Model Fuel Contract - Co-Firing Biomass with Coal[1]

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ABSTRACT

High yielding biomass crops may be produced at relatively low cost in Florida. Co-firing biomass with coal in an existing power plant is the lowest cost way to utilize biomass. The U.S. Energy Policy Act of 1992 provides subsidies and tax incentives to encourage electric utilities to utilize biomass to produce energy. Unlike fossil fuel, utilizing biomass for energy does not increase CO_2 in the atmosphere. A number of electric utilities including Lakeland Electric, Tampa Electric Co. (TECO) and Florida Power Corp. in west central Florida have expressed interest in utilizing biomass as part of their fuel mix. To protect the interests of both growers supplying biomass fuel and the utility, long-term contracts will be needed. A model biomass supply contract was developed with the cooperation of Lakeland Electric, a municipal electric utility, with input from potential biomass growers. Main points of the contract include: determining the annual quantity of biomass fuel to be delivered, establishing quality specifications, establishing a mechanism for determining the price for biomass fuel, establishing a way for the utility to subsidize the establishment of biomass plantations, establishing a method of financing plantations, and providing for an escape clause for both the utility and grower for events or conditions beyond their control. It was determined that about 7,000 acres (2,835 ha) of biomass crop would be required to replace 6% of the energy now supplied with coal. Lakeland Electric and TECO are taking additional steps toward being able to utilize biomass fuel.

INTRODUCTION

Wood and other plant material were man's earliest fuel source. This material is now referred to as "biomass" and could again become an important fuel source. Biomass can be co-fired with coal as an energy source for generating electricity. Co-firing biomass with coal requires no new power plants and only minor modifications to existing plants. It is the lowest- cost way to utilize biomass. The U.S. Government is supporting the use of biomass as one of the ways to reduce the build-up of CO_2 in the atmosphere. Biomass recycles atmospheric CO_2, while coal (and other fossil fuels) release CO_2 that has been stored for millions of years. Atmospheric CO_2 is believed to be a major contributor to global warming. Electric utilities in central Florida expressing interest in co-firing biomass with coal include Lakeland Electric, Tampa Electric Co. (TECO) and Florida Power Corp.

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Growing biomass crops for fuel will provide an alternative crop for Florida producers. Previous research has shown that high yielding biomass crops may be produced at relatively low cost per ton in central Florida (Rahmani et al., 1997 and 1998). This research indicated that production costs reported in central Florida were low when compared with costs for biomass fuels grown in other parts of the continental U.S. In addition, a project involving Lakeland Electric (a municipal generator of electric power), the Southeast Regional Biomass Energy Program, The Common Purpose Institute, and the Univ. of Florida explored the engineering and economic feasibility of co-firing biomass materials with coal at the McIntosh power plant (Segrest et al., 1998). The study found that biomass material can be introduced into the boiler via an existing structure used to burn municipal solid waste (MSW) or by gasifying the biomass fuel in an external gasifier. The same study also found that biomass fuel was cost competitive with coal when the value of the government subsidy is included. In addition, co-firing biomass with coal is the lowest-cost renewable energy alternative in Florida.

The U.S. Energy Policy Act of 1992 created a cash payment incentive of 1.5¢ KWh^{-1} for non-taxable utilities who use renewable energy sources. This incentive is called the Renewable Energy Production Incentive (REPI) (Sanderson et al., 1996). When converted to Btu equivalents the 1.5¢ converts to about \$1.50 million Btu^{-1} (mm Btu) ($1.055x10^9$ J). Lakeland Utilities' current cost for coal is reported to be about \$1.50 per mm Btu ($1.055x10^9$ J). With the REPI credit, many of the biomass fuels become cost competitive with coal. In addition, the Energy Policy Act makes tax credits available to tax-paying utility companies. Estimated net cost mm Btu^{-1} ($1.055x10^9$ J) (after REPI credit) for biomass material delivered to the power plant range from \$0.05 to \$0.42 mm Btu^{-1} ($1.055x10^9$ J) for Leucaena [*Leucaena leucocephala* (Lam.)], \$1.13 to \$1.58 for elephantgrass (*Pennisetum purpureum* L.), \$0.69 to \$0.94 for sugarcane (*Saccharum* sp.) presscake and approximately \$0.76 for *Eucalyptus* spp. (Segrest et al., 1998).

In southwest Polk County Rahmani et al. (1996) found that most landowners were not aware of biomass as a potential crop. The most important consideration for landowners to decide to grow a new crop was the potential net return. When asked how many acres of biomass crops they would grow at a given net return $acre^{-1}$, landowners were willing to grow 3,300 acres (1,340 ha) at \$40 $acre^{-1}$ (\$99 ha^{-1}), 7,300 (2,960 ha) at \$50 $acre^{-1}$ (\$124 ha^{-1}) and 12,000 (4,860 ha) at \$60 $acre^{-1}$(\$148 ha^{-1}). This area would be even larger if the results were extrapolated beyond the relatively small study area.

In order to successfully establish a co-firing program, growers must be willing to grow biomass crops to supply electric utilities. Because of the capital investment required and the long-term nature of growing biomass for fuel, both the grower and the utility will need to rely on long-term contracts to protect their interests. Many issues need to be considered including, moisture content of the fuel, the physical condition of the fuel in terms of particle size and presence of soil or other contaminates. Establishing a fair price for biomass for fuel for both grower and utility is perhaps the most important factor.

MATERIALS AND METHODS

Meetings were held with the Manager of Business Development and Fuels, and other managers, from Lakeland Electric. Lakeland Electric agreed to provide a copy of their coal fuel

contact to use as a basis for developing a model biomass contract. The Manager of Business Development and Fuels also agreed to appear on the program for a focus group meeting with area landowners. A meeting was also held with the Executive Vice President of Central Florida Farm Credit Service to discuss possible arrangements for financing landowners who want to establish and grow biomass crops for fuel. In addition, the Polk County Property Appraiser's office was contacted and asked to supply, based on their GIS program, names and addresses of landowners within a 20-mile (32 km) radius of Lakeland Electric's McIntosh power plant, who have land with Greenbelt tax classification or with phosphate land under reclamation.

A letter and return postcard was written and mailed to 130 landowners identified by the GIS program. A total of 23 returned the postcard indicating an interest in learning more about growing biomass and participating in a focus group. An agenda and letter of invitation to the focus group meeting were mailed to the 23 respondents.

The focus group meeting was held on 10 Feb. 1999 at the City of Lakeland Training Center. Six landowners attended and participated in the meeting, along with the Manager of Business Development and Fuels for Lakeland Electric, a supplier of waste biomass fuel, the Executive Vice President of Central Florida Farm Credit Service, and Univ. of Florida faculty and staff. The objectives of the focus meeting were 1) to increase landowner/grower awareness of biomass as a potential crop and 2) to discuss issues that should be addressed in a biomass fuel contract between growers and an electric utility.

The Manager of Business Development and Fuels for Lakeland Electric told the group that, as a municipal utility, Lakeland Electric is community oriented. Lakeland Electric doesn't have to answer to stockholders, but rather is interested in serving its clients who are residents of the city. A survey conducted by Lakeland Electric found that about 15% of their customers would be willing to pay a premium of 5% to 10% over the present electric rate for "green energy."

Possible length of a contract was discussed. The REPI credit is good for 10 yr starting when the utility begins burning biomass fuel. The contract could run for 10 yr plus the time it would take to plant and grow a plantation to first harvest. Cost of establishing a plantation and the possibility of recovering establishment cost was also discussed. Cost of establishing a plantation will vary by species selected, soil type, and from site to site based on the condition of the site. The Manager of Business Development and Fuels suggested that the contract might include a provision to guarantee the return of the establishment cost of the plantation if production was less than expected. Revenues above the cost of establishment could be shared by the utility and the grower.

In answer to a question of Lakeland Electric's contracting with individual growers for biomass fuel, it was stated that Lakeland Electric was interested in dealing with a single entity rather than multiple growers. Growers could band together in a cooperative and work through the cooperative to contract with a utility. Also, as an alternative to a cooperative, a private fuel supplier could contract with a utility to supply fuel and in turn contract with growers to grow biomass fuel. For this project, the model contract was developed with the assumption that the electric utility was contracting with a cooperative.

RESULTS AND DISCUSSION

Three main points came out of the focus meeting. The first was that Lakeland Electric has a genuine interest in biomass fuels. Secondly, the utility is not interested in dealing with a group of individual growers to secure a supply of biomass fuel. Third, landowners are looking for a way to recover their investment cost for planting even if yields are lower than expected or the deal with the utility falls through. These ideas were incorporated into the model biomass contract.

The model biomass contract was drafted with input from Lakeland Electric, taking into consideration needs of both landowners/growers and the utility. Based on discussions at the focus group meeting it was determined that two contracts were needed. One contract would be between a grower's cooperative (seller) and the utility (buyer), and the second contract would be between the cooperative and members of the cooperative.

Contract between the Electric Utility and Grower Cooperative

A copy of the contract titled "Energy Crop Biomass Fuel Supply Agreement between Environmental Fuels Cooperative and City of Lakeland, FL, Dep. of Electric and Water Utilities© " is available from the Univ. of Florida , Center for Natural Resources, Biomass Programs, Gainesville, FL. The main points of the contract between the buyer and the seller include: determining the annual quantity of biomass fuel to be delivered, quality specifications; determining the price for biomass fuel, crop establishment costs; and an escape provision for conditions beyond the control of either buyer or seller.

Annual quantity of biomass fuel

Both buyer and seller agree that at present a biomass fuel supply doesn't exist. Both buyer and seller will mutually agree on the area of each species to be planted and on a schedule of planting to provide a continuous supply of fuel to the utility. It is the responsibility of the cooperative, working with its members to establish plantations according to the agreed upon schedule. Once the biomass plantation has developed to the point of first harvest, both buyer and seller will mutually agree on the minimum annual quantity of biomass fuel to be delivered. Delivery schedules will be established by calendar quarter and itemized by month.

Quality specifications for biomass fuel were spelled out in the contract (Table 1). A total of seven categories were listed on both a dry basis and as received. The two most critical categories were heat of combustion (Btu lb^{-1}) (J kg^{-1}) and ash content. Particle size was also important because larger sized particles do not burn efficiently in the boiler. The contract specified that only an agreed upon quantity of the fuel may be larger than 0.25 inch (6.3 mm) in size. The buyer may, at buyers' discretion, sample biomass fuel and conduct a "short approximate analysis" including Btu lb^{-1} (J kg^{-1}), moisture, ash, sulfur, and particle size. Biomass fuel not in compliance with the specifications may be rejected by the buyer or be subject to a reduction in price agreeable to both buyer and seller. If the fuel is rejected, the seller has 10 working days to supply fuel that conforms to specifications. If the seller does not supply the fuel then the buyer may buy an equivalent amount of fuel from another source.

Table 1. Example of quality specifications for biomass fuel.

	Test number	Typical test results
Dry Basis		
Ash	ASTM D 5142[†]	1.93% by Wt.(19.3 g kg^{-1})
Heat of combustion	ASTM D 5865	8730 Btu lb^{-1}(4.18 x 10^6 J kg^{-1})
Carbon	ASTM D 5373	51.32% by Wt. (513.2 g kg^{-1})
Hydrogen	ASTM D 5373	5.62% by Wt.(56.2 g kg^{-1})
Nitrogen	ASTM D 5373	0.23% by Wt.(2.3 g kg^{-1})
Chlorine	ASTM D 3761	500 ppm (500 mg kg^{-1})
Sulfur	ASTM D 4239	0.08% by Wt.(0.8 g kg^{-1})
As Received		
Moisture, total	ASTM D 2013	51.50% by Wt. (515.0 g kg^{-1})
Ash	ASTM D 5142	0.94% by Wt.(9.4 g kg^{-1})
Heat of combustion	ASTM D 5865	4240 Btu lb^{-1} (2.03 x 10^6 J kg^{-1})
Carbon	ASTM D 5373	24.90% by Wt.(249.0 g kg^{-1})
Hydrogen	ASTM D 5373	2.73% by Wt. (27.3 g kg^{-1})
Nitrogen	ASTM D 5373	0.11% by Wt. (1.1 g kg^{-1})
Chlorine	ASTM D 3761	242 ppm (242 mg $kg^{-1)}$
Sulfur	ASTM D 4239	0.04% by Wt. (0.4 g kg^{-1})
General		
Heat of combustion, MAF[‡]	ASTM D 5865	8900 Btu lb^{-1} (4.26 x 10^6 J kg^{-1})
Sulfur–lbs mm Btu^{-1}	ASTM D 3180	0.092 lbs (0.042 kg)

[†] American Society of Testing Materials test number.
[‡] MAF= Moisture and ash free.

Price for biomass fuel

To determine the price the buyer will pay the cooperative for biomass fuel, three components are considered: the avoided cost for fossil fuel, economic value cost sharing, and the agreed upon percentage of economic value cost sharing going to the cooperative (Table 2). The

avoided cost is the value of a given amount of fossil fuel, on a mm Btu basis (1.055×10^9 J), replaced by biomass fuel. If a mm Btu (1.055×10^9 J) of biomass fuel replaces a mm Btu (1.055×10^9 J) of coal and the value of a mm Btu (1.055×10^9 J) of coal is 1.5¢ mm Btu^{-1} (1.055×10^9 J) then the value of the biomass fuel is 1.5¢. The avoided cost may be based on a 4-yr rolling average of a mix of fuels including coal, petroleum coke, and natural gas. Should the minimum value of the avoided cost base price drop below an agreed upon level, the utility will guarantee a minimum price. The base price could be adjusted based on the quality of the biomass fuel. For example, the price could be adjusted upward if the weighted average Btu content of biomass fuel exceeds the guaranteed amount. On the contrary, the base price could be adjusted downward if the ash content of biomass fuel is above the guaranteed level.

The economic value cost sharing includes a number of items consisting of: REPI credit for closed loop biomass fuel of \$1.50 mm Btu^{-1} (1.055×10^9 J), 5 to 10% premium for "green" energy which could add 10¢ or more mm Btu^{-1} (1.055×10^9 J), plus the avoided cost of other renewable energy options (wind, solar, or hydro) to achieve renewable energy portfolio standards proposed in federal electrical deregulation legislation. In addition, selling electricity produced from biomass to wholesale energy markets at premium prices could also increase the value of biomass fuel. Finally, credits for carbon taxes on fossil fuels, if enacted by the U.S. Congress, could provide additional income. The total value of the economic value cost sharing would be divided between the utility and the cooperative. The contract requires that all economic value cost sharing be distributed each year. The final price for biomass fuel would include the avoided cost base price plus an agreed upon percentage of the economic value cost sharing.

The contract also includes a provision for the utility to pay up to 50% of the establishment and maintenance cost of the energy crop plantation to first harvest. The utility will issue a letter of credit to the cooperative for each biomass plantation. The monetary value of the letter of credit will be based on 50% of the projected cost of establishing and maintaining the plantation until first harvest. The cooperative can use the letter of credit to obtain financing for the plantation. At first harvest, for each plantation, the utility will pay the cooperative up to 50% of the establishment and maintenance costs based on actual cost records kept by the cooperative.

Escape clause

The contract provides an escape clause for both the utility and the cooperative in the event that something happens that is beyond the control of either of the parties. Any event or cause beyond the reasonable control of either party, that cannot be prevented or eliminated by the exercise of due diligence, may result in cancellation of the contract. Examples of such events include: strike, lockout or other labor dispute, sabotage, fire, storm, freeze, wind, flood, excessive rainfall, disease or insect damage, drought, war, riot or insurrection, inability to secure supplies or governmental permit or authorization, unscheduled or forced outages at the generating station, or interruption of or shortage of transportation arrangements or equipment, etc. If the contract is canceled by the utility, the utility agrees to compensate the cooperative for the entire establishment cost of the plantations.

During the course of this project, it was discovered that energy crop plantations may be financed through regular farm financing channels. The biomass fuel contract and letter of credit

Table 2. Determining price cooperative receives for biomass fuel.

Price of biomass fuel = Avoided cost base price[†] + (economic value cost sharing[‡] x percent distribution[§]).

[†]Avoided cost base price = (Average fossil fuel cost (rolling 4 yr avg) x avoided cost fuel mix) + (if avoided cost base price is less than minimum agreed price) difference between avoided cost base price and minimum value of avoided cost base price ± quality adjustments.
[‡]Economic value cost sharing = value of renewable energy production incentive (REPI) credit + green energy premium+ avoided cost of the next best renewable energy option (eg. wind, solar) to achieve minimum renewable energy portfolio standards (if adopted) + premium for sale of renewable electricity to other utilities + carbon tax credits (if adopted).
[§]Percent distribution = the agreed upon percent of economic value cost sharing going to the Cooperative.

for up to 50% of the cost of establishing biomass plantations provides collateral for the loan. Also, loan guarantees are available through the USDA for a small increase in the interest rate. As a result of this project, private crop insurance is also available for biomass plantations. The cost of Energy Crop Insurance will range from \$1.50 to \$3.30 $acre^{-1}$ $year^{-1}$ (\$2.70 to \$8.15 ha^{-1} yr^{-1}). The lower cost (i.e., \$1.50 $acre^{-1}$ (\$2.70 ha^{-1})) is available if the following conditions are met: procure professional forestry management, have a pest control management plan, and have a fire control management plan.

Contract between Grower Cooperative and It's Members

The second contract, between the cooperative and it's grower members, mirrors the main contact. Other features of the contract include a requirement that the grower maintain crop insurance on the biomass crop plantation. It also specifies that the grower will submit a site plan for each biomass crop plantation to the cooperative. In addition, it provides an outline for determining establishment costs for the purpose of financing by the utility.

Developing the Biomass Energy System

Lakeland Electric's McIntosh power plant is a 365 Megawatt ($MW=10^6$ watts) base-load facility with a historical availability/capacity factor of 80%. In addition to pulverized coal, the plant was designed to burn MSW. To replace 6% of the Btus (J) now supplied by coal with biomass would require about 7,000 acres (2,833 ha) of biomass crop yielding about 32 green tons $acre^{-1}$ yr^{-1} (72 Mg ha^{-1} yr^{-1}).

Since development of the model biomass contract, Lakeland Electric has issued an "Invitation for Proposals" for a biomass processing system. The invitation says that the Lakeland Electric Dep. desires to receive, process and burn biomass material(s) at the McIntosh power plant facility. The invitation goes on to state that proposals should include, but not be limited to various forms or combinations of either a stand alone facility, such as a gasification facility converting biomass into combustible biogas fuel, or an addition/modification to the existing MSW facility, enabling the processing of additional amounts of biomass materials.

To further the development of a biomass energy system, the Common Purpose Institute is taking the lead in developing a demonstration planting of 200 acres (81 ha) of Eucalyptus and cottonwood (*Populus deltoides*) trees on a clay settling area in Polk County. TECO has agreed to contribute $40,000 to the project. This money will be added to funds from the Florida Energy Office and the U.S. Dept. of Energy. The demonstration site is scheduled to be planted in the summer of 2000. If the demonstration planting meets yield goals, and an efficient harvest system can be demonstrated, it is expected that contracts will be offered for commercial production of biomass fuel in central Florida. In addition, both Lakeland Electric and TECO have completed test burns of biomass fuel at their McIntosh and Gannon plants. TECO has also agreed to conduct a test burn at their Big Bend Generating Station, Unit No. 4. Both of TECO's plants are located on Tampa Bay in southern Hillsborough County.

CONCLUSION

A large electric utility is not willing to deal with a large group of independent growers for a fuel supply. A single entity such as a grower cooperative or fuel supplier will be needed to serve as a link between the utility and the growers. A year-around supply of high quality fuel will be required. Particle size of about 0.25 inch (6.3 mm) was desired for Lakeland's McIntosh plant, which will increase the cost of processing. Additional research is needed to determine moisture and chemical composition of samples from whole *Eucalyptus* trees and other biomass crops. Periodic sampling throughout the year is needed to determine seasonal variability, especially where harvest of a single species is extended over several months. The economic feasibility of growing biomass for fuel is highly dependent on the electric utilities willingness to share a substantial portion of the economic benefits with growers.

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