



Utilizing Pine for Energy Frequently Asked Questions June 2008

Pine trees, a type of woody biomass, are comprised of carbohydrates and lignin produced through photosynthesis, that can be converted in various forms to produce energy.

In this document, the use of pine refers to the use of whole pine trees, branches, tops, and other debris from harvesting operations. Traditionally, pine has been used in the pulp and paper industry, but with declining markets, as well as the need to reduce greenhouse gases, diversify energy markets, and increase national security, demand and use of these materials has expanded and changed.

Utilizing pine for energy, such as electricity, heat, and fuel, has multiple benefits. It can help reduce greenhouse gases, improve the health of forests, increase wildlife habitat, enhance rural economies, and create local energy supplies.

Below are some critical questions regarding the use of pine for energy. While multiple uses of pine for energy are important and touched on throughout the document, most the questions here are focused on the use of the pine for ethanol production due to the growing interest and debate in this sector.

Technology Development, Feasibility and Resource

What are the uses of pine for energy and where will the resource come from?

Pine can be used to produce ethanol, electricity, space and process heat, bio-oil, char, wood pellets, synthetic gas, and other chemical products.

All types of biomass resources could be utilized for energy and/or fuel production. Georgia has over 22 million acres of private forest land, 7- 8 million under plantation management. In addition to the 28 million tons of biomass from Georgia used for other traditional products, Georgia has the capacity to produce 20.6 million more tons (dry basis) of biomass each year.

Economics of supply, competition and processing will determine which materials are used. One advantage of using pine for energy is that currently unmerchantable biomass in forest stands can also be used. Further, the long-term supply of pine biomass for energy beyond 20 years into the future will depend greatly on reforestation investments by Georgia forestland owners starting today.

How much woody material is available on an annual basis in Georgia for use in energy production (electric generation, pellet production, synthetic gas and ethanol)?

There is in excess of 20 million dry tons of material per year in Georgia that is currently not commercially utilized that could be used for fuel or energy production. In addition, a tremendous amount of material is available annually from land clearing for development and yard trimmings.

When will wood based ethanol be produced in a commercial size plant in Georgia?

The U.S. Department of Energy is catalyzing the scale-up with significant grants to companies interested in building demonstration plants. Colorado-based Range Fuels has received a grant to build a commercial facility in Treutlen County, Georgia and began construction at the end of 2007. Production will begin in 2009. Georgia-based C2 Biofuels is a second company that is targeting Georgia's pine resource for cellulosic ethanol. Other companies who have announced plans to build demonstration or commercial-sized cellulosic ethanol facilities in other states include Mascoma Corporation, Zechem, Coskata, POET, Verenum, Abengoa, Iogen, SunOpta, DL Process Design, and Blue Fire Ethanol.

We can expect more development of pine to ethanol in the next 5-10 years.

How many gallons of fuel are consumed in Georgia each year for transportation?

Georgia currently uses about five billion gallons of gasoline per year and about two billion gallons of diesel.

Assuming that all woody biomass is converted to fuel (80 gallons per dry ton of material), over 1.5 billion gallons of ethanol, which is 30% of our gasoline consumption, could be made from Georgia's excess woody material. The ethanol would be consumed as a mixture with gasoline as E10 (10% ethanol), which can be used in any gasoline powered automobile; or as E85 (85% ethanol) which is suitable for flex fuel vehicles. In the near future, blends of ethanol may be expanded to include E20 (20% ethanol).

How much renewable ethanol fuel can be made from the 20 million tons of excess woody material available in Georgia and how would it be used?

65 – 115 gallons of ethanol can be produced per ton of dry wood. Utilizing all materials would produce 1.3-2.3 billion gallons of ethanol.

How much electricity could be generated if all 20 million dry tons of woody biomass were used for this purpose?

1,667 megawatts of electricity would be produced

How does pine compare to switchgrass as a feedstock for ethanol production?

Pine is an existing large resource with accompanying infrastructure to grow, harvest and deliver to processing plants at a predictable price. A second major advantage is the year round availability which eliminates the storage problem that must be addressed for annual harvest grasses and other crops. Switchgrass is a promising resource, but does not have the advantages listed above for Southern pine.

Is pine the optimal feedstock for ethanol?

Currently, pine is the best available renewable feedstock for energy and fuel production in Georgia. Transportation infrastructure and technology for utilizing pine currently exist putting the use of this feedstock at an advantage over other feedstocks still under evaluation. Further, it provides the best opportunity for large-scale ethanol production at this point in time because of the large available quantities at a low, predictable delivered cost. There is not enough information currently available about the optimal feedstock given the early stage of ethanol technology.

Much research is underway evaluating other feedstocks but the pine resource in Georgia will likely be a competitive source for decades to come.

Environmental Impacts

How does ethanol produced from pine compare with ethanol produced from corn?

Pine trees are not a food crop and they are grown on land that does not compete with food crops. In addition, ethanol from pine produces eight times as much energy for each unit of non-renewable fossil fuel, such as oil and natural gas used in its manufacture, compared to corn ethanol. This superior energy yield is due in part to high-energy lignin found in pine, which can be used as a fuel for the conversion process. And, unlike corn, pine does not require fossil fuel based fertilizer, pesticides and herbicides or irrigation to grow.

According to a study by Argonne National Laboratory, cellulosic-based ethanol such as that made from pine trees and pine waste emits 85 percent less in greenhouse gases than gasoline. Pine trees also can be harvested sustainably year-round, meaning there is no need to store them between growing seasons, as must be done with annual crops.

Further, pine ethanol provides several economic benefits. It is estimated that if Georgia can develop its ethanol industry to supply 20 percent of our gasoline needs within 10 years, it would deliver more than \$5 billion in economic benefit, much of it directly to rural Georgia.

What will happen to the carbon trapped in wood waste if it is left in the woods and not converted to energy use?

The carbon can be released into the atmosphere via wildfire. These fires also produce by-products like methane and nitrogen oxides (NO_x) which are harmful greenhouse gases.

Carbon can also be released through decomposition. The decomposition process releases carbon, but much slower and with less methane and NO_x emissions than with quick combustion via wildfire.

Will commercialization of multiple pine to energy projects lead to the conversion of Georgia's mixed and hardwood dominant acreage to pine?

Today, good markets exist for hardwood in many parts of the state. Hardwoods are often managed to produce wildlife habitat. The free market and alternative personal management objectives chosen by the landowner's will ultimately determine the reforestation species and methods.

How will development of a pine to energy industry in Georgia help maintain Georgia's 22.7 million acres of private forestland in forests?

Energy will be a new and additional source of income for forest landowners. Expanded markets and additional revenue streams for timber owners will help incentivise landowners to keep their land in productive forests and increase forests.

Will utilizing wood waste from harvesting operations for energy production result in the degradation of soil quality over time?

Any impacts are likely to be minimal for several reasons. It is not feasible to collect 100% of the logging residuals. Breakage, soil protection, and erosion control will contribute to some material being left on site. Further, as a tree grows and drops leaves and limbs they are returned to the soil. Harvesting the trees surface or subsurface biomass (roots/stump) would not occur for energy production.

In the Southeast, conventional harvest includes removal of the whole tree to a loading deck where the limbs and tops are removed from the merchantable stem. The limbs, leaves, and tree tops are not usually returned to the soil. They are often consumed in a site preparation burn to clear the site for easier planting or piled and left to rot. With this method, some biomass or ash remains on site but overall there would be similar nutrient loss to whole tree removals.

To contrast forest harvesting practices with other agricultural practices, farmers perform significant removals with row crops like wheat seasonally, and crop prices reflect the cost of adding nutrients back when the successive crop is planted. Sod farmers are carrying it one step further with the removal of a little bit of soil at each harvest.

Total removals were studied and results published in the Georgia Forest Research Paper #47 titled Nutrient Removal Under Whole Tree Utilization for Fuel Chips. The result of the study is that whole tree harvests remove on average the following percentage of the site nutrients:

Nitrogen (N)	5%
Phosphorus (P)	36%
Potassium (K)	24%
Calcium (Ca)	71%

What is “Carbon Sequestration” and why is it so important?

Actively growing forests remove carbon dioxide (CO₂), a byproduct of burning fossil fuels, from the atmosphere. Trees store the carbon in wood fiber and release oxygen. When trees capture and store carbon in forest vegetation, soil and forest products, it is called “carbon sequestration.”

Scientists say the world’s atmospheric carbon dioxide levels are increasing by about three billion metric tons every year. Carbon dioxide is a greenhouse gas that contributes to global warming. Trees sequester carbon and therefore help reduce the impacts of global warming. Further, as air pollution increases, so do the number of health problems for Georgians. More sustainable forests help increase the reduction of harmful particulates in the air.

Carbon sequestration is also an emerging market opportunity for southern forest owners (see below).

How much carbon can southern forests process?

Actively managed southern pine plantations sequester from one to four tons of carbon, per acre, per year. Annually, Georgia’s forests offset approximately 8% of our state’s carbon dioxide emissions.

Georgia’s forests produce from a low growth in unmanaged natural stands of four green ton/acre/year to a high of 10+ green tons/acre/year. Reducing this “wet” green tons back to dry carbon gives the ranges quoted above. This large range is a result of the species, land productivity and density of managed growth. The end result is that managed plantations produce a much greater sustainable yield of feedstock biomass than do unmanaged stands. The dilemma is that high yields grown close to the conversion plant means greatly reduced transportation and harvest costs, but more “plantation” acres. The discussion will continue around the balance between fewer more productive acres or more less-productive acres as collection sites.

How could a landowner realize value for carbon sequestration?

The sale of “carbon credits” could provide a new opportunity for income on a regular, ongoing basis. Systems that match emission-dependent companies with tree growers have been developed in Georgia, California, Maine, Oregon, and in other parts of the world. Companies, such as utilities, cost-share tree planting or afforestation in exchange for “carbon credits,” and transactions are recorded in a Carbon Registry. A national protocol for establishing such a registry does not yet exist.

How will using pine for energy affect global warming?

Our cars and power plants produce carbon dioxide (a major greenhouse gas (GHG) linked to global warming) when they burn fossil fuels like gasoline, diesel, and coal.

Pine trees form a natural carbon cycle. The use of pine or any other plant feedstock as a fuel will displace fossil fuels thus offsetting the addition of greenhouse gases to the atmosphere. Carbon dioxide, which is the largest volume greenhouse gas, is captured from the atmosphere in photosynthesis and becomes part of growing plants as solar energy is stored. The use of the plant as a fuel returns the carbon back to the atmosphere, most commonly in the form of carbon dioxide.

The use of fossil fuels, such as gasoline, in our vehicles results in a movement of carbon from long term storage in underground crude oil deposits to the atmosphere in the form of CO₂.

In addition, any use of fossil fuels, such as natural gas, petroleum based products or coal, used in planting, growing, harvesting or converting the plant to a fuel, would alter the greenhouse gas benefits.

What are the impacts of biofuels on water? How much water is consumed by a cellulosic ethanol production facility?

Like fossil fuel production the amount of water used to make biofuels will vary depending on the technology employed. For some technologies, the high water content in pine (50%) is an advantage because it offsets water which otherwise would have to be pumped from local sources. The actual water demand will be proven as the technologies are commercialized.

Cellulosic ethanol plants will require 1 - 1.5 gallons of water per gallon of ethanol produced. Corn-based ethanol plants require up to 4 gallons per gallon of ethanol produced.

A 50-megawatt biomass fired conventional power plant will require approximately 1.25 million gallons of water per day for the boiler and cooling tower.

Business and Policy Implications

How much does corn ethanol receive in subsidies from the federal government? Who receives the subsidy – the producers, the blenders? Is cellulosic ethanol entitled to the same subsidy?

The 2008 Farm Bill revised the existing tax credit for ethanol. It provides a cellulosic ethanol tax credit of \$1.01 per gallon of cellulosic ethanol. A producer of cellulosic ethanol will receive a \$0.56 tax credit for each gallon produced between January 1, 2009 and December 31, 2012. The blenders that purchase cellulosic ethanol will receive a tax credit of \$0.45 (down from \$0.51). The blender's credit is also available for all corn-based ethanol that they purchase.

The Energy Policy Act of 2005 (and amended in the Energy Independence and Security Act of 2007) also establishes the Renewable Fuel Standard (RFS), which requires that refiners and blenders include a minimum proportion of "renewable fuels" in the nation's fuel supply. In addition to ethanol, the 2007 RFS includes advanced and cellulosic biofuels. The RFS sets a floor on the demand for ethanol and lifecycle greenhouse gas reduction requirements for each fuel type. Congress designed the RFS to enable refiners and blenders to sell credits if they exceed their mandated requirements and to buy credits if they cannot or chose not to meet them. The Energy Policy Act of 2005 specifically mandates that **cellulosic ethanol receive 2.5 credits for every one credit for corn ethanol** under the trading program.

How will the use of pine for energy affect prices of pine for the existing pulp and paper and building materials markets?

While there is over 20 million dry tons of currently unused woody material available, prices may be affected when large consumers overlap collection areas. Most effects will be local.

Do we risk pushing the pulp and paper business offshore if the prices for pulpwood are raised due to increased competition for fiber between traditional users and ethanol/energy producers? Is it in the State's best interest and is it fair to traditional Georgia industries which have larger capital investments and account for perhaps 20 times the number of jobs expected from ethanol production to introduce a subsidized competitor for fiber into the pulp markets?

Yes, there is a risk. Traditional pulp and paper industries and new renewable energy industry will compete for biomass. However, since 1997, pulpwood consumption for the production of paper in the United States (U.S) has been on a steady decline. In the last 20 years, approximately 140 pulp mills have closed or been shut down. U.S. export of chips is on the decline. Inflation adjusted pulpwood pricing is declining while paper prices are remaining stable or rising. Timber inventories across the U.S. are also growing. There are abundant supplies for the short to medium term. Many global factors impact the U.S. pulp and paper industry; not only competition from

emerging renewable energy markets.

The state currently has over 20 million dry tons of available woody biomass annually. There will be a great benefit to the state if a new, healthy industry develops that takes advantage of the underutilized resource. The best scenario for a healthy Georgia is a diverse use of the state's rich pine resource that protects its economy from volatility in specific market segments and provides energy security.

How can you economically collect, transport and process branches, tops and waste woody material?

The "whole tree harvesting" systems used by most southern timber harvesting companies already remove the tops and branches from merchantable-sized trees and pile them at a log loading site. The biomass harvest must be completed by integrating a wood chipper into the traditional logging system or by piling the tops and branches in a manner where they can be easily chipped by a second operation following the timber harvest. Additional biomass from cull trees and other non-merchantable trees can be harvested similarly and chipped at the loading area along with the tops and branches.

Bioenergy markets will also encourage forest managers to thin overly-dense forests, which results in improved growth of the forest. These thinnings can be performed by a variety of equipment and produce biomass chips similar to those described above. The high cost of biomass transport will result in bioenergy facilities being sized and spatially located in a manner to efficiently and economically procure biomass from Georgia's productive forests.

University forest harvesting experts, loggers and equipment manufacturers are developing new systems and modifying current processes to determine the most efficient methods of forest biomass harvesting. Methods will certainly improve as the industry develops.

What is the estimated size and potential locations where ethanol or electricity production facilities would be sited?

Facilities used to produce electricity or ethanol are likely to be small and distributed across the state. To make them economical, they will be located close to the feedstock/forest. Transportation of biomass is expensive and this cost will continue to rise as diesel prices and other trucking costs rise. Therefore, it is more economical for a landowner and more environmentally sustainable, in terms of transportation, for the biomass to be located to the end user. Every ton/mile traveled while hauling biomass costs approximately 13 cents on average.

How much positive economic impact could this new industry create in Georgia?

Each gallon of renewable fuel produced in Georgia will produce \$2-\$3 of total economic benefit. With over 1.6 billion gallons of renewable fuel production possible in the next 10 years we could see over \$5 billion of positive annual economic benefit.

An analysis of the Range Fuels plant first phase by the University of Georgia available on the Department of Energy website, <http://www.eh.doe.gov/NEPA/ea/ea1597/appxh.pdf>, shows a \$150 million positive total state impact at 49 million gallons for \$3 per gallon fuel.

An analysis of the corn ethanol industry conducted for the Renewable Fuels Association can be found at http://www.ethanolrfa.org/objects/documents/2006_ethanol_economic_contribution.pdf, shows a \$23.1 billion total national gross domestic product impact from 5.5 billion gallons of production for \$4.2 per gallon fuel.

Net of incentives, a number of \$2-\$3 per gallon of annual impact seems reasonable and conservative. The reason that so many states are investing in biofuels is the magnitude of the potential impact. The Federal 2007 Energy Policy Act mandates production of 16 billion gallons of cellulosic ethanol. When this goal is realized, it will create an economic impact for the states of over \$40 billion a year, recurring each year.

The **Pine 2 Energy Coalition (P2E)** works to increase the development of a **pine** biomass to energy industry, decrease the nation's dependence on imported energy resources, improve the environment, and stimulate the region's economy, with a focus on rural areas. **P2E** is made up of forest and farm landowners and businesses, foresters, universities, environmental and conservation organizations, investors, energy developers, government agencies and other individuals and companies working to promote and expand the development of pine biomass to energy, utilizing sustainable technology.