

Testimony to the United States Senate Committee on Agriculture, Nutrition and Forestry

Southern Pine to Ethanol
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Introduction

Mr. Chairman, thank you for the opportunity to testify on the biofuels effort in the State of Georgia, specifically related to the production of Southern Pine to Ethanol and the potential for cellulosic based fuels in the southeast. I would also like to thank Senator Chambliss for his interest in ongoing development efforts involving this resource at both the Georgia Institute of Technology and the University of Georgia. This testimony will describe this particular resource and potential for its development and opportunities for adaptation into the marketplace.

The Georgia Tech Strategic Energy Initiative's mission is to actively engage industry and government to develop and commercialize high impact near term energy technologies. Utilizing Georgia Tech's world-class research community and coordinating with industry and government partners, SEI executes research, development, and demonstration projects on strategically selected new technologies that will provide continued national economic growth.

Transportation is at the heart of the U.S. economy and social structure, and transportation depends on oil. However, U.S. domestic oil production peaked in 1970 when oil was \$2 per barrel as shown in Figure 1. At \$60 per barrel, today's U.S. oil production is about 40 percent less than it was in 1970. This is due to the continuing depletion of the U.S. oil endowment. The U.S. is therefore becoming even more dependent on unstable oil producing regions of the world, and these increasing oil imports are adding significantly to our balance of payments deficit. A near term solution to our growing transportation oil demand is urgently needed.

Ethanol is the only transportation fuel that can have a significant impact on oil demand within the next five years. All gasoline vehicles can utilize up to 10% ethanol in their fuel mix, while flexible fuel vehicles can use up to 85% ethanol in their fuel mix. There are currently about 5 million flexible fuel vehicles on the road today, and they are being added to the nation's fleet at a rate of about a million per year. Corn ethanol is already providing about five billion gallons a year, and utilizing about 20 percent of the nation's corn supply. Cellulosic ethanol from unutilized southern pine can be a major additional ethanol resource that can be brought on line in the next three years.

The amount of energy contained in one gallon of ethanol can be described in terms of its lower heating value of 76,000 Btu/gal. To describe the efficiency of the ethanol production process, one needs to look at how much energy was required as an input to produce the ethanol. For the case of cellulosic ethanol, approximately 16,000 Btu's are required (in the form of harvesting and process energy) to produce one gallon of ethanol, resulting in a 79% efficiency.

Due to the declining U.S. paper products industry, the southern pine agricultural industry has a surplus of renewable pulpwood product that has no current market. Figure 2 shows a decline in pulpwood demand from 200 million tons annually to about 165 million tons. This has caused economic hardship in many southern rural communities. The infrastructure for harvesting and transporting this cellulosic ethanol resource is in place today, and the basic technology is in hand to convert this resource to ethanol at an estimated cost as low as \$0.80 per gallon. Add NREL plot.

In addition to the reduced dependence on imported oil from unstable regions of the world and a reduction in the negative U.S. balance of payments, greenhouse gas emissions are reduced over 90 percent from the production and use of southern pine ethanol compared to the utilization of gasoline from oil.

Southern Pine Biomass Resource

The forest products industry (including sawmills, pulp & paper mills, and other building products facilities) has been very important to the economy of the Southern States for many years. Seventy percent of U.S. timberland acres are located in the eastern half of the country. The U.S. South, composed of Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas and Virginia has 211,838,000 forested acres, 40 % of their total land area. Private landowners own over 90% of this forest land. However, recently the pulp & paper industry has seen some major setbacks in the region. From 1997 to 2004, the total southern pulpwood production declined from 201 to 169 million green tons, a 16 % decrease . From 2001-2004 the economic impact of the forest products industry in Georgia dropped from \$30.5 billion to \$22.7 billion and it slipped from #2 to #3 in terms of economic importance for the state . Additionally, over that same period, employment in this field fell from 204,000 to 145,000 jobs . The Georgia Forestry Commission is very concerned with these statistics and is looking for new ways to utilize wood and wood waste to give landowners new markets. New demand for a feedstock from an industry such as ethanol production could help reverse this trend, provide economic development for the state of Georgia, and contribute to increasing national security by utilizing a local renewable resource to reduce dependence on foreign oil.

Figure 3 shows the 2004 pulpwood production by state (1 cord = 2.65 green tons), while Figure 4 shows the cords of softwood per square mile on a map. Of the Southern States it can be seen that the Southeast leads in softwood production, which is largely because of southern pine used in pulp/paper mills.

Figure 3: 2004 Pulpwood Production by State and Broad Speciesi

Figure 4: Softwood Roundwood Production in the South by County or Parish, 2004i. Along with a decrease in the use of southern pine over the last few years, the available resource has grown through agricultural tree plantings spurred by the Conservation Reserve Program. This program paid for a portion of afforestation and also paid rent to farmers for involved

lands. Over one million acres of forests have been established in this program alone in Georgia (out of 24 million total acres of forest land in Georgia), providing a new southern pine resource that is sustainable at 2004 levels with a rate of harvesting of 10.1 million green tons per year. This is roughly equivalent to 400 million gallons of ethanol per year at current conversion yields.

There is also an unused unmerchantable timber resource in Georgia that could be harvested at a rate of 7.6 million green tons per year, or approximately 300 million gallons of ethanol per year. This includes thinnings, wastes, and other residues.

Overall in 2004, Georgia had 55.2 million green tons of southern pine available for production. The pulp and paper industry used 37.5 million green tons, leaving 17.7 million green tons of renewable southern pine resource available for ethanol production. This resource could produce approximately 700 million gallons of ethanol per year, which could displace approximately 20% of Georgia's gasoline use, without impact to other current wood product industries in the state. Extrapolating these results to the other Southern States, there may available southern pine resources for a 4 billion gallon per year ethanol feedstock available today.

Economic Impact

Ethanol, produced regionally, and on a large scale, can have a significant impact across both local and national markets. Because it is produced domestically, it can decrease the nation's dependence on foreign oil and increase national security. Additionally, it is a renewable fuel and its use helps to boost the economy of the nation's agricultural sector.

With minimal investment in technology and a partnered commitment from a consortium of industry, government, and university researchers economic, development opportunities for rural America and beyond will evolve. By building upon our current forestry infrastructure in Georgia and the South ethanol markets can expand rapidly, creating new jobs and transforming a declining industry into a sustainable new economic entity. By incorporating biofuel operations into the forest products value-chain, a new revenue stream could be generated providing increased demand for the South's wood resources and new rural economic growth opportunities.

A woody cellulose ethanol production facility in Georgia would provide a higher economic value wood waste feeds as well as provide the infrastructure for an alternative forest products business for Georgia. A 100 million gallon/yr facility, selling product wholesale for \$1/gallon would yield sales of \$100 million. Potentially, several plants of this size could be built in the state, and this new market would generate new jobs and needed revenues for the forest products industry, as well as reduce the flow of U.S. dollars for oil overseas to unstable parts of the world. Most of these jobs would be located within rural areas but the impact of cellulosic ethanol production and use would have a ripple effect in virtually every sector of local and national economies.

As of February, 2005, the ethanol industry has added more than \$25 billion to the nation's gross economic output through operating spending and capital spending for new plants; it has

supported over 147,000 jobs across all sectors of the economy; and \$4.4 billion went directly to consumers this past year through increased economic activity and new jobs .

Southern Pine to Ethanol Development Program

? Background

During the 1970s and 1980s Georgia Tech hosted several research programs concentrating on the production of alternative fuels from biomass feedstocks. These programs included production of char, liquids, and synthetic gases from wood feedstocks, and the construction of steam plants using woody biomass as fuel. In particular, there was a program carried out using funds from the U.S. Department of Energy which concentrated on producing ethanol from wood. At the time, most softwood (pine) resources were being fully utilized by the forest products and pulp and paper industries, so the research was centered on production of ethanol from hardwoods.

In 2004, conversations between staff of the Strategic Energy Institute (SEI) and the Georgia Forestry Commission made it clear that at this time there is a surplus of underutilized pine in the state, and there needed to be a renewed effort on the production of ethanol from pine resources.

? The Biomass Research Team

The Strategic Energy Institute (SEI) established a research team in 2005 to investigate the feasibility of producing ethanol economically from southern pine resources. In addition to SEI personnel, team members were recruited from the Georgia Tech School of Chemical Engineering, the Georgia Tech School of Chemistry, and the School of Biochemistry at the University of Georgia. Members from the academic units all had some experience in producing ethanol from biomass. The project has been funded from a combination of industrial partners, C2BioFuels and Chevron, and the Georgia Research Alliance.

The initial phase of the project has focused on ethanol production utilizing essentially existing technology. The work, supported by the State of Georgia and a private company, C2 Biofuels, has been conducted at Georgia Tech and the University of Georgia. This effort has identified applicable process technologies and specific laboratory results. It also identified areas of opportunity to substantially reduce the cost of ethanol production through technology improvement and development. Significant funding support has also been provided from private sources, primarily the Chevron Corporation, and the State of Georgia to develop enhanced technology.

Funding for joint research between Georgia Tech and the Chevron Corporation is focused on the development of commercially viable processes for the production of transportation fuels from renewable resources such as forest and agricultural waste. This is viewed as an important advancement over first-generation biofuels such as ethanol and biodiesel, which are made from agricultural crops. Specifically with regard to ethanol production, this includes activities aimed at enhancing pretreatment processes and at utilizing separation techniques utilizing distillation processes.

The State of Georgia, through the auspices of the Georgia Research Alliance, has funded

specific projects at Georgia Tech and the University of Georgia. These projects focus on improvements in pretreatment and enzymatic processes and on elimination of water resulting from the fermentation process.

? Preliminary Results

Initial laboratory trials using enzymatic hydrolysis pretreatment schemes were carried out at Georgia Tech and UGA, backed up by trials performed at Lund University (Sweden). Preliminary results show ethanol production using enzymes at 70% of theoretical. These results are very encouraging and sufficient for commercialization. These experimental results dispelled the widely held belief that ethanol production from softwoods is more difficult than from hardwoods.

? Steps to Commercialization

Current results have been obtained utilizing a wood to ethanol research laboratory in Sweden. The trials are continuing in an effort to optimize the enzyme formulations and pretreatment steps. The steps and schedule to commercialization are currently expected to be as follows:

A. Process Development Unit - Feb '07 (more funding details)

This plant will be used for pretreatment and enzyme optimization.

B. Pilot Plant - Dec '07

This plant will process 5 dry tons/day of feedstock and produce 400 gallons/day of ethanol.

C. Demonstration Plant - Dec '08

This plant will process 100 tons/day with an ethanol production capacity of 3 million gallons/year.

D. Commercial Plant - Jun '10

This commercial plant will produce 50 million gallons/year of ethanol.

The above steps starting with the pilot plant will rely on industry participation and sponsorship. Funding for the larger plants will depend on outside capital from banks and bondholders. The government could assist in these financings by providing loan guarantees and production tax credits.

? Other Research

There are opportunities for cost reductions throughout the ethanol production process. Key areas which are currently being researched are enzyme design, novel distillation technologies, and alternative pretreatment processes.

Conclusions

? Southern pine can be produced from southern pine efficiently and effectively

- o Proven in three different laboratories
- o High yield rates, 70 % of theoretical achieved to date
- o 79 % conversion energy efficiency
- o With current technology, production costs ~\$1.30/gal
- ? Southern pine biomass resource is abundant
- o Georgia
- ? 24 million acres of forest land
- ? 55.2 million green tons harvestable per year
- ? 37.5 million green tons currently used by other industries
- ? 17.7 million green tons available for a new industry
- ? Infrastructure Exists
- o Planting
- o Harvesting
- o Transporting
- ? Opportunities for cost reduction thru technology apparent
- ? Research
- o Processing technology
- o Development of high valued co-products from process
- o Genetic improvement of trees for increased yield
- ? Time Scale
- o Commercial plant operational in June 2010