposed to all dry sawdust. The boiler is feed by a conveyer that in turn is fed by a screw conveyor. The screw is perpendicular to the stock of sawdust sitting on a moving underground auger with hydraulic presses to regulate the amount of sawdust falling in the screw. The initial investment of the system including the building, the silo and the conveyers is about \$1.45 million; but with the help of the State of Alabama in 1999, their budget allocated to this project was reduced to \$1.37 million.



3) Freeman Patrick Lumber Company, Inc

Mr. Freeman and his wife started the sawmill in 1973. Today, Freeman Patrick Lumber Co. dries five million board feet each year. The biomass project involves a



direct-fired kiln installed in 1988 and a steam producing wood-fired boiler for big, slow-drying wood boards. Both systems are still in operation today. The direct-fired kiln utilizes a dual chamber cyclonic suspension combustor in which 1,200 tons of dry wood fuel is converted each year to heat energy with a conversion efficiency equal to that of fossil fuel burners. Wood fuel for this burner must be dry (i.e. less than 15% moisture content), clean with less than 1% ash, and finely divided to approximately 1/8 inch size or smaller. Combustion is accomplished by injecting precise ratios of wood fuel and combustion air into the primary chamber where the fuel is ignited with five gallons of propane and forced into a cyclonic flow. The cyclonic flow provides the retention time necessary for complete combustion. The secondary chamber is a multi-purpose chamber designed to complete combustion of oversized fuel particles and to

reduce combustion gas temperatures to the lower level required by the heat process system. The metering bin is a 50 cubic-foot bin with live bottom output screws driven with a DC motor. The output from the screws drops through a rotary airlock into a high-pressure delivery system that delivers fuel to the burner. The system measures the combustion air being delivered to the burner and controls the speed to the screws through the use of a differential pressure transmitter. A high- pressure blowing system is used to transport the fuel from the meeting bin directly into the burner. The burner produces 13,648.98 MMBTU per year, and is capable of drying 72,000 board feet of lumber in one load. In



doing so, the system is estimated to save natural gas annually at a value of \$85,000 per year. It has an estimated benefit of \$1,500,000 since it started operation in 1988.

Next to the direct-fired system, the company also has another steam-producing boiler burning bark that does not need to be as small in size as the burning material for the direct-fired boiler. Both systems require low maintenance. The surplus of wood waste is sold to chicken houses and fiberboard companies.

4) Capital Veneer Works

Capital Veneer is a family company for three generations and started operating in 1946. The company moved to the current location near Montgomery in 1963 with a capacity of approximately 6 million board feet each year and employing fifty people. In 1984, Mr. Pat Adams's father installed the 1,200 hp boiler capable of producing 20,700 pounds of steam per hour with a maximum pressure of 240 psi drying wood with a twenty minute run through. A concrete silo was erected next to the boiler house for fuel storage with chains inside to clean the inside walls and prevent cloaking of the wood particles. The boiler burns up to 6,250 tons of hardwood bark with a moisture content of 47%. The pollution control



system contains a re-injector to re-burn the collected soot particles. The boiler used a condensate principle where the steam that has been used in the veneer dryer is kept under pressure and re-injected in the boiler. This results in cutting fuel consumption in half with less maintenance, less machine wearing, and less ash to dispose of. The total project cost was \$800,000 with net annual savings from this boiler estimated at 35,000 MMBTU at a savings of \$200,000 in natural gas. The project is estimated to have saved four million dollars for Capital Veneer since 1984.

XIII. Terminology

Bioenergy - a term used to describe energy produced from biomass.

Biomass - potential fuel energy in the form of biological material such as timber, straw, etc.

Boiler - machine for extracting heat energy from fuel to provide hot water or steam.

BTU - unit of energy comparable to Watt or Joule.

Chips - (shortened form of woodchips) small fragments of timber sliced from a larger log or piece of timber by a chipper, usually to a specified size.

Gasification - conversion of solid material such as woodchip into a gas for use as a fuel.

Higher heating value (HHV) - the HHV of a fuel is the amount of energy available from its complete combustion, including the energy from condensing the water vapor that results from the combustion. The **Lower Heating Value (LHV)** is the HHV minus the energy from condensing the water vapor that results from the combustion. All fuels generate some water from hydrogen during the combustion process; this also results in a lower heating value. A HHV has a gross and a net value. The Gross Heating Value minus all the machine inefficiencies and moisture content factor is the **Net Heating Value**.

Kilowatt - a unit of energy equal to 1000 watts.

Kilowatt hour (Kwh) - the basic unit of energy equal to 1 kilowatt or 1,000 watts of power used for one hour. A single bar electrical fire would typically use about 1 kilowatt hour (kwh) of electricity if operated for 1 hour.

MBTU - Thousand BTU

MMBTU - Million BTU

Megawatt - unit of energy equal to one million watts, or one thousand kilowatts.

Megawatt hour (Mwh) - measure of energy production or consumption equal to one million watts produced or consumed for one hour (equal to 1000 kilowatt hours).

Moisture content (mc%) - the percentage by weight of water in a material.

Pellets - small diameter cylindrical section of compressed sawdust formed by passing dry sawdust under high pressure through a die (usually between 6-8mm in diameter and 10 to 30mm in length).

Watt - a unit of energy defined as one joule transferred or dissipated in one second.

Woodchips - small fragments of timber sliced from a larger log or piece of timber by a chipper, usually to a specified size.

Terminology list based on <http://www.usewoodfuel.co.uk/Terminology.stm>

XIV. Appendix

1) Companies that participated in the Biomass Energy Program that were successfully surveyed as part of this research

Alabama Timber Industry, Inc.
Babcock Lumber Company
Bennett Lumber Company
Boutwell Lumber Company
Brown Wood Preserving Company
Buchanan Lumber Company
Capital Veneer Works, Inc.
Chattahoochee Veneer
Freeman Patrick Wood Products, Inc.
Giles and Kindell, Inc.
Henderson, Black, and Green, Inc.
Jasper Lumber Company
Koch Foods – Destin Energy
Lassiter Lumber Company, Inc.
Lewis Brothers Lumber Company, Inc.
Linden Lumber Company, Inc.
Lumber Remanufacturing Services
Miller Company, Inc.
Moss Lumber Company, Inc.
Olon Belcher Lumber Company, Inc.
Owens Lumber Company
Pate Lumber Company, Inc.
Phenix Lumber Company, Inc.
Rock-Tenn Pulp and Paper
Scotch Plywood Company
Tolleson Lumber
Valley Lumber Company, Inc.

2) Companies that participated in the Biomass Energy Program that could not be successfully surveyed and are not reported as part of this research

Ala-Tenn Industries
Browder Veneer Company, Inc.*
Cahaba Pressure Treated Lumber
Ciba/Destin Energy
Creret Lumber
Crystal Lake Manufacturing
Hamilton Woods Veneer Company
Mars Pet Food/Destin Energy
McKinney Lumber Company, Inc.
Mobile Infirmary
Prime Pine International
Re’Vod Furniture, Inc.
Seaman Timber Company, Inc.
Southern Architect
Southern Wood Chips
Sumter Veneer Works
Wellborn Cabinet, Inc.
Wootten Farms**

*Browder Veneer Company, Inc. has applied for the program, but at the time of the research has not completed their boiler installation.

**Wootten Farms has applied for the program, but at the time of the research has not completed their boiler installation.

3) Companies in the program that are still in business today but not using their boiler system installed under the Biomass Energy Program

Browder Veneer Company, Inc.*
Henderson, Black, and Green, Inc.
Lassiter Lumber Company
Lumber Remanufacturing Services
Olon Belcher Lumber Company, Inc.
Pate Lumber Company
Phenix Lumber Company

*Browder Veneer Company, Inc. has applied for the program, but at the time of the research has not completed their boiler installation.

4) USDA Higher Heating Value – published in July 2004
<http://www.fpl.fs.fed.us/documnts/techline/fuel-value-calculator.pdf>

Table 4 Efficiency, Heating Values for Various Fuel Types

Efficiency, Heating Values (Gross and Net), and Cost Comparisons for Various Fuel Types

TYPE OF FUEL	Wood				Softwood (11% MC) ^a	Hardwood (11% dried) (9% MC) ^a	Wood pellets (premium) ^a	Natural gas	Electricity	Firewood (seasoned) (20% MC) ^a	Switchgrass (ovendried)	Bituminous coal	Steered corn (15% MC)	Fuel oil		Propane
	Green (50% MC) ^a	Semidried (30% MC) ^a	Air-dried (20% MC) ^a	Ovendried (0% MC)										#2	#6	
GROSS HEATING VALUE	8,600,000 Btu/ton	12,040,000 Btu/ton	13,760,000 Btu/ton	17,200,000 Btu/ton	15,824,000 (Btu/ton)	15,996,000 (Btu/ton)	16,400,000 (Btu/ton)	1,025,000 (Btu/1000 ft ³)	3,412 (Btu/kWh)	20,000,000 (Btu/cord)	15,500,000 (Btu/ton)	30,600,000 (Btu/ton)	392,000 (Btu/bu)	138,800 (Btu/gal)	150,000 (Btu/gal)	91,300 (Btu/gal)
EFFICIENCY	67%	74%	77%	80%	76%	75%	63%	80%	98%	77%	80%	85%	80%	83%	83%	79%
NET HEATING VALUE	5,740,000 Btu/ton	8,950,000 Btu/ton	10,560,000 Btu/ton	13,800,000 Btu/ton	12,300,000 Btu/ton	12,600,000 Btu/ton	13,600,000 Btu/ton	820,000 Btu/1000 ft ³	3,340 Btu/kWh	15,300,000 Btu/cord	12,400,000 Btu/ton	26,000,000 Btu/ton	314,000 Btu/bu	115,000 Btu/gal	124,000 Btu/gal	71,900 Btu/gal
\$/million Btu	\$/ton	\$/ton	\$/ton	\$/ton	\$/ton	\$/ton	\$/ton	\$/1000 ft ³	\$/kWh	\$/cord	\$/ton	\$/ton	\$/bu	\$/gal	\$/gal	\$/gal
1.0	5.74	8.95	10.56	13.77	12.30	12.62	13.61	0.82	0.003	15.35	12.40	26.01	0.31	0.11	0.12	0.07
1.5	8.61	13.43	15.84	20.66	18.45	18.94	20.42	1.23	0.005	23.02	18.60	39.02	0.47	0.17	0.19	0.11
2.0	11.48	17.91	21.12	27.55	24.60	25.25	27.22	1.64	0.007	30.70	24.80	52.02	0.63	0.23	0.25	0.14
2.5	14.35	22.38	26.40	34.44	30.75	31.56	34.03	2.05	0.008	38.37	31.00	65.03	0.78	0.29	0.31	0.18
3.0	17.22	26.86	31.68	41.32	36.90	37.87	40.84	2.46	0.010	46.05	37.20	78.03	0.94	0.34	0.37	0.22
3.5	20.08	31.33	36.96	48.21	43.05	44.18	47.64	2.87	0.012	53.72	43.40	91.04	1.10	0.40	0.43	0.25
4.0	22.95	35.81	42.24	55.10	49.20	50.50	54.45	3.28	0.013	61.39	49.60	104	1.25	0.46	0.50	0.29
4.5	25.82	40.29	47.52	61.98	55.35	56.81	61.25	3.69	0.015	69.07	55.80	117	1.41	0.52	0.56	0.32
5.0	28.69	44.76	52.80	68.87	61.50	63.12	68.06	4.10	0.017	76.74	62.00	130	1.57	0.57	0.62	0.36
5.5	31.56	49.24	58.08	75.76	67.65	69.43	74.87	4.51	0.018	84.42	68.20	143	1.72	0.63	0.68	0.40
6.0	34.43	53.72	63.36	82.64	73.80	75.74	81.67	4.92	0.020	92.09	74.40	156	1.88	0.69	0.74	0.43
6.5	37.30	58.19	68.64	89.53	79.94	82.06	88.48	5.33	0.022	99.77	80.60	169	2.04	0.74	0.80	0.47
7.0	40.17	62.67	73.92	96.42	86.09	88.37	95.26	5.74	0.023	107	86.80	182	2.20	0.80	0.87	0.50
7.5	43.04	67.15	79.20	103	92	95	102	6.15	0.025	115	93.00	195	2.35	0.86	0.93	0.54
8.0	45.91	71.62	84.48	110	98	101	109	6.56	0.027	123	99.20	208	2.51	0.92	0.99	0.57
8.5	48.78	76.10	89.76	117	105	107	116	6.97	0.028	130	105	221	2.67	0.97	1.05	0.61
9.0	51.65	80.57	95.04	124	111	114	123	7.38	0.030	138	112	234	2.82	1.03	1.11	0.65
9.5	54.52	85.05	100	131	117	120	129	7.79	0.032	146	118	247	2.98	1.09	1.18	0.68
10.0	57.39	89.53	106	138	123	126	136	8.20	0.033	153	124	260	3.14	1.15	1.24	0.72
11.0	63.12	98.48	116	152	135	139	150	9.02	0.037	169	136	286	3.45	1.26	1.36	0.79
12.0	68.86	107	127	165	148	151	163	9.84	0.040	184	149	312	3.76	1.37	1.49	0.86
13.0	74.60	116	137	179	160	164	177	10.66	0.043	200	161	338	4.08	1.49	1.61	0.93
14.0	80.34	125	148	193	172	177	191	11.48	0.047	215	174	364	4.39	1.60	1.73	1.01
15.0	86.08	134	158	207	184	189	204	12.30	0.050	230	186	390	4.70	1.72	1.86	1.08
16.0	91.82	143	169	220	197	202	218	13.12	0.054	246	198	416	5.02	1.83	1.98	1.15
17.0	97.55	152	180	234	209	215	231	13.94	0.057	261	211	442	5.33	1.95	2.10	1.22
18.0	103	161	190	248	221	227	245	14.76	0.060	276	223	468	5.64	2.06	2.23	1.29
19.0	109	170	201	262	234	240	259	15.58	0.064	292	236	494	5.96	2.18	2.35	1.37
20.0	115	179	211	275	246	252	272	16.40	0.067	307	248	520	6.27	2.29	2.48	1.44
30.0	172	269	317	413	369	379	408	24.60	0.100	460	372	780	9.41	3.44	3.71	2.16
40.0	230	358	422	551	492	505	544	32.80	0.134	614	496	1040	12.54	4.58	4.95	2.87
50.0	287	448	528	689	615	631	681	41.00	0.167	767	620	1301	15.68	5.73	6.19	3.59
60.0	344	537	634	826	738	757	817	49.20	0.201	921	744	1561	18.82	6.87	7.43	4.31

^aWet basis.

5) States that have a Biomass Energy Program

Alabama
Delaware
Florida
Georgia
Indiana
Kentucky
Louisiana
New Mexico
New York
South Carolina
Wisconsin

6) Biomass heating system overview

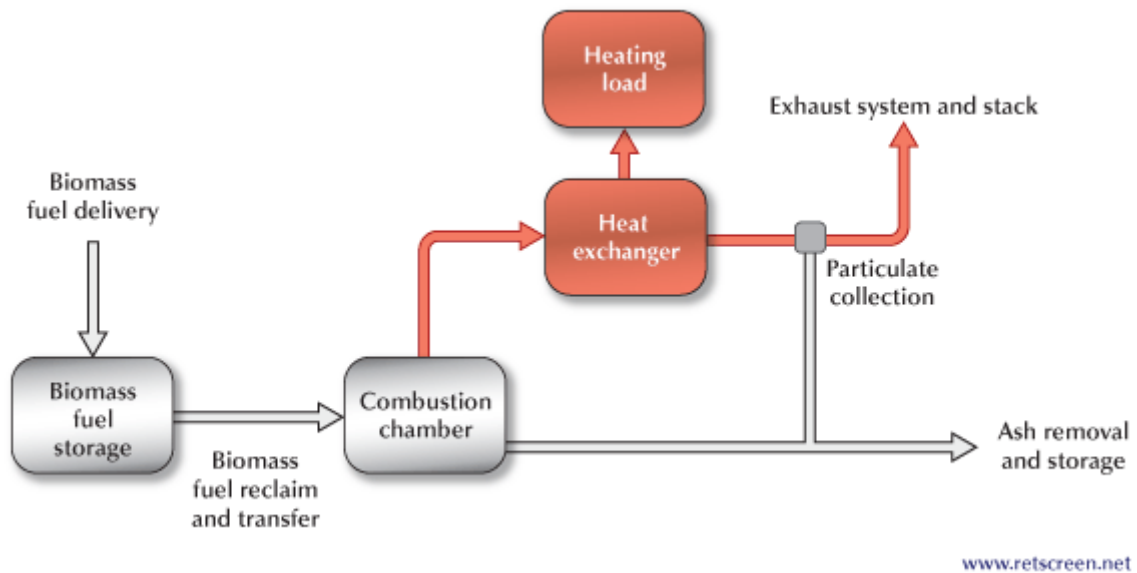


Figure 4 Biomass Heating System Description¹⁴

Relation between Air Ratio and Heat Efficiency

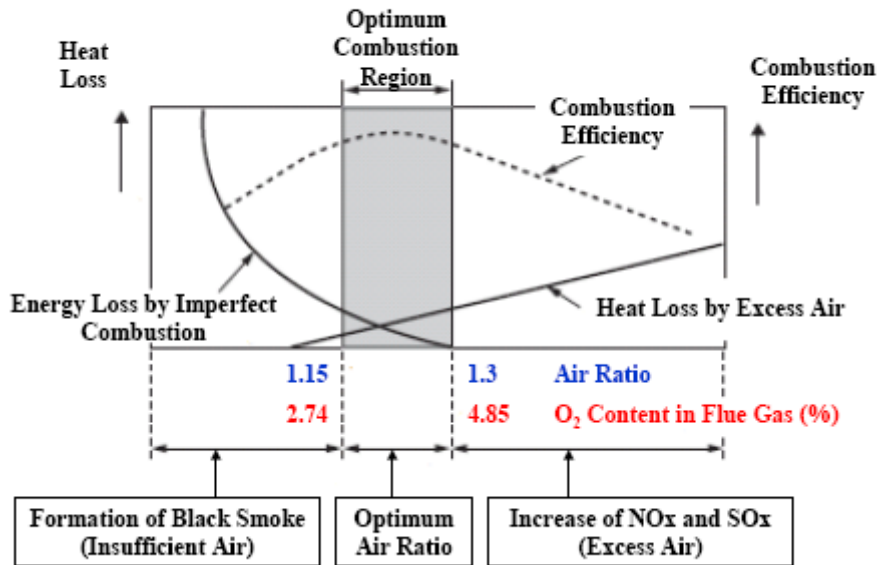


Figure 5:
between Air
Heat

Relation
Ratio and
Efficiency¹⁵

Boiler Heat Balance

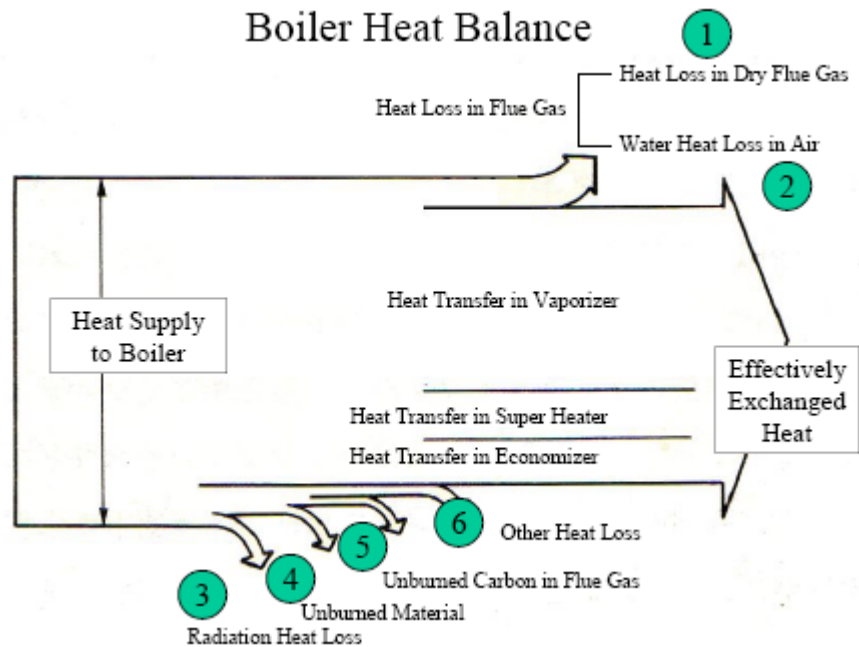


Figure 6 Boiler Heat Balance¹⁶

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