Final Technical Report
AgraPure Mississippi Biomass Project

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DISCLAIMER

EXECUTIVE SUMMARY
MISSISSIPPI BIOMASS PROJECT

The AgraPure Mississippi Biomass project was a congressionally directed project, initiated to study the utilization of Mississippi agricultural byproducts and waste products in the production of bio-energy and to determine the feasibility of commercialization of these agricultural byproducts and waste products as feedstocks in the production of energy. The final products from this project were two business plans; one for a Thermal plant, and one for a Biodiesel/Ethanol plant. Agricultural waste fired steam and electrical generating plants and biodiesel plants were deemed the best prospects for developing commercially viable industries. Additionally, oil extraction methods were studied, both traditional and two novel techniques, and incorporated into the development plans.

Mississippi produced crop and animal waste biomasses were analyzed for use as raw materials for both industries. The relevant factors, availability, costs, transportation, storage, location, and energetic value criteria were considered. Since feedstock accounts for more than 70 percent of the total cost of producing biodiesel, any local advantages are considered extremely important in developing this particular industry. The same factors must be evaluated in assessing the prospects of commercial operation of a steam and electrical generation plant. Additionally, the access to the markets for electricity is more limited, regulated and tightly controlled than the liquid fuel markets.

Domestically produced biofuels, both biodiesel and ethanol, are gaining more attention and popularity with the consuming public as prices rise and supplies of foreign crude become less secure. Biodiesel requires no major modifications to existing diesel engines or supply chain and offers significant environmental benefits. Currently the biodiesel industry requires Federal and State incentives to allow the industry to develop and become self-sustaining. Mississippi has available the necessary feedstocks and is geographically located to be able to service a regional market. Other states have active incentive programs to promote the industry. Mississippi has adopted an incentive program for ethanol and biodiesel; however, the State legislature has not funded this program, leaving Mississippi at a disadvantage when compared to other states in developing the bio-based liquid fuel industry.

With all relevant factors being considered, Mississippi offers several advantages to developing the biodiesel industry. As a result of AgraPure's work and plan development, a private investor group has built a 7,000 gallon per day facility in central Mississippi with plans to build a 10 million gallon per year biodiesel facility.

The development of a thermochemical conversion/generation facility requires a much larger financial commitment, making a longer operational time necessary to recover the capital invested. Without a renewable portfolio standard to put a floor under the price, or the existence of a suitable steam host, the venture is not economically viable. And so, it has not met with the success of the biodiesel plan. While the necessary components regarding feedstocks, location, permitting and technology are all favorable; the market is not currently favorable for the development of this type of project. In this region there is an abundance of energy generation capacity. Without subsidies or a Mississippi renewable portfolio standard requiring the renewable energy to be produced from Mississippi raw materials, which are not available for the alternative energy source selected by AgraPure, this facility is not economically viable.

SUMMARY: BIODIESEL FACILITY

The objective of this study and business plan was to determine the viability of a stand alone biodiesel production facility in Mississippi using Mississippi biomass material. Additionally, a goal was to research value added co-products for the agricultural community, study and develop alternative feedstock availability in Mississippi, study and determine what markets for biodiesel were present in the State and study and develop enhanced oil extraction methods. (The value added co-products that were developed during this study were derived from the enhanced and proprietary extraction methods and therefore are not part of this paper.)

The biodiesel market is relatively new, but is continuing to gain ground in both production volume and consumption. Any biodiesel produced in Mississippi would enjoy a regional market. The total petroleum diesel consumed in Mississippi is approximately 760 million gallons per year. By introducing a 20% biodiesel blend (B20) to the Mississippi market there is a potential in Mississippi alone for a 150 million gallon per year market.

The renewable fuels industry will be in competition with existing markets for available feedstock such as soy and corn resulting in an increase in demand and price for those feedstocks. Also the construction of plants will create new jobs in the plant locations. Currently biodiesel will require legislative support similar to that provided for the ethanol industry. The current Commodity Credit Corporation incentives, producer credits and various state incentives are necessary to enable this industry to develop and become self-sustaining.

Projections from various sources such as National Bio Diesel Board, the Mississippi Biomass Council and Frazier, Barnes & Associates demonstrate the increasing market for biodiesel and that it can be a viable industry in Mississippi. The necessary feedstocks are abundantly present and the geographic location is ideal for servicing several regional markets. Also the interest level of the local governments, agricultural community and potential investors is high.

During the course of our work a group of private investors stepped forward and built a biodiesel production facility in Rankin County, Mississippi, using the plan developed in this study. This facility was built to produce 7,000 gallons of biodiesel per day. The plant began operation in July of 2005 and has met its economic projections. Based upon this commercialization of the AgraPure work, there are currently plans, again through private investors, to build a 10 million gallon per year facility in Mississippi.

In recent years, an increased interest in alternative energy sources has developed due to economic, environmental and energy security related concerns associated with this nation's continued use of fossil-based fuels Our reliance upon petroleum is strongly believed to contribute to air pollution, an acceleration of global warming, and a persistent threat to our energy and economic security. In response to these concerns, Congress passed the Clean Air Act Amendments of 1990 and the Energy Policy Act of 1992. This legislation has been instrumental in spurring activities to commercialize biodiesel in North America.

There are currently 53 commercial biodiesel production plants operating in the United States. Of those 53 only 7 operate at a capacity exceeding 15 million gallons per year. Mississippi has two operating plants with one located in Meridian and the other in Nettleton. The number of developing biodiesel projects across the United States changes on a daily basis but the best estimate from the National Biodiesel Board is that at least 40 new plants being constructed in 2006.

Although the capacity of individual biodiesel manufacturing locations is closely guarded and owners are not particularly interested in revealing this information, capacity at some plants is known and many others can be estimated. The plant with the highest announced capacity that is currently operating in the U.S. is the 30 million gallon facility owned by Peter Cremer Company The balance of the existing plants are estimated to have biodiesel capacities ranging from 2 - 6 million gallons per year for a total capacity of 354 million gallons per year. The annual production of biodiesel is estimated at between 75 and 120 million gallons per year.

The potential market for biodiesel in Mississippi is based upon the current petroleum diesel fuel market. According to the Energy Information Administration (EIA), the total U.S. consumption of diesel fuel surpasses 57 billion gallons. Mississippi consumes over 760 million gallons of diesel fuel per year. The existing EPACT and the Renewable Fuel Standard in the EPACT of 2005 could create demand for over 15 million gallons of biodiesel per year in Mississippi if a 2% blend is instituted. The demand grows to over 152 million gallons in Mississippi if a 20% blend is utilized statewide.

Table A
Regional Biodiesel Demand Projections

Blends	B-2	B-20
Mississippi	15,219,680	152,000,000
Tennessee	24,387,780	243.300,000
Arkansas	18,845,560	188,400,000
Alabama	20,864,640	208,640,000
Louisiana	40,161,580	401,610,000

(Frazier Barnes and Associates)

This assumes no growth in overall diesel fuel use. If diesel fuel use were to increase as it has in the past, the estimates for biodiesel use would increase accordingly. One category that is particularly interesting is the on-farm diesel fuel use. Current farm use at a 2% blend would require 1.6 million gallons, while a 20% blend would require 16.7 million gallons. Producers have expressed an interest in using biodiesel assuming it is not significantly more expensive than petroleum diesel.

The market for B100 is limited. Due to the cost of B100, limitations on product availability and engine manufacturers hesitancy to recommend a B100 fuel, there is little chance that widespread distribution or usage of B100 will occur at any significant level in the near future even though it can be used in existing diesel engines with little or no modifications. Although there is an environmental benefit to B100 usage, there is no economic incentive that would drive demand and there is not enough production to justify all but a niche B100 market. The demand for biodiesel in the United States is projected to grow significantly over the next ten years due to the demand for cleaner air, an emphasis on energy security and a Renewable Fuel Standard that should be passed this year as part of the overall Energy Bill. The groundwork for biodiesel market development has already been established by existing legislation.

The best market for biodiesel fuel in the near-term involves trucking fleets that are required to comply with The Energy Policy Act of 2005 (EPACT) or otherwise required to use renewable fuels. EPACT requires that in fiscal year (FY) 1999 and beyond, 75% of all covered vehicle acquisitions by Federal agencies must be Alternative Fuel Vehicles ("AFV's"). Executive Order (EO) 13149 sets a goal for covered Federal agencies to reduce petroleum consumption by FY 2005, requiring agencies to increase alternative fuel use in AFV's. The Department of Energy (DOE) is one of the Federal leaders in the use of biodiesel.

The following factors should be considered in any site selection and will have a significant impact on the construction and operation of a biodiesel production plant in Mississippi:

1. Feedstock Availability and Cost: Since the feedstock cost in a biodiesel plant is 75% to 85% of the total cost of producing a gallon of biodiesel, the availability and cost will have a major impact on the plant profitability.
2. Biodiesel Market Access: Will impact the average distance from a biodiesel plant site to biodiesel market centers and also will affect the economy of scale of the biodiesel plant.
3. Truck Transportation Access: Access to ground transportation via interstates and major highways in close proximity (10 to 30 miles) is a top consideration in the placement of a plant because of its impact on delivered cost of feedstocks and transport costs for biodiesel products.
4. Rail Access: All potential processing projects should strongly consider access to main line railroads and/or established short line railroads. The quality and proximity of those connections may impact the actual profit margins of the facility.
5. Distance from Closest Biodiesel Production Plant: The closest current commercial scale biodiesel plants are in Mississippi, within 90 miles of one of the proposed sites, but, this should not significantly impact the biodiesel market for this plant.
6. Economic Incentives/Site Infrastructure: While economic incentives can seem appealing, ultimately they do not have a significant impact on the long term profitability of a plant; neither should they be a major factor in the selection of a site. The previously mentioned factors will play a much greater role in plant profitability long-term.
7. Low Cost Electricity/Energy: While a biodiesel plant does not consume a large amount of energy, electrical costs will impact the final cost of the product.

The biodiesel production process is relatively simple when compared to other agricultural processes. There are several companies that offer biodiesel processing technology. The key factors to be considered when selecting a biodiesel technology include selection between batch processing and continuous processing, process guarantees offered by the technology provider, processing yields, capability of handling multiple feedstocks, operational support, and capital and operating costs.

FEEDSTOCKS

Feedstocks account for the majority of the total cost of producing biodiesel; hence feedstock cost and availability are very important in determining the feasibility of locating a biodiesel plant in the state. Table A shows some of the more common and available feedstocks in the state, along with their average cost. Mississippi is a net exporter of soybeans, the primary source of oil currently used for biodiesel production. Mississippi, however, is not an exporter of soybean oil. Mississippi soybean producers are looking for opportunities to add value to their soybeans and other oilseed production due to persistently low soybean prices and the closure of all, but one of their soybean processing plants. The reduced market access and competition have forced producers to examine new opportunities to improve the economics of agriculture.

Table B: Availability and Cost of Feedstock

Feedstock	**Availability (gallons)**	**Average Cost** (per pound of feedstock)	**Average Cost** (per gallon of feedstock)
Soybean Oil	38.6 million	$0.25/lb	$1.92/gallon
Cottonseed Oil	16.0 million	$0.27/lb	$2.08/gallon
Yellow Grease	6 million	$0.13/lb	$0. 87/gallon

EXTRACTED SOURCES

This section describes potential feedstocks that are purchased in a pure or semi-pure form from various operations. Examples include: extracted plant oils, recovered waste greases, and other novel sources of extracted or separated lipids (separated from the gross feedstock mass).

Virgin Plant Sources - This option greatly reduces the processing requirements for a biodiesel producer, because these oils generally arrive at the facility ready for processing. Soybeans are by far the most commonly used lipid feedstock for biodiesel production within the US. This is not surprising given that soybean oil represents over 70% of the current US oilseed market.

The top oils produced poundage-wise in the US are listed below by descending order:

- Soybeans (~18 Billion lbs.)
- Corn (~2.5 Billion lbs.)
- Cotton Seed (~1 Billion lbs.)
- Sunflower (~1 Billion lbs.)
- Peanuts (~0.25 Billion lbs.)

Table C: Ranking of Mississippi in Production of Feedstocks.

Feedstocks	Relative Ranking of Mississippi Within US	Estimated Volume of Biodiesel Produced (mm gal)
Cotton Seeds (oil)	4	4.1
Rice (Rice Bran)	5	26.4
Sorghum	12	4.2
Soybeans	13	16.9
Corn	21	1.7

Source: USDA

When taking into account the above listed sources and assuming full production at each facility, Frazer-Barnes estimates that over 50 mm gal, per year of biodiesel could be produced from virgin plant oils within Mississippi (taken from their 2003 report to Mississippi Technology Alliance [MTA]).

Some of the established plant oil producers within Mississippi include:

1. Bunge North America (Marks, MS) – soybean oil
2. PYCO Industries (Greenwood, MS) – cottonseed oil
3. Delta Oil Mill (Jonestown, MS) – cottonseed oil

Developing Virgin Plant Material Sources - There is a wide variety of developing oilseed feedstock sources that may solve some of the inventory problems within the region. Examples include a ricin-free version of castor beans, black mustard, tall oil, tung oil, algae, heat-tolerant rapeseed, hibiscus, and Chinese tallow. Of particular interest to this study was the development of these novel feedstocks because of their high potential value as cheap and renewable feedstocks. Development of lower cost feedstocks will improve the profitability of biodiesel production.

Waste Lipids - Another extracted source of lipids that can be found in large volumes within Mississippi are waste greases/oils and meat-based fats. The current waste grease/oil market within Mississippi tends to be controlled by the established waste oil collection businesses, such as Gold Coast and Griffin Brothers. A review of the literature indicates that the waste cooking greases appear to retain the same fatty acid composition of the parent oil. A recent study of waste grease production within Mississippi performed by the GeoResources Institute of MSU indicates that the Hinds County Area produces the greatest volume of waste grease within the State of Mississippi (enough to support approximately an one million gallons per year biodiesel production facility, using a 50 mile radius around Jackson as the feeder source for the grease).

It is important to note that production of biodiesel from waste greases (such as waste cooking grease and grease trap sludge) appears to be the cheapest pathway. Most publications list grease trap sludges as being the cheapest of all options. If these feedstocks are to be considered, the extent of "preprocessing" required in terms of removing waste solids and other debris/chemicals of little to no processing value, may potentially pose processing problems downstream (i.e. bones, meat solids, excess water, etc.). Another problem with some of these feedstocks, involves their relatively poor flow characteristics. These characteristics are due to their high cloud points, causing them to be difficult to pump into processing reactors. Often, these feedstocks require some form of preheating to allow smooth flow through the biodiesel process, which increase biodiesel production costs. A review of waste lipid handlers as reported by Alcorn State University (ASU) for the Mississippi Technology Alliance (MTA) lists the following potential sources for waste lipids within the Mississippi Region:

1. Griffin Industries (Jackson, MS)
2. Gold Coast Commodities (Brandon, MS)
3. Ferguson Gravel (Greenwood, MS)
4. Birmingham Hide and Tallow (Birmingham, AL)
5. W.B. Riggins Tallow (Trussville, AL)

Virgin Animal-Based Fats - The largest industry within Mississippi is poultry raising and associated processing industries (Mississippi is ranked 4th in the US in terms of poultry production). Therefore, a tremendous volume of poultry fat is produced in Mississippi that may serve as a viable feedstock to a biodiesel production operation. Taking into account the volume of lipids produced during the processing of the lipids from poultry operations in Mississippi via rendering operations, Mississippi is capable of producing over 50 M gallons per year of biodiesel, if all of the rendered fat was converted to biodiesel. One word of caution is that many times of the year animal fats do contain appreciable amounts of free fatty acids that will form soap during base-catalyzed transesterification. Significant formation of soap increases the loading on post-production operations, such as biodiesel washing and waste residue management. Therefore, the use of the acid esterification and/or hybrid processes (combines both acid and base catalyzation) will be needed to maximize Fatty Acid Methyl Ester production,
A review of historical costs of these virgin animal fats generally places their price at about 50% of soy oil. Clearly, waste virgin animal fats offer a great opportunity for producing significant amounts of a relatively low-cost biodiesel product.

OIL EXTRACTION TECHNOLOGY

There are basically three options for chemically extracting lipids from oil seeds and lipid-containing solids. Each option is briefly discussed below:

<u>Pressing</u> – This is a common method of lipid extraction in developing countries and in the smaller domestic oil production facilities. During pressing, flaked feed is typically forced between a rotating screw and a stationary screen which forces the oil out through the screen and moves the along the screw flights to the meal hopper. One advantage of pressing and other non-hexane-based extraction methods is that these processes do not leave hexane (a chemical with a record of adverse human health impacts) residues in the resulting meal. Another reported advantage is that presses are capable handling multiple feeds at one time without any process modification. One key drawback with regard to pressing methods is the relatively high levels of lipids are left behind as opposed to hexane extraction: 5 – 6% for pressing versus 1 – 2% with hexane extraction (high oil contents in the cake or meal are prone to rancidity problems and unacceptable for use as some animal feeds).

Hexane Extraction – This extraction process is by far the most commonly used technique for the commercial extraction of lipids from oilseeds and other lipid-bearing media. In most developed countries and at larger facilities within the US, hexane extraction is used instead of pressing for most lipid extractions from oilseeds. In essence, this process involves the extraction of the lipids from solids placed within an extraction vessel in which hexane is injected for removal of the lipids. Some form of pretreatment is required of most feedstocks, such as bean size reduction or drying of "wet" media (algae for example). Hexane tends to provide the most efficient extraction from a total oil yield standpoint. The biggest drawback to hexane extraction is the dangerous properties associated with the hexane (both flammability and human/animal health issues). During processing, the hexane is contacted with the oil-bearing medium. The hexane is then separated from both the oil and cake phases for reuse and to ensure that the dangerous hexane is not remaining within either product phase. Note that if polar lipids are of interest, then hexane extraction as a stand-alone extractant will not be very effective. In this case, a more polar extractant is often added (i.e. methanol) to form a co-solvent extraction system.

"Other" Chemical Extraction Processes – A growing area in the lipid industry is the use of alternative chemical extractants for the replacement of hexane. The most developed of this category is supercritical carbon dioxide, which is a well-known process used for removal of caffeine from coffee. Supercritical carbon dioxide extraction has many positives including the use of a "safe" extractant and the resulting high quality cake that is accepted by all potential clients, even those concerned over the health implications of residual extractants being present in the meal (cake). Unfortunately, supercritical carbon dioxide is expensive compared to hexane extraction, operates a very high pressures, and is considered to be "scale-limited" in that very large commercial system have not been constructed to date. An alternative to supercritical carbon dioxide includes aliphatic chemicals used at their supercritical conditions (such as propane, butane, etc.). Of these alternatives, the state of development is such that they are both scale-limited and in various forms of development. However, the potential of these alternatives, including supercritical carbon dioxide and propane extraction, appears very high; particularly, as both the bulk and specialty lipid markets continue to grow at such a dramatically rapid rate.

MARKETS

The biodiesel market is still in its infancy in the United States, based on both production and consumption, but is a rapidly expanding industry that is poised for significant growth over the next decade. Current U.S. production of biodiesel is estimated between 30 and 50 million gallons per year. It is anticipated that this production capacity could expand by 400 - 600 million gallons per year over the next ten years given current and proposed state and federal support programs. Biodiesel produced in Mississippi would be marketed within the state and perhaps regionally, depending on overall demand. The total petroleum diesel consumption in Mississippi ranges from 700 million to 800 million gallons per year. This represents a potential demand for biodiesel in Mississippi as follows:

- 15 million gallons per year @ B2 (2 % biodiesel blend)
- 150 million gallons per year @ B20 (20 % biodiesel blend)

A significant amount of petroleum diesel in Mississippi is used in the agricultural sector. The potential on-farm use of biodiesel could be as much as 1.6 million gallons per year with a B2 blend.

The current production cost of biodiesel is about two dollars per gallon. Typically, in existing markets, a biodiesel blend costs the end user one cent per gallon for each percent of biodiesel mixed in with petroleum diesel. For example, a B5 blend would be five cents more than the cost of petroleum diesel and B20 would be 20 cents above the cost of petroleum diesel. As more biodiesel becomes available in the market we don't expect this premium to continue and biodiesel will have to be price competitive in this region to succeed.

Currently, there are three distinct sizes of biodiesel plants: hobby "backyard" operations producing any where from a few hundred to a few thousand gallons of biodiesel per year, small commercial plants in the range of 1 to 3 million gallons per year (mmgy) and those that can produce 10 million gallons or more per year of biodiesel. The backyard operations tend to utilize yellow grease collected from restaurants as a feedstock. Smaller, <3 mmgy units, process both yellow grease and virgin vegetable and animal fats. The larger plants rely primarily on virgin vegetable oil. In the United States, soybean oil is the preferred feedstock. A mid sized plant in the range of 5 to 7 mmgy, such as the one we are planning for Mississippi, could be developed with the flexibility of using either feedstock. However, the capital cost of the plant increases with the additional steps required for preconditioning the raw feedstocks in order to obtain a consistent feed to the reactors.

There are two philosophies of plant operations that can be considered. One is a simple stand-alone facility and the other combines soybean processing capabilities in addition to the biodiesel plant itself. Biodiesel is an emerging product that gives an alternative by which soybean producers can add value to their crop. Mississippi soybean producers have an opportunity to convert their lower value soybeans into higher value products such as biodiesel, soybean meal, vitamins, and other nutraceuticals. This type of "value-added" processing operation would require not only soybean processing capability that would yield soybean oil, soybean meal and hulls but also the ability to further process the deodorizer distillate. Deodorizing is the step that removes the aromatic compounds including the vitamins and other nutraceuticals from the soybean oil. Integrated with the soybean processing plant would be a biodiesel production facility capable of further processing the virgin soybean oil and possibly other oils, virgin and non-virgin, into biodiesel.

The other model that could be considered and the one we believe most feasible for Mississippi is a "stand-alone" biodiesel facility. This particular model requires less capital to construct and is more flexible in terms of selecting a site, but provides no value added benefit to farmers and relies on outside sources for feedstock. A stand-alone facility produces only biodiesel and glycerin.

Biodiesel production has the potential to provide a floor for soybean oil prices, providing stability for the farm economy, and an opportunity to capture a higher value revenue stream for the state's agricultural sector. Generally speaking, the renewable fuels industry tends to increase the feedstock prices and create jobs in the local economy. Prices of soybeans, animal fats, and yellow grease would be positively impacted with the advent of a biodiesel industry in the state. However, due to lack of end user awareness and no state support or commitment for use, near-term widespread utilization of biodiesel is not likely without assistance from the federal and state governments. Biodiesel represents a unique opportunity for the Mississippi Legislative body to promote a domestic agricultural product, while improving the air quality of Mississippi, lowering our dependence on foreign oil, and creating high quality jobs in the state. Several states around the country have already taken steps to attract biodiesel operations by initiating promotion and incentive programs.
Factors that may positively affect demand for biodiesel:

- Consumer awareness of benefits, i.e. increased mileage, increased torque, reduced emissions and particulates giving the resulting health effects
- Increased cost of petroleum based diesel
- Demand for cleaner air
- Federally mandated lowering of sulfur levels in automotive emission in the year 2006
- Emphasis on energy security
- Renewable Fuel Standard (Energy Bill)
- Adoption of biodiesel by government (Federal and State) fleets

These factors, when encouraged by the appropriate legislative actions, consumer education about the benefits of renewable fuels and the advent of cheaper biodiesel feedstocks and production technology could have a significant impact on the creation of a sustainable market for biodiesel in Mississippi.

Biodiesel Byproducts and Waste Products

Glycerin as the main byproduct of biodiesel has flooded the market as more plants have come on line. So the market of $0.10 per pound has evaporated, making it into a waste product that most plants must pay for its disposal.

Potassium Hydroxide catalyzed wash water has fertilizer value so it can be transported and land applied. While this will usually only bring in enough revenue to cover the transportation costs it does not add any additional costs, so it is a positive for the plant. This is not the case with sodium hydroxide catalyzed wash water, which has no fertilizer value so it must be sent through a wastewater treatment step and then to disposal adding to the cost of production.

Magnesium Silicate, used as a final cleanup step, has the possibility of being used as animal feed additive, if a market can be located, or if not it can be disposed of in a landfill.

Ethanol and Byproducts

Mississippi and the adjacent states are net corn importing states because of poultry and other animal feed demands. This currently makes ethanol production inside the state not competitive because of higher transportation costs to bring in the raw material need for these plants.

Dried distillers grains are used as animal feed but that use is not enough to justify in state production of ethanol, currently $70 per ton.

Cellulose based ethanol offers promise for ethanol production in Mississippi, if the technology can be proven to use wood and wood by products. Mississippi has over one million acres of land in the Conservation Reserve Program (CRP). The main market for this wood has been as pulp for paper mills. With the paper mills in Mississippi moving out of the country, the market for this wood is no longer viable leaving abundant raw materials available for ethanol production.

PLANT DEVELOPMENT, SITE SELECTION AND ECONOMIC FEASIBILITY

Processing type:
Batch verses continuous processing can be debated as to capital costs verses operational costs.
The batch process is generally more cost-effective for smaller levels of biodiesel production. Batch facilities typically require less capital and are well suited for switching between feedstocks. Batch facility capacities range from 500 gallons per year to 10 million gallons per year. Some continuous processing plants can be competitive with the capital cost of batch units, so the question largely is one of personal comfort with the technology provider and the expected feedstock mix.

In general, the larger the processing facility, the lower the per-unit capital and operating costs - this is true for biodiesel production as well.
The following are items that would need to be considered in the development of a small-scale (batch) facility.

- Tranesterification and esterfication units
- Machinery
- Storage Tanks
- Electrical
- Methanol Recovery
- Building
- Permits & Misc.
- Working Capital- 3 months

The capital cost to build a plant with a capacity of 10M gallons per year in Mississippi would be approximately $2,500,000.00 using proprietary technology and equipment. This project should enjoy a substantial capital cost advantage over better known technology with a price of about $1.00 per gallon or a ten million dollar capital cost.

Management and Labor

A biodiesel plant is a chemical conversion plant so some level of familiarity with chemical processing theory is needed in the plant management in addition to the usual management skills needed for plant operations. A chemical engineer is preferred but not absolutely necessary. A plant will employ about ten to twelve people of varying skill levels. The plant will operate with four twelve-hour shifts per two-week period. So, it will require eight operators, two per shift, an “A” operator, who will be the shift leader and will be expected to run the equipment, supervise and train the "B" operator. A truck driver and general office and bookkeeping personal will be required.

Site Selection and Projected Plant Economics

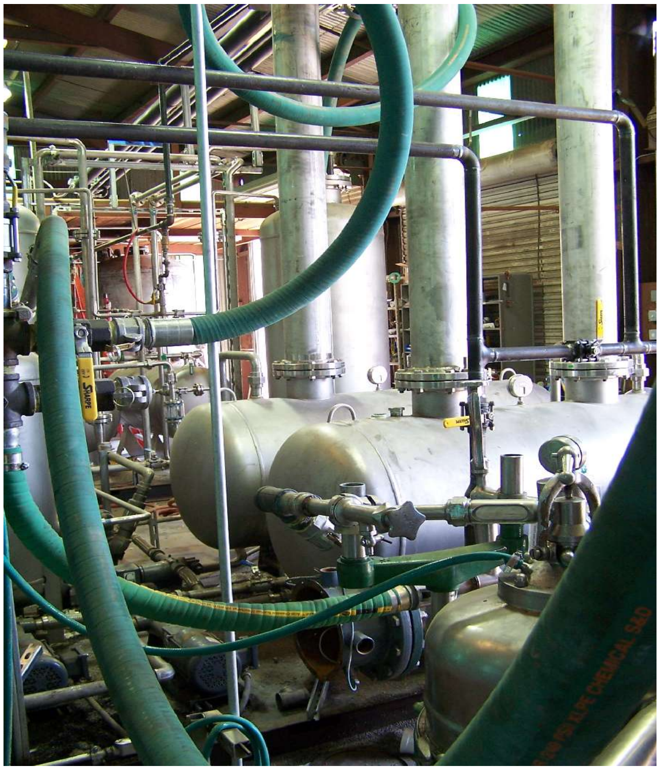
Potential sites were evaluated with primary considerations being infrastructure, raw material availability, proximity to the market, transportation, electric power costs, and availability of labor. There are several attractive sites for biodiesel plants in Mississippi. Labor to operate a plant is not a problem anywhere one would chose to locate in Mississippi. Also, there are no areas in the state that obtaining the permits needed to operate a biodiesel would be difficult to procure, providing that local zoning would permit the use of the location. The remaining criteria lead to sites that fall into groups; 1) close to the end user market, near Memphis Tennessee, Jackson, or along the gulf coast, 2) in areas with ready access to raw material for example, next to a rendering plant, Forest or Jackson, or 3) on a waterway for ease of raw material and finished product shipment, the Mississippi River towns of Greenville, Vicksburg, or Natchez, along the Tennessee-Tombigbee or on the Gulf of Mexico in Harrison or Hancock Counties. All of the above mentioned sites have industrial parks with all needed utilities and infrastructural improvements needed to make a plant operational. These improvements include adequate roads for transport trucks, railroad access, natural gas service, sewer or wastewater treatment, and three-phase 480-volt electric service. Sites in the Tennessee Valley Association (TVA) service area have a slight cost advantage; however, it is not significant.

With all of this in mind, a brown field site in Vicksburg has been identified as the probable site for the next larger scale plant. This location offers river access with its lower costs for transportation of raw materials and ease of shipping finished product to East Coast and European markets. Feedstock is available both via the river and overland from rendering plant in the Jackson and Forest areas. The large consumer market in Jackson is at hand as are the military bases in Meridian, Mississippi and Alexandra Louisiana. The attached project spreadsheet, Attachment 1 for the first year of operation shows that based upon biodiesel sales at $2.80 per gallon that when the plant is at full operating capacity it will be profitable. A six month ramp up period is anticipated to reach full production. The projected operating profit after twelve months of operation is $3,500,000.

CONCLUSIONS AND COMMERCIALIZATION OF AGRAPURE PLAN

As the research on this project was conducted potential investors were contacted and based upon the project outline Southern Bio Fuels, LLC was formed. Private investors build a 7,000 gallons per day capacity biodiesel production facility. This plant began operation in July of 2005 and has been commercially viable since that time. The plant achieved the projected goals in sales and profitability and was considered to be a successful implementation of the study and plan developed by AgraPure, even though AgraPure's work was not fully complete at the time of its utilization. Photographs of the operating facility follow:

Reactors


Recovery system

Initial processing tanks

Biodiesel holding tanks

Truck loading station

The construction and operation of a biodiesel facility in central Mississippi has attracted a great deal of attention from the tri-state area, and has brought many groups interested in biodiesel to tour the facility. This has also placed all of these potential investors and developers in contact with AgraPure and has initiated talks regarding the construction of a larger facility.

The conclusions of our study and resulting business plan are fully demonstrated by the construction and successful operation of the Southern Bio Fuels plant in Mississippi. There exists a sufficient market, necessary feedstock availability, adequate labor, supporting infrastructure, cooperative governmental entities and available capital to support several biodiesel plants in Mississippi.

SUMMARY: THERMAL GENERATION FACILITY

The objective of this portion of the study was to research the viability of developing a plan to deploy a thermal conversion electrical generation facility using various Mississippi produced renewable feedstocks, chicken litter in particular.

A review and analysis of all possible suitable feedstocks was done and a number of possibilities presented themselves. Availability, costs and other factors such as transportation and storage were analyzed. There are a number of feedstocks that would meet the necessary energetic value criteria to power a facility, but for other reasons such as availability, quantity, transportation or costs would not be suitable. It developed that a combination of these feedstocks, primarily chicken litter and forestry residue, would meet all of the criteria. The main issue with these feedstocks is that there is no plant currently operating in the United States that utilizes this particular feedstock for this purpose.

There is a plant utilizing litter currently being constructed in Minnesota by Fibrowatt, which we were able to draw information from. Fibrowatt also operates 3 other facilities using litter in the United Kingdom. For this facility in Minnesota a power purchase agreement that provides for a significantly enhance Biomass Rate which guarantees a fixed rate of return for investors. This contract is possible because of a Biomass Mandate adopted by the Minnesota legislature.

The available markets for the electricity generated were determined to be in the same geographic area of the State as the targeted feedstocks. All of the issues that would effect the construction of the plant and connectivity to the power grid were identified. Discussions were held with the three identified markets for the electricity that would be generated, those being South Mississippi Electrical Power Association, Entergy Mississippi and Tennessee Valley Authority. From these discussions it was determined that, while there was interest by the Tennessee Valley Authority their Green Switch Program did not provide for biomass to be considered a renewable energy source. The power generated from this proposed plant would have to be subsidized in a manner similar to the Fibrowatt plant in Minnesota. At this time Mississippi has no Biopower mandate that would cause a similar situation to arise. The new EPA regulations effective in 2007 regarding confined animal feeding operations will have a material effect on the poultry industry in Mississippi and very likely will result in similar legislation to that adopted in Minnesota. Without some type of enhanced biomass rate, a biomass plant can't be currently cost competitive in the electrical generation market with the traditional methods of electrical generation, not only in Mississippi, but in any state.

Interest in studying the viability of a thermal electrical generation facility in Mississippi using chicken litter as a possible feedstock become of interest to AgraPure after the opportunity to visit a Fibrowatt, LLC plant operating in the United Kingdom. This plant, along with two others was producing electrical power using chicken litter as its feedstock. With Mississippi being the 4th largest state nationally in broiler production with an average of 790 million broilers produced annually and with the resulting abundant supply of chicken litter therefore available, the determination of whether or not this type of project would be suitable for Mississippi needed to be made.

On the surface the necessary elements to build a biomass thermal power generation facility were available in the State. The technology was proven since there were three operating facilities in the United Kingdom and the technology was not proprietary. Obviously there were questions regarding feedstock such as availability, direct litter costs, transportation costs, storage as well as facility development costs, site costs and markets.

FEEDSTOCKS

Bulk Biomass as a Feedstock

Biomass covers a variety of materials and is broadly defined as any organic material derived from plants or animals. In Mississippi the most recognized biomass fuel is wood. Other feedstocks that were studied include; crops, animal manures, agricultural residues, sludges from municipal or pulp & paper wastewater treatment and municipal solid wastes. These biomass feedstocks were identified and characterized to determine the availability, costs, and other commercial factors associated with each feedstock. These can be loosely grouped into four main categories:

- Woody plant and residues
- Herbaceous plants / grasses
- Aquatic plants
- Manures

Our analysis focused on categorizing bulk-biomass feedstocks as to their ultimate source: cultured versus waste biomass. Waste biomass is essentially waste products that have an appreciable BTU value and handling characteristics allowing the feedstock to serve as a fuel into a power plant Cultured bulk biomass feedstocks are becoming an increasingly attractive option.

Plant-Based Feedstocks

Woody, herbaceous, and grass plants are biomass feed stocks particularly suited for thermal conversion. During thermal conversion the carbon trapped by the plant is converted to CO_2, CO, CH_4 , and various other large organic molecules. Woody plant species that should be targeted as sources for biomass feed stocks include:

- Willow
- Poplar
- Pine
- Forestry residues (sawdust, wood chips, etc.)
- Agricultural residues (cotton ginning trash, bagasse, etc.)

These feedstocks are targeted because of the direct tonnage available, or in the case of the fast-growing trees (willows, poplars, and pines) the high growth rate with a relatively short rotation period.

Feedstock Availability Analysis

The following feedstocks were evaluated for use in the proposed thermal plant:

- a combination of switchgrass and native hay grass
- chicken litter
- corn stover
- cotton gin trash
- cotton stalks
- rice
- sorghum
- soybeans
- switchgrass
- wood chips

In order to determine which of these resources best fit project needs, a comparison of both their chemical composition data as well as their dry matter data was made. Grass species that have been targeted as biomass feed stocks for energy conversion include:

- Miscanthyus
- Switchgrass
- Hemp
- Agricultural residues (corn and wheat)

The elemental analysis of various biomass feeds are presented in Attachment 2 and the selected properties of selected biomass are presented Attachment 3. In general, when comparing wood and biomass to coal, wood biomass has a heating valued of 0.25 – 0.5 of a typical coal (coal = 20-26 MJ/kg and switchgrass –15-17 MJ/kg). Thus, it would take approximately twice the weight of biomass to generate the same amount of heat provided from a given amount of coal.

<u>Corn Stover</u> - Corn stover is the remaining stalks and leaves after the corn is harvested for grain.

<u>Switchgrass</u> - Switchgrass is a fast growing thin bladed perennial grass. Since it is not an established crop at this time, further discussions with Mississippi Agricultural and Forestry Experiment Station (“MAFES”) experts are suggested if any particular area is being considered.

Rice Straw - In Mississippi, MAFES estimates that about 2.92 tons per acre per year of rice straw could be collected. Using the data in Attachment 4 about 167,500 tons per year of rice straw would be available for biomass conversion. Rice growing activity within Mississippi is located in the Mid-Delta Area.

Cotton Stalks - After the seed cotton has been harvested, the cotton stalks that are left in the field could be used as a feedstock. Much of this agricultural activity is found in the Delta Area of Mississippi.

Cotton Ginning Trash - After the seed cotton is harvested, it must be cleaned and the fiber and seed are separated in a cotton gin. The trash that is removed consists of the sticks, stems, hulls, and leaves and is referred to as "cotton gin trash".

Grain Sorghum - After grain sorghum is harvested, the stalks are left in the field. Samples collected from a harvested field indicated that approximately 1.65 tons of grain sorghum stalks could be collected per acre, yielding only 0.13 million tons per year.

Soybean Stalks - Soybean stalks left in the field after the soybeans have been harvested were sampled and it was determined that approximately 0.45 tons of biomass could be collected per acre. Most of the soy bean growing activity in Mississippi is found along the west side of the state. Based on the best available information, it appears that the entire state of Mississippi produces about 12.2 million tons (dry weight) of wood waste per year and another 6 million tons (dry weight) of wood waste from tree thinning operations, providing a total of 18 million tons of woody feedstock.

Wood Chips - Wood chips from three different types of trees were obtained from a local sawmill and analyzed by MAFES for their chemical and dry matter composition. The three types of wood evaluated were poplar, red oak, and pine along with sawdust. The results of the analyses are presented below. All the wood chips and sawdust have high lignin contents while the ash content ranged from 1.0 to 11.1 for red oak and sawdust, respectively. Energy content was highest for pine (8705.9 BTU/lb) with red oak (7559.8 BTU/lb) being the lowest, but they were all in the "high" category. Ash content was lowest for red oak (1.0%) and highest for sawdust (11.1%). All of the elements analyzed in the wood chips and sawdust were quite low except for iron, which was 452.5 and 306.5 ppm for pine and poplar, respectively.

Table D. Chemical Composition of feedstocks

Element	Soybean Stalks	Cotton Gin Trash	Chicken Litter	Pine	Poplar	Red Oak	Sawdust
% Nitrogen	2.36	1.53	3.1	.375	0.41	.675	0.375
% Phosphorous	0.24	.265	1.6	.01	0.025	.02	0.01
% Potassium	0.29	1.17	3.3	.11	0.165	0.095	0.11
% Calcium	0.83	1.71	2.5	.16	1.69	3.3	0.16
% Magnesium	0.16	.155	6.5	.025	0.105	0.045	0.025
% Sulfur	0.08	0.24	0.59	.02	306.5	0.02	0.02
% Iron	67	241	525	44	37.5	452.5	44
% Manganese	12	20	436	18	5.5	129.5	18
% Zinc	14	17	291	3	16.5	15.5	3
% Copper	8	7.5	718	6.5	10	2	6.5

(Mississippi State University & Zapco)

Poultry Litter - Litter from broiler and layer operations was sampled by MAFES. Dry matter and chemical analyses were performed to characterize this waste (Attachments 5 and 6). Based on one cleanout per year, it is estimated that about 1.2 million dry tons of chicken litter would be available in Mississippi for biomass conversion, fertilizer, or other uses. A good rule of thumb for estimating litter production numbers if firm data are not available is that 1 ton of dry litter is produced for every 1,000 birds.

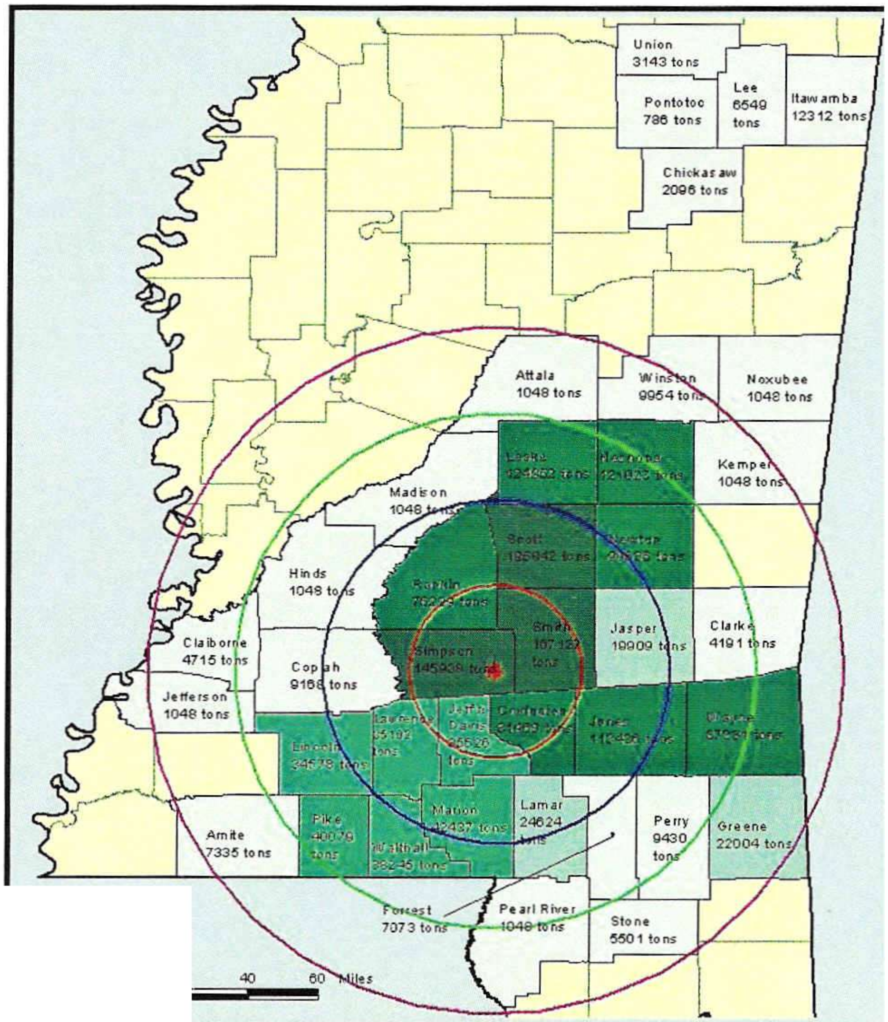
For the use of poultry litter to be economical and to sustain the operation of a thermal generation station, the source of the litter must be located relatively close (<30 miles) to the facility and in large enough quantities at a nominal price. As shown in Table E studies for the State of Mississippi indicate that the highest concentration of poultry litter is located in Scott, Smith, and Simpson Counties. In central Mississippi, in an area that is within a 50-mile radius of Ludlow, MS, there is about 485,000 tons (dry weight) of chicken litter produced per year. In the area that is within a 50-mile radius of the intersection of Neshoba, Kemper, Newton, and Lauderdale counties, there is nearly 404,000 tons (dry weight) of chicken litter produced per year. While there are no exact figures available on the tonnage of litter available, an estimate was made using the rule of thumb formula mentioned above

Table E: Estimated Chicken Litter in Proposed Plant Site Area.

County	Tonnage	Percent
Simpson	145,908	9.20
Smith	167,127	10.54
Scott	195,942	12.35
Neshoba	121,023	7.63
Leake	124,952	7.88
Newton	90,636	5.71
Kemper	1,048	.07
Total:	**846,636**	**53.38**

(McCallum Sweeney Consulting)

Map 1: Geographic Center of Litter Production in Mississippi



(McCallum Sweeney Consulting)

The chemical and dry matter analysis data for chicken litter is shown in Attachments 5 and 6.

The energetic value of dry poultry litter was 6,589 BTU/lbs, while the ash content was high at 21%. Poultry litter contained higher amounts of all the elements, with two exceptions that were analyzed when compared to all of the other feedstocks. Red Oak contained more magnesium than chicken litter and rice straw contained more manganese than did chicken litter.

Some additional information was found on the composition/energetic typical properties of poultry litter. One set of data is provided in Attachment 5. From this table, it can be seen that the heating value of litter ranges from 3,800 - 5,200 BTU/lbs. at 30% moisture (which fits nicely with the recent analyses performed by MAFES – see above). The actual heating value at the plant will depend on the moisture content of the litter. As seen in Table 3, the phosphorus (PO_4) and potassium (K) concentrations are high. The phosphate and potassium levels will likely result in an ash that has fertilizer value, but these minerals can result in clinker formation and bead agglomeration during thermal conversion processes.

One key point about poultry litter is that the characteristics of this potential feedstock are changing as more and more companies are requiring their growers to quit adding wood chips or any other bedding material onto the house floors. As an example, note the differences in data presented in Attachments 5 and 6 versus Attachment 7. The difference in ash and BTU content are most notable. The Attachment 5 and 6 data were performed on litter after bedding addition was ceased as opposed to Attachment 7 data which represents litter with bedding. .

Another potential change in terms of poultry litter characteristics is that Auburn University has proposed that sand be added as an alternative to lignocellulosic bedding materials. Clearly, if growers do begin to use sand as bedding, the materials handling, energetic value, and ash production will all be adversely impacted.

One final issue pertaining to handling poultry litter is the fact that these materials do have potential to contain heavy metals and other potential regulated materials. A series of studies have been published concerning the toxicity of poultry litter which should be taken as a point of caution as to how regulators and the general community may receive projects of this type. Also, many environmentalists have blamed poultry wastes for outbreaks of pathogens in the fish populations within the Eastern US Coastlines only adding to potential issues that may be raised by some concerned community members.

SUMMARY

Of all the feedstocks examined above, rice straw, soybean stalks, cotton stalks, grain sorghum stalks, and cotton gin stalks all had high energy values. The highest of these values were soybean stalks in the 9,000 BTU/lb range. Rice straw was in the 6,500 BTU/lb range, with the other three (corn stover, switchgrass, and the switchgrass-bermuda grass mixture) being in the mid 4,000 BTU/lb range. Ash content for all the feedstocks were low expect for rice straw. None of the feedstocks had exceedingly high contents of any of the elements tested except for the boron content of the rice straw. Data presented in the chemical analysis has shown no real problems with any of the feedstocks evaluated.

Conservatively there are 18 to 20 million tons of wood waste per year produced yearly within Mississippi that could be used for biomass conversion to power. Within the central region of Mississippi, which includes all or parts of about 15 counties, there is over 986,000 tons of wood waste available on an annual basis. The energetic value of these different types of wood chips varies from 7560 to 8700 BTU/lbs. and ash content varies from 11.1% to 1.% for red oak and pine (sawdust), respectively.

There is about 485,000 tons of poultry litter produced per year within the central region of Mississippi. The fuel value of the poultry litter was found to 6,000 BTU/lb and the ash content about 21%. Poultry litter also had higher amounts of elemental components than any of the feedstocks which leads to some slag formation. These levels can be advantageous in terms of the phosphate levels because of the potential for selling the ash as a fertilizer amendment; however, the heavy metals concentration need to be carefully evaluated (and monitored) to ensure that ash disposal does not become an issue.

<u>THERMAL CONVERSION PROCESSES</u>

The technologies that were examined by AgraPure have been utilized in this industry for a number of years. These technologies are in currently operating plants, available for viewing, enabling discussions of the actual physical operation of the plant with the current operators. All methods were considered, but because of the nature of some of the feedstocks under consideration modifications would have to be made to the delivery systems to accommodate those particulars.

DIRECT COMBUSTION

Oxygen plays a key role in the combustion process. Careful design and operation of a direct combustion system must account for an optimized feed of both carbon (biomass) and oxygen. Indirect heating is applied where the fuel is combusted in a boiler type device to generate steam which is used in industrial processes. The fuel is combusted using excess air (greater than the stochiometric oxygen required for combustion.) The steam can then be used to either provide heat or it can be sent to turbines to provide mechanical power that is typically used to generate electricity via generators.
With industrial combustion, hot gases are produced at temperatures around 800-1,000^{o}C. Reports generally agree that it is technically possible to burn any type of biomass, but in practice, combustion is feasible only for biomass with moisture contents less than 50%.
Industrial boilers that utilize biomass and direct combustion are classified into several types:

- Moving grate
- Spreader Stoker
- Fluidized bed
- Rotary kiln with waste heat recovery

- Stationary hearth with waste heat recovery

Moving Grate - A moving grate combustion unit as the name indicates employs a grate that moves. The biomass is fed so that it rests on the grate that moves through the combustion chamber. There are inherent inefficiencies in this process that make it unsuitable for this application.

Fluidized Bed – A fluidized bed combustion unit consists of a vessel containing an inert material, such as sand, that has a high thermal mass. A high gas velocity is maintained though the inert bed which acts to suspend or fluidize the inert bed. The fuel is injected into the fluidized bed and the bed serves both as a mixing and heat transfer media. The capital costs and operating and maintenance costs are higher for fluidized bed units than for grate systems.

Rotary kiln with Waste Heat Recovery – Rotary kilns are rotating, cylindrical-shaped, refractory-lined vessels. The cylinder is set at a slight incline and the biomass tumbles down the incline as the fuel is combusted. Auxiliary fuels are typically required for these systems. This system showed to be highly inefficient in biomass thermal conversion.

Stationary Hearth with Waste Heat Recovery –This process is primarily used for volume reduction and disposal.

Spreader Stoker - the spreader stoker is the most widely accepted, proven, means of combusting biomass. It is efficient in its operation and of all the systems surveyed produced the best results for the feedstocks that were studied.

Gasification

Gasification is an old established technology that is gaining interest in the United States. In this process the biomass is converted to a gaseous fuel by partial oxidation of the biomass under starved oxygen conditions (oxygen is introduced at less than the stochiometric amounts). Gasification occurs at high temperatures (800 – 900^oC) and a low calorie gas is produced (about 5-6 MJ/N m^3). This gas can be used directly as a fuel for heat conversion, power production using gas turbines, or converted into liquid fuels. While it is of interest the capital costs associated with the process cause it to be more expensive than some of the other processes reviewed and evaluated.

Pyrolysis

Pyrolysis is the conversion of biomass into a liquid (bio oil) under the absence of oxygen. At this time this process is commercially undeveloped for application to thermal electrical generation and would not be viable in our analysis.

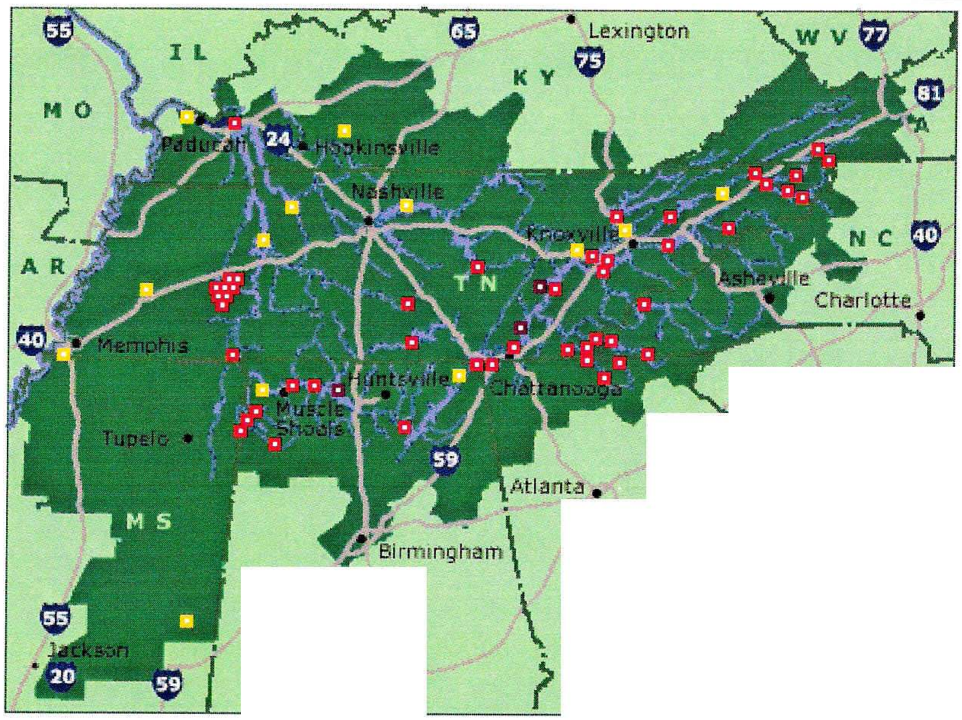
THERMAL CONVERSION SUMMARY

There are advantages and disadvantages to the various types of thermal conversion technologies. Currently based on the combustion characteristics of the poultry litter / waste wood, with its slag formation, direct combustion design appears to be the best choice. However further discussions with the boiler makers will be needed to finalize the design of the firebox and the fuel feed system. Pyrolysis and gasification have yet to be proven reliable using poultry litter as a feedstock and have been ruled out at this stage, but these technologies need to be monitored for future developments.

ECONOMICS OF POULTRY LITTER COMBUSTION

The main issue in accessing the economics associated with the thermal conversion of poultry litter in the US is that no plants are currently being operated. This makes the projection for the cost of building and operating a thermal conversion plant for poultry litter difficult. The cost for thermal conversion plants will vary widely depending on a variety of factors. In fact, Burt Bock of the Tennessee Valley Authority states that “Assessing the economic feasibility [of a poultry litter thermal conversion facility] is a difficult task because commercial examples are lacking and because several of the important factors are quite specific, including (1) competing fuel and electricity prices, (2) delivered poultry litter feed stock prices, and (3) net revenues that can be generated by an energy plant from poultry litter ash."

Many factors must be considered in the economic assessments. Cost estimating is a complex process with many uncertainties and renewable technologies are generally characterized by relatively high capital costs and outside of some niche market applications, they are not economically competitive with conventional sources of power and must be subsidized. Care should be utilized in interpreting and extrapolating the plant costs. With this in mind the following costs were extracted from the literature and are offered here. We found that there are several planned facilities in the United States and we have the benefit of drawing from their work and experience. One of those planned facilities is being developed by a company from the United Kingdom, which currently operates three facilities in that country. The company with the most experience appears to be FibroWatt and its subsidiaries. FibroMinn (part of FibroWatt) is currently constructing a 50 MW poultry litter-fed power generating facility in Benson, MN. Actual plant construction began very recently (11 May, 2005) and system operations are expected to commence by February 2007. It is reported that $202 million dollars have been acquired to finance construction of the plant and it is assumed that these funds will result in a turn-key faculty ready to accept poultry litter for power production. Of the $202 million, it is reported that $142 million will be applied to the capital cost for plant construction and the remaining $60 million will be used to pay financing and other startup costs. This plant is reported to consume over 500,000 tons of litter per year.

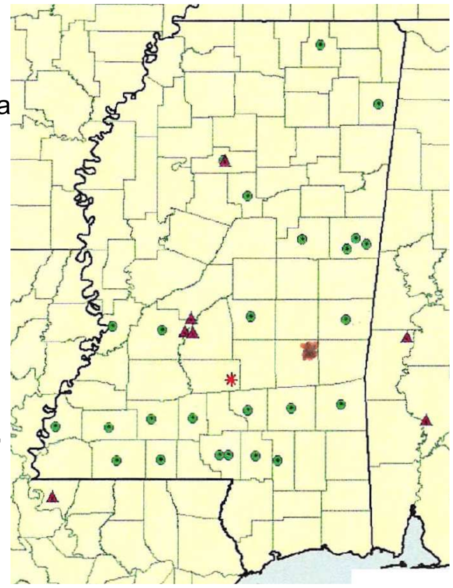


The Benson FibroMinn facility is reported to utilize a spreader stoker feed system. Based on other reported thermal conversion plant costs, the cost of the FibroMinn plant appears to be high. Regardless, this venture does represent the first US litter thermal conversion plant to be constructed and thus provides the best cost data available.

FibroWatt currently operates at least 3 litter thermal conversion facilities outside the US. These include the FibroPower facility in Suffolk, UK, the Fibrogen – Galnford Power Station facility in North Lincolnshire, UK, and the FibroTheford facility in Norfolk, UK. The FibroPower facility a 38.5 MW facility reported to be constructed at a cost of $118 million. This facility, like the FibroMinn facility, uses a spreader stoker for complete combustion of the litter. Details of other operating non-US FibroWatt facilities were not identified. FibroWatt reports that a proposed facility is planned to be located on the eastern shore of Maryland. The 38 MW FibroWatt facility is projected to utilize 200,000 – 300,000 tons of litter per year (as well as an additional 100,000 tons/yr of forestry residue, wood biomass feed) and is projected to cost between $60-$90 million dollars to construct. It was estimated that the plant must receive an income of $0.053/kWh for its power production.

POTENTIAL COMPETING USERS OF POULTRY LITTER

The delivered cost of litter is difficult to determine since there is no established market for litter. A brief survey for other groups who might be interested in using poultry litter as their respective feedstock or product was made to evaluate the potential for competition for poultry litter in this region. Discussions with poultry farmers generally indicate that this group of "feedstock" producers is anxious to receive at least $8/dry ton or more (FOB) for their material. In 2003, the Georgia Extension Service estimated that poultry litter had a net value of $25 or more per dry ton when used as a soil amendment. Texas A&M reported that the fertilizer value of poultry litter to be in the $20 per dry ton range. Reports of these types are generally reporting the net value of the minerals and not the actual prices provided to the poultry farmers. The most likely competitors for poultry litter include:



Cattle Feed - The value of poultry litter is changing as regulations pertaining to the feeding of litter to cattle are changing. To date, there still appears to be an open window allowing the feeding of poultry litter to cattle; however, as these opportunities diminish, this option only forces the litter producer to consider other, possibly lower cost, options for their product/waste.

On-Farm Digestion for Biogas Production – Currently, there is a demonstration at Brinson Farms, located in Collins, MS, using poultry litter as the feedstock for biogas production. This on-going demonstration will provide some idea as to the future of this option in Mississippi. Discussions between Dr. Mark Zappi of Mississippi State University and officials from the USEPA/DOE AgStar Program (a federally funded biogas advocacy group) indicate that this option is not expected to mature; however, preliminary results from Brinson Farm indicate that this AgStar assessment may be premature. However, even if this demonstration is a big success and the feasibility of litter to biogas becomes a viable option for the poultry farmer, the adoption of this on-farm system is not believed to be a widespread undertaking by the poultry raising industry, given the status of these projects within the dairy and swine industries (not many of these farms have opted for biogas production facilities on their respective farms).

Soil Amendment – This option has been discussed for some time among the poultry raising industry. The overall concept is to use the low levels of N & P (~3 and ~1% w/w, respectively) along with the organic carbon within the litter as a soil amendment. Most litter produced today within the US is currently used as a soil amendment. The farmers on their own farms use about one third of this poultry litter on their own farms, with the balance sold, given away, or disposal is paid for with removal to other locations.

SITE ASSESSMENT

Economically it is desirable to locate a plant closer to an end user or to an existing electrical grid, such as those maintained by the Tennessee Valley Authority ("TVA"). The TVA service area extends into East Central Mississippi to approximately east of Interstate 55 and north of Interstate 20 to the Alabama-Mississippi state line. TVA maintains a fossil plant in Kemper County Mississippi, which is also within the primary litter producing area of the State. It is also economically desirable to have the plant located as close as possible to the source of its feed stock, to reduce transportation costs. Map 2 below shows the location of the TVA service area and the location of its generation facilities. Note that there is currently only one generation facility located in Mississippi. The proposed site would be in the lower corner of the current service area.

Map 2: TVA Service Area

As shown in Table E, page 18, studies for the State of Mississippi indicate that the highest concentration of poultry litter is located in Scott, Smith, and Simpson Counties. In central Mississippi in an area that is within a 50-mile radius of Ludlow, MS, there is about 485,000 tons (dry weight) of chicken litter produced per year. In the area that is within a 50-mile radius of the intersection of Neshoba, Kemper, Newton, and Lauderdale counties, there is nearly 404,000 tons (dry weight) of chicken litter produced per year.

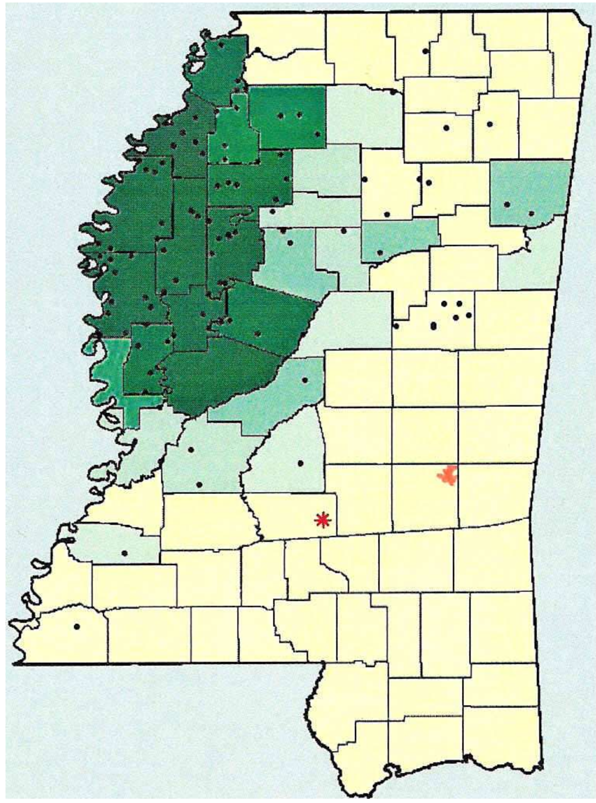
Additionally, there is an abundance of sawmills within a 100- mile radius, as well as paper and pulp mills. Almost 1.0 million acres are under CRP management.

Their locations can be seen in the Map below:

Map 3: Paper Mill and Saw Mill Locations.
(McCallum Sweeney Consulting)

Cotton gin waste is mostly in the northern part of the state. It is expected that gin wastes will be imported from other states once a full assessment of its suitability as a fuel source has been determined. There was concern expressed that fertilizers and pesticide commonly used in growing cotton would remain in the gin trash, which could be problematic if there are found in the emissions from combustion.

Map 4: Cotton Production and Gin Locations



(McCallum Sweeney Consulting)

While the cotton gin waste is generated in areas located some distance from possible plant locations in east central Mississippi, due to the gross energy BTU value there is a great possibility that litter and cotton gin waste or forestry residue could be combined as a feed stock mix.

The consideration of locations near to the TVA service area for interconnection purposes, location near to litter availability and forest residue, suggest that a plant location in the Kemper, Newton or Lauderdale counties would be feasible for this project.

An Interconnection study must be performed to ensure the security and adequacy of the transmission system. The addition of a generator onto the transmission system may have a significant impact on the operation of the system. Several factors may be affected and must be analyzed prior to the addition of generation. These include system stability, fault duty of existing equipment, overloading problems, and voltage violations.

DEVELOPMENT COST

The estimated EPC cost to build a biomass-fuel power plant is $2,000 to $2,500 per KW. With the foreign and domestic demand for building materials of all types the cost estimates are continuing to climb, almost on a daily basis, and therefore it is difficult to make a cost estimate that is good for more than 60 days without a signed contract and then it will contain cost adjustments based upon the cost of materials at the time they are obtained.
In the following table (Table 1) we have available the costs of facilities that have been built, estimates of those that are in the process of being built or project estimates on the following. In all cases these are prices that were available to us within the last 2 years and have not been updated for rising construction costs.

Table F: Construction costs

Entity	Location	Size	Estimated Cost (Millions)
Fibrowatt	Benson MN, USA	50MW	202
Fibrowatt	Suffolk, UK	38.5 MW	118
*Connective Energy Supply	Vienna, MD, USA	35 MW	52

An estimated cost for a 40 MW plant today would currently be $90,000,000.00.

Other Considerations:

The Environmental Protection Agency ("EPA") adopted confined animal feeding operations ("CAFO") in December of 2002. The legislation is designed to reduce and control the adding of pollutants to surface waters, therefore any size operation may have to file for a CAFO permit. If a poultry farmer is required to file for a permit they will need to implement a nutrient management plan. In the past the primary method of handling litter was land disposal. With these new regulations land disposal will also be more regulated. The options available for disposal are becoming more limited and the farmer is possibly looking at additional expense to deal with this issue. These regulations do not take effect until July 31, 2007.

The following is a list of the necessary Federal, State and Local permits required to construct the facility

Table G: Federal and State Permits

Permit Approval or Notice	Agency	When Needed	Time from Application To Issuance
Certificate of Public Convenience And Necessity	Mississippi Public Service Commission	Required for construction	60-90 days
Local zoning and building permits	City or County	Prior to Construction	60 days
Beneficial Use Permits to divert or withdraw water a. Pump Test Permit b. Final withdrawal Permit	Mississippi Department of Environmental Quality	Permit required for each well prior to use	60 days

NPDES Permit to discharge test well water	Mississippi Department of Environmental Quality	Permit required prior to discharge of water	Approximately 4 months prior to first discharge
Clean Air Act	Mississippi Department of Environmental Quality	Permit required prior to start of any construction	Approximately 9 months
State Air Permit to Operate	Mississippi Department of Environmental Quality	Prior to operation. Issued at same time as Permit to Construct	Approximately 9 months
NPDES for discharge of process waste water	Mississippi Department of Environmental Quality	Required if operations result in discharge of process waste water into water of State	Permit required prior to discharge, Approximately 9 months
Construction Storm water General Permit	Mississippi Department of Environmental Quality	Prior to site cleaning of surface facilities	90 days
NPDES General Storm water for Industrial Activity Permit	Mississippi Department of Environmental Quality	Before Operation begins	6 months
Local Solid Waste Management Plan	Mississippi Department of Environmental Quality	Prior to operation	120 days
Department of the Army (CWA 404)	U. S. Army Corps of Engineers	Before start of construction	9-12 months
Endangered Species Clearance Letter	U.S. Fish & Wildlife	Prior to clearing site/ construction	6 months
Endangered Species Permit	Mississippi Natural Heritage Program		6 months
National Historic Preservation Act Clearance Letter	State Historical Preservation Officer	Prior to clearing site/ construction;	6 months
Cultural Resources Survey	State Historical Preservation Officer	If required	6 months

Mississippi has promoted a unique program to help facilitate the smooth and efficient handling of the application, information submittal, coordination and receipt of permits. A Performance Pact is created by the Mississippi Department of Environmental Quality's (MDEQ) Environmental Permits Division (EPD).

The purpose of the pact, though a non-binding agreement between the applicant and the EPD, will still detail both parties' duties, expectations and time lines. The Performance Pact package is comprised of four documents.

- Pre-Application Questionnaire
- Project Awareness Checklist
- Blueprint for the Development of Performance Pacts
- Template for the Developing Performance Pacts

There is no charge for the above permits; however, to the extent those specialists from engineering/environmental consulting firms and legal counsel, the costs can be considerable, perhaps as high as $1.0 million dollars. This is contingent on the amount of involvement the company is willing and able to commit to this endeavor versus complete reliance on outside counsel, and the timely and accurate submission of data.

(B) Local Permits/Actions

(i) Local Non-hazardous Solid Waste Management Planning

The fuel hall, which stores litter, will be considered a non-hazardous solid waste facility according to the Mississippi Department of Environmental Quality17. As such, state law requires that local governments establish a 20-year solid waste management plan for wastes generated in their jurisdiction. The local governments can include counties, cities, regional solid waste management authorities or solid waste management districts.

(ii) Local Permits

1. City Zoning Regulations
   If a business is to be located within city limits, the business owner should check to be sure that the location is zoned for business usage. Contact: City zoning department.
2. County Zoning Regulations
   Most Mississippi counties do not have zoning ordinances, but the owner of a new business should check with officials to see if there are zoning requirements. Contact: County Zoning Department
3. City Building Permit
   If a business is to be located in a new or remodeled building inside the corporate limits of a city, the owner must get a city building permit before he begins construction or remodeling. Contact: City permit department.
4. County Building Permit
   If a business is to be located in a new or remodeled building outside the corporate limits of a city, the owner should check to see if a county building permit is required before he begins construction or remodeling. Some Mississippi counties require building permits. Contact: County permit department or chancery clerk.
5. City Business License
   An owner of a new business must get a city license from the city tax collector if the business is located within a city's corporate limits. Contact: City tax collector.
6. County Business License
   An owner of a new business must obtain a county license from the county Tax collector if the business is located outside a city's corporate limits. Contact: County tax collector.

MARKETS

Contact was made with representatives of the Tennessee Valley Authority, Entergy Mississippi and South Mississippi Electric Power Association ("SMEPA"). These were the only entities operating in the area determined to be the most feasible for location of an electrical generation plant using the locally produced feedstocks. Entergy or SMEPA both stated that they had no interest in adding additional generation capacity and if they did the rate that they were currently paying to purchase power was sufficiently lower than the anticipated cost of production.

TVA held preliminary discussions and expressed interest however; they could not classify a plant fired by poultry litter and other bio renewable crops as eligible for their Green Power Switch Program. This is a program that promotes renewable energy using solar, wind and methane. Due to the higher cost of production the consumers signing up for the program are upcharged $4.00 per block (150 kwhr) for each block purchased. This program also pays producers $.15 per kwhr. In all other circumstances TVA purchases power at approximately $.348 per kwhr. The Fibrowatt plant currently being built in Minnesota has an agreement to sell its production at a significantly enhanced “Biomass Rate” which includes annual escalation. Their contract provides several pass-through payments to minimize the risk from increases in certain taxes, fuel transportation costs, interconnection charges and decreases in ash sales. The purchaser in this case is driven by legislation passed by the Minnesota state legislature which requires the procurement of 125MW of biomass-fired generation as a condition to store spent nuclear fuel at a nuclear generating Facility.

CONCLUSION

There is adequate biomass available in the central Mississippi area to support a 30- 50 megawatt thermo chemical conversion plant. However without price support in the form of a subsidies or a renewable portfolio standard that would require the renewable energy to be generated from Mississippi sources and not from out of state solar, wind or other renewable sources, at the present time it is not economically feasible to construct an agricultural byproduct or waste product fueled steam electric plant.

ATTACHMENT 1. Financial Spreadsheet

Cost Data

			Operational Profit =	**4,263,453**
			Fed tax$0.10/Gal credit	**1,008,000**
BD Sale price	$2.80	/gal		
Feedstock - Average Delvd Price	$0.26	/lb		
Glycerine - Sales Price	$0.00	$/lb		

Methanol Price	$0.17	$/lb	Or $1.16 per gal	
Sodium Methylate Catalyst	$0.45	$/lb		
Magnesol	$0.72	$/lb		
Labor Rate	$646,000	Per Year		
Insurance	$60,000			
Mgt Salary	$150,000			
% Methanol Recovery	95.0%			

	Totals (thru 12 months)
No of Production Days	336
Production Rate Gal/day	
Biodiesel Prodn gallons	10,080,000
SALES	
Biodiesel Sales gallons	10,080,000
Biodiesel Sales $	28,224,000
Glycerine Sales gallons	1,008,000
Glycerine Sales $	-
TOTAL SALES	**28,224,000**
	-
VARIABLE COST OF SALES	-
Materials	-
Feedstock	19,393,920
Methanol	1,020,600
Catalyst	564,165
Magnesol	598,752
Total Material Cost	**21,577,437**
Cost/Gal	
Direct Labor	
Process Operators	646,000
Indirect Labor	
Truck Driver	288,000
OTHER VARIABLE EXPENSES	
Operating Supplies	96,000
Maintenance	60,000
Power	240,000
Fringe Benefits	174,420
Misc	13,000
ASTM/BQ9000 Cost	48,000

NBB Dues	100,800
Total Variable Expenses	23,243,683
MANAGEMENT	
Management	150,000
Fringe	40,500
FIXED EXPENSES	
Rent Building	42,000
Insurance - General Plant & Prod Liab	60,000
Waste Disposal Services	12,000
Debt service	401,364
TOTAL FIXED EXPENSES	**705,864**
TOTAL COST OF GOODS SOLD	**23,949,547**
GROSS PROFIT	**4,274,453**
SALES, GENERAL, AND ADMINISTRATIVE	-
Sales Expenses	-
Travel	**5,500**
R & D	**5,500**
TOTAL S, G, & A	**11,000**
MFG COST BIODIESEL ($/GAL)	**2.38**
PROFIT $/GAL OF SALES BD:	
EXCLUDING GLYCERINE SALES	**0.42**
INCLUDING GLYCERINE SALES	**0.42**
OPERATIONAL PROFIT	**4,263,453**

ATTACHMENT 2.
Analysis of Various Biomass Materials Presented on a Percent of Bulk Mass Basis

Material	C	H	O	N	S	Ash
Cypress	55.0	6.5	38.1	-	-	0.4
Ash	49.7	6.9	43.0	-	-	0.3
Beech	51.6	6.3	41.4	-	-	-
Wood	51.6	6.3	41.5	0	0.1	1
Miscanthyus	48.1	5.4	42.2	0.5	<0.1	2.8
Wheat straw	48.5	5.5	3.9	0.3	0.1	4
Barley straw	45.7	6.1	38.3	0.4	0.1	6
Rice Straw	41.4	5	39.9	0.7	0.1	
Bituminous coal	73.1	5.5	8.7	1.4	1.7	9
Lignite	56.4	4.2	18.4	1.6 a	--	5

(McKendy 2002)
a Combined N & S

ATTACHMENT 3.
Properties of Selected Biomass Materials

Material	Moisture Content %H2O	HHV MJ/kg	FM Content (%)	VM Content (%)	Ash Content	Alkali Metal Content(%)
Fir	6.5	21	17.2	82.0	0.8	
Danish Pine	8.0	21.2	19.0	71.6	1.6	4.8
Willow	60	20.0			1.6	15.8
Poplar	45	18.5			2.1	16
Cereal Straw	6	17.3	10.7	79.0	4.3	11.8
Miscanthyus	11.5	18.5	15.9	66.8	2.8	
Bagasse	45-50	19.4			3.5	4.4
Switchgrass	13-15	17.4			4.5	14
Bituminous Coal	8-12	26-2	57	35	8	

(McKendy2002)

ATTACHMENT 4.

Potential amount of several feedstocks found in Mississippi.

Crop residue[1]	Residue, ton per acre	2003 acreage, million acres	Residue available,[2] tons per year
Corn stover	2.66	0.53	357,500
Switchgrass[3]	10.00	0.75	7,500,000
Rice straw	2.89	0.23	167,500
Cotton stalks	2.25	1.10	625,000
Soybean stalks	0.50	1.42	177,500
Grain sorghum stalks	1.70	0.07	32,500
cotton gin trash	n/a	1.10	130,000
Total			8,990,000

[1]Switchgrass is not a crop residue but would be planted as a crop.

[2] Based on utilizing only 25% of available crop residue.

[3] Estimate if 750,000 acres planted.

ATTACHMENT 5.

Chemical composition of various feedstocks found in Mississippi.

Element	Corn stover	Switchgrass	Switchgrass hay mix	Rice straw	Cotton stalks	Soybean stalks	Grain sorghum	Cotton gin trash	Chicken litter	Poplar	Red Oak	Pine	Sawdust
% N	1.02	2.145	1.9425	1.41	1.23	[illegible]6	1.54	1.53	3.1	0.41	0.675	0.645	0.375
% P	0.145	0.17	0.1825	0.105	0.12	0.24	0.11	0.265	1.6	0.025	0.02	0.13	0.01
% K	0.61	0.965	1.99	1.215	0.35	0.29	0.13	1.17	3.3	0.165	0.095	0.09	0.11
% Ca	0.595	0.265	0.415	0.245	0.995	0.83	0.355	1.71	2.5	1.69	3.3	0.43	0.16
% Mg	0.14	0.2	0.3225	0.17	0.08	0.16	0.125	0.155	6.5	0.105	0.045	0.04	0.025
% S	0.065	0.07	0.1725	0.08	0.075	0.08	0.07	0.24	0.59	0.015	0.02	0.02	0.02
ppm Fe	52	100.5	72.25	93.5	30	67	74.5	241	525	306.5	161	452.5	44
ppm Mn	56.5	165.5	199.5	568	9.5	12	25.5	20	436	37.5	272	129.5	18
ppm Zn	10.5	18.5	23.5	26	8	14	34.5	17	291	5.5	2	15.5	3
ppm Cu	5	6	7.75	4.5	3.5	8	5	7.5	718	16.5	2.5	2	6.5
ppm Bo	8	2	3	2	17	18.5	3	40.5	53	10	7.5	2	3

Dry matter analysis of several feedstocks found in Mississippi.

Analysis	Corn stover	Switchgrass	Switchgrass hay mix	Rice straw	Soybean stalks	Grain sorghum	Cotton stalks	Cotton gin trash	Chicken litter	Poplar	Red oak	Pine	Sawdust
Dry matter, %	93.0	95.5	96.0	95.5	96.4	96.3	92.7	96.5	77.1	98.3	98.1	97.8	98.7
NDF, %	72.1	69.0	70.1	64.3	77.7	74.6	86.3	68.4	50.0	71.1	78.9	73.6	98.6
ADF, %	38.5	31.7	37.1	38.7	61.6	44.0	72.2	56.3	29.5	59.6	60.2	61.6	76.0
Ash, %	5.5	6.3	7.4	18.2	3.0	8.9	2.9	9.5	21.1	10.5	11.1	4.8	1.0
TDN, %	59.4	67.0	60.9	59.2	33.7	53.3	21.9	39.6	69.1	35.9	35.4	21.0	17.8
Lignin, %	3.0	2.0	3.5	4.5	19.0	7.5	16.6	14.5	9.5	23.9	21.3	26.8	16.2
Gross energy, BTU/lb	4457.6	4545.8	4385.2	6675.5	9042.2	8037.8	8492.0	7963.5	6588.7	7908.6	7559.8	8705.9	8447.1

ATTACHMENT 6

Attachment 7. Chemicals and Physical Characterization of Poultry Litter

Parameter	**Concentration in Percent (unless otherwise noted)**
Carbon	27.2
Hydrogen	3.7
Oxygen	23.1
Nitrogen	2 – 3
Sulfur	0.3
Chlorine	0.7
Ash	15.7
Moisture	20 – 40
Organic Matter	85
PH	8.8 (no units)
P2O5	0.71
K2O5	3.79
Higher Heating Value	10-13 MJ/kg
After Incineration Char Gas Product	 6.79 MJ/kg 4.79 MJ/kg