

## Biomass Energy, a Solution to a Problem

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As you walk into a room, one of the first things you may do is turn on a light or notice all the appliances or electronics you may have plugged into an outlet in the wall. Where does this magical power come from? What is it that gives us this power, this source that heats, cools, and make our house feel like home? What is it that allows us to use all these commodities that we can't live without? Look around the world and it will become clear that all this power and electricity is coming from three sources, coal, oil or natural gas. But wait, isn't that bad for the air? Aren't these sources of energy projected to be the cause of our so-called global warming? And are we not concerning ourselves these days with the protection of the environment and the animals that live in it? Isn't that what Earth Day is all about? Yet we see much of our environment destroyed by the digging up of these resource up and as we use them.

Granted coal and natural gases are not the only sources that are used to produce energy- nuclear energy and hydro energy are used as well; but most of the power the world produces comes from coal and gases. According to Figure 1(attached) we see that almost every region in the world relies heavily on the usage of coal, oil and gases as a main source of energy. These are nonrenewable resources, simply meaning that these resources are limited and when they are expended they will be gone. These resources take a very long time to form and at the rate which we are using them, they just don't have time to replenish themselves.

There are a lot of problems with the philosophy of relying so heavily on these nonrenewable resources. When it comes to mining these resources, we face many environmental problems. When these products are mined or brought out of the ground, we naturally have to break some ground somewhere. And what does this lead to? That's right, the degradation of not only the environment but also the ecosystem that belongs in that specific sight. This leads to the very highly debated issue of endangered species or even extinction of some species. It is difficult to estimate the rate at which humans are driving species to extinction because scientists believe that only a small percentage of the earth's species have been described. What is clear is that species are dying out at an unprecedented rate; minimum estimates are at least 4000 species per year.

Many scientists believe that another potential environmental problem from refining and burning large amounts of oil and other fossil fuels (such as coal and natural gas) occurs when carbon dioxide (a by-product of the burning of fossil fuels), methane (which exists in natural gas and is also a by-product of refining petroleum), and other by-product gases accumulate in the atmosphere. These gases are known as greenhouse gases, because they trap some of the energy from the Sun that penetrates Earth's atmosphere. This energy, trapped in the form of heat, maintains Earth at a temperature that is hospitable to life. Certain amounts of greenhouse gases occur naturally in the atmosphere. However the immense quantities of petroleum, coal, and other fossil fuels burned during the world's rapid industrialization over the last 200 years are a contributing source of higher levels of carbon dioxide in the atmosphere. During that time period, these levels have increased by about 28 percent. This increase in atmospheric carbon dioxide, coupled with the continuing loss of the world's forests (which absorb carbon dioxide), has led many scientists to predict a rise in global temperature. This increase in global temperature might disrupt weather

patterns, disrupt ocean currents, lead to more violent storms, and create other environmental problems. This would explain a lot of the droughts that many countries are facing right now.

In 1992, representatives of over 150 countries convened in Rio de Janeiro, Brazil, and agreed on the need to reduce the world's emissions of greenhouse gases. In 1997, world delegations again convened, this time in Kyôto, Japan. During the Kyôto meeting, representatives of 160 nations signed an agreement known as the Kyôto Protocol, which would require 38 industrialized nations to limit emissions of greenhouse gases to levels that are an average of 5 percent below the emission levels of 1990. In order to reduce their fossil fuel emissions to achieve these levels, the industrialized nations would have to shift their energy mix toward energy sources that do not produce as much carbon dioxide, such as natural gas, or to alternative energy sources, such as hydroelectric energy, solar energy, wind energy, or nuclear energy. While the governments of some industrialized nations have ratified the Kyôto Protocol, others have not, including that of the United States.

While this is a good step toward a solution to the problem, it has not done enough to reduce the problems that many countries face today. In itself this projected solution does not have the impact that is needed to solve the whole global warming issue. This is because we are still relying too heavily on oil as an energy source. Good, the coal burning has been regulated and there are measures to decrease the air pollution. But remember we still drive gasoline powered cars and burn oil every day. Oil is the most relied-on energy source.(See fig. 2)(attached) This is because we use our cars every day to go from place to place. As we burn the gasoline that we put into our cars, we also emit carbon monoxide, and this adds to the problem of global warming.

So what in the world is the solution to this problem? To find the answer we need to take a look at Brazil's agriculture, because Brazil has the largest national fuel ethanol industry. In other words, Brazil has a new energy source. Ethanol in itself is not the solution but rather the category it falls into, biomass energy, which is simply "bioenergy,"—the energy from plants and plant-derived materials. In fact we have been using this as a source of energy since the first fire was started by that oh so smart caveman. Think about it, people have been burning wood to cook food and keep warm since the cavemen. Wood is still the largest biomass energy resource today, but other sources of biomass can also be used. These include food crops, grassy and woody plants, residues from agriculture or forestry, and the organic component of municipal and industrial wastes. Even the fumes from landfills (which are methane, a natural gas) can be used as a biomass energy source. The use of biomass energy has the potential to greatly reduce greenhouse gas emissions. Burning biomass releases about the same amount of carbon dioxide as burning fossil fuels. However, fossil fuels release carbon dioxide captured by photosynthesis millions of years ago. Biomass, on the other hand, releases carbon dioxide that is largely balanced by the carbon dioxide captured in its own growth (depending on how much energy was used to grow, harvest, and process the fuel). The graph on Figure 3(attached) shows how these bioenergies are broken down and used in the world today.

The main biomass energy source that Brazil is known for is their ethanol. Unlike other renewable energy sources, biomass can be converted directly into liquid fuels, called "biofuels," to help meet transportation fuel needs. The two most common types of biofuels are ethanol and biodiesel. Ethanol is an alcohol, the same as in beer and wine (although ethanol used as a fuel is modified to make it undrinkable). It is made by fermenting any biomass high in carbohydrates through a process similar to beer brewing.

Today, ethanol is made from starches and sugars, but scientists are developing the technology to allow ethanol to be made from cellulose and hemicelluloses, the fibrous material that makes up the bulk of most plant matter. Ethanol is mostly used as a blending agent with gasoline to increase octane and cut down carbon monoxide and other smog-causing emissions. Biodiesel is made by combining alcohol (usually methanol) with vegetable oil, animal fat, or recycled cooking grease. It can be used as an additive (typically 20%) to reduce vehicle emissions or in its pure form as a renewable alternative fuel for diesel engines. Figure 4(attached) shows what products are used to make the biomass energies.

A key factor for the development of the ethanol industry in Brazil was the investment in agricultural research and development by both the public and private sector. The work of EMBRAPA, the state-owned company in charge for applied research on agriculture, together with research developed by state institutes and universities, especially in the State of São Paulo, have allowed Brazil to become a major innovator in the fields of biotechnology and agronomic practices resulting in the most efficient agricultural technology for sugarcane cultivation in the world. Efforts have been concentrated in increasing the efficiency of inputs and processes to optimize output per hectare of feedstock, and the result has been a threefold increase of sugarcane yields in 29 years, as Brazilian average ethanol yields went from 2,024 liters per hectars in 1975 to 5,917 liters per hectars in 2004; allowing the efficiency of ethanol production to grow at a rate of 3.77% per year. Brazilian biotechnologies include the development of sugarcane varieties that have a larger sugar or energy content, one of the main drivers for high yields of ethanol per unit of planted area. The increase of the index total recoverable sugar (TRS) from sugarcane has been very significant, 1.5% per year in the period 1977 to 2004, resulting in an increase from 95 to 140 kg/ha. Innovations in the industrial process have allowed an increase in sugar extraction in the period 1977 to 2003. The average annual improvement was 0.3%; some mills have already reached extraction efficiencies of 98%.

It is disputed whether corn ethanol as an automotive fuel results in a net energy gain or loss. As reported in "The Energy Balance of Corn Ethanol: an Update," the energy returned on energy invested (EROEI) for ethanol made from corn in the U.S. is 1.34 (it yields 34% more energy than it takes to produce it). Input energy includes natural gas based fertilizers, farm equipment, transformation from corn or other materials, and transportation. However, other researchers report that the production of ethanol consumes more energy than it yields. In comparison, sugar cane ethanol EROEI is at around 8 (it yields 8 joules for each joule used to produce it). Recent research suggests that cellulose crops such as switch grass provide a much better net energy production than corn, producing over five times as much energy as the total used to produce the crop and convert it to fuel. If this research is confirmed, cellulose crops will most likely displace corn as the main fuel crop for producing bioethanol.

Michael Grunwald reports that one person could be fed for 1 year "on the corn needed to fill an ethanol-fueled SUV". He further reports that though "hyped as an eco-friendly fuel, ethanol increases global warming, destroys forests and inflates food prices." Environmentalists, livestock farmers, and opponents of subsidies say that increased ethanol production won't meet energy goals and may damage the environment, while at the same time causing worldwide food prices to soar. Some of the controversial subsidies in the past have included more than \$10 billion to Archer-Daniels-Midland since 1980. Critics also speculate that as ethanol is more widely used, changing irrigation practices could greatly increase pressure on water resources. In October 2007, 28 environmental groups decried the Renewable Fuels Standard (RFS), a legislative effort intended to increase ethanol production, and said that the measure will

"lead to substantial environmental damage and a system of biofuels production that will not benefit family farmers...will not promote sustainable agriculture and will not mitigate global climate change."

Oil has historically had a much higher EROEI (Energy Returned on Energy Invested) than corn produced ethanol, according to some. However, oil must be refined into gasoline before it can be used for automobile fuel. Refining, as well as exploration and drilling, consumes energy. The difference between the energy in the fuel (output energy) and the energy needed to produce it (input energy) is often expressed as a percent of the input energy and called net energy gain (or loss). Several studies released in 2002 estimated that the net energy gain for corn ethanol is between 21 and 34 percent. In Brazil, where the broadest and longest ethanol producing experiment took place, improvements in agricultural practices and ethanol production improvements led to an increase in ethanol net energy gain from 300% to over 800% in recent years. It must be noted that Brazil produces ethanol more efficiently because its primary input is the sugar from sugar cane rather than starches from corn.

Much overlooked in most discussions about ethanol from corn are the by-products from the production of ethanol. In general, the waste product from corn distillation is distillers grains, a protein-rich food. The vast majority of corn produced in the US and the world goes to feed not people but livestock, which cannot naturally digest corn. The main result of feeding corn to a ruminant is excessive flatulence (production of methane gas, being a greenhouse gas), but the same animals can readily digest distillers grains. Seen in this light, all corn destined for livestock feeding should probably be distilled to harvest the ethanol fuel potential while simultaneously making the feed more nutritious to the livestock and avoiding unnecessary methane pollution. Wherever corn is used to feed livestock, farmers can take advantage of this process to make a profit on both food and fuel from the same bushel of corn.

Now it's time to break it down. If we are able to use agricultural products such as soybeans, corn, sugar, and stuff we can literally grow in our back yard, why would we want to continue to pollute the air with the burning of coal and the making and using of oils and natural gas? Save these natural resources for when we really need them and grow products that not only will reduce green house effects but also feed people at the same time. Remember that one bushel of corn can be used to make ethanol and then the waste products from refining it can be used to feed livestock and will then create a source of meals for the common people.

Now that we see what this will do for the whole pollution and global warming issue, let's look at how this will affect Brazil. Although Brazil is an important agricultural and industrial power, with the strongest economy in Latin America, poverty is widespread in Brazil. Despite recent improvements in income distribution, the issues of income inequality and social exclusion remain at the root of rural poverty. Brazil is a middle-income country and is rich in natural resources, but poverty levels and human development indicators in poor rural areas are comparable to those in the poorest countries of Latin America. As a whole, about 35 % of the population lives in poverty, with an average income of less than two dollars a day. Since approximately 19 per cent of the total population, or about 36 million people, live in rural areas, this means that Brazil has about 18 million poor rural people, the largest number in the Western Hemisphere. And Brazil's North-East region has the single largest concentration of rural poverty in Latin America. In the North-East region, 58 per cent of the total population and 67 per cent of the rural

population is poor. Poor rural communities live in disadvantaged conditions: education and health facilities are not readily available, water supply and sewage systems are generally inadequate, and rural people face severe constraints in accessing technology and infrastructure. People struggle to supplement farm income with income from salaried labors and small-scale enterprises such as handicrafts and other activities. Off-farm incomes have grown, and at least 30 per cent of rural people are engaged in non-agricultural employment as their main occupation. Lack of access to formal education and skills training is another major cause of rural poverty. In recent years the government has invested large amounts in resources to broaden the scope of technical assistance services and facilitate access to them, especially for poor rural people.

So how does this whole biomass energy help Brazil? With the production of the ethanol they are so well known for, jobs will be created to be able to produce and ship the ethanol on a large scale. As this paper outlined earlier, the main products used to make ethanol are corn and sugar. With this fact in mind, farmers growing corn or sugar have a place to sell it and therefore a source of income. Not only does this affect produce growers but those who raise cattle as well. The waste products from the refining of the ethanol can be used to feed the cattle or live stock cheaply. Invest less money into the livestock but being able to sell the meat from the livestock for the same price means that the farmers will then get a higher gross income on the same livestock.

A study found a gallon of ethanol makes almost twice as much energy as it consumes while it also has the potential to cut greenhouse gasses by 54% if cars ran on ethanol rather than gasoline. Ethanol production uses the starch portion of corn, but the leftover protein can be used to create a high-nutrient, low-cost animal feed. One acre of land can yield about 7,110 pounds (3,225 kg) of corn, which can be processed into 328 gallons (1240.61 liters) of ethanol. That is about 26.1 pounds (11.84 kg) of corn per gallon. With one bushel of corn we can create energy and feed the poor and the common people. This in turn will cut down the poor population in Brazil as a while and will then create a booming economy for Brazil as well as they will produce and ship ethanol to countries that need or want it. So if all this true, why are we still relying on all these nonrenewable resources? We need to wake up as a whole and look at the prospects of using biomass energy as a main energy source.

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