Feasibility Study for

Use of Poultry Litter to Create Biomass Energy

Final Report

Prepared For:

Michigan Biomass Energy Program
Grant No.: PLA-03-32
And
West Michigan Co-Gen LLC

Prepared By:

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TABLE OF CONTENTS

I. Project Introduction

A poultry producer group in western Michigan called Western Michigan Co-Gen (WMC) investigated methods of adding value to their poultry litter production. One alternative that showed promise was the conversion of this renewable biomass product into thermal (steam) energy and electrical power. To assist in this conversion opportunity, WMC engaged Frazier, Barnes & Associates (FBA) of Memphis, Tennessee to conduct a feasibility study for the use of poultry litter to create Biomass Energy. This Final Report summarizes the results of the feasibility study.

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A. This study is covered by the following agreements:

1. A Grant Agreement between the State of Michigan, Department of Consumer & Industry Services, and Michigan Allied Poultry Industries, Inc., Grant No. PLA-03-32, titled: *Use of Poultry Litter as a Biomass Energy Feedstock*.
2. A Letter of Agreement between Frazier, Barnes & Associates, LLC, and West Michigan Co-Gen, LLC, dated February 3, 2003.

B. Problem Statement

The Western Michigan agricultural production region, consisting primarily of the counties of Ottawa, Allegan, Muskegon, Kent and Barry, has historically had one of the highest levels of livestock production in the state. Until a few years ago the livestock wastes produced in this region were utilized as a nutrient source for agricultural cropland producing grains, oilseeds, hay, horticulture plants, fruit and vegetables. The application rate of these livestock wastes on agricultural production acreage was not regulated until a few years ago.

Recent Federal and State EPA regulations have been put in place to regulate the amount of livestock waste that can be placed on agricultural cropland. Designated as regulations for Concentrated Animal Feeding Operations (CAFOs), these regulations have been designed to limit the amount of livestock waste nutrients that can be applied to the land. The amount is limited to what can be utilized by crop production in a certain period of time. One of the primary nutrients contained in livestock waste is phosphorous. This nutrient has a tendency to build up in the soils since crops cannot utilize it at the same rate as the other two primary nutrient sources, nitrogen and potassium. This has resulted in a situation where much of the cropland in Western Michigan contains such high phosphorous levels that EPA regulations are severely limiting the levels of livestock waste applications. This has caused many Western Michigan livestock producers to seek other methods of utilizing their livestock waste production.

Early in 2002, a group of Western Michigan poultry producers began investigating the feasibility of converting their livestock waste (poultry litter) into other value-added products. Products that seemed to hold some promise were **thermal energy** and **electrical energy**. Since these products would be produced from a renewable biomass source—poultry litter—the products could be in more demand than thermal and electrical energy produced from traditional non-renewable sources, i.e. fossil fuels.

In the summer of 2002, seven Western Michigan poultry producers formed a company called West Michigan Co-Gen, LLC (WMC). Its purpose was to provide a sufficient volume of poultry litter to justify a poultry litter-to-energy conversion facility. Since this group was interested in both renewable thermal and electrical energy products that could be simultaneously produced from a single biomass conversion facility, they incorporated the term *co-generation* into their group's name. To begin the commercialization process for such a biomass conversion facility, a feasibility study was undertaken.

An outside agricultural processing consulting group, Frazier, Barnes and Associates (FBA) of Memphis, TN was engaged to assist in locating and sourcing public funds for a feasibility study for a Western Michigan Poultry Litter-to-Energy Conversion Facility. Public funding for the study was obtained in December of 2002 from the Michigan Biomass Energy Program, with matching funds provided by WMC members. FBA began working on the feasibility study based upon an agreement letter with WMC, executed in February of 2003.

A biomass conversion facility for poultry litter, and possibly other livestock wastes produced in Western Michigan, will have a positive effect on the other livestock waste producers in the region. Removal of a significant volume of livestock waste from cropland nutrient application will make the remaining volume of livestock waste become closer in balance with annual nutrient removal rates for the region and meet the compliance regulations of the emerging and developing CAFO Programs.

Another potential advantage the facility may have for WMC is a higher value market for their livestock waste products. This market will allow them to add more value to the products and provide sufficient returns for their investment in a poultry litter (biomass) conversion facility.

FBA has developed a comprehensive feasibility study plan to investigate all of the aspects of this project. This plan and study methodology is shown below in the feasibility study Scope of Work.

C. Study Scope of Work

The Scope of Work for the project includes the following deliverables:

1. <u>Regional Biomass Feedstock Analysis</u>
   The primary feedstock procurement region will be within a distance of 25 miles of the optimal site location. A secondary procurement region extending from a 25-mile radius to a 50-mile radius of the optimal site location will also be examined. The primary biomass feedstock, poultry litter, and other regionally available alternative biomass feedstocks (i.e. municipal waste, agricultural crop residues, other livestock waste) will be considered according to the following selection criteria:

   Biomass Feedstock Selection
   1. Current and future availability and risk (seasonality).
   2. Competing uses (including other biomass conversion facilities).
   3. Current and future cost (at source of feedstock).
   4. Handling and transportation cost from source location to biomass conversion site.
   5. Processability (i.e. density, handling characteristics, BTU content, moisture content, ash content, etc.).

   Location Analysis for Biomass Conversion Facility
   1. Determination of the optimal site location.

2. <u>Biomass Conversion Technology Review</u>
   A comparison of four biomass conversion technologies will be provided. The biomass conversion technologies to be considered are: direct combustion, gasification, fast pyrolysis, and anaerobic digestion. These are the only commercializable technologies considered available for a biomass conversion site. For each technology the following assessments will be made:

   1. Capital costs for the biomass conversion facility.
   2. Operating costs for the biomass conversion facility.
   3. Process steam and electrical power yields per unit of biomass feedstock and/or methane yield.
   4. Environmental impact of the biomass conversion facility.
   5. Economy of scale analysis (two facility sizes for each technology will be analyzed).
   6. By-product disposal/marketing costs.
   7. Reduction in poultry litter transportation and application costs associated with reduced volumes of nutrients resulting from the biomass conversion technology.
   8. Feedstock flexibility - ability to process multiple types of biomass feedstock.
   9. Site requirements:
      - Proximity to existing biomass feedstock(s)
      - Utility requirements
      - Utilization of existing available infrastructure
      - Size of construction site
      - Proximity to end-users of industry
   10. Capability of technology to separate Biomass Conversion and Energy Production Process steps for:
      - Direct Combustion

- Gasification
- Fast Pyrolysis
- Anaerobic Digestion

3. Product Marketing
   The two primary products produced, **renewable process steam** and **renewable electrical power**, will be analyzed for the following:

   1. Value of process steam to the potential regional process steam hosts, including the Zeeland Farm Soya Soybean Processing Plant.
   2. Availability of nearby process steam markets (within one mile of steam generation and electrical generation facility).
   3. Markets for "green" renewable electrical power:
      a. Zeeland Board of Public Works
      b. Consumer's Energy Company
      c. Regional rural electrical cooperatives
      d. Other electrical generating and distribution companies that can be reached through the electrical transmission grid
      e. Other nearby industrial electrical users
   4. Value of "green" power into these markets:
      a. Current value
      b. Long-term supply contract terms
   5. Federal or state government tax credits or production incentives that would improve the value of the process steam or "green" electrical power marketed.
   6. Markets for other smaller volume by-products.

4. Biomass Conversion Project Financial Analysis
   Pro forma financial projections will be provided for each of the best conversion technologies examined. These pro forma projections will contain:
   1. Feedstock requirements and delivered costs.
   2. Conversion facility operating costs (two sizes for each technology).
   3. Capital costs (including start-up—two sizes for each technology).
   4. Steam and electrical product values/markets.
   5. Return on Investment analysis.

5. Written Report and Presentation to WMC Project Stakeholders

6. Recommendation for Commercialization of Biomass Conversion Project
   1. Discussion of project commercialization steps.
   2. Recommended conversion technology and facility size.
   3. Recommended alternative feedstock.

7. Project Information Dissemination
   The findings of the feasibility study for poultry litter will be disseminated by FBA to potentially interested organizations in the following ways:
   1. FBA staff members will make an interim feasibility study presentation to the Michigan Allied Poultry Industries at their annual meeting in Ravenna,

Michigan on February 20, 2003. Also a final feasibility study presentation will be made at their July, 2003 summer meeting.

2. Project Update Press Releases will be developed by the FBA staff for display on the Michigan State University Agricultural Extension website. These updates will be displayed in the Poultry-Area of Expertise Team section of the website.
3. Several articles regarding this project will be prepared by the FBA staff for inclusion in the Michigan Allied Poultry Industries monthly newsletter. There are about 300 members of this organization that produce, process or supply the Michigan Poultry Industry.
4. Project Press Releases will be provided by FBA staff to Jan Wolford of the Michigan Department of Agriculture. Mr. Wolford is the coordinator of the Michigan Environmental Assurance Program that administers livestock waste management programs.

8. Renewable "Green" Electrical Power Credits
The potential of receiving and redistributing "green" electrical power credits for utilization of poultry litter and other renewable biomass feedstocks, i.e. municipal solid wastes, will be examined.

9. Further Processing of Biomass Conversion By-Products
The by-products generated from each biomass conversion technology could be further processed into higher value by-products. The feasibility of additional by-products processing will be examined.

10. Environmental Impact of Biomass Conversion
The environmental impact of each biomass conversion technology will be examined. The cost of environmental compliance will be included in this examination.

D. Project Milestones

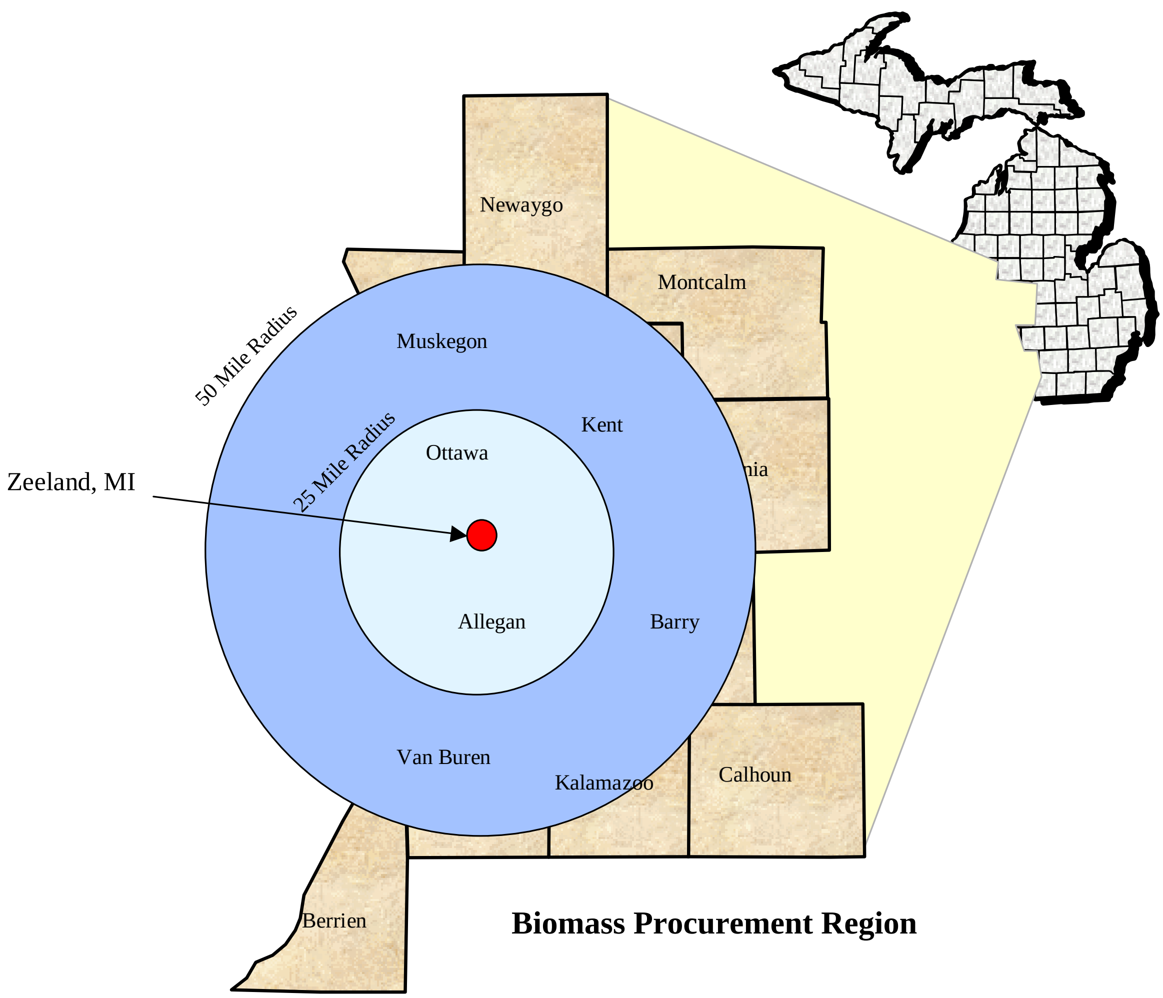
Milestone	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Project Start Date	2/23										
First Quarterly Progress Report Submittal		3/31									
WMC First Quarterly Report Presentation			4/29								
Second Quarterly Progress Report Submittal					6/24						
WMC Second Quarterly Report Presentation							8/8				
Third Quarterly Progress Report Submittal								9/30			
Completed Feasibility Submittal										2nd Half	
Final WMC Presentation											2nd Half
Projected Feasibility Study Approval by WMC & MBEP											2nd Half

II. Regional Biomass Feedstock Analysis

A. Biomass Procurement Region

Research for the Biomass Feedstock Analysis assumes that the primary biomass procurement territory will be located within 25 miles of Zeeland, Michigan, with a secondary procurement territory from 25 miles to 50 miles of Zeeland, as shown below.

The counties within the 25-mile radius procurement territory include Ottawa, Allegan and the southwestern quarter of Kent. The counties within the 50-mile radius of Zeeland include Muskegon, Kent, Barry, half of Kalamazoo and Van Buren, as well as a small portion of Newaygo, Ionia, and Berrien counties.



Biomass Procurement Region

B. Biomass Availability

The analytical process for determining the quantities of available biomass feedstocks was as follows. After selecting the counties that make up the study region, industry sources and producers were contacted. Available inventory of animals, population, and crop acreages in each county was determined and an appropriate mathematical factor calculated. This factor was used to tabulate the annual generation of waste in tonnage for each category.

WMC producer members were requested to complete a Feedstock Commitment Survey to determine the quantity of waste each would commit for this project, and in what form that waste would be. A copy of the letter and survey are included in the Addenda of this report. WMC Members committed to 42,500 tons of poultry litter, and 4,000 tons of other waste to the project, as shown below:

	Livestock Type	Feedstock Commitment
Member 1	Poultry	10,000 Tons
Member 2	Poultry	15,000 Tons
Member 3	Poultry	17,500 Tons
Total Poultry Waste Feedstock Commitment:		42,500 Tons
Member 4	Dairy	4,000 Tons
Total Other Feedstock Commitment:		4,000 Tons

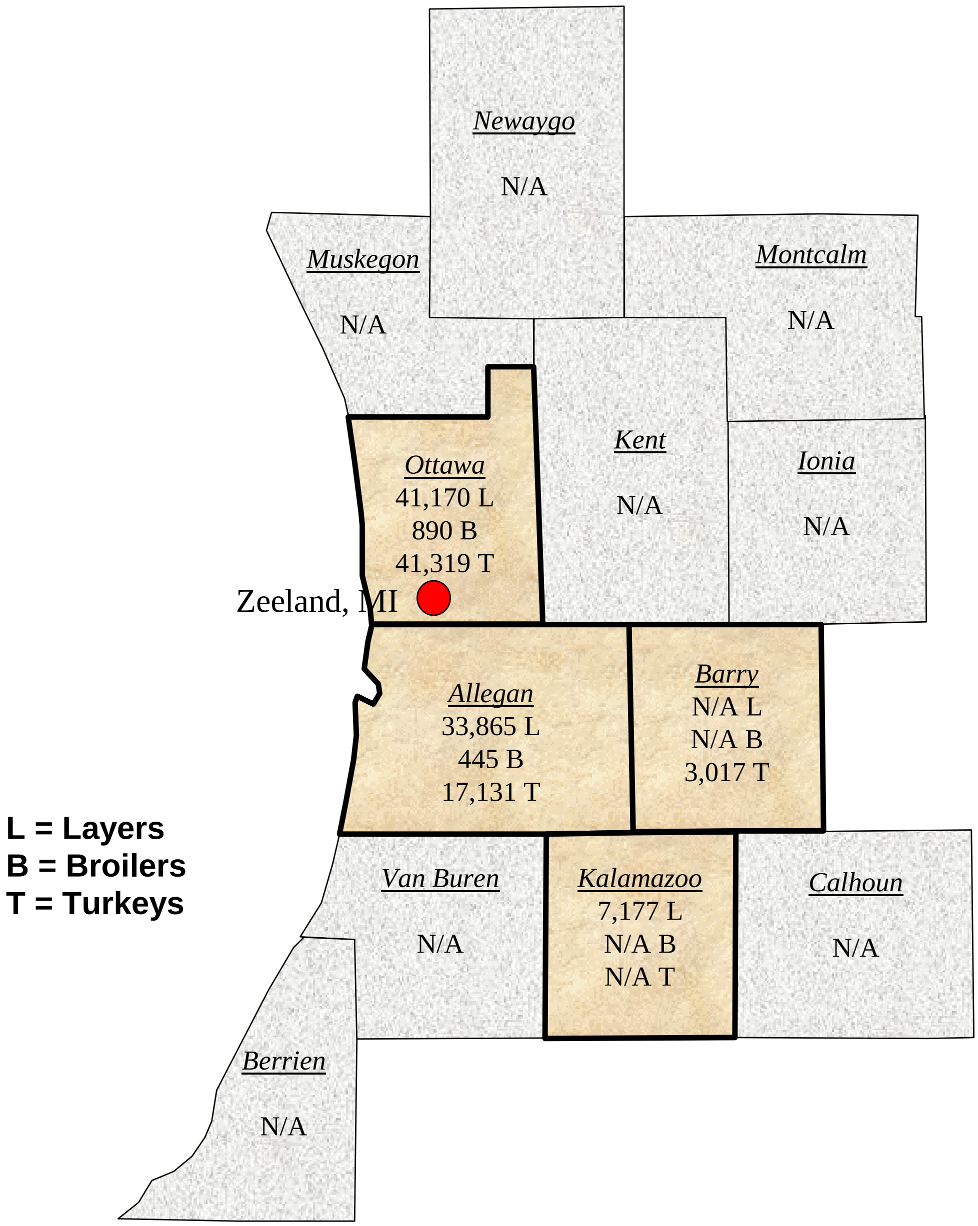
1. Primary Feedstocks:
The primary feedstocks for the biomass to energy project are poultry waste, a general term that includes **turkey litter, broiler litter,** and **layer waste**. Turkey and Broiler Litter is a combination of feces, urine, and bedding material; Layer Waste has not been supplemented with bedding material and is otherwise composed of feces and urine, and possibly silica or other elements.

Poultry waste feedstock quantities were calculated using the following method. The USDA provided statistical data on the inventory of turkeys and layers in the counties of the study region, while non-Member producers who were surveyed provided data on available broilers. Turkeys were assumed to have a maturity of 130 days per year, broilers 45 days per year, and layers 365 days per year. Using a stockpiled litter accumulation of 0.210 pounds per day for turkeys, a stockpiled litter accumulation of 0.040 pounds per day for broilers, and a surface-scraped value of 0.135 pounds per day for layers, and multiplying this value by the maturity gives an annual waste accumulation in pounds. These values were then converted to tons.

Poultry	Maturity	Accumulation		Annual Tons/Bird
		Daily	Annual	
Turkeys	130 days	0.210 lbs/day	27.3 lbs/year	0.01365 tons
Broilers	45 days	0.040 lbs/day	1.8 lbs/year	0.0009 tons
Layers	365 days	0.135 lbs/day	49.275 lbs/year	0.02464 tons

The following map shows available poultry waste in the study region, estimated at about 145,000 tons per year and all concentrated in the four counties of Ottawa, Allegan, Barry, and Kalamazoo. Over 50% of available poultry waste is in Ottawa County. Of the available wastes the largest percentage for biomass conversion is expected to come from turkey litter. **T** indicates turkey litter; **B** indicates broiler litter, **L** indicates layer waste; and **N/A** indicates no or little amount of Primary Feedstock is available in that county.

Poultry Waste Availability (Tons/Year)



2. Secondary Feedstocks:
Potential secondary feedstocks include **Livestock Waste** (non-poultry; i.e. Swine, Dairy, Horse waste), **Processing Waste** (Fruit & Vegetable Processing, Wood Processing), **Municipal Waste** (Municipal Sludge, Municipal Solid Waste), and **Foundry Sand**.

Secondary feedstocks will be used to supplement Primary Feedstocks if there is insufficient availability. Research was done to determine the compatibility and other problems that may arise when mixing Primary and Secondary biomass feedstocks.

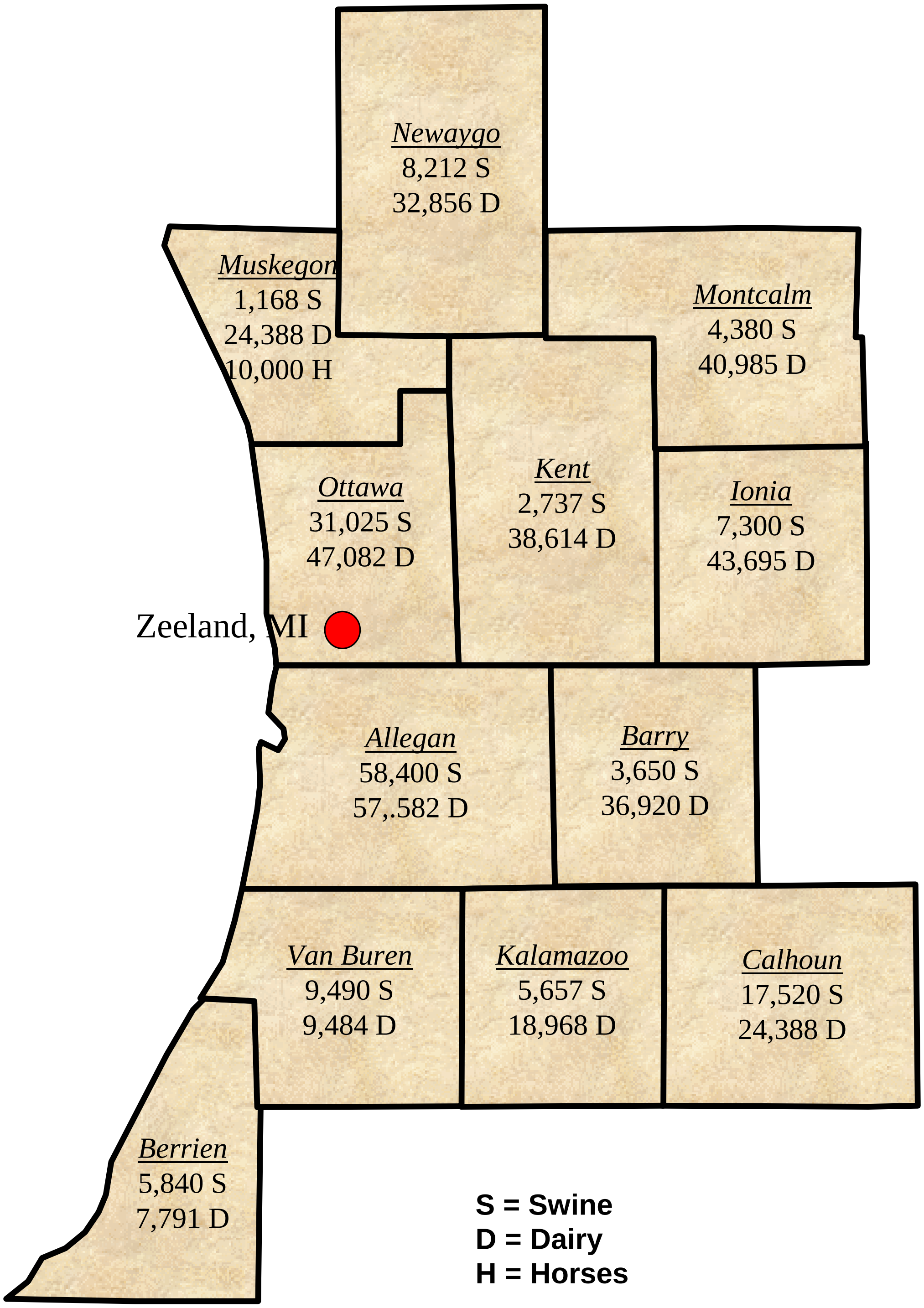
Livestock Wastes – Swine waste is fresh swine manure, including feces and urine, and is therefore very high in moisture. Dairy and Horse waste is also high in moisture, but is assumed to consist of some bedding material. Due to their relatively high moisture contents Livestock Wastes will require drying prior to mixing to make them compatible with other feedstocks with lower moistures. Therefore the available tonnage of swine, dairy and horse waste for use at the biomass conversion facility assumes using the solids only.

Livestock wastes were determined using the following calculation method. The USDA provided data on the total inventory of swine and dairy cattle in the study region. Swine waste consists of approximately 13% total solids by mass; assuming that an average animal weighing 135 pounds produces 11.1 pounds of liquid waste per day, then on a dry matter basis about 2 pounds per day of swine waste is generated. Dairy waste is about 14% total solid by mass and generates about 122.3 pounds of total manure for a 1,400 pound dairy cow; on a dry matter basis each cow produces about 18.56 pounds of solids per day. Daily waste accumulation was multiplied by the total number of animals in each county and converted to tons per year. One of the WMC Members, a horse farmer, provided data on annual horse manure tonnage in Muskegon County.

Livestock	Days Per Year	Accumulation		Annual Tons
		Daily	Annual	
Swine (fresh)	365 days	11.1 lbs/day	4,050 lbs/year	2.026 tons (fresh)
Swine (dry)	365 days	2.0 lbs/day	730 lbs/year	0.365 tons (dry)
Dairy (fresh)	365 days	122.3 lbs/day	44,640 lbs/year	22.32 tons (fresh)
Dairy (dry)	365 days	18.56 lbs/day	6,774 lbs/year	3.387 tons (dry)

The following map indicates the annual accumulation of Livestock Waste *on a dry matter basis* (tons per year). **S** indicates Swine Waste, **D** indicates Dairy Waste, **H** indicates Horse Manure.

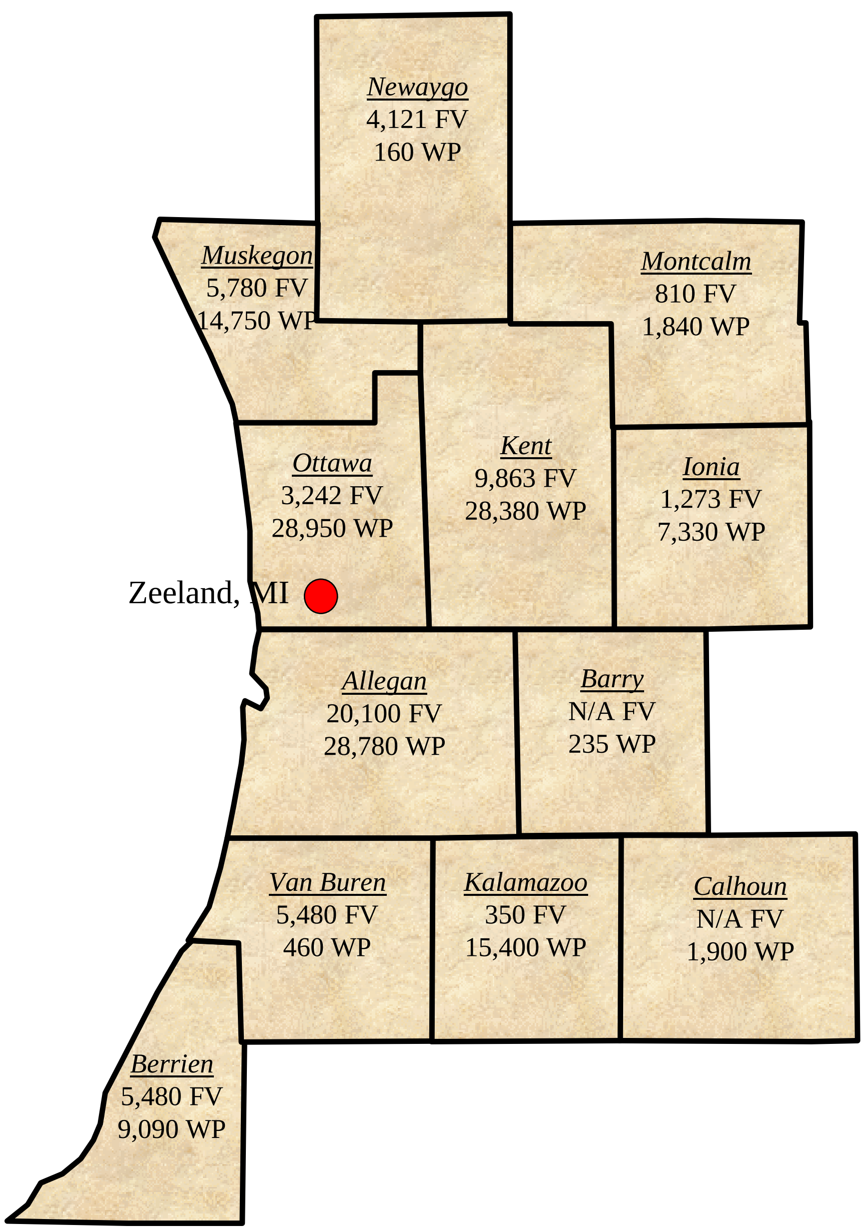
Livestock Waste Availability (Tons/Year)
On a Dry Matter Basis



Processing Wastes – Data on fruit and vegetable processing wastes came from a variety of sources, including the USDA, Missouri Agricultural Statistics, and Michigan State University. Fruit and vegetable waste consists of culls, pulp, purees, and other by-products resulting from their processing. Total tons of fruit and vegetable waste produced was estimated using a processing cull rate of 15%. Wood processing wastes include sawdust, chips, pallets, and mixed paper. Data on wood processing waste came directly from the Michigan Department of Natural Resources. In some cases the available data only showed volumes of waste produced; in such instances an average density of 23.5 lb/ft^3 was used to determine the total tonnage for wood processing waste. These totals do not include woods that are considered contaminated with various chemicals.

The map below indicates the annual tonnage of available processing wastes. **FV** indicates Fruit & Vegetable Processing Waste, **WP** indicates Wood Processing Waste.

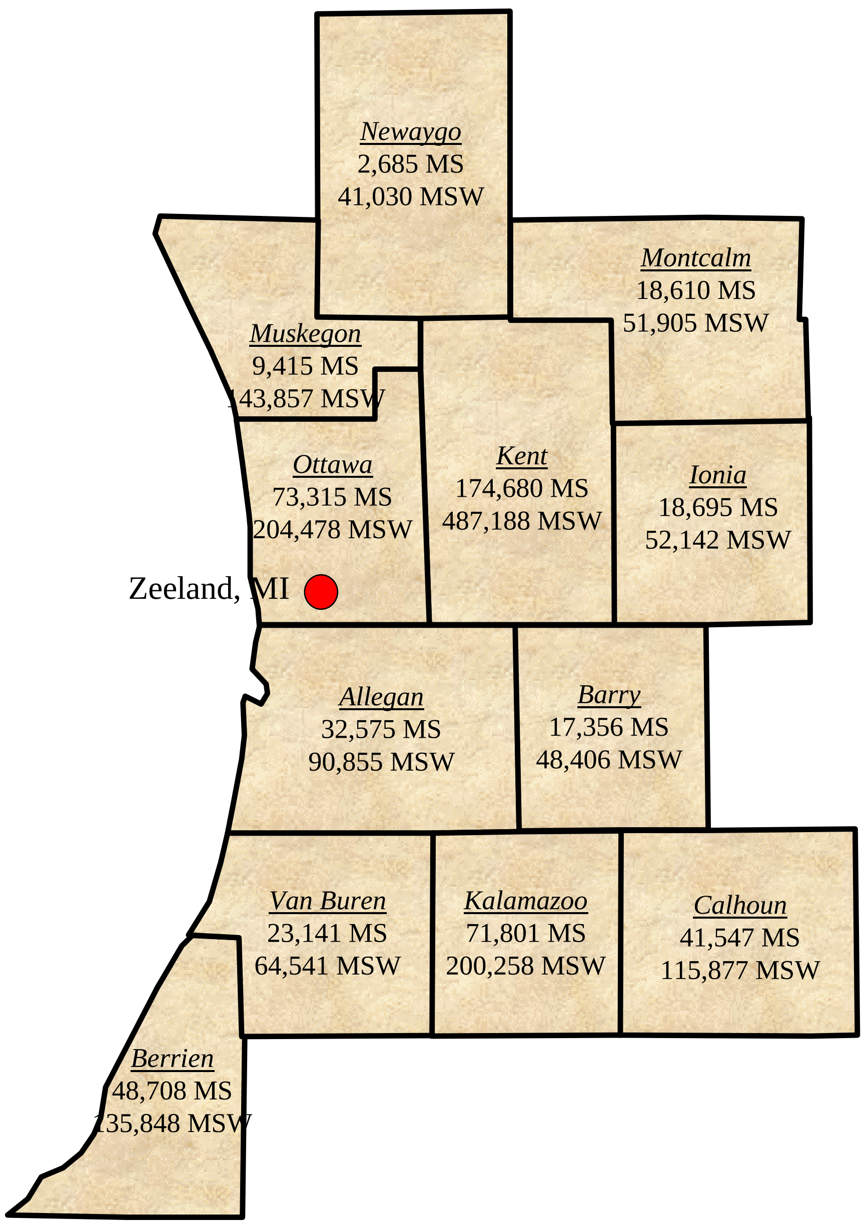
Processing Waste Availability (Tons/Year)



Municipal Wastes – Tonnage was developed using 0.30 pounds of waste per person per day for municipal sludge. Municipal Solid Waste was developed using 4.6 pounds of waste per person per day, confirmed by industry sources at The Michigan Department of Environmental Quality. Both Municipal Sludge and Municipal Solid Wastes constitute a relatively greater quantity than other Secondary Feedstocks; however, these Secondary Feedstocks have potential environmental issues, including safety concerns due to the possible contamination by heavy metals, and the exclusion of municipal sludge fertilizers for use in the production of organically certified agricultural crops.

The map below shows the total available quantities of Municipal Wastes in the study region (tons per year). **MS** indicates Municipal Sludge, and **MSW** indicates Municipal Solid Waste.

Municipal Waste Availability (Tons/Year)



Foundry Sand – One of the deliverables of the feasibility report was to determine the viability of utilizing Foundry Sand as a feedstock. However, a thorough analysis has determined that foundry sand is to be considered an additive, not a feedstock. Its only viable use for this project would be as a *bed media* for direct fire or gasification energy conversion technologies.

Foundry Sand is defined as the high quality sand typically used in the molding and casting industry. There are two main types of foundry sand: Green Sand, and Chemically Bonded Sand. *Green Sand* is used in 90% of casting processes and is high quality silica with clay used as a binder, a carbon additive to improve a casting surface finish, and 2% to 5% water. *Chemically Bonded Sand* is used where high strengths are necessary to withstand the heat of molten metal in mold making.

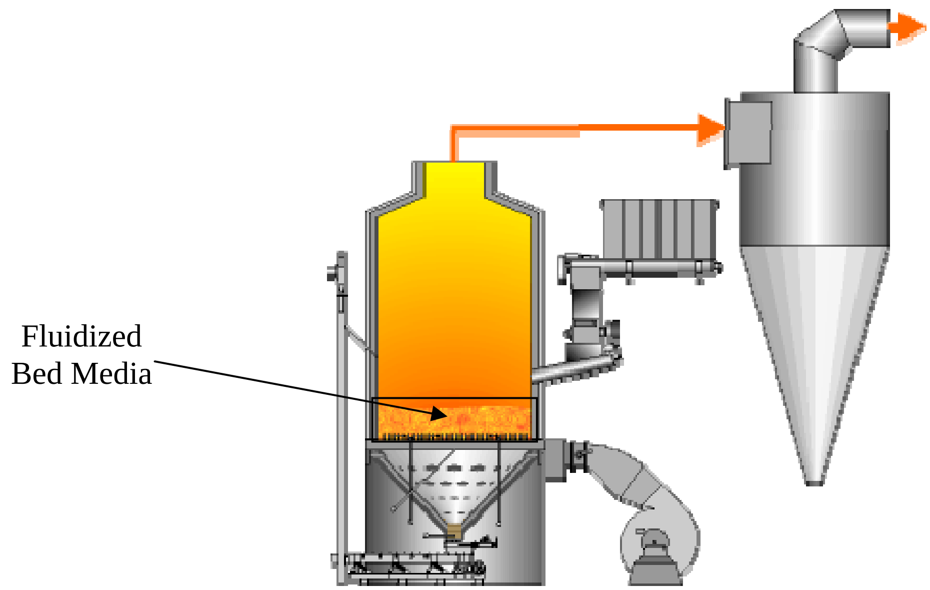
After foundry sand is used in industrial processes it is considered “spent”, and is coated with a film of carbon or residual binders (such as resins, clays) and dust. Spent foundry sand is typically recycled (to be used again in a foundry) or sent to a landfill. Spent foundry sand contains impurities, such as metals from the casting process, phenols which are formed during high temperatures, or even heavy metals generated from non-ferrous foundries, such as cadmium, lead, copper, nickel, and zinc. There are reports that some foundry sands are even corrosive to metals.

Foundries are seeking ways to decrease their operating costs by the recycling of foundry sand. One possible scenario is for a foundry to allow a third-party user to take away the spent foundry sand, recycle the spent sand at the third-party plant to remove the binders, and then sell the recycled sand back to the foundry. There are thermal reclamation systems that do just that, selling the recycled sand back to the foundry at a cost less than the purchase of new sand.

Theoretically, spent foundry sand may contain sufficient binder to be used as a potential source of energy. The energy content of foundry sand has been estimated at 1000 to 2500 Btu/lb., insufficient energy to make it suitable for use as a feedstock in an energy conversion system. Thermal reclamation systems heat spent foundry sand to combust the binder residues during the recycling process, but these systems require additional energy (natural gas) to combust the foundry sand; it is not a feedstock.

There is a potential revenue stream when foundry sand is used as a bed media. Bed media in a fluidized bed system (which can be used in direct fire or gasification technologies) is a quantity of sand or char heated to high temperatures (c.1500ºF). Air is pumped from underneath through the heated sand, and the feedstock is air-blown above or into the heated bed media. The bed media assists the combustion of the feedstock and airflow carries out the hot gases.

According to vendor contacts it may be possible to replace the standard light sand bed media with foundry sand, combust the feedstock and simultaneously burn off the binders on the sand and recycling the sand for sale back to foundries. The ash resulting from the combustion can be bagged and sold as fertilizer. However, details on this process are lacking. If the foundry sand is too fine compared to regular bed media sand it would be carried out with the flue gas and decrease the value of the fertilizer by-product. It is unknown at what rate foundry sand could be recycled in this manner; and it is also unknown what potential contaminants would remain in the ash fertilizer; i.e. how thorough the binders would be burned off. The determination of these details would require extensive pilot tests, according to Energy Products of Idaho.



Example of Fluidized Bed Gasifier System
(Source: www.energyproducts.com)

Clearly the highest and best use of spent foundry sand is as a recycled by-product. It has no use as an energy-based feedstock given the current technologies available for biomass energy conversion. Therefore, Foundry Sand is considered an additive and not a feedstock.

See Section V.B., Page 57, for an analysis of the value of foundry sand as a bed media replacement.

3. Summary of Feedstock Supplies:

The following two grids summarize all the available feedstocks in the Study Region.

Primary Feedstocks (In Tons per Year)				
County	**Turkey**	**Broiler**	**Layer**	**Total**
Newaygo	---	---	---	---
Muskegon	---	---	---	---
Montcalm	---	---	---	---
Ottawa	41,170	890	41,319	83,379
Kent	---	---	---	---
Ionia	---	---	---	---
Allegan	33,865	445	17,131	51,441
Barry	---	---	3,017	3,017
Van Buren	---	---	---	---
Kalamazoo	7,177	---	---	7,177
Calhoun	---	---	---	---
Berrien	---	---	---	---
Totals	**82,212**	**1,335**	**61,467**	**145,014**

Secondary Feedstocks (In Tons per Year)				
County	**Other Livestock**	**Processing Waste**	**Municipal Waste**	**Total**
Newaygo	41,068	4,391	43,715	89,174
Muskegon	35,556	20,658	153,272	209,486
Montcalm	45,365	2,660	70,515	118,540
Ottawa	78,107	32,290	277,793	388,190
Kent	41,351	38,427	661,868	741,646
Ionia	50,995	8,605	70,837	130,437
Allegan	115,982	49,175	123,430	288,587
Barry	40,570	235	65,762	106,567
Van Buren	18,974	14,204	87,682	120,860
Kalamazoo	24,625	16,452	272,059	313,136
Calhoun	41,908	1,900	157,424	201,232
Berrien	13,631	25,288	184,556	223,475
Totals	**548,132**	**214,285**	**2,168,913**	**2,931,330**

C. Current & Future Cost of Turkey Litter

Given the value of turkey litter as fertilizer, markets are currently available for the biomass with no downstream product liability. However, with the current wording of the CAFO regulations, product liability would remain with the generator of the turkey litter. Thus, the generator will eventually be responsible for ensuring that the litter is land-applied according to an approved waste management program. This is certain to raise the cost of the litter to the customer. It is projected that the turkey litter cost could increase by $2 to $5 per ton in order to comply with CAFO regulations. The result could be that the biomass generator may not be willing to assume the product liability risk or the customer may not be willing to pay the increased cost.

It should be noted that there are several lawsuits recently filed in federal court against the EPA's final rule on CAFO. At issue is an attempt by environmental groups seeking to reinstate regulations dealing with co-permitting requirements and groundwater monitoring. According to a March 17, 2003 article in *Feedstuffs Magazine*, the National Turkey Federation had convinced the EPA to drop such items from the EPA's final rule.

D. Handling & Transportation Cost

Given the fertilizer value of turkey litter it can be sold and transported to area customers for a fee. One producer stores litter on an asphalt pad and charges a fixed fee per load plus mileage. For example, the litter can be hauled to a customer's site for $150 per truckload (approximately $6/ton), plus $1.25 per loaded mile. Thus for a 100-mile run the truckload would cost $275 delivered ($150 + $125). For this size truck the litter would cost $9 to $11 per ton, delivered.

Turkey litter can be analyzed for nitrogen, phosphorous, and potassium, and the nutrient value ascertained. This value is in the range of $28 per ton. If the delivered cost is $10 per ton and the cost to load and spread is $5 to $10 per ton then the customer comes out ahead using turkey litter for its fertilizer value rather than purchasing commercial fertilizer.

E. Biomass Composition & Characteristics

Overview:

The key characteristics of biomass are:

- Biomass is renewable.
- Biomass is created by solar energy stimulating chemical reactions, which combine carbon with other elements, including water.
- Biomass is 100% natural.
- Biomass is carbon neutral—it adds no new carbon to the atmosphere, merely recycling the existing carbon.
- Emissions from the combustion of biomass are cleaner than emissions from chemical or fossil fuels.

The composition of each type of biomass varies widely due to several factors such as its moisture content and its original source. The data that is presented in this report should be viewed as averages.

Turkey Litter:
Three turkey litter samples were requested from each member of West Michigan Co-Gen. All samples that were submitted were sent to Woodson-Tenent Laboratories, Inc. in Des Moines, Iowa for analysis. The lab analyzed the samples for energy content using a bomb calorimeter, moisture content by use of a forced draft oven, and ash content. The laboratory results were averaged for those farms that submitted samples and are summarized in the following table.

Sample Group	Avg. Btu/lb.	Avg. Moisture	Avg. Ash Content
Farm 1	3,656	30.74%	23.9%
Farm 2	4,677	30.09%	14.5%
Farm 3	4,156	39.40%	13.5%

These samples indicate a range in energy content from 3,656 Btu/lb. to 4,677 Btu/lb., with a median of 4,166 Btu/lb. Moisture content ranged from 30.09% to 39.40%, with a median of 34.75%. Ash content ranged from 13.5% to 23.9%, with a median of 18.7%.

Turkey litter contains nitrogen, ammonium, phosphorus, and potassium as shown below. These quantities vary with feed ration, the manure handling system, and other factors and should be considered averages.

Nutrient Composition of Turkey Litter			
Nitrogen	Ammonium	Phosphorous	Potassium
36 Lb/Ton	8 Lb/Ton	72 Lb/Ton	33 Lb/Ton

Additional elemental analysis of the ash content of turkey litter is as follows:

Elements	Brooder	Grower
Ash	99.06%	99.10%
Phosphorus	5.9%	6.2%
Potassium	2.2%	1.8%
Calcium	7.3%	7.9%
Magnesium	2.4%	2.1%
Sodium	1.7%	2.0%
Zinc	0.25%	0.21%
Manganese	0.24%	0.22%
Aluminum	0.22%	0.18%
Iron	0.39%	0.37%
Total of Elements	20.6%	20.98%

The ash also contains numerous additional elements (20) in levels from 275 ppm to as low as 1.3 ppm.

According to ATTRA, an agriculture information service funded by the USDA, §205.602(a) of the National Organic Standard specifically prohibits the use of ash from manure burning in organic production. In other words, this standard prohibits the labeling of turkey litter ash as “organic” fertilizer, making the value of turkey litter ash comparable to and competing with commercial fertilizers.

Quantifying the elemental analysis of turkey litter ash is complicated by the technology used to convert the litter to the ash, since the method used to convert the litter to ash will change the final composition of that ash. Determining the actual N-P-K ratio of turkey litter ash requires trial tests under controlled conditions. The samples of fertilizer ash should be tested as applied to soil; however, such tests are beyond the scope of this study.

A preliminary estimate of the N-P-K can be determined by analyzing the typical characteristics of turkey litter. Assuming that all Nitrogen (N) has been reacted with (i.e., Nitrogen content in ash is zero), this leaves only the Phosphorus (P) and Potassium (K) to be calculated. Data on the Total Volatile Solids, Phosphorus (as P_2O_5), and Potassium (as K_2O) of Whole Turkey Litter is shown below. This research was supplied by the Agronomic Division of North Carolina University:

Parameter	**No. of Trials**	**Mean**
Total Volatile Solids (dry basis)	2	73%
P_2O_5	537	70 Lb/Ton
K_2O	548	41 Lb/Ton

The first step is to estimate the quantity of litter remaining after the Volatile Solids are consumed. This is the total amount of unreacted elements left (the ash content):

$$2000 \text{ Lb.} - \left(2000 \text{ Lb.} \times \%\,\text{Volatile Solids}\right) = \text{Ash Remaining}$$

Parameter	**Mean**
Total Volatile Solids (on dry basis)	73%
Quantity Remaining (Total Ash)	540 Lb.

The final calculation is dividing the quantity of Phosphorus or Potassium by the Ash Content (since the total quantity of P or K will not change during reaction).

$$\text{P/K Content} \div \text{Ash Content} = \text{P/K \%}$$

Thus,

Parameter	Mean
N-Content of Ash	0%
P_2O_5	70 Lb
Ash Quantity	540 Lb.
P-Content of Ash	13%
K_2O	41 Lb/Ton
Ash Quantity	540 Lb.
K-Content of Ash	8%

These calculations give an estimated N-P-K ratio for turkey litter ash of **0-13-8**.

Again, the above calculations should only be viewed as estimates. Trial tests by consuming the turkey litter through different technologies are required to establish more concrete values.

Horse Manure:
One member of West Michigan Co-Gen submitted a horse manure sample for analysis. The sample was sent to Woodson-Tenent Laboratories, Inc. in Des Moines, Iowa and underwent the same analysis as the turkey litter. The results are summarized below:

Manure Sample	Btu/lb.	Moisture	Ash Content
Farm 4	2,158	75.75%	2.83%

Cow Manure:
One member of West Michigan Co-Gen submitted a cow manure sample for analysis. The sample was sent to Woodson-Tenent Laboratories, Inc. in Des Moines, Iowa and underwent the same analysis as the turkey litter. The results are summarized below:

Manure Sample	Btu/lb.	Moisture	Ash Content
Farm 5	3,478	57.24%	3.20%

A summary of biomass characteristics for the Primary Feedstocks and the Secondary Feedstocks is shown below.

Biomass	Bulk Density	Energy Content (Btu/lb.)		Ash	Moisture Content	
		AR*	Dry Basis		AR*	Dry Basis
Primary Feedstocks						
Turkey Litter (Starter)	24.5 lb/ft^3	4,000	5,000	7.4%	30.0%	17.0%
Turkey Litter (Grower)	31.0 lb/ft^3	3,500	5,000	19.2%	44.5%	24.5%
Broiler Litter	29.5 lb/ft^3	4,500	5,700	16%	27.3%	26.5%

Layer Litter	46.7 lb/ft^3	4,700	6,400	17%	32.2%	19.3%
Secondary Feedstocks						
Municipal Sludge	59.3 lb/ft^3	7,500	5,000	40%	75%	N/A
Municipal Solid Waste	20.5 lb/ft^3	3,000	4,700	20%	55%	31%
Processed Wood Waste	23.5 lb/ft^3	2,000	7,500	1%	50%	27.6%
Fruit & Vegetable Waste	22.4 lb/ft^3	490	2,300	5%	75%	50.0%
Swine Waste	62.0 lb/ft^3	470	6,500	18%	92%	12.7%
Dairy Waste	50.5 lb/ft^3	1,200	3,800	18.5%	70.3%	12.8%
Foundry Sand	92 to 160 lb/ft^3	1,000 to 2,500**		N/A	10.1%	0.1%

* As-Received
** Estimate based on the energy value of residual binders only.

The significance of these values is as follows:

- Higher bulk densities are advantageous since this equates to a higher weight being loaded on a truck, thus reducing the transportation cost per ton.
- Higher energy content per pound is advantageous in that a smaller amount of biomass is needed to generate the energy required for the conversion system.
- Lower ash content equates to less by-product to handle, store and dispose.
- Lower moisture content makes the conversion system more efficient since less energy is needed to evaporate the water.

The ash quantity and quality is particularly important since ash will essentially be a by-product of any combustion process. As a by-product, it could be that **the value of the ash as fertilizer** would be an important component of the economics of the co-generation facility. The consistency of the ash analysis would be a function of the consistency of the feed to the animal and how the biomass is stored.

It is important to note that the mixture of Primary and Secondary Feedstocks would vary the composition of the fuel to the conversion process and therefore cause a variation in the composition and the quantity of the ash by-product. As such, the use of Secondary Feedstocks would need to be carefully scheduled in order to provide both a consistent quality feedstock and a consistent quality ash by-product.

Storability:
Utilizing biomass to generate electricity creates problems unique to that fuel source. Since the biomass is typically a by-product of the CAFO, the amount of waste generated and the rate at which it is generated is of limited control. In other words, the waste stream, once contracted for, has to be utilized since the animals from which the fuel originates cannot be fed more or less in order to control the volume of fuel. Therefore, the storability of the biomass is an important issue.

Since an increase in a feedstock's moisture content lowers its energy value, the feedstock should be stored in dry containers. This also helps prevent runoff and other environmental problems.

Feedstock Availability and Commitment:
Based on the results of a survey of WMC members, approximately 42,500 tons of primary feedstock and 4,000 tons of secondary feedstock (cow manure) have been committed to the project. Should the project move forward, the final level of feedstock available for the plant may increase, decrease or stay the same.

Secondary Feedstock Option:
Supplementing a Primary Feedstock with a Secondary Feedstock, such as wood chips, must be considered carefully. Secondary Feedstocks are plentiful in supply but often their moisture, ash and energy contents differ significantly from the Primary Feedstocks. If moisture is too high then the Secondary Feedstock must be dried, requiring additional cost. Another issue is whether the Primary and Secondary feedstocks are compatible. The processing of a feedstock mixture may generate undesired contaminants, require monitoring for environmental problems, or require special equipment designed with the feedstock mixture in mind, all potential sources of increased capital and operating costs. An ideal Secondary Feedstock would be of similar bulk density, ash content and composition; have similar energy and moisture content; be available year-round like poultry waste; have the same transportation and storage method; and allow an environmentally acceptable by-product.

Additional Sources of Primary Feedstock:
A second option to consider is seeking additional sources of Primary Feedstock. FBA obtained a list of 68 producers in the region from the University of Michigan Ag Extension office and mailed a Poultry Litter and Layer Waste Survey to those producers in the study region who are not members of WMC (a copy of this survey is in the Addenda). The purpose of the survey was to determine what the producers' level of interest is in this project, and what types and quantities of feedstocks they might commit to should their participation be requested.

Attempts were made to contact the producers on the list, initially by mail and later by phone. In some cases the producers had no listed phone number; in others phone messages were left but the producers did not respond. Of the 68 producers who were contacted by mail or phone, 29 responded. A summary review of the producer responses is shown below:

- Seven of the respondents are either no longer in the farming business or do not have poultry.
- Of those producers who responded, they have approximately 475,000 turkeys, 5,665,000 layers, 1,680,000 pullets, and 1,500,000 broilers.
- A third would expect a payment for picking up their litter waste from $2 to $25 per ton; and one-third would expect no payment; the rest did not answer this question.
- The average waste removal and storage costs ranged from $2 to $25 per ton ($5,000 to $10,000 per year).
- Transportation costs for removal of waste averaged about $2 per loaded mile.

F. Location Analysis for Biomass Conversion Facility

In searching for a potential site for the biomass conversion plant the following criteria were considered:

- Minimum 25,000 lb./hr steam demand (24 hours per day, 7 days per week);
- Feedstock proximity;
- Public acceptance;
- Co-Product Market Proximity;
- Host Acceptance; and,
- Thermal Power Load Factor.

The search for a potential site yielded the following five possible locations.

A discussion of each potential site follows.

Location #1: Zeeland Farm Soya – Zeeland, Michigan

Zeeland Farm Soya (ZFS) is a soybean processing plant that is located on the eastern edge of the town of Zeeland, Michigan. ZFS operates the plant on a twenty-four hour basis, seven days per week, 350 days a year. This results in a very high load factor for ZFS's thermal energy load and its electrical load.

ZFS has openly discussed the possibility of supplying its long-term thermal energy needs with landfill gas from the Autumn Hills Landfill. This would require the construction of a seven-mile long pipeline from the Autumn Hills Landfill to the ZFS property. It is FBA's understanding that ZFS is still negotiating a landfill gas supply agreement.

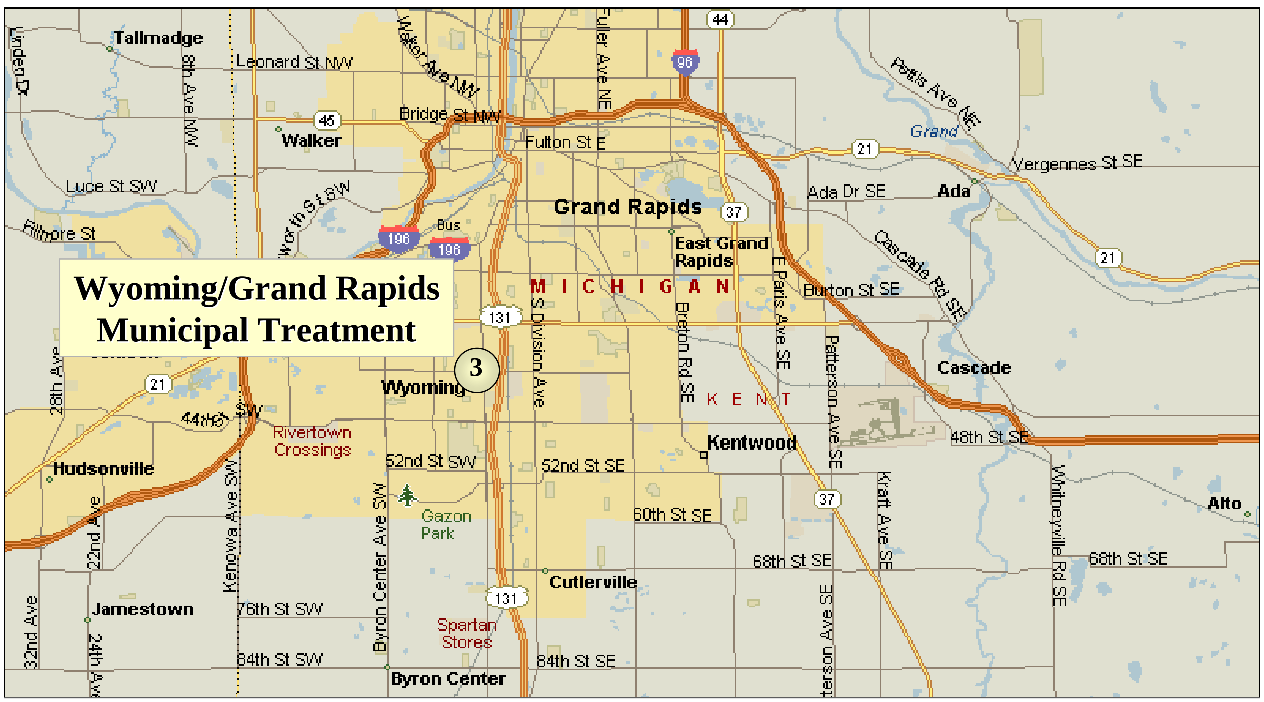
Location #2: Kruger Commodities – Hamilton, Michigan

Kruger Commodities operates a meat processing by-product rendering plant in western Allegan County. The plant is located near Hamilton, Michigan and normally operates on a two 8-hour shift/5 day per week basis. Kruger Commodities currently processes most of the by-products from the Michigan Turkey Producers processing plant located in Zeeland, Michigan, and also processes beef by-products from Packerland Foods. Kruger currently utilizes a natural gas-fired boiler to supply its thermal energy steam needs.

Location #3: Wyoming/Grand Rapids Municipal Treatment Plants – Wyoming, Michigan

The municipalities of Wyoming and Grand Rapids signed a Memorandum of Agreement on April 22nd, 2003 to develop a joint wastewater biosolids management facility. This facility would further process treated wastewater materials supplied from the Wyoming Clean Water Plant and the Grand Rapids wastewater plant into a high quality fertilizer and soil conditioner.

The wastewater biosolids management facility will require over 200,000 mmBTUs of thermal energy to dry the wet biosolid feedstock. An anaerobic digestion plant will be added as a portion of this project and will supply about 70% of the thermal energy requirement for the facility. In addition to this thermal energy requirement the electrical energy requirement for the facility will be about 0.3 Megawatts. The combined electrical demand for both Municipal Wastewater Facilities, 2.2 MW, could be supplied by the biomass conversion plant.



Location #4: Packerland Foods – Plainwell, Michigan

Packerland Foods is a beef processing plant located in Plainwell, Michigan. Packerland Foods was purchased by Smithfield Foods in 2001 and has expressed interest in cheaper supplies of thermal energy and electrical energy for the plant. The Packerland processing plant operates on a five or six day per week schedule and on a 24-hour basis.

As a further processor of Michigan produced livestock, Packerland is interested in assisting livestock producers in reducing the environmental issues associated with livestock production wastes.

Location #5: Autumn Hills Landfill – Southeast of Zeeland, Michigan

Waste Management Company operates a municipal landfill operation seven miles southeast of Zeeland, Michigan. This landfill is called the Autumn Hills landfill. Waste Management is currently working with Bob Evans of Lansing, Michigan to market the landfill gas produced at this site. Mr. Evans is working to construct a seven-mile landfill gas pipeline from the landfill site to the town of Zeeland, Michigan.

Mr. Evans has contacted Frazier, Barnes & Associates about locating the plant adjacent to the Autumn Hills Landfill and generating biogas. This biogas product could either be utilized to produce electrical power at the site or be transported to Zeeland through the seven-mile long landfill gas pipeline to markets with Zeeland Public Works.

Other Biomass Conversion Facilities

FBA has located one other operating existing biomass conversion facility in the study region. This facility is located in Grand Rapids and converts municipal solid waste into electrical energy and thermal energy (steam). The electrical energy produced from this facility is sold to Consumers Energy and the steam is transported to municipal buildings and businesses located in Downtown Grand Rapids. This facility is owned by Kent County Public Works and operated by a company called Coverta.

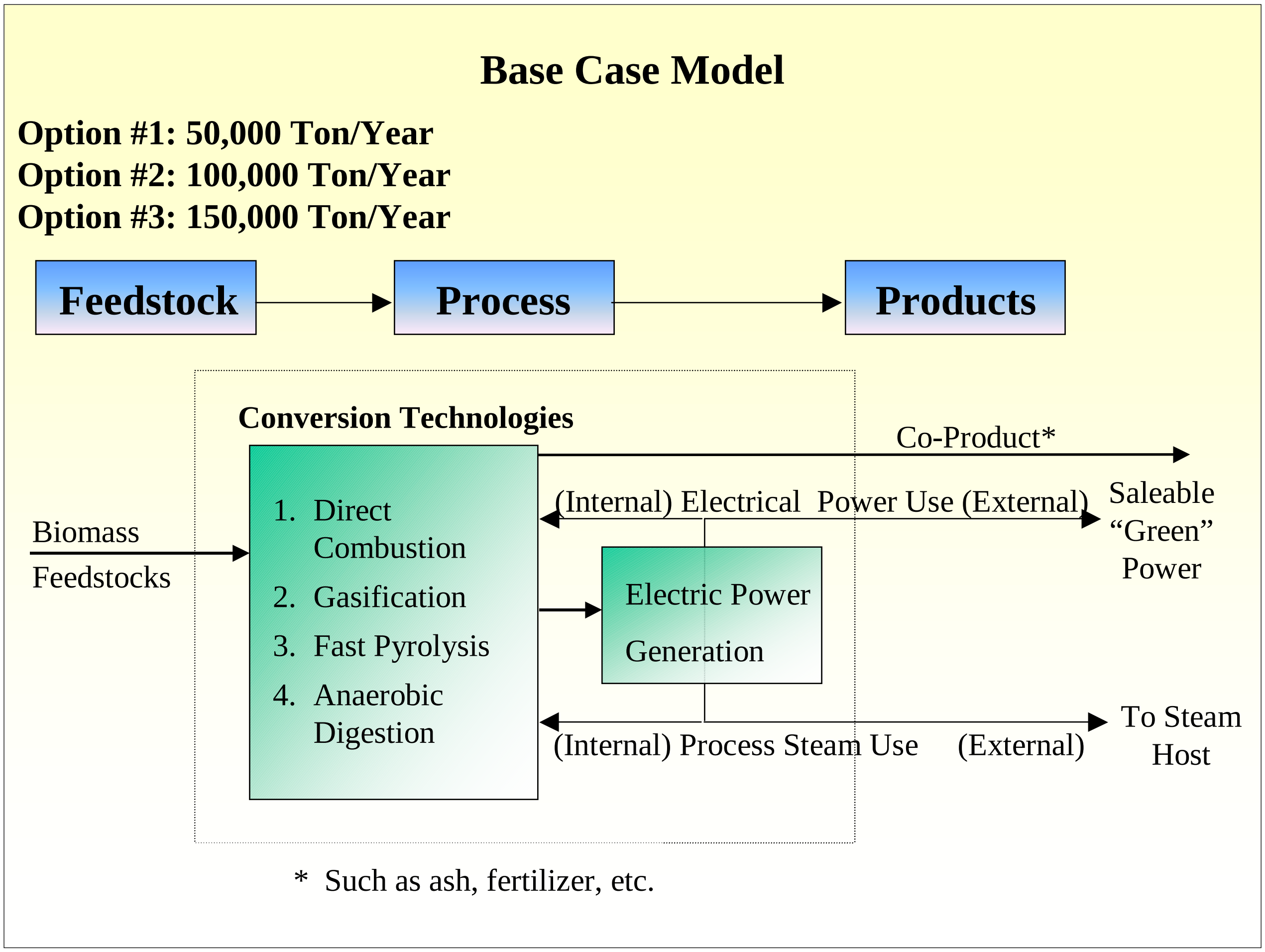
FBA contacted the Kent County Department of Public Works Director concerning potential expansion of this facility to accommodate other biomass feedstocks. The Director showed no interest in expanding this facility since the facility is already receiving 30% more municipal solid waste than it can process. The reason given for not expanding the facility is that it was more economical to landfill the excess municipal waste than process it in an expanded plant.

A summary of the potential locations for the biomass conversion facility is shown below.

Selection Criteria	Zeeland Farm Soya (Zeeland, MI)	Kruger Commodities (Hamilton, MI)	Wyoming/Grand Rapids Municipal Treatment (Wyoming, MI)	Packerland Foods (Plainwell, MI)	Autumn Hills Landfill (5 miles southeast of Zeeland, MI)
Annual Thermal Power Demand for Host	220,000 mmBTU	200,000 mmBTU	59,000 mmBTU	220,000 mmBTU	None
Annual Electrical Demand for Host	1.3 MW	1.5 MW	3.0 MW	5.0 MW	None
Feedstock Proximity	Excellent	Good	Good	Fair	Excellent
Public Acceptance	Poor	Fair	Very Poor	Fair	Excellent
Co-Product Market Proximity	Fair	Poor	Good	Fair	Fair
Host Acceptance	Good	Good	Fair	Good	Excellent
Thermal Power Load Factor	85%	60%	70%	80%	N/A

III. BIOMASS CONVERSION TECHNOLOGY REVIEW

The base case model for this report utilizes a blend of biomass feedstocks with different types of conversion technologies to produce process steam and electric power. This power, minus any internal power required, can then be sold to an adjacent power user or to the power grid as "green" power.



FBA researched four technologies that could convert poultry waste into energy: Direct Combustion, Gasification, Anaerobic Digestion, and Fast Pyrolysis. FBA contacted vendors that manufacture these technologies and requested quotations on their particular systems. A list of these vendors is shown below.

Technology	Vendor	Location
Direct Combustion	Energy Products of Idaho	Coeur d'Alene, ID
Gasification	Primenergy	Tulsa, OK
Fast Pyrolysis	Renewable Oil International	Florence, AL
Anaerobic Digestion	Anergen Corporation.	Northbrook, IL

The vendors were asked to provide capital and operating costs on two options for the processing plant Base Case Model:

Option 1	150 tons per day	(50,000 tons/year)
Option 2	300 tons per day	(100,000 tons/year)
Option 3	450 tons per day	(150,000 tons/year)

The vendors were instructed to assume that Options 1 and 2 would utilize 100% Primary Feedstocks from the draw area, and Option 3 would be 100,000 tons per year of Primary Feedstock mixed with 50,000 tons per year of Secondary Feedstocks.

Note: The data provided in this report is used as a sampling of the vendors manufacturing these technologies to show the typical capital and operating costs required. The purpose of this report is to determine if a poultry waste to energy project is feasible and it is not within the scope of this report to recommend a specific vendor, only a technology. FBA is not recommending any of the vendors at this time.

A review of these technologies follows.

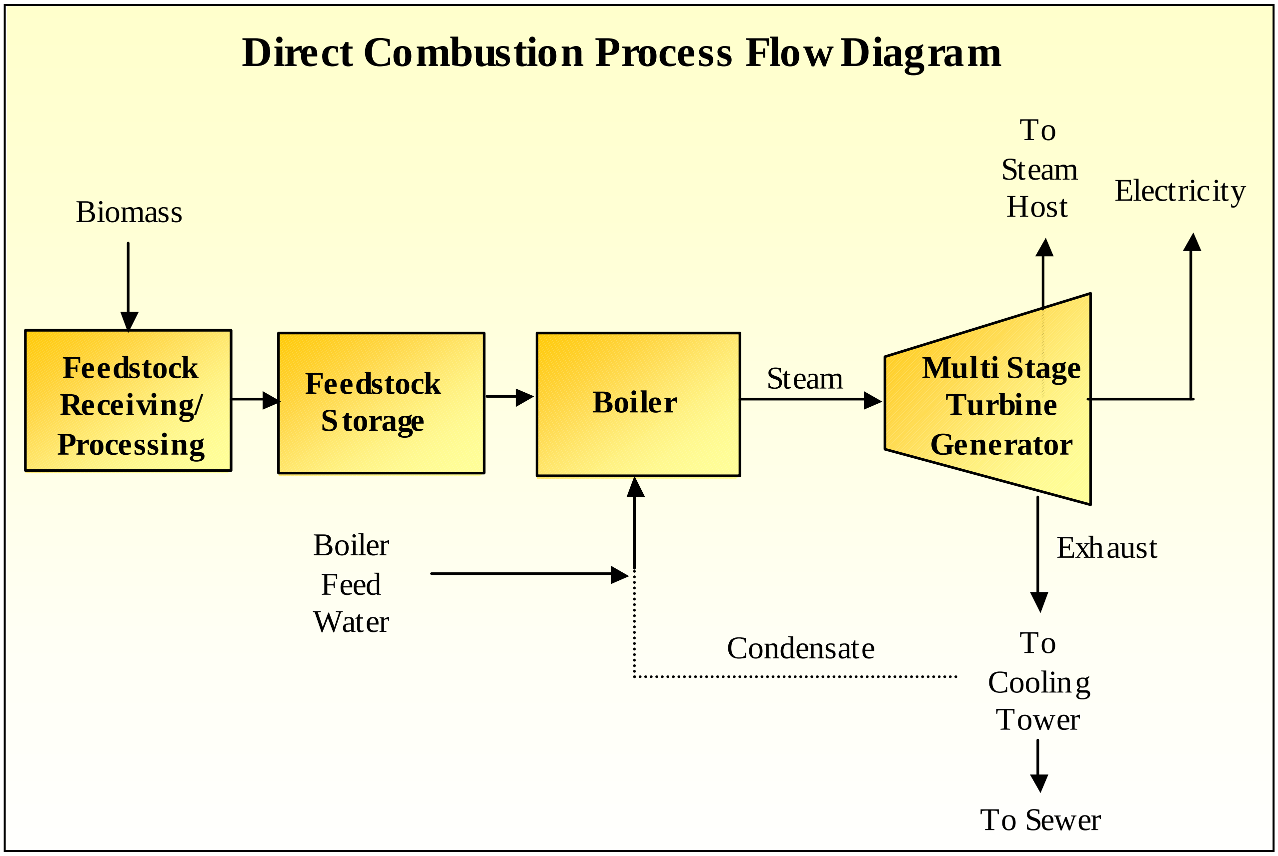
Base Case Model Assumptions:

Criteria	Assumptions		
	Option 1 (50,000 TPY)	**Option 2 (100,000 TPY)**	**Option 3 (150,000 TPY)**
Feedstock Type & Quantities	25,000 tons of Turkey Litter 25,000 tons of Layer Waste	50,000 tons of Turkey Litter 50,000 tons of Layer Waste	50,000 tons of Turkey Litter 50,000 tons of Layer Waste 50,000 tons of Wood Chips
Moisture Content	28%	28%	28%
Ash Content	18.1%	18.1%	12.4%
Energy Content	5,325 Btu/Lb.	5,325 Btu/Lb.	6,050 Btu/Lb.
Operating Days	330 Days per Year		
Steam Host Requirement	25,000 pph @ 150 psig		

A. <u>Direct Combustion (Technology Description)</u>

Direct Combustion technologies burn biomass material by application of direct heat. The biomass feedstock can be burned without pre-processing to produce steam. The steam can then be used in a process and/or passed through a steam turbine/generator set to produce electric power.

A typical flow diagram for a Direct Combustion system with the steam output passing through a multi-stage turbine generator is shown below.



EPI (Energy Products of Idaho) is a manufacturer of direct combustion technologies, with over 30 years of operating experience. They provided a proposal for a Fluidized Bed Combustion system (FBC) for the Western Michigan project, a proprietary design that is specifically designed to accommodate wood waste fuel but allows for a wide variety of fuels at an altered performance cost. The fluidized bed system is suitable for burning material with high moisture content while generating low emissions.

There are four components to the FBC system. Biomass arrives by truck and is dumped into pits, passed through grinders to reduce the feedstock to less than ¼", and then stored. After mixing with limestone and ammonia the feedstock is fed into the Fluid Bed Combustor, with the end result of process steam that is passed to the Power Generation System. Ash generated during the combustion process is collected and stored for shipping.

Capital costs, operating costs and outputs of the direct fire technology are shown below.

DIRECT FIRE ESTIMATED CAPITAL COSTS			
Plant Component	**Option 1 (150 WTPD)**	**Option 2 (300 WTPD)**	**Option 3 (450 WTPD)**
Feedstock Receiving & Storage	$1,500,000	$3,000,000	$3,900,000
Steam Generation System	$5,720,000	$9,300,000	$12,400,000
Electric Power Generation System	$2,934,000	$4,810,000	$8,470,000
Contingency (20%)	$2,031,000	$3,420,000	$4,950,000
Total Installed Cost	**$12,185,000**	**$20,530,000**	**$29,720,000**

DIRECT FIRE ESTIMATED ANNUAL OPERATING COSTS (per ton)			
Cost Category	**Option 1 (150 WTPD)**	**Option 2 (300 WTPD)**	**Option 3 (450 WTPD)**
Operating & Maintenance Costs	$25.76	$17.84	$14.17
Depreciation (13.5 years)	$18.05	$15.21	$14.67
Total Operating Costs	**$43.81**	**$33.05**	**$28.84**

DIRECT FIRE OUTPUTS			
Revenue Category	**Option 1 (150 WTPD)**	**Option 2 (300 WTPD)**	**Option 3 (450 WTPD)**
Steam Host Steam Requirements (pph)	25,000	25,000	25,000
Net Electric Power Output (kW)*	1,054	4,378	7,700
Ash (Tons per Year)	5,722	11,444	14,628

*Net of any internal power requirements

Assumptions:

- Options 1 and 2 have combined heat content of 7,055 Btu/lb and moisture of 31.36%; Option 3 has combined heat content of 7,139 Btu/lb and moisture of 32.57%.
- Design temperature is 68ºF
- Boiler produces superheated steam at 600psig and 650ºF.
- All capital costs are based on Free on Board (FOB) point of manufacture.
- Installation cost is approximately 35% of the capital equipment price.

Environmental Impact:
Direct fire technology must include stack gas cleaning equipment such as baghouses in order to meet clean air requirements. This is due to the ash particulates that are contained in the stack gasses. As with any combustion equipment the NO_x emissions must also be controlled. EPI controls these emissions by controlling both the location of combustion within the equipment and the temperature at which combustion occurs. Annual operating costs include the cost for operating environmental compliance equipment.

Feedstock Flexibility:
Direct fire technology is capable of handling multiple types of feedstock or a single feedstock as long as they are specified in the design. This particular type of direct fire technology is designed to handle feedstock of varying moisture and energy contents. This is accomplished by burning a small amount of fuel at any given time in conjunction with a computer control system that adjusts fuel feed rates rapidly as the fuel energy content varies.

Separation of Biomass Conversion & Energy Production:
Direct Fire Technology generates steam, which is not transportable any large distance. The effective distance steam can be transported is approximately one mile. Therefore locating a steam host within close proximity to the plant is essential in that it reduces capital and operating costs.

Site Requirements:
Given the potential environmental issues associated with siting a waste to energy facility, a larger than typical site is anticipated to act as a buffer to adjacent companies. Although the plant could be located in as little as 5 to 10 acres, a site 3 to 5 times that amount may prove beneficial.

Other requirements for the site would be the following:

1. Electrical power; 480 volt, 3-phase.
2. City water or treatable well water.
3. High capacity access roads for feedstock receipt and ash by-product shipping.

By-Product Disposal:
With direct fire, there is only one by-product, a dry ash fertilizer.

B. <u>Gasification (Technology Description)</u>

Gasification involves converting biomass in an atmosphere of steam or air to produce a medium or low calorific gas. This “biogas” is then used as a fuel in a steam boiler. The steam can then be piped to a steam turbine to generate electric power.

Primenergy, LLC:
Primenergy, L.L.C. is an Oklahoma corporation with principal offices located in Tulsa, Oklahoma. Their primary business is engineering, procurement and construction of

turnkey, biomass fueled energy conversion and recovery facilities. Their primary products are a unique and proprietary gasification technology and gas cleaning processes.

The process flow diagram on the following page illustrates the Primenergy gasifier process.

Estimates for the capital costs, operating costs and outputs for a gasification plant are shown below.

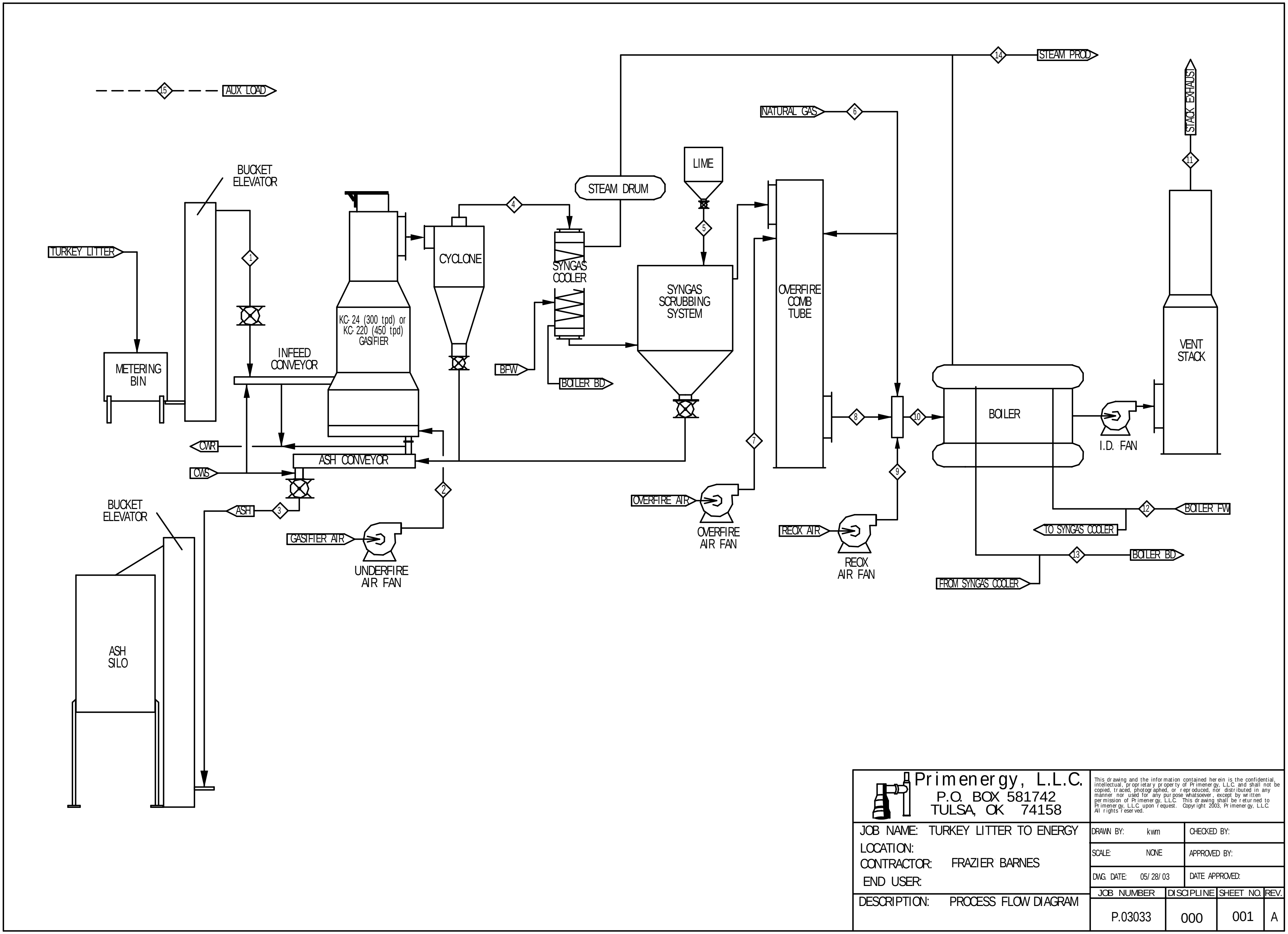
GASIFICATION ESTIMATED CAPITAL COSTS			
Plant Component	**Option 1 (150 WTPD)**	**Option 2 (300 WTPD)**	**Option 3 (450 WTPD)**
Feedstock Receiving and Storage	$1,500,000	$3,000,000	$3,900,000
Steam Generation System	$4,310,000	$7,000,000	$10,300,000
Electric Power Generation System	$3,161,000	$5,140,000	$8,200,000
Contingency (20%)	$1,794,000	$3,020,000	$4,480,000
Total Installed Cost Estimate	**$10,765,000**	**$18,160,000**	**$26,880,000**

GASIFICATION ESTIMATED ANNUAL OPERATING COSTS ($/Ton)			
Cost Category	**Option 1 (150 WPTD)**	**Option 2 (300 WTPD)**	**Option 3 (450 WTPD)**
Operating & Maintenance Costs*	$24.09	$16.66	$12.05
Depreciation (13.5 Years)	$15.95	$13.45	$13.27
Total Operating Cost Per Ton	**$40.04**	**$30.11**	**$25.32**

*Includes all labor & benefits, utilities, maintenance, and operating supplies.

GASIFICATION OUTPUTS			
Revenue Category	**Option 1 (150 WPTD)**	**Option 2 (300 WTPD)**	**Option 3 (450 WTPD)**
Steam Host Steam Requirement (pph)	25,000	25,000	25,000
Electric Power Output (kW)*	1,883	4,241	7,453
Ash (Ton per Year)	8,150	16,300	24,508

*Net of parasitic loads required to operate the plant.


AUX LOAD
15
STEAM PROD
14
NATURAL GAS
6
STACK EXHAUST
11
BUCKET ELEVATOR
STEAM DRUM
LIME
4
5
TURKEY LITTER
1
CYCLONE
SYNGAS COOLER
SYNGAS SCRUBBING SYSTEM
OVERFIRE COMB TUBE
VENT STACK
KC-24 (300 tpd) or KC-220 (450 tpd) GASIFIER
METERING BIN
INFEED CONVEYOR
BFW
BOILER BD
BOILER
8
10
I.D. FAN
CWR
CWS
ASH CONVEYOR
7
9
2
BUCKET ELEVATOR
ASH
3
OVERFIRE AIR
OVERFIRE AIR FAN
12
BOILER FW
REOX AIR
TO SYNGAS COOLER
GASIFIER AIR
UNDERFIRE AIR FAN
REOX AIR FAN
13
BOILER BD
FROM SYNGAS COOLER
ASH SILO
Primenergy, L.L.C.
P.O. BOX 581742
TULSA, OK 74158
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JOB NAME: TURKEY LITTER TO ENERGY
LOCATION:
CONTRACTOR: FRAZIER BARNES
END USER:
DESCRIPTION: PROCESS FLOW DIAGRAM
DRAWN BY: kwm
CHECKED BY:
SCALE: NONE
APPROVED BY:
DWG. DATE: 05/28/03
DATE APPROVED:
JOB NUMBER
DISCIPLINE
SHEET NO.
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Assumptions:

- Turkey litter temperature of 77ºF.
- 130 lb./hr of lime, per 150 tons/day of operation

Environmental Impact:
The biogas generated from a gasification system must be filtered in order to remove particulate matter (ash). This ash is returned to the ash collection system and sold along with the ash generated in the main gasifier unit. Controlling NO_x emissions is more challenging in a gasifier due to the higher temperatures reached in the system. This also results in the possibility of developing sticky ash, which becomes deposited on heat exchange surfaces, reducing efficiency. Annual operating costs assume the cost for environmental compliance.

Feedstock Flexibility:
Gasification technology is designed for a particular feedstock consistency and energy content. Although it can accommodate the feedstocks anticipated in Western Michigan, similar gasification plants blend their feedstocks to maintain a more consistent quality feedstock in terms of moisture and energy content.

Separation of Biomass Conversion & Energy Production:
Gasification technologies generate a low energy content wet biogas, which is transportable. Utilization in a gas turbine is not yet feasible due to the high moisture content of the biogas. In this analysis the biogas is fed into a conventional boiler and fired similar to natural gas.

Site Requirements:
The site requirements for Gasification are the same as for Direct Combustion; i.e.:

1. Site size of 15 to 50 acres
2. Electrical power; 480 volt, 3-phase.
3. City water or treatable well water.
4. High capacity access roads for feedstock receipt and ash by-product shipping.

By-Product Disposal:
With gasification, there is only one by-product, a dry ash fertilizer.

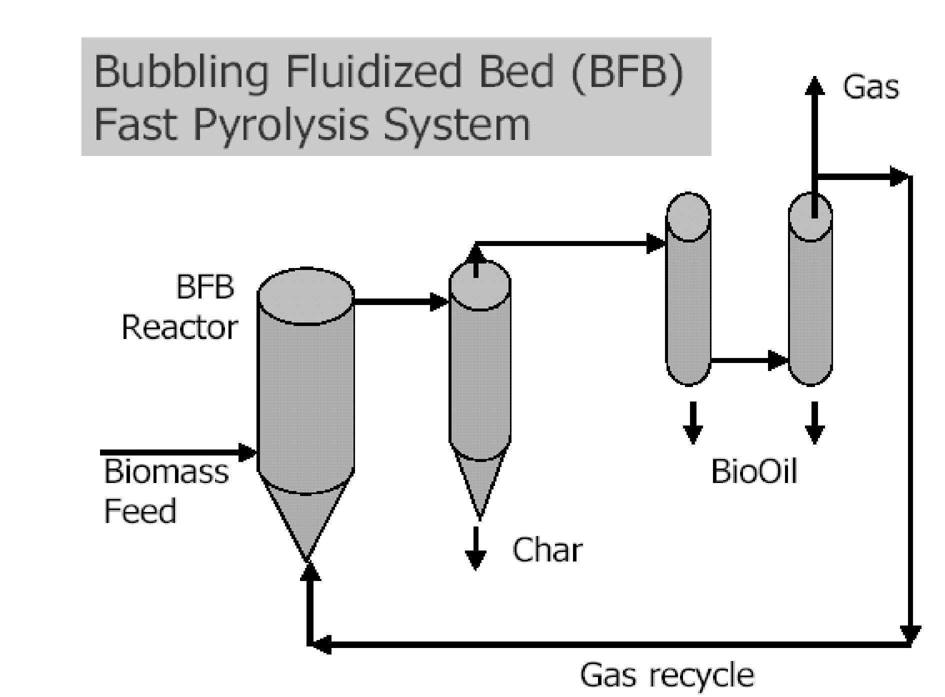
C. <u>Fast Pyrolysis (Technology Description)</u>

Pyrolysis is a process in which biomass is heated in the absence of oxygen (anaerobically). The biomass decomposes to generate vapors, aerosols, and some char. The material is cooled and condensed to transportable liquid oil with approximately half the heat content of conventional fuel oil.

Renewable Oil International, LLC is currently in the initial commercializing steps of a "fast" pyrolysis process based on locating small-sized plants close to the source of biomass. ROI's fast pyrolysis produces three products: liquid fuel (bio-oil) with a heating value of 80,000 BTU/gallon; charcoal that can be burned to drive the process and provide heat for the dryer; and Syngas, a low-Btu gas that can help provide preheat for the feedstock.

ROI's technology is constructed in 100-dry TPD modules consisting of 8' x 8' x 20' containers, so additional capacity requires the installation of more modules. A 100-dry TPD plant could supply about 4 MW of electricity using a combination of gas turbine and steam turbine. Capital costs for constructing a module is about $1,500,000, while operating costs are about $2.00 per mmBTU.

A simplified diagram of ROI's pyrolysis system is shown below.



Further research by FBA has determined that fast pyrolysis remains in the initial stages of commercialization. Although a viable technology, it remains to be proven commercializable. Therefore, fast pyrolysis has been excluded as an option for the West Michigan Co-Gen project.

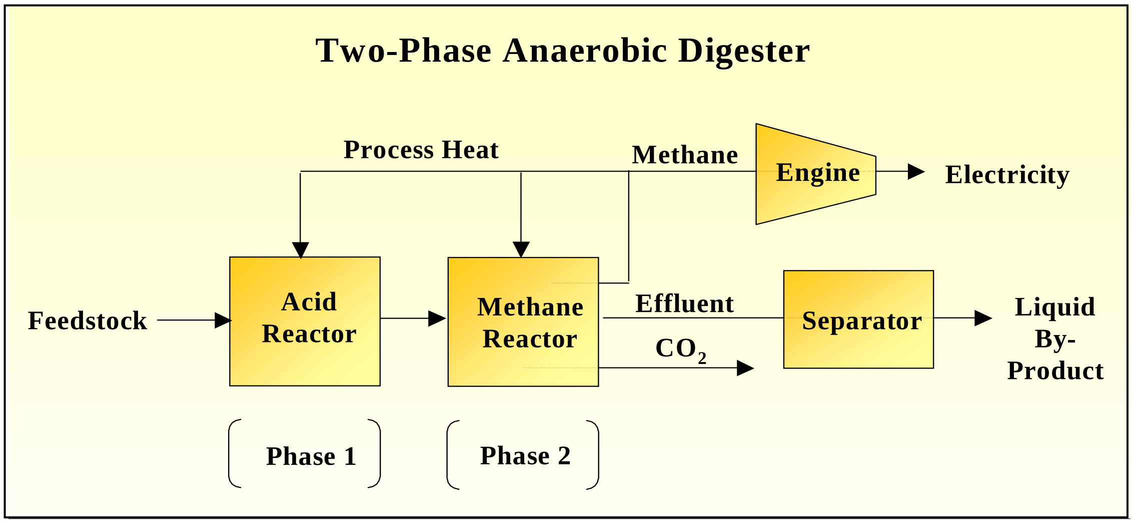
D. <u>Anaerobic Digestion (Technology Description)</u>

Anaerobic Digestion is the breakdown of animal or vegetable matter in the absence of oxygen to produce biogas. Anaerobic digestion occurs in a controlled environment such as a biogas plant, where organic waste and bacteria is placed in an airtight container, called the digester. The breakdown of material produces biogas, which can then be passed through a generator.

Anergen is the manufacturer of a Two-Phase anaerobic digester system. The industry standard is a Plug-Flow Digester, which can handle only a limited variety of feedstocks. The Two-Phase System is adaptable to any feedstock, destroys pathogens and reduces odor.

In the two-Phase System feedstock is pretreated to remove foreign materials, such as sand or grit. The resulting slurry is pumped into an acid reactor. The solid feedstock is converted to organic acid by bacteria in an anaerobic environment. From the acid tank the organic acids are transferred to another tank for additional bacterial reaction and converted to methane and carbon dioxide. The methane is burned to generate electricity or used for thermal process heating, while the effluent is passed through a solids separator, resulting in a nutrient-rich product that can be land-applied or marketed as an organic fertilizer.

A simplified diagram of Anergen's anaerobic digestion system is shown below.



Capital costs, operating costs and the outputs from the anaerobic digestion process are shown in the following tables.

ANAEROBIC DIGESTION			
Plant Component	**Option 1 (150 TPD)**	**Option 2 (300 TPD)**	**Option 3 (450 TPD)**
Feedstock Receiving and Storage	$1,500,000	$3,000,000	$3,900,000
Anaerobic Digestion Process & Electric Power Generation System	$7,750,000	$12,600,000	$16,800,000
Contingency (20%)	$1,850,000	$3,120,000	$4,140,000
Total Installed Cost	**$11,100,000**	**$18,720,000**	**$24,840,000**

ANAEROBIC DIGESTION ESTIMATED ANNUAL OPERATING COSTS (per ton)			
Cost Category	**Option 1 (150 TPD)**	**Option 2 (300 TPD)**	**Option 3 (450 TPD)**
Operating & Maintenance Cost	$14.64	$10.14	$10.91
Depreciation (13.5 years)	$16.44	$13.87	$12.27
Total Operating Costs	**$31.08**	**$24.01**	**$23.18**

ANAEROBIC DIGESTION OUTPUTS*			
Revenue Category	Option 1 (150 TPD)	Option 2 (300 TPD)	Option 3 (450 TPD)
Electric Power Output (kW)	1,474	2,948	3,931
Liquid Fertilizer Product (tons per year)	23,300	46,600	62,133

* The anaerobic digestion technology model converts all the biogas to electric power. No steam is generated with this model.

Assumptions:

- Manure must be fresh (without bedding material) to have the highest moisture contents; 69.1% moisture content of fresh manure is optimal for operation.
- N-P-K of 1.3-1.1-0.6 as percent of fresh manure.
- Egg wash liquid input equal to 15.3% of manure input (i.e. 22.95 tons egg wash liquid for every 150 tons).
- Surplus water to be discharged equal to 57.3% of manure input (85.95 tons of water to be disposed of for every 150 tons).

Environmental Impact:

Two common problems with most anaerobic digestion processes are the water required to slurry the feedstock to the proper concentration for the biological process to be efficient and the subsequent wastewater treatment system required to meet EPA discharge permit limits. The Anergen technology solves both of these issues by first cleaning the wastewater stream of pollutants then reusing the water. In effect the plant is a "zero discharge" facility from a wastewater perspective. Annual operating costs includes the cost for environmental compliance.

Feedstock Flexibility:

Since anaerobic digestion uses biological processes, which generate particular types of organisms, the technology is sensitive to changes in feedstock type and quality. It can be anticipated that the process guarantees for anaerobic digestion will be feedstock specific. The primary feedstock considered in this study also presents a particular issue with grit disposal and the slow rate of anaerobic digestion for the wood bedding material. Both of these items reduce the yield of energy for the system and result in additional operating costs. One of the benefits of using anaerobic digestion as a technology is that it can handle high moisture feedstocks; however because of its higher moisture content there are higher transportation costs.

Separation of Biomass Conversion & Energy Production:

The biogas generated from the anaerobic digestion process has approximately 75% of the energy content of natural gas (750 BTU/ft^3 vs. 1000 BTU/ft^3). This allows the biogas to be utilized directly in power generating equipment without expensive clean up systems. Biogas from anaerobic digestion systems is also compatible with landfill gas and would actually upgrade the quality of that product.

Site Requirements:
The site requirements for Gasification are the same as for Direct Combustion; i.e.:

1. Site size of 15 to 50 acres
2. Electrical power; 480 volt, 3-phase.
3. City water or treatable well water.
4. High capacity access roads for feedstock receipt and ash by-product shipping.

By-Product Disposal:
With anaerobic digestion, there is a liquid fertilizer product that is 60 to 75% water. The high moisture composition of this by-product decreases its value and reduces the potential markets that it can reach.

E. Technology Summary

The following tables summarize the capital costs, operating costs and outputs for those technologies researched for this report.

Technology	Vendor	Capital Costs		
		150 TPD	300 TPD	450 TPD
Direction Combustion	Energy Products of Idaho	$12,185,000	$20,530,000	$29,720,000
Gasification	Primenergy	$10,765,000	$18,160,000	$26,880,000
Anaerobic Digestion	Anergen	$11,100,000	$18,720,000	$24,840,000

Technology	Vendor	Operating Costs (per ton)		
		150 TPD	300 TPD	450 TPD
Direction Combustion	Energy Products of Idaho	$43.81	$33.05	$28.84
Gasification	Primenergy	$40.04	$30.11	$25.32
Anaerobic Digestion	Anergen	$31.08	$24.01	$23.18

Technology	Vendor	Electrical Power (kW)		
		150 TPD	300 TPD	450 TPD
Direction Combustion	Energy Products of Idaho	1,054	4,378	7,700
Gasification	Primenergy	1,883	4,241	7,453
Anaerobic Digestion	Anergen	1,474	2,948	3,931

Technology	Vendor	Fertilizer (Tons per year)		
		150 TPD	300 TPD	450 TPD
Direction Combustion	Energy Products of Idaho	5,722	11,444	14,628
Gasification	Primenergy	8,150	16,300	24,508

Anaerobic Digestion	Anergen	23,300	46,600	62,133

Requests were made of vendors to supply additional detail on assumptions and cost data for each of the technologies studied as part of this report. All available information has been included in the report. Of all the vendors contacted only one, EPI, provided a budget proposal for this project. Even in this case the EPI proposal, while very thorough in describing the outputs of the technology based on the feedstock data inputs, contained no capital or operating costs. The reasons vendors cited for providing such a dearth of information included the uniqueness of this turkey litter to energy project (there are no other plants of its kind operating in the United States), and the time that would be required to prepare a more detailed proposal without financial inducement.

The following individuals were the primary vendor technology contacts. Copies of available correspondence between FBA and the vendors, as well as supporting data such as assumption grids, has been included as part of the Addenda.

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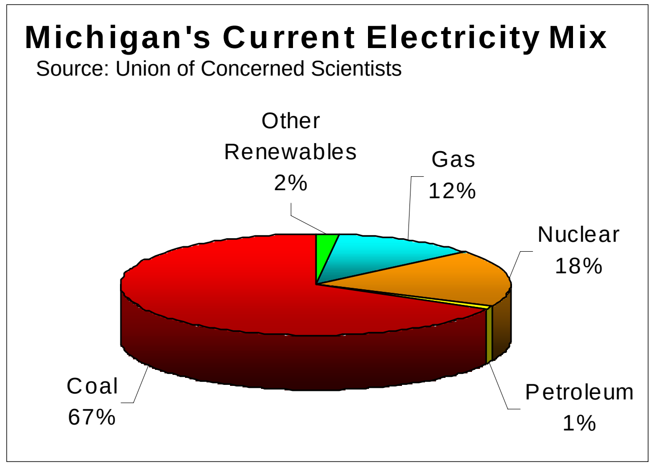
IV. Product and By-Product Markets

A. Michigan's Current Energy Profile

The state of Michigan is currently dependent upon natural gas, and imported coal and nuclear power to provide its energy needs. Only a fraction of Michigan's electricity requirements are being met by renewable energy sources.

Michigan has the potential to generate about 90% of its current electricity needs by utilizing renewable energy sources, such as wind and solar power, and bioenergy. However, this potential renewable energy generation is limited by economic, physical and other limitations. If Michigan were to adopt a Renewable Portfolio Standard it is anticipated that about 70% of this renewable energy could come from bioenergy sources, such as turkey and layer waste; about 10% could come from landfill gas, and the remainder from wind power.



B. Michigan Renewable Energy Program Participants

The State of Michigan has developed a limited experimental renewable electrical energy program where electrical consumers can pay a premium for renewable power. Since this is a voluntary program it has been slow to develop. The primary participants in this program have been a few electrical distribution cooperatives, Consumers Energy, industrial electrical end-users, and residential electrical end-users.

FBA made initial contact with the following groups in each of these participant categories:

1. Zeeland Board of Public Works (interested local electrical distribution cooperative).
2. Consumers Energy Company.
3. Herman Miller, of Zeeland Michigan (office furniture manufacturing facility), who is interested in "Green" Renewable Power because of its environmentally friendly corporate policy.

C. Product and By-Product Participants

Listed below is a summary of some of the current "green" energy programs for the state of Michigan.

Utility Name	Program Name	Type	Size	Start Date	Premium
Consumers	Experimental	Wind, various	1.8 MW	2001	3.2¢/kWh

Energy	Green Power Program				
Detroit Edison	Solar Currents	Central PV	55 kW	1996	$6.59/100 watts
Lansing Board of Water and Light	GreenWise Electric Power	Landfill gas, small hydro	---	2001	3.0¢/kWh
Traverse City Light and Power	Green Rate	Wind	600 kW	1996	1.58¢/kWh
We Energies	Energy for Tomorrow	Wind, landfill gas, hydro	8.2 MW	2000	2.04¢/kWh

From this listing of programs it can be seen that all participants in the green energy program are relatively small in scale, voluntary, and experimental in nature. This has resulted in very slow development of the green power market in Michigan. Not all of the electrical generating companies operating in the state of Michigan have green power marketing programs. The following news release describes recent action by the Michigan Public Service Commission to expand the renewable energy or green power options for Michigan electrical consumers.

Michigan Electric Companies Must Offer Green Power or Rate Refund

(April 29) The Michigan Public Service Commission is asking seven state electric companies to offer their customers renewable energy, green power options, and/or rate relief after the companies failed to implement education programs about customer electric choice.

Since electric choice was initiated in January 2002, the companies – Alpena Power, Indiana Michigan Power (American Electric Power), Edison Sault Electric Company, Upper Peninsula Power Company, Wisconsin Power Company, Wisconsin Public Service Corporation, and Northern State Power Company (Xcel Energy) have been collecting an 18-cents-per-meter charge to put together a consumer education program. The companies collected more than $542,000 during 2002 and incurred no expenses.

The PSC noted that it has been six years since the importance of a customer education program for restructuring was first recognized. In its recent order, the Commission noted that the state's Customer Choice and Electric Reliability Act, passed in 2000, allows use of the consumer education fund for promotion of green power and recruitment of potential alternative suppliers.

In an April order, the PSC declared that it was time to accomplish at least a portion of those goals and relieve customers from the obligation to contribute their monthly 18 cents to a nonexistent program. Thus, it ordered that the monthly charge be suspended and directed the companies to file a description by August 2003 on how they plan to use monies already collected to promote green power or refund the money to their customers.

Source: Michigan Public Service Commission

Currently, there are nine electrical cooperatives operating in Michigan that are scheduled to have "green" power options available for their customers by January 1st of 2005. These nine electrical cooperatives have petitioned the Michigan Public Service Commission for an extension of that date. These coops say that small customer retail choice would attract too few switchers to justify the cost of implementing the program. The coops are requesting that the green power implementation deadline for coop customers be extended until green power programs are successfully operating in other segments of the Michigan electrical retail market. This delay will only further slow the development of green power markets in Michigan.

For Michigan to more rapidly develop a green power market it would need to develop a Renewable Portfolio Standard (RPS) similar to the ones developed in the following states:

Arizona	1.1% by 2007 (66% Solar)
California	20% by 2017
Connecticut	13% by 2009
Iowa	2.0% by 2011
Maine	30% by 2010
Massachusetts	4% by 2009
Minnesota	4.8% by 2012
Nevada	15% by 2013
New Jersey	6.5% by 2012
New Mexico	10% by 2011
New York	*
Pennsylvania	(Varies by Utility)
Texas	2.2% by 2009
Wisconsin	2.2% by 2011

* In 2001, New York Governor Pataki issued an Executive Order requiring New York state agencies to provide 10% of their electricity needs from renewable energy by the year 2005, and 20% by the year 2010.

The Environmental Law and Policy Center (ELPC) of the Midwest recommends the establishment of a Michigan RPS requiring all retail electrical sellers to provide 8% of their electricity from renewable sources by 2010 and 20% by 2020. Other actions recommended by ELPC to more rapidly develop a "green" power market in Michigan are:

1. Removal of barriers to clean distributed power:
   - Apply net metering policies to all wind and photo voltaic renewable energy sources
   - Establish standard business and interconnection terms for renewable power
   - Suppliers apply clean air standards to small distributed generation sources
   - Establish uniform safety and power quality standards for interconnections
2. Establish a Renewable Energy Investment Fund (0.1¢/kWh) for the support of emerging technologies.
3. Ensure that transmission pricing policies and power pooling practices treat renewable sources fairly and account for their intermittent nature.

Of all of the actions that can be taken to facilitate the development of a green power electrical market, the most important would be a Renewable Portfolio Standard on a state level (Michigan) or a national level. The current national RPS legislation has been proposed that 20% of the U.S. electrical generation by 2020 come from renewable sources. This same type of approach is being used for liquid transportation biofuels in the 2003 U.S. Energy Bill. It calls for a certain volume (%) of the total consumption of liquid transportation fuels to be from renewable sources (biofuels). The current proposed level would be 5 billion gallons of liquid transportation biofuels, predominantly ethanol and biodiesel, by the year 2012. Utilizing the same approach for renewable electrical power will assure project developers, such as West Michigan Co-Gen, that there will be a growing, reliable market for renewable electrical power in the future and place Michigan on equal footing with most other states.

Green Power Credits:
Green power credits could assist Michigan electricity generators meet a Renewable Portfolio Standard.

Renewable Energy Credits (RECs), also called Tradable Renewable Certificates, or “green” tags as they are known in the energy industry, provide generators with a simple and flexible means for achieving self-directed or mandated renewable energy targets. One REC is created for every unit of renewable electricity generated. Renewable energy generators earn RECs and then sell them to those who need them to meet RPS requirements. A unit of renewable electricity is defined as a kilowatt; therefore 1 REC = 1000 kWh. So, for example, a 5MW renewable energy generating plant could generate 43,800 MWh per year (5 X 365 days X 24 hours), equal to 43,800 RECs/year.

A benefit of “green” tags is consumers and businesses may participate in the national transition to renewable energy even if individual states do not deregulate their energy markets. This allows the marketing of RECs in areas outside of the state where the RECs were generated. For example, assume that State A has regulated its energy market and requires its consumers to use renewable electricity; however, State A has no “green” energy producing sites. State A consumers buy RECs from State B, which does produce “green” electricity, thereby meeting their state regulations.

There exist a number of REC sellers under the Green-e Renewable Energy Certification Program, established to maintain certification standards for RECs. Most are available nationwide, the rest handing regional customers. Standardization prevents double-billing of the finite green energy and assures that the product is in fact “green.” Customers desiring to purchase RECs call these sellers or visit their websites and pay the premium, usually priced per year. In most cases the purchase of a REC is a separate expense than the regular electricity utility bill. Some of the available REC sellers include:

REC Seller	Location	Region RECs Sold
Bonneville Environmental Foundation	Portland, OR	Nationwide
Community Energy	Wayne, PA	Nationwide
Sterling Planet	Alpharetta, GA	Nationwide
Renewable Choice Energy	Boulder, CO	Nationwide
3 Phases Energy Services	San Francisco, CA	Nationwide

VisionQuest	Calgary, Alberta, Canada	Nationwide
Aquila Energy Resources	Kansas City, MO	Nationwide
Green Mountain Energy	Austin, TX	Regional (CA, CO, NJ, NY, PA, OH, OR, TX)

The cost of a REC varies by the type of REC being sold. Some of the RECs being offered include wind, solar, and other renewable sources of energy. A solar power "green" tag can generate about $40 per tag; wind $10 per tag, while biomass to energy "green" tags are currently being marketed at about $5 per tag. The cost of a REC is a reflection of the cost of generating the green electricity. For WMC, the current market value for their REC would be $5 per tag.

D. **Process Steam Markets**

FBA has contacted regional economic development authorities to determine if there are proposed plants within the study regions that might serve as steam hosts for the WMC Project. Unfortunately, the survey has not resulted in the location of any viable proposed "steam hosts." This should not be construed that potential steam hosts may not emerge in the future. Many projects that are in the planning phases must be kept confidential by regional economic development authorities. The five potential sites listed previously in this report are all that have been located at the time of the writing of this report. The analysis of each site is shown below.

Selection Criteria	Zeeland Farm Soya (Zeeland, MI)	Kruger Commodities (Hamilton, MI)	Wyoming/Grand Rapids Municipal Treatment (Wyoming, MI)	Packerland Foods (Plainwell, MI)	Autumn Hills Landfill (5 miles southeast of Zeeland, MI)
Annual Thermal Power Demand for Host	220,000 mmBTU	200,000 mmBTU	59,000 mmBTU	220,000 mmBTU	None
Annual Electrical Demand for Host	1.3 MW	1.5 MW	3.0 MW	5.0 MW	None
Feedstock Proximity	Excellent	Good	Good	Fair	Excellent
Public Acceptance	Poor	Fair	Very Poor	Fair	Excellent
Co-Product Market Proximity	Fair	Poor	Good	Fair	Fair
Host Acceptance	Good	Good	Fair	Good	Excellent
Thermal Power Load Factor	85%	60%	70%	80%	N/A

E. By-Product Markets

The primary by-product that will be produced from a poultry litter energy conversion process will be a fertilizer product for grain producers, horticulture producers or fruit/vegetable producers. Currently, unprocessed poultry litter is being primarily marketed to grain producers as a crop fertilizer. However, if poultry litter is composted it becomes more marketable to horticulture producers and/or fruit/vegetable producers. The composting process produces a fertilizer product with a lower pathogen level and lower odor content. An attractive feature of unprocessed or composted poultry litter is its organic label. Since these fertilizers are “natural” products they can be utilized by producers of organic crops, fruits or vegetables. It should be noted that there are some regulations on utilizing unprocessed poultry litter for fruit and vegetable production because of the pathogens in unprocessed poultry litter.

Fertilizer by-products produced from biomass energy conversion processes should have the following advantages over unprocessed or composted poultry litter fertilizer products.

1. Greater bulk density.
2. Greater nutrient concentration.
3. Pathogen-free.
4. Reduced odor content.
5. Improved flowability and handling characteristics.
6. Can still be utilized by organic crop producers as long as the feedstock comes from a “pure” organic biomass feedstock, i.e. poultry litter/waste, beef manure.

These improved fertilizer by-product features should allow these products to be sold at a higher price than unprocessed or composted poultry litter.

Another advantage that may be derived from combusting or gasifying poultry litter and converting it into a fertilizer by-product is that the use of this by-product would not be subject to the same CAFO requirements as unprocessed poultry litter. The removal of this restriction would put processed poultry litter into the same category as agricultural fertilizer products. Since CAFO regulations in the poultry industry are only being implemented now, the actual cost savings associated with non-compliance with them can only be estimated. FBA’s preliminary estimate of savings associated with CAFO non-compliance would be from $3.00/Ton to $7.00/Ton of poultry litter. If WMC members incorporated this cost savings into the value analysis of their poultry litter, it would significantly reduce the feedstock cost for the WMC conversion facility.

It should be noted that feedstock purity could be important to the marketing of fertilizer by-products. Mixing municipal sludge or some other secondary feedstock with the primary feedstock (poultry litter/waste) could significantly lower its value and the size of the markets that can be accessed.

The results of this research could have a significant impact on the marketability and value of process poultry litter by-products.

FBA primarily examined by-product fertilizer markets outside of the study region because of the heavy concentration of CAFOs inside of the region. The improved transportability and value of these products should make these markets much more available.

F. Product and By-Product Market Development

FBA has developed a summary of the current market situation for the two primary products, **process steam** and **renewable electrical power**, and the fertilizer by-product that would be produced at the WMC biomass conversion plant. The market development summary provided below also defines the primary "target" location for each of these products and by-products. The product market that is most troublesome to this project is the "green" renewable product market. Although this is a rapidly developing market, its anticipated size within the next five years may not be large enough to generate sufficient market access for the WMC project. Although legislative changes in Michigan and at the national level may improve the situation it may not be fast enough to generate sufficient market access for this product.

Market Development for WMC Biomass Conversion Plant Products and By-Products			
Primary Products and By-Products	**Market Constraints**	**Current Market Description**	**Primary "Target" Market Location**
Process Steam (Thermal Energy)	WMC Plant must be located within one mile of proposed steam host.	Lower cost alternative energy sources to natural gas.	Within or very near Western Michigan poultry production region.
Renewable Electricity ("Green" Electrical Energy)	Access to electrical distribution grid.	Developing market, limited market size.	Any "green" power residential or industrial customer.
Fertilizer By-Product	Bulk density and nutrient concentration.	Well-developed market for commercial fertilizers.	Any Michigan agricultural crop producers within transportable distance of WMC plant.

FBA has done considerable research on the development of "green" power markets in Michigan. The results of that research have been rather disappointing. It appears that the State of Michigan is taking a rather non-progressive approach to developing renewable "green" power markets. For "green" power generating projects to develop in Michigan will require either one or all of the following:

1. A state-mandated renewable portfolio standard.
2. A federal mandated renewable portfolio standard.
3. State "green" power generating incentives.
4. Federal "green" power generating incentives.
5. Federal/State initiatives to improve private electrical generating company access to the electrical distribution grid and retail electrical power markets.

The current partially regulated system of electrical power generation and distribution has allowed large electrical power companies to control the generation and distribution of electrical power. This control has denied private electrical generating companies access to these markets.

This control of market access will be a considerable deterrent to the development of a “green” power generating industry. Because of the lower economy of scale associated with “green” power generation most of this capacity in this emerging industry will come from private companies that own and operate small “green” power generating plants. The current large economy of scale for electrical generating plants utilizing fossil fuel feedstocks will only be able to produce a small portion of the “green” electrical power that would be required by a 10% or 20% state or federal renewable portfolio standard.

Federal Renewable Energy Production Credits:
There is a Federal program that provides credits for Electricity produced from renewable sources. Initially, this program provided credits for electricity produced from “closed-loop” biomass facilities. It was later expanded to include electricity produced from poultry waste and wind. The current proposed Energy Bill would expand the Renewable Energy Production Credit to include all of the following as “qualified energy sources”:

- Wind
- Closed-Loop Biomass
- Open-Loop Biomass
- Geothermal Energy
- Solar Energy
- Small Irrigation Power
- Municipal Solid Waste

The definition of Closed-Loop and Open-Loop is as follows:

> **CLOSED-LOOP BIOMASS** – The term “closed-loop biomass” means any organic material from a plant that is planted exclusively for purposes of being used at a qualified facility to produce electricity.
>
> **OPEN-LOOP BIOMASS** –
> “(A) IN GENERAL—The term ‘open-loop biomass’ means—
> ‘‘(i) any agricultural livestock waste nutrients, or
> ‘‘(ii) any solid, non-hazardous, cellulosic waste material which is segregated from other waste materials and which is derived from
> ‘‘(I) any of the following forest-related resources: mill and harvesting residues, pre-commercial thinnings, slash, and brush,
> “(II) solid wood waste materials, including waste pallets, crates, dunnage, manufacturing and construction wood wastes (other than pressure-treated, chemically-treated, or painted wood wastes), and landscape or right-of-way tree trimmings, but not including municipal solid waste, gas derived from the biodegradation of solid waste, or paper that is commonly recycled, or
> ‘‘(III) agriculture sources, including orchard tree crops, vineyard, grain, legumes, sugar, and other crop by-products or residues.
> Such term shall not include closed-loop biomass.
> ‘‘(B) AGRICULTURAL LIVESTOCK WASTE NUTRIENTS.—

> ‘‘(i) IN GENERAL.—The term ‘agricultural livestock waste nutrients’ means agricultural livestock manure and litter, including wood shavings, straw, rice hulls, and other bedding material for the disposition of manure.
> ‘‘(ii) AGRICULTURAL LIVESTOCK.—
> The term ‘agricultural livestock’ includes bovine, swine, poultry, and sheep.

WMC’s poultry manure and litter are eligible feedstocks for the program.

The rate for the Renewable Energy Production Credit has increased over time to compensate for inflation. The rate has increased from 1.6¢ per kWh in 1995, to 1.7¢ per kWh in 1999, and finally 1.8¢ per kWh in 2003.

Eligible participants in the program must complete IRS form 8835 for the kilowatt-hours produced and sold. A copy of the 1999 form is shown on a subsequent page.

WMC has three potential options available to market their primary products:

- Sell electricity on the grid
- Sell electricity to the “green” market as a renewable fuel
- Sell the Steam to a nearby “steam host”

Although all of these options could be viable in the future, they all need to be developed. The renewable “green” market is the most financially attractive option, as electricity from renewable sources currently commands a premium of 1.5¢ to 3.0¢ per kWh and possibly an even greater premium if a Renewable Portfolio Standard (RPS) is enacted nationwide for Michigan specifically. It would be difficult to justify a renewable electricity market without a RPS in place. Even with an RPS established, the market would need to be developed by entrepreneurs. For instance, the biodiesel market, which is a renewable diesel fuel, is growing at a rate in excess of 100% per year due to hard work from both public and private entities.

Without the federal Energy Bill or legislation specific to Michigan, WMC would need to work closely with entities in Michigan that need steam and/or electricity and negotiate contracts for that energy.

Form **8835**

Department of the Treasury
Internal Revenue Service

Renewable Electricity Production Credit

▶ Attach to your return.

OMB No. 1545-1362

1999

Attachment Sequence No. 95

Name(s) shown on return | Identifying number

Part I Current Year Credit

	Electricity produced by closed-loop biomass facility placed in service after 1992 or poultry waste facility placed in service after 1999:		
1	Kilowatt-hours produced and sold . . . . ________ × 0.017	1	
2	Phaseout adjustment (see instructions) . . . . $________ × ____	2	
3	Credit for electricity produced by closed-loop biomass or poultry waste facility. Subtract line 2 from line 1	3	
	Electricity produced by wind facility placed in service after 1993:		
4	Kilowatt-hours produced and sold (see instructions) . . . . . ________ × 0.017	4	
5	Phaseout adjustment (see instructions) . . . . $________ × ____	5	
6	Credit for electricity produced by wind facility. Subtract line 5 from line 4	6	
7	Total credit before reduction. Add lines 3 and 6	7	
	Reduction for government grants, subsidized financing, and other credits:		
8	Total of government grants, proceeds of tax-exempt government obligations, subsidized energy financing, and any other credits allowed for the project for this and all prior tax years	8	
9	Total of additions to the capital account for the project for this and all prior tax years	9	
10	Divide line 8 by line 9. Show as a decimal carried to at least 4 places	10	
11	Multiply line 7 by line 10	11	
12	Current year credit. Subtract line 11 from line 7	12	
13	Renewable electricity production credit(s) from flow-through entities: If you are a— a Shareholder . . Then enter the credit(s) from— Schedule K-1 (Form 1120S), lines 12d, 12e, or 13 . . . ; b Partner . . . Schedule K-1 (Form 1065), lines 12c, 12d, or 13 . . . ; c Beneficiary . . Schedule K-1 (Form 1041), line 14	13	
14	**Total current year credit.** Add lines 12 and 13	14	

Part II **Tax Liability Limit** (See **Who Must File Form 3800** to find out if you complete Part II or file Form 3800.)

15	Regular tax before credits: • Individuals. Enter amount from Form 1040, line 40 . . . . • Corporations. Enter amount from Form 1120, Schedule J, line 3 (or Form 1120-A, Part I, line 1) • Other filers. Enter regular tax before credits from your return			15	
16a	Credit for child and dependent care expenses (Form 2441, line 9)	16a			
b	Credit for the elderly or the disabled (Schedule R (Form 1040), line 20)	16b			
c	Child tax credit (Form 1040, line 43)	16c			
d	Education credits (Form 8863, line 18)	16d			
e	Mortgage interest credit (Form 8396, line 11)	16e			
f	Adoption credit (Form 8839, line 15)	16f			
g	District of Columbia first-time homebuyer credit (Form 8859, line 11)	16g			
h	Foreign tax credit	16h			
i	Possessions tax credit (Form 5735, line 17 or 27)	16i			
j	Credit for fuel from a nonconventional source	16j			
k	Qualified electric vehicle credit (Form 8834, line 19)	16k			
l	Add lines 16a through 16k			16l	
17	Net regular tax. Subtract line 16l from line 15			17	
18	Alternative minimum tax: • Individuals. Enter amount from Form 6251, line 28 . . . . • Corporations. Enter amount from Form 4626, line 15 . . . . • Estates and trusts. Enter amount from Form 1041, Schedule I, line 39			18	
19	Net income tax. Add lines 17 and 18			19	
20	Tentative minimum tax (see instructions)	20			
21	If line 17 is more than $25,000, enter 25% (.25) of the excess (see instructions)	21			
22	Enter the greater of line 20 or line 21			22	
23	Subtract line 22 from line 19. If zero or less, enter -0-			23	
24	**Renewable electricity production credit allowed for current year.** Enter the smaller of line 14 or line 23 here and on Form 1040, line 47; Form 1120, Schedule J, line 4d; Form 1120-A, Part I, line 2a; Form 1041, Schedule G, line 2c; or the applicable line of your return			24	

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V. Biomass Conversion Project Financial Analysis

From an analysis standpoint, FBA has narrowed the focus of this report to three commercializable technologies: Direct Fire, Gasification, and Anaerobic Digestion. Fast Pyrolysis was found to be in the early stages of commercialization and is therefore being dropped as a viable technology from this analysis.

A. Revenue Comparison:

In order to compare the three technologies, the following assumptions have been made. FBA estimates these are the highest values probable for the outputs.

1. Steam Host Steam Value = $6.00 per 1000 pounds of steam. The steam value is stipulated by the size of the co-generation plant; i.e. it is fixed. Therefore the revenue is identical regardless of technology plant size: 25,000 pounds per hour, at $6 per 1,000 lbs. = $1,188,000 potential revenue.
2. Electricity Generated Value = $0.05 per kWh average
3. Ash Value = $50 per ton net for Direct Fire & Gasification, $21/ton for liquid fertilizer product from anaerobic digestion
4. Simple payback = 8 years, i.e. 12% return

By assuming a return on investment, a model can be developed which reflects the maximum cost of delivered feedstock allowable. This is based on the following formula:

Revenue - Feedstock Cost – Operating Cost = Return

By rearranging the formula,

Revenue - Operating Cost – Return = Feedstock Cost

For the 150 TPD plant the model would be as follows:

Plant Size =50,000 Tons Per Year (150TPD)			
Revenue Streams	**Direct Fire**	**Gasification**	**Anaerobic Digestion**
Steam Revenue	$ 23.76	$ 23.76	$ -
Power Revenue	$ 8.35	$ 14.91	$ 11.67
Fertilizer Revenue	$ 5.72	$ 8.15	$ 9.79
Total Revenue	**$ 37.83**	**$ 46.82**	**$ 21.46**
Oerating Cost + Return			
Operating Cost	$ 25.76	$ 24.09	$ 14.64
Return @ 12%	$ 30.46	$ 26.91	$ 27.75
Total	**$ 56.22**	**$ 51.00**	**$ 42.39**
Maximum Feedstock Cost	**$ (18.39)**	**$ (4.18)**	**$ (20.93)**

The above table suggests that the Direct Fire plant must have the feedstock delivered to the plant for a $18.39 tipping fee to produce a 12% return on the investment; i.e. the plant must be paid to accept the feedstock. Gasification and Anaerobic Digestion must also have the feedstock delivered to the plant, for a $4.18 and $20.93 tipping fee in order to produce a return.

For the 300 TPD plant the model would be as follows:

Plant Size =100,000 Tons Per Year (300TPD)			
Revenue Streams	**Direct Fire**	**Gasification**	**Anaerobic Digestion**
Steam Revenue	$ 11.88	$ 11.88	$ -
Power Revenue	$ 17.34	$ 16.79	$ 11.67
Fertilizer Revenue	$ 5.72	$ 8.15	$ 9.79
Total Revenue	**$ 34.94**	**$ 36.82**	**$ 21.46**
Oerating Cost + Return			
Operating Cost	$ 17.84	$ 16.66	$ 10.14
Return @ 12%	$ 25.66	$ 22.70	$ 23.40
Total	**$ 43.50**	**$ 39.36**	**$ 33.54**
Maximum Feedstock Cost	**$ (8.56)**	**$ (2.54)**	**$ (12.08)**

The above table suggests that the Direct Fire plant must have feedstock delivered to the plant for an $8.56 tipping fee to produce a 12% return on the investment, the Gasification plant must have feedstock delivered to the plant for $2.54, and the Anaerobic Digestion plant must have feedstock delivered to the plant for an $12.08 per ton tipping fee in order to produce a return.

For the 450 TPD size plant the table would be as follows:

Plant Size =150,000 Tons Per Year (450 TPD)			
Revenue Streams	**Direct Fire**	**Gasification**	**Anaerobic Digestion**
Steam Revenue	$ 7.92	$ 7.92	$ -
Power Revenue	$ 20.33	$ 19.68	$ 10.38
Fertilizer Revenue	$ 4.88	$ 8.17	$ 8.70
Total Revenue	**$ 33.13**	**$ 35.77**	**$ 19.08**
Operating Cost + Return			
Operating Cost	$ 14.17	$ 12.05	$ 10.91
Return @ 12%	$ 24.77	$ 22.40	$ 20.70
Total	**$ 38.94**	**$ 34.45**	**$ 31.61**
Maximum Feedstock Cost	**$ (5.81)**	**$ 1.32**	**$ (12.53)**

For the largest size plant the Direct Fire and Anaerobic Digestion facilities would have to have feedstock delivered for a tipping fee of $5.81 and $12.53, respectively. The Gasification facility could pay up to $1.32 per ton delivered.

Because the steam revenue is independent of size of the co-generation plant the potential steam revenue remains the same regardless of the plant size, although when viewed on a per ton basis it drops significantly with plant size. The power revenue however increases with the size of the plant. A comparison of the steam revenue vs. the electric power revenue as the plant size increases is shown below.

Steam Revenue vs. Electric Power Revenue						
Direct Fire	**150 Tons/Day**		**300 Tons/Day**		**450 Tons/Day**	
Steam Revenue	$ 1,188,000	$ 23.76	$ 1,188,000	$ 11.88	$ 1,188,000	$ 7.92
Power Revenue	$ 417,384	$ 8.35	$ 1,733,688	$ 17.34	$ 3,049,200	$ 20.33
Fertilizer Revenue	$ 286,100	$ 5.72	$ 572,200	$ 5.72	$ 731,400	$ 4.88
Total Revenue	$ 1,891,484.00	$ 37.83	$ 3,493,888.00	$ 34.94	$ 4,968,600.00	$ 33.12
Gasification	**150 Tons/Day**		**300 Tons/Day**		**450 Tons/Day**	
Steam Revenue	$ 1,188,000	$ 23.76	$ 1,188,000	$ 11.88	$ 1,188,000	$ 7.92
Power Revenue	$ 745,668	$ 14.91	$ 1,679,436	$ 16.79	$ 2,951,388	$ 19.68
Fertilizer Revenue	$ 407,500	$ 8.15	$ 815,000	$ 8.15	$ 1,225,400	$ 8.17
Total Revenue	$ 2,341,168.00	$ 46.82	$ 3,682,436.00	$ 36.82	$ 5,364,788.00	$ 35.77
Anaerobic Digestion	**150 Tons/Day**		**300 Tons/Day**		**450 Tons/Day**	
Steam Revenue	$ -	$ -	$ -	$ -	$ -	$ -
Power Revenue	$ 583,704	$ 11.67	$ 1,167,408	$ 11.67	$ 1,556,676	$ 10.38
Fertilizer Revenue	$ 489,300	$ 9.79	$ 978,600	$ 9.79	$ 1,304,793	$ 8.70
Total Revenue	$ 1,073,004.00	$ 21.46	$ 2,146,008.00	$ 21.46	$ 2,861,469.00	$ 19.08

B. Foundry Sand

According to EPI, spent foundry sand can be used as a bed media in their Direct Fire system. The feedstock (poultry litter, for example) is used as an energy source and the heat generated bakes the bed media foundry sand clean of its binding material. The recycled sand is then sold back to a foundry. At this time there are no quantified numbers as to how much additional revenue this may generate; determining the amount of foundry sand that could be recycled through the system would require detailed analytical work by a technology vendor at additional cost. By making the following assumptions, however, an estimate can be made:

Assume that one ton of spent foundry sand per hour can be recycled in the system; it is not necessary to continuously recycle sand as once recycled it can be left in the system as a bed media—this is an assumed maximum. This equates to 24 x 330 = 7,920 tons per year, say 8,000 tons per year. At typical truck can hold 25 tons of material foundry sand. At a transport cost of $2/mile and an optimum distance from a foundry of 25 miles, a truck load costs about $2/ton to transport to and from the processing facility ($4/ton round trip). Since a typical recycling facility costs about $30 per ton to recycle “spent” foundry sand; it is reasonable to assume that clean or recycled sand has a value of $30 or more per ton. The potential revenue from recycling spent foundry sand is therefore about $26/ton ($30/ton - $4/ton).

8,000 Tons/Year X $26/Ton = $208,000

This revenue assumes a ready supply of spent foundry sand, that the foundry allows the recycler to pick up the spent sand at no cost, and that the foundry purchases the sand back from the recycler. It also assumes that ash remaining in the foundry sand does not further reduce its value. Other costs which would negatively impact using foundry sand as a bed media include the capital and operating costs for the handling and storage system, plus the energy cost from removing bed media on a continuous basis.

VI. Project Information Dissemination

FBA provided an article for the Michigan Allied Poultry Industries (MAPI) newsletter in May of 2003. A copy of this article is contained in the Addenda of this report. This article informed all Michigan poultry producers of the following:

1. The purpose of the WMC feasibility study for a poultry litter to energy conversion project.
2. The potential benefits that may accrue to the project.
3. How non-WMC members may be able to participate in the project.
4. How additional markets for poultry waste/poultry litter generated products may be developed with this project. (Thermal energy; “green” electrical power; and concentrated poultry ash fertilizer.)

This update article will provide more specific information on some of the feasible technologies and the economics associated with their commercialization.

VII. Financial Conclusions

A. Feedstock Value

The value of the turkey litter/poultry waste feedstock was estimated at $0 delivered to the WMC plant, for the base case model. This current low cost of feedstock is required to make the WMC plant economically viable basis the current availability of biomass conversion technology and current product values. If either of these improve in the future the value of the turkey litter/poultry waste feedstock will also improve. The current $0 value of the feedstock represents a delivery cost but no tipping or disposal fee. This would still be a significantly better option than having to pay a landfill access fee.

B. Return on Investment Analysis

A 15% to 20% return on investment will be required to attract equity capital and borrowed capital for the project. The current ROIs are subject to change if significant changes take place in the value of renewable electrical energy or other co-product values. Additionally, project ROI projections could improve if the value of unprocessed turkey litter and poultry waste drop (i.e. higher tipping fees) because of increased environmental pressure or the reduction of land application rates in Western Michigan.

A proforma grid was prepared for each size of each technology, 150 tons per day, 300 tons per day, and 450 tons per day. The grids (copies of which are included in the Addenda, as well as a fully-interactive version attached electronically) take into account Product Values and Feedstock Costs to generate a Net Operating Income Before Taxes. The resulting Return on Investment was averaged over the first 10 years of the project, under various equity ratios. The results are summarized below.

ROI Calculations/Equity Ratio Adjustment (10-Year)

	Direct Fire (tpd)			Gasification (tpd)			Anaerobic Digestion (tpd)		
Ratio*	50	100	150	50	100	150	50	100	150
30/70	-16%	0%	-1%	0%	13%	10%	-28%	-8%	-24%
40/60	-11%	1%	0%	2%	11%	8%	-19%	-5%	-17%
50/50	-8%	2%	0%	3%	10%	7%	-13%	-3%	-13%

* %Capital Investment/%Amount Financed

An initial analysis of these results shows a poor ROI return for three typical equity ratios. Since the most probable equity ratio is in the 40% to 60% of capital investment to obtain available financing, there is still no scenario that yields the required 15% to 20% ROI requirement to make the project financially attractive.

Anaerobic Digestion uses all generated heat for internal processes so there is no process steam, and thus no steam revenue. This is different than Direct Fire and Gasification systems. A study of the combined revenue streams for all three technologies (including steam revenue if applicable, electricity generation, and ash fertilizer revenue) indicates that Anaerobic Digestion clearly is at a disadvantage to Direct Fire and Gasification, with substantially less potential returns on investment in all size categories. For this reason, it is being dropped from further analysis.

C. Sensitivity Analysis of Capital Cost, Operating Costs, and Product Values

Because the two best technologies for this project are Direct Combustion and Gasification, only these two technologies will be analyzed with a Sensitivity Analysis. The following factors were assumed for the baseline analytical approach for both technologies:

- A power value of 0.05¢ per kWh for Renewable Electricity.
- Feedstock Cost of $0 for 50,000 tpy and 100,000 tpy (poultry litter cost), and $25 per ton for 150,000 tpy (50,000 tons of wood chips).
- Fertilizer Value of $50 per ton for ash fertilizer.

Once a baseline has been established the Sensitivity Analysis adjusts the above factors to assume variation in both revenue and costs. These results are summarized in the following table.

	Average Return on Investment (10-Years)					
	Direct Combustion			**Gasification**		
	50,000	100,000	150,000	50,000	100,000	150,000
Feedstock Cost						
$0	-11%	1%	0%	2%	11%	8%
- $5	-6%	7%	4%	8%	18%	12%
- $10	-1%	13%	8%	14%	25%	17%
- $20	9%	25%	16%	25%	38%	26%
Power Value/kWh						
5¢	-11%	1%	0%	2%	11%	8%
6¢	-9%	6%	5%	6%	16%	13%
7¢	-7%	10%	10%	9%	20%	19%

8¢	-6%	14%	15%	12%	25%	24%
Fertilizer Value/Ton						
$50	-11%	1%	0%	2%	11%	8%
$75	-8%	5%	3%	7%	17%	14%
$100	-5%	8%	6%	11%	22%	19%
Federal Renewable Energy Credit						
0¢/kWhr	-14%	-6%	-9%	-4%	3%	-2%
1.8¢/kWhr	-11%	1%	0%	2%	11%	8%
Green Energy Premium						
0¢/kWhr	-11%	1%	0%	2%	11%	8%
1.5¢/kWhr	-8%	8%	7%	7%	18%	16%
3¢/kWhr	-6%	14%	15%	13%	25%	24%

Feedstock Sensitivity:
The feedstock cost creates an improvement of 16% to 27% in the ROI as the feedstock realizes a tipping fee to the plant (from $5 to $20 per ton). The largest increase in potential revenue as a result of increasing feedstock cost is in the middle plant size (i.e. 100,000 tpy).

Power Value Sensitivity:
The ROI improves from 5% to 16% when the power value increases to 8¢, with the greatest change in revenue occurring in the largest plant size, 150,000 tpy, for both Direct Combustion and Gasification.

Fertilizer Value Sensitivity:
As the Fertilizer Value increases from $50/ton to $100/ton, the ROI increases from 5% to 11%. The highest increases occur in the medium sized plants (100,000 tpy).

Federal REC Sensitivity:
The base case scenario includes a Green Power Credit for sale of the renewable electrical energy of 1.8¢ per kilowatt-hour. If this Credit is remove the ROI decreases from 3% to 10%, with the largest drop occurring in the 150,000 tpy plant.

Green Power Premium Sensitivity:
Realizing a premium for sale of Green Power of 1.5¢ to 3¢ garners an additional 5% to 16% in ROI. The 150,000 tpy plant shows the most significant increase in potential ROI.

Summary
In all of the scenarios above the greatest profitability increases occur in the 100,000 tpy plant, as a result of tipping fees for feedstock. The least sensitive adjustment to potential ROI occurs with the loss of the Federal Renewable Energy Credit or an increase in the fertilizer value per ton. As the feedstock cost has proven to be the most sensitive adjustment, a tipping fee may be required in order to make the project feasible without higher value products and by-products.

VIII. Recommendations for Commercialization

1. Sensitivity Analysis of Capital Cost, Operating Costs, and Product Values – A sufficient amount of turkey litter and poultry waste must be made available to support a 300 ton per day (100,000 tpy) biomass conversion plant operating on a continuous basis throughout the year. One option for procuring this feedstock is to form a poultry producer cooperative to market all of the poultry waste products committed to the cooperative.

2. Adequate Primary Product (Renewable Electric Power) Market Value – The value of renewable electric power must increase in Michigan before commercializing this project. Several courses of action to increase renewable electrical power values are as follows:

   a. Adoption of a state renewable portfolio standard (RPS) in Michigan. Currently there are thirteen states that have an RPS for their state.
   b. Passage of a federal renewable portfolio standard. This legislation may appear in the final version of the Federal Energy Bill that is anticipated in January or February of 2004.
   c. Adoption of additional state and federal tax incentives for renewable electricity generation and distribution. These incentives could be made specific to livestock waste conversion to electricity.
   d. Passage of state legislation to improve market access to current Michigan electrical customers.

3. Capital Cost Investment Assistance – State and Federal program grants to assist with the construction of renewable electrical generating plants that utilize livestock wastes as plant feedstocks. This type of assistance should be aggressively pursued by WMC as a method of dealing with rising livestock waste disposal costs in Western Michigan.

4. Relationship With Selected Steam Host – A long-term relationship with the selected steam host will be needed to gain long-term supply agreements for the steam host's electrical and process steam needs.

Conclusions

The feasibility study yielded the following set of conclusions in the areas of feedstock, processing technology, product markets, and financial.

A. Feedstock Feasibility Factor Conclusions

1. Feedstock Availability – There is sufficient primary feedstock (turkey litter, layer waste and poultry litter) produced in Western Michigan to supply a 300 tpd/100,000 tpy biomass conversion to electricity plant.

2. Feedstock Quality – The primary feedstock has significant disadvantages to coal, which is the biomass feedstock of choice for electrical generation in the U.S. Those disadvantages are as follows:

		Turkey Litter	Coal
1	Bulk Density	20#/cu ft	60#/cu ft
2	BTU Content	5,000 BTU/lb	12,500 BTU/#
3	Storability	Biodegradable	Non-biodegradable
4	Quality Deterioration (while in storage)	Significant	Minimal
5	Odor & Other Emissions (while in storage)	Significant Issue	Non-Issue

3. Feedstock Cost/Value – The disadvantages that turkey litter and other poultry wastes have compared to coal render them a value somewhat less than coal. If the average U.S. price of coal is $50.00/ton, then the value of turkey litter or an equivalent BTU basis would only be $20.00/ton. With the significant disadvantages that turkey litter and other poultry wastes have compared to coal the value cost would be reduced to $10.00/ton or less.

4. Feedstock Renewability – The renewable feature associated with turkey litter and other poultry waste may increase their value as electrical generation feedstocks. This is the one advantage that they have over coal, which is a non-renewable feedstock. This renewable feature allows for the generation of “green” electrical power that cannot be supplied by coal.

5. Alternative Feedstocks – There are other renewable biomass feedstocks available in Western Michigan that can be substituted for the primary feedstocks or utilized to increase the size of the conversion plant. However, getting access to them at a value comparable to the primary feedstock may be difficult.

B. Processing Technology Factor Conclusions

1. Commercially Viable Technologies – The feasibility study yielded only two commercially viable technologies for conversion of turkey litter and other poultry wastes into electrical power—direct combustion and gasification. Both of these

technologies would produce thermal energy, which would be converted into high-pressure steam, 600 psig. This steam would be utilized to rotate a turbine connected to an electrical generator.

2. Economy of Scale – From the capital cost estimates it is clear that the larger the plant, the better the economy of scale. For the technologies examined the economy of scale for the three sizes is as follows:

	Capital Cost per Ton per Day of Feedstock		
	150 WTD	**300 WTD**	**450 WTD**
Direct Fire	$81,233	$68,433	$66,044
Gasification	$71,766	$60,533	$59,733
Anaerobic Digestion	$74,000	$62,400	$55,200

3. Capital Cost Requirements – The capital cost of 100,000 ton per year litter co-generation plant ($18 million, $180/ton of feedstock) is significantly higher than other comparable biofuel plants. For example, a 30 million gallon per year dry grind ethanol plant processing approximately 11 million bushels of corn (300,000 tons) will have a capital cost of $36 million or $120/ton. A significant portion of this capital cost is associated with the lower feedstock quality of turkey litter and poultry wastes compared to other agricultural unprocessed feedstocks such as whole corn.

C. Product Market Factor Conclusions

1. Electrical Market Access – The primary product produced from the turkey litter/ poultry waste co-generation plant is electricity. To gain access to all of the current electrical consumers would require placing the electrical product into the electrical distribution grid for transport to these customers. The primary power producer in Michigan, i.e. as Consumer's Power, has developed a regulated rate structure that significantly reduces the value of the product when distributed in this manner. This value reduction results in a significant loss of market access for electricity produced by small generating plants such as the proposed Western Michigan Co-Gen Plant

2. Renewable Electrical Market Access – With access to the bulk of the Michigan electrical consumers market denied, another option of gaining electrical market access is the developing renewable electricity market. This emerging market may offer Western Michigan Co-Gen its best market access opportunity for the following reasons:
    a) The current electrical generating industry is not capable of supplying renewable power in any significant quantities.
    b) Renewable electrical generation favors smaller economy of scale plants like Western Michigan Co-Gen.
    c) Renewable electricity currently sells at a premium to non-renewable electricity. This offers a higher value marketing opportunity to Western Michigan Co-Gen than selling it to just the steam host.

3. Steam Product Markets – To gain the advantage of co-generation requires access to a steam market. To gain this market access, the Western Michigan Co-Gen plant

must be located near (within one mile) a steam host market. To gain long-term market access to this steam host market will require some type of long-term agreement. Negotiating and executing a mutually acceptable agreement for Western Michigan Co-Gen and the steam host will require a significant amount of trust and time to develop.

4. Ash Co-Product Markets – Although the ash is the least value-added product produced at the WMC plant, it is an important product. Being able to market this product into the agricultural fertilizer market results in minimal or no waste product produced in the plant. This is important to the economic feasibility of the project. There may be other value-added opportunities associated with the ash co-product that may develop in the future. Also the value of this product may increase if phosphorous and potash nutrient costs increase in the future. It should be noted that steam and electricity are commodities and therefore have very limited quality differentials or value-added opportunities.

5. Steam and Electrical Values to Steam Host – Being able to supply both the electrical and steam needs of the steam host will be important in developing a long-term agreement with the steam host. The value of the electrical and steam products to the steam host will be limited by the amount that is currently being paid for retail electrical power, and generation energy source (such as natural gas) and the current cost of converting natural gas into steam. To gain market access WMC will have to discount their electrical and steam products sufficiently to gain market access to the steam host's energy requirements.

6. Renewable Energy Credits (Green Tags) – Renewable Energy Credits (RECs) may have value to the steam host customers. These tradable renewable credits represent the environmental attributes. A number of power generators may offer these credits to their electrical customers. These credits may have economic value to the steam host if the host would like to resell them. This addition of RECs may provide sufficient additional economic incentive to allow them to pay comparable retail values for the process steam and electricity.

7. Steam Host Sites – Of the five potential sites reviewed in the study there are only two that are viable at this time. Those sites are Kruger Commodities, near Hamilton, Michigan; and the Wyoming/Grand Rapids Municipal Treatment Plants in Grand Rapids, Michigan. The remaining three sites considered in the feasibility study may become viable if certain current conditions change. Therefore these sites should be reevaluated whenever the project moves closer toward commercialization in the future.

Addenda

May 29, 2003

West Michigan Co-Gen Members:
Brian Terborg
Chuck Pistis
Dick Patmos
Edward Hanenburg
Fred Walcott
Harold Walcott
Mike Wenkel
Rob Kamps
Harley Sietsema

Gentlemen:

As a follow up to my presentation to WMC on April 29th I have attached a Feedstock Commitment Survey, to be completed by each WMC Member. This survey includes those issues that were to be resolved during the 2nd Quarter of the project. Please answer each question as fully as possible and return this Feedstock Survey no later than Friday, June 13th so FBA can include the information in the Second Quarter Interim Report.

Please contact myself or Gerald Sherfy at (901) 725-7258 if you have any questions. Submit the completed Survey by email or fax to:

Email: fbaRod@FrazierBarnes.com
Fax: (901) 725-7245

Thank you for your assistance in this matter.

Thank you,

Rodney Frazier
President

WMC Member Feedstock (Poultry Waste) Commitment Survey

1. What is your annual production of poultry?
   Number of Turkeys _____________
   Number of Layers ______________
   Number of Pullets ______________
   Other _________________________

2. Please allocate this production to the County and township(s) that it is being produced.

3. What is your estimated annual production of poultry waste?
   Turkey Litter ___________________
   Layer Waste ____________________
   Other __________________________

4. The plant sizes being considered for the Biomass Conversion Project are 300 tons per day (100,000 tons annually), and 450 tons per day (150,000 tons annually). How many tons per year of poultry waste feedstock will you commit to the Project? Describe the form it will take (turkey litter, layer waste, etc.).

5. What is your poultry waste storability? How long are you currently storing it?

6. Does your poultry waste moisture content vary from season to season? If so, how much?

7. Are there other poultry waste compositional components that vary from season to season, i.e. phosphorous, nitrogen, or ash content?

8. Can poultry waste feedstock quality be preserved with your current storage methods? If not, what changes in storage would be required to preserve feedstock quality?

9. Have you had any complaints about your current poultry waste storage, such as odor or runoff?

10. What are your estimated poultry waste removal and storage costs?

11. What are your transportation costs (per mile basis) for poultry waste transported from your farm to end-users?

12. How many tons are transported in each load of poultry waste?

FRAZIER & BARNES Associates
Technical & Marketing Services

June 6, 2003

«First» «Last»
«Company»
«Address»
«City», «State» «Zip»

Dear «Salut» «Last»,

A group of Western Michigan Poultry Producers recently formed a company, West Michigan Co-Gen, LLC (WMC), to investigate methods of adding value to their poultry litter and layer waste production. One alternative that shows promise is the conversion of this renewable biomass product into thermal (steam) energy and electrical power. To determine the feasibility of this biomass cogeneration project, WMC has partnered with Michigan Biomass Energy Program (MBEP) and engaged Frazier Barnes & Associates (FBA) of Memphis, TN to conduct a project feasibility study.

In addition to adding value to their poultry waste, WMC members are looking for alternative markets besides direct application to agricultural cropland. It is anticipated that impending state and federal CAFO regulations will significantly reduce the volume of animal livestock waste products that can be applied to Western Michigan cropland. The relatively low moisture content (20% to 30%) of poultry litter and layer waste makes these livestock waste biomass products suitable for conversion to value-added energy products.

The first quarterly project report, completed in April, showed that the proposed feedstock requirements for the biomass conversion project are large enough that all Western Michigan poultry producers may be able to participate.

As a poultry producer in Western Michigan, FBA is asking for your assistance in determining how much poultry litter or layer waste is being produced in Western Michigan. From this information FBA will be able to determine a plant size that best fits the availability of poultry litter and layer waste being produced in Western Michigan. FBA would appreciate you taking a few minutes to fill out the enclosed survey and returning it in the enclosed self-addressed envelope. This information will be kept confidential, and will only be used for this project.

Thank you for your assistance.

Sincerely,

Gerald Sherfy
Project Coordinator
Frazier, Barnes & Associates

Western Michigan Poultry Litter and Layer Waste Survey (CONFIDENTIAL)

1. What is your annual production of poultry?
   Total Number of Turkeys ___________
   Number of Layers _____________
   Number of Pullets _____________
   Other Poultry Production___________

2. What is your estimated annual production of poultry litter or layer waste?
   Poultry Litter _________________
   Layer Waste __________________

   If known, please allocate by poultry site location:
   Site #1 County ___________ Township ______________ Volume _____________
   Site #2 County ___________ Township ______________ Volume _____________
   Site #3 County ___________ Township ______________ Volume _____________
   Site #4 County ___________ Township ______________ Volume _____________
   Site #5 County ___________ Township ______________ Volume _____________

3. What is your poultry waste storability? How long are you currently storing it?

4. Does your poultry waste moisture content vary from season to season? If so, how much?

5. Are there other poultry waste compositional components in your products that vary from season to season, i.e. phosphorous, nitrogen, or ash content?

6. What are your estimated poultry waste removal and storage costs?

7. What are your transportation costs (per mile basis) for poultry waste transported from your farm to end-users?

8. How many tons are transported in each load of poultry waste?

9. If the poultry litter or layer waste was picked up at your production facility as it is produced (in other words, according to your schedule) would you expect a payment for this product? If so, how much would you expect to receive for it?

West Michigan Co-Gen Biomass Conversion Project Update

A group of Western Michigan Poultry Producers recently formed a company, West Michigan Co-Gen, LLC (WMC), to investigate methods of adding value to their poultry litter production. One alternative that shows promise is the conversion of this renewable biomass product into thermal (steam) energy and electrical power. To determine the feasibility of this biomass cogeneration project, WMC has partnered with Michigan Biomass Energy Program (MBEP) and engaged Frazier Barnes & Associates (FBA) of Memphis, TN to conduct a project feasibility study.

For this project to be viable, WMC must locate a steam host in Western Michigan that utilizes large quantities of process steam and electrical energy. A WMC owned and operated biomass conversion facility located at the steam host site, could produce sufficient electrical energy and process steam to meet the steam hosts needs as well as provide renewable "green" electrical power and process steam for other regional consumers and industrial users.

In addition to adding value to their poultry litter, WMC members are looking for alternative markets besides direct application to agricultural cropland. It is anticipated that impending state and federal CAFO regulations will significantly reduce the volume of animal livestock waste products that can be applied to Western Michigan cropland. The relatively low moisture content (20% to 30%) of poultry litter and layer waste may make these livestock waste biomass products more suitable for conversion to value-added energy products than swine and dairy waste biomass products that have much higher moisture content.

Within the content of the feasibility study, FBA will provide regional biomass feedstock analysis, a comparison of four biomass conversion technologies, product marketing and project financial analysis.

The first FBA quarterly project report was completed in April and presented to the WMC members. This report showed that there are sufficient biomass feedstock requirements that non-WMC poultry producers may be able to participate. If you have layer waste production or poultry litter production that you may have interest in processing further, please contact:

Rod Frazier or Gerald Sherfy
WMC Biomass Conversion Project Coordinators
Frazier, Barnes & Associates
1835 Union Avenue, Suite 110
Memphis, TN 38104
Voice: (901) 725-7258
Fax: (901) 725-7245
Email: fbaRod@FrazierBarnes.com
fbaGerald@FrazierBarnes.com

FERTILIZER CONTACTS					
Unit Name	**Street**	**City**	**State**	**Zip**	**Phone Num**
Access Business Group, LLC	7575 E. Fulton Rd	Ada	MI	49355-0001	(616) 787-6139
Agro-Culture Liquid Fert	3026 West M-21	St. Johns	MI	48879	(989) 224-4117
Anderson Fert Services Inc	2301 W. Dewey Rd	Owosso	MI	48867	(989) 723-5205
Arends Farms	22644 40th Ave	Conklin	MI	49403	(616) 899-2136
Auburn Bean & Grain/Fert Div	Box 87, 4640 S. 7 Mile Rd	Auburn	MI	48611	(989) 667-0804
Barks Farm	3600 E Centerline Rd	St. Johns	MI	48879	(989) 224-6969
Barney's Produce, Inc	Box 147, 27910 C.R. 215	Bangor	MI	49013	(616) 427-8206
Battle Creek Farm Bureau Assn	Box 205, 14325 O.P. Ave	Climax	MI	49034	(616) 746-4286
Big Rapids Farm & Garden	310 N. Fourth Ave	Big Rapids	MI	49307	(231) 796-6363
Bio-Ag of Michigan, Inc	Box 243, 246 Cross Rd	Kinde	MI	48445	(989) 874-6009
Blenco, Inc	1174 Comstock St	Marne	MI	49435	(616) 677-5321
Bradford Transport Inc	4580 Knowles Rd	North Adams	MI	49262	(517) 287-5108
Braun Agriservice Inc	4175 Whitmore Lake Rd	Ann Arbor	MI	48105	(734) 662-9400
Brink Terminal	1220 Holton Rd	Muskegon	MI	49445	(231) 744-1631
Britton Elevator Inc	128 N Main St	Britton	MI	49229	(517) 451-8001
Brown Milling Incc	8731 E. Rosebush Rd	Mr. Pleasant	MI	48858	(989) 433-5335
Caledonia Farmers Elevator Co	146 E. Main St	Caledonia	MI	49316	(616) 891-8108
Cheboygan Coop Co	418 Cuyler St	Cheboygan	MI	49721	(231) 627-4605
Cheevers	37 W. Third St	Shelby	MI	49455	(231) 861-2526
Citizens LLC	870 S. Main St	Vermontville	MI	49096	(517) 726-0514
Cold Springs Farm, Inc	7905 Babcock Rd	Jeddo	MI	48032-9010	(810) 327-6273
Community Mills Inc	PO Box 157	Cassopolis	MI	49031	(616) 445-2401
Cooperative Elevator Co	7211 E. Michigan Ave	Pigeon	MI	48755	(517) 453-4500
Cremer Farm Center	1784 Howell Rd	Williamston	MI	48895	(517) 655-1566
Crop Production Services	7121 Maple Valley Rd	Brown City	MI	48416	(810) 346-8266
Crop Services Int'l Inc	1718 Madison SE	Grand Rapids	MI	49507	(616) 246-7933
Deerfield Cooperative	185 Carey St	Deerfield	MI	49238	(517) 447-3101
Eaton Farm Bureau Coop	2166 E Clinton Trail	Charlotte	MI	48813	(517) 543-1160
Eau Claire Fruit Exchange	Box 327, 6485 W. Main St	Eau Claire	MI	49111	(616) 461-6767
Emerald Isle Ltd	2153 Newport Rd	Ann Arbor	MI	48103	(734) 662-2727
Falmouth Cooperative Co	260 E. Propser Rd	Falmouth	MI	49632	(231) 826-3301
Farmers Coop Elevator Co	Box 219	Hudsonville	MI	49426-0219	(616) 669-9596
Farmers Coop Grain Co	Box 246, 338 Main St	Kinde	MI	48445	(989) 874-4200
Fowler Farm City Sales	2876 W. Washington Rd	Ithaca	MI	48847	(989) 875-4454
Fowlerville Farm Services	320 Garden Lane, Box 335	Fowlerville	MI	48836	(517) 223-9148
Freeland Bean & Grain Inc	1000 E. Washington St	Freeland	MI	48623	(989) 695-9131
Freeport Elevator Inc	Box 2, 223 Division St	Freeport	MI	49325	(616) 765-8421
Fremont Coop- Hart	3 East Main St	Hart	MI	49420	(231) 873-2158
Fremont Co-Operative Produce	540 W. Main St	Fremont	MI	49412	(231) 924-3851
Frutchey Bean Co	310 W. Third St	Oakley	MI	48649	(989) 845-7667
Gallagher's	4227 Ostrum Rd	Belding	MI	48809	(616) 761-3243
Gallaghers- Ionia	301 Mill St	Ionia	MI	48846	(616) 761-3243
Granger III & Assc	Granger Compost Service	Lansing	MI	48906	(517) 371-9727
Green Valley Ag, Inc	3957 108th Street SE	Caledonia	MI	49316	(616) 891-0075
Groeninks Elevator & Hrdw	11260 Michigan Ave	Nunica	MI	49448-0007	(616) 837-7391
Gummer Peat Co Inc	Box 259, 9467 Jefferson Rd	Lakeview	MI	48850	(989) 352-6631
Hamilton Farm Bureau	4670 E. Washington	Hamilton	MI	49419	(616) 751-5171
Harvey's Milling Co Inc	729 W. Main St	Carson City	MI	48811-0189	(989) 584-3466
Heffron Farms	7724 Ashley Ave	Belding	MI	48809	(616) 794-2527
Helena Chemical Co	1718 Gooding Rd	Conklin	MI	49403	(616) 887-9933
Hemlock Elevator Co	485 S. Hemlock Rd	Hemlock	MI	48626	(989) 642-5291
Herbruck's Poultry Ranch	6425 W. Grand River Ave	Saranac	MI	48881	(616) 642-9421
Hoffman Dale & Sons Elev Inc	21521 E. Michigan Ave	Marshall	MI	49068	(616) 781-2245
Ida Farmers Coop Co	2953 Lewis Ave	Ida	MI	48140	(734) 269-3325
Ittner Bean & Grain	301 Park St	Auburn	MI	48611	(989) 662-4461
John Marion Inc	PO Box 224	Saline	MI	48176	(734) 429-5740

FERTILIZER CONTACTS					
Unit Name	**Street**	**City**	**State**	**Zip**	**Phone Num**
Kent City Farm & Garden	30 Spring St, Box 280	Kent City	MI	49330	(616) 678-3333
KMP Partnership	26390 Schrader Rd	Sturgis	MI	49091	(616) 268-5463
Krompetz Elevator, Inc	1919 Nickless Rd	Gladwin	MI	48624	(517) 426-1816
Lapeer Grain East	155 S. Saginaw St	Lapeer	MI	48446	(810) 664-2907
Lott Elevator Inc	1495 Cohoctah Rd	Cohoctah	MI	48816	(517) 546-4202
Mainestream Organics	2153 Newport Rd	Ann Arbor	MI	48103	(734) 662-2735
Mann & Sons E G Inc	8400 Boettner Rd	Bridgewater	MI	48115	(734) 429-7027
Marks Bros & Co Inc	110 E. Sherwood St	Decatur	MI	49145	(616) 423-2201
Marsh Greenhouses, Inc	31820 W. Jefferson	Rockwood	MI	48173	(734) 379-9641
Mason Elevator Co	104 S. Lansing St	Mason	MI	48854	(517) 676-1016
Maybee Farmers Inc	7751 Bluebush Rd, Box 188	Maybee	MI	48159	(734) 587-8975
McBain Grain Co	111 Maple St, Box 127	Mcbain	MI	49657	(231) 825-2172
MI Agricultural Commodities	306 N. Caroline	Middleton	MI	48856	(989) 836-7263
Michigan Gypsum Company	2840 Bay Rd	Saginaw	MI	48603	(989) 792-8734
Miller Feed, Inc	3443 M-55	Prescott	MI	48756	(989) 345-1753
Millington Elevator & Supply Co	8457 Elevator St	Millington	MI	48746	(989) 871-2171
Moline Cooperative Milling Co	1231 Peony St, Box 290	Moline	MI	49335	(616) 877-4631
MST Investment, LLC	100 S. Mable St, Box 67	Pinconning	MI	48650	(989) 879-2511
N F O Acres Coop Inc	Box 295, 709 W. US-10	Scottville	MI	49454	(231) 757-2881
Napoleon Feed Mill Inc	120 Dupot Ct	Napoleon	MI	49261	(517) 536-8311
North Central Cooperative, Inc	220 W. Garfield	Colddwater	MI	49036	(517) 278-4561
Northern Ag Supply Inc	216 S. West St	Henderson	MI	48841	(517) 725-7808
Northern Star Minerals	3893 Heritage Ave, St B3	Okemos	MI	48864	(517) 347-6800
Nu Gardener	1000 Highview Drive	Webberville	MI	48892	(800) 224-2988
Nu-Arbor Tree & Shrub Care Prod	1730 Olson	Grand Rapids	MI	49503	(616) 456-8026
Nu-Gro Tech, Inc	2680 Horizon Drive, SE F-5	Grand Rapids	MI	49546	(888) 370-1874
Ottawa Lake Co-Operative Elevator	7433 Lynch Rd	Ottawa Lake	MI	49267	(734) 856-2909
Practical Soy, LLC	12651 Island Lake Rd	Dexter	MI	38130	(734) 428-0214
Prattville Fert & Grain	12755 Kipp St	Prattville	MI	49271	(517) 383-2244
Pullen's Fertilizer & Lime	508 N. Main St	Hersey	MI	49639	(231) 832-5356
Ray Meesseman Company	46324 Fairwind Drive	Macomb	MI	48044	(586) 263-7600
Ray's Feed Mill Inc	1076 Old Hwy 2 & 41	Bark River	MI	49807	(906) 466-2231
Rogers Elevator Co	8352 N. Vassar Rd	Mt Morris	MI	48458	(810) 631-6736
S & S Agricultural Supply	Box 915, 320 B Park St	Coloma	MI	49038	(616) 468-4801
SCU Nitrogen Inc	2680 Horizon Drive, SE F-5	Grand Rapids	MI	49545	(888) 370-1874
Shady Side Farm Inc	13275 Blair	Holland	MI	49424	(616) 786-3827
Shemin Nurseries Inc	6900 Pardee Road	Taylor	MI	48180	(313) 291-1200
Shephaerd Elevator	Box 339, 414 W. Wright Ave	Shepherd	MI	48883	(989) 828-5985
Simons E R Co	108 E. Railway	Coleman	MI	48618	(989) 465-1581
Southern MI Ag Services	1086 East Chicago	Quincy	MI	49082	(517) 639-2945
Springport Elevator Inc	206 Railroad St	Springport	MI	49284	(517) 857-2610
Star of the West Milling	3269 S. Van Buren Rd	Richville	MI	48758	(989) 868-4186
Stephenson Marketing	Box 399, W. 505 S. Drive	Stephenson	MI	49887-0399	(906) 753-2207
Thumb Farm Service Inc	2222 N. Verona Rd	Ad Axe	MI	48413	(989) 269-7957
Total Agri Services Inc	12025 4 Mile Rd	Lowell	MI	49331	(616) 897-8488
Trestle Town Turkeys	3376 47th	Hamilton	MI	49419	(616) 751-8953
Turf Chemicals Inc	Box 451	Owosso	MI	48867	(989) 725-7145
Turner Bean & Grain Inc	119 S. Railroad	Turner	MI	48765	(989) 867-4253
UAP Great Lakes	221 W. Lake Lansing, St 102	East Lansing	MI	48823	(517) 333-8788
United Horticultural Supply	221 W. Lake Lansing, St 102	East Lansing	MI	48823	(517) 333-8788
Voyce's Elevtor Inc	Box 228	East Leroy	MI	49051	(616) 729-5503
Washington Elevator Co	7030 W. Road, Box 156	Washington	MI	48094	(586) 781-4822
West Branch Farmers	124 N. 8th St	West Branch	MI	48661	(517) 345-0428
Westphalia Milling Co	310 W. Main St	Westphalia	MI	48894-0156	(989) 587-4531
Zeeb Company	1106 E. Steel St, Box 412	St. Johns	MI	48879	(517) 224-3234
Zeeland Farm Services Inc	2468 84th Avenue	Zeeland	MI	49464-0290	(616) 772-9042
Zensen J R Farms Inc	22641 29 Mile Road	Ray	MI	48096	(810) 781-4822

FEASIBILITY LEVEL FINANCIAL PROFORMA FOR MICHIGAN BIOMASS PROJECT

DIRECT COMBUSTION TECHNOLOGY

TONS BIOMASS ANNUALLY 50,000 **Tons**

Assumptions:

Projected Volume	150	Tons per Day (TPD)		
Actual Capacity	137	Tons per Day (TPD)		
Total Project Cost	$12,185,000			
Equity Rations:	40%	Capital	60%	Financed
Equity Investment	$4,874,000	(Assumes Financed by Lenders @ 7% Interest, Amortized 15 years)		

This Proforma is Based on Pre-Design Criteria and does not reflect specific site adjustments pursuant to final engineering.

Product Value	**Vol./Hr.**	**Value**		**Val/Ton**
Process Steam (PPH)	25,000	$6.00	Thou.	$23.76
Renewable Electricity (Kw/Hr)	1,054	$0.050	kWh	$8.35
Coproduct Fertilizer (TPHr)	0.72	$50.00	/Ton	$5.72
		Total Product Value Per Ton:		$37.83

Feedstock:	**Tons**	**$ FOB Origin**	**Transp. Cost**	**$ FOB Plant**
Turkey Litter	25,000	$0.00	$0.00	$0.00
Layer Waste	25,000	$0.00	$0.00	$0.00
Wood Chips	0	$15.00	$10.00	$0.00
		Feedstock Cost Per Ton:		$0.00

					Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Capacity					75%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Total Product Value Per Ton (VPT)					$28.37	$37.83	$39.34	$38.96	$38.21	$36.69	$34.80	$37.45	$38.96	$38.21
Total Product Value (VPT * TPY)					$1,418,613	$1,891,484	$1,967,143	$1,948,229	$1,910,399	$1,834,739	$1,740,165	$1,872,569	$1,948,229	$1,910,399
Feedstock Cost Per Ton (FCPT)					$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total Feedstock Cost (FCPT * TPY)					0	0	0	0	0	0	0	0	0	0
Gross Margin					$1,418,613	$1,891,484	$1,967,143	$1,948,229	$1,910,399	$1,834,739	$1,740,165	$1,872,569	$1,948,229	$1,910,399
Gross Margin Per Ton					$28.37	$37.83	$39.34	$38.96	$38.21	$36.69	$34.80	$37.45	$38.96	$38.21
Operating Cost			Cost/Ton											
Plant Operating Cost			$25.76		873,457	1,164,610	1,164,610	1,164,610	1,164,610	1,164,610	1,164,610	1,164,610	1,164,610	1,164,610
Land Expense			$3.00		150,000	0	0	0	0	0	0	0	0	0
Depreciation Expense on Equity (13.5 Years)			$18.05		612,093	816,124	816,124	816,124	816,124	816,124	816,124	816,124	816,124	816,124
Interest Expense on Borrowed Funds			$6.31		383,828	491,404	469,613	446,296	421,347	394,652	366,088	335,525	302,822	267,830
Total Operating Cost			$53.12		2,019,378	2,472,138	2,450,347	2,427,030	2,402,081	2,375,386	2,346,822	2,316,259	2,283,556	2,248,564
Less Startup Cost Contingency (15% of Capital)					1,827,750									
REC	$0.018	per Kwh	$3.01	per Ton	112,694	150,258	150,258	150,258	150,258	150,258	150,258	150,258	150,258	150,258
Green Energy Pre	$0.000	per Kwh	$0.00	per Ton	0	0	0	0	0	0	0	0	0	0
Net Processing Income Before Taxes					-$2,315,821	-$430,396	-$332,945	-$328,543	-$341,424	-$390,388	-$456,399	-$293,431	-$185,069	-$187,907
Net Processing Margin Per Ton					-$46.32	-$8.61	-$6.66	-$6.57	-$6.83	-$7.81	-$9.13	-$5.87	-$3.70	-$3.76
Return on Equity Investment					-48%	-9%	-7%	-7%	-7%	-8%	-9%	-6%	-4%	-4%

Average ROI (10-Years) -11%

Land Value		
Year 1	$	154,500
Year 2	$	159,135
Year 3	$	163,909
Year 4	$	168,826
Year 5	$	173,891
Year 6	$	179,108
Year 7	$	184,481
Year 8	$	190,016
Year 9	$	195,716
Year 10	$	201,587
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At end of Useful Life	$	314,067

Equipment Salvage Value at End of Useful Life: $304,625

Simple Cash Flow And Financial Analysis*

50 Ton Per Day Direct Fire

Year	Total Capital Investment**	Annual Income Generated	Less Principal Payment	Net	Add Depreciation	Cash Flow	PV of Cash Flow	Cumulative Cash Flow
0	$4,874,000					($4,874,000)	($4,874,000)	($4,874,000)
1		$2,315,821	$ (290,939)	$2,024,883	$612,093	$2,636,976	$2,293,022	($2,580,978)
2		$430,396	$ (311,304)	$119,092	$816,124	$935,216	$707,158	($1,873,820)
3		$332,945	$ (333,095)	($150)	$816,124	$815,974	$536,516	($1,337,304)
4		$328,543	$ (356,412)	($27,869)	$816,124	$788,255	$450,688	($886,616)
5		$341,424	$ (381,361)	($39,937)	$816,124	$776,187	$385,902	($500,714)
6		$390,388	$ (408,056)	($17,668)	$816,124	$798,456	$345,195	($155,519)
7		$456,399	$ (436,620)	$19,778	$816,124	$835,903	$314,247	$158,728
8		$293,431	$ (467,184)	($173,752)	$816,124	$642,372	$209,992	$368,720
9		$185,069	$ (499,887)	($314,817)	$816,124	$501,307	$142,503	$511,223
10		$187,907	$ (534,879)	($346,972)	$816,124	$469,152	$115,967	$627,190
	Tax rate:	0%				NPV:	Positive	
	MARR	15%				IRR:	20%	
	Simple Payback	6 - 7 years				MIRR:	13%	

*Based on Feasibility Level Projections

**Equity Investment (Bank earns its money on interest)

Amortization Schedule (15 years) **Interest Rate:** **7.0%**

Loan Amount: $7,311,000

Pmt	Principal	Interest	Cum Prin	Cum Int	Prin Bal
1	$ 290,939	$ 511,770	$ 290,939	$ 511,770	$ 7,020,061
2	$ 311,304	$ 491,404	$ 602,243	$ 1,003,174	$ 6,708,757
3	$ 333,095	$ 469,613	$ 935,338	$ 1,472,787	$ 6,375,662
4	$ 356,412	$ 446,296	$ 1,291,750	$ 1,919,084	$ 6,019,250
5	$ 381,361	$ 421,347	$ 1,673,111	$ 2,340,431	$ 5,637,889
6	$ 408,056	$ 394,652	$ 2,081,168	$ 2,735,083	$ 5,229,832
7	$ 436,620	$ 366,088	$ 2,517,788	$ 3,101,172	$ 4,793,212
8	$ 467,184	$ 335,525	$ 2,984,972	$ 3,436,696	$ 4,326,028
9	$ 499,887	$ 302,822	$ 3,484,858	$ 3,739,518	$ 3,826,142
10	$ 534,879	$ 267,830	$ 4,019,737	$ 4,007,348	$ 3,291,263
11	$ 572,320	$ 230,388	$ 4,592,057	$ 4,237,737	$ 2,718,943
12	$ 612,382	$ 190,326	$ 5,204,439	$ 4,428,063	$ 2,106,561
13	$ 655,249	$ 147,459	$ 5,859,688	$ 4,575,522	$ 1,451,312
14	$ 701,117	$ 101,592	$ 6,560,805	$ 4,677,114	$ 750,195
15	$ 750,195	$ 52,514	$ 7,311,000	$ 4,729,628	$ -
	$ 7,311,000	$ 4,729,628			

$ 12,040,628	Total Repaid
$ 802,709	Payment Amount
64.69%	Interest as Percentage of Principal

FEASIBILITY LEVEL FINANCIAL PROFORMA FOR MICHIGAN BIOMASS PROJECT

DIRECT COMBUSTION TECHNOLOGY

TONS BIOMASS ANNUALLY 100,000 Tons

Assumptions:

Projected Volume	300	Tons per Day (TPD)		
Actual Capacity	274	Tons per Day (TPD)		
Total Project Cost	$20,530,000			
Equity Rations:	40%	Capital	60%	Financed
Equity Investment	$8,212,000	(Assumes Financed by Lenders @ 7% Interest, Amortized 15 years)		

This Proforma is Based on Pre-Design Criteria and does not reflect specific site adjustments pursuant to final engineering.

Product Value	Vol./Hr.	Value		Val/Ton
Process Steam (PPH)	25,000	$6.00	Thou.	$11.88
Renewable Electricity (Kw/Hr)	4,378	$0.050	kWh	$17.34
Coproduct Fertilizer (TPHr)	1.44	$50.00	/Ton	$5.72
	Total Product Value Per Ton:			$34.94

Feedstock:	Tons	$ FOB Origin	Transp. Cost	$ FOB Plant
Turkey Litter	50,000	$0.00	$0.00	$0.00
Layer Waste	50,000	$0.00	$0.00	$0.00
Wood Chips	0	$15.00	$10.00	$0.00
		Feedstock Cost Per Ton:		$0.00

					Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Capacity					75%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Total Product Value Per Ton (VPT)					$26.20	$34.94	$36.34	$35.99	$35.29	$33.89	$32.14	$34.59	$35.99	$35.29
Total Product Value (VPT * TPY)					$2,620,416	$3,493,888	$3,633,644	$3,598,705	$3,528,827	$3,389,071	$3,214,377	$3,458,949	$3,598,705	$3,528,827
Feedstock Cost Per Ton (FCPT)					$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total Feedstock Cost (FCPT * TPY)					0	0	0	0	0	0	0	0	0	0
Gross Margin					$2,620,416	$3,493,888	$3,633,644	$3,598,705	$3,528,827	$3,389,071	$3,214,377	$3,458,949	$3,598,705	$3,528,827
Gross Margin Per Ton					$26.20	$34.94	$36.34	$35.99	$35.29	$33.89	$32.14	$34.59	$35.99	$35.29
Operating Cost			Cost/Ton											
Plant Operating Cost			$17.84		1,209,820	1,613,093	1,613,093	1,613,093	1,613,093	1,613,093	1,613,093	1,613,093	1,613,093	1,613,093
Land Expense			$1.50		150,000	0	0	0	0	0	0	0	0	0
Depreciation Expense on Equity (13.5 Years)			$15.21		1,031,290	1,375,054	1,375,054	1,375,054	1,375,054	1,375,054	1,375,054	1,375,054	1,375,054	1,375,054
Interest Expense on Borrowed Funds			$8.21		367,643	524,504	561,219	600,504	642,539	687,517	735,643	787,138	842,238	901,195
Total Operating Cost			$42.76		2,758,753	3,512,650	3,549,365	3,588,651	3,630,686	3,675,664	3,723,790	3,775,285	3,830,385	3,889,341
Less Startup Cost Contingency (15% of Capital)					3,079,500									
REC	$0.018	per Kwh	$6.24	per Ton	468,096	624,128	624,128	624,128	624,128	624,128	624,128	624,128	624,128	624,128
Green Energy Pre	$0.000	per Kwh	$0.00	per Ton	0	0	0	0	0	0	0	0	0	0
Net Processing Income Before Taxes					-$2,749,741	$605,366	$708,406	$634,182	$522,269	$337,535	$114,715	$307,792	$392,448	$263,613
Net Processing Margin Per Ton					-$27.50	$6.05	$7.08	$6.34	$5.22	$3.38	$1.15	$3.08	$3.92	$2.64
Return on Equity Investment					-33%	7%	9%	8%	6%	4%	1%	4%	5%	3%
Average ROI (10-Years)		1%												

Land Value

Year 1	$ 154,500
Year 2	$ 159,135
Year 3	$ 163,909
Year 4	$ 168,826
Year 5	$ 173,891
Year 6	$ 179,108
Year 7	$ 184,481
Year 8	$ 190,016
Year 9	$ 195,716
Year 10	$ 201,587
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At end of Useful Life	$ 314,067

Equipment Salvage Value at End of Useful Life: $513,250

Simple Cash Flow And Financial Analysis*

100 Ton Per Day Direct Fire

Year	Total Capital Investment**	Annual Income Generated	Less Principal Payment	Net	Add Depreciation	Cash Flow	PV of Cash Flow	Cumulative Cash Flow
0	$8,212,000					($8,212,000)	($8,212,000)	($8,212,000)
1		$2,749,741	$ (490,190)	$2,259,551	$1,031,290	$3,290,841	$2,861,601	($5,350,399)
2		($605,366)	$ (524,504)	($1,129,869)	$1,375,054	$245,185	$185,395	($5,165,004)
3		($708,406)	$ (561,219)	($1,269,625)	$1,375,054	$105,429	$69,321	($5,095,683)
4		($634,182)	$ (600,504)	($1,234,686)	$1,375,054	$140,368	$80,256	($5,015,427)
5		($522,269)	$ (642,539)	($1,164,808)	$1,375,054	$210,246	$104,529	($4,910,898)
6		($337,535)	$ (687,517)	($1,025,052)	$1,375,054	$350,001	$151,315	($4,759,583)
7		($114,715)	$ (735,643)	($850,358)	$1,375,054	$524,696	$197,253	($4,562,330)
8		($307,792)	$ (787,138)	($1,094,930)	$1,375,054	$280,124	$91,573	($4,470,757)
9		($392,448)	$ (842,238)	($1,234,686)	$1,375,054	$140,368	$39,901	($4,430,856)
10		($263,613)	$ (901,195)	($1,164,808)	$1,375,054	$210,246	$51,970	($4,378,886)
	Tax rate:	0%				NPV:	Negative	
	MARR	15%				IRR:	-10%	
	Simple Paybacl	?				MIRR:	3%	

*Based on Feasibility Level Projections

**Equity Investment (Bank earns its money on interest)

Amortization Schedule (15 years) **Interest Rate:** **7.0%**

Loan Amount: $12,318,000

Pmt	Principal	Interest	Cum Prin	Cum Int	Prin Bal
1	$ 490,190	$ 862,260	$ 490,190	$ 862,260	$ 11,827,810
2	$ 524,504	$ 827,947	$ 1,014,694	$ 1,690,207	$ 11,303,306
3	$ 561,219	$ 791,231	$ 1,575,912	$ 2,481,438	$ 10,742,088
4	$ 600,504	$ 751,946	$ 2,176,416	$ 3,233,384	$ 10,141,584
5	$ 642,539	$ 709,911	$ 2,818,956	$ 3,943,295	$ 9,499,044
6	$ 687,517	$ 664,933	$ 3,506,473	$ 4,608,228	$ 8,811,527
7	$ 735,643	$ 616,807	$ 4,242,116	$ 5,225,035	$ 8,075,884
8	$ 787,138	$ 565,312	$ 5,029,255	$ 5,790,347	$ 7,288,745
9	$ 842,238	$ 510,212	$ 5,871,493	$ 6,300,559	$ 6,446,507
10	$ 901,195	$ 451,256	$ 6,772,687	$ 6,751,815	$ 5,545,313
11	$ 964,278	$ 388,172	$ 7,736,966	$ 7,139,987	$ 4,581,034
12	$ 1,031,778	$ 320,672	$ 8,768,743	$ 7,460,659	$ 3,549,257
13	$ 1,104,002	$ 248,448	$ 9,872,745	$ 7,709,107	$ 2,445,255
14	$ 1,181,282	$ 171,168	$ 11,054,028	$ 7,880,275	$ 1,263,972
15	$ 1,263,972	$ 88,478	$ 12,318,000	$ 7,968,753	$ -
	$ 12,318,000	$ 7,968,753			

$ 20,286,753	Total Repaid
$ 1,352,450	Payment Amount
64.69%	Interest as Percentage of Principal

FEASIBILITY LEVEL FINANCIAL PROFORMA FOR MICHIGAN BIOMASS PROJECT

DIRECT COMBUSTION TECHNOLOGY

TONS BIOMASS ANNUALLY 150,000 Tons

Assumptions:

Projected Volume	450	Tons per Day (TPD)		
Actual Capacity	411	Tons per Day (TPD)		
Total Project Cost	$29,720,000			
Equity Rations:	40%	Capital	60%	Financed
Equity Investment	$11,888,000	(Assumes Financed by Lenders @ 7% Interest, Amortized 15 years)		

This Proforma is Based on Pre-Design Criteria and does not reflect specific site adjustments pursuant to final engineering.

Product Value	Vol./Hr.	Value		Val/Ton
Process Steam (PPH)	25,000	$6.00	Thou.	$7.92
Renewable Electricity (Kw/Hr)	7,700	$0.050	kWh	$20.33
Coproduct Fertilizer (TPHr)	1.85	$50.00	/Ton	$4.88
Total		Total Product Value Per Ton:		$33.12

Feedstock	Tons	$ FOB Origin	Transp. Cost	$ FOB Plant
Turkey Litter	50,000	$0.00	$0.00	$0.00
Layer Waste	50,000	$0.00	$0.00	$0.00
Wood Chips	50,000	$15.00	$10.00	$25.00
		Feedstock Cost Per Ton:		$25.00

					Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Capacity					75%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Total Product Value Per Ton (VPT)					$24.84	$33.12	$34.45	$34.12	$33.46	$32.13	$30.47	$32.79	$34.12	$33.46
Total Product Value (VPT * TPY)					$3,726,450	$4,968,600	$5,167,344	$5,117,658	$5,018,286	$4,819,542	$4,571,112	$4,918,914	$5,117,658	$5,018,286
Feedstock Cost Per Ton (FCPT)					$6.25	$8.33	$8.33	$8.33	$8.33	$8.33	$8.33	$8.33	$8.33	$8.33
Total Feedstock Cost (FCPT * TPY)					937,500	1,250,000	1,250,000	1,250,000	1,250,000	1,250,000	1,250,000	1,250,000	1,250,000	1,250,000
Gross Margin					$2,788,950	$3,718,600	$3,917,344	$3,867,658	$3,768,286	$3,569,542	$3,321,112	$3,668,914	$3,867,658	$3,768,286
Gross Margin Per Ton					$18.59	$24.79	$26.12	$25.78	$25.12	$23.80	$22.14	$24.46	$25.78	$25.12
Operating Cost			Cost/Ton											
Plant Operating Cost			$14.17		1,441,408	1,921,877	1,921,877	1,921,877	1,921,877	1,921,877	1,921,877	1,921,877	1,921,877	1,921,877
Land Expense			$1.00		150,000	0	0	0	0	0	0	0	0	0
Depreciation Expense on Equity (13.5 Years)			$14.68		1,492,935	1,990,580	1,990,580	1,990,580	1,990,580	1,990,580	1,990,580	1,990,580	1,990,580	1,990,580
Interest Expense on Borrowed Funds			$5.13		362,550	483,400	483,400	483,400	483,400	483,400	483,400	483,400	483,400	483,400
Total Operating Cost			$34.97		3,446,893	4,395,857	4,395,857	4,395,857	4,395,857	4,395,857	4,395,857	4,395,857	4,395,857	4,395,857
Less Startup Cost Contingency (15% of Capital)					4,458,000									
REC	$0.018	per Kwh	$7.32	per Ton	823,284	1,097,712	1,097,712	1,097,712	1,097,712	1,097,712	1,097,712	1,097,712	1,097,712	1,097,712
Green Energy Pre	$0.000	per Kwh	$0.00	per Ton	0	0	0	0	0	0	0	0	0	0
Net Processing Income Before Taxes					-$4,292,659	$420,455	$619,199	$569,513	$470,141	$271,397	$22,967	$370,769	$569,513	$470,141
Net Processing Margin Per Ton					-$28.62	$2.80	$4.13	$3.80	$3.13	$1.81	$0.15	$2.47	$3.80	$3.13
Return on Equity Investment					-36%	4%	5%	5%	4%	2%	0%	3%	5%	4%

Average ROI (10-Years) 0%

Simple Cash Flow And Financial Analysis*
150 Ton Per Day Direct Fire

Land Value	
Year 1	$ 154,500
Year 2	$ 159,135
Year 3	$ 163,909
Year 4	$ 168,826
Year 5	$ 173,891
Year 6	$ 179,108
Year 7	$ 184,481
Year 8	$ 190,016
Year 9	$ 195,716
Year 10	$ 201,587
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At end of Useful Life	$ 314,067

Equipment Salvage Value at End of Useful Life: $743,000

Year	Total Capital Investment**	Annual Income Generated	Less Principal Payment	Net	Add Depreciation	Cash Flow	PV of Cash Flow	Cumulative Cash Flow
0	$11,888,000					($11,888,000)	($11,888,000)	($11,888,000)
1		$4,292,659	$ (709,618)	$3,583,041	$1,492,935	$5,075,976	$4,413,892	($7,474,108)
2		($420,455)	$ (759,291)	($1,179,746)	$1,990,580	$810,834	$613,107	($6,861,001)
3		($619,199)	$ (812,441)	($1,431,640)	$1,990,580	$558,939	$367,512	($6,493,490)
4		($569,513)	$ (869,312)	($1,438,825)	$1,990,580	$551,754	$315,467	($6,178,022)
5		($470,141)	$ (930,164)	($1,400,305)	$1,990,580	$590,275	$293,471	($5,884,551)
6		($271,397)	$ (995,276)	($1,266,672)	$1,990,580	$723,907	$312,965	($5,571,586)
7		($22,967)	$ (1,064,945)	($1,087,912)	$1,990,580	$902,668	$339,346	($5,232,240)
8		($370,769)	$ (1,139,491)	($1,510,260)	$1,990,580	$480,320	$157,017	($5,075,223)
9		($569,513)	$ (1,219,255)	($1,788,768)	$1,990,580	$201,811	$57,367	($5,017,855)
10		($470,141)	$ (1,304,603)	($1,774,744)	$1,990,580	$215,835	$53,351	($4,964,504)
	Tax rate:	0%				NPV:	Negative	
	MARR	15%				IRR:	-5%	
	Simple Paybacl	?				MIRR:	5%	

*Based on Feasibility Level Projections
**Equity Investment (Bank earns its money on interest)

Amortization Schedule (15 years) **Interest Rate: 7.0%**
Loan Amount: $17,832,000

Pmt	Principal	Interest	Cum Prin	Cum Int	Prin Bal
1	$ 709,618	$ 1,248,240	$ 709,618	$ 1,248,240	$ 17,122,382
2	$ 759,291	$ 1,198,567	$ 1,468,909	$ 2,446,807	$ 16,363,091
3	$ 812,441	$ 1,145,416	$ 2,281,350	$ 3,592,223	$ 15,550,650
4	$ 869,312	$ 1,088,545	$ 3,150,662	$ 4,680,769	$ 14,681,338
5	$ 930,164	$ 1,027,694	$ 4,080,826	$ 5,708,462	$ 13,751,174
6	$ 995,276	$ 962,582	$ 5,076,102	$ 6,671,044	$ 12,755,898
7	$ 1,064,945	$ 892,913	$ 6,141,047	$ 7,563,957	$ 11,690,953
8	$ 1,139,491	$ 818,367	$ 7,280,538	$ 8,382,324	$ 10,551,462
9	$ 1,219,255	$ 738,602	$ 8,499,793	$ 9,120,926	$ 9,332,207
10	$ 1,304,603	$ 653,254	$ 9,804,397	$ 9,774,181	$ 8,027,603
11	$ 1,395,926	$ 561,932	$ 11,200,322	$ 10,336,113	$ 6,631,678
12	$ 1,493,640	$ 464,217	$ 12,693,963	$ 10,800,330	$ 5,138,037
13	$ 1,598,195	$ 359,663	$ 14,292,158	$ 11,159,993	$ 3,539,842
14	$ 1,710,069	$ 247,789	$ 16,002,226	$ 11,407,782	$ 1,829,774
15	$ 1,829,774	$ 128,084	$ 17,832,000	$ 11,535,866	$ -
	$ 17,832,000	$ 11,535,866			

$ 29,367,866	Total Repaid
$ 1,957,858	Payment Amount
64.69%	Interest as Percentage of Principal

FEASIBILITY LEVEL FINANCIAL PROFORMA FOR MICHIGAN BIOMASS PROJECT

GASIFICATION TECHNOLOGY

TONS BIOMASS ANNUALLY 50,000 Tons

Assumptions:

Projected Volume 150 Tons per Day (TPD)
Actual Capacity 137 Tons per Day (TPD)
Total Project Cost $10,765,000
Equity Rations: 40% Capital 60% Financed
Equity Investment $4,306,000 (Assumes Financed by Lenders @ 7% Interest, Amortized 15 years)

This Proforma is Based on Pre-Design Criteria and does not reflect specific site adjustments pursuant to final engineering.

Product Value	Vol./Hr.	Value		Val/Ton
Process Steam (PPH)	25,000	$6.00	Thou.	$23.76
Renewable Electricity (Kw/Hr)	1883	$0.050	kWh	$14.91
Coproduct Fertilizer (TPHr)	1.03	$50.00	/Ton	$8.15
		Total Product Value Per Ton:		$46.82

Feedstock	Tons	$ FOB Origin	Transp. Cost	$ FOB Plant
Turkey Litter	25,000	$0.00	$0.00	$0.00
Layer Waste	25,000	$0.00	$0.00	$0.00
Wood Chips	0	$15.00	$10.00	$0.00
		Feedstock Cost Per Ton:		$0.00

	Rate		Cost/Ton		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Capacity					75%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Total Product Value Per Ton (VPT)					$35.12	$46.82	$48.70	$48.23	$47.29	$45.42	$43.08	$46.36	$48.23	$47.29
Total Product Value (VPT * TPY)					$1,755,876	$2,341,168	$2,434,815	$2,411,403	$2,364,580	$2,270,933	$2,153,875	$2,317,756	$2,411,403	$2,364,580
Feedstock Cost Per Ton (FCPT)					$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total Feedstock Cost (FCPT * TPY)					0	0	0	0	0	0	0	0	0	0
Gross Margin					$1,755,876	$2,341,168	$2,434,815	$2,411,403	$2,364,580	$2,270,933	$2,153,875	$2,317,756	$2,411,403	$2,364,580
Gross Margin Per Ton					$35.12	$46.82	$48.70	$48.23	$47.29	$45.42	$43.08	$46.36	$48.23	$47.29
Operating Cost			Cost/Ton											
Plant Operating Cost			$24.09		816,832	1,089,109	1,089,109	1,089,109	1,089,109	1,089,109	1,089,109	1,089,109	1,089,109	1,089,109
Land Expense			$3.00		150,000	0	0	0	0	0	0	0	0	0
Depreciation Expense on Equity (13.5 Years)			$15.95		540,762	721,016	721,016	721,016	721,016	721,016	721,016	721,016	721,016	721,016
Interest Expense on Borrowed Funds			$5.57		393,962	525,283	525,283	525,283	525,283	525,283	525,283	525,283	525,283	525,283
Total Operating Cost			$48.61		1,901,556	2,335,408	2,335,408	2,335,408	2,335,408	2,335,408	2,335,408	2,335,408	2,335,408	2,335,408
Less Startup Cost Contingency (15% of Capital)					1,614,750									
REC	$0.018	per Kwh	$5.37	per Ton	268,440	268,440	268,440	268,440	268,440	268,440	268,440	268,440	268,440	268,440
Green Energy Pre	$0.000	per Kwh	$0.00	per Ton	0	0	0	0	0	0	0	0	0	0
Net Processing Income Before Taxes					-$1,491,989	$274,201	$367,847	$344,436	$297,612	$203,966	$86,907	$250,789	$344,436	$297,612
Net Processing Margin Per Ton					-$29.84	$5.48	$7.36	$6.89	$5.95	$4.08	$1.74	$5.02	$6.89	$5.95
Return on Equity Investment					-35%	6%	9%	8%	7%	5%	2%	6%	8%	7%

Average ROI (10-Years) 2%

Simple Cash Flow And Financial Analysis*
50 Ton Per Day Gasification

Land Value	
Year 1	$ 154,500
Year 2	$ 159,135
Year 3	$ 163,909
Year 4	$ 168,826
Year 5	$ 173,891
Year 6	$ 179,108
Year 7	$ 184,481
Year 8	$ 190,016
Year 9	$ 195,716
Year 10	$ 201,587
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At end of Useful Life	$ 314,067

Equipment Salvage Value at End of Useful Life: $269,125

Year	Total Capital Investment**	Annual Income Generated	Less Principal Payment	Net	Add Depreciation	Cash Flow	PV of Cash Flow	Cumulative Cash Flow
0	$4,306,000					($4,306,000)	($4,306,000)	($4,306,000)
1		$1,491,989	$ (257,033)	$1,234,956	$540,762	$1,775,718	$1,544,102	($2,761,898)
2		($274,201)	$ (275,026)	($549,226)	$721,016	$171,789	$129,897	($2,632,000)
3		($367,847)	$ (294,278)	($662,125)	$721,016	$58,891	$38,722	($2,593,278)
4		($344,436)	$ (314,877)	($659,313)	$721,016	$61,703	$35,279	($2,557,999)
5		($297,612)	$ (336,918)	($634,531)	$721,016	$86,485	$42,998	($2,515,001)
6		($203,966)	$ (360,503)	($564,468)	$721,016	$156,548	$67,680	($2,447,321)
7		($86,907)	$ (385,738)	($472,645)	$721,016	$248,371	$93,372	($2,353,949)
8		($250,789)	$ (412,740)	($663,528)	$721,016	$57,487	$18,793	($2,335,157)
9		($344,436)	$ (441,631)	($786,067)	$721,016	($65,051)	($18,492)	($2,353,648)
10		($297,612)	$ (472,546)	($770,158)	$721,016	($49,142)	($12,147)	($2,365,796)
	Tax rate:	0%				NPV:	Negative	
	MARR	15%				IRR:	#NUM!	
	Simple Paybacl	?				MIRR:	2%	

*Based on Feasibility Level Projections
**Equity Investment (Bank earns its money on interest)

Amortization Schedule (15 years) **Interest Rate:** 7.0%
Loan Amount: $6,459,000

Pmt	Principal	Interest	Cum Prin	Cum Int	Prin Bal
1	$ 257,033	$ 452,130	$ 257,033	$ 452,130	$ 6,201,967
2	$ 275,026	$ 434,138	$ 532,059	$ 886,268	$ 5,926,941
3	$ 294,278	$ 414,886	$ 826,337	$ 1,301,154	$ 5,632,663
4	$ 314,877	$ 394,286	$ 1,141,214	$ 1,695,440	$ 5,317,786
5	$ 336,918	$ 372,245	$ 1,478,132	$ 2,067,685	$ 4,980,868
6	$ 360,503	$ 348,661	$ 1,838,635	$ 2,416,346	$ 4,620,365
7	$ 385,738	$ 323,426	$ 2,224,373	$ 2,739,771	$ 4,234,627
8	$ 412,740	$ 296,424	$ 2,637,113	$ 3,036,195	$ 3,821,887
9	$ 441,631	$ 267,532	$ 3,078,744	$ 3,303,727	$ 3,380,256
10	$ 472,546	$ 236,618	$ 3,551,290	$ 3,540,345	$ 2,907,710
11	$ 505,624	$ 203,540	$ 4,056,913	$ 3,743,885	$ 2,402,087
12	$ 541,017	$ 168,146	$ 4,597,931	$ 3,912,031	$ 1,861,069
13	$ 578,889	$ 130,275	$ 5,176,820	$ 4,042,306	$ 1,282,180
14	$ 619,411	$ 89,753	$ 5,796,230	$ 4,132,058	$ 662,770
15	$ 662,770	$ 46,394	$ 6,459,000	$ 4,178,452	$ -
	$ 6,459,000	$ 4,178,452			

$ 10,637,452	Total Repaid
$ 709,163	Payment Amount
64.69%	Interest as Percentage of Principal

FEASIBILITY LEVEL FINANCIAL PROFORMA FOR MICHIGAN BIOMASS PROJECT

GASIFICATION TECHNOLOGY

TONS BIOMASS ANNUALLY 100,000 Tons

Assumptions

Projected Volume	300	Tons per Day (TPD)		
Actual Capacity	274	Tons per Day (TPD)		
Total Project Cost	$18,160,000			
Equity Rations:	40%	Capital	60%	Financed
Equity Investment	$7,264,000	(Assumes Financed by Lenders @ 7% Interest, Amortized 15 years)		

This Proforma is Based on Pre-Design Criteria and does not reflect specific site adjustments pursuant to final engineering.

Product Value	Vol./Hr.	Value		Val/Ton
Process Steam (PPH)	25,000	$6.00	Thou.	$11.88
Renewable Electricity (Kw/Hr)	4,241	$0.050	kWh	$16.79
Coproduct Fertilizer (TPHr)	2.06	$50.00	/Ton	$8.15
	Total Product Value Per Ton:			$36.82

Feedstock	Tons	$ FOB Origin	Transp. Cost	$ FOB Plant
Turkey Litter	50,000	$0.00	$0.00	$0.00
Layer Waste	50,000	$0.00	$0.00	$0.00
Wood Chips	0	$15.00	$10.00	$0.00
		Feedstock Cost Per Ton:		$0.00

			Cost/Ton		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Capacity					75%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Total Product Value Per Ton (VPT)					$27.62	$36.82	$38.30	$37.93	$37.19	$35.72	$33.88	$36.46	$37.93	$37.19
Total Product Value (VPT * TPY)					$2,761,827	$3,682,436	$3,829,733	$3,792,909	$3,719,260	$3,571,963	$3,387,841	$3,645,612	$3,792,909	$3,719,260
Feedstock Cost Per Ton (FCPT)					$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total Feedstock Cost (FCPT * TPY)					0	0	0	0	0	0	0	0	0	0
Gross Margin					$2,761,827	$3,682,436	$3,829,733	$3,792,909	$3,719,260	$3,571,963	$3,387,841	$3,645,612	$3,792,909	$3,719,260
Gross Margin Per Ton					$27.62	$36.82	$38.30	$37.93	$37.19	$35.72	$33.88	$36.46	$37.93	$37.19
Operating Cost			Cost/Ton											
Plant Operating Cost			$16.66		1,129,798	1,506,397	1,506,397	1,506,397	1,506,397	1,506,397	1,506,397	1,506,397	1,506,397	1,506,397
Land Expense			$1.50		150,000	0	0	0	0	0	0	0	0	0
Depreciation Expense on Equity (13.5 Years)			$13.45		912,237	1,216,316	1,216,316	1,216,316	1,216,316	1,216,316	1,216,316	1,216,316	1,216,316	1,216,316
Interest Expense on Borrowed Funds			$4.70		332,297	443,063	443,063	443,063	443,063	443,063	443,063	443,063	443,063	443,063
Total Operating Cost			$36.31		2,524,332	3,165,777	3,165,777	3,165,777	3,165,777	3,165,777	3,165,777	3,165,777	3,165,777	3,165,777
Less Startup Cost Contingency (15% of Capital)					2,724,000									
REC	$0.018	per Kwh	$6.05	per Ton	453,448	604,597	604,597	604,597	604,597	604,597	604,597	604,597	604,597	604,597
Green Energy Pre	$0.000	per Kwh	$0.00	per Ton	0	0	0	0	0	0	0	0	0	0
Net Processing Income Before Taxes					-$2,033,058	$1,121,256	$1,268,554	$1,231,730	$1,158,081	$1,010,783	$826,662	$1,084,432	$1,231,730	$1,158,081
Net Processing Margin Per Ton					-$20.33	$11.21	$12.69	$12.32	$11.58	$10.11	$8.27	$10.84	$12.32	$11.58
Return on Equity Investment					-28%	15%	17%	17%	16%	14%	11%	15%	17%	16%

Average ROI (10-Years) 11%

Simple Cash Flow And Financial Analysis*
100 Ton Per Day Gasification

Land Value	
Year 1	$ 154,500
Year 2	$ 159,135
Year 3	$ 163,909
Year 4	$ 168,826
Year 5	$ 173,891
Year 6	$ 179,108
Year 7	$ 184,481
Year 8	$ 190,016
Year 9	$ 195,716
Year 10	$ 201,587
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At end of Useful Life	$ 314,067

Equipment Salvage Value at End of Useful Life: $454,000

Year	Total Capital Investment**	Annual Income Generated	Less Principal Payment	Net	Add Depreciation	Cash Flow	PV of Cash Flow	Cumulative Cash Flow
0	$7,264,000					($7,264,000)	($7,264,000)	($7,264,000)
1		$2,033,058	$ (433,602)	$1,599,455	$912,237	$2,511,693	$2,184,081	($5,079,919)
2		($1,121,256)	$ (463,954)	($1,585,211)	$1,216,316	($368,894)	($278,937)	($5,358,856)
3		($1,268,554)	$ (496,431)	($1,764,985)	$1,216,316	($548,669)	($360,759)	($5,719,615)
4		($1,231,730)	$ (531,181)	($1,762,911)	$1,216,316	($546,594)	($312,517)	($6,032,132)
5		($1,158,081)	$ (568,364)	($1,726,445)	$1,216,316	($510,128)	($253,624)	($6,285,756)
6		($1,010,783)	$ (608,150)	($1,618,933)	$1,216,316	($402,616)	($174,062)	($6,459,818)
7		($826,662)	$ (650,720)	($1,477,382)	$1,216,316	($261,065)	($98,144)	($6,557,962)
8		($1,084,432)	$ (696,270)	($1,780,703)	$1,216,316	($564,386)	($184,499)	($6,742,461)
9		($1,231,730)	$ (745,009)	($1,976,739)	$1,216,316	($760,422)	($216,160)	($6,958,621)
10		($1,158,081)	$ (797,160)	($1,955,241)	$1,216,316	($738,924)	($182,651)	($7,141,271)
	Tax rate:	0%				NPV:	Negative	
	MARR	15%				IRR:	#DIV/0!	
	Simple Paybacl	?				MIRR:	-6%	

*Based on Feasibility Level Projections

**Equity Investment (Bank earns its money on interest)

Amortization Schedule (15 years) **Interest Rate:** **7.0%**

Loan Amount: $10,896,000

Pmt	Principal	Interest	Cum Prin	Cum Int	Prin Bal
1	$ 433,602	$ 762,720	$ 433,602	$ 762,720	$ 10,462,398
2	$ 463,954	$ 732,368	$ 897,557	$ 1,495,088	$ 9,998,443
3	$ 496,431	$ 699,891	$ 1,393,988	$ 2,194,979	$ 9,502,012
4	$ 531,181	$ 665,141	$ 1,925,169	$ 2,860,120	$ 8,970,831
5	$ 568,364	$ 627,958	$ 2,493,533	$ 3,488,078	$ 8,402,467
6	$ 608,150	$ 588,173	$ 3,101,683	$ 4,076,251	$ 7,794,317
7	$ 650,720	$ 545,602	$ 3,752,403	$ 4,621,853	$ 7,143,597
8	$ 696,270	$ 500,052	$ 4,448,673	$ 5,121,905	$ 6,447,327
9	$ 745,009	$ 451,313	$ 5,193,683	$ 5,573,217	$ 5,702,317
10	$ 797,160	$ 399,162	$ 5,990,843	$ 5,972,380	$ 4,905,157
11	$ 852,961	$ 343,361	$ 6,843,804	$ 6,315,741	$ 4,052,196
12	$ 912,669	$ 283,654	$ 7,756,472	$ 6,599,394	$ 3,139,528
13	$ 976,555	$ 219,767	$ 8,733,028	$ 6,819,161	$ 2,162,972
14	$ 1,044,914	$ 151,408	$ 9,777,942	$ 6,970,569	$ 1,118,058
15	$ 1,118,058	$ 78,264	$ 10,896,000	$ 7,048,833	$ -
	$ 10,896,000	$ 7,048,833			

$ 17,944,833	Total Repaid
$ 1,196,322	Payment Amount
64.69%	Interest as Percentage of Principal

FEASIBILITY LEVEL FINANCIAL PROFORMA FOR MICHIGAN BIOMASS PROJECT

GASIFICATION TECHNOLOGY

TONS BIOMASS ANNUALLY 150,000 Tons

Assumptions:

Projected Volume	450	Tons per Day (TPD)		
Actual Capacity	411	Tons per Day (TPD)		
Total Project Cost	$26,880,000			
Equity Rations:	40%	Capital	60%	Financed
Equity Investment	$10,752,000	(Assumes Financed by Lenders @ 7% Interest, Amortized 15 years)		

This Proforma is Based on Pre-Design Criteria and does not reflect specific site adjustments pursuant to final engineering.

Product Value	Vol./Hr.	Value		Val/Ton
Process Steam (PPH)	25,000	$6.00	Thou.	$7.92
Renewable Electricity (Kw/Hr)	7,453	$0.050	kWh	$19.68
Coproduct Fertilizer (TPHr)	3.09	$50.00	/Ton	$8.17
		Total Product Value Per Ton:		$35.77

Feedstock	Tons	$ FOB Origin	Transp. Cost	$ FOB Plant
Turkey Litter	50,000	$0.00	$0.00	$0.00
Layer Waste	50,000	$0.00	$0.00	$0.00
Wood Chips	50,000	$15.00	$10.00	$25.00
		Feedstock Cost Per Ton:		$25.00

					Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Capacity					75%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Total Product Value Per Ton (VPT)					$26.82	$35.77	$37.20	$36.84	$36.12	$34.69	$32.90	$35.41	$36.84	$36.12
Total Product Value (VPT * TPY)					$4,023,591	$5,364,788	$5,579,380	$5,525,732	$5,418,436	$5,203,844	$4,935,605	$5,311,140	$5,525,732	$5,418,436
Feedstock Cost Per Ton (FCPT)					$6.25	$8.33	$8.33	$8.33	$8.33	$8.33	$8.33	$8.33	$8.33	$8.33
Total Feedstock Cost (FCPT * TPY)					937,500	1,250,000	1,250,000	1,250,000	1,250,000	1,250,000	1,250,000	1,250,000	1,250,000	1,250,000
Gross Margin					$3,086,091	$4,114,788	$4,329,380	$4,275,732	$4,168,436	$3,953,844	$3,685,605	$4,061,140	$4,275,732	$4,168,436
Gross Margin Per Ton					$20.57	$27.43	$28.86	$28.50	$27.79	$26.36	$24.57	$27.07	$28.50	$27.79
Operating Cost			Cost/Ton											
Plant Operating Cost			$12.05		1,225,756	1,634,342	1,634,342	1,634,342	1,634,342	1,634,342	1,634,342	1,634,342	1,634,342	1,634,342
Land Expense			$1.00		150,000	0	0	0	0	0	0	0	0	0
Depreciation Expense on Equity (13.5 Years)			$13.27		1,350,272	1,800,363	1,800,363	1,800,363	1,800,363	1,800,363	1,800,363	1,800,363	1,800,363	1,800,363
Interest Expense on Borrowed Funds			$4.64		327,906	437,207	437,207	437,207	437,207	437,207	437,207	437,207	437,207	437,207
Total Operating Cost			$30.96		3,053,934	3,871,912	3,871,912	3,871,912	3,871,912	3,871,912	3,871,912	3,871,912	3,871,912	3,871,912
Less Startup Cost Contingency (15% of Capital)					4,032,000									
REC	$0.018	per Kwh	$7.08	per Ton	796,875	1,062,500	1,062,500	1,062,500	1,062,500	1,062,500	1,062,500	1,062,500	1,062,500	1,062,500
Green Energy Pre	$0.000	per Kwh	$0.00	per Ton	0	0	0	0	0	0	0	0	0	0
Net Processing Income Before Taxes					-$3,202,968	$1,305,376	$1,519,968	$1,466,320	$1,359,024	$1,144,432	$876,193	$1,251,728	$1,466,320	$1,359,024
Net Processing Margin Per Ton					-$21.35	$8.70	$10.13	$9.78	$9.06	$7.63	$5.84	$8.34	$9.78	$9.06
Return on Equity Investment					-30%	12%	14%	14%	13%	11%	8%	12%	14%	13%

Average ROI (10-Years) 8%

Simple Cash Flow And Financial Analysis*
150 Ton Per Day Gasification

Land Value	
Year 1	$ 154,500
Year 2	$ 159,135
Year 3	$ 163,909
Year 4	$ 168,826
Year 5	$ 173,891
Year 6	$ 179,108
Year 7	$ 184,481
Year 8	$ 190,016
Year 9	$ 195,716
Year 10	$ 201,587
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At end of Useful Life	$ 314,067

Equipment Salvage Value at End of Useful Life: $672,000

Year	Total Capital Investment**	Annual Income Generated	Less Principal Payment	Net	Add Depreciation	Cash Flow	PV of Cash Flow	Cumulative Cash Flow
0	$10,752,000					($10,752,000)	($10,752,000)	($10,752,000)
1		$3,202,968	$ (641,808)	$2,561,160	$1,350,272	$3,911,432	$3,401,245	($7,350,755)
2		($1,305,376)	$ (686,734)	($1,992,110)	$1,800,363	($191,748)	($144,989)	($7,495,743)
3		($1,519,968)	$ (734,806)	($2,254,773)	$1,800,363	($454,411)	($298,782)	($7,794,526)
4		($1,466,320)	$ (786,242)	($2,252,562)	$1,800,363	($452,199)	($258,546)	($8,053,072)
5		($1,359,024)	$ (841,279)	($2,200,303)	$1,800,363	($399,940)	($198,841)	($8,251,913)
6		($1,144,432)	$ (900,169)	($2,044,601)	$1,800,363	($244,238)	($105,591)	($8,357,504)
7		($876,193)	$ (963,180)	($1,839,373)	$1,800,363	($39,011)	($14,666)	($8,372,170)
8		($1,251,728)	$ (1,030,603)	($2,282,331)	$1,800,363	($481,968)	($157,556)	($8,529,726)
9		($1,466,320)	$ (1,102,745)	($2,569,065)	$1,800,363	($768,702)	($218,513)	($8,748,239)
10		($1,359,024)	$ (1,179,937)	($2,538,961)	$1,800,363	($738,599)	($182,570)	($8,930,809)
	Tax rate:	0%				NPV:	Negative	
	MARR	15%				IRR:	#DIV/0!	
	Simple Paybacl	?				MIRR:	-4%	

*Based on Feasibility Level Projections
**Equity Investment (Bank earns its money on interest)

Amortization Schedule (15 years) **Interest Rate:** **7.0%**
Loan Amount: $16,128,000

Pmt	Principal	Interest	Cum Prin	Cum Int	Prin Bal
1	$ 641,808	$ 1,128,960	$ 641,808	$ 1,128,960	$ 15,486,192
2	$ 686,734	$ 1,084,033	$ 1,328,542	$ 2,212,993	$ 14,799,458
3	$ 734,806	$ 1,035,962	$ 2,063,348	$ 3,248,956	$ 14,064,652
4	$ 786,242	$ 984,526	$ 2,849,590	$ 4,233,481	$ 13,278,410
5	$ 841,279	$ 929,489	$ 3,690,869	$ 5,162,970	$ 12,437,131
6	$ 900,169	$ 870,599	$ 4,591,037	$ 6,033,569	$ 11,536,963
7	$ 963,180	$ 807,587	$ 5,554,217	$ 6,841,157	$ 10,573,783
8	$ 1,030,603	$ 740,165	$ 6,584,820	$ 7,581,321	$ 9,543,180
9	$ 1,102,745	$ 668,023	$ 7,687,565	$ 8,249,344	$ 8,440,435
10	$ 1,179,937	$ 590,830	$ 8,867,503	$ 8,840,174	$ 7,260,497
11	$ 1,262,533	$ 508,235	$ 10,130,036	$ 9,348,409	$ 5,997,964
12	$ 1,350,910	$ 419,858	$ 11,480,946	$ 9,768,267	$ 4,647,054
13	$ 1,445,474	$ 325,294	$ 12,926,420	$ 10,093,560	$ 3,201,580
14	$ 1,546,657	$ 224,111	$ 14,473,077	$ 10,317,671	$ 1,654,923
15	$ 1,654,923	$ 115,845	$ 16,128,000	$ 10,433,516	$ -
	$ 16,128,000	$ 10,433,516			

$ 26,561,516	Total Repaid
$ 1,770,768	Payment Amount
64.69%	Interest as Percentage of Principal

FEASIBILITY LEVEL FINANCIAL PROFORMA FOR MICHIGAN BIOMASS PROJECT

ANAEROBIC DIGESTION TECHNOLOGY

TONS BIOMASS ANNUALLY 50,000 Tons

Assumptions:

Projected Volume	150	Tons per Day (TPD)		
Actual Capacity	137	Tons per Day (TPD)		
Total Project Cost	$11,100,000			
Equity Rations:	40%	Capital	60%	Financed
Equity Investment	$4,440,000	(Assumes Financed by Lenders @ 7% Interest, Amortized 15 years)		

This Proforma is Based on Pre-Design Criteria and does not reflect specific site adjustments pursuant to final engineering.

Product Value	Vol./Hr.	Value		Val/Ton
Process Steam (PPH)	0	$6.00	Thou.	$0.00
Renewable Electricity (Kw/Hr)	1,474	$0.050	kWh	$11.67
Coproduct Fertilizer (TPHr)	2.94	$21.00	/Ton	$9.79
		Total Product Value Per Ton:		$21.46

Feedstock:	Tons	$ FOB Origin	Transp. Cost	$ FOB Plant
Turkey Litter	25,000	$0.00	$0.00	$0.00
Layer Waste	25,000	$0.00	$0.00	$0.00
Wood Chips	0	$15.00	$10.00	$0.00
		Feedstock Cost Per Ton:		$0.00

			Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Capacity			75%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Total Product Value Per Ton (VPT)			$16.10	$21.46	$22.32	$22.10	$21.67	$20.82	$19.74	$21.25	$22.10	$21.67
Total Product Value (VPT * TPY)			$804,753	$1,073,004	$1,115,924	$1,105,194	$1,083,734	$1,040,814	$987,164	$1,062,274	$1,105,194	$1,083,734
Feedstock Cost Per Ton (FCPT)			$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total Feedstock Cost (FCPT * TPY)			0	0	0	0	0	0	0	0	0	0
Gross Margin			$804,753	$1,073,004	$1,115,924	$1,105,194	$1,083,734	$1,040,814	$987,164	$1,062,274	$1,105,194	$1,083,734
Gross Margin Per Ton			$16.10	$21.46	$22.32	$22.10	$21.67	$20.82	$19.74	$21.25	$22.10	$21.67
Operating Cost		Cost/Ton										
Plant Operating Cost		$14.64	496,406	661,874	661,874	661,874	661,874	661,874	661,874	661,874	661,874	661,874
Land Expense		$3.00	150,000	0	0	0	0	0	0	0	0	0
Depreciation Expense on Equity (13.5 Years)		$16.44	557,590	743,453	743,453	743,453	743,453	743,453	743,453	743,453	743,453	743,453
Interest Expense on Borrowed Funds		$5.74	406,222	541,630	541,630	541,630	541,630	541,630	541,630	541,630	541,630	541,630
Total Operating Cost		$39.83	1,610,218	1,946,957	1,946,957	1,946,957	1,946,957	1,946,957	1,946,957	1,946,957	1,946,957	1,946,957
Less Startup Cost Contingency (15% of Capital)			1,665,000									
REC	$0.018 per Kwh	$4.20 per Ton	157,600	210,133	210,133	210,133	210,133	210,133	210,133	210,133	210,133	210,133
Green Energy Pre	$0.000 per Kwh	$0.00 per Ton	0	0	0	0	0	0	0	0	0	0
Net Processing Income Before Taxes			-$2,312,865	-$663,820	-$620,900	-$631,630	-$653,090	-$696,010	-$749,660	-$674,550	-$631,630	-$653,090
Net Processing Margin Per Ton			-$46.26	-$13.28	-$12.42	-$12.63	-$13.06	-$13.92	-$14.99	-$13.49	-$12.63	-$13.06
Return on Equity Investment			-52%	-15%	-14%	-14%	-15%	-16%	-17%	-15%	-14%	-15%

Average ROI (10-Years) -19%

Simple Cash Flow And Financial Analysis*
50 Ton Per Day Anaerobic Digestion

Land Value	
Year 1	$ 154,500
Year 2	$ 159,135
Year 3	$ 163,909
Year 4	$ 168,826
Year 5	$ 173,891
Year 6	$ 179,108
Year 7	$ 184,481
Year 8	$ 190,016
Year 9	$ 195,716
Year 10	$ 201,587
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At end of Useful Life	$ 314,067

Equipment Salvage Value at End of Useful Life: $277,500

Year	Total Capital Investment**	Annual Income Generated	Less Principal Payment	Net	Add Depreciation	Cash Flow	PV of Cash Flow	Cumulative Cash Flow
0	$4,440,000					($4,440,000)	($4,440,000)	($4,440,000)
1		$2,312,865	$ (265,032)	$2,047,833	$743,453	$2,791,286	$2,427,205	($2,012,795)
2		$663,820	$ (283,584)	$380,236	$743,453	$1,123,689	$849,670	($1,163,124)
3		$620,900	$ (303,435)	$317,465	$743,453	$1,060,918	$697,571	($465,554)
4		$631,630	$ (324,676)	$306,954	$743,453	$1,050,407	$600,574	$135,020
5		$653,090	$ (347,403)	$305,687	$743,453	$1,049,140	$521,608	$656,628
6		$696,010	$ (371,721)	$324,289	$743,453	$1,067,742	$461,614	$1,118,243
7		$749,660	$ (397,742)	$351,918	$743,453	$1,095,372	$411,791	$1,530,033
8		$674,550	$ (425,584)	$248,966	$743,453	$992,420	$324,424	$1,854,457
9		$631,630	$ (455,375)	$176,255	$743,453	$919,709	$261,439	$2,115,896
10		$653,090	$ (487,251)	$165,839	$743,453	$909,292	$224,763	$2,340,659
	Tax rate:	0%				NPV:	Negative	
	MARR	15%				IRR:	32%	
	Simple Paybacl	?				MIRR:	17%	

*Based on Feasibility Level Projections
**Equity Investment (Bank earns its money on interest)

Amortization Schedule (15 years) **Interest Rate:** **7.0%**
Loan Amount: $6,660,000

Pmt	Principal	Interest	Cum Prin	Cum Int	Prin Bal
1	$ 265,032	$ 466,200	$ 265,032	$ 466,200	$ 6,394,968
2	$ 283,584	$ 447,648	$ 548,617	$ 913,848	$ 6,111,383
3	$ 303,435	$ 427,797	$ 852,052	$ 1,341,645	$ 5,807,948
4	$ 324,676	$ 406,556	$ 1,176,728	$ 1,748,201	$ 5,483,272
5	$ 347,403	$ 383,829	$ 1,524,131	$ 2,132,030	$ 5,135,869
6	$ 371,721	$ 359,511	$ 1,895,852	$ 2,491,541	$ 4,764,148
7	$ 397,742	$ 333,490	$ 2,293,594	$ 2,825,031	$ 4,366,406
8	$ 425,584	$ 305,648	$ 2,719,178	$ 3,130,680	$ 3,940,822
9	$ 455,375	$ 275,858	$ 3,174,553	$ 3,406,537	$ 3,485,447
10	$ 487,251	$ 243,981	$ 3,661,804	$ 3,650,518	$ 2,998,196
11	$ 521,358	$ 209,874	$ 4,183,162	$ 3,860,392	$ 2,476,838
12	$ 557,854	$ 173,379	$ 4,741,016	$ 4,033,771	$ 1,918,984
13	$ 596,903	$ 134,329	$ 5,337,919	$ 4,168,100	$ 1,322,081
14	$ 638,687	$ 92,546	$ 5,976,605	$ 4,260,645	$ 683,395
15	$ 683,395	$ 47,838	$ 6,660,000	$ 4,308,483	$ -
	$ 6,660,000	$ 4,308,483			

$ 10,968,483	Total Repaid
$ 731,232	Payment Amount
64.69%	Interest as Percentage of Principal

FEASIBILITY LEVEL FINANCIAL PROFORMA FOR MICHIGAN BIOMASS PROJECT

ANAEROBIC DIGESTION TECHNOLOGY

TONS BIOMASS ANNUALLY 100,000 **Tons**

Assumptions:

Projected Volume	300	Tons per Day (TPD)		
Actual Capacity	274	Tons per Day (TPD)		
Total Project Cost	$18,720,000			
Equity Rations:	40%	Capital	60%	Financed
Equity Investment	$7,488,000	(Assumes Financed by Lenders @ 7% Interest, Amortized 15 years)		

This Proforma is Based on Pre-Design Criteria and does not reflect specific site adjustments pursuant to final engineering.

Product Value	Vol./Hr.	Value		Val/Ton
Process Steam (PPH)	0	$6.00	Thou.	$0.00
Renewable Electricity (Kw/Hr)	2,948	$0.050	kWh	$11.67
Coproduct Fertilizer (TPHr)	5.88	$21.00	/Ton	$9.79
		Total Product Value Per Ton:		$21.46

Feedstock:	Tons	$ FOB Origin	Transp. Cost	$ FOB Plant
Turkey Litter	50,000	$0.00	$0.00	$0.00
Layer Waste	50,000	$0.00	$0.00	$0.00
Wood Chips	0	$15.00	$10.00	$0.00
		Feedstock Cost Per Ton:		$0.00

					Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Capacity					75%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Total Product Value Per Ton (VPT)					$16.10	$21.46	$22.32	$22.10	$21.67	$20.82	$19.74	$21.25	$22.10	$21.67
Total Product Value (VPT * TPY)					$1,609,506	$2,146,008	$2,231,848	$2,210,388	$2,167,468	$2,081,628	$1,974,327	$2,124,548	$2,210,388	$2,167,468
Feedstock Cost Per Ton (FCPT)					$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total Feedstock Cost (FCPT * TPY)					0	0	0	0	0	0	0	0	0	0
Gross Margin					$1,609,506	$2,146,008	$2,231,848	$2,210,388	$2,167,468	$2,081,628	$1,974,327	$2,124,548	$2,210,388	$2,167,468
Gross Margin Per Ton					$16.10	$21.46	$22.32	$22.10	$21.67	$20.82	$19.74	$21.25	$22.10	$21.67
Operating Cost			Cost/Ton											
Plant Operating Cost			$10.14		687,644	916,859	916,859	916,859	916,859	916,859	916,859	916,859	916,859	916,859
Land Expense			$1.50		150,000	0	0	0	0	0	0	0	0	0
Depreciation Expense on Equity (13.5 Years)			$13.87		940,368	1,253,824	1,253,824	1,253,824	1,253,824	1,253,824	1,253,824	1,253,824	1,253,824	1,253,824
Interest Expense on Borrowed Funds			$4.84		342,544	456,726	456,726	456,726	456,726	456,726	456,726	456,726	456,726	456,726
Total Operating Cost			$30.35		2,120,556	2,627,408	2,627,408	2,627,408	2,627,408	2,627,408	2,627,408	2,627,408	2,627,408	2,627,408
Less Startup Cost Contingency (15% of Capital)					2,808,000									
REC	$0.018	per Kwh	$4.20	per Ton	315,200	420,267	420,267	420,267	420,267	420,267	420,267	420,267	420,267	420,267
Green Energy Pre	$0.000	per Kwh	$0.00	per Ton	0	0	0	0	0	0	0	0	0	0
Net Processing Income Before Taxes					-$3,003,850	-$61,134	$24,707	$3,247	-$39,673	-$125,514	-$232,814	-$82,594	$3,247	-$39,673
Net Processing Margin Per Ton					-$30.04	-$0.61	$0.25	$0.03	-$0.40	-$1.26	-$2.33	-$0.83	$0.03	-$0.40
Return on Equity Investment					-40%	-1%	0%	0%	-1%	-2%	-3%	-1%	0%	-1%

Average ROI (10-Years) -5%

Land Value		
Year 1	$	154,500
Year 2	$	159,135
Year 3	$	163,909
Year 4	$	168,826
Year 5	$	173,891
Year 6	$	179,108
Year 7	$	184,481
Year 8	$	190,016
Year 9	$	195,716
Year 10	$	201,587
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At end of Useful Life	$	314,067

Equipment Salvage Value at End of Useful Life: $468,000

Simple Cash Flow And Financial Analysis*
100 Ton Per Day Anaerobic Digestion

Year	Total Capital Investment**	Annual Income Generated	Less Principal Payment	Net	Add Depreciation	Cash Flow	PV of Cash Flow	Cumulative Cash Flow
0	$7,488,000					($7,488,000)	($7,488,000)	($7,488,000)
1		$3,003,850	$ (446,973)	$2,556,877	$940,368	$3,497,245	$3,041,083	($4,446,917)
2		$61,134	$ (478,261)	($417,128)	$1,253,824	$836,696	$632,663	($3,814,255)
3		($24,707)	$ (511,740)	($536,446)	$1,253,824	$717,378	$471,687	($3,342,568)
4		($3,247)	$ (547,561)	($550,808)	$1,253,824	$703,016	$401,952	($2,940,616)
5		$39,673	$ (585,891)	($546,217)	$1,253,824	$707,607	$351,806	($2,588,810)
6		$125,514	$ (626,903)	($501,389)	$1,253,824	$752,435	$325,298	($2,263,512)
7		$232,814	$ (670,786)	($437,972)	$1,253,824	$815,852	$306,709	($1,956,803)
8		$82,594	$ (717,741)	($635,148)	$1,253,824	$618,676	$202,246	($1,754,557)
9		($3,247)	$ (767,983)	($771,230)	$1,253,824	$482,594	$137,183	($1,617,373)
10		$39,673	$ (821,742)	($782,069)	$1,253,824	$471,755	$116,611	($1,500,763)
	Tax rate:	0%				NPV:	Negative	
	MARR	15%				IRR:	7%	
	Simple Payback	?				MIRR:	9%	

*Based on Feasibility Level Projections

**Equity Investment (Bank earns its money on interest)

Amortization Schedule (15 years) **Interest Rate:** 7.0%

Loan Amount: $11,232,000

Pmt	Principal	Interest	Cum Prin	Cum Int	Prin Bal
1	$ 446,973	$ 786,240	$ 446,973	$ 786,240	$ 10,785,027
2	$ 478,261	$ 754,952	$ 925,235	$ 1,541,192	$ 10,306,765
3	$ 511,740	$ 721,474	$ 1,436,974	$ 2,262,665	$ 9,795,026
4	$ 547,561	$ 685,652	$ 1,984,536	$ 2,948,317	$ 9,247,464
5	$ 585,891	$ 647,323	$ 2,570,426	$ 3,595,640	$ 8,661,574
6	$ 626,903	$ 606,310	$ 3,197,329	$ 4,201,950	$ 8,034,671
7	$ 670,786	$ 562,427	$ 3,868,116	$ 4,764,377	$ 7,363,884
8	$ 717,741	$ 515,472	$ 4,585,857	$ 5,279,849	$ 6,646,143
9	$ 767,983	$ 465,230	$ 5,353,840	$ 5,745,079	$ 5,878,160
10	$ 821,742	$ 411,471	$ 6,175,582	$ 6,156,550	$ 5,056,418
11	$ 879,264	$ 353,949	$ 7,054,846	$ 6,510,499	$ 4,177,154
12	$ 940,812	$ 292,401	$ 7,995,659	$ 6,802,900	$ 3,236,341
13	$ 1,006,669	$ 226,544	$ 9,002,328	$ 7,029,444	$ 2,229,672
14	$ 1,077,136	$ 156,077	$ 10,079,464	$ 7,185,521	$ 1,152,536
15	$ 1,152,536	$ 80,678	$ 11,232,000	$ 7,266,198	$ -
	$ 11,232,000	$ 7,266,198			

$ 18,498,198	Total Repaid
$ 1,233,213	Payment Amount
64.69%	Interest as Percentage of Principal

FEASIBILITY LEVEL FINANCIAL PROFORMA FOR MICHIGAN BIOMASS PROJECT

ANAEROBIC DIGESTION TECHNOLOGY

TONS BIOMASS ANNUALLY 150,000 Tons

Assumptions:

Projected Volume	450	Tons per Day (TPD)		
Actual Capacity	411	Tons per Day (TPD)		
Total Project Cost	$24,840,000			
Equity Rations:	40%	Capital	60%	Financed
Equity Investment	$9,936,000	(Assumes Financed by Lenders @ 7% Interest, Amortized 15 years)		

This Proforma is Based on Pre-Design Criteria and does not reflect specific site adjustments pursuant to final engineering.

Product Value	Vol./Hr.	Value		Val/Ton
Process Steam (PPH)	0	$6.00	Thou.	$0.00
Renewable Electricity (Kw/Hr)	3,931	$0.050	kWh	$10.38
Coproduct Fertilizer (TPHr)	7.85	$21.00	/Ton	$8.70
Total		Total Product Value Per Ton:		$19.08

Feedstock	Tons	$ FOB Origin	Transp. Cost	$ FOB Plant
Turkey Litter	50,000	$0.00	$0.00	$0.00
Layer Waste	50,000	$0.00	$0.00	$0.00
Wood Chips	50,000	$15.00	$10.00	$25.00
		Feedstock Cost Per Ton:		$25.00

			Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Capacity			75%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Total Product Value Per Ton (VPT)			$14.31	$19.08	$19.84	$19.65	$19.27	$18.50	$17.55	$18.89	$19.65	$19.27
Total Product Value (VPT * TPY)			$2,146,102	$2,861,469	$2,975,928	$2,947,313	$2,890,084	$2,775,625	$2,632,551	$2,832,854	$2,947,313	$2,890,084
Feedstock Cost Per Ton (FCPT)			$6.25	$8.33	$8.33	$8.33	$8.33	$8.33	$8.33	$8.33	$8.33	$8.33
Total Feedstock Cost (FCPT * TPY)			937,500	1,250,000	1,250,000	1,250,000	1,250,000	1,250,000	1,250,000	1,250,000	1,250,000	1,250,000
Gross Margin			$1,208,602	$1,611,469	$1,725,928	$1,697,313	$1,640,084	$1,525,625	$1,382,551	$1,582,854	$1,697,313	$1,640,084
Gross Margin Per Ton			$8.06	$10.74	$11.51	$11.32	$10.93	$10.17	$9.22	$10.55	$11.32	$10.93
Operating Cost		Cost/Ton										
Plant Operating Cost		$10.91	1,109,792	1,479,723	1,479,723	1,479,723	1,479,723	1,479,723	1,479,723	1,479,723	1,479,723	1,479,723
Land Expense		$1.00	150,000	0	0	0	0	0	0	0	0	0
Depreciation Expense on Equity (13.5 Years)		$12.27	1,247,796	1,663,728	1,663,728	1,663,728	1,663,728	1,663,728	1,663,728	1,663,728	1,663,728	1,663,728
Interest Expense on Borrowed Funds		$4.29	303,020	404,027	404,027	404,027	404,027	404,027	404,027	404,027	404,027	404,027
Total Operating Cost		$28.46	2,810,608	3,547,478	3,547,478	3,547,478	3,547,478	3,547,478	3,547,478	3,547,478	3,547,478	3,547,478
Less Startup Cost Contingency (15% of Capital)			3,726,000									
REC	$0.018 per Kwh	$3.74 per Ton	420,303	560,403	560,403	560,403	560,403	560,403	560,403	560,403	560,403	560,403
Green Energy Pre	$0.000 per Kwh	$0.00 per Ton	0	0	0	0	0	0	0	0	0	0
Net Processing Income Before Taxes			-$4,907,704	-$1,375,605	-$1,261,147	-$1,289,761	-$1,346,991	-$1,461,450	-$1,604,523	-$1,404,220	-$1,289,761	-$1,346,991
Net Processing Margin Per Ton			-$32.72	-$9.17	-$8.41	-$8.60	-$8.98	-$9.74	-$10.70	-$9.36	-$8.60	-$8.98
Return on Equity Investment			-49%	-14%	-13%	-13%	-14%	-15%	-16%	-14%	-13%	-14%

Average ROI (10-Years) -17%

Simple Cash Flow And Financial Analysis*
150 Ton Per Day Anaerobic Digestion

Land Value	
Year 1	$ 154,500
Year 2	$ 159,135
Year 3	$ 163,909
Year 4	$ 168,826
Year 5	$ 173,891
Year 6	$ 179,108
Year 7	$ 184,481
Year 8	$ 190,016
Year 9	$ 195,716
Year 10	$ 201,587
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At end of Useful Life	$ 314,067

Equipment Salvage Value at End of Useful Life: $621,000

Year	Total Capital Investment**	Annual Income Generated	Less Principal Payment	Net	Add Depreciation	Cash Flow	PV of Cash Flow	Cumulative Cash Flow
0	$9,936,000					($9,936,000)	($9,936,000)	($9,936,000)
1		$4,907,704	$ (593,099)	$4,314,605	$1,247,796	$5,562,401	$4,836,870	($5,099,130)
2		$1,375,605	$ (634,616)	$740,989	$1,663,728	$2,404,717	$1,818,312	($3,280,818)
3		$1,261,147	$ (679,039)	$582,108	$1,663,728	$2,245,836	$1,476,673	($1,804,144)
4		$1,289,761	$ (726,572)	$563,189	$1,663,728	$2,226,917	$1,273,247	($530,897)
5		$1,346,991	$ (777,432)	$569,559	$1,663,728	$2,233,287	$1,110,338	$579,441
6		$1,461,450	$ (831,852)	$629,597	$1,663,728	$2,293,325	$991,468	$1,570,909
7		$1,604,523	$ (890,082)	$714,441	$1,663,728	$2,378,169	$894,042	$2,464,951
8		$1,404,220	$ (952,388)	$451,833	$1,663,728	$2,115,561	$691,581	$3,156,531
9		$1,289,761	$ (1,019,055)	$270,707	$1,663,728	$1,934,435	$549,887	$3,706,418
10		$1,346,991	$ (1,090,388)	$256,602	$1,663,728	$1,920,330	$474,676	$4,181,095
	Tax rate:	0%				NPV:	Positive	
	MARR	15%				IRR:	28%	
	Simple Payback	7 - 8 years				MIRR:	16%	

*Based on Feasibility Level Projections

**Equity Investment (Bank earns its money on interest)

Amortization Schedule (15 years) **Interest Rate:** **7.0%**

Loan Amount: $14,904,000

Pmt	Principal	Interest	Cum Prin	Cum Int	Prin Bal
1	$ 593,099	$ 1,043,280	$ 593,099	$ 1,043,280	$ 14,310,901
2	$ 634,616	$ 1,001,763	$ 1,227,715	$ 2,045,043	$ 13,676,285
3	$ 679,039	$ 957,340	$ 1,906,754	$ 3,002,383	$ 12,997,246
4	$ 726,572	$ 909,807	$ 2,633,326	$ 3,912,190	$ 12,270,674
5	$ 777,432	$ 858,947	$ 3,410,758	$ 4,771,137	$ 11,493,242
6	$ 831,852	$ 804,527	$ 4,242,610	$ 5,575,664	$ 10,661,390
7	$ 890,082	$ 746,297	$ 5,132,692	$ 6,321,962	$ 9,771,308
8	$ 952,388	$ 683,992	$ 6,085,080	$ 7,005,953	$ 8,818,920
9	$ 1,019,055	$ 617,324	$ 7,104,134	$ 7,623,278	$ 7,799,866
10	$ 1,090,388	$ 545,991	$ 8,194,523	$ 8,169,268	$ 6,709,477
11	$ 1,166,716	$ 469,663	$ 9,361,238	$ 8,638,932	$ 5,542,762
12	$ 1,248,386	$ 387,993	$ 10,609,624	$ 9,026,925	$ 4,294,376
13	$ 1,335,773	$ 300,606	$ 11,945,397	$ 9,327,531	$ 2,958,603
14	$ 1,429,277	$ 207,102	$ 13,374,674	$ 9,534,633	$ 1,529,326
15	$ 1,529,326	$ 107,053	$ 14,904,000	$ 9,641,686	$ -
	$ 14,904,000	$ 9,641,686			

$ 24,545,686	Total Repaid
$ 1,636,379	Payment Amount
64.69%	Interest as Percentage of Principal