B1OMASS TECHNOLOGY: PANACEA FOR WORLD ENERGY CONSUMPTION CRISIS

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Abstract

Biomass is a renewable energy resource derived from numerous sources, including by-products of limber industry, agricultural crops and major parts of household waste. These materials can be converted to steam for heating, generating electricity, and biofuels such as biodiesel, bioethanol and biogas. Biofuels are known to be renewable, nontoxic and biodegradable. Biornass is now recognized as an important source of energy and a good alternative to fossil fuels, which are not only limited in supply but have grave environmental consequences. Today, biomass energy is being used in the United States, Brazil, India, etc. However developing countries such as Nigeria arc faced with the challenges of applying appropriate technology for the production of biofuels. In this regard, this paper discusses the technological processes involved in converting biomass into steam, and biofuels; their environmental benefits as well as strategies being developed to enhance the quality of biofuels. It is recommended that these *Third World* countries, particularly Nigeria that is blessed with good vegetation, should embrace biomass technology towards a sustainable global development.

Introduction

Throughout human history, growing population and developing technology have demanded ever-increasing amounts of energy. All matter has energy which is either potential (inactive), or kinetic. Modern technology has relied mainly on fossil fuels (petroleum, natural gas and coal). However, during the latter half of the 20' century, petroleum and natural gas prices soared, and it became apparent that the supplies of fossil fuels were fast dwindling (Aldridge & Aiuto, 1993).

This situation often called energy crisis, according to Cromie (1998), led to the establishment of the Department of Energy in the United States in 1977. The department is concerned with the use, conservation and distribution of fuels, electric power and other energy resources and the development of technology to make new resources available on a commercial scale.

Efforts to find alternative sources of energy and to fully exploit secondary sources of petroleum products were put into effect by many industrialized nations. However, many of their proposed solutions to the problem of dwindling energy resources pose still other problems. Scientists were thus, prompted into research and discovered various ways to wrest energy from Biomass. Biomass is a renewable energy resource derived from land and water plants, farm crops, garbage, manure and sewage. These materials can be converted to steam to generate electricity, liquid fuels (bio fuels), and gaseous fuels (biogas), (USDE, 2005).

Biomass technology, which is currently being applied in Brazil, United States, India, etc, is renewable and has a lot of environmental benefits. This paper discusses various ways of converting biomass into energy, their environmental bone fits as well as strategies been developed to enhance the quality and quantity of biofuels.

Methods for Converting Biomass to Energy

There are several methods of converting biomass into energy. These methods include burning, alcohol fermentation, pyrolysis and anaerobic digestion.

Burning: Direct burning of biomass is the most straightforward method of energy production. Mankind has burnt wood and other forms of biomass for thousands of years to keep warm, cook food, as well as develop weapons and other tools. In biomass technology, trash, garbage, and wood chips are burnt in special waste-burning plant to reduce air pollution. These plants; lire designed with electrostatic devices that scrub dust and other particles out of exhaust gases by means of electrostatic attraction. Other types of scrubbers use water to wash particles out of smoke. The energy released by direct combustion takes the form of heat, which can be used to directly influence the temperature of small environment; or to power steam-driven turbines to produce electricity.

Alcohol Fermentation: In alcohol fermentation, the starch in organic matter is converted to sugar by heating. This sugar is then fermented by yeast (as in the production of beer and wine). The resulting ethanol (also known as ethyl alcohol or grain alcohol), is distilled and can be blended with gasoline or used on its own. Alcohol fuels have been used successfully in Brazil and the United States as an alternative to regular gasoline (Okafor, 1987).

Anaerobic Digestion: Anaerobic digestion converts biomass especially waste products into methane - a major component of natural gas - and carbon dioxide. The biomass is mixed with water and stored in an airtight tank (digester). This form of biomass energy conversion is, attractive because it converts human, animal, and agricultural waste into a gas that is readily used as an energy source. Although the process is quite costly, it is relatively efficient.

Pyrolysis: Pyrolysis involves the heating of biomass in the absence of oxygen. Biomass, such as wood chips and agricultural wastes, is healed to about 400°C (about 1000"F), and allowed to decompose into gas and charcoal (carbon). A major advantage of pyrolysis is that carbon dioxide, a major *greenhouse* gas contributing immensely lo the global warning phenomenon, is not produced. It only requires significant amount of energy.

Electricity from Biomass

Studies have shown that many cities around the world solve their waste disposal problems by burning thrash, wood waste or garbage to produce steam for electricity generation or heat for industries/homes. Indeed, about 111 such facilities arc known lo exist in the United Stales, producing substantial amount of electricity annually. It has equally been shown that waste materials can produce almost as much energy as burning coal. Coal produces heat energy of 28 million to 38 million joules per 2.2 pounds, whereas old dry newspapers and cooked meal scraps can generate 20 million and 29 million joules per 2.2 pounds, respectively. Similarly, half a kilogram of dry plant tissue can produce as much as 1890 Kcal of heat, equivalent to the heat available from a quarter of a kilogram of coal (Cromie, 1998).

Studies reveal that about 3500 MW of power can be generated from biogas in the existing 430 sugar mills in India. Moreover, around 270 MW of power has already been commissioned and more are under construction. Wood chips can also be burnt to generate electricity, in the process of converting a tree into lumber, 20 to 60 percent of each tree is wasted. This waste can be used as a source of steam instead of liquid or gas fuels. A mini biogas digester has been designed and developed, and is currently in Field-test for domestic lighting.

Bioethanol as Transportation Fuel

Bioethanol is a clear, colorless, alcohol fuel made from the sugars found in grains such corn, sorghum, wheat, potato skins and rice. Ethanol can made from these materials by using yeast to ferment the sugar which is then fermented into alcohol. As transportation fuel, bioethanol can be used as a total or partial replacement for gasoline. The National Energy Education Development Project (2004), stated that Gasoline containing 10% bioethanol (E_{10}), is used in many urban areas that do not meet clean air standards. Any vehicle that runs on gasoline can use E_{10} without changes to its engine. Over 99% of the bioethanol produced in the United Slates is usually mixed with gasoline to make EK>. $E_8$5 is an alternative fuel that is 85% ethanol and 15% gasoline mainly used in mid-western and southern Europe. Vehicles are modified to run on E_{85}. They are specially manufactured as flexible fuel vehicles. Flexible fuel vehicles can use any mixture of ethanol and gasoline up to E_{g5}. Studies recorded that there are about 146,000 cars and trucks using E_{85} most of which are fleet vehicles. Though, ethanol when burned releases carbon dioxide, growing plants for ethanol will reduce the *greenhouse* effect since plants makes use of carbon dioxide to produce oxygen.

Biodiesel as A Transportation Fuel

Biodiesel can be made from oil crops such as soybeans, animal fats, vegetable oils or greases. Biodiesel is much less a pollutant than petroleum diesel. Its use results in much lower emission of almost all known pollutants, including carbon dioxide, sulfur oxide, participates, carbon monoxide, air toxics and unburnt hydrocarbons (Perry, 1990).

Most trucks, buses and tractors in United States use diesel fuel. Diesel is a non-renewable fuel made from petroleum. According to US Department of Energy (2005), the use of biodiesel substantially reduces dependence on petroleum diesel. Biodiesel is most often blended with petroleum diesel in the ratio of 2% (B_2), 5% (B_5), or 20% (B_{20}). It can also be used as pure biodiesel ($B|_{(w}$). Biodiesel fuels can be used in regular diesel vehicles without making any changes to the engine.

Biodiesel results in less environmental pollution than petroleum diesel. Because it is clean burning and easy to use, biodiesel is the fastest growing and most cost efficient fuel for fleet vehicles. Many school districts are switching to biodiesel blends for their school buses. Biodiesel is also being used for fleets of snowplows, garbage trucks and military vehicles. So far, the use of biodiesel has been limited to fleets of vehicles that have their own fueling station. As the number of public fueling stations that offer biodiesel grows, it may become more popular with individual consumers.

One hundred percent biodiesel (Bum), and biodiesel blends are sensitive to cold weather and may require special anti-freeze, just like petroleum-based diesel fuel. Biodiesel acts like a detergent additive, loosening and dissolving sediments in storage tanks. Because it is solvent, biodiesel may cause rubber and other components to fail in older vehicles, but this problem does not occur with biodiesel blends (Marrier& Stoiaken, 1988).

Biogas

Biogas can be produced from animal waste, garbage and sewage. Garbage can be chemically converted to a gas fuel by the action of bacteria. Certain species of Bacteria are able to completely degrade or decompose various categories of organic matter, converting them to CO2, water, and some inorganic by products. This is often referred to as mineralization, i.e. complete biodegradation (Odokuma & Okara, 2005; Okara & Lewechi, 2007). In landfills, biomass rots and releases methane gas, also called biogas or landfill gas. Some landfills have a system that collects the methane gas so that it can be used as a fuel source.

Some diary farmers collect biogas from banks called digesters where they put all of the muck and manure from their barns. Sewage is also a commercial source of methane. Both Modesto, California, used methane derived from sewage to fuel a fleet of city vehicles for two years. Although the methane proved cheaper, cleaner and less damaging to engines than gasoline, economic and technical problems caused Modesto to abandon sewage-powered vehicles after the trial period. China has over 500,000 biogas digesters using human and pig waste which provide methane for on-farm use (Molua, 2007). At present, biogas technology provides an alternative source of energy in rural India for cooking. Biogas plants have been set up in many areas and are becoming very popular. A mini biogas digester has recently been designed and developed, and is being field-tested for domestic lighting.

Environmental Benefits of Biomass

Biomass is a renewable energy source that is readily available unlike fossil fuels that are limited in supply. Though biomass when burnt releases carbon dioxide, it does not add carbon dioxide to the atmosphere as it absorbs the same amount of carbon in growing as it releases when consumed as a fuel. Burning biomass fuels does not produce pollutants like sulfur that can cause acid rain as fossil fuels do.

Collecting and using landfill and biogas reduces the amount of methane that is released into the air. Methane is one of the *greenhouse* gases associated with global climate change. Biodiesel, unlike regular diesel, is renewable, nontoxic, and biodegradable. It is clean-burning and produces less air pollutants. Biomass can be used to generate electricity with the same equipment or power plants that are now burning fossil fuels. Using garbage as a source of energy helps clean up the environment.

Developing Strategies for Biofuel Enhancement

Methanol or ethanol fermented from wood or agricultural waste respectively, has only half of the energy content of the ordinary car gasoline it is meant to replace. There are plans on how to raise certain species of unicellular algae in high-light and high-nutrient conditions so that much of their primary production goes into high-energy content oil (Perry, 1990)..

There are also energy plantations where acres of fast growing trees like *Eucalyptus* are planted. Such examples of energy plantations can be found in Hawaii. Here the trees are reduced to chips and burnt to generate electricity. The US Department of Energy is also studying the possibility of raising oil rich varieties of algae on special 'farms'. The oil from the algae would be extracted for conversion to liquid fuel and the plants returned to the farm ponds for re-growth.

Plants that burn waste to make electricity are now being designed with special electrostatic devices that remove harmful gases and particles from coming out of their smoke stacks. Instead of burning loose biomass directly, it can now be made into dense briquette form that can be used directly as fuel in.-lead of coal in traditional furnace or in the gasifier to produce biogas. In this way, carbon dioxide is not produced.

Recommendations

In view of the foregoing, it is recommended that Nigerian Government, through its relevant organs, should focus attention on this novel technology which is being applied in advanced economies like United States and Sweden. The cultivation of energy plantation for biomass production is equally recommended. In this regard, appropriate legislation to protect and preserve such plantation from undue exploitation would be necessary. Such legislation should equally prohibit wanton deforestation.

Conclusion

Synthetic fuels from biomass provide a lasting solution to the problem of dwindling resources of oil and natural gas. As non-renewable energy sources are depleted, biomass becomes increasing!;-important to keep the lights on and the wheels turning for a sustainable global development. More importantly, biofuels are environment-friendly: they are biodegradable and non-toxic. Burning biomass fuels do not produce pollutants like sulfur that can cause acid rain. Also when burned, biomass does not release carbon dioxide, a *greenhouse* gas, instead a nearly equivalent amount o: carbon dioxide is captured through photosynthesis.

Economically, biomass is relatively very cheap as the materials utilized are often land/water plants, farm crops, garbage, manure sewage and grasses! Biomass technology with certainly be o: great benefit to Nigeria considering that the economy is largely dependent on petroleum exploration and exploitation with their attendant environmental degradation, which has over the years engendered the hydra-headed politically/economic crisis in the Niger Delta region.

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