STRATEGIES FOR ENHANCING BIOMASS FUEL POWER PLANTS AS AN ALTERNATIVE FOR ENERGY GENERATION IN NIGER STATE.

BY

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2008/2/31432BT

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SEPTEMBER, 2012.

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2008/2/314632BT

A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION, SCHOOL OF SCIENCE AND SCIENCE EDUCTION, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF THE AWARD OF BACHELOR OF TECHNOLOGY (B.TECH) IN INDUSTRIAL AND TECHNOLOGY EDUCATION

SEPTEMBER, 2012.

CERTIFICATION

I, Ajayi O. Abayomi with Matric. Number 2008/2/31432BT an undergraduate student of the Department of Industrial and Technology Education certify that the work embodied in this project is original and has not been submitted in part or full for any other diploma or degree of this or any other University.

Name

Signature

APPROVAL PAGE

This project has been read and approved as meeting the requirement for the award of B.Tech degree in Industrial and Technology Education, School of Science and Science Education, Federal University of Technology,Minna.

Supervisor Signature/Date

Head of Department Signature/Date

External Supervisor Signature/Date

DEDICATION

I humbly dedicate this project to Almighty God whose wisdom has enabled me to attain this free academic height. Finally to my family; for stimulating my interest in the Educational pursuit to create my own future

ACKNOWLEDGEMENT

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All glorification, magnification and adoration are due to Almighty God for sparing my life and guided me throughout my course of academic pursuit. It is with a honest and deep sense of appreciation that I sincerely acknowledge my project supervisor Dr. S. A. Maaji whose expert suggestions in this research have greatly inspired me in carrying out this project, behind every successful project there must be a good and dedicated supervisor.. May Almighty God reward you abundantly. A very big appreciation to Mr Alawide Opeyemi who came at a very crucial time to assist with my project work, i also owe it as a duty to extend my thanks to the Head of Department Industrial and Technology Education, Dr. E.J. Ohize for piloting the canoe of this great Department untiringly, you are truly a mentor. I equally thank the project coordinator Mr. T.M SABA for coordinating the task in the right direction. My special thanks go to Prof. G.D. Momoh, Prof. K.A. Salami, Prof. B.N. Atsumbe, my level adviser Mallam Abdul Bello Kagara and the Examiner Mallam Abdulkadir Muhammed. To all the lecturers in the Department of Industrial and Technology Education, I say a big thank you for your patience, wisdom and contributions that help to create a better ME, may Almighty God reward you abundantly. My unreserved appreciation and special thanks goes to my parent, brothers, sisters, friends and beloved ones who all contributed financially and otherwise towards my educational pursuit, a special cheer for you all.

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ABSTRACT

The project titled "strategies for adopting biomass power plants as an alternative for energy generation in Minna metropolis, Niger state" was carried out with the aim to identify strategies to be adopted in employing the use of biomass power plants for alternative energy generation. Four questions were provided for the study and four hypotheses were formulated. Data for the study were collected through the administration of questionnaire to randomly selected small scale industries and students of electrical engineering/industrial technology. The results of their responses were analyzed using the mean of the two groups. Also t-cal and t-table, means score of respondents, standard deviation are used in respect to four liker scale, all used as the decision rules for the data analysis. A null hypothesis was tested at 0.05 degree of acceptance to show the relationship between the respondents. The discussion of the findings showed at the end of this study, the researcher recommended that the government of Niger state should encourage biomass power conversion for the generation of electrical energy in Minna, Niger state.

CHAPTER ONE

INTRODUCTION

Background of the study

Energy it is an essential ingredient for socio-economic development and economic growth. The objective of the energy system is to provide energy services. Energy services are the desired and useful products, processes or indeed services that result from the use of energy, such as for lighting, provision of air-conditioned indoor climate, refrigerated storage, transportation, appropriate temperatures for cooking etc. The energy chain to deliver these cited services begins with the collection or extraction of primary energy, which is then converted into energy carriers suitable for various end-uses. These energy carriers are used in energy end-use technologies to provide the desired energy services (Sambo, 1997). Energy as defined by Wikipedia: (*energeia in Greek*) is an indirectly observed quantity that is often understood as the ability of a physical system to do work on other physical system.

Currently a high proportion of the world's total energy output is generated from fossil fuels such as oil and coal. In general, the quest for an option to conventional power schemes for extension to remote and rural locations of developing countries like Nigeria arises from the high costs associated with the extensions, as well as the maintenance, of the power grid system to rural areas. Although research and development activities are still being seriously undertaken in various aspects of renewable energy utilizations, a number of the technologies have since been shown to be feasible and ready, for adoption into the economy. These technologies are very suitable for the rural areas of Nigeria (Sambo, 1992).

However, it is universally accepted that fossil fuels are finite and it is only a matter of time before their reserves become exhausted. Estimates of reserves of fossil fuels all reach the same conclusion. Extended use of these reserves, worldwide, in the current manner will continue for no more than some decades to come. The need supplementary or even alternatives that ideally will be non- depletable energy sources have since been recognized. These non-depletable sources are replenish-able and are also referred to as renewable energy sources as they are available in cyclic or periodic basis. These renewable sources of energy includes: Solar energy which has an estimated worldwide average power potentials of 24W per square meter of the earth's surface (assuming 10% efficiency); hydropower, major sources of which are still underdeveloped, has an estimated potential of the range 2-3TW with an annual output of 10,000-20,000TWh but is only available in certain areas of the world; also available in limited areas of the world are wind energy and biomass (Considine, 1977).

Biomass refers to energy derivable from sources of plant origin such as trees, grasses, agricultural crops and their derivatives, as well as animal wastes. As an energy resource, biomass may be used as solid fuel, or converted via a variety of technologies to liquid or gaseous forms for the generation of electric power, heat or fuel for motive power. Biomass resources are considered renewable as they are naturally occurring and when properly managed, may be harvested without significant depletion. Biomass resources available in the country include: fuel-wood, agricultural waste and crop residue, sawdust and wood shavings, animal dung/poultry droppings, industrial effluents/municipal solid waste. The rain forest in the south generates the highest quantity of woody biomass while the guinea savannah vegetation of the north central region generates more crop residues than the Sudan and Sahel savannah zones. Industrial effluent such as sugar cane molasses is located with the processes with which they are associated. Municipal wastes are generated in the high-density urban areas.

As per the estimation and the result of the statistics, the biomass construct can generate about 7,000 megawatts of renewable electricity. It has been considered as a suitable resource for producing energy because it fabricates less sulphur dioxide than coal. The operations of the Mill give the impression to be the chief basis of biomass energy in the U.S. On the contrary, Europe illustrates its foremost source of bio-energy from urban wood squander. However, the third world countries make lumber their most important source of the bio-energy. As per the statistics, 11% of the world obtains s its energy from biomass stations. Developing countries use about 35% of the biomass energy; by contrast the poorest ones use roughly 90%.

Electricity is a form of energy produced by the movement of electrons. Electricity is electrical power or an electric current, this form of energy can be sent through wires in a flow of tiny particles. It is used to produce light and heat and to run electric motors. Electricity is a basic feature of all matter, and everything in the universe. We need energy in various forms like heat, light, sound etc. the development of new technology made it possible to convert electrical energy into any form of energy. This gives electrical energy an important position in the world. The running of industrial structure depends on the low cost and modern uninterrupted supply of electricity. In short, we can say a country is developed if the per capital consumption of electrical energy is high. Electrical energy is considered to be superior over other energy forms. It is clear that energy is an essential input to all aspects of modern life. It is indeed the livewire of industrial production, the fuel for transportation as well as for the generation of electricity in conventional thermal power plants.

The energy which has been generated from the natural resources, like the sunlight, rain, tides, wind, and geothermal heat which can refill tranquilly is called renewable energy. It has been estimated that in the year 2006, about 18% of the global energy consumptions came from renewable sources from which 13% imminent from biomass like from burning of the wood. Hydroelectricity is known to be among the largest resource of the renewable energy which conduced 3% of the energy consumption and 15% of electric generation across the globe in the year 2008 (Global Status Report 2007). Wind power is also a famous form of the renewable energy which has a remarkable growth rate of around 30% annually with a installed capacity of over 121,000 megawatts in the year 2008, which has been massively used in Europe and in the United States of America (USA) (Renewable Global Status Report: 2009).

A country like Brazil who has the largest setup program of the renewable energy; it is also involved in the production of ethanol fuel which has been produced with the help of the sugar cane and the essence of the ethanol provides 18% of the country's automotive fuel. Apart from the Brazil, ethanol fuel is also amply available in USA, while most of the renewable energy projects and its production on the large scale are also suited to the small off-grid applications which sometimes located in the rural and remote areas, wherein the component of the energy are so essential for the human development. World Energy Assessment (2001). *Renewable energy technologies*. Kenya is the country which has the world's highest household solar ownership rate with roughly 30,000 small (20-100 watt) solar power systems sold per year (What Solar Power Needs Now Renewable Energy Access, 13 August 2007).

Biomass fuels come from the forestry like the wood products, agriculture, constructions and transportation. Like the hydropower energy, which can be produce by replace the water into energy, it has also produced by reinstate the coal into the power plant which produces the energy.

The market of the renewable energy has envisaged a continuous growth but the climate change like the high oil prices and mounting government support are driving spurring renewable energy legislation incentives and commercialization. The availability of biomass resources follows the same pattern as the nation's vegetation which is considered as a large source for energy generation resources and fabricates less sulphur dioxide than coal or any other fossil fuels.

STATEMENT OF THE PROBLEM

For many years now, Nigeria and indeed Nigerians have not enjoyed steady power supply from the power holding company of Nigeria (P.H.C.N) as it used to be in past years and Solar thermal power station is also one of the famous alternatives that has not been effectively used in solving the issue of generating electrical energy. The situation today is such that electricity is supplied for a few hours then it goes off' only to be restored again after many hours and so the situation seems to become a tradition. In some areas or states, the supply is rationed such that some area enjoy the power supply for 12 hours, 24 hours etc. while other areas will have total power outage at this same period or for the same number of hours. In some cases again, the industrial areas, business centers and residential areas dominated by highly influential and well to do individuals are being given more preference in the supply and distribution of electricity.

This is the true picture of electricity supply and distribution in Niger state. The consequences of electric power supply for this nature is very adverse in many ways.

- Industries are being incapacitated.
- Businesses such as hair dressing salons, computer centers just to mention a few, are seriously affected.

- Patients die in hospital theatres, drugs are being wasted as a result of unfavorable storage conditions.
- Discomfort and destruction of electronic gadgets as a result of power fluctuations etc.

This forms the background of this project research which aims at using biomass fuels as alternatives to generate electrical energy for domestic and industrial consumption as well as to complement the existing forms of power generation. If this source of energy can be successfully and effectively harnessed, it would bring about the overall total energy generation at the national grid level and improve power distribution, encourage the use of other sources of energy and reduce the dependence of the Nigerian economy on petroleum and petroleum product and hydroelectricity as a major source of revenue.

Purpose of the Study

This research work is specifically aimed at enhancing strategies for adopting biomass power plants as an alternative for energy generation in Niger state. The study shall investigate:

1. The current state of electrical power generation in Niger state.
2. Possible strategies for adopting biomass fuel power plants as an alternative for power generation.
3. Other available alternative sources for energy generation.
4. The effectiveness of biomass fuel conversion for power generation.

Significance of the study

The findings of the research study will be of importance to the current state of electrical energy generation in Niger state and the need to implement an alternative energy source for industrial and residential consumption, for effective electrical power supply. Similarly, the study will also contribute to the development of power generation at state level and commercial development of small and medium scale industries.

Also, the study will enhance the management of the power holding company of Nigeria, in providing adequate service to consumers of electricity.

Scope of the study

The study is focused on biomass as an alternative electrical energy sources for effective electrical power supply in Minna metropolis of Niger state. The study also analyses the available biomass fuels of various kinds and how it can be effectively utilized to generate electricity by energy conversion.

Research Questions

In an attempt of utilizing biomass as an alternative energy source for effective electric power generation and supply, the following research questions has been formulated to guide the study:

1. What is the present state of electrical energy supply in Niger state?
2. What are the possible strategies for adopting biomass fueled power plants as an alternative to electrical energy generation in Niger state?
3. What are the other available alternatives for electrical energy generation in Niger state?
4. How effective is biomass fuel energy for power generation?

Hypothesis

Ho_1 There will be no significant differences between the mean responses of respondents on the current state of electricity supply in Nigeria particularly in Minna metropolis, Niger state.

Ho_2 There is no significant difference in the mean response of respondents on possible strategies for adopting biomass fuel power plants as an alternative to electric energy source in Nigeria

Ho_3 There is no significant difference in the mean response of respondents on the availability of alternatives for electrical energy generation

Ho_4 There is no significant difference in the mean response of respondents on the effectiveness of biomass fuel conversion.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter review the related literature to broaden the understanding of biomass fueled power plants by discussing the history and concept of biomass fuels and its use for power generation , this project utilizes biomass fuels and this chapter gives a brief theoretical knowledge under the following sub headings;

1. What is biomass
2. Defining bio-electricity
3. Historical background of biomass and bio-fuels
4. Conversion and bioconversion process for bio-fuels production
5. Resource for bio-fuel products development (BIOMASS)
6. Bio-energy and bio base products
7. Bio-refinery
8. Bio-fuels
9. Types of bio-fuels
10. Benefits
11. Effects on the environment
12. Sustainability
13. Bio-energy generation flow chart
14. How energy is generated
15. Conclusion

WHAT IS BIOMASS?

Biomass is the (living or recently dead) biological material from which bio-energy is extracted. Biomass is often plant matter grown to produce heat or generate electricity. Examples include timber, miscanthus, straw wood chippings, and biodegradable waste. Biomass used for heat and power typically falls into one of three categories:

a) Conventional Forestry Management

Biomass is sourced from the management of woodlands and forest. This includes thinning, felling, sawmill residues and parts of trees unsuitable for timber.

b) Dedicated Energy Crops and Agricultural Residues

Fast growing crops grown for heat and electricity generation are typically ‘woody’ perennials, such as miscanthus grass and willow, which can be grown on lower grade land unsuitable for food crops. The harvested crop is chopped, chipped, pelleted or baled and burnt directly in stoves, boilers or dedicated biomass power stations. Biomass can also be sourced from the residues of food crops, such as straw, husks and kernels.

c) Biodegradable Wastes and Residues

A wide range of biomass wastes and residues are used for undergoing anaerobic digestion treatment to produce biogas. These include sewage sludge, animal manure, chicken litter, waste wood from construction and food waste.

DEFINING BIOELECTRICITY

The development of renewable energy sources, including biomass, is fundamental to a sustainable energy future. Biomass could play a significant role as a renewable energy source, and there are a number of reasons that make it an attractive option:

- It can provide a (very) low-carbon source of electricity.
- The use of modern biomass conversion technologies can keep emissions affecting air quality to (very) low levels.
- Suitably managed energy plantations can lead to environmental benefits such as the rehabilitation of degraded lands and the protection of watersheds.
- Its widespread, diverse and renewable nature can contribute to energy security and diversity.
- Its production for energy use can contribute to rural regeneration and development.

Rural development can be defined as improving economic growth in rural areas through the strengthening of the agricultural and forestry sectors and the preservation of the rural environment and heritage.

However, biomass energy is characterized by a variety of resources and possible conversion routes, which complicates the understanding of its implications. In particular, a number of issues need clarification in order to understand the potential of biomass as a sustainable energy source: resource and land availability, feedstock supply logistics, fuel chain costs and environmental impacts. Also, the agricultural and forestry dimensions are fundamental to the potential of biomass as a sustainable energy source. In particular, questions such as the quantity of residues the can be used, the types of energy plantations and where and how they should be grown, and the development of suitable feedstock supply infrastructures need careful consideration.

HISTORICAL BACKGROUND

During the peacetime post-war period, inexpensive oil from the Middle East contributed in part to the lessened economic and geopolitical interest in biofuels. Then in 1973 and 1979, geopolitical conflict in the Middle East caused OPEC to cut exports, and non- OPEC nations experienced a very large decrease in their oil supply. This energy crisis resulted in severe shortages, and a sharp increase in the prices of high demand oil-based products, notably petrol/gasoline. There was also increased interest from governments and academics in energy issues and biofuels. Throughout history, the fluctuations of supply and demand, energy policy, military conflict, and the environmental impacts, have all contributed to a highly complex and volatile market for energy and fuel. In the year 2000 and beyond, renewed interest in biofuels has been seen (Wikipedia, 2012).

Fossil oil and natural gas are being replaced by carbohydrates from renewable resources as low-cost, renewable feedstock. in particular, the development of technology to convert cellulosic biomass from agricultural waste or energy crops into fermentable sugars offers the perspective of producing ethanol and other bulk organic chemicals at low cost. The cost of biomass-based ethanol produced on a commercial scale, for example, is expected to undercut the cost of gasoline with oil at $30 per barrel. A first semi-commercial ethanol plant using straw is being operated by Iogen and shell in Canada. More companies have started their own endeavors in this field, including dupont, John Deere, genencor, novozymes, and abengoa (Wikipedia, 2012).

Since the second half of the 70's, and as a result of the 1973 oil crisis, the Brazil government has been promoting ethanol as a fuel. By 1978 the first gasohol automobile was developed. The Brazilian government provided three important initial drivers for the ethanol Industry: guaranteed purchases by the state-owned oil company Petrobras, lowinterest loans for agro-industrial ethanol firms, and fixed gasoline and ethanol prices where hydrous ethanol sold for 59% of the government-set gasoline price at the pump. These pump-primers have made ethanol production competitive yet unsubsidized in recent years, the Brazilian untaxed retail price of hydrous ethanol has been lower than that of gasoline per gallon (Lovins, 2005). Approximately US$50 million has recently been allocated for research and projects focused on advancing the abstention of ethanol from sugarcane in São Paulo, (Balister, 2006).

In May 2003, Volkswagen built for the first time a production flexible fuel car, the Golf 1.6 Total Flex. Chevrolet followed two months later with the Corsa 1.8 Flexpower, using an engine developed by a joint-venture with Fiat called PowerTrain. That year production of full flex-fuel reached 39.853 automobiles and 9.411 light commercial vehicles. By 2005, popular manufacturers that build flexible fuel vehicles are Chevrolet, Fiat, Ford, Peugeot, Renault, Volkswagen, Honda, Mitsubishi, Toyota and Citröen, (Lashinsky and Schwartz, 2006). Flexible fuel cars were 15.2% of the car sales in 2004, 38.6% in 2005, 59.7% for 2006 and 71.9% for 2007, National Association of Motor Vehicle Manufacturers; Brazil (ANFAVEA, 2007). By March 2008, the fleet of dual-fuel vehicles, including autos and light commercial vehicles, had reached 5 million, (Globo 2008).

CONVERSION AND BIO-CONVERSION PROCESS FOR BIOFUEL PRODUCTION

Fischer-Tropsch Conversion Process

Renewable fuel production includes fuels such as ethanol, methanol, and hydrogen, biodiesel, and Fischer-Tropsch (FT) liquids. FT liquids are fuels derived using the Fischer-Tropsch conversion process. The FT process can produce diesel, naptha, and other fuels that can be used as substitutes for gasoline (Wikipedia, 2012).

Landfills Methods

Landfills produce a methane rich biogas that is most commonly used for power generation as previously discussed by many authors. Landfill gas is already used for heat and power generation as well as being upgraded to pipeline quality. Landfill gas is also being used as transportation fuel (Kidder, 2002). Landfill sites generate gases as the waste buried in them undergoes anaerobic digestion. These gases are known collectively as landfill gas (LFG). This can be burned and is considered a source of renewable energy, even though landfill disposal are often non-sustainable. Landfill gas can be burned either directly for heat or to generate electricity for public consumption. Landfill gas contains approximately 50% methane, the same gas that is found in natural gas (Wikipedia, 2012).

Bioconversion

Bioconversion of wastes could make a significant contribution to the production of organic chemicals. Over 75% of organic chemicals are produced from five primary base chemicals: ethylene, propylene, benzene, toluene and xylene which are used to synthesis other organic compounds, which in turn are used to produce various chemical products including polymers and resins (Coombs J, Marrow J.E, Lees E.W, 1987). The aromatic compounds might be produced from lignin whereas the low molecular mass aliphatic compounds can be derived from ethanol produced by fermentation of sugar generated from the cellulose and hemicelluloses.

Anaerobic Conversion

A surveys on the potential for biomass to alleviate energy problems in Tanzania through utilization of agro-industrial residues for anaerobic conversion into biogas and biodiesel, sisal industry, the largest producer of agro-industrial residues, has a potential to produce energy that could greatly supplement the current shortfall of hydropower generation (Kivaisi and Rubindamayugi, 1996). Anaerobic digestion can be used as a distinct waste management strategy to reduce the amount of waste sent to landfill and generate methane, or biogas. Any form of biomass can be used in anaerobic digestion and will break down to produce methane, which can be harvested and burned to generate heat, power or to power certain automotive vehicles (Wikipedia, 2012).

Fermentation

With the exception of feedstocks of low water content, most of this biomass undergoes some form of transformation, prior to being utilized as a fuel. Biological processes for the conversion of biomass to fuels include ethanol fermentation by yeast or bacteria, and methane production by microbial consortia under anaerobic conditions. So far research on sisal waste centered on pretreatment methods for processing of fibre fraction in order to increase the methane yield; evaluation of the requirement for nutrient addition; optimal reactor set-up and performance (Wikipedia, 2012).

Thermal De-polymerization

Oils and gases can be produced from various biological wastes by thermal depolymerization of waste which can extract methane and other oils similar to petroleum (Wikipedia, 2012).

Bioreactor System

GreenFuel Technologies Corporation developed a patented bioreactor system that uses nontoxic photosynthetic algae to take in smokestacks flue gases and produce bio-fuels such as biodiesel, biogas and a dry fuel comparable to coal (Wikipedia, 2012). Ethanol has been produced continuously in an attached biofilm expanded bed bioreactor of *Zymomonas mobilis* and *Saccharomyces cerevisiae* in biofilm reactors (Bland, 1982),(Kunduru and Pometto, 1996) while (Krug and Daugulis, 1983) used *Zymomonas mobilis* immobilized on an ion exchange resin for ethanol production. Adsorbed cells of *Saccharomyces cerevisiae* have also been used in a packed bed continuous bioreactor to produce ethanol from molasses (Tyagi and Ghose, 1982). (Lynd 1991) investigated ethanol yield and tolerance in continuous culture during thermophilic ethanol production.

Pyrolysis, Combustion and Gasification

Syngas is produced by the combined processes of pyrolysis, combustion, and gasification. Biofuel is converted into carbon monoxide and energy by pyrolysis. A limited supply of oxygen is introduced to support combustion. Gasification converts further organic material to hydrogen and additional carbon monoxide. Gasification normally relies on temperatures above 700°C. Lower temperature gasification is desirable when co-producing biochar (Wikipedia, 2012).

Collocation of Synergistic Processes

Collocation of synergistic processing plants can enhance efficiency. One example is to use the exhaust heat from an industrial process for ethanol production, which can then recycle cooler processing water, instead of evaporating hot water that warms the atmosphere (Wikipedia 2012).

RESOURCE FOR BIOPRODUCTS DEVELOPMENTS

Biomass

Biomass is material derived from recently living organisms. This includes plants, animals and their by-products. For example, manure, garden waste and crop residues are all sources of biomass. It is a renewable energy source based on the carbon cycle, unlike other natural resources such as petroleum, coal, and nuclear fuels (Wikipedia, 2012). A wide variety of biomass resources are available on our planet for conversion into bioproducts. These may include whole plants, plant parts (e.g. seeds, stalks), plant constituents (e.g. starch, lipids, protein and fibre), processing byproducts (distiller’s grains, corn soluble), materials of marine origin and animal byproducts, municipal and industrial wastes (Howard G. and Ziller, S., 2008). These resources can be used to create new biomaterials and this will require an intimate understanding of the composition of the raw material whether it is whole plant or constituents, so that the desired functional elements can be obtained for bioproduct production, (Forge F., 2007).

Wastes

Waste contains three primary constituents: cellulose, hemicellulose and lignin, and can contain other compounds (e.g. extractives). Cellulose and hemicellulose are carbohydrates that can be broken down by enzymes, acids, or other compounds to simple sugars, and then fermented to produce ethanol renewable electricity, fuels, and biomassbased products. Lignocellulosic biomass represents the primary fraction of municipal solid waste; sulfuric acid to biomass that has been dried to 10% with cellulose (35–50%) its major structural component of it, (Puri, 1984, Wyman and Goodman, 1993 and Van Wyk, 2001).

Solid waste production is of global concern and development of its bioenergy potential can combine issues such as pollution control and bioproduct development, simultaneously. Various wastepaper materials, a major component of solid waste, have been treated with the cellulase enzyme from *Trichoderma viride*, thus bioconverting their cellulose component into fermentable sugars (Van Wyk, 1999). Wastes and residues currently constitute a large source of biomass. These include solid and liquid municipal wastes, manure, lumber and pulp mill wastes, and forest and agricultural residues. Wood wastes in the paper and pulp industries and bagasse from the sugar-cane industry are examples of biomass likely to accumulate at a single site. Also, (Akpan 1988) produced ethanol from gari effluents using *Aspergillus niger* in a one-step fermentation process.

Agricultural Residues

Biomass can come from waste plant material. Though, most of the agricultural residues are directly disposed off to the river. More than 20 million dry tons of agricultural residues per year are been generated. Half of this amount can be effectively used for energy and other biomass-based production. Soybean curd residue supplement has been found to be very significant for enhancement of methane production from pretreated woody waste. There are also agricultural products specifically grown for biofuel production include corn, switch grass, and soybeans, primarily in the United States; rapeseed, wheat and sugar beet primarily in Europe; sugar cane in Brazil; palm oil and miscanthus in South- East Asia; sorghum and cassava in China; and jatropha in India. Hemp has also been proven to work as a biofuel. Biodegradable outputs from industry, agriculture, forestry and households can be used for biofuel production, either using anaerobic digestion to produce biogas, or using second generation biofuels; examples include straw, timber, manure, 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 climate change, though alone they are not a comprehensive solution to these problems, (Wikipedia, 2012).

Municipal Waste

Municipal wastes is a combination of household and industrial/ commercial refuse which include municipal solid wastes (MSW), municipal wastewater or sewage, and bio-solids from wastewater treatment. Landfill gas generated from waste disposed in landfills and biogas from wastewater treatment is also included in municipal waste. These materials include construction and demolition wood residue, paper and cardboard, grass, landscape tree removals, other green waste, food waste, and other organics. Remaining wastes are disposed in landfills and the mass-burn incineration facilities. Diverted wastes are used for compost, recycling, and energy, Wikipedia (2012).

Waste vegetable oil which has been filtered is another source of bio-fuel. Using waste biomass to produce energy can reduce the use of fossil fuels, reduce greenhouse gas emissions and reduce pollution and waste management problems, US Environmental Protection Agency USEPA (2007). A recent publication by the European Union highlighted the potential for waste-derived bio-energy to contribute to the reduction of global warming, European Environmental Agency EEA (2006). The report concluded that 19 million tons of oil equivalents are available from biomass by 2020, 46% from bio-wastes: Municipal Solid Waste (MSW), agricultural residues, farm waste and other biodegradable waste streams (India eNews 2006, Business Line 2005, Marshall 2007).

BIOENERGY AND BIOBASED PRODUCTS

Biomass can also provide raw materials for a diversity of biobased products. For e.g. plastics from biomass are being produced using polylactic acid from corn. According to Block (1999) executive order and proposed bill will boost biobased products and bioenergy in nations that sees the need for it. Indeed, the combination of bio-based feedstock, bio-processes and new products offers the potential to revolutionize chemical industry structures. In less than 10 years, integrated bio refineries will play a role comparable to today's oil and gas crackers (Keppler F. Hamilton J.T.G, Brab M. and Rockman T., 2006) discovered that living plants also produce methane CH_4. The amount of methane produced by living plants is 10 to 100 times greater than that produced by dead plants in an aerobic environment but does not increase global warming because of the carbon cycle (Kolumbus, 2007).

BIOREFINERY

The most profitable way to operate a biomass-to-ethanol plant is as a refinery producing a variety of products from processing all the chemical components; hemicelluloses, cellulose, lignin, and extractives of cellulosic feedstock. The plant could make use of extractives by converting them to resin acids, or pharmaceuticals for example taxols from specific conifers. Cellulose derivatives can be processed into a variety of products including higher value animal feeds. The lignin fraction can be an energy source for the biorefinery or for an adjacent electric power plant. The biomass power plant can be a customer for the lignin produced by the ethanol plant, using it as a fuel for the power-plant, while the ethanol plant would benefit from cheaper steam and electricity (Wikipedia, 2012).

BIOFUELS

In recent times, many developed countries have returned to carbohydrate – based industries for industrial products, (Louwrier, 1998). Renewable fuel production includes fuels such as ethanol, methanol, and hydrogen, biodiesel, and Fischer-Tropsch (FT) liquids (fuels derived using the Fischer-Tropsch conversion process). The FT process can produce diesel, naptha, and other fuels that can be used as substitutes for gasoline (Wikipedia, 2012).

TYPES OF BIOFUELS

FIRST GENERATION BIOFUELS

First-generation biofuels refer to biofuels made from sugar, starch, vegetable oil, or animal fats using conventional technology. The basic feedstocks for the production of first generation biofuels are often seeds or grains such as wheat, which yields starch that is fermented into bioethanol, or sunflower seeds, which are pressed to yield vegetable oil that can be used in biodiesel. These feedstocks could also enter the animal or human food chain, and as the global population has risen their use in producing biofuels has been criticised for diverting food away from the human food chain, leading to food shortages and price rises (Wikipedia, 2012). The most common first generation biofuels are:

Vegetable Oil Use as Renewable Fuel and Alternative Energy

Vegetable oil can be used for either food or fuel; the quality of the oil may be lower for fuel use. Vegetable oil can be used in many older diesel engines (equipped with indirect injection systems), but only in warm climates. In most cases, vegetable oil is used to manufacture biodiesel, which is compatible with most diesel engines when blended with conventional diesel fuel. MAN B&W Diesel, Wartsila and Deutz AG offer engines that are compatible with straight vegetable oil. Used vegetable oil is increasingly being processed into biodiesel and at a smaller scale, cleaned of water and particulates and used as a fuel (Wikipedia, 2012).

Biogas Production and Use as Renewable Fuel and Alternative Energy

Biogas is a renewable fuel and electricity produced from it can be used to attract renewable energy subsidies in some parts of the world (Wikipedia, 2012). Depending on where it is produced, biogas can also be called swamp, marsh, and landfill or digester gas. A biogas plant is the name often given to an anaerobic digester that treats farm wastes or energy crops. Biogas can be utilized for electricity production, space heating, water heating and process heating. If compressed, it can replace compressed natural gas for use in vehicles, where it can fuel an internal combustion engine or fuel cells. Methane within biogas can be concentrated to the same standards as natural gas, when it is, it is called biomethane. If concentrated and compressed it can also be used in vehicle transportation.

The prospects for biogas cannot be underestimated (Pankhurst, 1983). Biogas is produced by the process of anaerobic digestion of organic material by anaerobes. It can be produced either from biodegradable waste materials or by the use of energy crops fed into anaerobic digesters to supplement gas yields. The solid byproduct, digestate, can be used as a biofuel or a fertilizer. Biogas can be produced utilizing anaerobic digesters. These plants can be fed with energy crops such as maize silage or biodegradable wastes including sewage sludge and food waste. The composition of biogas varies depending upon the origin of the anaerobic digestion process. Landfill gas typically has methane concentrations around 50%. Advanced waste treatment technologies can produce biogas with 55-75% CH_4, (Kolumbus, 2007).

In the UK, the National Coal Board experimented with microorganisms that digested coal in situ converting it directly to gases such as methane. Biogas contains methane and can be recovered from industrial anaerobic digesters and mechanical biological treatment systems. Landfill gas is a less clean form of biogas which is produced in landfills through naturally occurring anaerobic digestion. If it escapes into the atmosphere it is a potent greenhouse gas, (Kolumbus, 2007).

Biodisel Production and Use as Renewable Fuel and Alternative Energy

Biodiesel is a biofuel produced from fats processed to obtain chemical compounds that are used as is, or blended with diesel fuel. The fats can come from a variety of sources, such as used cooking oils, plant extracts and animal fats (Forge, 2007). Biodiesel production is a completely renewable resource. Biodiesel product is made from soya and canola, which is a self-sustaining fuel. Best of all it provides a market for excess soya bean oil production. Biodiesel is a substitute for fuels that produce a lot of soot and carbons. These poisonous elements, which are, associated with regular diesel fuel emissions especially buses. However, biodiesel has been around for decades as a supplement that is added to conventional diesel fuel to improve the lubricity of diesel engines. The bottom line is that biodiesel lubricates machinery far better than petroleum diesel fuel. Even biodiesel levels as low as one percent can provide up to a 65% increase in lubricity in distillate fuels.

A Biodiesel fuel consists of methyl esters of soybean oil. Many car manufacturers are seeing the wisdom of creating vehicles that can accommodate a biodiesel product by creating a diesel car that is friendly to the use of vegetable oil blended with diesel fuel. In addition to displacing North America's reliance on imported petroleum, the use of biodiesel product has been shown to reduce air pollution and greenhouse gases. In some countries biodiesel is less expensive than conventional diesel. Most transportation fuels are liquids, because vehicles usually require high energy density, as occurs in liquids and solids. Vehicles usually need high power density as can be provided most inexpensively by an internal combustion engine. These engines require clean burning fuels, in order to keep the engine clean and minimize air pollution (Wikipedia, 2012).

BIOALCOHOLS: - ALCOHOL FUEL USED AS FUEL

Biologically produced alcohols, most commonly ethanol, and less commonly propanol and butanol, are produced by the action of microorganisms and enzymes through the fermentation of sugars or starches, or cellulose. Fermentation of sugars or starches is the easiest while fermentation of cellulose is more difficult. Biobutanol; also called biogasoline is often claimed to provide a direct replacement for gasoline, because it can be used directly in a gasoline engine in a similar way to biodiesel in diesel engines. In the current alcohol-from-corn production model in the United States, considering the total energy consumed by farm equipment, cultivation, planting, fertilizers, pesticides, herbicides, and fungicides made from petroleum, irrigation systems, harvesting, transport of feedstock to processing plants, fermentation, distillation, drying, transport to fuel terminals and retail pumps, and lower ethanol fuel energy content, the net energy content value added and delivered to consumers is very small. And, the net benefit after all things has been considered, does little to reduce unsustainable imported oil and fossil fuels required to produce the ethanol (Wikipedia, 2012).

Bioethanol Production and Use as Renewable Fuel and Alternative Energy

Ethanol is an alcohol produced through fermentation of sugar sources, such as plants. It can be used as is, or blended with regular gasoline. Fuel blends containing 5-10% ethanol require no changes to the engine and are the most widely available at present. Other blends are also available, such as E-85 (85% ethanol, 15% gasoline). In Brazil, more than 15% of cars can run on pure ethanol (Forge, 2007). Ethanol is an excellent transportation fuel and blends of it have benefits, such as reduced gasoline use, thus lowering the need for fossil fuels. It also improves the performance of an ethanol–gasoline blend and ethanol provides oxygen for the fuel resulting in a more complete combustion with a low atmospheric photochemical reactivity. Even though CO_2 is released during the fermentation of sugars to form ethanol and the burning of ethanol as a fuel, the CO_2 is reutilized to grow new biomass replacing that harvested for ethanol production.

Ethanol can be used in petrol engines as a replacement for gasoline; it can be mixed with gasoline to any percentage. Most existing automobile petrol engines can run on blends of up to 15% bioethanol with petroleum/gasoline. Gasoline with ethanol added has higher octane, which means that engine can typically burn hotter and more efficiently. In high altitude ie. thin air locations, some states mandate a mix of gasoline and ethanol as a winter oxidizer to reduce atmospheric pollution emissions (Wikipedia, 2012).

There have been increased industrial uses of agricultural commodities to produce different products (Lee, 1994). The production of ethanol from biowaste can improve energy security and decrease pollution. Alcohol fuels are produced by fermentation of sugars derived from wheat, corn, sugar beets, sugar cane, molasses and any sugar or starch that alcoholic beverages can be made from like potato and fruit waste, etc. The ethanol production methods used are enzyme digestion to release sugars from stored starches, fermentation of the sugars, distillation and drying. The distillation process requires significant energy input for heat which is often unsustainable natural gas fossil fuel, but cellulosic biomass such as bagasse, the waste left after sugar cane is pressed to extract its juice, can also be used more sustainably (Nemethy E.K, Otvos J.W, Calvin M, 1981).

Biobutanol and 2, 3-Butanediol Production and Use as Renewable Fuel and Alternative Energy

Butanol is an alcohol that can be produced by fermentation of the same types of sugar sources that are used for ethanol. As it can also be produced from fossil fuels, it is called “biobutanol” when it is derived from biomass. Butanol has various advantages over ethanol: it delivers more energy, evaporates more slowly, and can be transported by pipeline. According to DuPont, an American pharmaceutical company, existing ethanol plants can be economically converted to produce biobutanol. In June 2006, British Petroleum (BP) multinational Oil and Gas Company announced that it would make biobutanol commercially available in the United Kingdom in 2007. Butanol is also an important industrial chemical that can be produced from a number of carbohydrates using a number of microbial cultures. Butanol can be used as a fuel and has higher/greater energy content than ethanol. Production of butanol has been investigated in batch, fed-batch, free cell continuous, immobilized cell continuous, and cell recycle continuous reactors (Maddox 1989). Continuous production of 2, 3-butanediol from whey permeate using cells of *Klebsiella pneumoniae* immobilized on to bonechar was reported by (Maddox I.S, 1988).

Butanol is also formed by acetone, butanol, and ethanol (ABE) fermentation and experimental modifications of the process show potentially high net energy gains with butanol as the only liquid product. Butanol will produce more energy and allegedly can be burned straight in existing gasoline engines without modification to the engine or car, and is less corrosive and less water soluble than ethanol, and could be distributed through existing infrastructures. DuPont and Britian prime minister are working together to help develop butanol (Wikipedia, 20012).

Methanol and Biocharcoal Production and Use as Renewable Fuel and Alternative Energy

Methanol is currently produced from natural gas, a non-renewable fossil fuel. It can also be produced from biomass as biomethanol. The methanol economy is an interesting alternative to the hydrogen economy, compared to today's hydrogen produced from natural gas, but not hydrogen production directly from water and state-of-the-art clean solar thermal energy processes. Gasification normally relies on temperatures above 700°C. Lower temperature gasification is desirable when co-producing biochar (Wikipedia, 2012).

Most people confused the making of methanol by pyrolysis which gives a 2% yield amongst all the other products from hardwood and 0% from softwoods, with making methanol from synthesis gas - $CO + H_2$, in which case you get above 50% yield. The Coal Ash Research Center, established in the early 1970s, develops environmentally friendly, commercially viable uses for coal ash from power plants. Innovative strategies for wastewater treatment from industrial processes are reducing adverse environmental effects while simultaneously developing valuable by-products. The Center for Biomass Utilization focuses on developing the following technologies: Cofiring biomass with coal using agricultural wastes and food-processing wastes to produce transportation fuels and chemical feedstocks.

Syngas Production and Use as Renewable Fuel and Alternative Energy

Syngas is produced by the combined processes of pyrolysis, combustion, and gasification. The resulting gas mixture, syngas, is itself a fuel. Using the syngas is more efficient than direct combustion of the original biofuel; more of the energy contained in the fuel is extracted. Syngas may be burned directly in internal combustion engines. The wood gas generator is a wood-fueled gasification reactor mounted on an internal combustion engine. Syngas can be used to produce methanol and hydrogen, or converted via the Fischer-Tropsch process to produce a synthetic petroleum substitute (Wikipedia, 2012).

Microbial Hydrogen Production as an Alternative Energy

Hydrogen is currently produced by fossil fuel-based processes which emit large amounts of CO_2, and relatively smaller amounts of other air pollutants such as sulphur dioxide and nitrogen oxides. Researchers explore microbial hydrogen production as key to an alternative energy source at bare base facilities ie. Locations without permanent living facilities. Researchers are developing a biological method of producing hydrogen from waste streams created by dining halls, kitchens, latrines, and other places at bare base facilities. When successful, researchers will demonstrate that hydrogen production from bare base waste streams is a feasible alternative energy source for fuel cells. Using hydrogen as an alternative energy source is an exciting option due to its high conversion efficiency and nonpolluting nature. Though hydrogen is the most abundant element on earth, it is bound to other elements from which it must be separated before it can be used in energy generation (Wikipedia, 2012).

SECOND GENERATION BIOFUELS

Supporters of bio-fuels claim that a more viable solution is to increase political and industrial support for, and rapidity of, second-generation bio-fuel implementation from non food crops, including cellulosic bio-fuels. Second-generation bio-fuel production processes can use a variety of non food crops. These include waste biomass, the stalks of wheat, corn, wood, and special-energy-or-biomass crops for example Miscanthus. Second generation (2G) bio-fuels use biomass to liquid technology, including cellulosic bio-fuels from non food crops. Many second generation bio-fuels are under development such as biohydrogen, biomethanol, DMF, Bio-DME, Fischer-Tropsch diesel, biohydrogen diesel, mixed alcohols and wood diesel (Wikipedia, 2012).

Cellulosic ethanol production uses non food crops or inedible waste products and does not divert food away from the animal or human food chain. Lignocellulose is the woody structural material of plants. This feedstock is abundant and diverse, and in some cases like citrus peels or sawdust, it is a significant disposal problem. Producing ethanol from cellulose is a difficult technical problem to solve. In nature, Ruminant livestock like cattle eat grass and then use slow enzymatic digestive processes to break it into glucose (sugar). In cellulosic ethanol laboratories, various experimental processes are being developed to do the same thing, and then the sugars released can be fermented to make ethanol fuel. Scientists also work on experimental recombinant DNA genetic engineering organisms that could increase bio-fuel potential, (Howard and Ziller, 2008).

THIRD GENERATION BIOFUELS

Algae Fuel

Algae fuel, also called oilgae or third generation bio-fuel, is a bio-fuel from algae. Algae are low-input/high-yield feedstocks to produce bio-fuels and algae fuels are biodegradable: With the higher prices of fossil fuels (petroleum), there is much interest in algaculture (farming algae). One advantage of many bio-fuels over most other fuel types is that they are biodegradable, and so relatively harmless to the environment if spilled. The United States Department of Energy estimates that if algae fuel replaced all the petroleum fuel in the United States, it would require 15,000 square miles (38,849 square kilometers), which is roughly the size of Maryland. Second and third generation bio-fuels are also called advanced bio-fuels. On the other hand, an appearing fourth generation is based in the conversion of vegoil and biodiesel into gasoline (Wikipedia, 2012).

FOURTH GENERATION BIOFUELS

Craig Venter's company Synthetic Genomics is ge-netically engineering microorganisms to produce fuel directly from carbon dioxide on an industrial scale (Wikipedia, 2012).

Solid Bio-fuels

Examples of solid biofuels include wood, grass cuttings, domestic refuse, charcoal, and dried manure (Wikipedia, 2012).

TECHNOLOGY AND ECONOMICS

The technology for harnessing power and heat from biomass fuels is already available. Electricity generation from biomass fuels currently uses the same basic technology used in power plants that burn solid fossil fuels. However, new technologies are being developed to improve power production efficiency from biomass. The potential also exists for local sources of electricity production from biomass by using small-scale gasification plants or systems involving fermentation of biomass.

By factoring in the pollution-related environmental and social costs generated by fossil and nuclear fuels, bioelectricity becomes a competitive energy source. The cost of biomass fuel supply depends on the cost of producing or recovering the 'feedstock' – raw materials – and those incurred during its transport and pre-processing prior to use in a power plant. Costs vary widely, from extremely cheap for existing residues that simply require disposal, to relatively expensive for production and use of dedicated energy plantations.

Ultimately, the cost of bioelectricity will depend on the economics of feedstock supply, power generation technology, the scale of operation, and the extent to which fossil fuel power plants can be adapted for biomass fuels. Combined heat and power (CHP or cogeneration) results in a more efficient use of biomass and could contribute significantly to the economic viability of electricity from biomass.

THE BENEFITS

Biomass is a carbon-neutral power source in that CO_2 absorbed by the raw material while growing offsets that generated during combustion. Achieving the 15 % bio-power target will deliver cuts in CO_2 emissions of between 538 and 1 739 million tonnes annually. At present CO_2 emissions in industrialized countries total some 11 467 million tonnes – a figure projected to rise to more than 14 298 million tonnes by 2020.

Unlocking the potential of the 15 % biomass blueprint is expected to create more than 400,000 jobs in industrialized countries by 2020. This estimate is based on research that has shown that two direct and indirect jobs are created for every megawatt of bio-energy installed. Another advantage is that employment could be generated where there is often the greatest need, in rural areas. Here, the production of biomass fuels offers a new income stream for cash-strapped farmers. In countries with economies in transition, where agriculture already employs a significant percentage of the national workforce, biomass production can strengthen job security.

EFFECTS ON THE ENVIRONMENT

The development of biomass resources and the conservation of biodiversity and local environments can go hand in hand. The biomass production has several environmental advantages, including: substituting fossil fuel use with a CO_2-neutral alternative; reducing emissions of other atmospheric pollutants, such as Sulphur; protecting soil and watersheds; increasing or maintaining biodiversity: and reducing fire risk in forestry.

These benefits provide a powerful argument for accelerating the introduction of biomass energy in virtually all industrialized countries. However, because the production of biomass feedstock differs between growing sites, the development of ‘one size fits all’ policies should be avoided.

To maximize likely benefits and minimize potential impacts, the following guidelines should be followed:

- Bio-power schemes need to be subject to rigorous and transparent environmental impact assessments.
- Good agricultural and forestry practices must be adopted, suitable for local conditions.
- There should be no conversion of natural forests or High Conservation Value habitats involved in raw material production or supply.
- Biomass growing practices must protect and enhance soil fertility.
- Water use should be assessed throughout the production and conversion chain, with particular emphasis on avoiding damage to watersheds.
- On the production side, best available conversion technologies should be used to minimize emissions.
- Ash quality from conversion processes should be monitored and where possible nutrient-rich ash should be recycled back to the land.

SUSTAINABILITY CRITERIA

In order for biomass to fulfill expectations as a sustainable source of electricity, it must satisfy a number of economic, environmental and social criteria including:

- Biomass must be derived from renewable sources.
- Bioelectricity costs must be kept low to ensure economic efficiency.

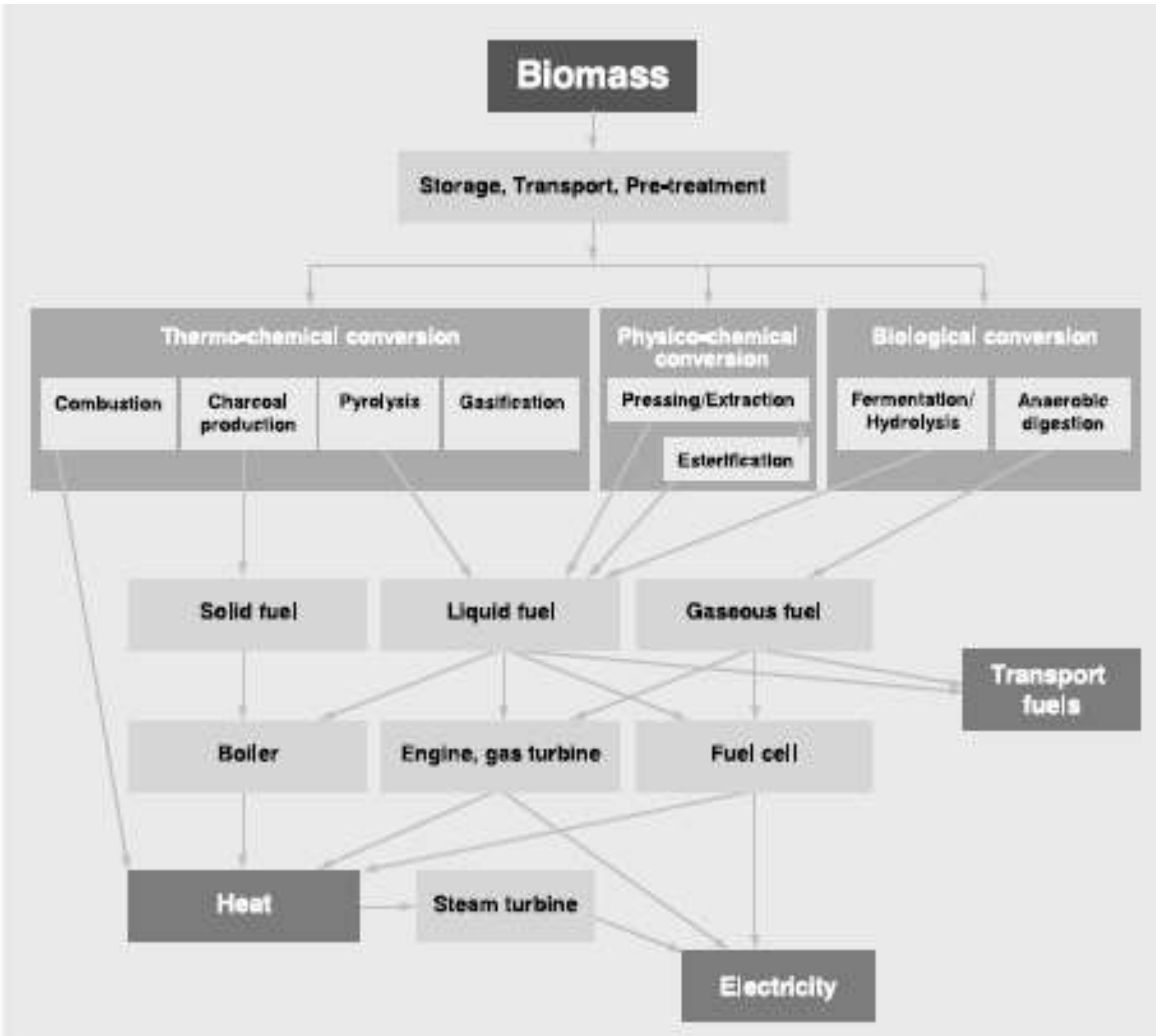
- Non-renewable energy inputs to bioelectricity chains must be kept low to ensure low carbon emissions.
- Best available logistics and conversion technologies must be used to reduce emissions affecting air quality.
- Sustainable forestry and agricultural management practices must be followed to avoid negative impacts on soil and water and to foster biodiversity.
- Biomass to electricity schemes must be designed to benefit rural development and gain broad acceptance by the general public.

The broad criteria listed above mask the huge range in technology options and site-specific factors implicit in biomass production for energy, where the sustainability of bioelectricity depends on the sustainability of each stage in the fuel chain. Therefore, national and even regional policies must be sufficiently robust to ensure sustainability but flexible enough to allow entrepreneurs to develop efficient fuel production and conversion chains and to encourage investments and improvements in productivity and conversion efficiency.

In evaluating bioelectricity chains, as with other renewable electricity chains, it is clear that simple cost-benefit analysis does not capture a range of ‘external’ costs and benefits that arise from the supply of energy services.

National and regional regulation should be designed to capture such externalities and ensure their consideration in decision-making related to energy provision.

BIO ENERGY GENERATION FLOW-CHART



HOW IS ENERGY GENERATED?

a) Electricity: plants designed primarily for the production of electricity are generally larger schemes, in the range of 10 to 40 Mega Watts electrical (MWe). Excess heat generated as part of the process is often not productively used.

b) Heat: plants designed for the production of heat cover a wide range of applications and sizes can range from a few kilowatts (domestic boilers) to above 5 Mega Watts thermal (MWth) (district heating schemes).

c) Combined Heat and Power (CHP): is a system of co-generation, the simultaneous production of more than one form of energy using a single fuel and facility. The primary product of CHP plants (typically sized from 5 to 30MWth) is the generation of electricity, but the excess heat is used productively. This could be through providing heat for industrial processes or in a district heating scheme.

There are several ways of capturing the stored chemical energy in biomass:

1) Direct Combustion

Direct combustion is a mature and reliable technology. It is used to heat space or water (domestic boilers or wood stoves) or to raise steam to drive a steam engine or turbine to generate electricity (mainly co-firing in coal power plants). The fuel is dry biomass including wood pellets, wood chips and energy crops. The equipment ranges from very small wood stoves used for domestic heating, to multi-megawatt plants for electricity production. State-of-the-art systems can achieve efficiencies greater than 90 per cent.

Applications include:

- Domestic or single large buildings, such as schools and leisure centers.
- District heating
- Large scale power or CHP plants.

2) Anaerobic Digestion

Anaerobic digestion (AD) is a readily available and proven technology. It involves the decomposition of organic materials. These can be solid or fluid biomass or waste streams, such as agricultural, household and industrial residues and sewage sludge. The decomposition occurs in the absence of air to produce biogas (which is high in methane content). The biogas is then burnt in a gas turbine, internal combustion engine or domestic boilers (through the gas grid) to produce heat and/or electricity.

Applications include:

- community district heating
- Bio-gas cleaned and fed into the existing gas grid.

3) Pyrolysis

Pyrolysis is an emerging and relatively expensive technology. It involves heat treatment of the feedstock (solid biomass or waste) at very high temperatures, in the absence of oxygen. This is similar to traditional charcoal production. Pyrolysis produces a combustible gas or liquid (oil). The fuel produced is used to generate heat and/or electricity in an internal combustion engine or gas turbine. Total electrical efficiencies are approximately 20 per cent. The only application is commercial at a large scale (larger than 2 Mega Watts electrical - MWe).

4) Gasification

Similarly to pyrolysis, gasification is an emerging technology. Solid fuel (solid biomass) undergoes incomplete combustion in a limited air supply to produce a combustible gas – syngas. Syngas can be burned in a boiler, or used as fuel for an engine or gas turbine. The fuel conversion efficiency of the gasification process is in the range of 60 to 70 percent.

Applications include:

- industrial and commercial buildings (100 kilo Watts electrical KWe, and above)
- Smaller plants of less than 5 MW are becoming more common.

CONCLUSION

Ethanol fuel is the most common bio-fuel worldwide, particularly in Brazil. It is evident; therefore, that utilization of lignocellulosic resources, biomass and other waste is a viable alternative for recovering energy in the form of biogas, bio-fuel and biodiesel at the same time abating energy and environmental pollution crises. The development of an efficient cellulose-to-ethanol technology may promote the use of raw materials such as agricultural residues, straw and wood chips. Iogen, an Ottawa based company, has built a demonstration plant and has been producing cellulosic ethanol for several years now. Bio-butanol is another possibility, as it is produced from the same feedstocks as ethanol, but has the advantage of delivering more energy. The technologies exist, but they must be made more economically attractive if they are to displace bio-fuel production from conventional agricultural products. Once these technologies have been implemented, bio-fuels will be more likely to enable a significant reduction in our dependence on fossil fuels and these will greatly enhance global energy security and sustainable socioeconomic development.

CHAPTER III

This chapter describes the research design, area of the study, population of the study, sample, instrument for data collection, validation of the instrument of data collection, administration of the instrument, method of data analysis and decision rule.

RESEARCH DESIGN

In carrying out this study, the survey design was used: the survey research design is considered to be the best design for this study because of the type of information needed for this investigation. In support of this, (Nworgu, 1991) stated that a research design is a plan or blueprint which specifies how data relating to given problem should be collected and analyzed. And also (Sowande, 2000) defines survey research as a research that employs the study of large and small population by selecting sample chosen from the population to discover the relative incidence, which by impact can easily serve as a forecaster and predictor. The study seeks the opinion of small scale industries and random selection of students of electrical engineering and industrial technology within Minna metropolis.

Area of Study

The study was carried out in Minna metropolis, the Niger state capital.

Population

The population of the study comprises of the students of Industrial and Technology Education and Small Scale Industries of Minna metropolis. Shown below:

Table 1: Distribution of the population of the study.

S/No.	Area	Small scale industries	Students of industrial and technology education	Total
1	Minna Metropolis	30	100	130

Sample

Table 2: below shows the breakdown of the sample under study.

S/No.	Area	Small scale industries	Students of industrial and technology education	Total
1	Minna metropolis	30	50	80

Instrument for Data Collection

The instrument for data collection was a structured questionnaire developed by the research for this study. It consists of part I part II. Part I Consists of personal data of the respondents and direction on how the questionnaire will be answered. While part II consist of forty (40) items divided into four sections of A, B, C and D.

Part I:

This part of the questionnaires contains personal data of the respondents.

Part II:

Section A: contain 10 item which deals with what is the current state of electric energy in minna Township. Section B: contain 10 item which deals with available alternative sources of energy Section C: contain 10 items which deals the available alternative sources of electrical energy. Section D: contains 10 items which deals with the effectiveness biomass fuel conversion.

Validation of the Instrument

The instrument was given to the researcher supervisor for approval and his suggestion was incorporated in the final draft of the instrument with appropriate modification as base on the suggestion and correction. This is to ensure that the instrument would be capable of eliciting necessary information or data needed for the study. And also, copies of the draft questionnaire was given to the research supervisor and two (2) other lecturers of industrial and technology education to make necessary modifications on the structuring and organization of the item and their suggestions were considered.

Administration of the Instrument

The researcher administered the question to the respondent personally and with the help of research assistants from each section. The administered questionnaire was later collected after completion.

Method of data analysis

The data collected by the researcher was analyzed using frequency count, mean, standard deviation and T-test as statistical tools. Mean was used to answer the research questions while standard deviation and t-test were used for testing the null hypothesis formulated at 0.05 level of significant in order to determine if there is any significant difference between operators and maintenance with regards to the research questions.

The data obtained for the study was analyzed using frequency count and mean of the four point items.

Strongly agree	(SA)	4
Agree	(A)	3
Disagree	(D)	2
Strongly disagree	(SD)	1

Decision Rule

To determine the acceptance level, a mean score of 2.50 and above was computed in line with a four point rating scale. Any items that attracts up to 2.50 and above was considered AGREED and any item below 2.50 was considered as DISSAGREED. The acceptance level for the hypotheses testing is base on the degree of freedom (d.f = n_1 + n_2 -2) of 63 degree which gives a t-table value at 0.05 level of significance of = 1.98. Therefore any item with the t-calculated value less than ±1.98 is considered as accepted while those equal or greater than ±1.98

is considered as rejected.

CHAPTER IV

PRESENTATION AND DATA ANALYSIS

This chapter deals with the presentation and analysis of data with respect to the research questions formulated for this study, the result of this data analysis for the research questions are presented as follows.

RESEARCH QUESTION I

What is the present state of electricity in Niger state, particularly in Minna metropolis?

TABLE 1:

Mean scores of the respondents in relation to the current state of electricity in Minna, Niger state.

Response $N_1 = 30$ $N_2 = 50$

S/N	ITEMS	$\bar{X}_1$	$\bar{X}_2$	X_t	Remarks
1	There is steady power supply	2.00	1.83	1.92	Disagree
2	There is proper transformation and load shed	1.90	2.00	1.95	Disagree
3	The power interruption do not interfere with operation of critical equipment	2.14	2.03	2.09	Disagree
4	Reduction of monthly bill	1.56	1.40	1.48	Disagree
5	Proper installation of electrical equipment	2.10	2.73	2.42	Disagree
6	Good management of the local supply organization body	2.18	2.13	2.16	Disagree
7	Consistency of electrical supply over long period of time	1.92	1.47	1.70	Disagree
8	Availability of constant power on daily bases	1.54	2.00	1.77	Disagree
9	The power supply is not interrupted frequently	1.60	1.67	1.64	Disagree
10	Availability of tools and equipments for proper maintenance	2.80	2.00	2.40	Disagree

KEY: N1 = number of small scale industries

N2 = Number of students of electrical engineering/ industrial technology

$\overline{X}_1$ = Mean score of small scale industries

$\overline{X}_2$ = mean score of Residential occupants.

X_t = average mean score of both small scale industries and students.

The table 1 above revealed that both groups of respondent disagreed with all items 1 - 10 in this section with mean score ranging from 1.48 – 2.42.

RESEARCH QUESTION 2

What are the possible strategies for adopting biomass power generation as an alternative power source for effective electrical power supply in Minna, Niger state?

TABLE 2:

Mean scores of the respondents in relation to the possible strategies for adopting biomass power generation as an alternative source for effective power supply.

Response $N_1 = 30$ $N_2 = 50$

S/N	ITEMS	$\bar{X}_1$	$\bar{X}_2$	X_t	Remarks
11	It has low cost of maintenance	2.86	2.83	2.85	Agree
12	Its installation can be operated for many years	3.10	3.10	3.10	Agree
13	It is an ecological friendly alternative	3.46	3.27	3.37	Agree
14	Reducing transmission and distribution losses	3.00	3.03	3.02	Agree
15	Grid connection can be easily connected locally	3.13	3.20	3.17	Agree
16	Availability of waste or biomass fuel is plentiful	3.30	3.20	3.25	Agree
17	It is a renewable energy source	3.12	3.67	3.40	Agree
18	Biomass energy is pollution free during use	3.04	3.30	3.17	Agree
19	Operating cost is low compared to the existing power plants	3.16	2.83	3.00	Agree
20	If properly designed, it can produce hundreds of kilowatts to power heavy machinery	3.50	3.10	3.30	Agree

The table 2 above revealed that both groups of respondent agreed with all items, with the mean score ranging from 2.85 – 3.30.

RESEARCH QUESTION 3

What are the other available alternatives for electrical energy generation in Niger state?

TABLE 3: Mean scores of the respondents in relation to the other available alternative sources of electrical power generation in Niger state.

Response $N_1 = 30$ $N_2 = 50$

S/N	ITEMS	$\overline{X}_1$	$\overline{X}_2$	X_t	Remarks
21	There is availability of sufficient sunlight for solar power plants	3.50	3.67	3.59	Agree
22	There is availability of rivers for hydro power generation	2.04	3.33	2.69	Agree
23	There is availability of coal for coal fired steam power plants	3.20	2.83	3.02	Agree
24	There is availability of wind flow for wind mills and power generation through wind	3.02	2.63	2.83	Agree
25	There is availability of batteries for inverters	2.98	2.70	2.84	Agree
26	There Is availability of petroleum for mechanical engines for electricity generation	2.80	2.93	2.87	Agree
27	There is availability of gas for gas powered steam plants	2.88	2.50	2.69	Agree
28	There is availability of geothermal energy for electrical power generation	3.20	2.93	3.07	Agree
29	There is availability of bio-fuel in sufficient quantities to establish biomass power plants within the state.	3.16	3.23	3.20	Agree
30	There is availability of wood as combustible fuel for power generation	3.16	2.97	3.07	Agree

The table 3 above revealed that both groups of respondent agreed with all items with the average mean score ranging from 2.69 – 3.59 respectively.

RESEARCH QUESTION 4

How effective is biomass fuel energy conversion?

TABLE 4: Mean scores of the respondents in relation to the effectiveness of bio-fuel conversion for electrical energy generation.

Response $N_1 = 30$ $N_2 = 50$

S/N	ITEMS	$\bar{X}_1$	$\bar{X}_2$	X_t	Remarks
31	Biomass is a relatively cheap source of energy	3.06	2.90	2.98	Agree
32	Biomass power plants are capable of generating electrical power in the range of Megawatts	3.10	2.50	2.80	Agree
33	Biomass fuel power generation is environmental friendly	3.36	3.17	3.27	Agree
34	Biomass power generation produces less waste and hence can be said to be very efficient	3.10	3.40	3.25	Agree
35	There is availability of biomass waste materials and bio-fuels in abundant quantities	2.94	3.00	2.97	Agree
36	There is complete combustion of biomass fuels with less waste	2.78	3.30	3.04	Agree
37	It is capable to provide constant generation of power	2.98	2.87	2.93	Agree
38	It brings about the reduction of municipal wastes in the environment.	2.70	3.30	3.00	Agree
39	Biomass energy generation running and maintenance cost is high.	3.06	2.30	2.68	Agree
40	The process of biomass energy conversion is easily achievable.	2.80	3.23	3.02	Agree

The table 4 above revealed that both groups of respondent agreed with all items, with the mean score ranging from 2.68 – 3.27 respectively.

HYPOTHESIS 1

There is no significant difference between the mean responses of small scale industries and students of engineering/industrial technology on the current state of electricity supply in Minna metropolis, Niger state.

Table 5:

t-test analysis of small scale industries and students of industrial technology on the current state of electricity supply in Minna metropolis, Niger state.

		Response		**$N_1 = 30$**		**$N_2 = 50$**	
S/N	ITEMS	$\overline{X}_1$	$\overline{X}_2$	SD_1	SD_2	T-cal	Remarks
1	There is steady power supply	2.00	1.83	0.63	0.69	1.10	NS
2	There is proper transformation and load shed	1.90	2.00	0.94	0.89	-0.48	NS
3	The power interruption do not interfere with operation of critical equipment	2.14	2.03	1.08	1.14	0.43	NS
4	Reduction of monthly bill	1.56	1.40	0.64	0.61	1.11	NS
5	Proper installation of electrical equipment	2.10	2.73	0.94	0.85	-3.08	S
6	Good management of the local supply organization body	2.18	2.13	0.93	0.88	0.24	NS
7	Consistency of electrical supply over long period of time	1.92	1.47	0.56	0.62	3.26	S
8	Availability of constant power on daily bases	1.54	2.00	0.73	0.77	-2.64	S
9	The power supply is not interrupted frequently	1.60	1.67	0.75	0.47	-0.51	NS
10	Availability of tools and equipments for proper maintenance	2.80	2.00	0.87	0.58	4.93	S

Key

N_1 = Number of small scale industries (30),

N_2 = Numbers of students (50),

$S.D_1$ = standard deviation of small scale industries,

$S.D_2$ = standard deviation of students,

T = t-test value of small scale industries and students of engineering,

$\overline{X}_1$ = mean of small scale industries

$\overline{X}_2$ = mean of students of electrical engineering/ industrial technology

S = Significant,

NS = Not significant.

The analysis in this table 5: showed that the t-cal values of all the 10 items were below the t-cal except for 4 items 5, 7, 8 and 10. Therefore, the null hypothesis was rejected for each of the four items while it was accepted for each of six other items. Hence the opinion of the respondents differed in four items but did not differ in six items in relation to the state current state of electricity supply in Minna metropolis, Niger state.

HYPOTHESIS 2

There is no significant difference between the mean responses of respondents on possible strategies for adopting biomass fuel power plants as an alternative to electric energy source in Minna metropolis, Niger state.

Table 6:

t-test analysis of small scale industries and students of industrial technology on possible strategies for adopting biomass fuel power plants as an alternative to electric energy source in Minna metropolis, Niger state.

		Response		**$N_1 = 30$**		**$N_2 = 50$**	
S/N	ITEMS	$\overline{X}_1$	$\overline{X}_2$	SD_1	SD_2	T-cal	Remarks
1	It has low cost of maintenance	2.86	2.83	0.85	0.69	0.17	NS
2	Its installation can be operated for many years	3.10	3.10	0.70	0.83	0.00	NS
3	It is an ecological friendly alternative	3.46	3.27	0.54	0.89	1.06	NS
4	Reducing transmission and distribution losses	3.00	3.03	1.00	0.98	-0.13	NS
5	Grid connection can be easily connected locally	3.13	3.20	0.98	0.95	-0.32	NS
6	Availability of was or biomass fuel is plentiful	3.30	3.20	0.83	0.79	0.54	NS
7	It is a renewable energy source	3.12	3.67	0.86	0.47	-3.70	S
8	Biomass energy is pollution free during use	3.04	3.30	0.94	0.82	-1.30	NS
9	Operating cost is low compared to the existing power plants	3.16	2.83	0.81	1.07	1.46	NS
10	If properly designed, it can produce hundreds of kilowatts to power heavy machinery	3.50	3.10	0.67	0.83	2.24	S

The analysis in this table 6: showed that the t-cal values of all the 10 items were below the t-cal except for 2 items 7 and 10 Therefore, the null hypothesis was rejected for each of the two items while it was accepted for each of eight other items. Hence the opinion of the respondents differed in two items but did not differ in eight items in relation to the possible strategies for adopting biomass fuel power plants as an alternative to electric energy source in Minna metropolis, Niger state.

HYPOTHESIS 3

There is no significant difference in the mean response of small scale industries and students of engineering/industrial technology on the availability of alternatives for electrical energy generation in Minna metropolis, Niger state.

Table 7:
t- test analysis of small scale industries and students of industrial technology concerning the availability of alternatives for electrical energy generation in minna metropolis, Niger state.

		Response		**$N_1 = 30$**		**$N_2 = 50$**	
S/N	ITEMS	$\bar{X}_1$	$\bar{X}_2$	SD_1	SD_2	T-cal	Remarks
1	There is availability of sufficient sunlight for solar power plants	3.50	3.67	0.67	0.47	-1.33	NS
2	There is availability of rivers for hydro power generation	2.04	3.33	1.02	0.75	-6.49	S
3	There is availability of coal for coal fired steam power plants	3.20	2.83	0.75	1.07	1.66	NS
4	There is availability of wind flow for wind mills and power generation through wind	3.02	2.63	0.88	0.87	1.93	NS
5	There is availability of batteries for inverters	2.98	2.70	0.95	0.90	1.32	NS
6	There Is availability of petroleum for mechanical engines for electricity generation	2.80	2.93	0.98	0.73	-0.68	NS
7	There is availability of gas for gas powered steam plants	2.88	2.50	0.97	0.96	1.71	NS
8	There is availability of geothermal energy for electrical power generation	3.20	2.93	0.75	0.93	1.35	NS
9	There is availability of bio-fuel in sufficient quantities to establish biomass power plants within the state.	3.16	3.23	0.83	0.72	-0.40	NS
10	There is availability of wood as combustible fuel for power generation	3.16	2.97	0.83	0.84	0.98	NS

The analysis in this table 7: showed that the t-cal values of all the 10 items were below the t-cal except for item 2. Therefore, the null hypothesis was rejected for only one item, while it was accepted for each of nine items. Hence the opinion of the respondents differed in only one item but did not differ in nine items in relation to the availability of alternatives for electrical energy generation in minna metropolis, Niger state.

HYPOTHESIS 4

There is no significant difference between the mean responses of small scale industries and students of engineering/industrial technology on the on the effectiveness of biomass fuel conversion.

Table 8:

t-test analysis of small scale industries and students of industrial technology concerning the on the effectiveness of biomass fuel energy for power generation.

		Response		**$N_1 = 30$**		**$N_2 = 50$**	
S/N.	ITEMS	$\overline{X}_1$	$\overline{X}_2$	SD_1	SD_2	T-cal	Remarks
1	Biomass is a relatively cheap source of energy	3.06	2.90	0.90	0.98	0.73	NS
2	Biomass power plants are capable of generating electrical power in the range of Megawatts	3.10	2.50	0.94	0.96	2.73	S
3	Biomass fuel power generation is environmental friendly	3.36	3.17	0.77	0.69	1.14	NS
4	Biomass power generation produces less waste and hence can be said to be very efficient	3.10	3.40	0.94	0.66	-1.67	NS
5	There is availability of biomass waste materials and bio-fuels in abundant quantities	2.94	3.00	1.08	0.82	-0.28	NS
6	There is complete combustion of biomass fuels with less waste	2.78	3.30	0.90	0.82	-2.65	S
7	It is capable to provide constant generation of power	2.98	2.87	0.95	0.88	0.53	NS
8	It brings about the reduction of municipal wastes in the environment.	2.70	3.30	1.10	0.64	-3.08	S
9	Biomass energy generation running and maintenance cost is high.	3.06	2.30	0.79	0.94	3.71	S
10	The process of biomass energy conversion is easily achievable.	2.80	3.23	0.98	0.80	-2.14	S

The analysis in this table 8: showed that the t-cal values of all the 10 items were below the t-cal except for four items: 6, 8, 9, and 10. Therefore, the null hypothesis was rejected for four items, while it was accepted for each of six items. Hence the opinion of the respondents differed in four items but did not differ in six items in relation to the effectiveness biomass fuel energy for power generation.

Summary of the findings

Based on the data collected and analyzed, the following findings were made according to the research questions raised for the study.

Findings based on The Present State of Electricity In Niger State, Particularly In Minna Metropolis.

1. There no is steady power supply
2. There is no proper transformation and load shed
3. The power interruption interferes with operation of critical equipment
4. There is no reduction of monthly bill
5. There is no proper installation of electrical equipment
6. No good management of the local supply organization body
7. No consistency of electrical supply over long period of time
8. No availability of constant power on daily bases

Findings related to the possible strategies for adopting biomass power generation as an alternative power source for effective electrical power supply in Minna, Niger state.

1. It has low cost of maintenance
2. Its installation can be operated for many years
3. It is an ecological friendly alternative
4. Reducing transmission and distribution losses
5. Grid connection can be easily connected locally
6. Availability of was or biomass fuel is plentiful

7. It is a renewable energy source
8. Biomass energy is pollution free during use

Findings related to the available alternatives for electrical energy generation in Niger state,

1. There is availability of sufficient sunlight for solar power plants
2. There is availability of rivers for hydro power generation
3. There is availability of coal for coal fired steam power plants
4. There is availability of wind flow for wind mills and power generation through wind
5. There is availability of batteries for inverters
6. There Is availability of petroleum for mechanical engines for electricity generation
7. There is availability of gas for gas powered steam plants
8. There is availability of geothermal energy for electrical power generation

Findings related to the effective of biomass fuel energy for power generation

1. Biomass is a relatively cheap source of energy
2. Biomass power plants are capable of generating electrical power in the range of Megawatts
3. Biomass fuel power generation is environmental friendly
4. Biomass power generation produces less waste and hence can be said to be very efficient
5. There is availability of biomass waste materials and bio-fuels in abundant quantities
6. There is complete combustion of biomass fuels with less waste
7. It is capable to provide constant generation of power
8. It brings about the reduction of municipal wastes in the environment.

Discussion of Findings

The discussions of the findings are based on the research questions raised for the study.

The findings from table1, above indicates that there is inadequate electrical power supply in Minna metropolis of Niger state. The failure of national electrification in Nigeria over the last three decades is attributed to corruption, poor maintenance and uncompleted projects. Of Nigeria's 79 power stations, most of which date from the 1970s and 1980s, only about 15 are currently working – often not to full capacity (The Economist 2007). Supply problems according to (DOE, the potential benefits of distributed Generation and rate; 2007) leads to the philosophy that it will be necessary and wise at the same time to decentralize at least the future installation using renewable energy sources. Decentralized energy systems such as heat pumps, solar thermal and biomass plants have less pollution effects on their environment that centralized energy systems. Furthermore they play an important role in reducing the demand for hydro electricity and other primary energy carriers. This paper highlights the overall picture of the present electric energy situation and throw light on the changes in energy consumption, distribution and production.

Table 2 presents the strategies for developing and adopting biomass power plant energy conversion, professor barth Nnaji should be credited with charting the plan and path for the power sector. The road map for power sector reform is a 149 page document released in august 2010. It is a decently conceived document that provides milestones and projections that delineate Nigeria's path path towards reaching the vaunted goal of reliably providing 40,000mw of power by the year 2020. The power sector roadmap focus on hydro, coal and natural gas as the framework around which Nigeria's energy sector will be built. Renewable energy sources like solar, wind and biomass-to-energy are strongly encouraged.

Table 3 also highlights the available alternative renewable sources of energy generation. From a book titled: (**Nigeria treading a renewable path** by sowmya surnyanarayanan October, 2009) Over the past few years, the Nigerian government has shifted its focus towards harnessing alternative energy. As noted earlier, the remote areas in Nigeria lack access to energy supply with less than 20 percent of the households connected to the national grid. Given this, basic energy needs such as pumping of water for irrigation and rural electrification can be achieved through development of solar energy and small hydro-power projects in remote villages. An unbridled supply of power will ensure progress of sectors and make the rural economy more self-reliant.

The topography of Nigeria is such that it gives ample scope for generation of biomass. The north central region creates large amount of crop residues and farm wastes. In addition, the municipal solid wastes generated from expanding urban centers such as Lagos and Kano can also be utilized to produce energy through proper solid waste management. A large part of the population in Nigeria depends almost entirely on fuel wood at present. However, studies have shown that only 5-12 percent of the fuel-wood is gainfully utilized for cooking and domestic purposes annually. If this trend of overdependence and inefficient use of fuel-wood continues, the southern part of the country is likely to become vulnerable to erosion and desertification in the future. Biomass is no doubt a viable alternative energy option for Nigeria; however, it is necessary to expand biomass energy derived from municipal and agricultural wastes and also efficiently use fuel-wood in order to conserve forest resources. Apart from solar, hydro-power and biomass energy, Nigeria also stands to gain from investing in wind energy. Feasibility studies have shown that certain parts of Nigeria have the potential to generate power from wind energy. In the past, investments have been made to harness wind energy to pump water, especially in the northern region in states such as Sokoto and Kano. However, as prices of domestic petroleum products dropped, wind energy was no longer considered a cheaper alternative over fossil fuels. Given the present volatility of oil prices, Nigeria must look at generating energy from wind energy. Currently only about 0.6 percent of the total electricity generated is contributed by renewable energy.

The Nigerian government has taken positive steps at the policy level to harness renewable energy. In 2007, it launched the Renewable Energy Master Plan (REMP). The Plan envisions generating an overall 2,945 MW of energy from wind, solar, small hydro and biomass by 2025 through short term, medium term and long term projects. And yet, little progress has been made in implementing these projects till now. Nigeria requires not just proactive policies but also greater political commitment and large scale foreign investments to diversify its energy base. Foreign investments in renewable energy will open up the market for competition and make energy more cost effective in the long-run. One of the major pitfalls of oil revenues was that it resulted in the concentration of wealth in the oil sector. Adoption of renewable energy technologies will lead to the growth of non-oil sectors and promote equitable distribution of income and wealth. The world is slowly moving towards developing a non-fossil energy system to tackle climate change. Owing to this, the future demand and price of fossil fuels are likely to substantially diminish. The economic impact of this will be greater on the Nigerian economy since oil revenues contribute almost 70 percent of Nigeria's federal revenue. Given the profitable nature of fossil fuels, enlarging the role of renewable energy in the overall energy consumption mix will pose a serious economic and political challenge. However, it is important to note that at least two forms of alternative energy resources such as solar and biomass are available in abundance and accessible in all parts of the country. In addition, ease of application of technologies in rural areas and environmentally sustainable nature of alternative fuel offers immense opportunities for Nigeria to progressively invest and expand renewable energy resources to meet growing energy demand.

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATIONS.

Summary of the study

The purpose of this study is to identify and recommend strategies for adopting biomass fuel power plants as an alternative for the generation of energy in form of electrical power to complement or supplement the current primary source of energy generation in Niger state, which is hydro-electric power plant. The related literature that were reviewed in this study are stated under the following headings: What is biomass, defining bio-electricity, historical background of biomass and bio-fuels, conversion and bioconversion process for bio-fuels production, bio-refineries, types of bio-fuels and sustainability. Statistical tools such as mean, standard deviation and t-test were used to analyze the data by using both small scale industries and students of electrical engineering/industrial technology as respondents for the research. A 40 items questionnaire was used as instrument for data collection and was analyzed according to each of the research questions.

A research survey design was used in carrying out the study. Four research questions were formulated for the specific purpose of guiding the study, the hypotheses were tested at 0.05 level of significance. The study among others revealed that there is a very pressing need for power generation to meet up with the high demand for power which at the same time would be renewable and environmentally friendly (Eco-friendly). However, certain strategies have already been identified in this study for the adoption of biomass power plans as alternative energy generation. This would in turn improve the industrialization of the Niger state with Minna metropolis in particular, improve revenue generation and also create a medium for waste recycling.

Implication of the study

The findings of this study obviously have certain implication on the current state of electric power supply in Minna metropolis Niger state and strategies for adopting biomass energy conversion as an alternative for effective electrical power supply. The findings has information on the current state of hydro electric power supply and challenges faced by small scale industries in Minna metropolis, identifying problems affecting consistency of electric power supply and identifying ways of improving electric power supply by adopting biomass fuel conversion in Minna metropolis, which if not considered, will affect the activities of small scale industries and power interruption to Minna residents.

Conclusion

In conclusion, biomass energy as an alternative power source in Minna metropolis will be very effective and reliable because of the abundance of biomass fuels and municipal waste materials in the state. Using the existing electrical load at station, as standard sized biomass power plant can effectively electrify Minna metropolis. The biomass power plant can be compared in economic terms with the hydro-electric power plant as a major source of primary electrical energy carrier is fast declining in quantity demanded due to its unreliable nature. This call for a major shift from depending on hydro-electric power supply and replacing or complementing with alternative renewable energy sources like biomass and solar energy in all its forms. Other conventional forms of energy sources that are non-renewable like nuclear reactors, coal and gas are still going to play major role in energy supply for some time to come.

Recommendation

Based on the findings of this study, the researcher hereby made the following recommendations: the wide scale use of biomass power plants as an alternative for electrical energy generation will require:

1. Major cost in the initial building of power plants
2. Improving liability
3. The capability with a reminder of the electric grid system
4. Economic and reliable energy generation
5. Replacement of old distribution equipments and facilities including constant servicing.
6. Increase revenue generation as more customers will be captured.

With proper and efficient management through improved technology of biomass power plants as alternative source of energy generation. The Importance of energy cannot be over estimated. That is why virtually in the world government, ministries of energy and energy research are established. Their ability to meet the energy requirements of any country depends on the emphases place by the government and backed by sound energy policy.

Suggestions for further research:

1. Strategies for improving electrical power generation through the use of eco-friendly renewable sources in Minna, Niger state.
2. The Impact of steady electrical power supply on industrialization and the economic development of Nigeria as a nation.

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APPENDIX B

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

DEPARTMENT OF INDUSTRAIL AND TECHNOLOGY EDUCATION

ELECTRICAL/ELECTRONICS TECHNOLOGY OPTION

QUEISTIONAIRE ON:

STRATEGIES FOR ENHANCING BIOMASS FUEL POWER PLANTS AS AN ALTERNATIVE FOR ENERGY GENERATION IN NIGER STATE

SECTION A

PERSONNAL DATA

Please kindly provide the information required below. All information and responses supplied to the items of this questionnaire will be used particularly for the purpose of this research work and will be treated as confidential. Your prompt and honest response will be duly appreciated.

Respondent:

Small scale industry ☐

Students of industrial and technology education ☐

QUESTIONAIRES

Please indicate the option that appeal to you by ticking the appropriate box.

Key to response options

SA = Strongly Agreed

A = Agreed

D = Disagreed

SD = Strongly Disagreed

SECTION B

RESEARCH QUESTION I

What is the present state of electricity in Niger state, particularly in Minna metropolis?

TABLE 1:

S/N	**ITEMS**	**SA**	**A**	**D**	**SD**
1	There is steady power supply				
2	There is proper transformation and load shed				
3	The power interruption do not interfere with operation of critical equipment				
4	Reduction of monthly bill				
5	Proper installation of electrical equipment				
6	Good management of the local supply organization body				
7	Consistency of electrical supply over long period of time				
8	Availability of constant power on daily bases				
9	The power supply is not interrupted frequently				
10	Availability of tools and equipments for proper maintenance				

SECTION C

RESEARCH QUESTION 2

What are the possible strategies for adopting biomass power generation as an alternative power source for effective electrical power supply in Minna, Niger state?

TABLE 2:

S/N	**ITEMS**	**SA**	**A**	**D**	**SD**
1	It has low cost of maintenance				
2	Its installation can be operated for many years				
3	It is an ecological friendly alternative				
4	Reducing transmission and distribution losses				
5	Grid connection can be easily connected locally				
6	Availability of waste or biomass fuel is plentiful				
7	It is a renewable energy source				
8	Biomass energy is pollution free during use				
9	Operating cost is low compared to the existing power plants				
10	If properly designed, it can produce hundreds of kilowatts to power heavy machinery				

SECTION D

RESEARCH QUESTION 3

What are the other available alternative resources for electrical energy generation in Niger state?

TABLE 3:

S/No.	ITEMS	SA	A	D	SD
1	There is availability of sufficient sunlight for solar power plants				
2	There is availability of rivers for hydro power generation				
3	There is availability of coal for coal fired steam power plants				
4	There is availability of wind flow for wind mills and power generation through wind				
5	There is availability of batteries for inverters				
6	There Is availability of petroleum for mechanical engines for electricity generation				
7	There is availability of gas for gas powered steam plants				
8	There is availability of geothermal energy for electrical power generation				
9	There is availability of bio-fuel in sufficient quantities to establish biomass power plants within the state.				
10	There is availability of wood as combustible fuel for power generation				

SECTION E

RESEARCH QUESTION 4

How effective is biomass fuel energy for power generation?

TABLE 4:

S/No.	ITEMS	SA	A	D	SD
1	Biomass is a relatively cheap source of energy				
2	Biomass power plants are capable of generating electrical power in the range of Megawatts				
3	Biomass fuel power generation is environmental friendly				
4	Biomass power generation produces less waste and hence can be said to be very efficient				
5	There is availability of biomass waste materials and bio-fuels in abundant quantities				
6	There is complete combustion of biomass fuels with less waste				
7	It is capable to provide constant generation of power				
8	It brings about the reduction of municipal wastes in the environment.				
9	Biomass energy generation running and maintenance cost is high.				
10	The process of biomass energy conversion is easily achievable.				

APPENDIX C

FORMULAR

The mean response of each item was obtained using the formula

$$\bar{X} = \frac{\Sigma FX}{N}$$

Where:

Σ = Summation of

X = Normal value of option

$\bar{X}$ = Grand mean response to all item

N = Total number of response of an items

F = Frequency of response to each option

Standard Deviation

$$S.D = \sqrt{\frac{\Sigma f\,(X - \bar{X})^2}{\Sigma f}}$$

Where:

Σ = Summation of

F = Frequency

X = Normal value of option

X = Mean response of all item

t–test

t–test was used to compare the mean of the groups. For instance the mean response of small scale industries and students of electrical engineering/industrial technology was compared. Each t–value calculated that is less than the t – critical value (±1.98) at 0.5 level of significance was accepted while t-value that is equal or exceed (±1.98) was rejected.

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2 + S_2^2}{N_1 + N_2}}}$$

Where:

t = Test of significant

$\bar{X}_1$ = Grand mean of small scale industries

$\bar{X}_2$ = Grand mean of students of industrial and technology education.

N_1 = Number of Small scale industries

N_2 = Number of students of industrial and technology education

$S^2{}_1$ = Variance of small scale industries

$S^2{}_2$ = Variance of Apprentice Students

D.f = $N_1 + N_2 - 2$

$30 + 89 - 2 = 78$