



The University of Georgia

Center for Agribusiness and Economic Development

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The Impact on Georgia Biomass for Feedstock from Rising Input and Transportation Costs in 2008

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Executive Summary

The purpose of this study is to update projected costs for biomass resources produced in Georgia that could be available for producing energy. The Center for Agribusiness and Economic Development carried out an initial study in 2003 and updated the study in 2007 evaluating the potential of utilizing Georgia's biomass resources to produce energy. Given continued interest in this area and coupled with increases in input costs, it was decided to re-evaluate the biomass prices in April 2008.

Georgia has a large amount of potential biomass feedstocks available for conversion into energy. There may be in excess of 13 million tons of material that could possibly be converted each year. Estimated annual electricity use in Georgia during 2006 was about 137.2 billion kilowatt hours. If all 13 million tons of bio-mass were converted into electricity using the best technology explored in the study, it would produce about 8.6 percent of the estimated Georgia electricity use. While that is an impressive amount, the likelihood of utilizing all available bio-mass for electricity production is unlikely. The cost of delivery of the biomass to a conversion facility would require a sales price of the electricity well above the current prevailing sales prices.

The properties and characteristics of each potential bio-fuel have important implications to the feasibility of individual biomass sources. In order to optimize feasibility, feedstocks must provide generators with an abundant supply at the lowest cost of delivery possible. In addition, the heat content (BTU) of feedstocks varies depending upon the type of biomass, so a high energy fuel is critical. Biomass sources also differ in ash and moisture content. This affects the energy value of biofuels, since the chemical make-up of ash generally has no energy value and the amount of water in bio-fuel affects, in a decisive manner, the available energy within every bio-fuel.

This report reflects the estimated cost of biomass sources in the state. Market prices were used for any marketable biomass feedstock. For sources where a market currently does not exist the costs include production costs for energy crops. For residue sources currently without a market, the costs include all costs necessary to harvest or gather the residues into an easily transportable form and subsequent transportation within a 50 mile radius to a facility for utilization as a feedstock. These costs are current costs assuming prices in April 2008.

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Introduction

In 2003, the Center for Agribusiness and Economic Development (CAED) completed a study of the feasibility of generating electricity from biomass fuel sources in Georgia. The study results indicated that it was not economically feasible to produce electricity with the technologies available at that time without significant subsidies. In 2007, the study was re-evaluated to consider current economic trends and advancements in bio-energy technologies.

A significant aspect of the study was an assessment of biomass resources in the state. Both the availability and the costs of such sources were considered. Late 2007 and early 2008 could be considered turbulent times with the price of fuel and crop inputs skyrocketing. Commodity prices have seen significant increases, but along with that has come significant increases in the direct inputs used to produce those crops including fuel, fertilizer, pesticides and seed. The purpose of this report is to update the cost aspect of biomass sources considered in the aforementioned biomass to electricity study of 2007.

BioMass Feedstock Issues

The CAED amassed data concerning the sources and costs of providing biomass for the conversion to energy process and evaluated the economics costs involved.

Georgia has a large amount of potential biomass feedstocks available for conversion into energy. There may be in excess of 13 million tons of material that could possibly be converted each year. Different potential feedstocks will have vastly different delivered costs per ton due to both the current market price of the product and its relative cost of transportation per unit. In addition, some of the potential feedstocks are only available on a seasonal basis. Since generation of electricity in a minute-to-minute operation, assurance of a continuous supply of feedstocks is of utmost importance.

Other factors to consider when evaluating potential feedstocks are things such as the moisture content and ash content. High moisture content implies high drying costs that can add to the total cost of electricity production, perhaps making a given feedstock not economically viable. The other major factor concerns the ash content of the feedstock. High ash content feedstocks require added boiler design considerations that raise capital costs. Ash disposal costs are also a consideration.

The quantity, location, price, transportation cost, and heat content of Georgia's current available supply of biomass was updated and determined utilizing prior feasibility analysis and secondary production data sources, such as the *2005 Georgia Farm Gate Value Report*, which lists the total amount of agricultural and forest products produced

each year. To determine the amount of residuals left after harvest, various experts in the field were consulted. The field experts provided estimates from the residual quantity to production information. Market prices were used for any marketable biomass feedstock. Cost of producing selected biomass feedstocks were calculated where market prices did not exist. Transportation costs are also included to deliver the biomass feedstock to the plant. Freight costs are based on hauling to within a 50 mile radius at a cost of \$2.75 per mile.

The total amount of agricultural by-products was evaluated based on the annual production of total yield mass and the percent of residues left over after harvest for each potential source. Quantities for closed-loop sources, those which are grown specifically for power generation, were determined by multiplying the annual yield per acre by the total acres in production. The following section describes Georgia's biomass feedstock in greater detail. The appendix contains selected Georgia maps showing the location of various bio-mass sources and values.

Alternative Crops—Kenaf and Switchgrass were identified as alternative possibilities for increasing farm income and biomass. Neither crop has been planted in large acreage in Georgia. Research indicates each crop yields around 6 to 10 tons per acre. Both crops would be available in the fall.

Applying inflation factors to the budgeted costs derived in 2003 results in a total cost per ton of \$57.50 to \$72.50 for kenaf for 2007 and the average cost of \$65 per ton was utilized in the study for kenaf. Further increases, primarily in fuel and fertilizer in early 2008 has further inflated the cost for kenaf. Current prices for producing kenaf are estimated to be between \$63.70 and \$106.15 per ton for an average price of \$84.93 per ton. When transportation costs are included the delivered cost per ton for kenaf is estimated to be \$98.68 per ton. The estimated ash content on a dry basis for kenaf is 3.60% and mmBTU/ton is estimated to be 14.78. The resulting delivered cost per mmBTU is \$6.68, an increase of 29% over 2007 cost at \$5.16 per mmBTU.

Budgeted costs and expected yields for areas throughout the southeastern US were considered for switchgrass. Switchgrass estimated cost range from \$70 to \$90 per ton, with the average of \$80 per ton utilized for analysis in the study in 2007. Estimated cost of production for switchgrass for 2008 range from \$78.39 to \$130.66 per ton with an average of \$104.53 per ton. Including transportation the estimated cost per ton for this fall crop is \$118.28 per ton. The ash content on a dry basis for switchgrass is 5.40% and 14.01 mmBTU per ton. The resulting delivered feedstock price per mmBTU for 2008 is \$8.44 a 30% increase over the 2007 cost of \$6.51 per mmBTU.

Since neither crop currently has significant acreage in Georgia acreage projections were considered. It was estimated that 13,000 acres of kenaf and 1,000 acres of switchgrass may be planted in the near future to meet potential market demands. The expected yields were assumed to be 6.98 tons per acre for kenaf and 6 tons per acre for switchgrass. Thus, the total tons of biomass are estimated to be 90,750 from kenaf and 6,000 from switchgrass.

Traditional Row and Forage Crops - Southern agriculture is very diverse. Production of various row and forage crops is common in Georgia. Many of these crops have residues that could provide a source of biomass for the state. In this section various crops that are considered “traditional” row crops and forage crops are analyzed. Production data from the *2005 Farmgate Value Report* and expert opinions are used as the basis for tonnage estimates.

Corn Stalks—After grain is harvested, corn stalks remain in the field—a little bent and broken but still a good source for biomass. It is estimated that 1,200 pounds of stalk per acre remain after grain is harvested. The estimated production of corn stalks in Georgia based on 2005 Farmgate data is 164,570 tons. Cost associated with corn stalks would be that necessary to remove the stalks and get them into a readily transportable form. It is assumed that a hay rake (windrower) and hay baler will be used to accomplish this. Utilizing a machine cost calculator to estimate the total cost for these operations, the estimated cost in 2007 was \$36 to \$60 per ton. For 2008 those costs increase to \$48 to \$80 per ton with an average of \$64 per ton. With the addition of transportation costs the total cost per ton is \$77.75 for corn stalks. They would be available from mid-summer to early fall. Given current grain prices, the total tons of biomass available from corn stalks could significantly increase.

The ash content on a dry basis for corn stalks is estimated to be 6.4% with 14.62 mmBTU per ton. The delivered cost per mmBTU for 2008 is estimated to be \$5.32 vs. \$4.05 for 2007. This represents an increase of 31.3% from 2007 to 2008.

Cotton Stalks—Many cotton producers cut and till cotton stalks back into the field. These stalks are a potential biomass product. To estimate cotton stalk production the total 2005 Farmgate acreage was multiplied by the estimated pounds of stalk available per acre. Based on prior research, it was assumed that irrigated cotton stalks yield 4,900 lbs per acre and non-irrigated yield 4,200 pounds per acre. It was estimated that 35% of Georgia’s cotton acreage is irrigated. Therefore, a weighted average 4,445 pounds of stalks per acre was used. The total estimated cottons stalks produced are 2.72 million tons.

The cost to harvest cotton stalks using a forage harvester and nutrient replacement ranged from \$35 to \$55 per ton in 2007 depending on the machinery used and irrigated versus non. For 2008 this cost is estimated to range from \$48.75 to \$81.25 per ton. With the inclusion of transportation costs the estimated average cost is \$72.28 per ton with availability ranging from late summer to early to mid fall. The estimated ash content for cotton stalks is 17.2% with 12.37 mmBTU per ton. The delivered feedstock price is \$5.84 per mmBTU up 41.8% from \$4.12 in 2007.

Gin Trash—Gin trash is another potential biomass source produced in Georgia. Based on conversations with local ginners and researchers at the University of Georgia, it is estimated that every bale of cotton ginned produces 185 pounds of gin trash. Assuming and average weight of 500 pounds per bale and that all cotton bales produced in the state

are ginned in the state, the total estimated gin trash produced is 205,226 tons. Calculating the economic cost requires further assumptions be made. Most gins give the gin trash away if someone will come and get it. Gin trash is a light material and to be handled efficiently. It was assumed the gin trash would be placed in a module.

The cost of packing the gin trash into a module is estimated to be \$0.005 to \$0.009 per pound or \$10 to \$18 per ton for an average price of \$14 per ton. This price is up from \$12 per ton in 2007. With the inclusion of freight charges the total cost per ton for 2008 is estimated to be \$23.71. The ash content dry basis for gin trash is estimated to be 17.6% with 13.10 mmBTU per ton. The resulting delivered cost per mmBTU is \$1.81 up 19.1% from 2007. One of the most common uses of gin trash is as supplemental cattle feed.

Peanut Hay—It is estimated that each acre of peanuts produces between 3 and 4 bales of peanut hay weighing 1,200 pounds per bale. Using the total acreage, as reported in the *2005 Farmgate Report*, it is estimated that Georgia produces 1.6 million tons of peanut hay. Baling the hay is a relatively inexpensive venture and a market exists for the hay. Current market prices range from \$30 to \$40 per bale or \$50 to \$67 per ton up from \$30 to \$50 per ton in 2007. The market price covers the harvest and baling cost of the hay and provides a small return to the producer.

Caution must be used in the sale and transfer of peanut hay. According to label recommendations, certain pesticides used in peanuts do not allow for the use of hay as a feedstock for livestock. There is also a concern with Alfa toxins associated with peanuts, especially in non-irrigated production.

Peanut Hulls—The total tons of peanut hulls available was estimated by taking 25% of the total production. Hulls comprise approximately 25% of the weight of peanuts. Using the 2005 Farmgate production data, the estimated tons of peanut hulls is 289,000. Shellers pointed out three major uses of peanut hulls including cattle feed, “filler or floor-liner” in poultry houses, and chemical carriers. Depending on the intended use and market, the hulls may be used directly after shelling or ground through a hammer mill. Given their low density, peanut hulls may also be pelletized for more efficient transport. Prices ranged from \$15 per ton for bulk loads to \$65 per ton for pelletized peanut hulls. The average cost per ton of \$40 per ton was utilized in this study. Prices have remained similar in 2007 and 2008 for peanut hulls with an average delivered price of \$45.66 per ton. However, the availability of them has decreased in 2008. If demand continues to increase, it is logical to assume that the price will follow. The estimated ash content for peanut hulls is 5.9% with 16.03 mmBTU per ton with an estimated cost per mmBTU of \$2.85 up 2.5% from 2007 due to increased delivery costs.

Pecan Hulls—To estimate the tons of pecan hulls available, the total production was multiplied by the typical shelling rate (33%) and the average percentage of hulls (51%). The total estimated tons available based on 2005 Farmgate data is 7,976. Shellers contacted stated that they usually allow hulls to be loaded from their operation free of charge. The best way to load pecan hulls would be mechanically. The rental price for a

front-end loader is about \$350 per day. It is estimated that 4 to 5 tons per hour can be handled by one person. Assuming an 8 hour day and a labor cost of \$10 per hour, the total cost per hour would be about \$54 or \$12 per ton. Including delivery the estimated price is \$20.90 per ton and availability would be from fall to early winter. Assuming an ash content of 5.8% and 16.35 mmBTU per ton the resulting delivered feedstock price is \$1.28 per mmBTU up 17.3% from 2007 cost of \$1.09.

Excess Hay—In certain years hay production in Georgia is in excess of consumption. Given recent droughts, strong cattle prices, and growing equine industry in the state, hay may not be a consistent form of biomass. However, years with timely rainfalls may produce excess quantities of forage. Often farmers are willing to dispose of excess hay. A cost per ton of \$40 to \$60 was assumed in 2007. It was assumed that 25% of the hay produced was in excess of the demand. Based on 2005 Farmgate data, the estimated tons of hay available would be 674,811. This figure will change more frequently due to overall changes in demand and variations in weather conditions and its impact on supply.

Given continued drought pressure in late 2007 and early 2008, the estimated price for hay ranges from \$50 to \$100 per ton. Including delivery, the average price per ton for 2008 is estimated to be \$88.75 per ton with availability from summer through fall. For hay the estimated ash content is 5.7% with 14 mmBTU per ton. The resulting cost of hay as a feedstock is \$6.34 per mmBTU up 44.7% from the 2007 estimate of \$4.38.

Wheat and Rye Straw—Each of these commodities produces between 110 to 120 square bales per acre weighing around 30 pounds per bale. Using the 2005 Farmgate production data, if the straw from every acre of wheat and rye was baled, Georgia would produce 366,834 tons of wheat straw and 139,993 tons of rye straw.

Straw has a relatively strong market in the landscape sector with market prices estimated between \$2.00 to \$3.00 per bale in 2008. The resulting cost per ton of straw would be from \$133 to \$200. The average price for 2008 is estimated to be \$166.50 per ton, up from the 2007 average of \$150 per ton, utilized in the study. With the inclusion of delivery charges the total cost per ton is \$184.29 with availability from late spring to early summer.

For wheat straw the estimated ash content is 3.5% with 14.57 mmBTU per ton. Rye has slightly lower characteristics with ash content estimated to be 3% and 12.70 mmBTU per ton. The resulting cost per mmBTU is \$12.65 and \$14.51 for wheat and rye straw respectively. These estimates represent a 12% increase over 2007 costs.

Poultry Products

Poultry Litter—The poultry and egg industry is Georgia's most valuable agricultural sector and leads the nation in poultry production. Thus, a significant amount of poultry litter is produced in Georgia. To arrive at the total tons of poultry litter produced in the state the number of head for breeder pullets, broilers, and layers was used in respect to their annual pounds of litter produced per head—8 pounds for breeder pullets, 44 pounds for hatching egg layers, 40 pounds for table egg layers, and 0.50 pounds per pound of

bird for broilers. Using the 2005 Farmgate production data the total tons of poultry litter available was estimated at 2.65 million tons.

Farmers use poultry litter as fertilizer but experience criticism in urban areas and encounter issues with compliance of the Environmental Protection Agency regulations. Overuse of poultry litter raises the phosphorus level in soil to unacceptable amounts. Spreading of poultry litter will continue to be popular in areas of high crop production because the crops reduce the phosphorus. It is also seen as a less expensive source of nutrients given the rising cost of traditional fertilizer. In Northeast Georgia limited acreage of crops exist and alternatives to spreading the litter are continuously being researched. The average cost per ton of litter was estimated to be \$12 to \$25 based on market conditions for litter as fertilizer in 2007. These prices have seen further increases given the demand for chicken litter in 2008 since traditional fertilizer has experienced significant price increases. The estimated price per ton of chicken litter is \$25.00 plus \$7.28 delivery charge for a total of \$32.28 per ton in 2008.

The ash content is estimated to be 26.68% with 8.89 mmBTU per ton. For 2008 the delivered feedstock cost per mmBTU is up 32% at \$3.63.

Forest Related Products - Current information for forest related products was derived from communications and data supplied by the Georgia Forestry Commission. Analysis utilized the estimated annual harvest acreage for timber products in Georgia. The three primary sources of forest residue to be considered in this study are bark, wood chips, and wood (harvesting) residues.

For consistency, tonnage available was calculated utilizing similar assumptions as prior analysis. However, it is important to point out that given recent emphasis on renewable fuel sources and interest in biomass forest resources, the Georgia Forestry Commission has extensive research considering forest biomass sources in much greater detail than will be covered in this report.

Analysis in this report will base availability on the estimated annual harvested acreage in Georgia. The Georgia Forestry Commission estimates this acreage to be about 500,000 acres. The total forestland in the state is estimated to be 24.2 million acres with roughly 11 million being softwood (pine) forests.

Bark—Foresters estimate that 322 cubic feet of bark is produced per acre. An estimated weight per cubic foot is 20 pounds. Foresters at the Warnell School of Forestry and timber companies indicated that 85% of the bark produced in the state is retained for fuel by the timber companies. Using the total number of harvested acres multiplied by the total bark per acre and 15% for the portion not utilized within the timber companies, results in 241,500 tons of available bark. Two main outlets exist for bark—power and landscaping. Many lumber and pulp mills use the bark to heat and fuel the machinery. Higher quality bark is sold to the landscaping industry. Bark prices ranged from \$16 to \$20 per ton depending on the quality and size of the final material in 2007. These prices have elevated slightly in early 2008 with estimates ranging from \$16 to \$22 per ton.

Inclusion of freight results in a total cost of \$27.09 per ton. This is a market price where landscapers and large firms can purchase the bark from the timber companies.

The ash content is estimated to be 3.3% with 14.08 mmBTU per ton for a cost of \$1.92 per mmBTU in 2008. This represents a 10% increase over 2007 estimated costs.

Wood Chips—Based on assumptions defined in prior analysis, potential biomass from wood chips was estimated. Research (Koch, 1976) suggests that 1.5 tons of wood chip residuals are produced per thousand board feet (mbf) of timber products produced. Considering the estimated annual harvested acreage of 500,000 acres, the average harvest in Georgia is 4,196.2 mbf. The total wood chips available would be 6,294 tons.

Wood chip prices ranged from \$18 to \$22 per ton in 2007 with uses ranging from a base in poultry houses to industrial applications for particle board. Chip prices also saw a slight increase in 2008 with the range increasing from \$18 to \$24 per ton. The inclusion of freight increases that total to \$29.90 per ton. The estimated ash content for wood chips is 1.30% with 9.09 mmBTU per ton for a total feedstock cost of \$3.29 per mmBTU in 2008. This cost represents a 9.6% increase over 2007 costs.

Wood (Harvesting) Residue—Wood residues are the remains (branches, bark, and needles) from harvested acreage. It is estimated that 15% of the tree remains after harvest. The average yield per acre is 2,254 cubic feet. Thus, approximately 338 cubic feet per acre of harvest residue is left for every harvested acre. A cubic foot of residue is estimated to weigh 49.9 pounds. Considering these estimates and the state average of harvested acreage, 500,000 acres, approximately 4.2 million tons of wood residues are created annually.

One problem with efficient utilization of harvesting residue is transportation. Stacking branches on the bed of a trailer and/or truck is not efficient. The branches need to be processed through a wood chipper for the most efficient means of transportation of the waste material. This adds cost to an almost free product. The estimated operating and ownership cost for an industrial chipper was estimated by Morbark, Inc. The total estimated cost for owning and operating the chipper in 2007 was \$130 to \$150 per hour with a throughput of 50 tons per hour. Throughput will vary considering the volume of and distance between residue piles.

Another cost to be considered is nutrient replacement. Foresters estimate that 85% of the nitrogen in the soil comes from the remains left after harvest. To replace this amount of nitrogen would cost about \$115 per acre in 2007. Considering the cost for chipping and the opportunity for fertilizer, the total cost per ton of wood residue was estimated to be \$18 to \$23 in 2007. For 2008 those estimates increase to \$27 to \$30 per ton. Assuming an average price of \$28.50 and including freight cost of \$7.28 per ton, the total cost for wood residue is \$35.78. The ash content is estimated to be 3.20% with 8.86 mmBTU per ton. The delivered feedstock cost per mmBTU is \$4.04, up 35% over 2007 estimated cost. A positive factor on each of the forestry related sources is the year-round availability.

Pine Straw—Using the total acreage of all pines in the state and a yield factor of 25 bales per acre at 20 pounds per bale results in 2.75 million tons of pine straw. Prices for pine straw range from \$250 to \$300 per ton. Most trading of pine straw occurs as bales with prices ranging from \$2.50 to \$3.00. These are the average wholesale sales price in the landscaping industry. Given the relatively high cost per ton, pine straw does not seem to be a feasible source of biomass.

Biomass Wood Resource Assessment on a County-by-County Basis for the State of GA - Recent reports prepared for the Georgia Forestry Commission estimate total harvesting residues at 5.314 million dry tons with only 5% currently utilized. Thus, approximately 5.05 million dry tons of harvesting residues are estimated to be available for use in Georgia. Mill residues, which would include bark and wood chips, are estimated between 6.99 and 7.97 million dry tons. However, it is estimated that only 1% of those residues are currently not utilized, resulting in only 69,930 to 79,703 dry tons available. The county-by-county biomass wood resource assessment completed by General Bioenergy for the Georgia Forestry Commission also included other wood resources including unmerchantable timber, urban wood waste, pecan shells, paper mill sludge, and black liquor production. The total estimate of available resources in Georgia based on this study is 18.87 million dry tons.

Biomass Properties

The properties and characteristics of each potential biofuel have important implications to the feasibility of individual biomass sources. In order to optimize feasibility, feedstocks must provide generators with an abundant supply at the lowest cost of delivery possible. In addition, the heat content (BTU) of feedstocks varies depending upon the type of biomass, so a high energy fuel is critical. Biomass sources also differ in ash and moisture content. This affects the energy value of biofuels, since the chemical make-up of ash generally has no energy value and the amount of water in biofuel affects, in a decisive manner, the available energy within every biofuel.

Biomass sources also vary in weight and size. The altering weight, size, structure, and dimensions of varying biomass sources results in different processing and equipment use, which ultimately influences the transportation costs. Types of biomass that are most dense, or can be processed to use less space per ton, will have the lowest cost of transport and storage. A summary of Georgia's farm produced biomass resources is shown in Table 1, which shows the total tons of biomass produced, price per ton, average price per ton, delivered cost per ton, and the season of harvest.

Table 1. Biomass Supply and Delivered Prices

BioMass	Tons Available	Price/Ton	Avg Price/Ton	Freight cost per ton (50 Miles)	Cost Per Ton Delivered @ (\$2.75)/Mile	Season
Pecan Hulls	7,976	\$9 – 15	\$ 12.00	\$ 8.90	\$ 20.90	Fall
Poultry Litter	2,651,372	\$15 -35	\$ 25.00	\$ 7.28	\$ 32.28	Year Round
Gin Trash	205,226	\$10 -18	\$ 14.00	\$ 9.71	\$ 23.71	Late Summer - Early Fall
Wood Chips	6,294	\$18 -24	\$ 21.00	\$ 8.90	\$ 29.90	Year Round
Bark	241,500	\$16 -22	\$ 19.00	\$ 8.09	\$ 27.09	Year Round
Wood Residue	4,217,798	\$27-30	\$ 28.50	\$ 7.28	\$ 35.78	Year Round
Peanut Hulls	289,000	\$15 - 65	\$ 40.00	\$ 5.66	\$ 45.66	Late Summer - Early Fall
Cotton Stalks	2,717,505	\$48.75 – 81.25	\$ 65.00	\$ 7.28	\$ 72.28	Late Summer - Early Fall
Hay* Includes Peanut Hay	2,290,914	\$50 - 100	\$ 75.00	\$ 13.75	\$ 88.75	Late Summer - Early Fall
Corn Stalks	164,570	\$48 - 80	\$ 64.00	\$ 13.75	\$ 77.75	Mid Summer - Early Fall
Kenaf	90,750	\$63.70 – 106.15	\$ 84.93	\$ 13.75	\$ 98.68	Fall
Switchgrass	6,000	\$78.39 – 130.66	\$ 104.53	\$ 13.75	\$ 118.28	Fall
Wheat Straw	366,834	\$133 -200	\$ 166.50	\$ 17.79	\$ 184.29	Late Spring - Early Summer
Rye Straw	139,993	\$133 -200	\$ 166.50	\$ 17.79	\$ 184.29	Late Spring - Early Summer

Table 2 shows a summary of historical energy data for Georgia from the Energy Information Administration. The delivered fuel cost and quantity for electricity generation for coal, petroleum and natural gas for 1999 through September 2006 is shown.

Table 3 shows the biomass feedstock quality and delivered cost for some common agricultural biomass sources in Georgia. Research suggests that the fuels with the least delivered cost per million BTU (mmBTU) will be the most likely fuel sources for a biomass power generation facility.

Table 2. Delivered Fuel Costs and BTU Yield for Coal, Petroleum and Natural Gas

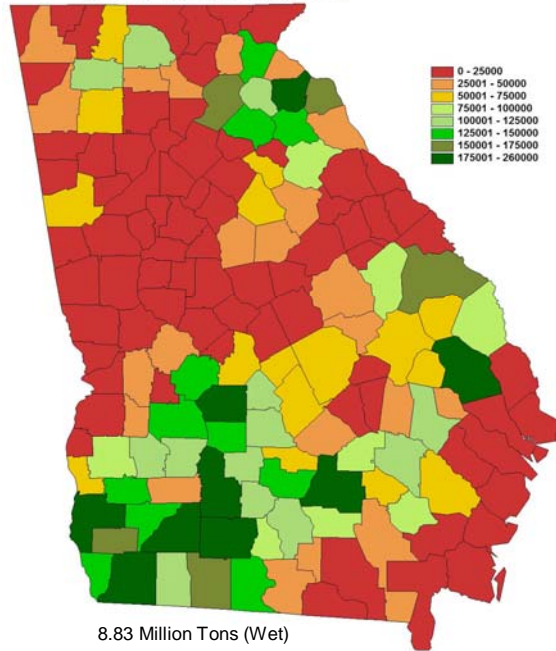
Fuel	2006	2005	2004	2003	2002	2001	2000	1999
Coal (dollars per million Btu)	\$2.39	\$2.14	\$1.79	\$1.72	\$1.68	\$1.66	\$1.54	\$1.55
Average heat value (Btu per Pound)	9,994	9,994	9,990	10,041	10,119	10,169	10,256	10,245
Petroleum (dollars per million Btu)	\$12.05	\$9.48	\$7.60	\$6.37	\$5.10	\$5.95	\$5.89	\$3.48
Average heat value (Btu per gallon)	147,357	147,357	147,429	147,190	146,976	147,595	147,357	147,738
Natural Gas (dollars per million Btu)	\$7.14	\$9.77	\$6.38	\$5.73	\$3.65	\$3.28	\$4.18	\$2.49
Average heat value (Btu per cubic foot)	1,028	1,028	1,027	1,025	1,020	1,026	1,021	1,022

Table 3. Characteristics of Potential Georgia Biomass Feedstocks and Delivered Costs, April 2008

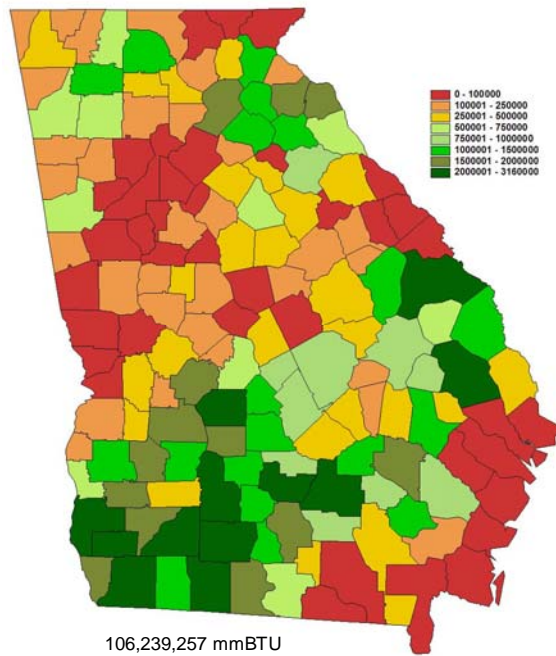
Biomass	Ash Content Dry Basis	mmBTU/Ton	Price/Ton (low)	Price/Ton (high)	Average Price/Ton	Calculated Average \$/mmBTU	Freight Cost per Ton Mile	50 Mile Frt/Ton	50 Mile Frt/mm BTU	Delivered F/S \$/mmBTU
Pecan Hulls	5.80%	16.35	\$ 9.00	\$ 15.00	\$ 12.00	\$ 0.73	\$ 0.18	\$ 8.90	\$ 0.544	\$ 1.28
Gin Trash	17.60%	13.10	\$ 10.00	\$ 18.00	\$ 14.00	\$ 1.07	\$ 0.19	\$ 9.71	\$ 0.741	\$ 1.81
Bark, Pine	3.30%	14.08	\$ 16.00	\$ 22.00	\$ 19.00	\$ 1.35	\$ 0.16	\$ 8.09	\$ 0.574	\$ 1.92
Coal (2006 US\$)	NA	NA	NA	NA	NA	NA	NA	NA	NA	\$ 2.39
Peanut Hulls	5.90%	16.03	\$ 15.00	\$ 65.00	\$ 40.00	\$ 2.50	\$ 0.11	\$ 5.66	\$ 0.353	\$ 2.85
Wood Chips	1.30%	9.09	\$ 18.00	\$ 24.00	\$ 21.00	\$ 2.31	\$ 0.18	\$ 8.90	\$ 0.979	\$ 3.29
Poultry Litter	26.68%	8.89	\$ 15.00	\$ 35.00	\$ 25.00	\$ 2.81	\$ 0.15	\$ 7.28	\$ 0.819	\$ 3.63
Wood Residue	3.20%	8.86	\$ 27.00	\$ 30.00	\$ 28.50	\$ 3.22	\$ 0.15	\$ 7.28	\$ 0.822	\$ 4.04
Corn Stalks	6.40%	14.62	\$ 48.00	\$ 80.00	\$ 64.00	\$ 4.38	\$ 0.28	\$ 13.75	\$ 0.940	\$ 5.32
Cotton Stalks	17.20%	12.37	\$ 48.75	\$ 81.25	\$ 65.00	\$ 5.25	\$ 0.15	\$ 7.28	\$ 0.588	\$ 5.84
Hay	5.70%	14.00	\$ 50.00	\$ 100.00	\$ 75.00	\$ 5.36	\$ 0.28	\$ 13.75	\$ 0.982	\$ 6.34
Kenaf	3.60%	14.78	\$ 63.70	\$ 106.15	\$ 84.93	\$ 5.75	\$ 0.28	\$ 13.75	\$ 0.930	\$ 6.68
Natural Gas (2006 US\$)	NA	NA	NA	NA	NA	NA	NA	NA	NA	\$ 7.14
Switchgrass	5.40%	14.01	\$ 78.39	\$ 130.66	\$ 104.53	\$ 7.46	\$ 0.28	\$ 13.75	\$ 0.981	\$ 8.44
Petroleum (2006 US\$)	NA	NA	NA	NA	NA	NA	NA	NA	NA	\$ 12.05
Wheat Straw	3.50%	14.57	\$ 133.00	\$ 200.00	\$ 166.50	\$ 11.43	\$ 0.36	\$ 17.79	\$ 1.221	\$ 12.65
Rye Straw	3.00%	12.70	\$ 133.00	\$ 200.00	\$ 166.50	\$ 13.11	\$ 0.36	\$ 17.79	\$ 1.401	\$ 14.51

APPENDIX

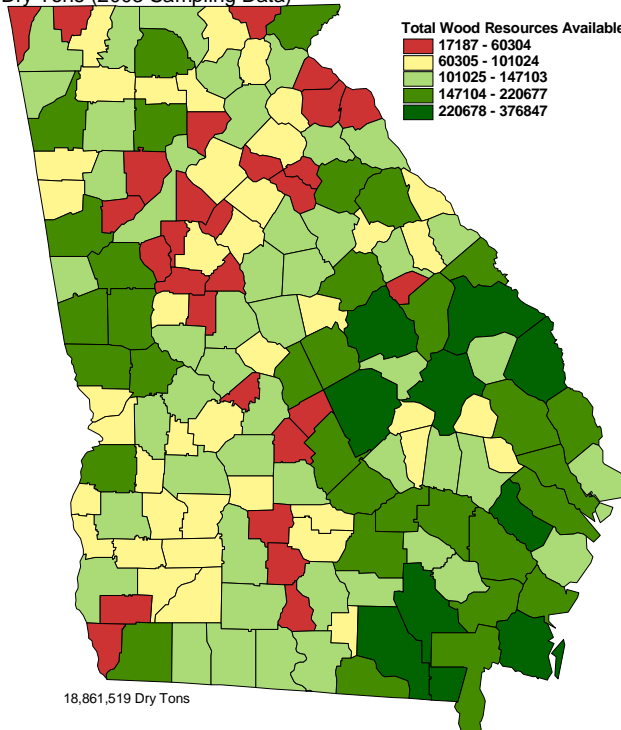
Estimated Biomass Available from
Ag-Related Sources (Tons)



Estimated Biomass available from Ag-Related Sources, (mmBTU)

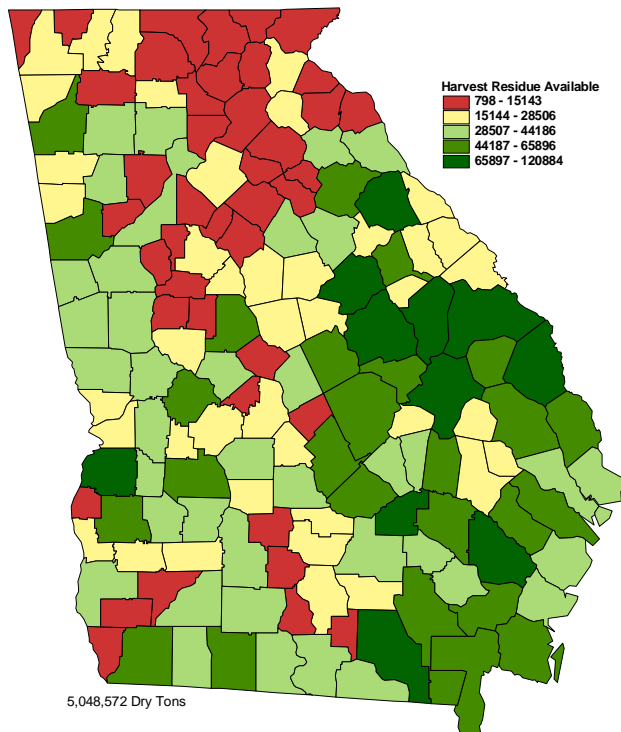


Biomass Wood Resource, Forestry Resources: Total Wood Residues Available including Residual Wood and Unmerchantable Timber, Dry Tons (2003 Sampling Data)



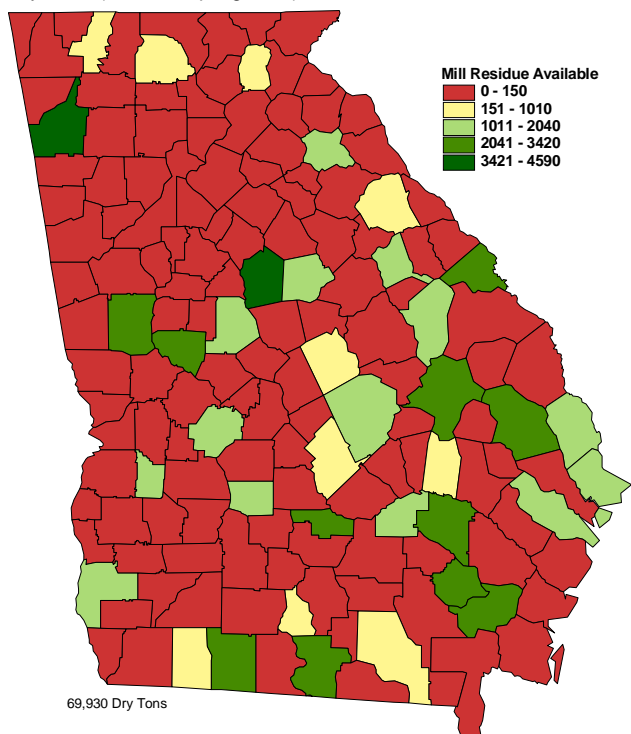
Source: "Biomass Wood Resource Assessment on a County-by-County Basis for the State of Georgia," November 9, 2005, Prepared by General Bioenergy, Inc., Prepared for the Georgia Forestry commission and the Southern States Energy Board.

Biomass Wood Resource, Forestry Resources: Harvesting Residue Available, Dry Tons (2003 Sampling Data)



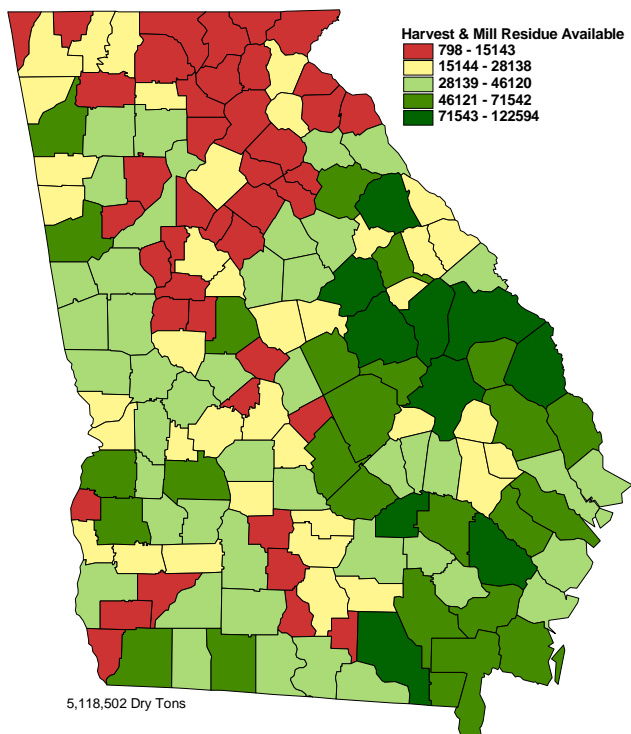
Source: "Biomass Wood Resource Assessment on a County-by-County Basis for the State of Georgia," November 9, 2005, Prepared by General Bioenergy, Inc., Prepared for the Georgia Forestry commission and the Southern States Energy Board.

Biomass Wood Resource, Primary Processing: Mill Residue Available
Dry Tons (2003 Sampling Data)



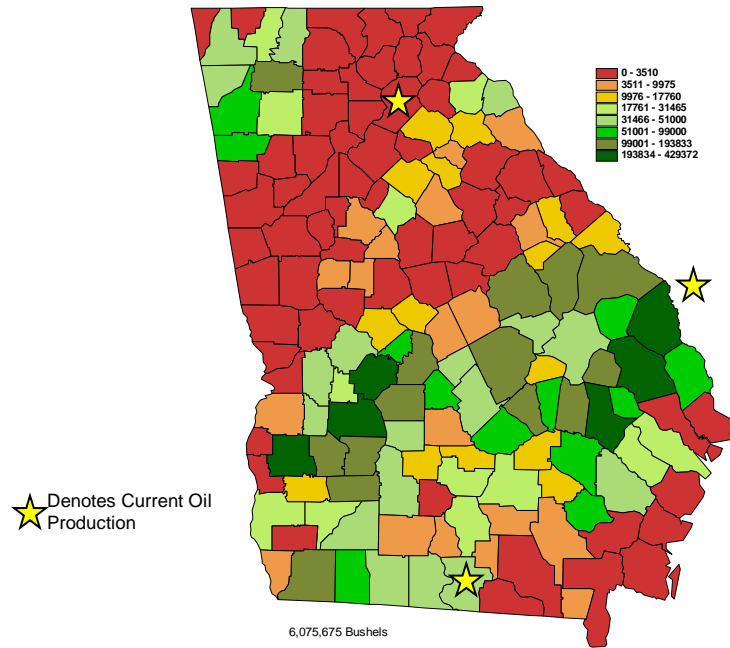
Source: "Biomass Wood Resource Assessment on a County-by-County Basis for the State of Georgia," November 9, 2005, Prepared by General Bioenergy, Inc, Prepared for the Georgia Forestry commission and the Southern States Energy Board.

Biomass Wood Resource, Forestry Resources:
Harvesting & Mill Residue Available, Dry Tons (2003 Sampling Data)

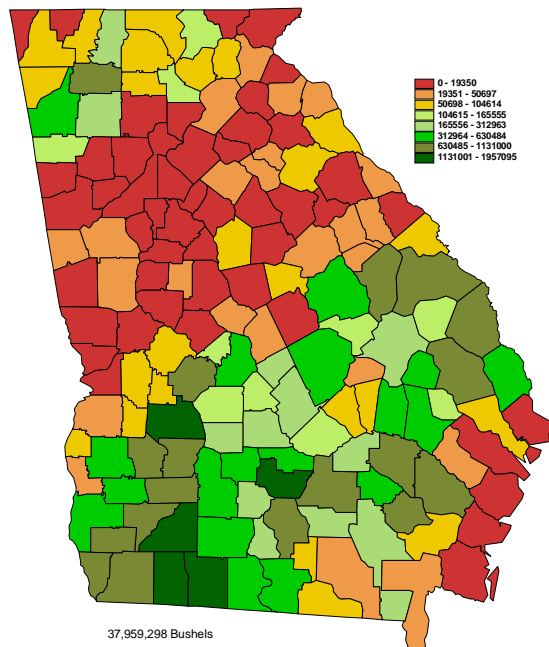


Source: "Biomass Wood Resource Assessment on a County-by-County Basis for the State of Georgia," November 9, 2005, Prepared by General Bioenergy, Inc, Prepared for the Georgia Forestry commission and the Southern States Energy Board.

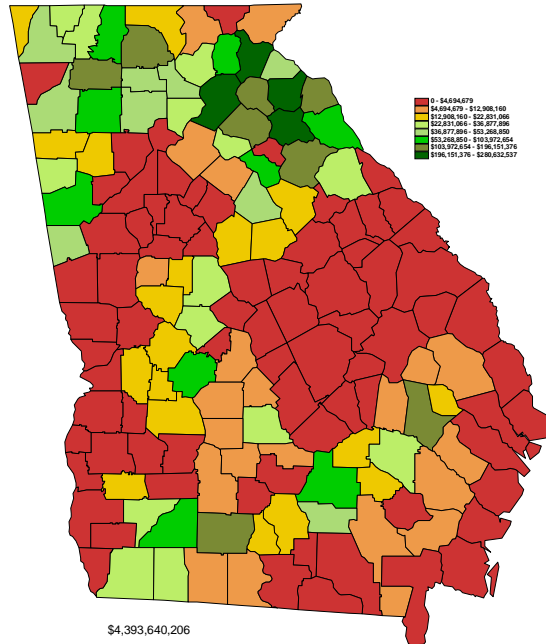
Soybean Production, Total Bushels
(2006 Farm Gate Value Report)



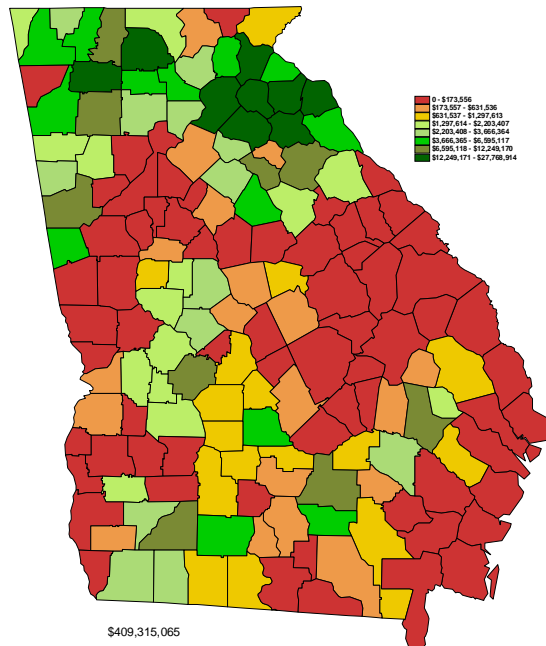
Corn Production, Total Bushels
(2006 Farm Gate Value Report)



Poultry & Eggs, Total Farm Gate Value
(2006 Farm Gate Value Report)



Broiler Grower, Total Farm Gate Value
(2006 Farm Gate Value Report)



The Center for Agribusiness & Economic Development



The Center for Agribusiness and Economic Development is a unit of the College of Agricultural and Environmental Sciences of the University of Georgia, combining the missions of research and extension. The Center has among its objectives:

To provide feasibility and other short term studies for current or potential Georgia agribusiness firms and/or emerging food and fiber industries.

To provide agricultural, natural resource, and demographic data for private and public decision makers.

To find out more, visit our Web site at: <http://www.caed.uga.edu>

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Date/Year April 2008

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J. Scott Angle, Dean and Director