Bio-fuels and Bio-ethanol Production: Strategies and Policy Framework for improving Environmental Health in Nigeria

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ABSTRACT

Bio-fuels are becoming an increasingly important alternative source of energy. The use of bio-fuels will reduce the use of fossil fuels, thereby minimizing the emission of green house gasses. Increased use of bio-fuels will enhance the quality of the environment. The use of bio-fuels is 100% environmental friendly, it is suitable and visible source of energy which will reduce the dependency on depleting fossil fuels. Increasing attention is being focused on the production of bio-fuels especially ethanol and bio-diesel as the alternative that will contribute to global reduction in greenhouse gas emission. This study attempts to explain the Status of Bio-fuels in Nigeria and presents the existing polices. It also focus on bio-ethanol production in Nigeria as well as strategies and policy framework for improving environmental health in Nigeria.

Keywords: *Bio-ethanol, bio-fuels, distillation, first generation biofuels, inceptives, policies.*

INTRODUCTION

In Nigeria, the Nigeria National Petroleum Cooperation (NNPC) is pursuing a plan to develop Bio-ethanol in a 10% blend (E10) with Premium motor Spirit. The sugarcane plant has been identified as feedback for Bio-ethanol production. It is projected that if the total land under sugarcane estate is well harnessed, 40% of the current NNPC ethanol production target will be met in Nigeria and that devoting 400,000 hectares of land to sugarcane production in the long run will meet $50 Bio-ethanol demand for the country. Therefore, the National Agricultural Research Institute is devoting resources to provide sufficient healthy and improved sugarcane seedlings using breeding and tissue culture techniques. The possibility of using by-products such as sugarcane molasses, bio-gasses and cellulose materials as feedstock for ethanol production instead of sugars, cassava and grain cereals that are valuable as food for humans. Ethanol fuel is ethanol (CH3-CH2-OH) the same type of alcohol found in alcoholic beverages. It is most often used as a motor fuel, mainly as bio-fuels additive for gasoline. World ethanol production for transport fuels tripled between 2000 and 2007 from 17 billion to more than 52 billion litres Wikipedia

(2012). The share of ethanol production in global gasoline type fuel use increase from 3.7% - 5.4% worldwide and Ethanol fuel production reached 19.5% Wikipedia (2012). Bio-ethanol unlike petroleum is a form of renewable energy that can be produced from agricultural feedstock. It can be made from very common crops such as sugarcane, potato, cassava, and maize (Ru'ther, 2007). However, there has been considerable debate on how useful Bio-ethanol will be in replacing gasoline. Concerns about its production and use relate to increased food prices, the large amount of arable land required for crops, as well as the energy and pollution balance of the whole cycle of production, especially from corn. Recent developments with cellulosic ethanol production and commercialization may allay some of these concerns. Cellulosic ethanol offers promise because cellulose fibres, a major and universal component in plant cells walls, can be used to produce ethanol. The International Energy Agency states that, cellulosic ethanol could allow ethanol fuels to play a much bigger role in the future than previously thought (Zillman, 2010).

BIO-FUELS AND ITS CLASSIFICATION

Wikipedia (2012) states that Bio-fuels is a type of fuel whose energy is derived from biological Carbon fixation. Bio-fuels include fuels derived from Biomass conversion, such as solid biomass, liquid fuels and various biogases. Although fossil fuels have their origin in ancient carbon fixation, they are not considered bio-fuels because they contain carbon that are out of carbon cycle for a very long time. The biomass constitutes the feedstock destined for conversation into bio-fuels. Bio-fuels are renewable energy resources and considered as a viable alternative to the non-renewable fossil fuel, coal, crude oil and natural gas. Base on the feedstock, bio-fuels can be classified as their first and or second generation.

First Generation Bio-fuels: Are those derived from food sources. These bio-fuels utilize food crops and other food sources as feedstock. They include Bio-Ethanol and Bio-Diesel. Bio-Ethanol is a bio-fuel that is traditionally produced from the fermentation of food crops such as corn, sugar beet, cassava and sugarcane. Bio-ethanol can be blended with petrol for use in petrol-engine vehicles. Bio-Diesel is a bio-fuel produced from various feedstock such as vegetable oils (derived from oil palm, rapeseed and soya beans), animal fats (tallow). They are used to run diesel-engine vehicles and machines.

Second Generation Bio-fuels: Bio-fuels derived from non-edible feedstock. They are generally considered as second generation bio-fuels. They include:

(a) ***Bio-Ethanol:*** The following non-food plants can be used as feedstock for producing bio-ethanol.
   - (i) ***Bio-gases:*** It is a sugarcane waste.
   - (ii) ***Switch grass:*** It is native to the U.S and known for its hardness and rapid growth.
   - (iii) ***Miscanthus:*** It is also called elephant grass. It is a genus of about 15 species of perennial grasses native to subtropical and tropical regions of Africa and Southern Asia.

(b) ***Bio-diesel:*** The non-food sources for bio-diesel include:

(i) Jatropha: It is non-edible evergreen shrub found in Asia, Africa and West indices.

(ii) Algae: They are primitive plants, usually aquatic, capable of manufacturing their own food by photosynthesis. They are still being invested as a possible feedstock for biodiesel.

Fuel Ethanol and Sources of Ethanol

Fuel ethanol (ethyl-alcohol) is made by fermenting and distilling simple sugars. It is the same compound found in alcoholic beverages. The biggest use of fuel ethanol in the United States is as an additive in gasoline. It serves as an oxygenate, to prevent air pollution from carbon monoxide and ozone; as an octane booster, to prevent early ignition, or "engine knock" and as an extender of gasoline stocks. In purer forms, it can be used as an alternative to gasoline in automobiles specially designed for use. Ethanol is a renewable energy source because the energy is generated by using a source, sunlight, which is naturally replenished. Creation of ethanol starts with photosynthesis causing a feedstock, such as sugarcane or corn, to grow. These feedstocks are processed into ethanol, Petroleum Products and about 5% of the ethanol produced in the world in 2003 was actually a petroleum product. It is made by the catalytic hydration of ethylene with sulphuric acid as the catalyst. It can also be obtained via ethylene or acetylene, from calcium carbide, coal, oil gas, and other sources. Two million tons of petroleum-derived ethanol is produced annually. The principal suppliers are plants in the United States, Europe, and South Africa. Petroleum derived ethanol (synthetic ethanol) is chemically identified to bio-ethanol and can be differentiated only by radiocarbon dating.

Carbon based feedstock: Bio-ethanol is usually obtained from the conversion of carbon based feedstock. Agricultural feedstock are considered renewable because they get energy from the sun using photosynthesis, provided that all minerals required for growth (such as nitrogen and phosphorus) are returned to the land. Ethanol can be produced from a variety of feed stocks such as sugarcane, biogases, miscanthus, sugar beet, sorghum, grain sorghum, switch glass, barley, hemp, kennel, potatoes, sweet potatoes, cassava, sunflower, fruit, molasses, corn, Stover, grain, wheat, straw, cotton, other biomass, as well as many types of cellulose waste and harvesting, whichever has the best well-to-wheel assessment.

Algae: An alternative process to produce bio-ethanol from algae is being developed by the company Algenol. The algae can grow in sunlight and produce ethanol directly which is removed without killing the algae. It is claimed that the process can produce 6000 gallons per acre per year compared in 400 gallons for corn production.

Bio-Ethanol production Process

Currently, the first generation processes for the production of ethanol from corn use only a small part of ethanol from the plant, the corn kernels are taken from the corn plant and only starch, which represents about 50% of the dry kernel mass, is transformed into ethanol. (Halilu, 2008) stresses that two types of second processes are under development. The first type uses enzymes and yeast to convert the plant cellulose into ethanol while the second type uses pyrolysis to convert the whole plant to either a liquid bio-oil or a syngas.

Second generation processes can be used with plants such as grasses, wood or agricultural waste material such as straw. The basic steps for large scale production of ethanol are:

- Cellulolysis for some crops.
- Microbial (yeast) fermentation.
- Distillation.
- Dehydration and
- Denaturing (optional).

Prior to fermentation, some crops require Saccharification of hydrolysis of carbohydrates such as cellulose and starch into sugars. Saccharification of cellulose is called cellulolysis.

Fermentation: Ethanol is produced by microbial fermentation of the sugar. Microbial will currently only work directly with sugars. Two major components of plants, starch and cellulose, are both made up of sugars and can principle be converted to sugars for fermentation. Currently, only the sugar (for example, sugarcane) and starch (for instance, corn) portions can be economically converted. However, there is much activity in the area of cellulosic ethanol, where the cellulosic part is broken down to sugars and subsequently converted to ethanol.

Distillation: Further treatment in order to burn in combination with gasoline in gasoline engines, dehydration of the ethanol to be useable as a fuel must be done. Most of the water is removed by distillation, but the purity is limited to 95-96% due to the formation of a low-boiling water ethanol zoetrope. The 95% m/m (95.5% v/v) ethanol, 4.4% m/m (3.3% v/v) water mixture may be used as a fuel alone, but unlike anhydrous ethanol, is immiscible in gasoline, so the water fraction is typically removed.

Dehydration: There are basically five dehydration processes to remove the water from an azeotropic ethanol/water mixture. The first process used in many early fuel ethanol plants is called azeotroppic distillation and consist of adding benzene or cyclohexane to the mixture. When these components are added to the mixture, it forms a heterogeneous azeotropic mixture in vapor-liquid-liquid equilibrium, which when distilled produces anhydrous ethanol in the column bottom, and a vapor mixture of water and cyclohexane/ benzene. When condensed, this becomes a two-phase liquid mixture. Another early method, called extractive distillation consists of adding tertiary components which will increase ethanol relative volatility. When the tertary mixture is distilled, it will produce anhydrous ethanol on the top of the column. With increasing attention being paid to saving energy, many methods have been proposed that avoid distillation all together for dehydration of these methods, a third method has emerged and has been adopted by the majority of modern ethanol plants. This new process uses molecular sieves to removes water from fuel ethanol. In this process, ethanol vapor under pressure passes through a bed of molecular sieve beads. The bead's pores are sized to allow absorption of water while excluding ethanol. After a period of time, the bed is regenerated under vacuum or in the flow of inert atmosphere (N) to remove the absorbed water. Two beds are used so that one is available to absorb water while the other is being regenerated. This dehydration technology can account for energy saving of 3,000 btus/gallon (840 kj/l) compared to earlier azeotropic distillation.

Uses of Ethanol

1. It servers as additive in gasoline.
2. It serves as an oxygenate.
3. It prevents air pollution from carbon monoxide and ozone.
4. It serves as an octane booster to prevent early ignition or "engine knock".
5. It serves as an extender of gasoline stocks.
6. In its purer forms, it can also be used as an alternative to gasoline in automobiles specially designed for its use.

BIO-ETHANOL PRODUCTION IN NIGERIA

Nigeria being eager to jump on to the bandwagon for bio-fuels has a policy to meet ten percent bio-ethanol content in fuel by 2020 (Halilu;2008). In pursuance of this policy, the Chief Olusegun Obasanjo's regime earmarked thousands of hectares of virgin land for cultivation of cassava to supply feedstock for production of ethanol. The cassava, as it was called, did not however, succeed. In a new development, Global Bio-fuels Limited has embarked on a project which use about 10,000 hectares of virgin land (forest and grasslands). Covering seven states (Osun, Oyo, Kwara, Ondo, Ekiti, Niger and Kogi) in Nigeria, to cultivate sweet sorghum feedstock for ethanol fuel production (Azih, 2007). Global Bio-fuels Limited plans to set up seven plants each valued at over 3 billion U.S dollars (345 billion naira) in the seven states, to produce about 1 million litres of ethanol per plant on a ethanol fuel production project in Nigeria.

Nigerian National Petroleum Cooperation (NNPC) as at 2006 has so far worked out plans to acquire farmlands in Anambra, Benue, and Cross River for large scale cultivation of cassava. It has acquired a large plantation site of over 20,000 hectares at Agufa village for the large scale production of cassava and sugarcane in Jigawa State and already MoU on that regard has been signed between the two parties. The MoU is expected to be a win-win situation for both parties as the NNPC will reap between 75 million and 100 million litres of ethanol and up to 80,000 metric tons of sugarcane annually, while the State will in turn generate employment and wealth for its citizens. In addition, the venture will also enable the Jigawa Government to acquire world-class technology and farm management best practices in the large scale production of sugarcane.

NIGERIAN BIO-FUEL POLICY AND INCENTIVES

At present , Nigeria has a policy on bio-fuels entitled Nigerian Bio-fuel Policy and Incentives (2007). The Policy Document was approved by the Federal Executive Council on June 20th, 2007 and gazetted as a national bio-fuels policy at the same time. The Nigerian National Petroleum Cooperation was given the mandate to create an environment for the take-off of a domestic ethanol fuel industry. The aim is to gradually reduce the nation's dependence on imported gasoline, reduce environmental pollution while at the same time creating a commercially viable industry that can precipitate sustainable domestic jobs. Demirbas (2009) states that the framework of the policy and the incentives is meant to create an enabling environment that is expected to sensitize the development of the country's bio-fuels industry. The bio-fuel programme constitutes a major and unique attempt to

integrate the agricultural sector of the economy with fostering the downstream petroleum sector, while fostering the use of other renewable energy sources. To make the project a realizable objectives, the Federal Government through the Nigerian National Petroleum Cooperation, (NNPC) create the Renewable Energy Division (RED), to champion the implementation of the programme. The NNPC, by mandate of the former President, Olusegun Obasanjo, inaugurated the Renewable Energy Division in Nigeria. Renewable Energy Department (RED) shall provide a constant, steady supply of alternative fuel to the utmost satisfaction of customers and continuously seek to improve the quality of its management systems. The implementation plan includes:

i. Initial market seeding (E-10).
ii. A bio-fuel production programme (PPP) to achieve 100% domestic production by 2020
iii. A complete bio-fuel uptake arrangement.
iv. And joint-venture distilleries.

This is anchored on agricultural productivity and competiveness. The policy is intended to create market demand for bio-fuel products. Already, U.S $ 4 billion has been committed to a sugarcane sourced ethanol project in the Northern States of Jigawa and Benue while cassava sourced ethanol projects are earmarked for the Southern Anambra and Ondo States.

STRATEGIES AND POLICY FRAMEWORK FOR IMPROVING ENVIRONMENTAL HEALTH NIGERIA

Ru'ther (2007) suggests that for the purpose of implementing the provision of Bio-fuel policy, a Bio-fuels Energy Commission shall be established. The Bio-fuels energy Commission is charged with the responsibility of implementing the strategies for bio-fuels for improved environmental health in the country. He emphasizes that the commission shall specially exercise the following responsibilities:

1. Register all bio-fuel plants/projects in the country.
2. Issues license to bio-fuel operators for the production of fuel ethanol or/and bio-diesel in Nigeria.
3. Formulate and recommend fiscal, financial and other incentive policies for the bio-fuel industry, as well as production measures if required.
4. Periodically, review and assess the economic, technical, environmental and social impact of the use of bio-fuels, and determine changes in policies required when necessary.
5. Monitor the supply and utilization of bio-fuels, and bio-fuel blends and recommend appropriate measures to the department of Petroleum Resources in case of shortages in supply of bio-fuels or feedstock.
6. Review and adjust the minimum mandate bio-fuel blends as it deems appropriate.
7. Determine and put in place industry stabilization mechanisms.
8. Designate and oversee the activities of the investment bank appointed to manage the Bio-fuel Industry Equity Fund.
9. Establish and support the Bio-fuels Research Agency to be established under the Bio-fuels programme.

10. Monitor intra-industry commerce, in particular relationship between out growers and bio-fuel producers. Present quarterly reports and briefings on the status of the bio-fuel industry to the National Assembly.
11. Disseminate and share information with investors and interested members of the public.
12. Liaise with the Energy Commission of Nigeria in the formulation, revision and implementing of the National Energy Policy.
13. Liaise with the National Sugar Development Council as may be required.
14. Liaise with government ministries, agencies, parastatals, and research institutes.

Provision for incentives in the bio-fuel industries has also been made. For instance, there exist provisions for application for waivers granting Pioneer Status for an initial 10 years period with possibility of additional 5 years extension since bio-fuel is not listed as one of the companies benefiting from such under the Industrial Development (Income Tax Relief) Act. The policy explores the various provisions of the tax in Nigeria in order to create a wide range of incentives to the bio-fuels market. It therefore, becomes necessary for the amendment of the tax laws in the country to bring them in consonance with the intent and purpose of the policy. A research agency to be known as the Bio-fuels Research Agency shall be established to act as the central coordinating body for bio-fuel research in the country. The policy stresses a collaborative efforts with local research institutes in feasibility studies namely, International Institute of Tropical Agriculture (IITA), National Cereal Research Institute (NCRI), National Root Crops Research Institute (NRCRI), National Biotechnology Development Agency (NABDAC), Institute for Agriculture Research and Extension Service (IARES) and other relevant agencies. There is also collaboration with Government agencies and parastatals in bio-fuels policy development.

INCENTIVES AVAILABLE FOR ETHANOL PRODUCTION IN NIGERIA

The Federal Government introduced Nigeria's Bio-fuel production programme to establish a thriving fuel ethanol industry by utilizing agricultural products. A number of incentives have been introduced to stimulate Nigeria's bio-fuel industry. These include:

(a) Pioneer Status: All registered businesses engaged in activities related to bio-fuels production and/or the production of feedstock for the purpose of bio-fuel production and co-generation within the country shall be accorded pioneer status within the provisions of the Industrial Development (Income tax relief) Act.
(b) Withholding tax on interest dividends, etc.
(c) Waiver on import and custom duties.
(d) Waiver on Value Added Tax. Bio-fuel companies that are involved in the production of bio-fuels feedstock or the production of bio-fuels and/or the generation of electricity from biomass shall be exempted from payment of Value Added Taxes on all products and services consumed by them.
(e) Long term preferential loans.

Apart from the effort federal government in development ethanol production in the nation, States government's support and provision of such incentives for both indigenes and non-indigenes bio-ethanol investors should be done.

CONCLUSION

Adequate policies and legislative frame work on bio-fuel are lacking in African Countries to fast track the implementation of reliable and efficient bio-ethanol programme and to safeguard environmental health. The lack of enabling legislation in the Nigerian Energy Sector has retarded the implementation of clean energy policies. Technical information on bio-fuels has also been hindered. Besides, there have been logistic bottlenecks. Moreover, the government has not encouraged the research and development required to enable the use of bio-fuels and other renewable sources of energy to achieve full efficiency and sustainability. No effort has been made toward the development of local expertise and institutional procedures to facilitate project finance and provision of appropriate fiscal and economic incentives, hence the call for enabling legislation that will fill these regulatory gaps in the energy sector.

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