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MARKET/INVESTMENT
CASE: POTENTIAL OF BIO ENERGY/MASS IN NIGERIA: (SOUTH EAST)

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FOREWORDS

The research and writing work has been done in Aba, Abia State Nigeria (Southeast), and Vaasa, Finland, during the time period of December 2009 – March 2010. My supervisor was Dr, Adebayo Agbejule a principal lecturer and also a current researcher at Vaasan ammattikorkeakoulu of Applied Sciences Finland, and in collaboration with some IT companies in Finland.

I would like to thank those who contributed to this research work and my dear mother Pastor Mrs Ruth C Okorie for her prayers during the research work. Also to receive my commendations are my uncle, Dr Onunna Nwakanma and my supervisor Dr Adebayo Agbejule who directed me and gave me up-to-date information. This made it easy for me to have something to lay hand on, which resulted in this thesis.

In conclusion I would say that this research work has made me more familiar with the benefits and the potentials of Bio energy/mass in Nigeria and across the world especially in terms of Investment and marketing aspect of it for the benefits of the country´s economic growth

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ABSTRACT

Author	Matthew Uchechukwu Okorie
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The aim and purpose of this thesis is to explore the market/investment potential of bio energy/mass in Nigeria with South East Nigeria as a case study. Data for the study consists of primary and secondary sources. From the data analysis the findings of the research showed that biomass can be found in Nigeria (South East) in sustainable and sufficient quantity. Market potential of bio-energy/mass is found to be significant with potentials for growth. The research reveals that the quantum of conventional energy in the energy market that can be substituted by bio fuel is substantial. The study also reveals that Nigeria's investment potential in bio energy/mass production may depend on government mandate, production cost of bio-fuels relative to other fuel substitutes, subsidy on petroleum products and the level of agricultural productivity. In terms of capacity for commercial deployment, feedstock supply, sustainability, Nigeria has huge reserve of natural resources and factors deployable for alternative energy production - productive arable land, favourable climatic conditions, abundant and potential feedstock production like cassava, maize, palm oil, sugarcane etc.

Keywords: Market, Investment, Bio energy, Biomass, Potential

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TIIVISTELMÄ

Tekijä	Matthew Uchechukwu Okorie
Aihe	Markkinointi/Investointi, Tapaus: Potentiaalinenbioenergia/ Biomassa Lounais-Nigeriassa
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Tämän lopputyön tarkoitus on tutkia bioenergian ja -massan markkinointi- ja investointipotentiaalia Nigeriassa, Lounais-Nigerian toimiessa tapaustutkimuksen tarkempana kohteena. Tutkimuksen aineisto koostuu sekä ensisijaisista, että toissijaisista lähteistä. Aineistoanalyysissä tutkimuksen tulokset osoittavat, että biomassaa löytyy Lounais-Nigeriasta kestävä ja riittävä määrä. Bioenergian ja–massan markkinapotentiaalin on yleisesti nähty olevan merkittävä ja sen kasvunäkymän potentiaalinen. Tutkimus osoittaa, että konventionaalisen energian määrä, joka pystytään muuttamaan biopolttoaineeksi, on huomattava. Tutkimus todistaa myös, että bioenergian ja–massan investointipotentiaali on riippuvainen hallituksen toimeksiantosopimuksista, biopolttoaineen valmistuskustannuksista muihin polttoaineen korvikkeisiin verrattuna, raakaöljytuotteiden tukiaisista ja maataloudellisen tuottavuuden tasosta. Nigerialla on valtava potentiaali, mitä tulee kaupallisiin sijoituksiin ja raaka-aineen saantiin, sillä Nigerialla on suuret luonnonvarat ja tarvittavat tekijät vaihtoehtoisen energian tuotantoon – hedelmällinen ja viljelykelpoinen maa, suosiolliset sääolosuhteet sekä runsas potentiaali raaka-aineiden, kuten maniokkipensaan, maissin, palmuöljyn ja sokeriruo'on tuotantoon.

Avainsanat: Markkinointi, Investointi, bioenergia, Biomassa, Potentiaal

1. INTRODUCTION

1.1 Background of the Study

Bio energy holds great potential for better energy future. That was my major motivation for embarking on this research. Also, the susceptibility to depletion of natural resources such as petroleum, coal and nuclear fuels as well as their negative environmental impact was of concern to me. This concern however was doused, since from my research, bio energy portends better prospects for future energy sustainability and a cleaner environment.

As the world's population continues to increase with its associated rapid development, especially in areas where the demand on fossil resources had been very low per capita, it is expected that the energy and material needs of human society will become unprecedented in the near future. This will lead to more demands and increasing cost of fossil resources for energy, fuels, chemicals and materials. It has also become apparent that fossil fuels emit greenhouse gases and the continued emissions of these gases are influencing the world climate. The reduction of global demand for fossil fuel resources has been proposed as a major strategy to ameliorate the effects of climate change.

Biomass has been ticked as one of the solutions to energy future. It is a renewable source of energy that can provide heat, electrical energy, and transportation fuels which can reduce CO_2 emissions, Sulphur and Heavy Metals in the atmosphere. Biomass also has the potential of improving rural income and energy security.

Nigeria is a developing country and her technological endowment has not reached a very high level of development. To a large extent, the traditional economic system is still predominant, although appreciable progress is being made towards making the economy more market oriented. The country is ranked the sixth producer of crude oil and is therefore heavily dependent on it as a major source of revenue and energy. In recent times awareness has been created on biomass as the alternative to fossil resources and Nigerian government in alignment with relevant multilateral institutions is developing its capability in the sphere of biomass. With

the shortcoming of non renewability and unfriendly environmental attribute of fossil resources, there is a strong need for the development of alternative clean energy supply in Nigeria. It is estimated that Nigeria's oil reserve can only last for the next 30 years and with its growing population of over 150 million and a large expanse of arable land, there is a huge potential for the commercial development of biomass energy. The use of bio energy resources will reduce environmental pollution as degradable domestic and industrial waste can be converted into energy. Exploitation of biomass resources will contribute to the diversification of the energy supply mix and as well increase the country's Gross Domestic Product (GDP).

1.2 The Aim and Purpose of the Study

The aim of this study is to explore the market/investment potential of bio energy/mass in Nigeria. This research attempts to answer the question: is there prospect in developing bio fuel as alternative energy source in Nigeria? The study tries to find answers to these questions:

A. Where can biomass resources be found in South-eastern Nigeria and are they sustainable and in sufficient quantity?
B. What is the market potential?
C. How much of the conventional energy in the energy market can be substituted by bio fuels?
D. What effect will the price of conventional energy units have on the price and demand for bio fuels?
E. Investment potential will it be determined by the value of the extra investment on the conventional energy compared to the value of bio energy investment?

1.3 Scope of the Study

The research does not include bio energy/mass production technology. The analysis of market/investment potential will concentrate only on information that is relevant to the study. That includes information on bio energy resources, its

market potential, and the level of investment requirement in biomass to sustainably meet energy demand in Nigeria.

The study highlights general information about bio energy/mass but presents theoretical findings only on relevant issues on biomass energy resources. As a background study the researcher explores the prospects of bio energy/mass against the backdrop of the impact of fossil resources on the environment. The market/investment potential of bio energy/mass in South-eastern Nigeria also explores the socio-economic benefits of biomass an alternative energy source.

The research method for this study is mainly qualitative based on descriptive analysis of official data existing in Nigeria though a degree of quantitative analysis of this data will be necessary to buttress home the questions raised. First, I present an overview of Nigeria's energy resources as well as some current, basic information about bio energy/mass.

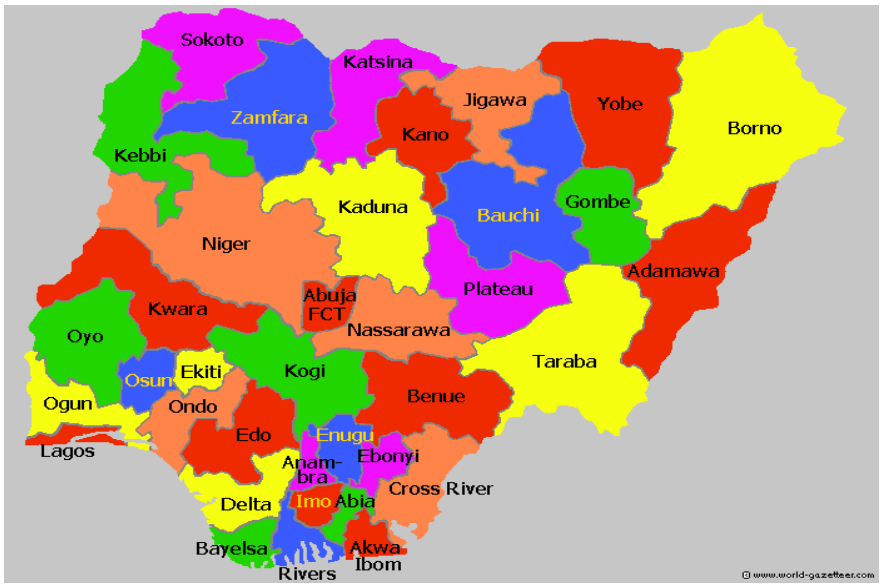
The presentation of research methods follows in chapter two. The theoretical study begins in chapter three with bio energy/mass market prospects. Chapter four discusses the marketing strategy. The bio energy option and nature of bio energy investment are presented in chapters five and six respectively.

The theoretical study is followed by a presentation of the research study in chapter seven: I present data from secondary sources and analyze them based on my research questions. The analysis followed discussion of findings. The study ends with a conclusion of the entire study.

1.4 **Case Country Nigeria: (South East) Brief History**

Nigeria, the "Giant of Africa" with a land area size of (923, 733 square kilometres and the largest population in Africa (Estimated at between 150 and 160 million people) and in the south east zones is about 37.5 percent of the population. Nigeria is blessed with abundant mineral resources like oil, cold and others but still yet hunger is still the talk of the country today. Nigeria is made up of more

than 250 ethnic groups, but the major ones are Hausa, Fulani, Igbo and the Yoruba, which together account for more than half the population. Other sizable groups include Edo, Ibibio/Effic, Ijaw, Tiv, Nupe, Kanuri, Igala, and Urhobo. Although most Nigerians speak at least one of the three major indigenous languages like Hausa, Igbo or Yoruba but other 250 languages are spoken, and the official language, a colonial inheritance, is English. The predominantly Muslim Hausa/ Fulani mostly inhabit the Northeast. The predominantly Christian Igbo who are arguably the most mobile ethnic group (owning partly to their commercial dexterity), mostly inhabit the southeast. Lastly, Nigeria has in world record as the sixty oil producing country the whole world. To this end, the market size potential of Bioenergy/mass in southeast Nigeria is found to be 37.5 percent of the total population of the country.



Loking at the map, you can found the states that made up of the South Eastern zones in Nigeria. namely, Abia, Anambra, Akwa ibom, Enugu, Imo, Ebonyi, and this states are near each others for that reason the logistics of the bioenergy/mass product will not cost all that much during the prduction.

1.5 **Nigeria's Energy Resources**

Nigeria is blessed with abundant primary energy resources. These include reserves of crude oil and natural gas, coal, tar sands and renewable energy resources such

as hydro, fuelwood, solar, wind and biomass. However, since the late 1960s, the economy has been solely dependent on the exploitation of oil to meet its development expenditures. In 2001, oil revenue alone accounted for about 98.7% of exports and 76.5% of total government revenues**.** However, its contribution to

GDP was only 10.6%. This shows the low level of value added, by the oil sector, to the economy (Nigeria Energy Policy 2003: 3.)

The total commercial energy consumption in 2001 was 45.55 million tce**.** The dominant source of commercial energy had been oil, accounting for over 66% of commercial energy consumption between early 1970s and 1988. Its contribution**,** however, dropped from 46.7% to 31.9% between 1990 and 2001. Natural gas production, which is mostly in association with oil production, is appreciable. Its contribution to commercial energy consumption, on the other hand, had increased from 29.8% in 1990 to 61.9% in 2001**.** However, not less than 50% of the natural gas produced was being flared by the end of 2001. Up to the early 1960s coal production was significant and dominated the commercial energy supply. It was also the predominant source of energy for rail transportation and electricity generation. However, partly due to fuel substitution to oil and gas, coal production and utilization has dropped to an insignificant level. In 2001, coal's share of the total commercial energy consumption was about 0.02%. With respect to the renewable energy resources, hydro power plants entered the Nigerian energy scene in the 1960's. Presently hydro is the second largest energy resource for electricity generation in the country, contributing about 32% of the total installed grid-connected electricity generating capacity. Currently, fuelwood accounts for over 50% of overall energy consumption in the country and is the dominant source of energy in the domestic sector. It is also used in other sectors of the economy, such as cottage industries. Over the years the fuelwood supply/demand imbalance in some parts of the country has adversely affected the economic well-being of the people. On the national level, increasing fuelwood consumption contributes to deforestation with consequent desertification and soil erosion. (Nigeria Energy Policy 2003:4.)

Solar energy intensity is generally high in the country. Solar energy is widely used in the country for drying, most especially for agricultural products. But it is normally lumped with the informal sector, which is not adequately captured in the national accounts. Nevertheless, solar energy has great potential for the provision of power for rural development. (Nigeria Energy Policy 2003: 5.)

Over-dependence on oil has slowed down the development of alternative fuels. Diversification to achieve a wider energy supply mix will ensure greater energy security for the nation. The domestic demand for petroleum products is growing rapidly. The development of alternative fuels from locally available energy resources is imperative because, the rural populace, whose needs are often basic, depend to a large extent on traditional sources of energy, mainly fuelwood, charcoal, plant residues and animal wastes. This class of fuels constitutes over 50% of total energy consumption in the country. Fuelwood supply/demand imbalance in some parts of the country is now a real threat to the energy security of the rural communities. Hence, special attention is being paid to the diversification of the energy supply mix in the rural areas. Even when there exist of adequate and diversified energy supply options in the country, the problem of unreliability of supply constitutes a huge drain on the national economy. This leads to energy insecurity and had constituted a major characteristic of the energy crisis experienced by the country over the last decade, especially with regards to the supply of electricity and petroleum products. Therefore, attention is being given to adequate production levels and a reliable distribution network for all fuel types to ensure steady economic growth. (Nigeria Energy Policy 2003:5.)

With the exception of the upstream oil and gas sub-sectors, and to a smaller extent the electricity sub-sector**,** government has been large**l**y responsible for the ownership and operation of the energy sector industries. In particular, investment capital had been sourced from public funds, while the industries had relied on the sense of public interest, within management, as the motivation for responsible and transparent management of the industries. (Nigeria Energy Policy 2003: 6.)

The funds required for the maintenance and refurbishment of the energy supply infrastructure, and for the expansion of capacity, are enormous. In the face of increasing demands on government for investments in other areas of the economy such as transport, health, education and security, government has been unable to provide the funds needed by the energy sector. Efficient and transparent management of the industries had also not been achieved. Consequently, established facilities had progressively deteriorated while new capacity had not been added, in spite of increasing demand. Furthermore, the funding and management deficiencies had given rise to inadequate and unreliable supply, especially of electricity and petroleum products, insecurity of the energy supply system and loss of productivity in the economy. It is believed that increased private sector participation in the energy sector will attract new investments to the sector, while the profit motive will assist in solving much of the management problems experienced under public ownership. The restructuring of the sector, required to bring this about, will involve both deregulation and privatization. The greater proportion of private investment funds required by the sector will be foreign capital. Thus, the environment must be made conducive to attract foreign investments to the sector. This notwithstanding, it is necessary to encourage and promote indigenous private sector participation in the sector (Nigeria Energy Policy 2003: 6.)

Given the array of energy resources, it has been observed that the traditional sources of energy – fuelwood, charcoal, plant residues and animal waste - constitute over 50% of total energy consumption in the country. This is an indication that bio energy/mass market is very significant. The development of this form of energy in the country is still at the experimental/rudimentary stage. As researches are being conducted on this energy sub-sector, there are promising results that the solution to future energy needs will depend significantly on bio energy. This means that the demand for bio energy/mass will continue to increase. In order to meet the increasing demand investment has to be made to beef up supply. Interestingly, government energy policy is encouraging and promoting foreign and indigenous private sector participation in the industry.

1.6 **Sources of Bio energy/mass**

Bio energy is renewable energy made available from materials derived from biological sources. In its most narrow sense it is a synonym to bio fuel, which is fuel derived from biological sources.

Biomass is any organic material which has stored sunlight in the form of chemical energy. As a fuel it may include wood, wood waste, straw, manure, sugar cane, and many other by-products from a variety of agricultural processes. Bio energy is the energy extracted from the biomass, as the biomass is the fuel and the bio energy is the energy contained in the fuel. There is a slight tendency for the word bio energy to be favoured in Europe compared with bio fuel in North America. (http://en.wikipedia.org/wiki/Bioenergy #cite_note-0 29.10.09)

Other sources of bio energy/mass include plants, animals and their by-products, garden waste and crop's residues. There are various agricultural products being grown for bio energy around the world. These include Corn, Switchgrass, Soybeans, Rapeseed, Wheat, Sugar Beet, Sugar Cane, Palm Oil, Miscanthus, Sorghum, Cassava, Jatropha etc. Biodegradable outputs from Industry, Agriculture, Forestry and Households can also be used for bio energy production, using for example anaerobic digestion to produce biogas, gasification to produce syngas or by direct combustion. Examples of biodegradable wastes include Straw, Timber, Manure, Saw Dust, Cocoa Husk, Rice Husks, Sewage, and Food Waste. The use of biomass fuels can therefore contribute to waste management as well as fuel security and help to prevent or slow down climate change, although alone they are not a comprehensive solution to these problems.

(http://en.wikipedia.org/wiki/Bioenergy#cite_note-0 29.10.09)

2. RESEARCH METHODS

The survey research design method was used for this study. It involves using a self designed questionnaire in collecting data from respondents. This method was chosen in order to make reference to relevant information from secondary data and it is relatively economical in terms of time and resources.

The scope of this study is limited to market/investment of bio energy/mass in Nigeria (South East). As a result of the nature of the research topic, the choice of respondents to the questionnaire was restricted to one hundred Nigerians (South East) from the public and private sectors of the economy. Respondents with bias on energy and agriculture from the public and private sectors were drawn randomly from different government concerns, Chambers of Commerce and Industries across the country for sample. The simple random sampling was used; it is a basic sampling design, which allows equal representation and selection of samples.

The selection of respondents was done in such a way to include persons from various sectors of the economy. This was done in anticipation that such a sampling of respondents will provide the necessary variety of information required of this study.

Considering the scope of the study, the primary and secondary sources of information form the basis of data selection. The primary data is sourced from the case study and it contains information obtained through questionnaire. The secondary data is sourced from books, the internet, official government documents etc. I hope that my choice of data will help to identify and disclose all information required for the study.

Collection of data is through questionnaire. This quantitative method of data collection was used for easy analysis and interpretation. The instrument used both open and close-ended questionnaire, which sought to collect information about the

market/investment potential of bio energy/mass in Nigeria (South East).

3. BIO ENERGY/MASS: MARKET PROSPECTS

Despite the abundant energy resources in Nigeria, the gap between energy demand and supply is still substantial. Many institutions, companies and homes depend heavily on standby generating sets to meet their energy need. Despite the installed petroleum products refining capacity of 445,000 barrel/day and electricity generation capacity in excess of 8,000 MW, Nigeria imports over 70% of its petroleum products requirement, while electricity supply is inadequate at just about 3,000 MW now. (Sambo 2009)

Electricity crisis is one of the major infrastructure bottlenecks in Nigeria today. All types of firms in Nigeria experience power outages and 85 percent of them own generators as alternative source of power generation. An estimated 60 million Nigerian resident's use power generating sets of varying sizes for their electricity. The estimate for average residential expenditure in fuelling power generators is about N1.56 trillion ($13.35 billion) per annum. Similar level of expenditure on private power generation has characterized the affairs of industrial and commercial power consumers. The efforts of government to rectify the electricity crisis have continued to totter. Nigerians have been promised 6,000 megawatts electricity supply by December 2009. http://www.energy.gov.ng/index.php?option=comcontent&task=view&id=51&Itemid=58.

The promised 6000 megawatts electricity supply is grossly inadequate when compared to 2010 projected demand of 15,730 megawatts at 7% GDP growth (Energy Commission of Nigeria 2006). Demand for electricity in the country is growing but the development of this energy sector is not keeping pace with the expanding economic activities.

The petroleum products supply in Nigeria is characterized by occasional hitches that give rise to petroleum products scarcity and its attendant hike in prices. At such times economic activities slow down and many urban dwellers resort to alternative fuel sources like fuelwood and charcoal for their cooking. With a projected demand of about 36 million litres/day for PMS (Premium Motor Spirit), 8 million litres/day for DPK (Dual Purpose Kerosene) and 15 million litres/day for AGO (Auto Motor Gasoil), the supply in 2007 of about 24.27 millions/day of PMS, 3.8 million litres/day of AGO and 1.5 million litres/day for DPK were inadequate. Even then, over 80% of the PMS consumed was imported due to low capacity utilization of the local refineries that arose due to technical problems and vandalization of crude supply lines to the refineries (Sambo 2009). At present the energy production and supply have not improved significantly.

3.1 **Quantum of Demanded Energy Unmet**

The shortfall between energy demand and supply in Nigeria is significant when compared with the 2010 projected electricity demand of 15,730 MW and the 3,000 MW that is currently being supplied, and the wide gap between petroleum products demand and supply. The quantum of demanded energy unmet portends an opportunity for bio energy investment.

The bio energy market can take advantage of the unmet energy demand by increasing its market share in the energy market. A lot of market opportunity exists in the biomass feedstocks and bio fuel production. Biomass feedstock resources are widely available and can provide raw materials to bio-refineries. The blending of bio fuels with petroleum products is one of the possible means of boosting the bio energy market and at the same time increasing fuel supply in the economy. Municipal waste conversion into biogas is also an investment opportunity that can boost bio energy market share. The biogas can provide energy for household units, factories and power generating stations.

The rural and peril-urban inhabitants are heavily dependent on fuelwood for their domestic energy need. This segment of the energy market constitutes over 50% of

total energy consumption in Nigeria. Also, other sectors of the economy, such as cottage industries use fuelwood. The prevalence of fuelwood consumption is attributable to its availability and cheapness compared to other sources of energy. Over the years the fuelwood supply/demand imbalance in some parts of the country has adversely affected the economic well-being of the people. On the national level, increasing fuelwood consumption contributes to deforestation with consequent desertification and soil erosion (Energy Commission of Nigeria 2006).

Low purchasing power (LPP) is a major factor most rural dwellers are unable to discontinue the use of fuelwood. In some parts of rural community fuelwood can easily be fetched from the forest and farmlands at little or no cost, but in some other areas fuelwood trade is thriving, competing with the furniture and construction industries for wood resources. Liquid bio fuels made from biomass holds a vista of hope for rural development because of its potential to create jobs. Besides increasing energy security, bio fuels will improve living conditions of the rural populace.

Given the global focus on the effects of fossil fuels on climate change as well as the economic and development opportunities that come with developing bio fuels, the Nigerian National Petroleum Corporation (NNPC) is already investing heavily in the bio energy exploitation by initiating a joint-venture setting up ethanol plants in several parts of the country in a public-private partnership arrangement that ensures it uptakes all bio fuel production for hybridization activities. The abundance of bio-energy feedstock in Nigeria propels this desire even higher. Already the initial target is the achievement of 10% ethanol blend (E-10) in Nigeria fuel consumption. This initiative promises to create a multiplier on employment generation and enlarged agricultural opportunities in the rural sector (Innocent Azih 2007.)

3.2 **Market Demand**

Market potential depends on the effective measurement and forecasting of the market demand. When a target market for a product is defined, determining the level of sales to that market for a specified period is imperative. A products' market demand is the level of sales (in units and monetary terms) that will be made of the product in a given period. By properly determining the sales level for a product, a successful marketing plan can be developed (Okafor 1996.)

Also, it will help to determine how much of investment will be made to meet the anticipated market share.

Marketing opportunities exist in biomass feedstock as well as bio energy products. But what marketing strategy will be used to distribute, promote and price the products? The decision to produce as well as the control of the allocation of necessary resources must establish who will buy the product. Actual and potential buyers of a product define a market. In order to achieve business objective a product must be promoted and distributed to consumers and potential buyers. This involves marketing.

4 MARKETING STRATEGY

A strategy outlines the manner in which marketing is used to accomplish an objective. Biomass products as distinct from other products would have to develop a strategy peculiar to its nature. Such strategy will take cognizance of various market products available in the sector.

4.1 **Market Product**

Biomass feedstock includes cassava, sugar cane, cereals, biodegradable municipal waste, crop residues, sawdust, cocoa husks, palm kernels, animal waste, etc. Bio fuels include biogas, ethanol, biodiesel etc.

From our product lines feedstock would be sold to bio-refinery companies. Bio power generating stations are not in existence now as a result of non availability of bio fuels. However, the potential for such companies is significant as soon as such products are made available in commercial quantity. There are already existing independent power plant generating companies (IPP) that depend on natural gas and petroleum products, like Uniliver Nigeria PLC, and other companies of the same or lower categories. These companies can use bio fuels if made available and relatively cheaper. Due to the inefficiency of our national electric power corporation, industries and factories have resorted to the use of generators which make their cost per unit output uncompetitive to their foreign counterparts. Therefore a cheaper power alternative provided through the bio energy will be readily acceptable.

Biomass feedstock is in abundance in Nigeria (South East). However, a key determinant for biomass supply is an infrastructure that ensures economically viable feedstock logistics and handling from farm to bio-refineries. Other determining factors include cost of inputs, demand for other uses, local resources (water), and enabling infrastructure (e.g., storage and transportation facilities, for feedstocks and liquid fuels).

Ethanol, biodiesel and biogas are some products of processed biomass. These products can be sold as transportation and cooking fuel as well as for power generation, and how these products are marketed will depend on government policy. For example, Nigeria government has expressed intention to deregulate her petroleum industry. When this is done it means that petroleum refining and marketing will no longer be under the monopoly of the nation's Petroleum Corporation, NNPC. If government adopts competitive market structure for bio energy products, the implication is that there will be no control over price and no restriction of entry into the market. Currently petroleum product pricing is controlled, but with deregulation price control and subsidy will give way to forces of demand and supply to determine prices. How will this impact on bio energy market share?

It is expected that deregulation of the petroleum industry will bring about increase in prices of petroleum products. As subsidy is removed product prices will adjust to reflect market price. If the market price of petroleum products is high relative to bio fuels it will encourage investment in bio energy/mass production. This would boost bio energy market share as bio fuels could be sold as substitute or blended with petroleum products. Already the government energy policy encourages hybridization. Currently the Nigerian National Petroleum Corporation (NNPC) is investing heavily in the bio energy exploitation by initiating a joint-venture setting up ethanol plants in several parts of the country in a public-private partnership arrangement that ensures it uptakes all bio fuel production for hybridization activities. Under this partnership arrangement would bio fuel pricing be market driven?

Having NNPC as a major bio energy buyer means it will have some measure of influence over price determination. In the case of power, government does not provide for independent distribution network rather independent power producers are meant to feed to the national power grid and are compensated accordingly at a price agreed by the government and the investors. This will make it difficult for abnormal or arbitrary charges. Bio energy could as well be made relatively

cheaper than other energy sources through such marketing strategy. In that case the competitive market structure will not apply.

4.2 Energy Market Implications for Bio fuel Demand

Energy prices that are high enough, relative to the cost of producing bio fuels, could induce a level of bio fuel production and, thus, feedstock demand would increase. Whether or not bio fuel demand would increase with increased energy prices depends on the manner in which bio fuels interact with other liquid fuels (e.g., as a substitute or an additive used in fixed proportions) and on the difference between the level of bio fuel demand and supply. An increase in bio fuel demand could simply hike feedstock and bio fuel prices. The growth of bio energy market share would largely depend on how it competes in the energy market.

Low energy prices relative to the cost of producing bio fuels would adversely affect bio fuel demand. As bio fuel price increases demand for cheaper energy sources increases too.

5. BIOENERGY OPTION

Energy has a major impact on every aspect of our socio-economic life. It plays a vital role in the economic, social and political development of our nation. Inadequate supply of energy restricts socio-economic activities, limits economic growth and adversely affects the quality of life. Improvements in standards of living are manifested in increased food production, increased industrial output, the provision of efficient transportation, adequate shelter, healthcare and other human services. These will require increased energy consumption. Thus, our future energy requirements will continue to grow with increase in living standards, industrialization and a host of other socio-economic factors.

Nigeria (South East) stands a good chance of benefiting from bio energy/mass production as nations around the world are looking at bio fuels to help mitigate pollution and global warming. Also, bio energy/mass has the potential to create modern industries and provide employment for Nigerians. This would not only empower entrepreneurs and companies but it would help build vibrant and diverse economy. It is also a wise economic choice for long-term development.

Biomass resources of Nigeria can be identified as wood, forage grasses and shrubs, animal wastes and wastes arising from forestry, agricultural, municipal and industrial activities, as well as aquatic biomass. The biomass resources of the Nigeria (South East) have been estimated to be significant. Plant biomass can be used as fuel in thermal power plants or converted to produce solid briquettes, which can then be utilized as fuel for small-scale industries. Biogas digesters of various designs are capable of sustaining household, industrial and institutional energy needs. It has indeed been shown that the remaining biomass material after digestion is a better fertilizer than the original waste. The intensive application of this will reduce the existing heavy reliance on chemical fertilizers.

The main technologies currently in use for producing ethanol fuel involve the conversion of starchy parts of food or sugar into ethanol. Starch-based feedstocks in the country include corn, sugar cane, cereals and cassava. The abundant energy

available from biomass can be meaningfully introduced into the nation's energy mix through the development of a comprehensive programme. The nation’s Policy on Bio fuel seeks to establish a thriving fuel ethanol industry utilizing agricultural products as means of improving the quality of automotive fossil-based fuels in Nigeria. It hopes to prepare regulations for sale and use, and guarantee off-take under contractual terms. It aims to achieve job creation, rural and agricultural development and technology acquisition and transfer; attract foreign investment and streamline roles of Federal, State and Local Governments in bio fuels development. Implementation plan include initial market seeding (E-10) of bio fuel production programme under Public Private Partnership (PPP) to achieve 100% domestic production by 2020, complete bio fuel uptake arrangement, joint-venture distilleries. This is anchored on agricultural productivity and competitiveness. Already US$4 billion is committed to sugar-cane 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 (National Policy on Bio fuel, 2007.)

Over 60% of Nigeria's population depends on fuelwood for cooking and other domestic uses. The consumption of fuelwood is worsened by the widespread use of inefficient cooking methods, the most common of which is still an open fire. This system has a very low thermal efficiency and the smoke is also hazardous to human health, especially to women and children who mostly do the cooking in homes. The rate of consumption of fuelwood far exceeds the replenishing rate to such an extent that desert encroachment**,** soil erosion and loss of soil fertility are now serious problems in Nigeria (Nigeria Energy Policy 2003: 6.)

The largest sources of fuelwood at present are from forests, communal farmlands and private farmlands. Supply from natural forest regeneration is continuously being diminished due to the additional activities such as the clearing of forests for development projects, agricultural and industrial activities. Since forests are essential for healthy environment and as a check on wind and water erosion and desertification, and also serve as energy sources, it is essential that they are cropped on a rational basis.

Management of the nation's energy resources has not benefited greater number of Nigerians despite substantial energy subsidy. This is why most Nigerians still rely on fuelwood for energy despite the enormous non-renewable energy resources in the country. The effect of uncontrolled large-scale use of fuelwood in the rural and peril-urban areas is the penalty Nigerians are paying for inefficiency in the energy sector. Investment in fossil energy resources is capital intensive; exploration and exploitation are highly regulated. For over two decades no new refinery has been built, yet 70% of refined petroleum products are imported. Why go for further investment on infrastructure of the conventional energy while the existing ones are operating below installed capacity? Liquid fuels from biomass will it offer better alternative to fossil energy investment?

5.1 **Criteria for Sustainable Bio energy**

Aside from environmental concerns, the anxiety of what happens when the oil wells run dry is a major driver in the development of bio energy. One of the reasons bio energy has been tipped as a better energy alternative to fossil fuel hinges on sustainability. Unlike fossil resources which are susceptible to depletion, bio energy crops can be sustainably cropped.

The common use of the term "sustainability" began with the 1987 publication of the World Commission on Environment and Development report, *Our Common Future,* which defined sustainable development as "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs."

Ideally, determining whether feedstock production is sustainable requires an understanding of a wide array of direct and indirect benefits, impacts, and costs associated with its production. A first step is to define sustainability criteria and then develop an accounting method of measurable indicators to determine whether established criteria are met.

Sustainable renewable energy production, conversion, and delivery systems must not only be productive, but also environmentally, economically, and socially viable now and for future generations. A variety of national and international discussions are considering how to describe sustainable biomass production. Currently, there is little consensus on which criteria or indicators should be used to assess biomass sustainability for trade or environmental protection purposes. Many commonly used criteria apply to the lifecycle of a bio fuel's production and use. First, the bio fuel should reduce energy consumption and enhance energy security through reduced use of petroleum-based products. Second, it should have environmental benefits, such as reducing greenhouse gas emissions, preserving varied land use, and maintaining soil productivity, water quality/quantity, and biodiversity. Third, it should enhance other ecosystem services and not unduly reduce supplies of food and other resources. Fourth, it should be economically competitive, and fifth, it should contribute more energy than is required to produce it (Hill et al., 2006).

To determine if the above criteria are met, ideally one would evaluate a set of sustainable bio fuels criteria over the full lifecycle of the bio fuels system to determine all the costs, benefits (both market and nonmarket), and environmental effects. This analysis would also account for the choices that producers and consumers make, which reflect potential substitutions among energy sources, technologies, and relative prices, and which lead to a new set of equilibrium prices and energy uses.

Analyzing the various economic, social, and environmental aspects of bio fuels is challenging. Sustainability indicators can guide decision-making and can be used to evaluate the performance and progress of bio fuel production systems.

5.2 **Environmental Benefits**

The production of crops and crop residues for use as bio energy feedstocks involves soil cultivation; application of fertilizer, pesticides, and other chemicals; and irrigation, all of which can impact soil, water quality and quantity, air quality, site productivity, and greenhouse gas emissions. Activities and management practices can be evaluated on the degree to which they enhance overall

environmental attributes while mitigating negative environmental impacts. The principles for determining the sustainability of practices focus is on whether the land can continue to provide goods and services (e.g., wood, water, food, feed, habitat supporting biodiversity, fibber, energy) over the long term and conform to water quality and other environmental standards. To determine whether feedstock production practices lead to sustainable outcomes beyond the farm would require comprehensive analyses of off-farm releases and outcomes.

Some environmental outcomes and benefits that should be considered when evaluating the sustainability of biomass production include:

Reduced greenhouse gas emissions The net carbon load and greenhouse gases released in production and consumption of the bio fuel should not exceed the amounts released in producing and using a like amount of fossil fuel energy. Assessing the carbon impact of bio fuel production and greenhouse gas emission is likewise important.

Water Biomass feedstock production systems can be evaluated regarding the degree to which they prevent or avoid adverse impacts on water resources. Water and nutrient use efficiency can be included when developing sustainability indicators.

Site productivity Long-term site productivity is a concern when large volumes of organic material are removed, especially material that would have remained on the field to cover the soil and recycle nutrients. Crop and management systems should maintain or enhance soil productivity.

Water Quantity As feedstock production increases, water supply may become a limiting factor in some locations. Water is used to irrigate feedstocks and to convert feedstocks to bio fuels. To ensure water availability for societal purposes, advances in sustainable feedstock practices are needed to optimize efficient water use through crop development, production, use, and management; conservation practices; and water purification, reuse, and distribution technologies.

Water Quality Maintenance and enhancement of water quality is essential to ensure safe drinking water, fishable and swimmable waters, agricultural production, and manufacturing and other economic activities. Sedimentation, nutrient flow, and pesticide runoff have the potential to degrade both water quality and aquatic habitat (National Academies, 2007). Attenuation of sediment and chemical inputs will depend on the soil type, season, crop, and farm management practices. Additional work is needed in assessing, understanding, and modelling cumulative water quality impacts from feedstock production over broad spatial scales, especially in accumulative water systems and as a gauge for sustainability. As bio fuels production becomes more geographically dispersed, it will become more important to mitigate cumulative effects on larger bodies of water.

Land-Use Change Pertinent land-use categories include land already in production (for food, fuel, or fibber) and uncultivated land. Land-use shifts among categories have the potential for economic, social, and environmental benefits and/ or impacts. Shifting from one crop to another or one crop production system to another can affect availability of the displaced crop and/or productivity of the land. These shifts can affect crop prices, labour, and resources, with potential adverse or beneficial economic and environmental effects. Bringing uncultivated land into production may change the function of that land relative to goods and services. To achieve sustainability, the complex relationships of land use and the goods and services provided by the land must be managed efficiently.

Soil Productivity Soil productivity (and its enhancement) is a central, fundamental resource for biomass production, and is often considered a non-renewable resource. Soil loss through erosion is the most obvious environmental indicator of a sustainability concern. Soil structure and compaction, soil organic matter, and soil microbial communities all influence soil productivity and, more generally, long-term soil tilth. Such soil attributes also influence the ability of soil to provide essential environmental services, such as adsorbing and assimilating mobile nutrients and sequestering carbon. Tracking soil characteristics having a robust relationship to sustainability would provide useful measures related to soil productivity.

The system used to produce bio fuel feedstocks can affect erosion potential through the tillage practices used and soil properties. The extent of the impact depends on geography and the physical characteristics of the farm. Expanded crop production can include either conventional tillage or some form of conservation tillage, including no till. The farmer's choice of tillage practice depends on many factors such as available equipment, fuel prices, or incentives. As more acres of crop are grown for bio fuels, use of conventional tillage incurs greater erosion potential.

Residue Removal Corn Stover and straw are the residue materials left in fields after the crops are harvested for grain. These residues have been considered by some to be trash, with no value. However, these materials help prevent water and wind erosion of soil, replace soil organic carbon lost to the atmosphere due to cultivation, enhance soil structure, return inorganic nutrients to the soil, sustain microbial life in the soil, and increase water filtration through the soil. Residues also help maintain the soil's organic carbon levels to support crop productivity. The amount of residue needed to maintain soil organic carbon and crop productivity is generally greater than the residue needed simply to avoid soil erosion. Crop residue beyond that needed to sustain the land's productivity could be removed and used for bio fuel feedstock.

The amounts of sustainably harvestable residues for a specific location will vary depending upon climate, soil texture, and the production practices used. Corn produced with conventional tillage requires that more residues be left in the field than corn produced in no-tillage systems. Similarly, corn grown in rotation with soybeans requires more remaining residue than continuous corn because soybeans produce less residue than corn. Crops grown in higher rainfall areas or under irrigation produce more biomass than crops grown in areas with less precipitation or without irrigation (Gershwin et al., 2007; Wilhelm et al., 2007)

Forest and Wood Feedstocks: Generally, forestry sustainability is achieved through either the application of best management practices (BMPs) that are either voluntary or statutory (regulated by States). In all cases, these practices are

science-based and have the goals of protecting ecological function and minimizing negative environmental impacts. Many versions of forest sustainability criteria exist because of the various approaches to applying BMPs. Most include core ecological and environmental aspects, with additional considerations for economic and social implications. Forestry sustainability criteria usually have these basic elements:

- Conservation of biological diversity,
- Maintenance of productive capacity,
- Maintenance of forest ecosystem health and vitality,
- Conservation and maintenance of soil and water resources,
- Maintenance of forest contribution to global carbon cycles,
- Maintenance and enhancement of long-term multiple socioeconomic benefits, and
- Legal, institutional, and economic framework for forest conservation and sustainable management.

General harvest activities—Logging, when properly applied under BMPs, regulations, does not have significant negative ecological and environmental impacts. In the U.S., for example, much effort has gone into educating timber-harvesting operators and designing equipment to minimize ecological impacts. Cautionary actions are taken to minimize soil disturbance, to prevent soil or machine fluids from entering streams and other water bodies, and to meet prescribed biodiversity/habitat requirements, like leaving downed/standing dead trees, protecting sensitive areas, and using retention trees.

***Removing residues*—**Logging slash, the un-merchantable trees and tree components, can be removed so as not to accelerate erosion or degrade the site. Studies have shown how to minimize such impacts through use of buffer zones, leaving adequate biomass residue, and nutrient management programs.

***Thinnings*—**Thinnings leave some stand structure to provide continuous cover, erosion control, and habitat. Under correct prescriptions and harvesting operations, thinning enhances forest health and vitality by removing excess biomass.

Mill and urban wastes— Generally, it is more sustainable to use waste material than to dispose of it. This is even more important with urban wastes, especially if the only disposal option is landfills. Most mill wastes are being utilized for energy and other products (Fight et al., 2006; Biesecker and Right, 2006).

5.3 Socio-economic and Environmental Impacts

Sustainable development usually refers to a development that has economic and social benefits, and that can limit its negative environmental impacts. These three criteria, along with the available technologies, are therefore the three most widespread factors that will affect the conduction of a project. Bio energy projects are, in this way, similar to other projects, and also need to be evaluated based on the benefits it can provide to the economy, to society and the benefits and detrimental effects it will have on the environment http://www.megill.ca/bioenergy/impact/

Economic Impacts

The first step in any project always concerns the evaluation of the costs and the expected revenues. Bio energy projects always need to produce energy in a cost-effective way compared to other conventional methods of energy production. In some cases, bio energy can be undertaken despite the fact that other options seem, on a short term, to be more profitable, because of declining feedstocks or because of higher social or environmental benefits that will lead to increased governmental contributions http://www.megill.ca/bioenergy/impact/

Bio energy projects affect the communities in which they are implemented in various ways. This can go from improved water quality to the creation of new jobs

in economically depressed regions http://www.megill.ca/bioenergy/impact/

Some uses of bio energy require a feedstock based on dedicated field production (such as energy crops) or residues from agricultural production. Some agricultural fields are marginal for food production and bio energy production could improve these marginal lands. However, in some cases, the production of energy crops may have a detrimental effect on food security http://www.megill.ca/bioenergy/impact/

A good example on the social impacts of bio energy concerns corn ethanol and rising oil prices. Since corn is an energy-intensive crop and requires the use of fossil fuels, an increase in the cost of the barrel of oil also increases the production costs related to corn production. At the same time, this increase in oil prices increases the profits a farmer can make from the production of corn ethanol. Under competitive market conditions, the increase in oil prices limits the supplies of crop feedstocks and favours the transformation of corn supplies to corn ethanol. These consequences limit the supply of corn for animal and human consumption and can affect the global prices of corn, making it a less affordable product http://www.megill.ca/bioenergy/impact/

Environmental impacts

According to the World Health Organization, one of the leading causes of child mortality (under 5 years old) in poor countries is acute respiratory infections. These types of infections can be caused by an insufficient ventilation system to evacuate the accumulation of indoor air pollutants caused by the use of biomass as a cooking fuel. Bio energy can therefore have a detrimental effect on air quality. The use of pesticides and fertilizers can also affect water quality. Therefore, a proper assessment of the environmental impacts is often required prior to the implementation of bio energy technologies, in order to improve the quality of life of the people who will benefit from this technology. The use of briquettes, for example, have been investigated as a low-technology, cost-efficient fuel that could be used in developing countries in order to improve the efficiency of

cooking fuel

and to improve indoor air quality http://www.megill.ca/bioenergy/impact/

6. NATURE OF BIOENERGY INVESTMENT

Defining the nature of an investment determines its resources commitment, risk and the benefits thereof. Bio energy investment is expected among other things to promote rural development and poverty reduction. It is also expected to reduce the emission of Greenhouse Gases. What nature of bio energy investment would address this concern? Nigeria as a developing country has developmental challenges. Therefore bio energy investment policy tailored toward poverty reduction and rural development should be encouraged. Small-scale energy crop production could significantly increase both yield and incomes, securing real, long-term poverty reduction in rural communities. Large-scale bio energy/mass production could also provide benefits in the form of employment, skills development and secondary industry.

Huge capital investments and Foreign Direct Investments (FDIs) will be attracted into rural-sited feedstock chain stretching from agricultural through agro-industrial and petroleum-based enterprises. It will also lead to increased infusion of modern technology in these sectors. Increased demand for alternative energy light goods such as home appliances and equipments (stoves, lamps, etc) will increase the rate of light goods industrialization in the rural economy. In addition, Nigeria (South East) will attract the benefits of the Clean Development Mechanism (CDM) under the Kyoto Protocol meant to mitigate the effects of climate change, reduce poverty and increase rural development.

Concerning the quality of energy consumed the huge dependence of greater number of the Nigeria population on traditional biomass energy (fuel-wood and charcoal) portends many negative effects on economic development, human health and the environment. Commercialization of bio energy resources in the Nigeria (South East) should seek maximization of the wellbeing of the citizenry.

The inefficient management of the petroleum resources created socio-economic challenges which the nation is grappling with. This should not be the case with bio energy resources. Promoting investment climate that ensures energy security without compromising food security should be pursued.

The exploitation of bio energy for socio-economic wellbeing of society is vital for sustainable human development. Benefits of bio energy resources can only be actualized through investment. The nature of bio energy investment involves feedstock, bio fuel production and bio chemicals. Biomass feedstocks that can be produced in Nigeria (South East) include corn, palm oil, cassava, etc. With proper land use and water resource management these crops can provide sustainable feedstock as well as ensure adequate supply of industrial raw materials and food security. Other biomass resources that can be found in Nigeria (South East) also includes: coca husk, saw dust, palm kernel, municipal waste etc.

In recent years there has been renewed global interest in bio fuels and a rapid expansion of bio fuels markets. Arguably their greatest appeal lies in their potential to reduce greenhouse gas emissions by partial replacement of oil as a transport fuel. This could help Nigeria meet her commitments under the Kyoto Protocol and mitigate the effects of climate change. Further driving forces behind bio fuel market development include the development and promotion of greater energy security; rural development; and poverty reduction. These factors combine to place bio fuels at the top of today's most pressing policy agendas.

Bio fuel technologies are already well developed and available in many countries. Many governments have begun introducing policies to increase the proportion of bio fuels within their energy portfolio. Worldwide production of bio fuels is expected to quadruple in the next twenty years, accounting for about 10 per cent of global motor fuel http://www.researchandmarkets.com/reports/451894/ (referred 10.11.2009).

Feedstock Investment

Investment in feedstock production requires arable land, water, labour, machine (technology), money and materials. The nature of bio energy investment will

Consider among other things alternative feedstocks for bio fuels. The foundation of the feedstock market is the underlying land base. Additional options for emerging feedstocks would reduce pressures on land, either because they are jointly produced with other products (e.g., crop or wood residues) or because their production could be concentrated in a limited area. However, because most feedstocks are land-based and the amount of land in agriculture is relatively constant, allocating more land to growing feedstocks may mean less land is allocated to other uses. The manner in which that tradeoff is resolved has implications for feedstocks as well as food/fibber markets. The economics of land market competition could influence the market dynamics for alternative feedstocks.

7. RESEARCH METHODOLOGY

Questionnaire as well as official data was used in the analysis of the Market/Investment potential of bio energy/mass in Nigeria (South East). The study made use of existing official data to analyze the market potential of bio fuel in Nigeria. The data analysis focus is on how much of the conventional energy supply in the energy market that can be substituted for bio fuel. Data obtained from questionnaire is presented in tabular form and analyzed using percentage frequencies. A total number of one hundred (100) questionnaires were distributed to top public servants and private investors. Eighty (80) questionnaires were completed and returned while twenty (20) were not returned. Therefore, the analysis of sampled opinions will be based on the completed and returned questionnaires. A copy of the questionnaire seen as Appendix 1 contains the questions that form part of the basis of this research.

7.1 Research Question A

Table 1: Potential **Effect of Biomass on Electricity Production**

Source Types	Area/region/city	Distance from /nearness to your location	Quantity produce/year (million tons)	Calorific Value (MJ/kg) (mega joule)	Measurement 1kw=1kilowatts 1000kw=1MW. Total Biomass energy (TJ) (terajoule)	calculation of MJ to KWH (MJ= KWH)	Total biomass energy (MWh) per year
Sawdust	Aba,	Close	5.20	15	78.000,000	0,277778	21.666684
	Abakiliki,		2.34	15	35.100.000	0,277778	9.7500078
	Enugu,		4.17	15	62.550.000	0,277778	17.375013
	Owerri,		3.847	15	57.705.000	0,277778	16.029179
	Umuahia		2.736	15	41.040.000	0,277778	11.400009
Cocoa husk	Umuahia	Close	1.22	18.3	22.326.000	0,277778	6.2016716
	Uyo		1.38	18.3	25.254.000	0,277778	7.0148035
Palm kernel	Aba,	Close	66	18.30	1.207.800	0,277778	335.50026
	Abakiliki,		33	18.30	603.900.000	0,277778	167.75013
	Enugu,		64	18.30	1.171.200	0,277778	352.33359
	Onitsha,		43	18.30	786.900.000	0,277778	218.5835
	Owerri,		58	18.30	1.061.400	0,277778	294.83356
	Umuahia		44	18.30	805.200.000	0,277778	223.66684
Biodegradable municipal waste (usorted)	Aba,	Close	225	9	2.025.000	0,277778	562.50045
	Abakiliki,		103	9	927.000.000	0,277778	257.5002
	Enugu,		221	9	1.989.000	0,277778	552.50044
	Onitsha,		218	9	1.962.000	0,277778	545.00043
	Owerri,		222	9	1.998.000	0,277778	555.00044
	Umuahia		105	9	945.000.000	0,277778	262.50021
Total			**1422.893**	**275.4**	**4.399.4274**	**0.277778**	**3.862.1067**

Source: Field Survey 2009

Table 1 shows some of the cities where biomass resources can be found in Nigeria (South East). It also shows that the quantity of biomass available is significant and that it is sustainably sufficient to supply regular electricity energy in South East Nigeria and also contribute to the national grid. All the respondents said they would like to have regular electricity supply but only 37% of them indicated that they would like to have personal electricity plant for this supply. However, most of the respondents added that they will opt for personal electricity supply if they can afford it and if at the long run it will be relatively cheaper than the public electricity supply. In my calculation I tried to use each of the quantity of tons units to calculate it by multiplying it with each calorific value of mega joule per kilogram (MJkg) to get the measurement of kilowatts hour of total biomass energy´ s terajoule (TJ), and also multiply each of the total biomass energy with the calculation of mega joule = kilowatts hour (MJ = KWH) with the figure shown at the diagram 0.277778 to get the total biomass energy megawatts hour (MWH) per year. Finally the table will show you how the calculations were made to each other.

7.1.2 **Research Question B**

Table 2: **Projected Contributions of Bio fuels in the Nigeria Energy Market**

Bio fuel		**Time Frame**		
		Short term 2010	Medium term 2015	Long term 2030
Bio-ethanol	Demand (billion litres/year)	1.4	3.40	47
	% contribution to Premium Motor Spirit (PMS) Supply	10% (E10)	15% (E15)	50% (E50)
Bio-diesel	Demand (billion litres/year)	0.30	1.95	20.5
	% contribution to diesel fuel supply	5% (B5)	20% (B20)	50% (B50)

Source: Energy Commission of Nigeria 2009

Table 2 above shows that 2010 projections for bio-ethanol demand is 1.4 billion litres. This represents 10% of the total market demand for PMS (Premium Motor Spirit) for the year. It is evident from the table that the market size for bio-fuels is significant with potentials for growth.

7.1.3 **Research Question C**

Table 3: **Projected 2010 Energy Demand in Nigerian**

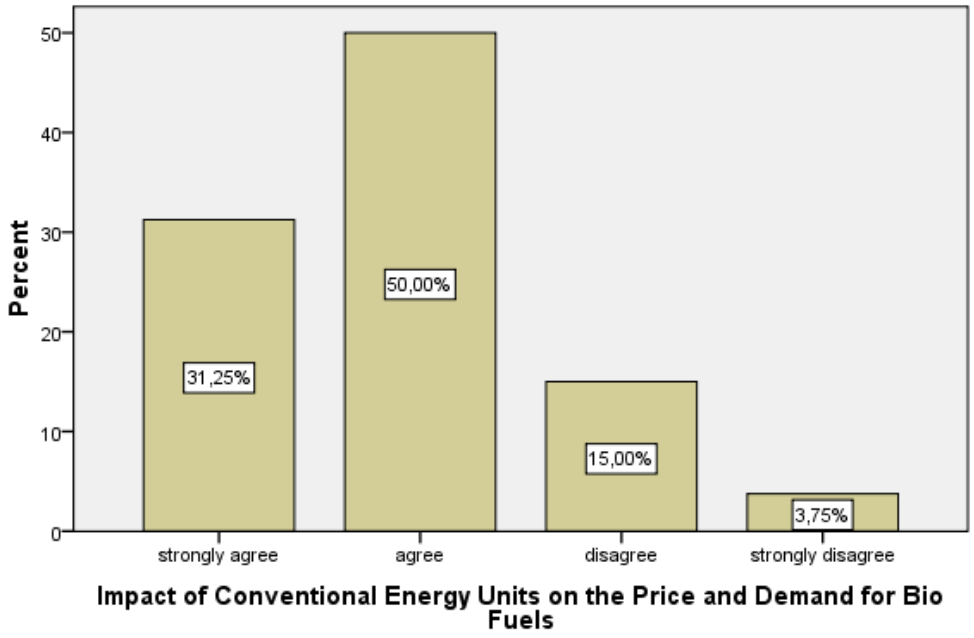
S/no	Petroleum Product(s)	Market demand per year (litres)
1.	PMS (Premium Motor Spirit)	13,879 billion
2.	DPK (Dual Purpose Kerosene)	2,990 billion
3.	AGO (Auto Motor Gasoil)	6,012 billion

Source: Energy Commission of Nigeria (2006)

Table 3 shows the quantum of conventional energy in Nigeria energy market that can be substituted for bio energy/mass. This indicates that 13,879 billion litters of PMS can be substituted for bio ethanol in the Nigeria energy market.

7.1.4 **Research Question D**

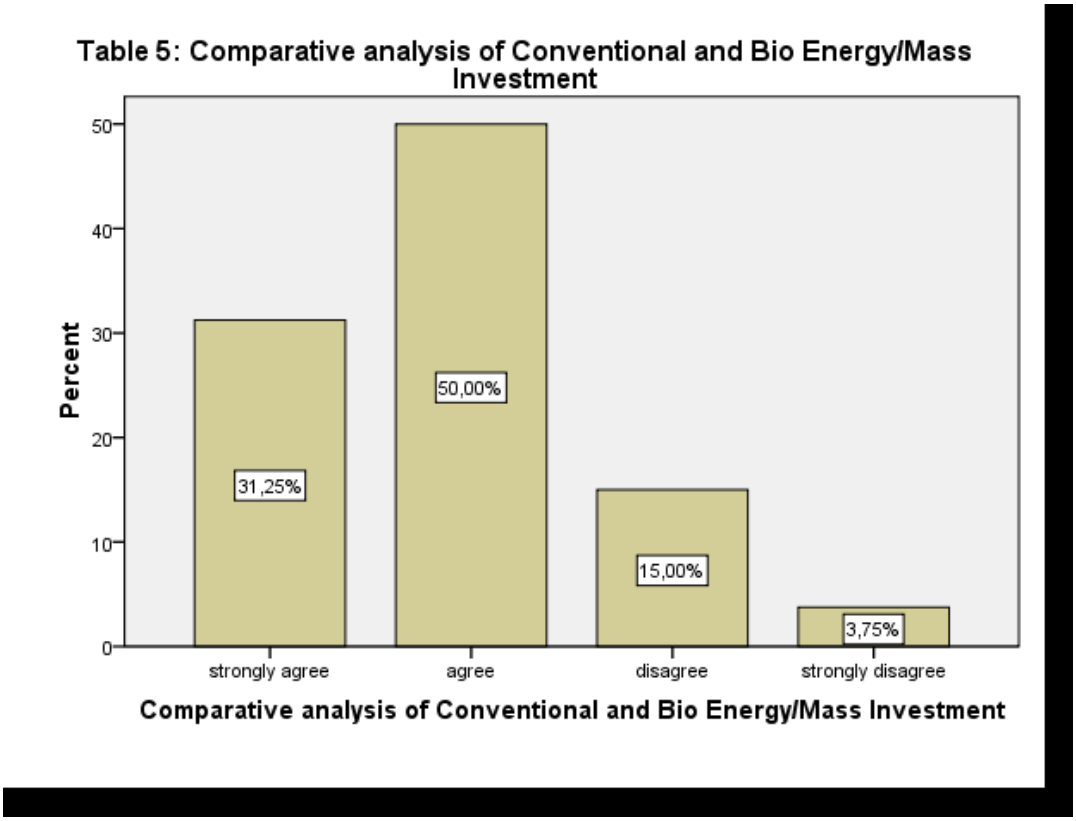
Table 4: Impact of Conventional Energy Units on the Price and Demand for Bio Fuels



Source: Field Survey, 2009

In table 4, 50% of the respondents agreed that conventional energy units will affect the price and demand for bio energy market share while 3.75% strongly disagreed. This is an indication that conventional energy units will adversely affect bio energy market share.

7.1.5 **Research Question E**



Source: Field Survey, 2009

From Table 5, 50% of the respondent agreed that the value of bio energy/mass investment if comparatively cheaper further investment in conventional energy would not be ideal. This view was not sheared by 3.75% of the respondent. This indicates that Investment potential of bio energy will be determined by the value

of the extra investment on the conventional energy compared to the value of bio energy investment.

7.2 Analysis of Questionnaire

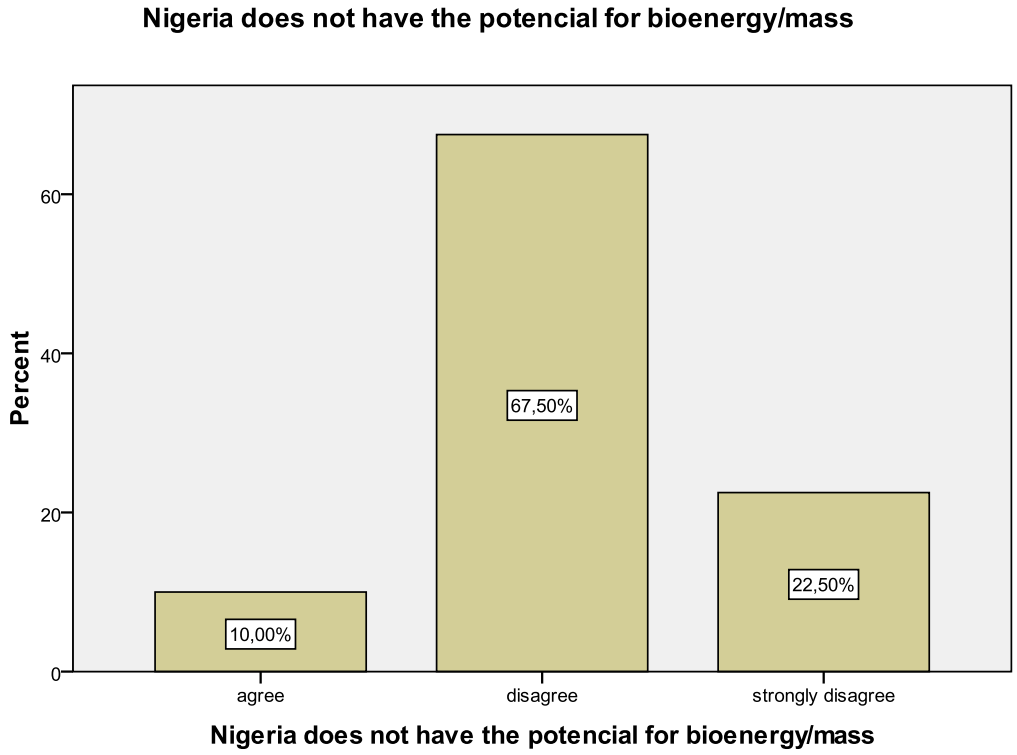
Table 6: **Distribution and Collection of Questionnaire**

Total Number of Questionnaire Distributed	Number of Questionnaire Returned	Percentage of Number of Questionnaire Returned	Percentage Number of Questionnaire Not Returned
100	80	80	20

Table 6: shows that a total of 100 questionnaires were distributed to respondents and 80 were returned. The figure represents 80% of the total questionnaire distributed. The analysis is made based on this figure.

Question 7 of the Questionnaire:

Table 7:

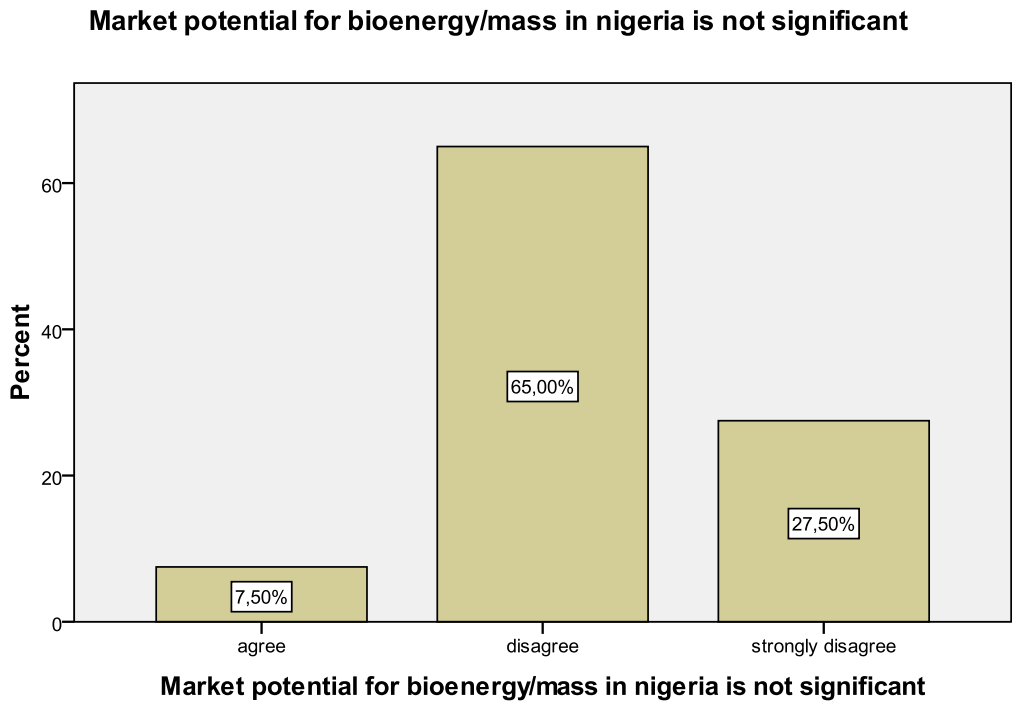


Source: Field Survey, 2009

In table 7, 67.5% of the respondents disagreed that Nigeria does not have the potential for investment in bio energy/mass while 10% agreed. The analysis from the above table therefore shows that the country has the potential for investment in bio energy/mass.

Question 8 of the Questionnaire:

Table 8:

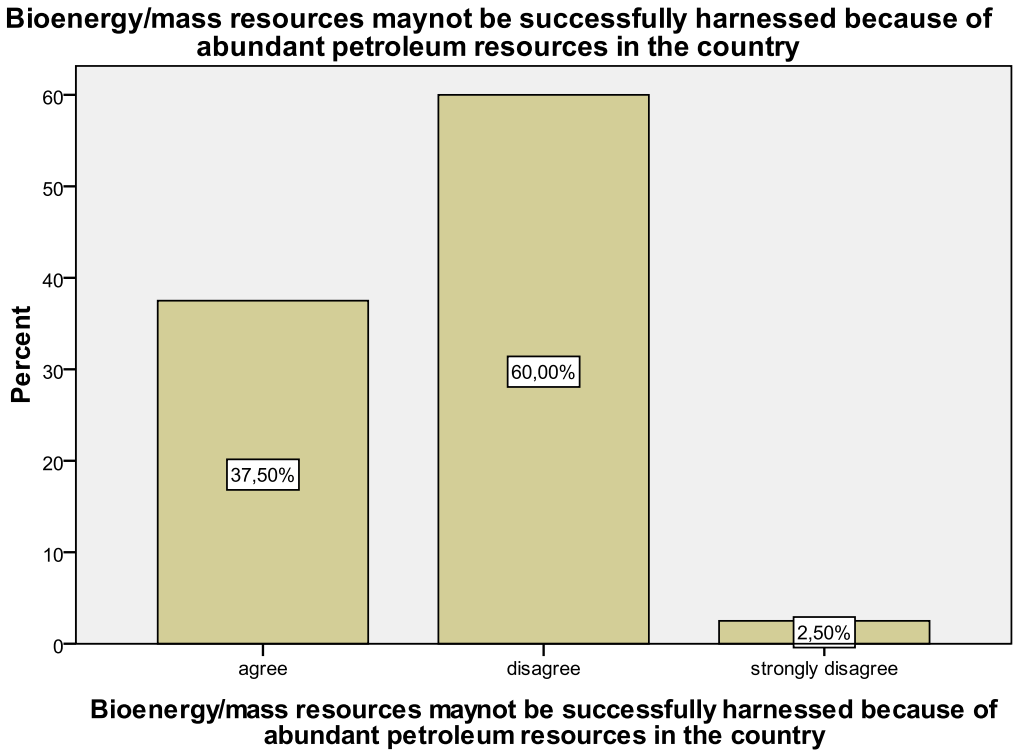


Source: Field Survey, 2009

Table 8 shows the market potential analysis of bio energy/mass. Greater percentage (65%) disagreed that market potential of bio energy/mass in Nigeria is not significant while 7.5% agreed, indicating that there exists significant market potential of bio energy/mass in the country.

Question 9 of the Questionnaire:

Table 9:

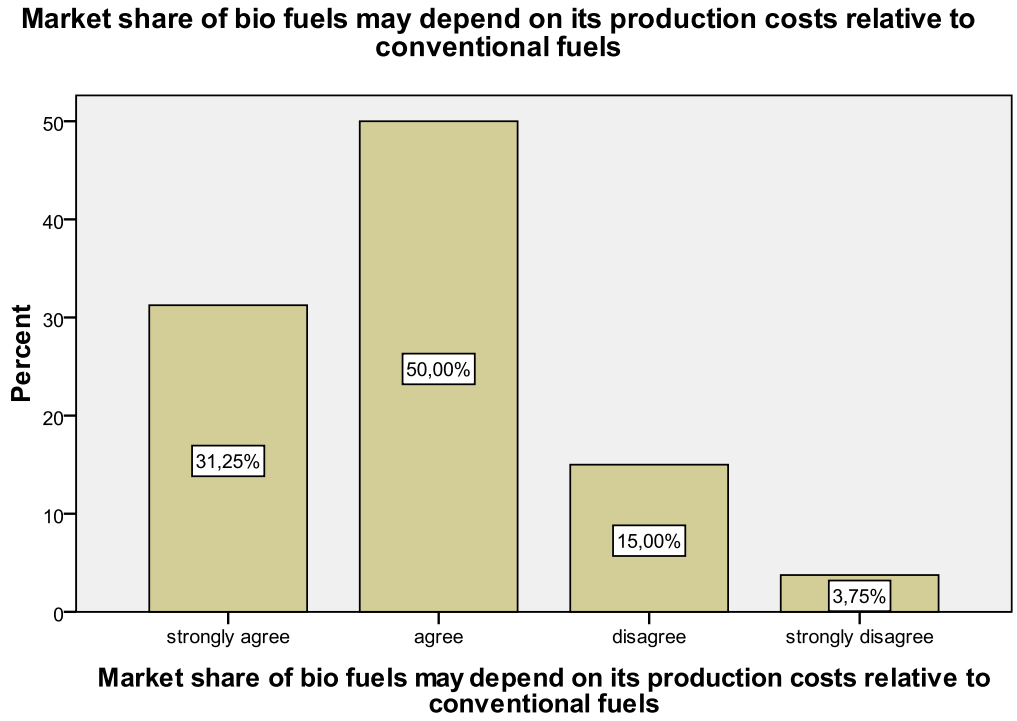


Source: Field Survey, 2009

The effect of petroleum resources on bio energy/mass market/investment is represented in table 9. The percentage of respondent which disagree that Bio energy/mass resources may not be successfully harnessed because of abundant petroleum resources is 60% while 37.5% agreed. With this result, it can be stated that the nation's petroleum resources would not affect bio energy/mass commercialization.

Question 10 of the Questionnaire:

Table 10:

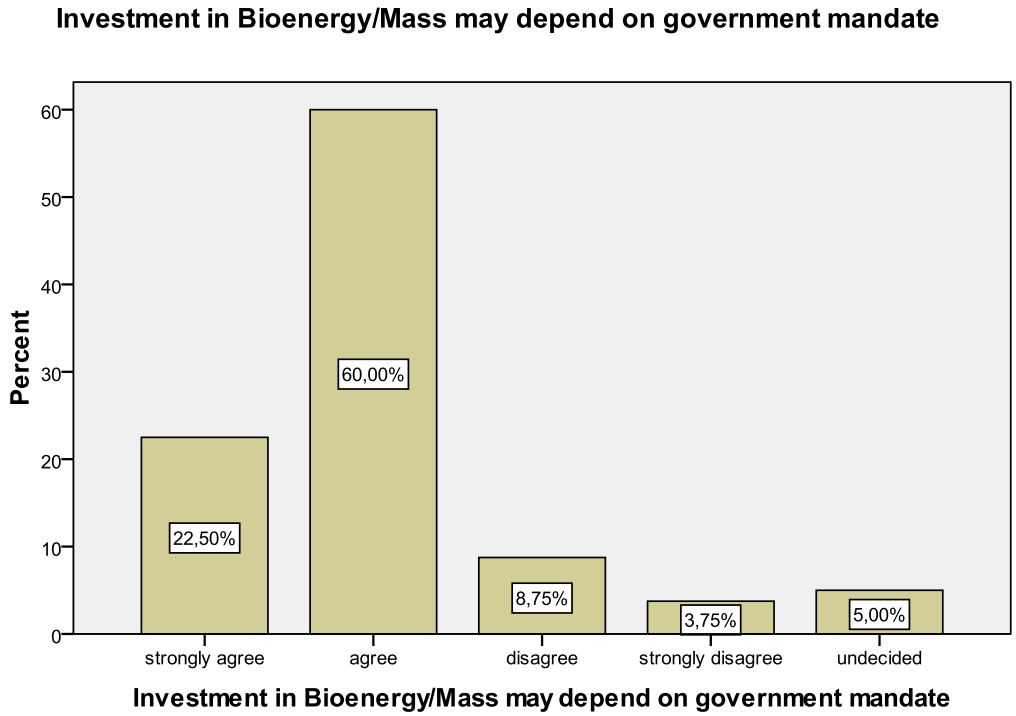


Source: Field Survey, 2009

Table 10 shows that 50% of respondents agreed that market share of bio fuels may depend on the production cost of conventional fuels while 3.75% strongly disagreed. This shows that market share of bio fuels will be influenced by the production cost of conventional fuels.

Question 11 of the Questionnaire:

Table 11:

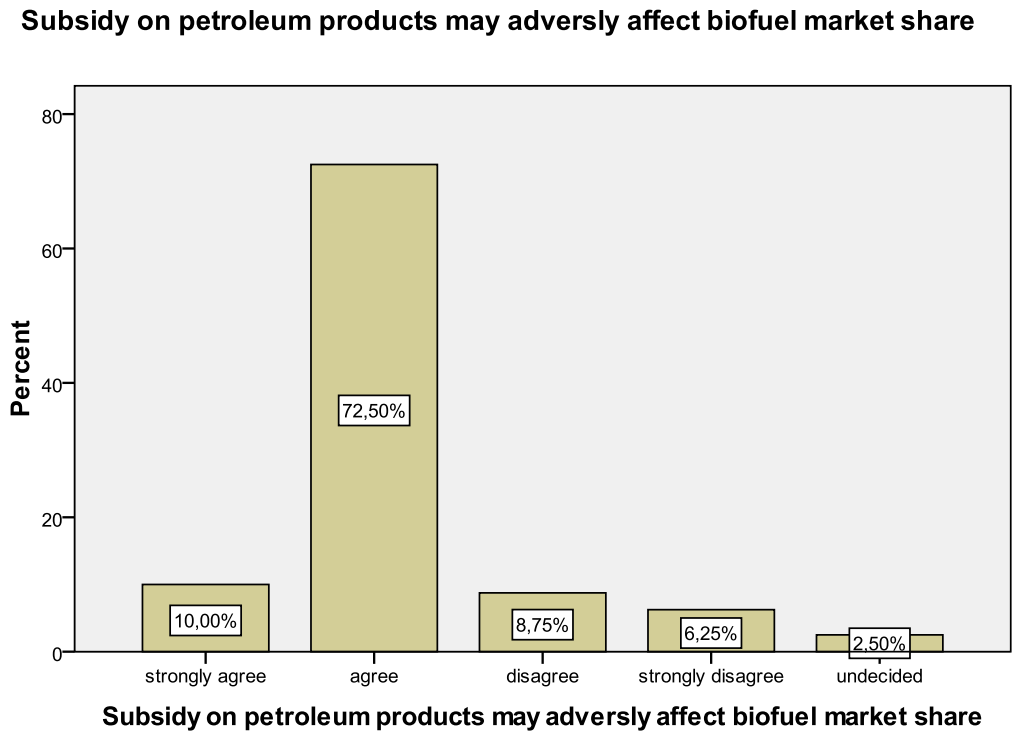


Source: Field Survey, 2009

From the analysis of table 11, 60% of the respondents agreed that bio energy/mass investment may depend on government mandate while 3.75% strongly disagreed. This indicates that investment in bio energy/mass will be greatly influenced by government policy.

Question 12 of the Questionnaire:

Table 12:

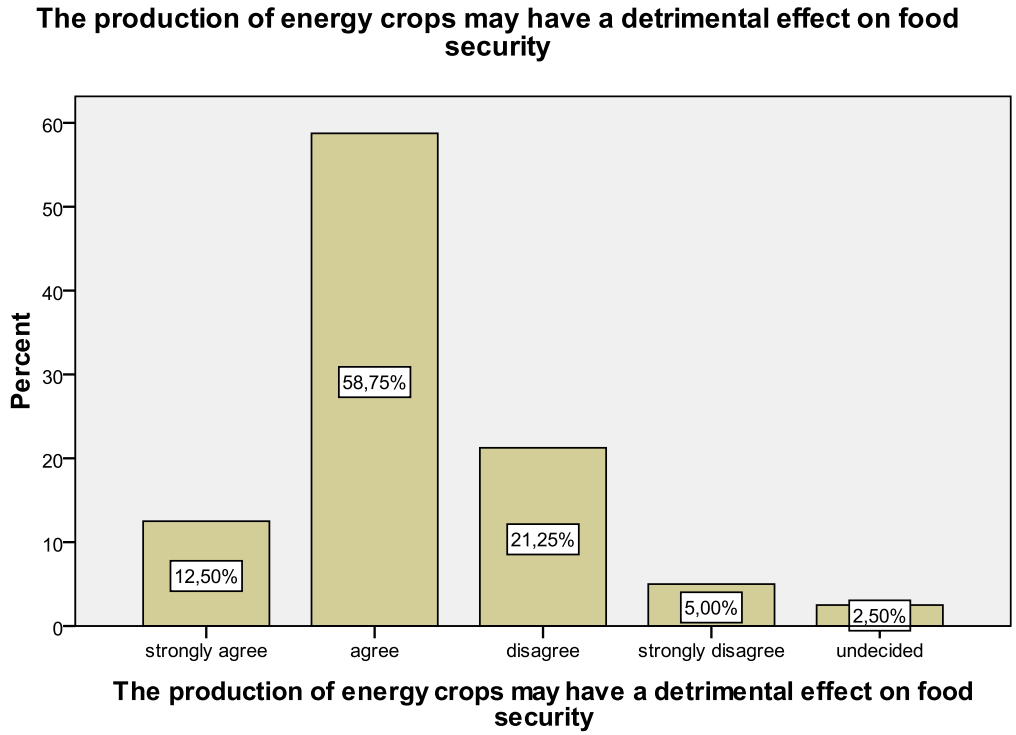


Source: Field Survey, 2009

It can be seen from the analysis of Table 12 that 72.5% of the respondents agreed that petroleum product subsidy will adversely affect bio energy market share while 6.25% strongly disagreed. This is an indication that bio energy market/investment will be greatly influenced by petroleum subsidy.

Question 13 of the Questionnaire:

Table 13:

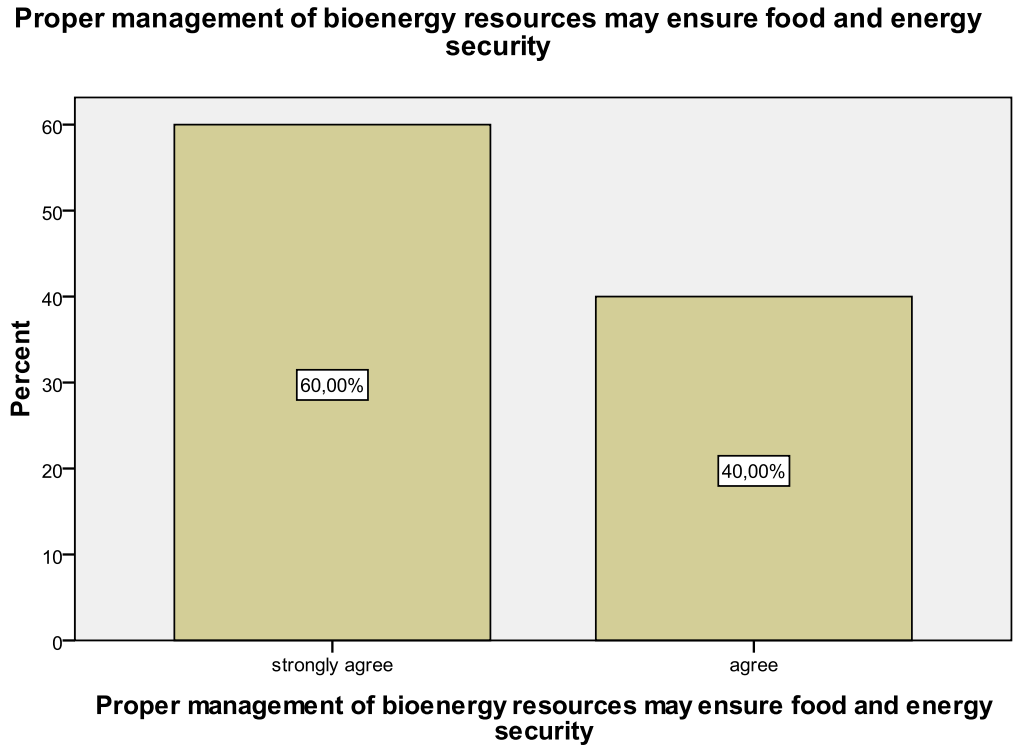


Source: Field Survey, 2009

The analysis of table 13 shows that 58.75% respondents are of the opinion that production of energy crops may adversely affect food security while 5% strongly disagreed. From this analysis it is apparent that food security concern is a major factor in determining the market/investment potential of bio energy/mass in Nigeria.

Question 14 of the Questionnaire:

Table 14:

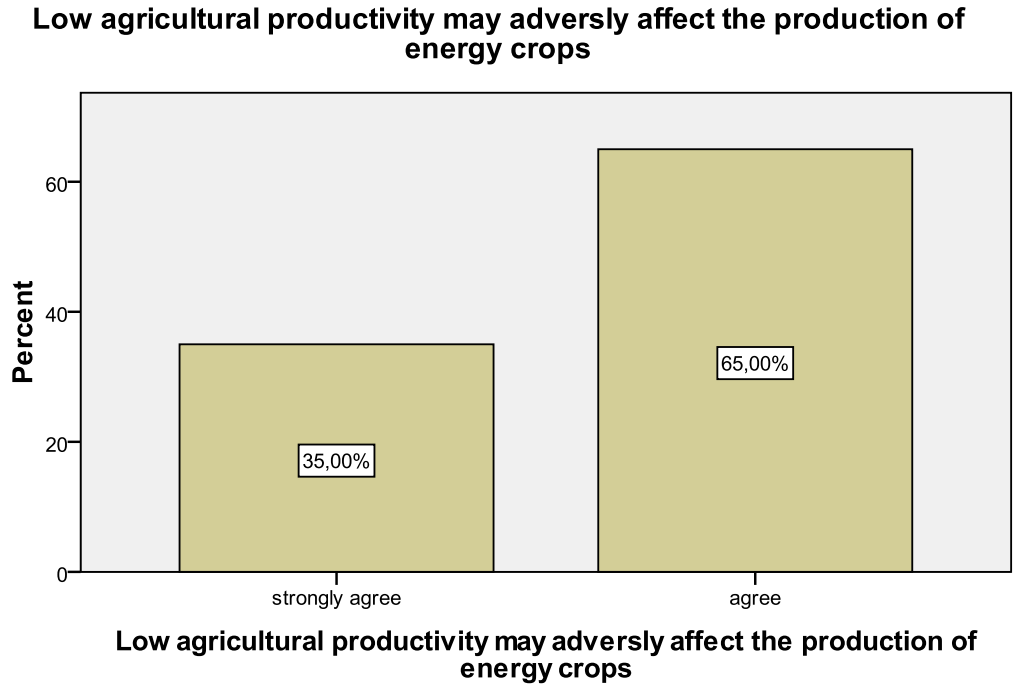


Source: Field Survey, 2009

As can be seen from Table 14, all the respondents are of the opinion that proper management of bio energy/mass resources will ensure food and energy security. This indicates that efficiency of bio energy/mass resource management is the key to bio energy/mass sustainability.

Question 15 of the Questionnaire:

Table 15:



Source: Field Survey, 2009

Table 15 shows that all the respondents are of the opinion that low agricultural productivity may adversely affect energy crop production. This indicates that agricultural productivity is a key determinant of market/investment potential of bio energy/mass production in Nigeria.

7.3 Discussion of Findings

From the data analysis it is evident that Nigeria (South East) has bio-energy/mass market/investment potential. From table 1 in the research analysis it was found

that biomass resources that can be found in South East Nigeria are in sufficient and sustainable quantity to supply for example regular electricity energy. The implication of this finding is that the exploitation of bio energy/mass will help mitigate the electricity energy supply challenges in Nigeria. The research finding reveals that bio energy/mass market potential is significant with potentials for growth. Investment in bio energy/mass business will be worthwhile in Nigeria (South East) given the market potential. Thus an adoption of for example E10 for petrol and E5 for diesel will have a positive impact on employment generation in Nigeria (Southeast) especially among the rural populace. Many bio-fuel production processes are labour-intensive and most bio-ethanol-related jobs involve low-skilled and poor workers in rural areas. The World Bank reports that bio-fuel industries require about 100 times more workers per unit of energy produced than the fossil fuel industry. Bio fuel production is expected to generate more employment per unit of energy than conventional fuels and more employment per unit investment than in the industrial, petrochemical or hydropower sector **(UN-Energy 2007).**

The study finding reveals that the quantum of conventional energy supply in Nigeria that can be substituted for bio energy/mass is substantial. The implication is that if Nigeria government adopts a policy of substituting for example fossil fuel for bio energy/mass it will bring about benefits bio energy/mass portends. The research found that investment potential in bio energy/mass production may depend on government mandate, production cost of bio-fuels relative to other fuel substitutes, subsidy on petroleum products and the level of agricultural productivity. Low agricultural productivity may adversely affect the production of bio-energy crops. Without efficient agricultural sector bio energy crop production may affect food security.

CONCLUSION

The impact of fossil fuels on the environment sparked off the quest for alternative energy sources that are environmentally friendly. Bio energy/mass has been tipped as energy future because of its attributes of low carbon emission and socio-economic benefits. It is expected that bio energy/mass will be top on the list of possible substitutes for fossil fuel. Sometime in the future crude oil wells will run dry. This does not mean that civilization will come to a halt. The world will need energy to drive its economy and bio energy/mass is that vista of hope that the world is banking upon to replace fossil fuel. Given this expectation, it becomes apparent that the market potential of bio energy/mass is substantial. It is only natural that investment flow will tilt towards bio energy/mass to meet present as well as future energy demand.

Bio energy/mass has its benefits and shortcomings. The socio-economic and environmental benefits also come with constrains that are likely to limit bio energy/mass market potential. Some of these constraints identified by this study include: production cost of bio-fuels relative to other fuel substitutes, subsidy on petroleum products and the level of agricultural productivity. Some energy crops provide industrial raw materials and food. These energy crops will compete for the scarce land and water resources to provide energy, raw materials for the industries and food. As a renewable energy, bio energy/mass sustainability will depend on efficient management of biomass resources and government policy.

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APPENDIX 1

QUESTIONNAIRE ON MARKET/INVESTMENT POTENTIAL
OF BIO ENERGY/MASS IN NIGERIA (SOUTH EAST)
THIS QUESTIONNAIRE IS GOING TO BE USED
PURELY FOR AN ACADEMIC RESEARCH

SECTION A

1. Will you like to have a regular supply of electricity energy? Yes/No
2. Will you like to have your personal electricity plant for this supply? Yes/No
3. How much biomass (palm kernel, cocoa husk, saw dust, biodegradable municipal waste etc.) can be produced in your area per year? ……
4. For how long do you think this production/business will continue in existence? ……
5. What is the distance from/nearness of (any of the above mentioned) to your location? ……..
6. Are you ready to pay the following rates for that: ₦5/kwhr (domestic), ₦7/kwhr (commercial), and ₦9/kwhr (industrial)?

SECTION B

Please mark X in any option you consider appropriate for the questions.

The statements below are related to market/investment potential of bio energy/biomass in Nigeria: (Southeast) please circle the response number that best describes how you feel about each statement.

Note: (1) **Strongly agree** (2) **Agree** (3) **Disagree** (4) **Strongly disagree** (5) **Undecided**

7. Nigeria does not have the potential for investment in bio energy/mass.

   1☐ 2☐ 3☐ 4☐ 5☐

8. Market potential for bio energy/mass in Nigeria is not significant.

   1☐ 2☐ 3☐ 4☐ 5☐

9. Bio energy/mass resources may not be successfully harnessed because of abundant petroleum resources in the country.

   1☐ 2☐ 3☐ 4☐ 5☐

10. Market share of bio fuels may depend on its production cost relative to Conventional fuels.

    1☐ 2☐ 3☐ 4☐ 5☐

11. Investment in bio energy/mass may depend on government mandate.

    1☐ 2☐ 3☐ 4☐ 5☐

12. Subsidy on petroleum products may adversely affect bio fuel market share.

    1☐ 2☐ 3☐ 4☐ 5☐

13. The production of energy crops may have a detrimental effect on food security.

    1☐ 2☐ 3☐ 4☐ 5☐

14. Proper management of bio energy resources may ensure food and energy security. 1☐ 2☐ 3☐ 4☐ 5☐

15. Low agricultural productivity may adversely affect the production of energy crops.

    1☐ 2☐ 3☐ 4☐ 5☐

APPENDIX 11

Frequency Table Results:

Nigeria does not have the potential for bioenergy/mass

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	agree	8	10,0	10,0	10,0
	disagree	54	67,5	67,5	77,5
	strongly disagree	18	22,5	22,5	100,0
	Total	80	100,0	100,0	

Market potential for bioenergy/mass in Nigeria is not significant

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	agree	6	7,5	7,5	7,5
	disagree	52	65,0	65,0	72,5
	strongly disagree	22	27,5	27,5	100,0
	Total	80	100,0	100,0	

Bioenergy/mass resources may not be successfully harnessed because of abundant petroleum resources in the country

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	agree	30	37,5	37,5	37,5
	disagree	48	60,0	60,0	97,5
	strongly disagree	2	2,5	2,5	100,0
	Total	80	100,0	100,0	

Market share of bio fuels may depend on its production costs relative to conventional fuels

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	25	31,3	31,3	31,3
	agree	40	50,0	50,0	81,3
	disagree	12	15,0	15,0	96,3
	strongly disagree	3	3,8	3,8	100,0
	Total	80	100,0	100,0	

Investment in Bioenergy/Mass may depend on government mandate

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	18	22,5	22,5	22,5
	agree	48	60,0	60,0	82,5
	disagree	7	8,8	8,8	91,3
	strongly disagree	3	3,8	3,8	95,0
	undecided	4	5,0	5,0	100,0
	Total	80	100,0	100,0	

Subsidy on petroleum products may adversely affect biofuel market share

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	8	10,0	10,0	10,0
	agree	58	72,5	72,5	82,5
	disagree	7	8,8	8,8	91,3
	strongly disagree	5	6,3	6,3	97,5
	undecided	2	2,5	2,5	100,0
	Total	80	100,0	100,0	

The production of energy crops may have a detrimental effect on food security

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	10	12,5	12,5	12,5
	agree	47	58,8	58,8	71,3
	disagree	17	21,3	21,3	92,5
	strongly disagree	4	5,0	5,0	97,5
	undecided	2	2,5	2,5	100,0
	Total	80	100,0	100,0	

Proper management of bioenergy resources may ensure food and energy security

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	48	60,0	60,0	60,0
	agree	32	40,0	40,0	100,0
	Total	80	100,0	100,0	

Low agricultural productivity may adversely affect the production of energy crops

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	28	35,0	35,0	35,0
	agree	52	65,0	65,0	100,0
	Total	80	100,0	100,0	

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