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APPLICATION OF BIOMASS FOR BIO BASED INNOVATIVE INDUSTRIAL PRODUCTS

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ABSTRACT

Biomass is renewable organic material that comes from plants and animals. Biomass includes wood, agricultural wastes (crop residues) and cow-dung. Biomass is another form in which solar energy manifests itself. This is because all the plants and trees which provide biomass (like wood) used sun's energy to grow. Biomass is material that comes from living things. Because living things have energy, biomass provides a renewable source of energy to fuel our vehicles, heat our homes, and make electricity. Biomass energy is generated by living beings. The most common biomass materials used for energy include plants viz, corn, soy, etc. The energy from these organisms can be burned to create heat or converted into electricity.

Keywords; Biomass, Bioenergy, economic importance

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INTRODUCTION

Biomass is organic, meaning it is made of material that comes from living organisms, such as plants and animals. The most common biomass materials used for energy are plants, wood, and waste. These are called biomass feedstocks. Biomass energy can also be a non-renewable energy source. Renewable energy is energy that is collected from renewable resources There are five major renewable energy sources

- Solar energy from the sun.
- Geothermal energy from heat inside the earth.
- Wind energy.
- Biomass from plants.
- Hydropower from flowing water.

First-generation biofuels include ethanoland biodiesel and are directly related to a biomass that is more than often edible. Ethanol is generally produced from the fermentation of C_6 sugars (mostly glucose) using classical or GMO yeast strains such as Saccharomyces cerevisiae

Second-generation biofuels, also known as advanced biofuels, are fuels that can be manufactured from various types of non-food biomass. Biomass in this context means plant materials and animal waste used especially as a source of fuel.

The third-generation bioethanol is focused on the use of marine organisms such as algae. The public acceptance on the ability of algae to provide biomass for bioethanol production is positive as this action can limit the feedstock competition from agriculture plants. The fourth-generation biofuels combine genetically engineered feedstock with genomically synthesized microorganisms, such as cyanobacteria, to efficiently generate bioenergy, and they are made using nonarable land similar to third-generation biofuels.

MATERIAL AND METHODS

As biomass is an important industrial products, therefore different information were collected and emerged into one single documents that will provide prompt knowledge to research workers

Biomass—renewable energy from plants and animals

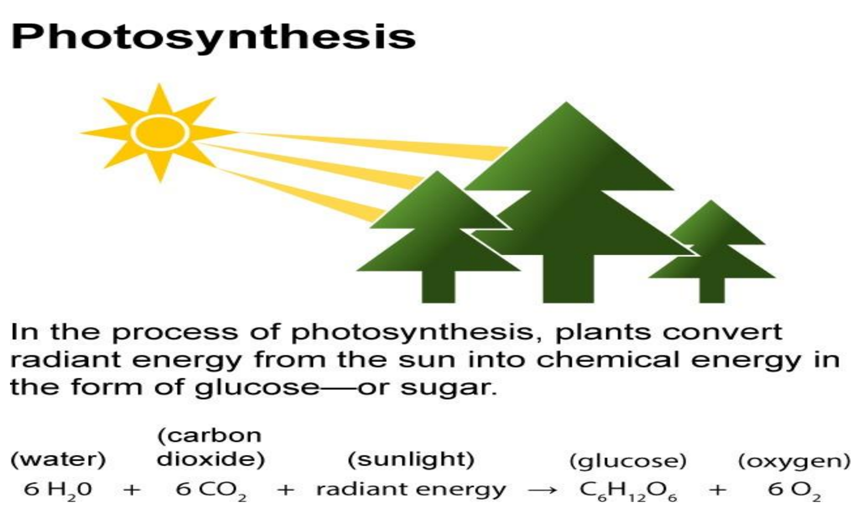
Biomass is renewable organic material that comes from plants and animals. Biomass was the largest source of total annual U.S. energy consumption until the mid-1800s. Biomass

continues to be an important fuel in many countries, especially for cooking and heating in developing countries. The use of biomass fuels for transportation and for electricity generation is increasing in many developed countries as a means of avoiding carbon dioxide emissions from fossil fuel use. In 2020, biomass provided nearly 5 quadrillion British thermal units (Btu) and about 5% of total primary energy use in the United States.

Biomass contains stored chemical energy from the sun. Plants produce biomass through photosynthesis. Biomass can be burned directly for heat or converted to renewable liquid and gaseous fuels through various processes.

Biomass sources for energy include:

- Wood and wood processing wastes— firewood, wood pellets, and wood chips,lumber and furniture mill sawdust and waste, and black liquor from pulp and paper mills
- Agricultural crops and waste materials— corn, soybeans, sugar cane, switchgrass, woody plants, and algae, and crop and food processing residues
- Biogenic materials in municipal solid waste—paper, cotton, and wool products, and food, yard, and wood wastes
- Animal manure and human sewage



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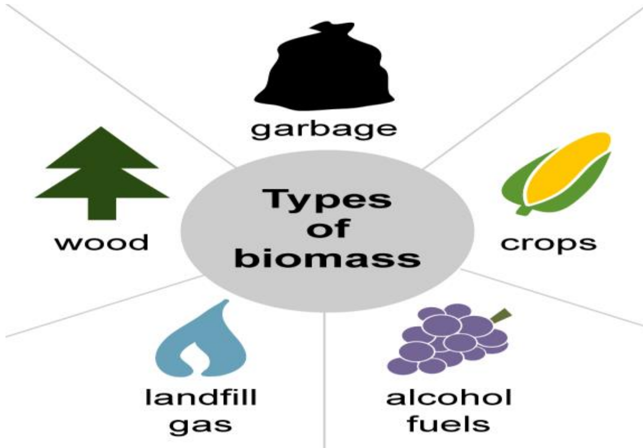

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Converting biomass to energy

Biomass is converted to energy through various processes, including:

- Direct combustion (burning) to produceheat
- Thermochemical conversion to producesolid, gaseous, and liquid fuels
- Chemical conversion to produce liquidfuels
- Biological conversion to produce liquidand gaseous fuels

Direct combustion is the most common method for converting biomass to useful energy. All biomass can be burned directly for heating buildings and water, for industrial process heat, and for generating electricity in steam turbines.

Thermochemical conversion of biomass includes *pyrolysis* and *gasification*. Both are thermal decomposition processes in which biomass feedstock materials are heated in closed, pressurized vessels called *gassifiers* at high temperatures. They mainly differ in the process temperatures and amount of oxygen present during the conversion process.

- Pyrolysis entails heating organic materials to 800–900ºF (400–500 ºC) in the near complete absence of free oxygen. Biomass pyrolysis produces fuels such as charcoal, bio-oil, renewable diesel, methane, and hydrogen.
- Hydrotreating is used to process bio-oil

(produced by *fast pyrolysis*) with

hydrogen under elevated temperatures and pressures in the presence of a catalyst to produce renewable diesel, renewable gasoline, and renewable jet fuel.

- Gasification entails heating organic materials to 1,400–1700ºF (800–900ºC) with injections of controlled amounts of free oxygen and/or steam into the vessel to produce a carbon monoxide and hydrogen rich gas called synthesis gasor *syngas*. Syngas can be used as a fuel for diesel engines, for heating, and for generating electricity in gas turbines. It can also be treated to separate the hydrogen from the gas, and the hydrogen can be burned or used in fuel cells. The syngas can be further processed to produce liquid fuels using the Fischer–Tropsch process.

A chemical conversion process known as *transesterification* is used for converting vegetable oils, animal fats, and greases into fatty acid methyl esters (FAME), which are used to produce biodiesel.

Biological conversion includes fermentation to convert biomass into ethanol and anaerobic digestion to produce renewable natural gas. Ethanol is used as a vehicle fuel.Renewable natural gas—also called *biogas* or *biomethane*—is produced in anaerobic digesters at sewage treatment plants and at dairy and livestock operations.It also forms in and may be captured from solid waste landfills. Properly treated renewable natural gas has the same uses as fossil fuel natural gas.

Researchers are working on ways to improvethese methods and to develop other ways to convert and use more biomass for energy.

How much biomass is used for energy?

In 2020, biomass provided about 4,532 trillion British thermal units (TBtu), or about 4.5 quadrillion Btu and equal to about 4.9% of total U.S. primary energy consumption. Of that amount, about 2,101 TBtu were from wood and wood-derived biomass, 2,000 TBtu were from biofuels (mainly ethanol), and 430 TBtu were from the biomass in municipal wastes.Biomass contains energy first derived from the sun: Plants absorb the sun’s energy through photosynthesis, and convert carbon dioxide and water into nutrients (carbohydrates).

The energy from these organisms can be

transformed into usable energy through direct and indirect means. Biomass can be burned to create heat (direct), converted into electricity (direct), or processedinto biofuel (indirect).

RESULTS AND DISCUSSION

Thermal Conversion Biomass can be burned by thermal conversion and used for energy. Thermal conversion involves heating the biomass feedstock in order to burn, dehydrate, or stabilize it. The most familiar biomass feedstocks for thermal conversion are raw materials suchas municipal solid waste (MSW) and scraps from paper or lumber mills.

Different types of energy are created through direct firing, co-firing, pyrolysis, gasification, and anaerobic decomposition.

Before biomass can be burned, however, it must be dried. This chemical process is called torrefaction. During torrefaction,biomass is heated to about 200° to 320°Celsius (390° to 610° Fahrenheit). The biomass dries out so completely that it losesthe ability to absorb moisture, or rot. It loses about 20% of its original mass, but retains 90% of its energy. The lost energy and mass can be used to fuel the torrefaction process.

During torrefaction, biomass becomes a dry, blackened material. It is then compressed into briquettes. Biomass briquettes are very hydrophobic, meaning they repel water. This makes it possible to store them in moist areas. The briquettes have high energy density and are easy to burn during direct or co-firing.

Direct Firing and Co-Firing Most briquettes are burned directly. The steam produced during the firing process powers a turbine, which turns a generator and produces electricity. This electricity can be used for manufacturing or to heat buildings.

Biomass can also be co-fired, or burned witha fossil fuel. Biomass is most often co-fired in coal plants. Co-firing eliminates the need for new factories for processing biomass. Co-firing also eases the demand for coal. This reduces the amount of carbon dioxide and other greenhouse gases released by burning fossil

fuels.

Pyrolysis

Pyrolysis is a related method of heating biomass. During pyrolysis, biomass is heated to 200° to 300° C (390° to 570° F) without the presence of oxygen. This keeps it from combusting and causes the biomass to be chemically altered.

Pyrolysis produces a dark liquid called pyrolysis oil, a synthetic gas called syngas, and a solid residue called biochar. All of these components can be used for energy.

Pyrolysis oil, sometimes called bio-oil or biocrude, is a type of tar. It can be combusted to generate electricity and is also used as a component in other fuels and plastics. Scientists and engineers are studying pyrolysis oil as a possible alternative to petroleum.

Syngas can be converted into fuel (such as synthetic natural gas). It can also be converted into methane and used as a replacement for natural gas.

Biochar is a type of charcoal. Biochar is a carbon-rich solid that is particularly useful in agriculture. Biochar enriches soil and prevents it from leaching pesticides and other nutrients into runoff. Biochar is also anexcellent carbon sink. Carbon sinks are reservoirs for carbon-containing chemicals, including greenhouse gases.

Gasification

Biomass can also be directly converted to energy through gasification. During the gasification process, a biomass feedstock (usually MSW) is heated to more than 700° C (1,300° F) with a controlled amount of oxygen. The molecules break down, and produce syngas and slag.

Syngas is a combination of hydrogen and carbon monoxide. During gasification, syngas is cleaned of sulfur, particulates, mercury, and other pollutants. The clean syngas can be combusted for heat or electricity, or processed into transportation biofuels, chemicals, and fertilizers.

Slag forms as a glassy, molten liquid. It can be used to make shingles, cement, or asphalt.

Industrial gasification plants are being built all over the world. Asia and Australia are constructing and operating the most plants, although one of the largest gasification plants in the world is currently under construction in Stockton-on-Tees, England. This plant will eventually be able to convert more than 350,000 tons of MSW intoenough energy to power 50,000 homes.

Anaerobic Decomposition

Anaerobic decomposition is the process where microorganisms, usually bacteria, break down material in the absence of oxygen. Anaerobic decomposition is an important process in landfills, where biomass is crushed and compressed, creating an anaerobic (or oxygen-poor) environment.

In an anaerobic environment, biomass decays and produces methane, which is a valuable energy source. This methane can replace fossil fuels.

In addition to landfills, anaerobic decomposition can also be implemented on ranches and livestock farms. Manure and other animal waste can be converted to sustainably meet the energy needs of the farm.

Biofuel

Biomass is the only renewable energy source that can be converted into liquid biofuels such as ethanol and biodiesel. Biofuel is used to power vehicles and is being produced by gasification in countries such as Sweden, Austria, and the United States.

Ethanol is made by fermenting biomass that is high in carbohydrates, such as sugar cane, wheat, or corn. Biodiesel is made from combining ethanol with animal fat, recycled cooking fat, or vegetable oil.

Biofuels do not operate as efficiently as gasoline. However, they can be blended with gasoline to efficiently power vehicles and machinery, and do not release the emissions associated with fossil fuels.

Ethanol requires acres of farmland to grow bio crops (usually corn). About 1,515 liters (400 gallons) of ethanol is produced by an acre of corn. But this acreage is thenunavailable for growing crops for food or other uses. Growing enough corn for ethanol also creates a strain on the environment because of the lack of variation in planting, and the high use of pesticides.

Ethanol has become a popular substitute for wood in residential fireplaces. When it is burned, it gives off heat in the form of flames, and water vapor instead of smoke.

Biochar

Biochar, produced during pyrolysis, is valuable in agricultural and environmental use. When biomass rots or burns (naturally or by human activity), it releases high amounts of methane and carbon dioxideinto the atmosphere. However, whenbiomass is charred, it sequesters, or stores, its carbon content. When biochar is added back to the soil, it can continue to absorb carbon and form large underground stores of sequestered carbon—carbon sinks—that can lead to negative carbon emissions and healthier soil.

Biochar also helps enrich the soil. Itis porous. When added back to the soil, biochar absorbs and retains water and nutrients.

Biochar is used in Brazil's Amazon rain forestin a process called slash-and-char. Slash- and-char agriculture replaces slash-and- burn, which temporarily increases the soil nutrients but causes it to lose 97% of itscarbon content. During slash-and-char, the charred plants (biochar) are returned to thesoil, and the soil retains 50% of its carbon. This enhances the soil and leads to significantly higher plant growth.

BlackLiquor

When wood is processed into paper, it produces a high-energy, toxic substance called black liquor. Until the 1930s, black liquor from paper mills was considered a waste product and dumped into nearbywater sour ces.

However, black liquor retains more than 50%of the wood’s biomass energy. With the invention of the recovery boiler in the 1930s, black liquor could be recycled and used to power the mill. In the U.S., paper mills use nearly all their black liquor to run their mills, and the forest industry is one of the most energy-efficient in the nation as a result.

More recently, Sweden has experimented in gasifying black liquor to produce syngas, which can then be used to generate electricity.

Hydrogen Fuel Cells

Biomass is rich in hydrogen, which can be chemically extracted and used to generate power and to fuel vehicles. Stationary fuel cells are used to generate electricity in remote locations, such as spacecraft and wilderness areas. Yosemite National Park in the U.S. state of California, for example, uses hydrogen fuel cells to provide electricity and hot water to its administration building. Hydrogen fuel cells may hold even more potential as an alternative energy source for vehicles. The U.S. Department of Energy estimates that biomass has the potential to produce 40 million tons of hydrogen per year. This would be enough to fuel 150 million vehicles.

Currently, hydrogen fuel cells are used to power buses, forklifts, boats, and submarines, and are being tested on airplanes and other vehicles.

However, there is a debate as to whether this technology will become sustainable or economically possible. The energy that it takes to isolate, compress, package, and transport the hydrogen does not leave a high quantity of energy for practical use.

Biomass and the Environment

Biomass is an integral part of Earth's carbon cycle. The carbon cycle is the process by which carbon is exchanged between all layersof the Earth: atmosphere, hydrosphere, biosphere, and lithosphere. The carbon cycle takes manyforms. Carbon helps regulate the amount ofsunlight that enters Earth's atmosphere. It is exchanged through photosynthesis, decomposition, respiration, and humanactivity. Carbon that is absorbed by soil as anorganism decomposes, for example, may be recycled as a plant releases carbon-basednutrients into the biosphere through photosynthesis. Under the right conditions, the decomposing organism may become peat, coal, or petroleum before being extracted through natural or human activity.

Between periods of exchange, carbon is sequestered, or stored. The carbon in fossil fuels has been sequestered for millions of years. When fossil fuels are extracted and burned for energy, their sequestered carbon is released into the atmosphere. Fossil fuels do not re-absorb carbon.

In contrast to fossil fuels, biomass comes from recently living organisms. The carbon in biomass can continue to be exchanged in the carbon c ycle.

In order to effectively allow Earth to continue the carbon cycle process, however, biomass materials such as plants and forests must be sustainably farmed. It takes decades for trees and plants such as switchgrass to re-absorb and sequester carbon. Uprooting or disturbing the soil can be extremely disruptive to the process. A steady and varied supply of trees, crops, and other plants is vital for maintaining a healthy environment.

Algal Fuel

Algae is a unique organism that has enormous potential as a source of biomass energy. Algae, whose most familiar form is seaweed, produces energy through photosynthesis at a much quicker rate than any other biofuel feedstock—up to 30 times faster than food crops!

Algae can be grown in ocean water, so it does not deplete freshwater resources. It also does not require soil, and therefore does not reduce arable land that could potentially grow food crops. Although algae releases carbon dioxide when it is burned, itcan be farmed and replenished as a living organism. As it is replenished, it releases oxygen, and absorbs pollutants and carbon emissions. Algae takes up much less space than other biofuel crops. The U.S. Department of Energy estimates that it would only take approximately 38,850 square kilometers

(15,000 square miles, an

area less than half the size of the U.S. state of Maine) to grow enough algae to replace all petroleum-fueled energy needs in the United States.

Algae contains oils that can be converted to a biofuel. At the Aquaflow Bionomic Corporation in New Zealand, for example, algae is processed with heat and pressure. This creates a "green crude," which has similar properties to crude oil, and can be used as a biofuel.

Algae's growth, photosynthesis, and energy production increases when carbon dioxide is bubbled through it. Algae is an excellent filter that absorbs carbon emissions. Bioenergy Ventures, a Scottish firm, has developed a system in which carbon emissions from a whiskey distillery are funneled to an algae pool. The algae flourishes with the additional carbon dioxide. When the algae die (after about a week) they are collected, and their lipids (oils) are converted into biofuel or fish food.

Algae has enormous potential as an alternative energy source. However, processing it into usable forms is expensive. Although it is estimated to yield 10 to 100 times more fuel than other biofuel crops, in 2010 it cost $5,000 a ton. The cost will likely come down, but it is currently out of reach for most developing economies.

People and Biomass

Advantages

Biomass is a clean, renewable energy source. Its initial energy comes from the sun, and plants or algae biomass can regrow in a relatively short amount of time. Trees, crops, and municipal solid waste are consistently available and can be managed sustainably. If trees and crops are sustainably farmed, they can offset carbon emissions when they absorb carbon dioxide through respiration.

In some bioenergy processes, the amount of carbon that is re-absorbed even exceeds thecarbon emissions that are released during fuel processing or usage. Many biomass feedstocks, such as switchgrass, can be harvested on marginal lands or pastures, where they do not compete with food crops. Unlike other renewable energy sources, suchas wind or solar, biomass energy is stored within the organism, and can be harvested when it is needed.

Disadvantages

If biomass feedstocks are not replenished as quickly as they are used, they can become non-renewable. A forest, for instance, can take hundreds of years to re-establish itself. This is still a much, much shorter time than a fossil fuel such as peat. It can take 900 years for just a meter (3 feet) of peat to replenish itself.

Most biomass requires arable land to develop. This means that land used for biofuel crops such as corn and soybeans are unavailable to grow food or provide natural habitats.

Forested areas that have matured for decades (so-called “old-growth forests”) are able to sequester more carbon than newly planted areas. Therefore, if forested areas are not sustainably cut, re-planted, and given time to grow and sequester carbon, the advantages of using the wood for fuel are not offset by the trees’ regrowth. Most biomass plants require fossil fuels to be economically efficient. An enormous plant under construction near Port Talbot, Wales, for instance, will require fossil fuels imported from North America, offsetting some of the sustainability of the enterprise. Biomass has a lower “energy density” than fossil fuels. As much as 50% of biomass is water, which is lost in the energy conversionprocess. Scientists and engineers estimate that it is not economically efficient to transport biomass more than 160 kilometers(100 miles) from where it is processed. However, converting biomass into pellets (as opposed to wood chips or larger briquettes)can increase the fuel’s energy density and make it more advantageous to ship.

CONCLUSION

Abundant amount of biomass is being wasted every year in agriculture country like Pakistan, which is already facing huge number of problems including fuel shortage. Majority of biomass can be converted into many of bio products including biofuels that will fulfill shortage of both LPG and CNG. Therefore, it is important to convince farmerthat burning of biomass in their agriculture fields are releasing carbon monoxide, carbon dioxide, nitrogen oxides, and otherpollutants. If these pollutants are not

captured and recycled, burning biomass cancreate smog and even exceed the number of pollutants released by fossil fuels. These are main factors those are damaging our environment and making climatic disasters in Pakistan.