

Sustainable Biofuel Energy Production in the Niger Delta

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Abstract

The Federal Government of Nigeria's planned removal of petroleum subsidy will cause a lot of hardship to the people of Niger Delta region and the country and there is need to research on sustainable environmental energy production as an alternative source to fossil fuel from food wastage. This can address the negative impact on our environment as it has the potential of reducing gas flaring and throwing of wasted food (as sources of pollution) as well as mitigating high prices of petroleum products. The study shows that all the supermarkets and fast food centres wasted foods being thrown away which can be converted to sustainable energy to enhance positive impact for human sustenance. This shall lead to reduction of electricity bills, prices of petroleum products, maintenance of good sanitation, control of environmental pollution, etc. Bio-fertilizer will also be produced during the operation. Bio-fertilizer is the bye product of biogas, the application of which shall enhance rapid crop production and serve as animals feed when dried into feed pellets. This approach shall create employment opportunities for people and improve their standard of living and reduce youth restiveness.

Keywords: Food wastage, fossil fuel, sustainable energy, biofuel, bio-fertilizer, environment, Niger delta.

1.0 Introduction

There is increasing incidence among residents of Yenagoa, Bayelsa State, of food wastage in domestic homes and supermarkets. The wasted foods in our homes and supermarkets could be used to generate bioenergy. There are a lot of refuse dump sites in the state causing negative health implication. Burning of this refuse in Yenagoa, the state capital also causes environmental pollution that affects the respiration of people. Refuse dumps could be used as a source of raw materials to feed the digester for biogas production, instead of wasting the useful raw materials. When refuse is properly managed, it will create cleanliness in our environment. Biogas is a renewable energy obtained through fermentation of food wastage and other organic materials. However, there are four classes of bacteria that are involved for this process Hydrolytic, Acidogenic, Acetagenic, and Methanogenic.

Over the last quarter-century, the twin concepts of sustainability and renewable energy have emerged as defining imperative of humanity that is situated at the nexus of science [Kacan., 2015], technology [Effendi, and; Courvisanos, 2012], culture, economics [Leijon, *et al.*, 2010], policy [Sun; Nie, .2015] and the environment [Zeb, *et al.*, 2014]. These twin

concepts are both framed as a means to mitigate the negative impacts of natural resource depletion [Davidsson, *et al.*, 2014], energy consumption [Al-Karaghoul and Kazmerski., 2013], water consumption [Oseni, 2012] and climate changing greenhouse gas (GHG) emissions [Arent, 2014] associated anthropogenic activities. Due to the energy crisis, environmental, economic, political, market and social issues, researchers have been attracted to develop sources of sustainable and renewable energies to secure energy consumption, protect the environment, and to promote regional development.

The implementation of successful renewable energy that is sustainable in time, especially at the community level, has been related to more open and participatory processes where views, expectations and framings from different stakeholders become integrated to ascertain the levels sustainable environmental energy production. In the issues of sustainability and renewable energy, various methodologies can be applied throughout the literature. Some of them are scenario planning, which seek to address and put limits on uncertainty, improving the response capacity to multiple features [Li, *et al.*, 2012]. Kowalski, *et al.*, [2009], using a combination of scenario planning and Multi Criteria Assessment (MCA) to reduce uncertainty in energy development, where a diversity of stakeholders is included in the decision-making process, considering a broad spectrum of social, economic, environmental and technical criteria.

Initially, the feedstock to the digesters is received in a primary pit or liquid storage tank, when loaded into the digester by different approaches depending upon the constitution of waste materials. In the digestion tanks, series of biological processes were harnessed in order to produce biogas. Hydrolysis is the process where the organic material is solubilized into the digestion liquid. It then undergoes the intermediate steps of acidogenesis and acetogenesis which create the precursor molecules for methanogenesis. Methanogens feed off these precursors and produced methane as a cellular waste product. Biogas containing this biologically-derived methane is contained and captured in a gas storage tank which is located separately to the main digester, or alternatively can form its roof. The gas storage tank acts as a buffer in order to balance fluctuations in the production of gas in the digesters. The biogas is then converted into renewable power in the form of electricity and heat via cogeneration/ CHP with gas engines.

The biogas may contain high levels of water (humidity) and sulphur, depending upon the feedstock of the digester. Bioenergy has no known negative side effect on the climate when compared with fossil fuels. This practice is usually carried out in the western world, in countries like Germany, UK, Sweden, USA and Asian countries such as China and India. In Nigeria no State has executed this project, but some scholars in Nigerian Universities are experimenting on it. Currently, in Niger Delta University, Wilberforce Island, Bayelsa State in the Department of Crop and Soil Science, this researcher [Dr. Azawei Alamene] is

introducing the students to the practical processes involved in the production of Biogas/Bio-fertilizer.

1.1.Objectives of the Study: The objectives of the study include

- i. Exposition of the hidden potential of food wastage;
- ii. To demonstrate the difference between Biogas and Bio-fertilizer; and
- iii. Compare the significant of cost effective approach between Biofuel and Fossil fuel.

2.0 Literature Review

2.1 Converting Food Wastage to Biogas at USA: Sustainable Gastor Dining

The availability of renewable energy sources is growing rapidly in many developed and developing countries (Peterson, *et al.*, 2003). Growth in two common renewable energy sources - wind and solar photovoltaics (PV) [Kowalski, *et al.*, 2009] has been significant in recent years. Moreover, these high growth rates are expected to continue for renewable technologies for several years to come in the Niger Delta Area of Nigeria, if one believes the flurry of optimistic estimates by industrial groups and energy analysts. The basic premise of all renewable energy development policies is that they create demanded for climate-friendly technologies that otherwise would not exist at all or not at desired levels under the current market conditions [Gyamfi, *et al.*, 2015]. An integrated renewable energy system includes renewable energy generation [Talaie, *et al.*, 2014], energy storage [Zhang, *et al.*, 2013] and certain transmission components [Gude, 2015]. A renewable energy system could have a life-cycle efficiency of less than 100% and still be superior to a fossil based system in terms of energy resources sustainability strategies. The use of modern renewable energy technologies, including wind turbines [Kolhe, *et al.*, 2003], solar panels [Liu, *et al.*, 2013], biomass pellets [Chen, *et al.*, 2009], small hydro [Sharma *et al.*, 2008] and others are increasing rapidly. Renewable energy might solve some of the existing problems. The research and development of a renewable energy plan is imperative to fuel the transportation fleets of the future and to promote the new energy economy. As the number of new renewable energy policies at the state level has increased, so have policy analyses and evaluations focusing on individual programs [Sharma *et al.*, 2008]. In addition, due to diversification opportunities in bioenergy, biomass production has the potential to enhance the feasibility of agricultural business [Yin, and Powers, 2010]. For example, in the Czech Republic, Havlíčková and Suchý [2010] made an analysis on the future prospects of energy crop propagation for bioenergy production. Using data envelopment analysis, Ďatkov and Effenberger [2010] investigated the efficiency of biogas plants, nevertheless problems regarding energy planning are very complex with multiple criteria and multiple decision makers (DMs).

It is alarming that human activities in fossil fuel production are causing global climate change which has affected negatively on the Ozone layer. One of the major causes of this change is the atmospheric accumulation of carbon dioxide (CO₂) released by the burning of fossil fuels. As human development continues to increase geometrically with the attendant burning of fossil fuels, alternative sources of energy should be explored as a replacement for fossil fuels. The need for alternative sources of energy has become inevitable in order for society to maintain a sustainable quality of human life. Rather than a single energy source taking the place of fossil fuels, the sustainable energy future need to rely on an integrated suite of renewable energy technologies such as biofuel, biogas and bio-fertilizers. One sustainable energy technology with great promise is biogas production from organic waste.

Biofuels in general have come under serious scrutiny in recent years. Energy could be obtained from some biofuels, such as corn ethanol. Currently biofuels utilize feedstock that requires significant input of land, water, and fertilizer resources. Biofuels have become the subject of a “food versus fuel” debate. By growing vital energy crops such as Cassava, Sugar cane, Sweet Potatoes and Soya bean, etc, specifically for fuel production, there is direct competition between food and fuel demands. This inevitably raises the price of food and, in a global economy, it may be devastating to developing nations like Nigeria. This scenario does not hold true for biogas derived from waste material. Rather than using land and crops to grow fuel, biogas energy is captured from organic material that is otherwise a burden to the people living in under developed societies. Biogas technology is essentially the bio-digestion of any organic material under anaerobic conditions without oxygen (O₂) as a key factor.

This process of biogas generation is biologically driven by a mixed culture of bacteria in the absence of oxygen. Anaerobic digestion produces gaseous product called biogas, which is composed mostly of methane and some carbon dioxide (CO₂). The biogas fuel can be collected and combusted for cooking, heating, or to produce electricity.

Biogas is considered as carbon neutral because all of the carbon released during combustion has been recently taken from the atmosphere through photosynthesis, unlike fossil fuels that have stored carbon for millions of years. Thus biogas is a sustainable alternative to natural gas. Since anaerobic digestion only releases carbon to the gas phase, the other nutrients (nitrogen, phosphorus, and micronutrients) remain in the effluent, which makes it a high quality organic fertilizer and soil amendment for rapid crop development or growth.

Beyond making a carbon-neutral, renewable alternative to natural gas, biogas production offers a sustainable method for disposing of organic wastes. Discarded food is a major component of municipal waste. In fact, Americans throw away about 25 percent of the food they prepare, equal to 96 billion pounds annually, which comprises 12 percent of the municipal waste stream [Mila, 2014].

What a waste! The true cost of wasted food also includes the water, energy, nutrients, and labor that are used to grow, harvest, transport, process, and prepare the food. The vast majority of this food waste is disposed of in landfills, with less than three percent recovered. Landfills or dumping ground of waste requires transportation energy, human labour, and land. The production system release methane, a potent greenhouse gas, into the atmosphere and lock up nutrients that could otherwise be used to grow crops in order to meet the demand of food for the teeming population geometrically of the under developed society. Food waste can also be disposed of in an aerobic sewage treatment facility, but this process requires a large expenditure of energy for wastewater aeration. Two other methods of food waste disposal are composting or combustion. However, with composting, the nutrients are retained but the energy is lost; with combustion, energy is captured but the nutrients are lost. In anaerobic digestion, both the energy and the nutrients can be captured and recycled, providing a closed-loop system that minimizes negative environmental impact and maximizes resource recovery. Food waste makes an ideal feedstock for biogas production; it is readily biodegradable and is available in large amounts from point sources (e.g., restaurants, grocery stores, food processing plants). An initial study investigating campus food waste as a possible source of renewable energy was conducted by interns from the UF-IFAS Bioenergy School in the summer of 2006.

The current research entailed a more comprehensive study to analyze the food waste stream from Broward Dining Hall (BDH), a campus dining hall at the University of Florida in Gainesville, and to assess the potential for biogas production from the food waste.

2.2 Sainsbury's stores at UK go green by turning food waste into energy

Large stores in the United Kingdom have begun to exploit food waste for bioenergy generation for their electricity needs. This is the case with **Sainsbury's Stores**. In partnership with the UK's leading food waste recycler, ReFood, a number of Sainsbury's supermarkets across the country are now powered by green gas. Produced entirely from wasted food, the energy generated in a year is 10% of Sainsbury's entire national gas consumption. ReFood have supplied the retailer with a cumulative amount of 50 million KWh of biomethane gas to date (Figure 1).



Fig. 1: A Bioenergy plant in the UK

As part of the agreement, food waste is collected from Sainsbury's' two depots in Sherburn-in-Elmet and Haydock, before being converted into gas, heat and fertilizer at ReFood's state-of-the-art anaerobic digestion (AD) processing facilities. The green gas is then exported to the national gas grid by ReFood and, through a third party, is imported by Sainsbury's stores nationwide. The green gas is used to generate carbon-neutral electricity for power and heating. The agreement is one of the largest of its kind in the UK, seeing ReFood supplying both green gas and supporting certification.

As a result of the partnership, ten stores have already significantly increased their use of renewable energy, while lowering utility bills. The partnership also helps to deliver Sainsbury's commitment to send zero operational waste to landfill, by finding a use for inedible waste products. All surplus edible food is donated to local charity partners. Commenting on the project, Paul Densham, utilities buyer at Sainsbury's, said: "Increasing the sustainability of our UK stores is a key corporate priority and we're making great progress in our drive to reduce food waste across the business. Working in partnership with ReFood allows us to effectively recycle our food waste while creating green gas (Figure 1).

Philip Simpson, commercial director at ReFood, added: "Using their national network of processing plants, have provided a truly sustainable solution for stores across the UK. Generating a significant volume of green gas in result, the partnership has enabled Sainsbury's to use less fossil fuels, minimize utility bills and eliminate unnecessary food waste disposal. What's more, with a highly effective sustainable biofertiliser also generated via the AD process, stores nationwide are working together to effectively close the food supply chain – from farm to fork and back again."

Anaerobic digestion is a natural process where organic materials are broken down by naturally occurring micro-organisms. This releases biogas that can be used to generate renewable heat and power, helping to reduce dependence on fossil fuels, while minimizing greenhouse gas emissions. The volume of green gas created by the partnership is enough to have continually powered 5,000 homes for a year.

2.3 UK Supermarket Meets 100% of Its Energy Demands from Food Waste

Mila (2014) also asserts that generating electricity from food waste and leftovers is not a new concept at all but it is a new concept in Nigeria with some other developing countries. But using the electricity generated from expired produce to fully power an entire supermarket is now a great innovation at the 21st century (Figure 2).



Fig. 2 Cannock, U.K. Sainsbury's store

The first ever supermarket to be 100% powered by food waste from its shelves, opened its doors in Cannock, UK. Sainsbury's store, together with a waste recycling company Biffa, accomplished their mission to produce enough energy through anaerobic digestion of leftover food so that the store can safely disconnected from the national power grid (Figure 2).

The energy generation will not take place in-house. All food waste will be transported to Biffa's nearby plant, where it will be converted into biogas and used for energy generation. The produced electricity will then be sent back to the store via a 1.5 kilometer transmission line.

2.4 Food Waste and Electricity Generation in Nigeria

Nigeria wastes 40% of food, while millions of citizens are dying of hunger according to the then Minister of Agriculture, Chief Audu Ogbe in a 2017 broadcast. The United Nations (UN) in 2017 also reported that 75% of foods produced in Nigeria were wasted due to post-harvest

losses. These losses could cause Nigerians starve to death. However, the wasted food can be converted to biofuel (biogas) which will create employment opportunities to jobless people in the society for sustenance and also serve as source of power to big Super Markets and big Fast Food Institutes in the Niger Delta Area of Nigeria, particularly in Bayelsa State and Rivers State to create the awareness of the above mentioned subject matter (Figure 3). The use of biofuel (biogas) will generate electricity to empower business outfits and this will lead to increased profit as well as create employment opportunities for youths in the Niger Delta.

The advantages of this exercise are unlimited. Therefore, it is suggested that the Niger Delta University should enter into cooperative venture with business houses which generate large quantities of food waste to produce biofuels for industrial and domestic use in the Niger Delta. The Super Market and Fast Food establishment visited by this researcher during field survey showed interest in such ventures in supplying the waste food to a possible Institute of Biofuel (Biogas) production in the Faculty of Agriculture (Figure 4). Below are some of the business houses visited:

- i. Market Square Opolo, Yenagoa, Bayelsa State
- ii. Peperone Fast Food Institutes [Opolo and Akenfa], Yenagoa, Bayelsa State
- iii. Spar Supermarket, Port Harcourt, Rivers State
- iv. Well Done Supermarket, Port Harcourt, Rivers State
- v. Peter Obi's Next Supermarket, Port Harcourt, Rivers State, etc.

Wasted Food Dump site



Fig. 3 Waste Dump Site

Processing of Wasted Food with a Crusher



Fig. 4. Processing of Wasted Food with a Crusher

3.0 Conclusion

The awareness of food wastage conversion to bioenergy will enhance power generation, which will solve several issues like electricity bill, natural cooking gas, reduced the cost of Fossil fuel, also maintain good sanitation, control of environmental pollution in our environment, Bio-fertilizer is the bye product of biogas and its application will enhance rapid crop production and also serve as animal feed when dried and finally create employment opportunity to jobless people.

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