**Sources of bioenergy and their practicality in the modern world**

**1Natarajan Shanthi,2 Subbiah Murugesan, Pillathil Jegan Pillathil Senthil Mani**

**Abstract**

One of the many options obtainable to help us meet our require for energy is bioenergy. It is a source of renewable energy made from organic compounds. Wood, agricultural products, and organic waste are examples of these materials. Due to its high biodegradability, low toxicity, and capability to alternative diesel fuel in a number of applications, biodiesel production appears to be a particularly attractive developing sector at the moment as energy require rises. As a result, interest in bioenergy has increased recently, which will allow the growth of a sustainable bioenergy sector. The world economy and efforts to sluggish climate change are usual to increase from increased production of these fuels.

**Introduction**

The development of civilization and industrial revolution also led to drastic climate changes. Due to the minor increase in global temperature that was brought on by this, there was a danger that both plants and animals would go extinct. Climate change brings about a number of environmental issues, including coastal erosion, sea level rise, storms, cyclones, floods, and problems with the availability of clean water for people and animals. Research on energy-saving initiatives and renewable energy sources should be conducted in order to reduce the effects of climate change. Although conventional energy has many benefits, renewable energy sources are more expensive to create. It decreases reliance on fossil fuels and poses less of a threat than nuclear power (Paulina Drożyner *et al*., 2013). These renewable energies are of many types and among them bioenergy fuel is considered to be the most important nowadays. One significant renewable resource that can aid in supplying the energy needed to support an expanding population and the development of industry is bioenergy. It is a type of renewable energy produced from recently living organic material, or biomass, which is used to generate heat, electricity, and transportation fuels.

**Source of Bioenergy**

Article 2 of the Biocomponents and Liquid Biofuels Act of August 25, 2006 states that biomass is made up of solid or liquid materials of plant or animal origin that degrade as a result of agricultural and forestry production wastes, leftovers, and other wastes, particularly agricultural raw materials.

**Food crops**

For the manufacture of bioethanol, potential crops include cassava, sugarcane, rice, and sweet sorghum; for the production of biodiesel, potential crops include palm oil, groundnuts, and palm kernels. Brazil is another nation on the list of those engaged in the production of biofuels. Physic nut, sunflower, soybean, castor bean, African palm, cotton, peanut, linseed, sesame, canola, and other crops are examples of potential biofuel crops in Brazil. The Brazilian Federal Government has passed laws allowing the use of biodiesel in the country's fuel markets (Lopes et al., 2013).

**Oil rich algae**

Some of the micro- and macroalgae employed in the creation of bioenergy include *Chlorococcum sp., Prymnesium parvum, Gelidiumamansii, Gracilaria sp., Laminaria* sp., *Sargassum* sp. and *Spirogyra* sp (Eshaq et al., 2011; Rajkumar et al., 2014). Land plants grow only seasonally and contain only 5% dry weight, but algae produce very rapid and have high oil content, typically doubling within 24 hours, while some microalgae produce each three and a half hours. Microalgae typically only contain 20–50% oil, however certain strains can contain up to 80% oil (Metting, 1996; Spolaore *et al*., 2006). These algae frequently need light, nutrients, and carbon dioxide in order to produce significant amounts of polysaccharides like starch and cellulose. These polysaccharides are amenable to hydrolysis into fermentable sugars, fermentation into bioethanol, and distillation-based purification. Algae farming has a number of advantages over conventional biofuel crops, including much higher yields. According to Adeniyi *et al*. (2018), more than half the oil was converted to dry biomass. Bioethanol, biodiesel, methane, kerosene for airplanes, biobutanol, biogas, and green diesel can all be produced from algae. Algal biodiesel has the potential to dramatically increase transportation energy security. The production of jet fuel from algae has enormous potential for use in aviation. Additionally, bio-jet fuel is acknowledged as a short- to medium-term method for cutting GHG emissions in the industry. (European Environment Agency, 2020). For this reason, the algae-to-biofuel industry is concentrating on microalgae.

**Stored municipal waste**

Municipal solid waste (MSW) is one of the resources utilized to produce bioenergy, and it includes organic garbage. One of the primary by-products of urbanisation is MSW.   
1.3 billion tonnes of solid garbage are produced annually by the estimated 3 billion urban dwellers on the planet. By the year 2100, the production of MSW could total 4 billion tonnes (Hoornweg and Bhada-Tata, 2012). If this volume of solid waste is not managed effectively, it might be a significant source of methane emissions, air pollution, health hazards for people and ecosystems, and contaminated groundwater. The organic fraction of municipal solid waste (OFMSW) is a popular feedstock for anerobic digestion (AD) and a promising source for the production of biogas, according to van Lier *et al*. (2001) and Abudi *et al*. (2016). AD is a natural process that transforms feedstock into digestate and renewable fuel (in this case, biogas) in the absence of oxygen. Bhakov *et al*. (2014) claim that the main components of biogas from AD are CH4 (50–70%), CO2 (30–50%), and a few important pollutants such NH3, H2S, siloxane, halides, and water vapour. Due to the very complicated substrates employed in AD, hydrolysis has been found to be the rate-limiting process among the four stages that take place during AD, namely acidogenesis, acetogenesis, and methanogenesis (Rafique et al., 2010; Ma et al., 2011). The most prevalent method of converting trash into heat or power is direct combustion. In order to generate energy during this process, the removed waste fuel is burned in the presence of extra oxygen (the oxygen that collects from the air). Waste gasification converts organic materials into syngas with CO, H2, CO2, N2, CH4, and other components at high temperatures and under controlled oxygen conditions (Patel et al., 2016). The basis for this statement was describing the distinctive kinetics of protein, lipid, and carbohydrate biodegradation. To increase energy recovery from trash now disposed of in landfills, it is imperative to create effective waste to energy systems (WtE). WtE refers to the methods or processes used to produce and optimise the output of an energy source such as heat, electricity, or waste fuel (Mofijur et al., 2020). The need for bioenergy is driven by the desire to reduce our carbon footprint Mofijur *et al*., 2016; Ong *et al*., 2020) and ensure the security of our fuel supply (Ong *et al*., 2019; Muhammad *et al*., 2021).

**Efficacy**

The effectiveness of biomass depends on its chemical make-up, energy content, and water content. There are two types of biomass feedstock: those with a low heating value and those with a high heating value. For the majority of biomass feedstock, a dry feedstock would have a high heating value since it contains less water and burns more readily. Lower values would be associated with aquatic and wet waste biomass. The chemical composition of a feedstock is also significant for biochemical conversion processes such as biofuel generation (ethanol, biodiesel, and so on)(Efficiency of Biomass Energy). The many thermochemical and biochemical procedures used to convert biomass energy into power, heat, transportation fuels, and chemicals play a significant role in determining the efficiency of the process. Brazil, India, Germany, the US, and China, respectively, consumed 31%, 21%, 11%, 5%, and 4.5% of the world's energy in 2018 due to BE (Kim et al., 2020). Energy crop biomass potential is anticipated to increase from 11 EJ in 2020 to 96 EJ in 2050 (Destek, et al., 2020). The 2030 climate and energy framework includes the 2021–2030 policies and objectives. The primary goals are to reduce greenhouse gas emissions by at least 40% from 1990 levels, use 32% or more renewable energy, and improve energy efficiency by at least 30%. According to Lin   
*et al*. (2014), the direct use of biofuels results in significantly lower CO2 emissions than the use of fossil fuels.

**Sustainability**

Biofuels have advantages and disadvantages with regard to the long-term survival of the environment, the economy, and society (Azapagic and Stichnothe., 2011). On the one hand, the reduction of GHG emissions, energy security, and rural development are the primary global drivers of biofuels. However, there are drawbacks to increasing biofuel production, such as pressure on food prices, a potential increase in greenhouse gas (GHG) emissions due to direct and indirect land-use change (LUC) from the production of biofuel feedstocks, as well as dangers of ecosystem degradation and the deterioration of land, forests, water resources, and other natural resources (UNEP, 2009). Different sustainability requirements for biofuels are outlined in regulatory regulations like the RED and RFS in order to promote the sustainable development of these fuels. The life cycle GHG emissions are one of the primary criteria. The RED requires that biofuel installations operating before October 2015 and starting after that date have emissions that are at least 50% lower than those of their fossil fuel counterparts, and installations starting after that date must have emissions that are 60% lower. Biofuel installations starting after that date must have emissions that are 65% lower than those of their fossil fuel counterparts (Daystar *et al*., 2015). Manufacturers of advanced biofuels must reduce GHG emissions by at least 50%, as opposed to the 20% reduction required for standard biofuels (EPA, 2010). The climate change impact related to GHG emissions and other sustainability elements of biofuels should be analyzed on a life cycle basis using life cycle assessment (LCA) to avoid moving costs from one component of the life cycle or supply chain to another.

**Improvement bioenergy**

With 55% of all renewable energy and more than 6% of the world's energy supply coming from contemporary bioenergy, it is currently the most important source of renewable energy. In order to replace fossil fuels by 2030, the Net Zero Emissions by 2050 (NZE) Scenario expects a sharp increase in the usage of bioenergy. Modern bioenergy use is on the rise and is expected to grow by about 3% year between 2010 and 2022.Additionally, the development of synthetic microbial cells with planned malfunctions of internally residing genes and/or other sources of gene expression (microalgae species), systems biotechnology (for global cellular information), and synthetic and systems biology (bacterial or yeast species) can successfully improve the production of biofuel.

**Deconstruction and separation**

Deconstruction Division will investigate specific microbial communities. In order to create engineered microbial communities, organisms, pathways, and enzymes that efficiently depolymerize polysaccharides into monosaccharides and depolymerize and catabolize lignin into intermediates that can be transformed into biofuels and bioproducts (US Department of energy). Removal of lignin and a decrease in cellulose crystallinity are frequent elements that have been established to improve biomass deconstruction under different pretreatment measures (Gao et al., 2014). Diverse substances, including but not limited to ammonia   
(Sousa et al ., 2016), ionic liquids (George et al.2015), diluted acids (Langanet al. 2014), and deep-eutectic solvents , have demonstrated some effectiveness in breaking down biomass. But it has recently been demonstrated that using multifunctional cosolvents is a particularly efficient and cost-effective way to dissolve plant cell walls and present the products in a way that makes them suitable for conversion into high-value products like biofuels. The interactions of co-solvents with biomass and the workings of co-solvent pretreatment, however, are not well understood. Therefore, these methods are typically carried out under high co-solvent and acid concentrations and/or high reaction temperature conditions in order to produce highly digestible pretreated solids at the cost of significant total sugar losses, pricey solvent recovery techniques, or excessive solvent slippage during liquid-solids separations (Shuai et al., 2016; Agnihotri et al., 2015). This positive outcome emphasizes the advantages of a separation-free process that converts IL pretreated biomass directly into biofuels or other bioproducts without requiring any transitional parting measures between conversion unit operations. While the production of ethanol has been established in the existence of concentrated ionic liquids, no method has so far exposed the production of advanced biofuels such as molecules suitable for diesel and jet fuel under such situation. Likewise, no fermentation process has so far shown the conversion of both pentose and hexose sugars in the presence of concentrated ionic liquids (Eric Sundstrom et al.,2018).

**Conclusion**

In order to retain a stable supply of energy, bioenergy is an necessary part of the renewable energy mix. Biomass holds the carbon that is absorbed by plants during photosynthesis. The carbon is simply released into the environment when this biomass is burned to produce electricity, making modern bioenergy a promising fuel with almost no emissions. Future bioenergy shares will likely range from 15-20% in conventional situations, 30-45% in moderate scenarios, and 50-95% in high scenarios. High shares of transport energy are regarded to be the most unpredictable, high shares of heating/cooling are thought to be the hardest to obtain, and high shares of electricity are thought to be the easiest. Energy provide technologies, increasing energy require, and increasing levels of energy efficiency are all present in all energy scenarios.

**References**

1. Abudi, Z. N., Hu, Z., Sun, N., Xiao, B., Rajaa, N., Liu, C. Batch anaerobic co-digestion of OFMSW (organic fraction of municipal solid waste), TWAS (thickened waste activated sludge) and RS (rice straw): inﬂuence of TWAS and RS pretreatment and mixing ratio. Energy. 2016; 107, 131–140. doi: 10.1016/j.energy.2016.03.141.
2. Adeniyi, O.M.; Azimov, U.; Burluka, A. Algae biofuel: Current status and future applications. *Renew. Sustain. Energy Rev.* 2018; 90, 316–335.
3. Agnihotri, S., Johnsen, I., Bøe, M., Øyaas, K. & Moe, S. Ethanol organosolv pretreatment of softwood (Piceaabies) and sugarcane bagasse for biofuel andbiorefinery applications. Wood Science and Technology. 2015; 49, 881-896.
4. Azapagic A, Stichnothe H. Assessing sustainability of biofuels. In Sustainable development in practice: case studies for engineers and scientists, 2nd edn (eds Azapagic A, Perdan S). Chichester, UK: John Wiley & Sons. 2011.
5. Bhakov, Z.K., Korazbekova, K. ., and Lakhanova, K. The kinetics of biogas production from codigestion of cattle manure. Pak. J. Biol.Sci. 2014; 17,1023–1029. doi: 10.3923/pjbs.2014.1023.1029.
6. Daystar J, Treasure T, Gonzalez R, Reeb C, Venditti R, Kelley S. The NREL biochemical and thermochemical ethanol conversion processes: financial and environmental analysis comparison. Bioresources. 2015; 10, 5096–5116.
7. Destek, Mehmet Akif & Aslan, Alper, "Disaggregated renewable energy consumption and environmental pollution nexus in G-7 countries," Renewable Energy, Elsevier, 2020; 151(C), pages 1298-1306.
8. Efficiency of Biomass Energy ,Alternative Energy Tutorials post. 2010.
9. EPA. Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis (EPA-420-R-10-006). U.S. Environmental Protection Agency, Office of Transportation and Air Quality, Assessment and Standards Division. 2010.
10. Eric Sundstrom a, Junko Yaegashi bc, Jipeng Yan a, Fabrice Masson a, Gabriella Papa ac, Alberto Rodriguez cd, Mona Mirsiaghi a, Ling Liang ORCID logoa, Qian He ORCID logoa, Deepti Tanjore a, Todd R. Pray a, Seema Singh ORCID logocd, Blake Simmons ORCID logoac, Ning Sun a, Jon Magnuson b and John Gladden.Demonstrating a separation-free process coupling ionic liquid pretreatment, saccharification, and fermentation with Rhodosporidiumtoruloides to produce advanced biofuels.Green Chem. 2018; 20, 2870-2879.
11. Eshaq, F.S., Ali, M.N., and Mohd, M.K. Production of bioethanol from next generation feed-stock alga *Spirogyra* species. *Int. J. Eng. Sci. Technol.* 2011; 3, 1749–1755.
12. European Environment Agency. Transport: Increasing Oil Consumption and Greenhouse Gas Emissions Hamper EU Progress towards Environment and Climate Objectives; EEA: Copenhagen, Denmark, 2020.
13. Gao, X.D. Comparison of enzymatic reactivity of corn stover solids prepared by dilute acid, AFEX (TM), and ionic liquid pretreatments. Biotechnol. Biofuels. 2014; 7, 71.
14. George, A. Design of low-cost ionic liquids for lignocellulosic biomass pretreatment. Green Chem. 2015; 17, 1728–1734.
15. Hoornweg, D. and P. Bhada-Tata.  *What a waste: A global review of solid waste management*. The World Bank, Urban Development Series Knowledge Papers, no. 2012; 15.
16. Kim, GwanSeon& Choi, Sun-Ki & Seok, Jun Ho, 2020. "Does biomass energy consumption reduce total energy CO2 emissions in the US?," Journal of Policy Modeling, Elsevier, vol. 42(5), pages 953-967.
17. Langanet, P. Common processes drive the thermochemical pretreatment of lignocellulosic biomass. Green Chem.2014; 16, 63–68.
18. Lin, Boqiang& Moubarak, Mohamed, "Renewable energy consumption – Economic growth nexus for China," Renewable and Sustainable Energy Reviews, Elsevier, 2014; 40(C), pages 111-117.

## Lopes Daniela de Carvalho, Antonio José Steidle Neto, Adriano Aguiar Mendes, Débora Tamires Vítor Pereira.Economic feasibility of biodiesel production from Macauba in Brazil.[Energy Economics](https://www.sciencedirect.com/journal/energy-economics). 2013; 40: 819-824.

1. Ma, J., Duong, T.H., Smits, M., Vestraete, W. and Carballa, M. Enhanced biomethanation of kitchen waste by diﬀerent pretreatments. Bioresour. Technol. 2011; 102:592-599.
2. Technol.. 102, 592–599.
3. Metting, F.B. Biodiversity and application of microalgae. Journal of Industrial MicroBiology. 1996; 17:477-489.
4. Mofijur, M., Kusumo, F., Fattah, I. M. R., Mahmudul, H. M., Rasul, M. G., Shamsuddin, A. H. Resource recovery from waste coffee grounds using ultrasonic-assisted technology for bioenergy production. Energies. 2020b. 13 (7), 1770. doi:10.3390/en13071770.
5. Muhammad, G., Alam, M. A., Mofijur, M., Jahirul, M. I., Lv, Y., Xiong, W.Modern developmental aspects in the field of economical harvesting and biodiesel production from microalgae biomass. Renew. Sustain. Energ. Rev. 2021; 135, 110209.

doi:10.1016/j.rser.2020.110209.

1. Ong, H.C., Chen, W.H., Farooq, A., Gan, Y.Y., Lee, K.T., and Ashokkumar, V.Catalytic thermochemical conversion of biomass for biofuel production: a comprehensive review. Renew. Sustain. Energ. Rev.2019; 113, 109266. [10.1016/j.rser.2019.109266](https://doi.org/10.1016/j.rser.2019.109266).
2. Ong, H. C., Tiong, Y. W., Goh, B. H. H., Gan, Y. Y., Mofijur, M., Fattah, I. M. RRecent advances in biodiesel production from agricultural products and microalgae using ionic liquids: opportunities and challenges. Energy Convers. Manag. . 2020;113647, 121.
3. Paulina Drożyner, Wojciech Rejmer Piotr Starowicz, Andrzej Klasa, Krystyna A. Skibniewska.Technical Sciences. 2013; 16(3), 211–220. Biomass as a renewable source of energy.
4. Patel, M., Zhang, X., and Kumar, A. Techno-economic and life cycle assessment on lignocellulosic biomass thermochemical conversion technologies: a review. Renew. Sustain. Energ. Rev. 2016; 53, 1486–1499. doi:10.1016/j.rser.2015.09.070.
5. Raﬁque, R., Poulse, T.G., Nizami, A.S., Asam, Z.Z., Murphy, J.D., and Kiely, G. Eﬀect of thermal, chemical and thermo-chemical pretreatments to enhance methane production. Energy. 2010; 35, 4556–4561. doi: 10.1016/j.energy.2010.07.011
6. Rajkumar, R., Yaakob, Z., and Takriff, M.S. Potential of the micro and macro algae for biofuel production: a brief review. *Bioresour.* 2014; 9, 1606–1633. doi:10.15376/biores.9.1.
7. Shuai, L., Questell-Santiago, Y. &Luterbacher, J. A mild biomass pretreatment using [gamma]-valerolactone for concentrated sugar production. Green Chem. 2016; 18,937-943.
8. Spolaore, P., Joannis-Cassan, C., Duran, E., Isambert, A. Commercial application of

microalgae. Journal of Bioscience and Bioengineering. 2006; 101:87-96.

1. Sousa, L.D. Next-generation ammonia pretreatment enhances cellulosic biofuel production. Energy Environ. Sci. 2016; 9, 1215–1223.
2. UNEP.  **Towards sustainable production and use of resources: assessing biofuels**. United Nations Environment Programme.2009.
3. van Lier, J. B., Tilche, A., Ahring, B. H., Macarie, H., Moletta, R., Dohanyos, M., et al. (2001). New perspectives in anaerobic digestion. Water Sci. Technol. 43, 1–18.