Energy Diversity through Renewable Energy Source (RES) – A Case Study of Biomass

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Abstract

Biomass has played a dominant role in the energy need of the continued world growing population. Its conversion from biomass to biogas in its production, have been a very promising means of producing an energy carrier from renewable resources and of achieving environmental benefits in multiples. As the population continue to grow coupled with the devastating effects of climate, efforts are being made by all and sundry at all level such as; scientists, researchers and policy makers in finding a lasting solution to the current predicament of climate change. As it is known fact now that the present demand for oil for biofuel production greatly exceeds the supply, this as a result has led to alternative sources of biomass being required. In achieving this, various biomasses have been considered for energy production, such as microalgae, yeast, grass and other renewable biomass substrates. Apart from the contribution biomass have made to sustainable development, it will also provide energy security for the growing population which currently stands at 7 billion. The resources availability and easily conversion process into the secondary energy carriers without much capital intensive makes this study a high profile research. Through this, it also aid in the reduction of greenhouse gas emissions by offsetting fossil fuel greenhouse gas (GHG) emissions when produced and used in a sustainable way
Biomass as a renewable energy source is being discussed therein. Though there are large variations in biogas yields and composition of the gas among the raw materials considered. This is due to the variation in their compositions, digestion technologies and their digestion conditions that are applicable. Energy diversity through (RES) is herein therefore considered using biomass as a case study with particular emphasis on biogas/biofuel production.

1. Introduction

Recent studies and further analysis on to the fossil fuel uses has shown that fossil fuel dwindling reserves and rising greenhouse gases requires a growing need in identifying alternative sustainable energy sources [1- 3]. As the declining oil production results, after peak production is assumed to cause a global energy gap to develop, and this will be needed to be bridged by unconventional and renewable energy sources having been projected by the energy expert that the global oil supplies will only meet demand until global oil production has peaked sometime up to 2020 [1]. Energy from renewable sources is considered to further promote sustainable development. And investigations into alternatives energy strategies have therefore recently become important particularly for future world stability [4] and amongst this alternative renewable energy sources, biomass seem to have taken the lead as it compete most favourably in all countries of the world. Biomass for energy generation has attracted much attention at global and national scales [5-7]. This makes renewable biofuel feedstock never to compete with food crops or cause any carbon debt and negative environmental impacts [8], this is due to the easily availability from waste or as crop. Most appropriately, these resources comes in form of agricultural crops and their wastes as well as others, such as, municipal solid waste, animal wastes and waste from food processing. They are considered as potential renewable and sustainable energy source with the highest potential to contribute to the energy needs of both the industrialized and developing countries worldwide [9]. Li et al. [10] pushed further in their investigation of variety of biomasses from different sources including that from forestry, agricultural and aquatic sources as feedstock for production showed its ability of being able to be used in the production of different biofuels including biodiesel, bio-ethanol, bio-hydrogen, bio-oil and biogas. Using aquatic feedstock compete favourably well with agricultural feedstock in the same way in terms of bioenergy/biofuel production. Biofuel made from waste biomass can offer advantages in reducing greenhouse

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gas (GHG) emissions and still on the consideration of GHG emission, Faaji et al., [11] viewed the process of landfill gas utilisation as that with significant benefits in that useful energy carriers produced from gas contribute to the build-up of methane GHG in the atmosphere, this has stronger impact compared to the CO2 emitted from the power plant, and the process is presently attracting GHG mitigation within the EU, North America and of increasingly importance across other countries. This makes landfill another considerable chioce of biomass conversion technolgy as the methane production rich landfill sites from landfill sites makes a huge contribution to atmosphere emissions of methane.

2. Concerns of Biofuel Production

Based on the current energy trends across the globe, biofuels are thought by the governments and environmentalists as the most promising renewable alternatives needed in achieving the goals of reducing the overall dependence on fossil fuels as well lowering CO2 emissions as this to a greater deal will support local agriculture and develop economies [12, 13]. Late 2000s have seen biofuels being characterized by environmental and developmental groups as 'a big green con' and crime against humanity' [14, 15]. The resourcefulness of the product of biomass and its residues has been a common factor to the developmental needs of its use as a feedstock for energy improvement. Though this has not suffices that there are not issues that militates against its full potential, but this varies from one country to another. The controversy on energy development from biomass has mainly been associated with agriculture and currently, as the world population has hit the 7 billion mark, this means that the land space for crop production needs to be increased to enable there to be food sufficiency for all rather than drifting that away for energy crop development. As some proponents of biofuels argue that biofuels are unfairly demonised while the use of land for food and other non-food goods escapes scrutiny [16] and it is therefore important to consider the wider industrial agricultural system of which biofuels are a part. This therefore becomes questionable as to controversy surrounding biofuel. In furtherance to this, [17] highlighted the legitimacy problems of biofuels not being able to address by sustainability indicators or new technologies alone as they have risen from the spatial ordering of biofuel production.

On the contrary, despite its advantages over petroleum-based fuels, biofuel production and use may result in significant negative consequences for biodiversity through pollution, soil degradation, and climate impacts from their cultivation, transportation, refining, and burning [18] and since there are no legislative or rather few of them in place, that provides follow up standards and principles in the protection of the environment. In achieving environmental goals that will provide protection to biodiversity, policies will then need to be outlined to deal with such issues of environmental standards for biofuel production [19].

2.1. Main Challenges

The greatest challenge of biomass use in energy production and development is its sustenance which has competes favourably well, as compared to other renewable energy sources (RES). In fact, it is topmost amongst the (RES). This competitiveness of biomass has therefore make biofuels a serious option to compete with oil in the transport system compared to other technologies such as hydrogen, because biofuel technologies are already well developed and available in many countries. Bioethanol and biodiesel when mixed with the petroleum products (gasoline and diesel) they serve as substitute which can be burned in traditional combustion engines with blends of up to 10 per cent biofuels without the requirement for modifications of engine [20]. And as the future starts now, its development and uses is becoming more pre-eminent. This having previously been considered as the favourable choice of fuel consumption due to their renewability, biodegradability and generating acceptable quality exhaust gases [21] and Delfort et al. [22] talked about it as one of many energy alternatives within such as hydrogen, natural gas and synthesis (syngas). These four are likely to emerge as the strategically important fuel sources in the foreseeable future. [23] forecasted biofuels therefore as emerging as one of the most strategically important sustainable fuel sources and are considered an important way of progress for limiting greenhouse gas emissions, improving air quality and finding new energetic resources. Another challenge pose to it, is the use of arable land for sourcing its crops and these therefore have limited those land from growing crops for human consumption but on the other hand, the waste from these foods have also now taken the position of the land being saved for human crops consumption. As part of the future challenges and sustainability concern on the use of biomass, [24] pushed it further that biologically derived energy carriers do offer an alternative to traditional petroleum-derived fuels but may be uneconomical, energy insufficient and environmentally deleterious while Srirangan et al. [25] eventfully summed it up that challenges could results in the form of; viability economically and policy implementations, efficient scalability (that is; land availability and natural resources valuation), social concerns and socioeconomic impacts, as well as environmental aspects. These challenges need to be overcome for commercial-scale production of biofuels to be realized.

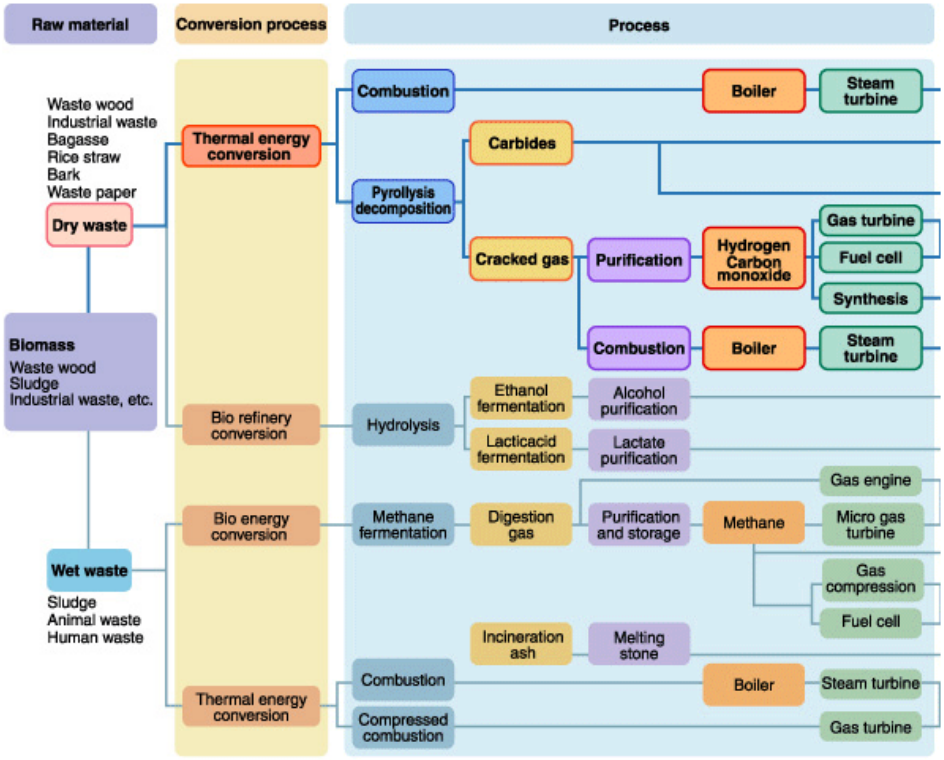

Figure 1: Biomass Conversion Technology [26]

2.2. Biomass – An energy source of a wider scope

There has been renewed interest all over the world in terms of biomass being an energy source with a difference and situation has really called for this. As analyzed by [27], considering the technological developments as regards its conversion and as known, it available on a renewable basis, either through natural processes or made available as a by-product of human activities. Biomass use for energy production will not only serve as solution to eventful correction of climate and environmental disaster but, it will also provide an avenue for creating jobs. As purported, Thornley et al. [28] have it that investment in renewable energy sources are linked to the creation of new jobs and employment opportunities in all stages of the biomass energy supply chain. Through its social issue consideration, its cohesion and stability, regional development, decrease in rural migration, increase in net labour income, and self-sufficiency in energy production were also observed as social benefits of the bioenergy [29] Retrospectively, when compared against other renewable energy sources, there are reasons for biofuel to be considered as the energy need of the future. Biofuels have been seen to be part of the energy discussions for decades, apart from prices which has shown to be on the rise with crude oil, governments on their own part have viewed it beyond this path by considering a greater interest in the product even when the subsidies needed are commercially viable. These accordingly [20] considers as being energy security, concerns about trade balances, desire in decreasing GHG emissions as well as potential benefits to rural livelihoods.
As the potential of biomass energy derived from forest and agricultural residues worldwide is estimated at about 30 EJ/year, when compared to world-wide energy demand annually, results over 400 EJ [27]. This are seen as part of a strategy in the diversification of energy so as to reduce supply risks even though poorer importing nations of oil spend larger part of their foreign currency reserve to buy oil, producing biofuels as alternative to imports of oil tends to reduce or eliminate the oil bill. In meeting the production cost of biofuel, some other efficient techniques have been developed such as using yeast [30] and enzymes in the production of lignocellulosic bioethanol whose production cost are assumed to drop in the nearest future.

2.3. Biomass Conversion Technologies

The inherent properties of biomass source, thus determines both the choice of conversion process and any subsequent processing difficulties that may arise [27] Also the choice of biomass source is influenced by the form in which the energy is required. The introduction of flexibility into biomass use as an energy source is considered through the interplay between these two aspects. In using biomass as energy production substrates, various technologies are involved in the conversion process. Hence it is the only form of energy which can be

utilized in reducing the energy production impact and use on the global environment. This in conformance with the previous study, [31] highlighted that there are limitations on the use and biomass application and this must compete not only with fossil fuels but renewable energy sources like wind and solar. As biomass involve the conversion of one product (substrate) to another product for energy purposes, the key combustion issues today are concern with efficiency and environmental performance which is similar to fossil fuels while on the contrary, it stand out from fossil fuel in that the emissions of carbon dioxide derived from biomass combustion to the atmosphere are essentially in an equilibrium such that there are uptake of carbon dioxide from photosynthesis by the biosphere [32]. Since biomass is used in meeting variety of energy needs including generating electricity, heating homes, fueling vehicles and for providing process heat for industrial facilities, the conversion technologies required for utilizing this biomass therefore can be separated into four basic categories. These are direct combustion processes, thermochemical processes, biochemical processes and agrochemical processes [33] and further stressed that thermochemical conversion means is subdivided into gasification, pyrolysis, supercritical fluid extraction and direct liquefaction. The various products and conversion technologies applied, is dependent on the characteristics of the region and the type of biomass material considered [26] (as shown in figure 1). For example, gasification is a known form of pyrolysis performed under high pressure so as to optimize gas production and is the latest form in the generation of biomass energy conversion processes for improving efficiency and in reducing the investment costs of biomass electricity generation through using gas turbine technology. Devi et al. [34] also reported that high conversion efficiency can make gasification of lignocellulosic biomass attractive in receiving considerable attention from thermochemical conversion technologies; and from this, it can as well help with bioremediation plans through converting biomass wastes into clean fuel gases and biofuels [35].

3. Present and Future Demand of Energy from Biomass

Current and future energy needs will depend heavily on the use of renewable energy source for meeting the sustenance of the world growing population and of great priority amongst the renewable energy source, will continue to be biomass of any form. The current development of this energy will determine what the future need will look like. Though there will be variance from one country to another but this will cut across the globe in the demand for this energy use.

Present studies suggests biomass energy can play an important role in reducing greenhouse gas emissions since when produced and utilized in a sustainable way, the use of biomass for energy offsets fossil fuel greenhouse emissions [36] Also, since energy plantations can create new employment opportunities in rural areas in developed countries, this therefore also contributes to social aspect of sustainability. While [37] highlight that at present biomass is mainly used as traditional fuel. The production and conversion costs of biomass energy are expected to be reduced as a result of the modern biomass energy gaining share in the future energy market, this will tends to be realized due to the resources being widely available and this therefore will result in an unexpected increase in the demand for CO2 neutral fuels. The extent biomass will penetrate future energy markets depends on such factor as the availability of the resources, the costs of primary biomass, the development of conversion technologies, the cost of converted biomass energy and implementation, social and/or institutional factors and also of importance are the demand for energy carriers and the costs of other energy sources which are thought to compete favourably with biomass [38].

4. Conclusion

Energy, being a crucial feature of human life, has evolved to match with contemporary human development and requirements [39]. Changing from fossil fuel and nuclear energy to renewable energy source as energy provision means will be great transition, which is going to be accomplished over time even as the population grows. Biomass use as envisaged will come to provide the bulk of the energy as compared to other energy source. This is because biomass availability, developed conversion technologies and most importantly, the cost of converting biomass energy and implementation which is going to be easily affordable in the nearest future will make biomass take the lead of energy producing resources. Biomass has much to offer in the drive for energy development and as such it will be considered a way forward through its development and application to solving the world's problem.

It would be impossible to unite the entire world to tackle the issue of climate change/global warming because only a fraction of the entire world accepts the threat that it poses [40]. Though the world will need to eventually accept this fact as a change to energy use but it will take a while to have this completely implemented.

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