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ANALYSIS OF BIOMASS AND BIOFUELS AS A SOURCE OF ENERGY

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ABSTRACT

As a pending global energy crisis appears more and more imminent, it is important to consider many different options for new energy sources. Renewable energy sources are ideal because they are more efficient, environmentally friendly and, ultimately, better for consumers. Biomass can be converted into fuels through a number of different processes, including solid fuel combustion, digestion, paralysis, and fermentation and catalyzed reactions.

INTRODUCTION

Electricity is generated in many places through solid fuel combustion. The majority of America's electricity is fueled by coal combustion. However, many states, especially California, are encouraging companies to use biomass fuels to generate electricity. These products are usually wood matter, vegetation, waste from lumber yards, and the like. Power plants burn such fuels to heat a boiler, and the resulting steam powers turbines & generators. This process still releases a lot of carbon dioxide and other polluting gases into the environment, but helps eliminate waste efficiently.

Digestion is another process that makes use of existing waste. The term is a misnomer. Digestion is the naturally occurring process of bacteria feeding on decaying matter and making it decompose. It is that which releases gases like methane, hydrogen, carbon monoxide, etc. In many landfills, owners are experimenting with set-ups to best collect the gases produced by such bacteria. The standard system includes pipelines running through the waste to collect the gases. Animal feed lots and other facilities are also exploring tapping such resources. A zoo in upstate New York is using their elephant manure to do the same thing.28 Benefits of this process include the relative lack of impurities in the gases produced and the fact that the synthesis gases (carbon monoxide and hydrogen) can be converted to any kind of hydrocarbon fuel.

A third process, **pyrolysis**, creates a product much like charcoal, with double the energy density of the original biomass, making the fuel highly transportable and more efficient. Anhydrous pyrolysis heats the biomass at intense temperatures in the absence of oxygen or water. Scientists assume that this is the process that originally produced fossil fuels (under different conditions). Most industrial processes of pyrolysis convert the biomass under pressure and at temperatures above 800° F (430° C). A liquid fuel can also be produced using this process.

The most widely used alternative fuel, ethanol, is created through **fermentation** of organic materials. Ethanol has a current capacity of 1.8 billion gallons per year, based on starch crops such as corn. Again, the fuel conversion process takes advantage of a natural process. Microorganisms, especially bacteria and yeasts, ferment starchy, sugary biomass products (like corn), yielding products like ethanol, which can be used as fuels in a variety of applications. Biodiesel is an increasingly popular fuel, especially in the transportation sector. This mono-alkyl ester is formed by combining fuel-grade oil, processed from sources like vegetable oil, animal fats, algae and even used cooking grease, with an alcohol (like methanol or ethanol), using a **catalyst**. It shows great promise as both a neat fuel (used alone) and as an additive to petroleum diesel.

Using biomass could be the answer to the energy questions made more imminent by the recent crises that have further threatened our oil supply. The current technologies take advantage of many natural, long-utilized processes in order to create "new" kinds of fuel. Upon further observation, one realizes that these fuels are very basic, using the most readily available energy sources with very simple, standardized processes that greatly reduce pollution and offer hope for the future.

Biomass as an energy source (Biomass energy)

Biomass is – generally – a solid that has absorbed solar energy through the photosynthesis. Thus, the use of biomass for energy purposes is really to make use of solar energy that has been stored in the most natural way.

Typically, biomass is regarded as a very low-quality fuel, and this is true to some extent. But let's have a look at some fundamental facts to clear out a few misunderstandings:

Woody biomass – and that is what has to be the basis for a sustainable energy production – will typically have an energy content (dry basis) of about 15-20 MJ/kg. If you are not comfortable with MJ, you can divide by 3.6 to obtain kWh instead, so that 18 MJ is exactly equivalent to 5 kWh.

So, 5 kWh are contained in 1 kg of dry wood.

- A generic car battery – 12 V, 50 Ah – contains 0.6 kWh.
- Lifting a 12 ton bus 2 m for service requires 0.06 kWh.
- On the other hand:
- 1 kg of fossil diesel oil contains almost 12 kWh.
- 1 m^3 of fossil gas at ambient conditions contains about 8 kWh.

So the biomass is not that inefficient as a storage for energy – is it? Especially when you consider what happens as long as it is not harvested. Then the biomass grows! And if the stored solar energy is in the form of woody biomass – i.e. trees – then the demand for land area is minimized because they grow high. And it does not compete with the need of land for agricultural biomass, food and fibre – because it grows on forest land.

Now some people will argue that the handling and the transport of the biomass requires so much energy that the total balance becomes negative – i.e. more energy is required for the fuel handling, transports and upgrading, than actually is contained in the biomass itself. The very simple argument against this misconception is the mere fact that commercial companies today produce wood pellets in Canada and ship them across to Sweden – and they would not do that if it was not commercially viable. And if we assume – for simplicity – that the economy of the process reflects the input of work and energy, then it is clear that the vulgar argument against biomass as an energy source must be wrong.

Facts are that most any energy carrier, be it gasoline, fossil gas, electricity, coal, raw biomass or upgraded biofuels all seem to converge to about the same total energy balance as seen over the supply chain. About 2-10 % of the energy transferred through a supply chain is lost, or consumed for the transport – and this seems to hold true for any energy carrier.

Thus, if we assume 5 % and attribute that only to the transports, then you may use 5 % of 12 kWh to transport 1 kg of diesel oil (which is 0.6 kWh). To transport 1 kg of dry woody biomass (effectively wood pellets) you may similarly use 5 % of 5 kWh, which is only 0.25 kWh. Thus oil can be transported longer distances by truck than diesel oil. And this is exactly what happens. Looking at Sweden, you will find pellet producers spread all over the country so that the transport distances by car and truck are kept short while you will see oil trucks travel long distances.

So one of the fundamental properties of biomass is that it is more local than fossil fuels, simply because it is less concentrated with respect to energy. On the other hand – this tends to promote local, small scale, sustainable business in the forest regions of the country. So the use of biomass for energy does not only have a positive impact on the climate issue – it also has a positive

1. What Is Biomass?

Biomass is any organic matter-wood, crops, seaweed, animal wastes-that can be used as an energy source. Biomass is probably our oldest source of energy. For thousands of years, people have burned wood to heat their homes and cook their food.

Biomass gets its energy from the sun. All organic matter contains stored energy from the sun. During a process called photosynthesis, sunlight gives plants the energy they need to convert water, carbon dioxide, and minerals into oxygen and sugars. The sugars, called carbohydrates, supply plants (or the animals that eat plants) with energy. Foods rich in carbohydrates (like spaghetti) are a good source of energy for the human body!

Biomass is a renewable energy source because its supplies are not limited. We can always grow trees and crops, and people will always produce garbage.

2. Using Biomass Energy

Usually we burn wood and use its energy for heating. Burning, though, is not the only way to convert biomass energy into a usable energy source. There are four ways:

Burning

We can bum biomass in special plants to produce steam for making electricity, or we can burn it to provide heat for industries and homes.

Bacterial Decay

Bacteria feed on dead plants and animals, producing a gas called **methane.** This is a natural process that happens whenever waste decays. Methane is the same thing as natural gas, the gas sold by natural gas utilities.

Fermentation

Adding a yeast to biomass produces an alcohol called **ethanol.** This is how wine, beer, and liquor are made. Wine is just fermented grape juice.

Conversion

Biomass can be converted into gas or liquid fuels by using chemicals or heat. In India, cow manure is converted to methane gas to produce electricity. Methane gas can also be converted to **methanol,** a liquid form of methane.

3. Types of Biomass

We use four types of biomass today: 1) wood and agricultural products; 2) solid waste; 3) landfill gas; and 4) alcohol fuels.

Wood and Agricultural Biomass

Most biomass used today is home grown energy. Wood-logs, chips, bark, and sawdust-accounts for about 79 percent of biomass energy. But any organic matter can produce

biomass energy. Other biomass sources include agricultural waste products like fruit pits and corn cobs.

Solid Waste

There is nothing new about people burning trash. What's new is burning trash to generate electricity. This turns waste into a usable form of energy. A ton (2,000 pounds) of garbage contains about as much heat energy, as pounds of coal.

Power plants that burn garbage for energy are called waste-to-energy plants. These plants generate electricity much as coal-fired plants do except that garbage-not coal-is the fuel used to fire an industrial boiler.

Making electricity from garbage costs more than making it from coal and other energy sources. The main advantage of burning solid waste is it reduces the amount of garbage dumped in landfills by 60 to 90 percent, and reduces the cost of landfill disposal.

Landfill Gas

Bacteria and fungi are not picky eaters. They eat dead plants and animals, causing them to rot or decay. Even though this natural process is slowed in the artificial environment of a landfill, a substance called **methane** gas is still produced as the waste decays.

New regulations require landfills to collect methane gas for safety and environmental reasons. Methane gas is colorless and odorless, but it is not harmless. The gas can cause fires or explosions if it seeps into nearby homes and is ignited.

Landfills can collect the methane gas, purify it, and then use it as an energy source. Methane, which is the same thing as natural gas, is a good energy source. Most gas furnaces and gas stoves use methane **supplied by natural** gas utility companies. The city landfill in Florence, Alabama recovers 32 million cubic feet of methane gas a day. The city purifies the gas and then pumps it into natural gas pipelines.

Today only a tiny portion of landfill gas is used to provide energy. Most is burned off at the landfill. Why? With today's low natural gas prices, this higher-priced "biogas" has a hard time competing.

Alcohol Fuels

Wheat, corn, and other crops can be converted into a variety of liquid fuels including ethanol and methanol.

Using ethanol as a motor fuel is nothing new. Its use is almost as old as the automobile. In the early 20th century, automobile pioneer Henry Ford advocated using **gasohol,** a mixture of ethanol and gasoline, to run his cars.

Today ethanol is a high cost fuel and its use has become a controversial issue. It is estimated that a barrel of oil will have to more than double in price before ethanol can compete with gasoline as a transportation fuel.

In spite of this, the ethanol industry has continued to grow, mainly because the federal government exempts ethanol fuels from the federal highway tax. This exemption has been extended to the year 2000.

Because ethanol is expensive, and because car engines must be modified to run on pure ethanol, ethanol is usually mixed with gasoline to **produce gasohol.** (Cars can **run** on gasohol without adjustments.)

Gasohol is 10 percent ethanol and 90 percent gasoline. In 1994, 12 percent of the nation's motor fuel consisted of this ethanol and gasoline mixture. However, in some corn-growing states, gasohol use is as high as 50 percent.

Gasohol does have some advantages over gasoline. It has a higher octane rating than gasoline (provides your car with more power), and it is cleaner-burning than unleaded gasoline, with one-third less carbon monoxide emissions. Gasohol may also help reduce America's dependence on foreign oil.

There are many types of plants in the world, and many ways they can be used for energy production. In general there are two approaches: growing plants specifically for energy use, and using the residues from plants that are used for other things. The best approaches vary from region to region according to climate, soils, geography, population, and so on.

Energy Crops

Energy crops, also called "power crops," could be grown on farms in potentially very large quantities, just like food crops. Trees and grasses, particularly those that are native to a region, are the best crops for energy, but other, less agriculturally sustainable crops such as corn tend to be used for energy purposes at present.

Trees. In addition to growing very fast, some trees will grow back after being cut off close to the ground, a feature called "coppicing." Coppicing allows trees to be harvested every three to eight years for 20 or 30 years before replanting. These trees, also called "short-rotation woody crops," grow as much as 40 feet high in the years between harvests. In the cooler, wetter regions of the northern United States, varieties of poplar, maple, black locust, and willow are the best choice. In the warmer Southeast, sycamore and sweetgum are best, while in the warmest parts of Florida and California, eucalyptus is likely to grow well.

Grasses. Thin-stemmed perennial grasses used to blanket the prairies of the United States before the settlers replaced them with corn and beans. Switchgrass, big bluestem, and other native varieties grow quickly in many parts of the country, and can be harvested for up to 10 years before replanting. Thick-stemmed perennials like sugar cane and elephant grass can be grown in hot and wet climates like those of Florida and Hawaii.

Other crops. A third type of grass includes annuals commonly grown for food, such as corn and sorghum. Since these must be replanted every year, they require much closer management and greater use of fertilizers, pesticides, and energy. While corn currently provides most of the liquid fuel from biomass in the United States, there are more sustainable ways to produce energy from plants.

Oil plants. Plants such as soybeans and sunflowers produce oil, which can be used to make fuels. Like corn, though, these crops require intensive management and may not be sustainable in the longer term. A rather different type of oil crop with great promise for the future is microalgae. These tiny aquatic plants have the potential to grow extremely fast in the hot, shallow, saline water found in some lakes in the desert Southwest. In 2004, Green Fuel Technologies, a Massachusetts-based company, harnessed the ability to capture and use carbon dioxide emissions from power plants as a means to stimulate algae growth. The algae is then converted into a various range of fuels. This technology, known as Emissions-to-Biofuels, is demonstrating great promise and has the potential to transform the way utilities produce energy.

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