Bioenergy Production and Environmental Impacts

Dr.Vinay Kumar S.B
Department of Electronics and Communication Engineering, Faculty of Engineering and Technology, Jain (Deemed-to-be University), Bengaluru, India
Email: sb.vinaykumar@jainuniversity.ac.in

ABSTRACT: Energy is essential for the formation of almost every part of life across the globe, along with the survival of ecological life, human being development. However, using a conventional energy source will result in series of problems. First is that extensive use of fossil oils result in energy crisis because they are non-renewable energy sources. Second is that the fossil fuels are the polluting factor because they encourage the global warming. To overcome this environmental issue, bioenergy as a substitute for conventional fossil fuels is developed that has been grown over the last few decades. Due to the renewable nature and vast supply of the bioenergy's they have a clear advantage over traditional fossil fuels; hence they play a critical role in ensuring energy stability. The existing study has looked upon various bioenergy production approaches and their impacts on the environment and ecological life. According to a recent report it is critical to consider capital and environmental cost when introducing bioenergy development. By the middle of the century, bioenergy is expected to be considered a legacy commodity. As a result, policymakers should restrict near-term bioenergy incentives and instead give incentives for the next wave of technology that will enable a carbon-free future.

KEYWORDS: Bioenergy, Biomass Energy, Environment, Renewable, Sources.

INTRODUCTION

Energy is vital for the growth of almost every part of a culture across the globe, as well as the survival of ecology, humanity, and modern civilization. Nevertheless, using traditional energy sources will result in a sequence of issues. First, conventional oil (i.e., fossil fuels) is nonrenewable, and its widespread use would result in a substantial energy shortage, which is now a major global concern. Second, conventional energy sources may be contaminating sources that contribute to global warming by increasing carbon dioxide and other greenhouse gases, among other things. Last, nitrogen oxides released as a result of fossil fuel burning degrade quality of the air and damage human health. Unfortunately, the world's energy demand is largely reliant on fossil fuels (80%), and it is expected to rise by more than 50% over the next 20 years. As a result, bioenergy, a potent renewable fossil fuel substitute, has grown in popularity in recent centuries, especially in North America and Europe, with the goal of meeting global population growth, ensuring energy stability, and mitigating global warming. Bioenergy have attracted much attention and has taken an important position in the biosphere's energy utilization and combat in contradiction of climatic alternation, despite the fact that bioenergy actually accounts for just 14% of world vitality depletion (World energy sources 2016)[1].

Bioenergy is the most exciting and scalable green energy source, and its extraction from polluted fields has the ability to contribute in satisfying the global energy demand. It has the potential to expand clean energy production and boost land use productivity. Most nations have been urged to advance bioenergy use and to facilitate the advancement of bioenergy technology and policies as a result of these benefits. The Energy Independences and Security Act (EISA) was enacted in the United States in 2007, with the aim of increasing green energy availability through biofuel manufacturing. Malaysia's government implemented the Fifth Fuel Policy in the Eighth Malaysia Plan (2001–2005) to inspire the development of bioenergy's. The European Commission has fixed obligatory goals for the use of inexhaustible energy's in transportation in the E. China, as the world's biggest developed country and second-largest market, has a high inherent need for bioenergy supply to meet its fast-growing economy, avoid an energy shortage, and meet its carbon emissions mitigation targets. In reality, owing to the increase in profit and ecological impact of swapping slope cropland with perennial grass, China has a huge potential for bioenergy crop cultivation. Scientists from all around the world have been studying the correlation between bioenergy innovation and public conservation, taking into account a variety of methods, including best management practices (BMPs).

Raising unpalatable seed oils, such as nyamplung (Calophyllum inophyllum L.), in poor soils to produce bioenergy has recently sparked concern due to its several benefits, which could mitigate an exchange amongst foodstuff and fuel supply as certain palatable crops could expand in poor soils that does not sustain agricultural productions. When these crops are planted on polluted and underutilized lands with little benefit for carbon storage and protecting natural plants and ecosystems, they can help to reduce global warming. In addition, using these bioenergy species to restore polluted fields may offer a host of environmental resources, such as carbon storage, soil depletion control, and ecosystem enhancement[1].

According to the Australian Renewable Power Agency, bio based energy is a usage of inexhaustible energy that results from biomasses and utilized to produce current, heat, or petroleum products for transportation. It comes in a variety of types, including farming, forestry, industrial, and other wastes (Figure 1).

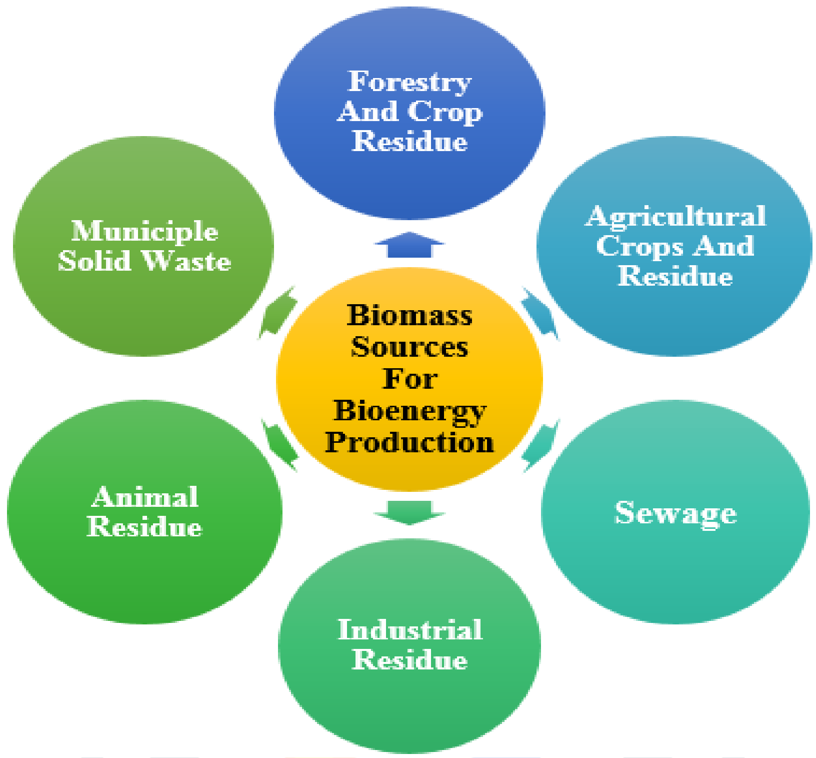

Figure 1: Sources of Biomass for Bioenergy Production[2].

Crop plants, plants and animals residues, algae, wood, and organic residences waste are only a few examples of biomass sources. The type and volume of bioenergy that can be generated, as well as the technologies that can be used to generate it, are determined by the type of biomass. Liquid biofuels including ethanol and biodiesel can be made from any farm product, such as corn and canola. Anaerobic digestion is used to make biogas from damp wastes like manure, which can then be burned for energy and heat or converted into a transportation fuel. Rising, cutting, and scorching wood for heat production are examples of bioenergy processing processes that are relatively straightforward. Others, such as algae processing for transportation fuels, are more complicated. To transform biomass into bioenergy for heating, power, or transporting fuels, a number of transformation paths may be used. Thermochemical, biochemical, and mechanical transfer processes are often used to convert biomass, either separately or in amalgamation. Biomasses may be transformed to electrical vitality in a variety of ways, ranging from modest hardwood burning furnaces to blast furnaces and bio digesters that provide vapor or gases for progression heat or to power machinery and turbine[2].

Residues from forestry, irrigation, numerous carbon-based waste streams, and committed biomass creation from pasture land, wood plantations, and sugar canes are among the current bioenergy options(Figure 2). Land and agricultural wastes, as well as industrial waste in cogeneration plants, are currently the most used biomass feedstocks for power and heat generation. In the long run, lignocellulosic crops will provide bio - energy products for second generation biofuel, which are much more workable, offer more terrestrial utilization prospects, and decrease crop production costs[3].

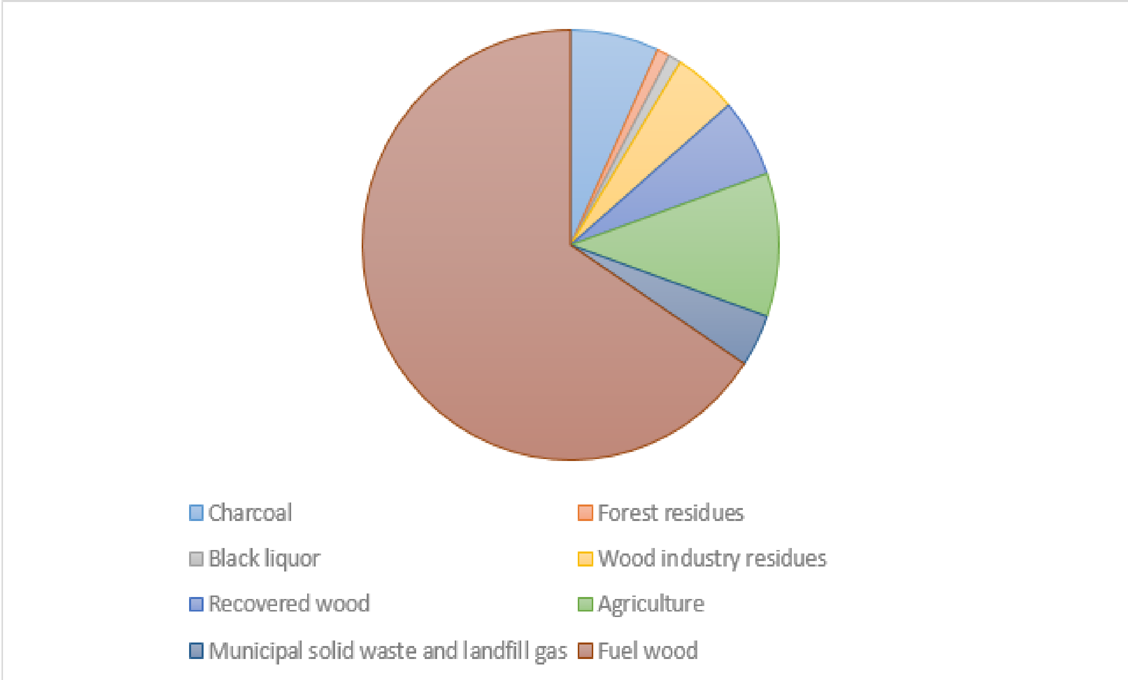

Figure 2: Schematic Representation of Shares of Biomass Sources in The World[3]**.**

Through sustaining and developing cost-effective bioprocesses for bioenergy, biogas and methane energy (bioethanol and bio hydrogen) production can be a good option for residents of rural communities in any country in the region.

1. *Environmental Effects of Bioenergy Resources:*

Reasonable bacterial strains have been fabricated using engineering skills to increase the intensity of biochemical responses for the supreme processing of biofuels with the best energy transference. Any kind of lignocellulosic biomass resource can be converted into a variety of biofuels using an easy and cost-effective action system that can be accomplished by the incorporation of a creative method. Agrarian lignocellulosic and byproducts have now been identified as a potential fermentation process substrate for bioethanol biosynthesis, resulting in lower operating cost and carbon emissions. Fermentation of crop residues and rapidly growing marine plants may be a successful material for biofuel production since they are readily available and do not require farmland. Various types of appropriate microbes have been discovered for the processing of various types of biofuels from different kinds of starting materials, involving several methods for biofuels study ranging from small laboratory centres to commercial scale.

Because of their enormous ability to substitute fossil fuels in electricity generation, biomass power sources provide considerable opportunities for reducing greenhouse gas emissions. Since short-rotation grains or plantations built on unused farmland absorb carbon in the soil, biomass lowers pollution and improves carbon sequestration. Bioenergy usually has an irreversible mitigating effect by reducing carbon dioxide emissions at the origin, but if biomass fuels are produced in an inefficient way, it may emit more coal every unit of energy than carbon fuels. By means of thermochemical conversion technology, biomass plays a significant role in reducing dependence on fossil fuels. Furthermore, expanded use of biomass-based fuels would aid in environmental protection, creation of new employment opportunities, economic growth, and health changes in rural areas. The advancement of effective biomass handling technologies, improved agroforestry systems, and the development of small and massive biomass-based power stations will all contribute to rural development and long-term biomass use. Biomass energy has the potential to help in modernizing the agricultural economy. Biomass energy decreases reliance on international energy supplies and improves national energy efficiency because it uses locally generated fuels. As seen in Figure 3, integrating biomass-fueled gasifiers into coal-fired power plants would benefit in terms of increased versatility in response to variations in biomass supply and lower capital costs.

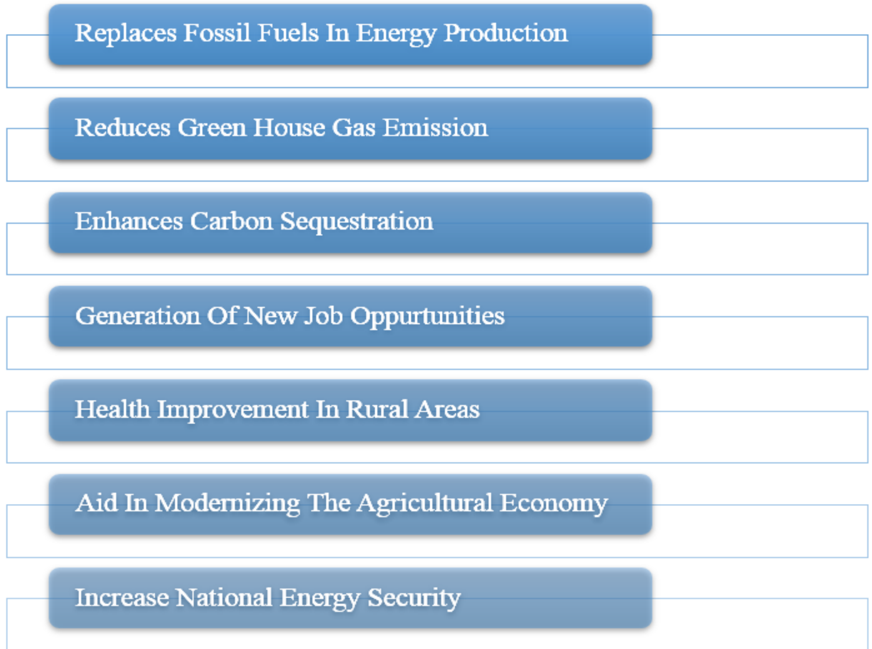

Figure 3: Different Significant Offers of Biomass Energy Systems.

2. *Production of Bioenergy:*

Bioenergy have varieties of ways to be generated. The right pathway and technologies to use are determined by the biogas content and the type of biofuel needs to be generated. Rising, cutting, and combustion byproducts for heat production are examples of relatively simple processes. Such dynamic processes, such as the cultivation of algae for transportation fuels, necessitate a carefully regulated growing ecosystem involving specific microalgae organisms. To transform biomass into biofuel in the form of fire, power, or vehicle fuel, a number of alteration trails could be used. Thermal, biochemical, and mechanical transfer mechanisms for biomass may be used individually or in amalgamation. Biomasses can be transformed to electricity using a number of methodologies, ranging from modest hardwood warmers to furnaces and bio incinerators, which produce gas for use as natural gas or to fuel engines and machines. Biorefineries, including standard oil refineries, are facilities that turn wood into a variety of fuels and other bio-products. Fuel batteries can convert biomass-derived hydrogen into electrical power for use in stationary or handheld applications. There are a variety of feedstock's available, as well as processes and technologies for harvesting forms of energy and converting it into stationary bioenergy for heat and/or energy. Traditional combustion, gasification, pyrolysis, and anaerobic breakdown are amongst the most extensively used approaches (Figure 4).

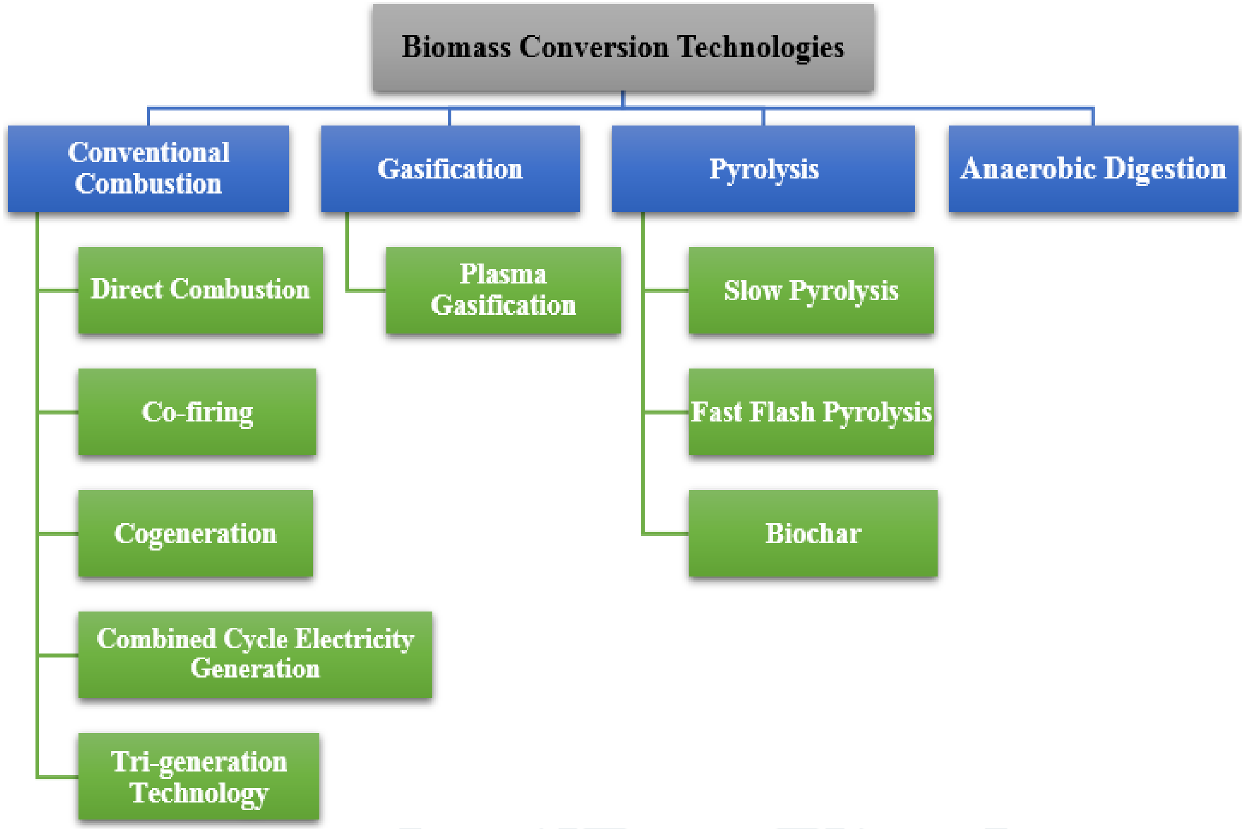

Figure 4: Biomass Transformation Technologies for Static Electricity and Heat Production[4]**.**

2.1.Undeviating Combustion:

It is the greatest ostentatious and widely utilized bio - energy technologies for converting biomasses to energy that can be used for space temperature controlling, heating water, industrial activities, or power harvesting using a condensed water generator or turbine. The voltage level of combustion is normally 20-35 percent. Set bed combustion and fluidized bed ignition are the two most popular burning techniques.

2.2.Co-Firing:

Biomass fuels, like wood shavings, biomass flakes, or biogas, are mixed with a fuel blend, such as coal or LPG, and burned together. To reduce the emission of greenhouse gas co-firing can be the effective and the cost effective way.

2.3.Co-Generation:

Combined Heat and Power (CHP) has better energy translation abilities since power generation absorbs excess heat from electrical energy output and can be utilized for space warming or conditioning through captivation coolers. Where there is a constant need for heating or cooling and power is available on site, co-generation is a good option.

2.4.Combined Cycle Electricity Generation:

Explains steam turbine arrangements that absorb deplete gases and use them to elevate water temperature and generate heat that is used to operate a steam turbine.

2.5.Gasification:

It's a thermo-chemical procedure in which biomass feedstock's is excited to about 800-1000°C in a gasifier with a low energy flow. In these situations, petroleum is only partially burnt and is instead transformed to 'synthetic gas,' a combination of methane, hydrogen, CO, Co2, and nitrogen. Gasification produces only a small volume of charcoal.

2.6.Plasma Gasification:

Technology that integrates electricity with an arc digester to provide a high temperature that decomposes waste and synthetic waste into syngas, which is then used to generate electricity.

2.7.Pyrolysis:

Pyrolysis is analogous to gasification in that it entails the heat oxidation of biomass temperature elevation without or with very little air or oxygen.

2.8.Slow pyrolysis:

After heating biomass to temperature of about 500°C, biofuels, fluid (bio-oil), and synthesis gas are generated in approximately equal amounts.

2.9.Fast 'flash' Pyrolysis:

It is carried out at many extreme temps and may produce up to 80% bio-oil that can be utilized in other static energy and biofuels processing methods. Limited amounts of synthetic gas and bio-solids are generated by reckless pyrolysis.

2.10. Bio-solids:

It's a stable type of charcoal that can be made in a variety of forms, resulting in a wide range of chemical and structural characteristics.

2.11. Anaerobic Digestion:

Certain types of biomass can be digested in the absence of air in biological incinerators, but the process is better for wet feedstock's that don't contain lignin. Effluent, waste, wet agricultural residues, hay, and sludge will be recycled in the absence of oxygen to harvest biogas, which is a combination of typically methane and carbon dioxide. Bio digesters are closed systems that are designed to encourage the regulated biogas production[4].

LITERATURE REVIEW

Giuseppe Pulighe et al. discussed the ongoing and developing matters for sustainable bio-energy fabrication on peripheral domains in the Mediterranean areas. The planting of peripheral plots for bioenergy processing has recently aroused the attention of scientific societies interested in agronomy and agricultural economics. A qualitative practice was accepted to estimate the performance of eight key issues that bioenergy growers, academics, and lawmakers reflect in terms of agronomic, techno-economic, and procedural practices for rising bioenergy feedstock's. In specified case studies, emissions of greenhouse gases, soil category, land reconstruction and bioremediation capability, water utilization and effectiveness, diversity, terrestrial use/cover reforms, agriculturalists' preparation and implementation of fresh agro-systems, and sequence management viability are some of the issues addressed. The results of existing research showed that designated energy collects can be cultivated on peripheral plots with prominent environmental benefits, and then further agricultural research is required, particularly on water utilization capacity and biodiversity preservation.

Yustina Artat et al. investigated factors affecting landowners' inclinations for bioenergy creation. The authors used Firth's logistic regression model to examine 150 property holders with spirit expertise in Buntoi village in Central Kalimantan. Bioenergy production on reclaimed land offers a chance to safe a fresh inexhaustible energy basis while also converting degraded land into sustainable farmland to meet Indonesia's increasingly increasing energy demand. According to the findings, 76 percent of landowners favored well-known species with a ready demand for regeneration on polluted soil, such as sengon and rubber tree. Just 8% of people favor nyamplung as a source of bioenergy. These findings helped to define crucial requirements for a bottom-up method to bio-energy development from Indonesia's ruined soil..

Magdalena Muradin et al. identified hotspots in bioenergy series fabrication. The thesis used two complementary paths, a collected work analysis, and observational experiments on four related biogases plant in Poland to identify the hotspots. The formation of hot - spots based on life cycle assessments reduces environmental loads and is an important step in adopting a bio economy policy. To categorize unit procedures or actions that are extremely detrimental to the atmosphere, the entire bioenergy supply chain was subjected to a life cycle assessment (LCA) and an energy return on investment (EROI) analysis. The findings revealed that biomass delivery processes, especially tractor-driven road transport, have the greatest impact.

Abdul Raheem et al. discussed about the fabrication of bioenergy and biofuel founded on sustainable microalgae's. The author also included a current state-of-the-art analysis of algae biomasses modification procedures into a variety of biofuels goods, such as biodiesels, synthetic gas, biogases, and bioethanols. The heavy dependence on fossil fuels for electricity production, transport, and construction, as well as strict land use policies, are the primary causes of weather change. Moreover, the present shares of inexhaustible biofuels making in general fuel requests are inadequate to fully substitute fossil fuels. Microalgae, on the other side, provide a long-term and complementary biofuel platform with a slew of benefits. Discarded water management and phytoremediation to extract CO2 and fix nitrogen's and phosphorus from industrialized, rural, and civic bases are also considered[5].

Helmut Haberl et al. estimated worldwide bioenergy possibilities in the year 2050, succeeding a "food first" method. Founded on a stable illustration of FAO upcoming agrarian growth estimates in a worldwide biomasses equilibrium models, it proposes 2050 grain, livestock's, agronomy, and bioenergy states. The model has defined eleven regions, ten grain agglomerates, two livestock agglomerates, and ten food aggregates. It includes detailed field accounts, universal net primary production (NPP) and human's expectations, along with social and economic biomasses movement equilibriums for the year 2000, which are updated using a set of situation norms to calculate biomasses prospective for 2050. Based on biomass balance and worldwide land utilization data, the author estimated the possibility to develop bioenergy's yields and the remainder capacities from croplands, and concluded that food needs for an expanding world population, especially feed for livestock's, powerfully influences bioenergy's potential, and that combined methods are required to increase food and bioenergy stock[6].

DISCUSSION

As per the existing study, vast quantity and renewability of bioenergy makes advantage over conventional fossil fuels, and hence plays a critical role in ensuring global energy stability. Different forms of bioenergy can be produced from various methodologies (Conventional combustion, Gasification, Pyrolysis, Anaerobic digestion) and these methodologies depends upon the type of bioenergy needs to be generated. This substitute of conventional energy is useful because it provides multiple advantages over conventional fossil fuels like it reduces the greenhouse gas emission, enhances carbon sequestration, generates new job opportunities, improvises health condition in rural areas, increase national energy security. So in the present times the bioenergy holds a significant position because it helped in converting the waste streams into new form of energy which persist commercial importance globally, also reduces energy cost and possibly increase new returns streams. Use of biomass helps in building flexibility in agrarian, wooden and food-processing trades.

CONCLUSION

The building of sustainable environment requires the reduction of the resiliency on conventional fuels and lowers the amount of pollution generated. Bioenergy production is an area in which these two goals can be addressed simultaneously. The current study has discussed about the production of the bioenergy by means of biomass conversion technologies, advantages of bioenergy over conventional one, effects of bioenergy resources, shares of biomass sources in the world, sources of biomass energy production. It is observed that traditional combustion, gasification, pyrolysis, and anaerobic breakdown are amongst the most extensively used approaches. From the study it is observed that fermentation pf crop residues and rapidly growing marine plants may be a successful candidate for the biofuel production as they are readily available and do not require farmland and also these methods are cost effective. Bioenergy production occupies a unique and important role because it is ecologically responsible. Future studies should learn from the top nations in this area, obtain more expertise, and draw optimal business intelligence for supervising the growth of bio-energy in emerging nations.

REFERENCES

[1] Y. Wu *et al.*, "Bioenergy production and environmental impacts," *Geoscience Letters*. 2018, doi: 10.1186/s40562-018-0114-y.

[2] "what is bioenergy," *enviro heat autralia*, 2014. .

[3] V. G. Gupta, M. G. Tuohy, C. P. Kubicek, J. Saddler, and F. Xu, *Bioenergy research: Advances and applications*. 2014.

[4] "Bioenergy: sustainable renewable energy," *Victoria's Traditional Owners and Aboriginal communities*, 2017. .

[5] A. Raheem, P. Prinsen, A. K. Vuppaladadiyam, M. Zhao, and R. Luque, "A review on sustainable microalgae based biofuel and bioenergy production: Recent developments," *J. Clean. Prod.*, 2018, doi: 10.1016/j.jclepro.2018.01.125.

[6] H. Haberl *et al.*, "Global bioenergy potentials from agricultural land in 2050: Sensitivity to climate change, diets and yields," *Biomass and Bioenergy*, 2011, doi: 10.1016/j.biombioe.2011.04.035.