ASSESSMENT OF SUSTAINABLE ENERGY PLANNING IN BIDA MUNICIPALITY, NIGER STATE, NIGERIA

BY

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(M.TECH/SSSE/2007/1630)

A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL, FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF TECHNOLOGY (M.TECH) IN GEOGRAPHY (ENVIRONMENTAL MANAGEMENT)

DECEMBER, 2010

DECLARATION

I, Kuso Umaru, declare that this thesis work was written by me and has not been presented anywhere, either in whole or part, for the award of any postgraduate degree. All literatures cited have been duly acknowledged in the reference.

Kuso Umaru

1/03/2011
Date

CERTIFICATION

This thesis titled: Assessment of Sustainable Energy Planning – Bida Municipality, Niger State, Nigeria, by: KUSO, Umaru (M.Tech/SSSE/2007/1630) meets the regulations governing the award of the degree of Master of Technology, (M.Tech) of the Federal University of Technology, Minna and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This research work is dedicated to Almighty Allah and my beloved parents whose encouragement, in many ways, saw me to the success of this yet another academic feat. My sincere regards to them all.

ACKNOWLEDGEMENTS

I cannot (in anyway) pay back the efforts, time and painstaking guidance offered by my project supervisor, Dr. A.S. Abubakar. May you be rewarded with good health and academic wisdom so that you can continue with your desirous academic exploits. No must I also forget invaluable advice and contributions of the departmental postgraduate coordinator, in person of Mr. Salihu Saidu, who always created time to attend to our academic demands. Finally, I am grateful to my family and all those who helped me in one way or another to ensure the success of this work. I am also grateful to my fellow students, some of whom contributed immensely to the success of this research work. Mention must specially be made of Mr. Abiodun and Adam Hussain who always offered their useful suggestions as to the success of this research work. I must also commend my amiable wife for her patience and encouragement towards the entire programme. My regards are due to them all.

ABSTRACT

In this study, current and future views of energy utilization and biomass energy option in Bida municipality were examined and discussed from the standpoint of sustainable development. It is a common fact that conventional energy sources can no longer sustain the ever-increasing economy of Nigeria hence; the country is susceptible to serious energy disruptions that have impacted negatively on the economy and the overall human comfort. The escalating demand in energy arising from economic activities and an increasing population has not been marched by investment in the provision of infrastructure required to meet the energy needs. The overdependence on conventional sources of energy and oil has exposed Bida municipality (and Nigeria at large) to a risk in view of the high inefficient energy utilization, inefficient and unreliable energy supply system, environmental concerns, poor energy financing, inadequate technological capabilities in the energy sector and weak institutional framework. The electricity production capacity based largely on fossil fuel sources is at present below 3149MW (PHCN, 2009) in a country with an approximate population of 150 million people. And yet her vast renewable energy resources comprising mainly hydro, solar, biomass and wind is very enormous and remain largely untapped. Energy production strategy that does not capture full exploitation and promotion of renewable energy resources especially the biomass and solar energy that are more ubiquitous, in the energy supply mix cannot guarantee secure energy future and sustainable energy development in Nigeria.

TABLE OF CONTENTS

Contents **Page**

CHAPTER TWO: Page

CHAPTER THREE:

CHAPTER FOUR: **Page**

CHAPTER FIVE: **Page**

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Nigeria's recent energy crisis reveals the economic and political consequences of not thinking systematically about the nation's basic infrastructure and energy needs, as business and residents of the entire country find themselves wondering whether any thing would happen when they turn on their lights. While there are federal – level efforts being made to plan for the nation's long – term energy needs, progress at the state and local levels is beginning, though slowly. In part, this is because there is a long – standing perception that energy conservation and the pursuit of more sustainable energy sources are matters best left to Federal policy – makers (Allen & Hoekstra, 1992), Niger state uses more than 170 megawatts (MW) of electricity, with a peak demand of 320 megawatts (PHCN Minna, 2009). One hundred percent of this energy is produced within the state from only one source – the hydro stations. There are not yet any reasonable efforts made to compliment the said generated amount of electricity by some other environmentally pleasant renewable sources such as wind, solar, and geothermal as well as biomass.

Electricity demand can be grouped into five major sections. Listed in declining order by their overall share of consumption, these are: - commercial, residential, industrial, agriculture, and others. The commercial sector has accounted for an increasing share of overall energy use. The global energy crisis coupled with the threats of climate change bring into sharp focus both opportunities and challenges for developing countries. Developing countries have to address the increasing energy demands of growing economies, as well as address energy poverty issues often highlighted by extreme disparities in income. They also need to deal with the real and potential impacts of climate change. In addition to these challenges is the global imperative to reduce carbon emissions in order to prevent climate change. While developing nations have thus far been sheltered from obligations to reduce carbon emissions, we cannot anticipate that this situation will continue. Within this context developing nations need to follow a very different development path from that established by first world countries. This development path is a low energy, low carbon, and generally a resource efficient one. Economies across the world need to change the assumptions of this paradigm in order to build a sustainable reality. As financial and environmental impacts soar, the real costs of resource inputs and of waste generation need to increasingly be taken into account. These factors are making efficiency, conservation, reuse, recycling and renewable energy sources primary considerations for a healthy economy.

Bida local government can engage in sustainable energy planning in three important ways: it can investigate ways to achieve energy sustainability through generation of information and materials that lead to a better understanding of sustainable urban energy planning options and practices. It can also promote efficient energy use and alternative resources in the private sector through the judicious use of incentives, policies, regulations, and demonstration projects. Moreover, sustainable urban energy planning can also be achieved through the use of renewable energy technology that guarantees clean, safe and reliable energy flow which exerts a lighter touch on the natural environment.

1.2 Statement of the Problem

Bida local government, like many other local governments, have compelling reasons to become involved in energy – related activities, but majority of the local governments continue to look up to the Federal Government to continue to handle the energy issue. As such, a number of states and local governments continue to regard energy planning as outside of their responsibility, while others – including those about considering energy programs – are discouraged and hampered along the line by the interrelated barriers that increase risk, create uncertainty, and prevent these pubic bodies from making the most of the opportunities available to them. Together, this barrier undermines the capacity of state and local governments to involve themselves in sustainable energy planning efforts or adopt policies to improve energy efficiency and deploy advanced energy technologies. These barriers include: insufficient knowledge of the costs and benefits of various energy – related policies or actions; technical gaps; regulatory obstacles; and the institutional mismatch between statement and the scope of the energy system.

Over the years the demand for energy, has continued to increase and there is no corresponding increase in supply. The use of energy, the types of energy used and the lack of access to sufficient energy which have plagued Bida Local Government Area have far reaching implications for a city's economic development, its environmental health and for the poor. The burning of fossil fuels to provide energy is the major contributor to excess carbon in the atmosphere which is the cause of global warming. Cities which implement sustainable energy and climate action plans reduce their vulnerability to energy scarcity and to energy price rises; they have less traffic congestion and lower energy input costs; they have cleaner air and their low-carbon economies can afford them a competitive economic edge globally. And, specifically for cities in developing countries, a sustainable energy and climate action plan should consider the users' needs first – this means that poorer households and small energy users should be prioritized.

Meanwhile, the major energy issues in Bida municipality as well as in Nigeria can be conveniently categorized as inefficient energy utilization, in efficient and unreliable energy supply system, environmental concerns, financing, inadequate technological capabilities in the energy sector and weak institutional framework (world energy council, 1993). It is a common knowledge that overdependence on conventional energy sources and fuel wood as the commonest means of providing energy has put Bida Municipality at a risk of degrading forest reserves and ensuing environmental concerns, in efficient and unreliable energy supply system, lack of awareness of technological capabilities in the energy sector, poor energy financing, weak institutional framework and inadequate knowledge on energy consumption patterns of Bida makes it difficult to plan a strategy that will ensure explosion in energy supply mix and efficient energy utilization. This necessitates the need to evolve a renewable energy strategy in Bida, and an attempt was made at assessing the possible potentiality of the biomass strategy in Bida Municipality.

1.3 Justification

State and local governments have recognized the consequences of energy crisis. Cost is the primary energy – related concern of state and local governments. However, a number of other factors, including the public health and safety considerations of reliability, economic development, quality of life, environmental quality, and environmental justice of energy production and use will lead Niger state government to lead the way and also, for local government to consider energy within their own policy making. The need for sustainable urban energy planning cannot be overemphasized; the bedrock of any economy anywhere in the world depends solely on it, Bida is not an exception. As local governments manage or oversee all city activities and city development, they should play a central role in determining the energy and carbon emissions picture of their cities. They also have direct access to their citizens and are best placed to know their needs and to influence their behaviour.

Every city is different – it has different resources at its disposal, different needs, different development paths and different mandates and powers. A city's energy plan must be built on its particular needs and the resources at its disposal. These are some of the ways in which local governments play a central role in the energy picture of their cities: They plan and manage city development and growth, they establish and enforce building codes and approve building plans, they are big energy users themselves – in their streets and buildings as they are major employers, they can directly influence their employees energy use patterns, they are engaged in significant procurement of paper, fuel, building materials, light bulbs, vehicles and so on Local governments can make significant energy savings in their own operations, thereby saving money, setting a good standard for themselves and become independent in running their economic activities without hitches.

1.4 Scope and Limitation of the Study

Although any study that involves sustainable urban energy planning encompasses a broad- field, the scope of the study is only limited to the biomass energy technology and how its potential could be assessed in Bida Municipality. As a result of the conduct of this research work, three problems emanated. The problem of time constraint due to short duration stipulated for the research work by the post graduate school affected slightly the volume of data that should have been gathered altogether. Inability of some respondents to give adequate responses when contacted during the study also imposed some limitations to the study as a result of their failure to give precise and clear responses to the research questions that were forwarded to them during the course of study.

1. 5 Aim and Objectives

The aim of this research work is to assess the potential and generate information that can leady to the possibility of using the biomass energy strategy in Bida Municipality.

The specific objectives of this study are to:

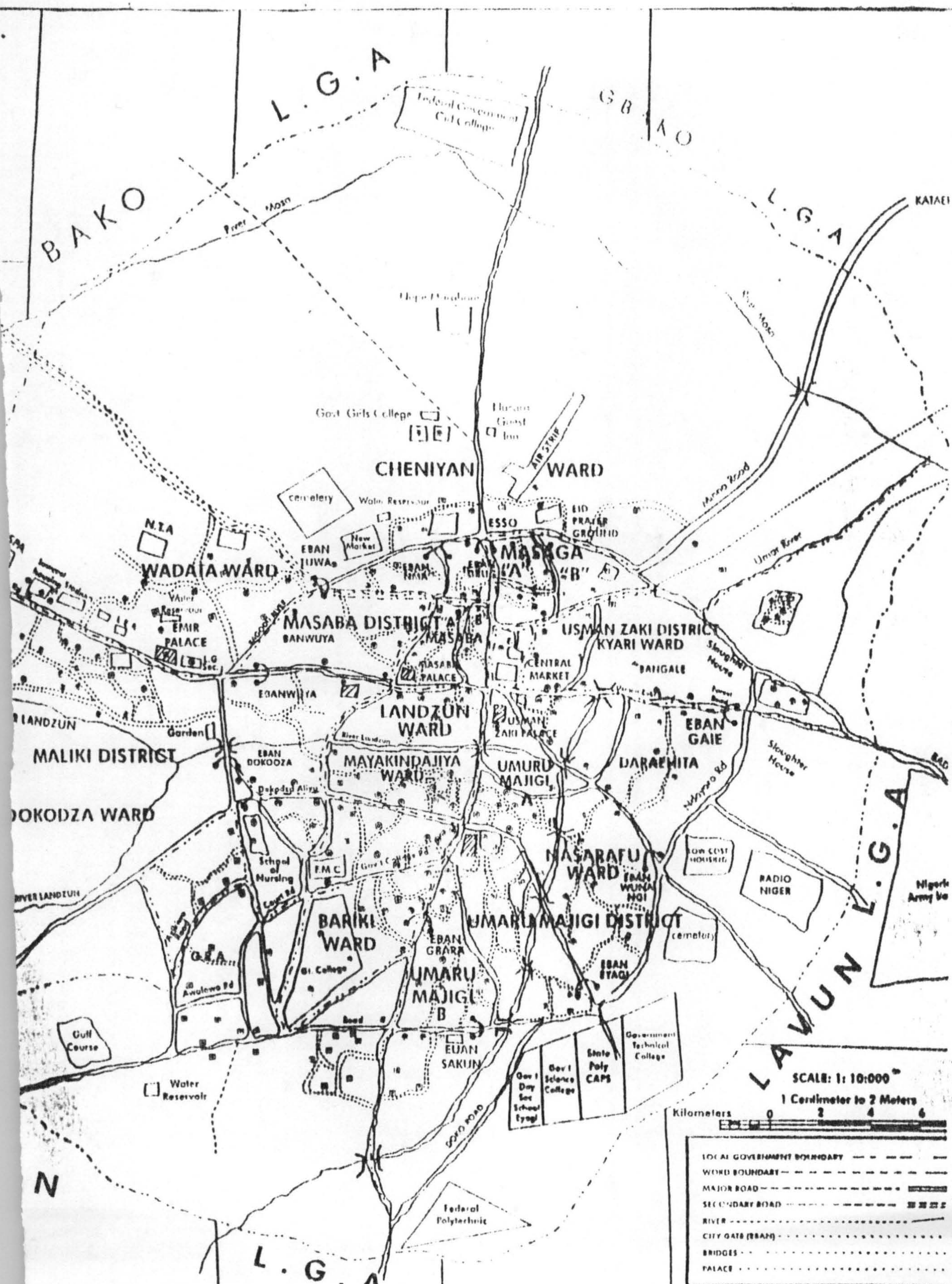
I. Assess the energy consumption pattern in Bida Municipality

II. Assess the potential of using biomass technology in Bida municipality

III. Determine ways of achieving biomass efficient technology in Bida municipality

1.6 Description of the Study Area

Bida Local Government is one of the twenty five Local Governments in Niger State. It is the local government that is the centre of civilization of the Nupe


BAKO L.G.A
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KATAEI
CHENIYAN WARD
AIR STRIP
Govt Girls College
cemetery
New Market
ESSO
EID PRAYER GROUND
N.T.A
WADATA WARD
EBAN JUWA
MASAGA "A" "B"
MASABA DISTRICT 'A' 'B'
BANWUYA
MASABA
MASABA PALACE
EMIR PALACE
USMAN ZAKI DISTRICT
KYARI WARD
BANGALE
CENTRAL MARKET
Slaughter House
EBANWUYA
LANDZUN WARD
USMAN ZAKI PALACE
EBAN GAIE
LANDZUN
Garden
MALIKI DISTRICT
EBAN DOKOOZA
MAYAKINDAJIYA WARD
UMURU MAJIGI
DARACHITA
DOKODZA WARD
LOW COST HOUSING
RADIO NIGER
School of Nursing
F.M.C
MASARAFU WARD
EBAN WUNANGI
RIVER LANDZUN
Nigeria Army
BARIKI WARD
EBAN GRARA
UMARU MAJIGI DISTRICT
cemetery
G.R.A
Awolowo Rd
UMARU MAJIGI B
EBAN ETAGI
Golf Course
EBAN SAKUN
Govt Day Sec School Eyagi
Govt Science College
State Poly CAPS
Government Technical College
Water Reservoir
Federal Polytechnic
SCALE: 1: 10:000
1 Centimeter to 2 Meters
Kilometers 0 2 4 6
LOCAL GOVERNMENT BOUNDARY
WORD BOUNDARY
MAJOR ROAD
SECONDARY ROAD
RIVER
CITY GATE (EBAN)
BRIDGES
PALACE

people. Its cosmopolitan outlook and character permits a lot of social and economic activities to take place in the area. The entire Bida and environs is located on latitude 9^0.06N, Longitute 6^0.00E. The town is on the valley of the river Niger and, therefore, its surface generally lies below 300m above sea level. The general climatic conditions of Bida and its environs exhibit only two different seasons, namely, a short wet season and prolonged dry season. This area experiences consistently high temperatures all year round. Since temperature varies only slightly, rainfall distribution, over space and time, becomes the single most important factor in differentiating the seasons.

With a population of about 200, 000 people each taking part in a variety of economic activities, the entire landscape of Bida and its adjoining areas are favoured for agriculture, art work, commerce and industry as well as other government paid employments. Bida local government is divided into Bida north and south constituencies. Each constituency is further subdivided into seven wards to make a total of fourteen wards. The urbanization level in Bida is accelerating and since the residents use significantly large volume of energy, the increased urbanization has had significant implications for power generation requirements, hydro electric generation, and overall energy security. It is in this regard; therefore, it is thought that the development of new sustainable urban energy systems will ultimately address the energy needs of this urban expansion and growth.

CHAPTER TWO

2.0 LITERATURE REVIEW

In Nigeria, owing to the recent energy crisis, it is mandatory for states and local governments to play a much active role in helping the nation adjust and avoid extensive power disruptions. State and local governments are crucial stakeholders in Nigeria's energy future. Electricity is the second largest expenditure of state government, after human resource development. (Botkin & Keller, 2003). The combination of price hikes caused by the recent energy crisis in Nigeria and of economic downturn only aggravated the fiscal crisis facing state and Local Governments. Price stability is in fact a major reason why state and local governments should begin to consider their options for various forms of municipal utility arrangements. Electricity reliability has become a public health and safety issue. For example, since these blackouts are likely to occur during hot days as a result of surging demand from air conditions at – risk populations become vulnerable to dangerous heat waves.

Local governments are in a position to play a critical role in advancing the national and states policies for the reliability, affordability, and environmental sustainability of its electric energy supply. The regulatory and institutional landscape of federal and state energy policy makes local governments critical partners in promoting efficient resource use, market transformation, and location efficiency within the built environment. Local governments have strong reasons to promote what can be considered sustainable urban energy planning practices, and a number of local governments in Nigeria have already taken the initiative. Among the main energy-related concerns driving local action are: the need for price stability; the public health and safety consequences of energy unreliability; the centrality of affordable and reliable energy to economic development; strong public support for environmental initiatives; quality of life considerations; and environmental justice demands by disproportionately impacted communities.

However, local governments also face formidable obstacles to greater participation that create risk and uncertainty. These obstacles include: a lack of awareness of (or knowledge gaps about) program and policy options and effectiveness; technical gaps that result from a lack of effective tools and a historical avoidance of energy issues within the urban and environmental planning profession; competing priorities that draw scarce attention and fiscal resource; regulatory obstacles caused by the shifting policy terrain and fractured decision-making; and institutional mismatches between overall system issues and the scope of local action. Together these obstacles reinforce one another, creating an inhospitable environment for action and preventing local governments from taking advantage of most of the available opportunities – or sometime from even taking the first step.

Local governments can engage in sustainable energy planning in three primary ways. First is within their own operations, Local governments are often large users of electricity in buildings and public facilities, in water systems, and in other capital infrastructure such as streetlights. Efficient energy use within the public realm is directly tied to cost reductions and provides the most direct incentive for local action. Second, local governments can promote efficient energy use and alternative resources in the private sector through their dominant role in shaping the built environment. Potential areas for action include: improving building efficiency in existing construction; promoting energy efficiency in new buildings (in both commercial and residential sectors); facilitating the sitting of distributed generation resources; and incorporating energy-efficient site planning and urban design new development. Third, local governments can help shape long-term development patterns in order to promote location efficiency and reduce the effects of urbanization on the energy system and the environment in general. Measures include growth management planning at both the city/neighborhood and regional scale, and this planning necessarily involves linkages with the transportation system that facilitates and underpins development. Apart from these direct local actions, effective planning support tools can help planners, citizens, and policy makers visualize the long-term consequence of alternative growth choices and improve the overall decision making process, while alternative planning techniques may help provide local governments with supplemental information for consideration within state and federally mandated planning. The energy profiles of alternative development patterns and alternative water supply and treatment strategies are not well known. Because many urban management decisions occur without the benefit of such information, officials are unable to adequately assess the full impact of their decisions.

2.1 Energy Sustainability

In the ideal, energy sustainability means the harnessing of resources that are not substantially depleted by continued use; do not emit substantial pollutants or other hazards to the environment; and do not involve the perpetuation of substantial health hazards or social injustices. Yet, there are no environmentally costs – free energy production or use – even renewable technologies such as wind, solar, geothermal, and biofuels require industrial infrastructure and life cycle energy inputs. As such, energy sustainability is a relative, rather than absolute concept. Under such circumstances, it is then imperative to identify a comprehensive set of criteria and indicators for what constitutes energy sustainability, and then develop an agenda to achieve energy sustainability through a combination of incentives and regulatory measures for conservation and efficient use, research, and development of advanced technologies and methods (Bajura, 2002).

2.2 State involvement in Sustainable Energy Planning Through Local Governments

State governments are in a position to play a critical role in advancing the nation's policies for the reliability, affordability, and environmental sustainability of its electric energy supply. The regulator and institutional landscape of federal energy policy makes states critical partners in promoting efficient resource use, market transaction, and location efficiency within the built environment. Several studies have examined the institutional aspects of local energy programs. Burke (2003) conducted a broad survey of local government energy activities in California, identifying the breadth of activities and their general funding sources.

The local government commission has conducted extensive outreach in its energy activities and in 2002 held a workshop to specifically discuss the development of sustainable institutional structures for local energy activities. Although there is little detailed comparative work, local governments that seek to undertake energy – related activities have access to a variety of resources. The Urban consortium's sustainable energy planning guide (Anderson, 1992), funded by the department of energy, provides a simple, step – by – step framework for developing a local energy plan and highlights examples of polices in San Francisco, San Jose, Portland and Oregon. However, the local government commission provides links to technical assistance and funding opportunities, but still points to the insufficiency of current support systems for local programs. Virtually every municipal official interviewed during the course of this project noted the institutional barriers and capacity constraints, and some indicated the need for comprehensive training to develop local energy program professionals.

However, tools to support the establishment of local government energy programs are being developed. In January 2004 Navigant Consulting began work on the California Energy Efficiency project (CALeep) to produce a process template for creating community energy efficiency programs that can be used by a variety of local public entities to stimulate energy efficiency activity in their jurisdictions. The project is now in its third phase, where Navigant is testing the effectiveness of its draft template by developing, implementing, and evaluating pilot projects customized to meet the needs of a variety of jurisdictional settings. Lessons from these pilot projects will be incorporated into a "prototype" energy program for California's local governments that will be disseminated through partnerships with state and federal energy agencies, and with industry associations.

The introduction of community choice aggregation into local government's toolbox has the potential to dramatically change the landscape for local activities. Additionally, it may provide a source of stable funding for other local energy – related activities and speed introduction of demand – based pricing, net metering, energy efficiency, and renewable energy. For example, one preliminary study has shown that local governments may be able to reach a renewable portfolio of up to 40% and remain competitive with independent – owned – utilities rates, depending on the ultimate rule structure.

2.3 Local Energy Program Effectiveness

The Sustainable development, sustainable energy, and urban planning fields have all developed a rich literature of research, and there exist numerous excellent recent resources for national (and to an extent, state – level) energy polices and until recently there has not been an adequate amount of research integrating these three fields or assessing the effectiveness of the various approaches (Naess, 2001; McGranahan and satterwhaite, 2003). Several studies have conducted extensive evaluations of the efforts of a number of European cities taking part in European Union – supported energy programs (Nijkamp, 1994; Butera, 1998; Nijkamp and pepping, 1998; Capello, 1999; Qlerup, 2000).

McGeough (2004a) provides a corresponding effort for a systematic examination and evaluation of the energy polices of selected American cities, along with a comprehensive overview of the range of energy – related actions that local governments can take. Burke (2003) outlines the various types of energy – related activities undertaken by California's local governments, but this is not a comparative analysis. Neither Burke nor McGeough evaluate the effectiveness of local government programs in terms of costs or energy savings. In February 2005 a consortium of independent – owned – utilities, municipal utilities, and municipal utility districts, and independent power producers launched the Energy Efficiency Best practices project (EEBPP), a systematic nationwide evaluation of energy programs designed to improve the design, implementation, and effectiveness of energy – related activities. The Energy Efficiency uses a benchmarking methodology to identify best practices for public education and improving efficiency in residential and commercial structures. The database also provides examples ninety different energy efficiency programs, eleven of which are implemented by public agencies. The pilot projects undertaken by California Energy Efficiency project and other similar efforts can offer additional data points for continued evaluation and refinement of local energy programs.

2.4 Renewable Energy Systems using coal – based Technology

Nigerian cities have a wide range of energy needs – fuels for transport, heating, cooking, electrical power, space heating, etc – but they face daunting energy supply challenges. With abundance of petroleum and natural gas as well as coal which Nigeria needs to diversify its energy sources, with several billion of standard cubic feet of both the associated and non - associated gas reserves and about six billion tones of coal reserve only in the south - eastern part of Nigeria, together with massive coal reserves in other part of the country, she has a secured energy future utilizing clean coal technologies. The first step along this direction is for Nigeria to train the needed manpower and build their capacities. It is known, for example, that about 2.4 million tons of coal generates about 2,500 mega- watts of electricity and with requisite technology chances are that generated outputs could be higher, forming an integral part of energy supply mix.

While the inefficient combustion of coal has led to severe air pollution and other environmental concerns, a radically different vision of coal use is possible; one which is closely attuned to the engineering side of the policy debate. In this vision, advanced technologies such as integrated gasification combined cycle (IGCC) units gasify the coal, generating both efficient thermal energy services (steam for district heating, chillers, etc.) and electrical power for the growing city "polygeneration" (polygen) applications utilizing liquefaction technological approaches can provide a range of chemicals (including methanol, dimethyl ether, fischer-Tropsch (F-T) liquids, and town gas) that can serve as additives to transportation fuels, supplies for nascent chemical industries, and clean fuels for domestic cooking and other assorted energy needs. Over the longer term, these same processes might be used to generate hydrogen for fuel cells, or serve as a starting point for further advanced chemical processes in so-called "carbon refining" applications. Another key element is their potential suitability for capturing Carbon dioxide for storage.

A further step might integrate nuclear power into the mix. Nigeria should currently consider a different kind of nuclear energy technology than the light water reactors routinely employed in the west. Small scale "pebble bed" reactors are gas cooled "inherently safe" reactors that can be built in much smaller modular units (200 Mw in size) that could be integrated into urban energy supply programs. Research in the 1970s suggested that nuclear facilities might be able to provide the process heat coal gasification and liquefaction processes, and increase output by 40 – 50%. Current designs typically use energy in the coal to drive the processes, but it may be possible to increase output significantly by treating the coal more like a chemical feedstock. This should be a starting point as nuclear energy facilities have already served in district heating applications in other countries around the world, so their integration into an urban energy system is feasible.

Niger state should devise a means of identifying a variety of ways to include energy consideration into its overall land development planning in its General plan guidelines, and each of these strategies should require local government decision to implement. It should be an integrated policy through land use act: that certain decisions concerning land use should be kept at the local level and that bottom-up approach to planning that gives mandate to the local government and its people to be willing partners in planning process should be adopted. Local governments in Nigeria, while being allowed to participate in sustainable renewable energy planning, should also be allowed to pool the electricity demand of residents and businesses in order to promote cleaner sources of power.

Katsina state, for example, is in the forefront for this kind of approach. It uses Kurfi, Daura and a host of other local governments as case studies to generate clean source of electricity from Biomass technology. Under this strategy, Katsina State government (with the support of the above named local governments) helped to secure community digesters, converters, numerous green generators and domestic gas cookers which are substantially pressure – free as well as energy – saving electric bulbs. The importance of this environmentally cost – free electricity generation is that it can be used to earn carbon credit; that is earning money by carbon reduction. The size of the digester determines the quantity of residues to be fed into it. Small – size digester takes one full month for it to be replenished, whereas bigger one takes an upward of five to six months to be replenished. These digesters have converters in them that convert the emanating gas from the residues to either cooking gas or for electricity generation. In Katsina, about 35 % of gas generated is used for generation of electricity whereas about 65 % of it is used for cooking (N.T.A documentary, 2009).

In china about 150 million households have been connected, using biomass technology (World Energy Outlook, 2005). Recently, in an effort by the Nigerian Electricity Regulatory commission to promote sustainable energy use in Nigeria, has issued generation Licenses to three solar companies as part of National integrated power projects to generate power from miscellaneous sources. These companies are to generate 20 megawatts and 135 megawatts respectively to the national grid. Such efforts should be intensified at the local government's level especially those efforts that are aimed at promoting alternative clean energy sources. In rural areas due to difficulty in accessibility, the proliferation of off – grid companies that can sell power to the national grid should be allowed to come on board. Nigeria, as a nation, should have it as a policy, to generate a certain percentage of electricity from alternative energy source.

Germany, for example, is the Europe's leader in development of alternative source of energy. It generates close to 20 % from renewable energy source and has decided to increase the renewable energy share. Belgium's share of renewable energy source is 18%. Britain is about 8 % followed by France which is between 6 and 7 % (B.B.C world report, 2009). In conclusion, local governments in Nigeria should be seen to making tremendous efforts in advancing efficient energy – use which leads to reduction in per capital energy use and energy intensity – the amount of energy used to produce one naira of gross domestic product. A substantial share of Bida local government's energy intensity reduction is attributed to the composition of its economy. However, with the development of alternative sources such as solar, wind, small hydro, and coal – fired technology as well as with implementation of alternative energy policy instrument through Energy commission of Nigeria, divergent energy source that will ensure promotion and optimum utilization of renewable energy source in our various local governments in Nigeria will be enhanced. The Nigerian legislature should adopt a renewable portfolio standard which will lead to increased share of non – fossil fuel energy source by a large percentage (say, 20 %) of the overall supply mix of the independent power production by 2015. the energy commission of Nigeria should take that vision further and ensure that up to 35 % of the National energy be generated from renewable source by 2020. This effort will help ensure that renewable have a larger place in the market and may alleviate need to use more polluting generation source (which is the hallmark of sustainable strategy) during periods of constrained demand.

Modern cities that are the products of fossil fuels technology can only power themselves efficiently and effectively by sustainable energy systems. Therefore, a clever combination of energy efficiency, combined heat – and – power, wind power, solar energy systems, and full cell technology that certainly holds the promise of a clean and secure energy future needs to be taken seriously. So far, the introduction rate of these technologies has been much too slow to offset annual global increase in urban energy demands. A much more vigorous and deliberate phasing in of sustainable energy systems by Nigeria as well as the world's cities is now urgently called for. Some European cities have taken significant initiatives on this direction- as a result of local as well as national policy: Leipzig and several other European cities have substantial investment in insulating large numbers of buildings and substantially reducing their energy consumption. Cities in Scandinavia, such as Helsinki, Stockholm and Copenhagen, have also made very substantial investments in combined- heat- and power technology, greatly improving the efficiency of their energy supply. In addition, 20 percent of Copenhagen's electricity supply now comes from on – shore and off – shore wind farms in Denmark. The country greatly benefits from many years of active support for wind energy by previous Danish governments.

Similarly, Nigerian government, through Nigeria Electricity regulatory commission (NERC) should give encouragement by licensing entities or independent bodies that seek to provide renewable energy technologies such as wind turbine energy resource, especially in its rural electrification programme. With the introduction of National Integrated power project in its current energy policy frame work, Nigeria can ensure adequate support to various power projects particularly those projects that consider renewable energy resources as their centerpiece. Another important way Nigeria can develop its renewable energy resource is by its introduction of mandatory solar ordinance legislation. This piece of legislation should ensure that all new housing, offices, restaurants and public buildings in Nigeria which use substantial amount of hot water have to install solar hot water system. Old buildings also should be fitted with solar hot water system when they are refurbished.

2.5 Biomass Gasification Technologies

Biomass gasification has a long development history. Numerous systems have been developed and commercialized in the past to supply thermal energy and fuel gas or synthesis gas (syngas) for industrial and transportation applications. Simple gasification systems are still available today that are suitable for developing countries where large quantities of easily accessible biomass are available. These systems are generally low efficiency and produce either heat or electrical power. Advanced systems are needed for western countries for power and combined heat/power generation. Advanced systems provide high efficiencies with reduced emissions to mitigate greenhouse gas emissions. A Literature review was conducted to identify and define various gasification systems for heat and/or electrical power generation. Much information was obtained from the internet through company websites, news releases, and various interest groups. The literature survey summarizes simple systems for heat and/or power generation (that are suitable when efficiency and emissions are not priority factors) and advanced systems for power and combined heat/power generation. Biomass refers to energy drivable 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 availability of biomass resources follows the same pattern as the nation's vegetation. 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 (Sambo, 2005). Over the period 1989-2000, fuelwood and charcoal constituted between 32 and 40% of total primary energy consumption. In year 2000, national demand was estimated to be 39 million tonnes of fuelwood. About 95% of the total fuelwood consumption was used in households for cooking and for cottage industrial activities, such as for processing cassava and oil, seeds, which are closely related to household activities. A smaller proportion of the fuelwood and charcoal consumed' was used in the services sector.

About 350,000 hectares of forest and natural vegetation are lost annually due to various factors, by the beginning of the last decade, with a much lower forestation rate of 50,000 hectares/yr. with the depleting natural wood reserves, women and children have to travel as far as six kilometers to collect wood, sometimes fresh trees are cut down and allowed to dry for harvest as fuel wood thus putting further pressure on the vegetation. Recent studies show that national demand for traditional energy (mostly fuel wood and charcoal) is 39 million tones per annum (about 37.4% of the total energy demand and the highest single share of all the energy forms). It is projected to increase to 91 million tons by 2030 (Olayinka, 2010). The deforestation rate is expected to similarly increase if no special programme is put in place to discourage the use of wood, promote the use of its alternative and replenish through deliberate aforestation and fuel woodlot. This has grave implications on sustainable environment, food security and the health of the low income households who depend on fuelwood.

The strategic development' in this regard is a two-prong approach of reducing consumption rate through promotion of more efficient wood stoves and development of alternatives to fuel wood through policy instrument and pilot demonstration renewable projects. Fuel wood lot is being established, while improved wood stoves of various configurations are being promoted. Under an integrated rural energy supply project, selected communities are assessed for renewable energy resources, energy requirement and available human resources, and an integrated energy supply system is then designed that utilizes the available renewable energy resources to supply the energy requirement. For sustainability, the local human resources are trained to maintain the system. The three-stone stove commonly used in the households have efficiencies as low as 15%. Improved versions have been developed locally by the ECN through its energy research centers at the University of Nigeria, Nsukka and Usumanu Dan Fodiyo University in Sokoto. These stoves which could reduce fuel wood consumption for a particular process by 50% are already being adopted. For instance the international institute for Tropical Agriculture (IITA) cottage cassava industry at Moniya, Ibadan adopted these technologies. Indeed the improved wood-burning stoves are found in many local markets in the northwestern part of the country.

Agricultural Residue and Municipal solid waste Residues associated with agriculture either as on-the-farm crop wastes such as cornstalks or as processing waste such as rice husk, corn shells, palm kernel shell, cassava peels. Etc, are also good sources of fuels. They are currently burned directly as starter or supplement material in addition to fuel wood. There are potentials for further processing for higher energy contents. There are, however, other competing demands for crop residues for feeding livestock and roofing thatched houses in the villages' Animal waste (e.g., Cow dung, poultry droppings and abattoir wastes) are also available at specific sites. Biogas digester technology has been domesticated and a number of pilot biogas plants have been built. Considerable local capability exists for building both floating dome and fixed dome biodigesters using a variety of bio-resources, Examples include a human waste biogas plant at the Zaria prison, cow dung based biogas plants at the fodder farm of the National Animal production Research Institute (NAPRI), Zaria and Mayflower secondary school Ikenne, Ogun State; an $18m^3$ capacity pig waste biogas plant at the pigry farm of the Ojokoro/Ifelodun cooperative Agricultural Multipurpose society in Lagos State. A number of indigenous outfits are producing economically viable systems for converting municipal waste to energy sawdust and wood are other important biomass resources associated with the lumber industry.

Small particle biomass stoves already exist for burning saw dusts and wood shaving. Biomass utilization as energy resources is currently limited to thermal application as fuel for cooking, crop drying; tobacco curing, etc. opportunities exist in power generation from biomass resources in the following: fuel woodlot, biogas generation/biofertilizer production, electricity generation from industrial effluents such as bagasse and ethanol production. There is no existing biomass fired power plants in Nigeria and so no local experience. However, there is considerable experience in biogas generation and utilization of fine particle biomass opportunities also exist for briquetting of sawdust and other fine biomass.

Biomass energy refers to the energy of biological systems such as wood and wastes. Biomass energy is an indirect form of solar energy because it arises due to photosynthesis. The biomass resources of Nigeria can be identified as wood biomass, forage grasses and shrubs, residues and wastes (forestry, agricultural, municipal and industrial) as well as aquatic biomass. Wood, apart from being a major source of energy in the form of fuelwood is also used for commercial purposes in various forms as plywood, sawnwood, paper products and electric poles. For energy purposes, Nigeria is using 80 million cubic metres (43.4 x 109 kg) of fuel wood annually for cooking and other domestic purposes. The energy content of fuelwood that is being used is 6.0 x 109MJ out of which only between 5 - 12% is the fraction that is gainfully utilized for cooking and other domestic uses. Although the biomass availability as at 1973 was put at 9.1 x 1012 MJ, it is expected that the overall biomass resource availability at present is lower than the 1973 figure. This is largely due to the demand of wood also for construction and furniture industries in addition to its use as an energy source. As for forage grasses and shrubs, estimates show that 200 million tonnes of dry biomass can be obtained from them and this comes up to 2.28 x I 06MJ of energy. For crop residues and wastes, estimates of the 6.1 million tonnes of dry biomass that are produced annually leave residues whose energy content approximate to 53 x 1011 MJ. Estimates made in 1985 give the number of cattle, sheep, goats' horses and pigs as well as poultry birds as 166 million. These produce 227,500 tonnes of animal wastes daily which come to 2.2 x 109 MJ taking the calorific value of animal dung to be 9,800 MJ/tone. Animal residue can be converted to biogas and estimates show that this is of the order of 5.36 x 109 m3 which has an energy content amounting to 2.93 x 109 kWh (Sambo, 2009).

2.6 Simple Biomass Gasification Systems

Simple gasification systems produce syngas with a low- heating content at atmospheric or low pressure. The fuel syngas can be used for operating gas engines for small-scale power production. In general, the syngas is not suitable for advanced turbines or chemical production. Biomass Gasification (BG) Technologies USA, Inc, has licensed gasification technology from Ankur Scientific Energy Technologies of India for worldwide distribution. Ankur Scientific has over 400 installations worldwide using this technology for processing wood chips, palm nut shells, cotton stalks, rice husks, maize cobs, soy husks, coconut shells, and sawdust. The BG Technologies electric system consists of a biomass gasifier, gas cleaning and cooling equipment, and a diesel generator. The diesel generator is operated under dual fuel mode using diesel and producer gas from the gasifier which reduces diesel consumption by about 70%. The main objective of this system is to displace some of the fuel requirement for the diesel generator. Three systems are offered at 100, 250, and 400 Kwh capacities with conversion efficiencies ranging from 70-75%. The typical composition of the syngas is 19±3% Carbon Monoxide (CO), 10±4% Carbon Dioxide (CO_2), 50% Nitrogen (N_2), 18±2% Hydrogen (H_2), and up to 3% of Methane (CH_4).

2.7 Bivkin Gasification Technology

The Netherlands Energy Research Foundation (ECN) in Petten, Netherlands, developed and built a pilot circulating fluidized bed (CFB) gasification plant using the BIVKIN (Biomassa Vergassings Karakeriserings Installatie) process in cooperation with Novem, Afvalzorg, and Stork (Van den Broek, 1997). The plant was initially used at the ECN location in Petten for the characterization of more than 15 different biomass species, including wood, sludge, grass, and manure. ECN has been conducting tests to improve the gas quality so that it can be used for electrical generation in a gas engine. The CFB gasifier is integrated with a 500 KW/H internal combustion (IC) engine at the pilot plant.

Operation of the pilot plant was initiated in 1996. It had operated for more than 500 hours with various fuels as of August 2000. The operation of the gasifier is very stable, and complete automation of the gasifier is possible. A non-confidential version of the report is available from ECN (Van der Drift et al., 2000). The study evaluated three different sizes with the following scenarios: 5 MW gasifier with gas engine for electricity production, 12.5 MW gasifier with gas engine for electricity production, and 14.7 MW gasifier with gas engine and steam turbine for electricity production. The fuels evaluated were clean biomass at 40% moisture, clean biomass at 10% moisture, and contaminated biomass at 10% moisture. For the wet biomass (40%), the fuel inputs were adjusted to 4.62, 11.55, and 13.58 MW to compensate for the additional water. A dryer is required to remove the excess water to provide the stated fuel input to the gasifier. The total efficiency of the plant is assumed to be 70% and 65% with and without the steam turbine, respectively. The efficiency drops to 66% and 61%, respectively, with the 40% moisture biomass. One of the conclusions that can be drawn is that the added steam turbine does not warrant the extra investment at these scales.

2.8 Brightstar Synfuels Co./Brightstar Environmental

Brightstar Synfuels, Co., (BSC) developed a gasification concept in 1989 with tests in a 25-90 kg/h pilot plant. They subsequently scaled up to a commercial unit in 1994 at a particleboard plant. The plant had a capacity of 17,600 kg/h of sander dust. It was terminated in 1995 because of problems with the heat recovery equipment used in the gas cooling system. A free standing Commercial

Demonstration Facility (CDF) was built near Baton Rouge, Louisiana, in 1996 with design throughput of 680 kg/h. The facility was operated continuously to prove the concept and refine the process. This facility was considered a commercial scale facility because of the "tubular entrained flow" design. Multiple gasifiers would be used in larger capacities. Various feed stocks such as sawdust and sander dust, bark and wood chips, pulp and paper mill sludge, rice hulls, sugar cane bagasse, and sewage sludge were tested. Louisiana State University's Institute for Environmental Studies supported the demonstration plant in Louisiana. The syngas produced from the system had the following composition: 30-40% Hydrogen (H_2), 20-30% Carbon Monoxide (CO), 10-15% Methane (CH_4), 15-20% Carbon Dioxide (CO_2), and 1% Nitrogen (N_2).

The major steps in the Brightstar process are:

1. Delivery of biomass to a metering bin from which it is conveyed with recycled syngas or steam without air or oxygen into the gasifier.
2. Reforming of material into hot syngas that contains the inorganic (ash) fraction of the biomass and a small amount of unreformed carbon.
3. Recovery of sensible heat in the hot syngas to produce heat for the reforming process. Cleaning of the cool syngas through a filter and removal of the particulate in the syngas to produce a dry, innocuous waste. Clean syngas is then available for combustion in engines, turbines, or standard natural gas burners with minor modifications. Brightstar entered a license agreement and strategic alliance with Energy Developments Limited (EDL) of Australia to commercialize the Brightstar process in Australia for municipal solid waste (MSW) feedstock.

The waste-to-energy concept that is being developed in Australia is called SWERFTM (Solid Waste Energy and Recycling Facility). The facility initially converts green wood waste to electricity using the Brightstar gasification process. It was designed to process green organic materials such as urban tree toppings at 20,000 metric ton/a (22,046 ton/a). The syngas is burned with natural gas to produce electricity. The second phase will extend this to process 150,000 metric ton/a (165,345 ton/a) (of MSW to generate 120 GWh/a of electricity. The final design would consist of four gasifiers and eight generator modules. The plant was completed and opened in 2001. During the test period the plant was ramped up to a throughput level equating to about 60% of the nameplate capacity measured at the primary gasifier.

One of the problems from the system was the carryover of fine char particles from the gasifier vessel with the gas stream. The other systems have performed to expectations. Modifications to the char gasifier are planned to prevent the aforementioned problem. Brightstar is planned to complete the nameplate capacity late this year before the start of the next SWERFTM projects.

2.9 Cratech Gasification Systems

Western Bioenergy funded Cratech in Tahoka, Texas, in 1998 to develop a gasification project for converting straw, grass, and shells. A 1 Mega Watt unit was developed and tested. The Cratech gasifier is a pressurized, air-blown fluidized-bed reactor. Biomass is injected with a biomass pressurization and metering unit. The product gas is passed through a hot-gas cleanup system followed by injection into a turbine combustor. The system uses the higher practical thermodynamic efficiency of the Brayton cycle over the Rankin cycle.

The maximum design pressure of the Cratech system is 1,353 kPa (202.8 psi) at a feed rate of 1,996 kg/h (2.2 ton/h) of wood at temperatures below 730 °C. The syngas is cleaned by a hot- gas filter and is directed to the combustion chamber of a gas turbine engine. Wet scrubbers are not used. Catalysts and higher temperatures are not needed for tar destruction before combustion. The Cratech system can fuel a turbine of 1.5 MWh with a maximum pressure ratio of about 11.0. The initial gas turbine combustion test was performed with a Solar Spartan turbine rated at 225 kWh with a pressure ratio of 4.0.

2.10 Energy Products of Idaho

Energy Products of Idaho (EPI) claimed to design and build the first fluidized bed combustor for firing wood which also operates on 100% paper sludge. EPI has designed and supplied more than 79 gasification plants worldwide since 1973. Their expertise is in atmospheric fluidized-bed (AFB) gasifiers. The bed material can be either sand or char or a combination of both. The fluidizing medium is usually air. Their AFB can process fuel with moisture contents up to 55% and high ash contents over 25%. Temperature is maintained below the fusion temperature between the ash and the slag which increases the utilization of the slagging fuels. The product gas is cleaned by cyclones. The heating content of the gas is about 7.4 MJ/scm.

The EPI website listed a total of 63 operating units in the world. These facilities process a wide variety of biofuels such as wood waste, bark and wood chips, hogged fuel, agricultural waste, urban wood waste, coal, polyethylene terephthalate, and polyvinylbutyryl. Most of these plants produce heat and steam. Several plants produce electricity in the range of 25 to 50 MW. One plant was scheduled for start up in October 2001 in Verzuolo, Italy, for heat and steam production using paper sludge and wood waste feedstock. Another system is scheduled for start up in the fall of 2002 at Trus Joist Weyerhaeuser in Northwest Ontario, Canada, for heat and steam generation.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Data Collection

Principally, two methods of data collection were employed: personal interview and use of a questionnaire. Data was collected to assess the biomass potential. Data were also gathered on the different forms of energy consumed in Bida Municipality through the use of questionnaires.

3.1.1 Personal Interview and Questionnaire

Objective 1: Additional primary data were also obtained through participatory methods such as. Focus Group Discussions. This involved bringing together between 5 and 10 people to represent target group to talk about sources of energy used, ways of generating them, how easily accessible or expensive such forms of energy were and their willingness to accept the biomass technology as an alternative energy resource.

Objective 2: The potential biomass resources were physically inspected in the 14 wards and quantities estimated to assess the potential of the existing different forms of fuel resources in Bida Municipality. Also, direct contacts were made with the existing local craftsmen to discover their approximate number, ward by ward, and their inherent capabilities to fabricate local end-use devices in Bida Municipality as well as the possible number of sheds in each ward.

Objective 3: In order to find ways of achieving the biomass energy technology, information were obtained through contact with PHCN staff, energy experts and strategy adapted in Katsina under the auspices of Katsina State Government and the concerned Local Governments in the State. Opinions of the people were also sought about the potential sources of funding the project and also about how to access the biomass components. Data were also collected on ways to generate information and how to increase knowledge base of local practitioners in order to improve local capability for the biomass technology as well as ways to achieve energy sustainability through alternative renewable energy resources in general.

3.2 Sampling Technique

Politically, Bida local government is divided into two constituencies of Bida north and south with each having seven wards. Following the political division into wards, different forms of data were obtained either through direct contact or use of questionnaire. A total of two hundred and eighty (280) questionnaires were administered with each of the wards having twenty (20) questionnaires to be shared among the households in each ward.

3.3 Global Positioning System (GPS)

The coordinates for the study area was taken using the Global Positioning System, this was used to ascertain the actual extent of the study area, and the exact location of the area.

3.4 Reconnaissance Survey.

To get first hand information on the study area and have a personal assessment of the area, several reconnaissance visits were taken to the area to ascertain and see the state of the things physically.

3.5 Method of Data Analysis

Varieties of data collected were analyzed using percentages and Pearson's product moment correction coefficient. Different fuel sources tables and end-use technology table and other related tables were shown to further analyze varieties of obtained data.

3.6 Presentation of Results

The results were presented in tables for easy understanding and comprehension. The results showed information on each of the objectives and also pointed out conclusions drawn from each objective.

CHAPTER FOUR

4.0 RESULTS

4.1 Summary of Information and Field Survey on Energy Consumption Pattern

The summary of information on energy consumption pattern in Bida Municipality was presented in table 4.1. Various aspects of energy, ranging from the common household energy to agricultural, community and commercial energy needs, were studied in Bida. Energy consumption pattern of the study area were categorized into domestic, commercial and community needs. It is based on these sectoral groupings that they were assessed.

Table 4.1: Summary of Information and Field Survey on Energy Consumption Pattern in Bida Municipality

ouse Hold ector	%	Commercial Needs	%	Agricultural Production	%	Community Needs	%
ooking	25	Small to medium industries	20	Water pumping & distribution for small irrigation	1	Hospitals & Clinics	13
ouse lighting	10	Business establishments	10	Operation of agric equipments	1	Schools	3
omestic water umping and stribution	2			Drying and processing of agric products	3	Barracks and prison house	4
elevision and adio powering	1						
/ater heating and efrigeration	2						

4.2 Potential Biomass Resources and the Estimated Quantities

Various feed stocks of biomass were found in the study area and table 4.2 below gives the estimated quantities found in each ward. The quantities were estimated in thousands of tones and the corresponding energy values were in mega joule.

Table 4.2: Potential Biomass Resources and the Estimated Quantities in Bida Municipality

Resources	Quantity (Thousand Tonnes)	Energy Value (M.J)
Fuel wood	52388.88	68605
Agro-waste	17527.648	20826
Saw dust	23255.	40611
Animal wastes	29390 (daily)	258397
Municipal solid waste	9264.9	9483

4.3 Location of Different Biomass Feedstock in Different Wards of Bida Municipality

Different biomass feedstock and their types as well as the quantities at different sites in the study area were identified. The biomass fuels were estimated in thousands of tonnes. Also, their respective number of sites in each ward where these biomass feedstock could be found in the study area.

Table 4.3 Location of Biomass Feedstock, Type and the Estimated Quantities at Respective Sites

Wards	Type	No. of Site(s)	Quantity in Wards
Wadata	Field wood, sawdust, agro- wastes, municipal solid	5	9300.25
Ceniyan	Fuel wood, saw dust, agro-waste, animal waste	7	18405
lasaba 'A'	Municipal solid waste	3	4122
lasaba 'B'	Municipal solid waste	2	2400
lasaga 'A'	Fuel wood, Animal waste, municipal solid waste	7	13050
lasaga 'B'	Municipal solid waste	2	2605.10
yari	Municipal solid waste, Animal waste, Agro-waste	6	10407.50
okodza	Fuel wood, municipal waste, Agro-waste, Animal waste	7	14208.00
ariki	Fuel wood, Animal waste Agro-waste, saw dust, municipal waste	8	15608.00
andzun	Municipal solid waste	11	1200.00
layaki Ndajiya	Municipal solid waste	2	1100.00
maru Majigi 'A'	Municipal solid waste	1	1700.00
Jmaru Majigi 'B'	Municipal solid waste	1	1020.00
lassarafu	Fuel wood, municipal waste, Animal waste Agro-waste	4	6602.00

4.4 Human Resource Potential that could be harnessed for End-use Services Fabrication

An estimated figure of available human resource (local craftsmen and the black smiths) that could be readily harnessed and trained on the design, construction or fabrication, operation and maintenance of appropriate energy end-use devices. The survey considered the possibility of utilizing already established black smith compounds and elaborates welding sheds to fabricate metal digesters, efficient burning stoves and other valuable components of biomass technologies.

Table 4.4: Available (sampled) Human Resource Potential (Local craftsmen) that could be Harnessed for the fabrication of End-use Devices.

Ward	No of Sheds	No of Workers in the Shed (Average)
Wadata	9	63
Ceniyan	13	91
Masaba 'A'	14	98
Masaba 'B'	6	42
Masaga 'A'	25	175
Masaga 'B'	4	28
Kyari	3	21
Dokodza	35	735
Bariki	2	14
Landzun	16	112
Mayaki Ndajiya	2	14
Umaru Masagi 'A'	1	7
Umaru Masagi 'B'	-	-
Nassarafu	4	28
Total	134	1428

4.5 The Use of Pearson's Product Moment Correlation to Test the Relationship between Number of Sites of Biomass Residues and their Quantity

We calculate the degree of relationship between number of sites in the 14 wards of the study area and their quantity in those respective wards.

Table 4.5 The Use of Pearson's Product Moment Correlation to Test the Relationship Between Number of Sites of Biomass Residues and their Quantity.

NO OF SITES (X)	QUANTITY (Y)	XY	X^2	Y^2
5	9300	46500	25	864900 000
7	18405	128835	49	338744025
3	4122	12366	9	16690884
2	2400	4800	4	5760 000
7	13050	91350	49	170302500
2	2605	5210	4	6786025
6	10407	62442	36	108305649
7	14208	99456	49	201867264
8	15608	124864	64	243609664
1	1200	1200	1	1440000
2	1100	2200	4	1210000
1	1700	1700	1	2890000
1	1020	1020	1	1040400
4	6602	26408	16	43586404
56	101727	476946	305	1229022815

$\frac{980532}{2788709.455} = 0.351607801$: This means that there is a correlation between number of sites of biomass residues and their quantity.

4.6 The Use of Pearson's Product Moment Correlation to find the Relationship Between Number of available sheds in ward and number of workers in the sheds in the Study Area

We calculate degree of relationship between the number of available sheds in different wards of the study area and estimated number of local craftsmen to be used to fabricate end-use devices.

Table 4.6 The Use of Pearson's Product Moment Correlation to find the Relationship between Number of available sheds in ward and number of workers in the sheds in Bida Municipality.

NO OF SITES (X)	NO OF WORKERS (Y)	XY	X^2	Y^2
9	63	567	81	3969
13	91	1183	169	8281
14	98	1372	196	9604
6	42	252	36	1764
25	175	4375	625	30625
4	28	112	16	784
3	21	63	9	441
35	735	25725	1225	540225
2	14	28	4	196
16	112	1792	256	12544
2	14	28	4	196
1	7	7	1	49
-	-	-	-	-
4	28	112	16	784
134	1428	35616	2638	609462

$\frac{271656}{310048.196} = 0.87617$: This means that there is a very good correlation between number of available sheds and number of workers in sheds.

4.7 Potential Sources of Capital for Funding Biomass Project in the Study Area

A study was carried out on the potential sources for generating capital for funding of biomass project in the study area. About 8 wards were sampled for the study of different funding strategies. The responses given by the respondents in each ward were in percentages.

TABLE 4.7 Potential Sources of Capital for Funding Biomass Project in Bida Municipality

Funding sources	Wadata	%	Masaba 'A'	%	Ceniyan	%	Masaga 'B'	%	Dokodza	%	Bariki	%	u/majigi	%	Nassarafu	%
Comm. Dev. Block Grant	14	30	19	38	9	20	7	17	10	23	2	5	6	13	4	10
Direct Grant from Bida Local Govt. State etc.	22	47	27	54	30	65	26	62	18	41	35	92	37	77	28	70
Other funding sources such as GEF, IMF, World Bank etc	11	23	4	8	7	15	9	21	16	36	1	3	5	10	8	20

4.8 Potential Ways of Accessing Biomass Components in the Study Area

A study was carried out on how biomass components in the study area could be accessed and funding strategies that could be evolved to ensure availability of funds for the project.

TABLE 4.8: Potential Ways of Accessing Biomass Components in Bida Municipality

Funding sources	Wadata	%	Masaba 'A'	%	Ceniyan	%	Masaga 'B'	%	Dokodza	%	Bariki	%	u/majigi	%	Nassarafu	%
Purchase through personal savings	9	19	13	26	4	9	6	14	12	28	2	5	8	17	7	18
Community Purchase through black grant	11	23	17	34	8	17	10	24	16	36	6	16	15	31	9	22
Govt. donation etc.	27	58	20	40	34	74	26	62	16	36	30	79	25	52	24	60

4.9 Biomass End-use Devices that were Fabricated in the Study Area

The study provides a glimpse of end-use devices that were fabricated so that general acceptability of the biomass energy strategy was monumental in the study area. Each type of device was tied to its expected capacity.

Table 4.9: Biomass End-use Devices that were Fabricated in Bida Municipality

S/no	Type of Project	Size of Project/Capacity
1.	Improved wood stove	Many
2.	Sawdust briquetting machine	2 tonnes/day
3.	Biogas plant fitted with digesters, converters etc	$20m^3$

CHAPTER FIVE

5.0 DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Discussion

Table 4.1 highlighted energy consumption patterns of Bida municipality by sector. The pattern of consumption is shown in percentage from the analysis of the survey; the house hold sector used more energy more than any other sector in the municipality. Fuel wood was found to be the predominant energy source in the house hold sector with about 70-80% of house hold in Bida depending on it as their cooking fuel. The consequence of this to the natural environment is that unchecked felling of trees to provide the fuel wood requirement will exacerbate soil erosion and loss of soil fertility in the study area. Of the overall energy total, 40% is used for domestic need. Of this 40%, between 60and 70% is used for cooking, about 10% for house lighting, television and radio powering 3%, water heating and refrigeration 15% and 25 for domestic water pumping and distribution.

Commercial sector in the city received its energy from PHCN supply. This is supplemented by electricity generating sets that are fueled by either petroleum or automotive gas oil (diesel). The bulk of the small-scale industries in the city are on human power which is the bulk of energy for glass and brass works, ceramic/pottery, blacksmithing, weaving and handicraft etc. commercial sector comprised about 25% of the overall energy share of the city.

The transport sector comprised about 10% of the total energy supplied in the city premium motor spirit is mostly used by cars and medium –sized buses. For Lorries and trucks, the predominant fuel is automotive gas oil (diesel). Over 70% of the 10%

transport energy demand is from petroleum. Agricultural sector consumed about 5% of the total energy in Bida municipality.

Human and animal powers provide the bulk of the energy requirement for agricultural production in the area. Evidence of use of petroleum products for agricultural production is also noticed. This though small when compared with human and animal power, is significant because it showed the utilization of motorized irrigation pumps and dies powered tractors for mechanized agricultural activities. Under services sector, human power is used for water lifting from wells, with some use of diesel powered pumping systems to lift water from boreholes.

Hospitals and health centres in the study area rely on electricity and diesel generators for lighting, sterilizing of appliances as well as for storage of drugs and vaccines. About 20% of energy is consumed in this sector in the study area. The house situation is the same in boarding school, the two barracks and the prison house.

The gross exploitable biomass potential in Bida municipality is put at approximately over 398000 tonnes. However, the biomass resources base of some natural forest, agro-waste and crop residue have been made from wood volume and oven dry specific data. The biomass resources available in Bida include fuel wood, agricultural waste and crop residue, sawdust and wood shavings, animal dung, poultry droppings, and municipal solid waste (Table 4.2). Biomass is important because of its high share of the total primary energy consumption. The total bio-energy capacity in Bida municipality based on the recoverable energy potential from the aggregate of biomass fuels in Table 4.2 is estimated at over 398282MJ.

Fuelwood is the most widely used domestic renewable energy resource in Bida municipality and especially by low-income groups in the area from the survey carried out, it is estimated that fuel wood and charcoal constitute between 50 and 60% of the total primary energy consumption with about 52388.88 thousand tones estimate or even more in area demand in 2010 (Table 4.2). It forms the largest percentage of the non-commercial energy and will continue to dominate the non-electricity needs for the majority of the people in Bida. Presently, about 52388kg of fuelwood with an average daily consumption ranging from 0.5-1.0kg of dry fuelwood/person is being consumed in Bida municipality annually. Sawdust and wood chips are other biomass energy resources of high potential in Bida municipality. It is estimated that about 42 tonnes of saw dust is generated for every 100 tonnes of timber produced with an average of about $4.39x10^6m^3$ of log splits and plywood processed annually (Onyegegbu, 2003). The potential for sawdust generation, in Bida municipality, however, can be estimated at 23255 tones annually (Table 4.2). This form of bio energy is presently not exploited in Bida municipality and yet constitutes an environmental pollution problem. Some other common sources of fuel prominent in Bida municipality were the agricultural based residues like corns' talks, ricehusk, cassava peels, palm kernel shells and bagasse from sugarcane. It was also established from the survey that annual production of biomass in Bida area would continue to be enormous.

Table 4.3, however, shows ward location of biomass feed stock, different types of biomass materials found in each ward as well as the estimated quantities of these materials that were determined as a result of several visits undertaken to these various sites. For each ward in the study area, averages of three or more biomass fuels were found. Some wards had up to five different biofuels, that is ceniyan and

Bariki wards others like Umaru Majigi, and masaga 'B' had the least bio fuels with only one biomass material each in substantial quantity. However, there were some wards with up to seven different sites where biomass materials were deposited. Masaga 'A' Ceniyan and Dokodza had a total of seven different sites each where biomass materials were deposited. Only Bariki ward had up to eight different sites of these different materials. Kyari ward had six. Other remaining wards had between one and three wards on the average. Finally, correlation statistics was obtained (i.e. 0.351607801) which shows that there is a relationship between number of sites in each ward and quantity of materials found in each ward of the study area.

Table 4.4 studied an estimated number of human resources that could be harnessed and possibly trained on the design, fabrication, operation as well as maintenance of appropriate end-use devices. The results of the survey showed the number of blacksmithing and welding sheds found in each ward. An average of seven local craftsmen and welders was adopted; and it was discovered that Wadata ward with a total of nine work sheds has an average of sixty-three workers. Dokozda ward, which is the home of local blacksmithing, had a total of 35 work sheds and an average total of 735 workers. Masaba and landzun wards were next in the order of number of workers. Only Umaru Majigi 'B' had no work shed in it and it was assumed, thus, that it had no local craftsmen or welders. In all, there was a lot of potential human resource across various wards in Bida municipality to draw from to start the biomass energy program. Again, correlation statistic is obtained (i.e. 0.87617) which shows that there is relationship between number of work sheds and number of workers in each ward.

Table 4.7, however, explored the potential sources of capital necessary for funding the biomass project. In a combined study of the fourteen wards comprising of both Bida North and South, 71 (20%) respondents believed that funding for the project could be generated through the pool of money contributed by the community in form of community development Block Grant. However, 223 (62.8%) respondents had a contrary opinion by emphasizing that only the government (whether Local, State or National) could make the required impact and jump start every efforts at ensuring proliferation of alternative energy sources, including the biomass energy technology in our environments. The same study revealed that 61 respondents, representing 17.2% of the total, said that funds for the project could be sourced from sources other than the community or grant from the government. They believed that International Development Agencies such as the World Bank, international Monetary fund or the Global Environment facility could be of great help In this area. They also believed that funds from conventional sources such as the power Holding Company of Nigeria (PHCN) could be set aside to fund alternative renewable energy effort of which biomass energy is one.

Table 4.8, however, tried to explore the potential ways of accessing biomass components or infrastructure in Bida municipality. It became apparent that to be involved in biomass energy provision, as an alternative energy resource, requires certain basic infrastructure like the green generators, converters, digesters, energy-saving bulbs etc. In order to make the success of biomass energy a reality in Bida municipality, efforts must be made at accessing these biomass components either through personal savings by individuals or community purchase through block grant or inform of direct donation by respective governments through evolving legislation or through policy formulation that allows access to such accessories.

It was shown in Table 4.8 that 61 (17%) of the respondents believed that biomass components could be purchased through personal savings. 92 respondents, who represented 26% of the total respondents, opted for an aggregate pool of money from the community to purchase these accessories. This could be in form of community Block Grant which could be harnessed to buy biomass energy infrastructure for that community. However, the survey places heavy burden on the government, both at the Local, State and national levels, to revolutionalize renewable policy framework that would facilitate and make available, either by way of subsidy or direct donation, basic biomass accessories and infrastructure for the teaming populace of Bida and beyond. 202 (57%) respondents believed that it was government's (any level of government) responsibility to facilitate general adoption of biomass technology by freely donating the accessories or by heavily subsidizing these components. In a similar study, a direct interview conducted with PHCN staff in Bida confirmed that, not only in Bida, any efforts at evolving sources would be futile unless there is a replication of the national renewable energy master plan document and a sort of direct 'feed – in' legislation which will make available fixed subsidies and favourable tariffs to induce the adoption of biomass or any other alternative energy sources.

A scoping study of ways of achieving the biomass technology in Bida municipality found a celebrated case study in Katsina strategy. For that reason, therefore, it is believed that step-by-step observance of Katsina strategy could also be replicated in Bida municipality in order to bring about achievement of the energy technology as it has not found any established root in Niger State as in Katsina and Kano, for example. The first step taken by the Katsina State government and the pilot Local Governments was embarking on active and vigorous enlightenment and sensitization campaign in the pilot local governments of Kurfi, Daura and a host of other local government as to what renewable energy technology through the biomass energy strategy is all about. The state then went further to enact a Renewable Energy Policy Edict which served as a complimentary law to the National Energy Policy for the entire country which facilitated research development, demonstration as well as diffusion of activities related to renewable energy systems generally and biomass technology in particular. And, in order to ensure that the project was universally accepted by the people, dedicated organization and offices were set up to serve as Energy Extension Centre which were mandated to carryout demonstration and diffusion activities related to biomass efforts and also sponsor installation of pilot biomass energy systems for use by the benefiting communities. The Energy Extension Centre were also to ensure that there was some existing level of development of the biomass systems and end-use devices Katsina afforestation project unit (KTAPU) and other related ministries were in the forefront in these efforts. Active involvement of Energy Extension Centres in promoting the introduction of technologies based on individual biomass energy sources and the full implementation of the biomass projects and programmes enable the people to be so encouraged especially the local entrepreneurs in adopting the biomass energy technology for mass production and subsequent commercialization. The Centres were also active in the promotion and training of already of existing local craftsmen, blacksmiths, welders and other related artisans on the design, fabrication, operation and maintenance of biomass energy components or end-use devices and also carried out detail audit and assessment of the potentiality of the biomass energy resources or fuels of the pilot local governments.

Finally, after all the training of local craftsmen and sensitization of the masses, soft loans were offered to the craftsmen for onward commencement of fabrication of end use devices and the entire community people as a subsidy for the purchase of these components and other affiliated converters green generators, pressure free gas cookers, fabricated briquetting machines, and energy saving bulbs etc. The above narration forms the policy thrust of Katsina State Government in collaboration with the identified local governments and such strategy can be replicated in Niger State in collaboration with Bida Local Government.

In the meantime, the policy thrust was followed closely by even more practical approach or measures. These began with onsite identification of pilot areas and determination of which biomass resource or fuel to be used in the areas. For Katsina agro-waste and saw dust were much used and similar fuels were adopted in Bida municipality. Wadata and Dokodza wards were selected for the pilot scheme. Local entrepreneurs and craftsmen in these wards were contacted and formed into energy working groups or committees (EWC) for sensitization on how to key into the programme by actively participating in the training for the design and operation of end-use devices, for sourcing of biomass fuel (agro-waste and saw dust), in the construction of metal digesters or digging of pit digesters as well as the need to massively fabricate together end-use technologies and to pool financial resources together through community effort to be supplemented by government's grants under the direct supervision of the related ministry and the constituted Energy Extension Centre. Overall, the availability of funds in the study area from either direct grant from government or other agencies remains the only much awaited financial resource that can jump start the biomass energy strategy as the study revealed that both human and material resources are in abundance in the study area.

5.2 Summary

In this research, the following findings have been made:-

(a) The energy utilization in Bida Municipality is characterized by inefficiency through direct loss as a result of energy wastage and only the introduction of renewable sources of energy to the mix will guarantee efficient energy utilization and curb wastages.

(b) The present modes of energy used in the study area impacts negatively on the environment and, more so, energy tariff is becoming more and more expensive as the people groan under the unabating electricity bills. Biomass energy strategy could provide huge relief to the people of the area.

(c) There is need to raise the awareness of the local community towards re-direction of alternative renewable energy use especially the biomass strategy.

(d) The introduction of biomass energy technology is a multi stakeholder issue and should be approached as such.

(e) Local craftsmen and entrepreneurs need to play active roles towards the success of the programme.

(f) Government needs to play a leading role by strengthening offices and organizations that will be charged with the responsibilities of ensuring the full implementation of projects in the study area and to actively fund the projects.

5.3 Conclusion

The conclusion which emerges from the analysis is that, although sustainable energy planning through biomass technology as an alternative energy strategy will involve a major technological change in Bida municipality, the impact of this energy development strategy will not be felt without strenuous efforts and commitment (both in terms of financial and induced technological change) on the part of various levels of governments in Nigeria as it was observed- and rightly so- that the respondents placed much emphasis and responsibility on the various levels of governments to facilitate and make provision for funding and meeting all the technical requirements of the technology. As it is, presently, the knowledge base of the masses of Bida municipality regarding biomass technology is low as was observed in the study and this can make the people to be jittery and misunderstand any future efforts to introduce the technology in the area. As energy strategy is one of the basic needs strategy, the concept of the Basic Needs Strategy which focuses on the satisfaction of the primary needs of communities and individuals should be vigorously pursued so that high technological requirements for biomass technology can be developed in the area to pave the way for more immediate urban energy measures to be implemented at the municipal level. The development of biomass energy technology in Bida municipality requires continued efforts to accomplish and introduce a new technological feat, energy efficiency and conservation measures; and additional use of other renewable energy technologies.

Meanwhile, there were alot of biomass potentials in the study area. The various potentials of different biomass fuels, if harnessed and exploited, would help in the integration of the biomass energy technology in the study area in order to fast track the desire to tap existing renewable energy potentials in various local governments in the country. This, however, cannot be achieved without re awakening existing inherent potentials of the people of the study area such as the local craftsmen and entrepreneurs. Energy extension outfits and other similar bodies also needed to be set up in the State and Bida Local Government.

5.4 Recommendations

As the energy security threat aligns both local and national interests, continued local economic development and Nigeria's economic prosperity is affected, biomass technology and other alternative energy sources certainly hold the key to the Nigeria's growth and development. And, in order for Bida municipality to substantially benefit from energy planning through biomass technology, the recommendations below must be adhered to strictly:

1. Alternative energy, especially the biomass energy technology, awareness campaign should be pursued vigorously to allow the people of Bida municipality to enthusiastically accept (with open arms) any future efforts to introduce the technology in Bida
2. Government, especially at the national level, should evolve policies and programmes that can factor in and facilitate unfettered access to financial requirements as well as other requisite technological requirements of the energy strategy so as to greatly reduce huge cost of participation into the programme in the study area.
3. Nationally, the central government should evolve and institute a kind of 'feed-in' legislation which will ensure and guarantee both subsidies and favourable tariffs for those who whole- heartedly accept and key into the biomass energy programme. They could be paid an enticing sum of money for selling a particularly kw/h of electricity back to the national grid. This policy, if enacted, will lead to a massive growth in demand for biomass energy technology across Nigeria.
4. Urgent and immediate replication of the national renewable energy master plan documents should be carried out so as to fast track and further help in

disseminating knowledge about forms, mode of operation, technological requirements and other relevant information concerning alternative renewable energy technologies in general.

5. Finally, as a waste management strategy, numerous waste to energy facilities should be built across Nigeria so that these facilities can provide both thermal and electrical energy services and can also be tied into district heating systems. Methane capture and use in urban landfills, digester gas cogeneration at municipal waste water treatment facilities, and similar municipal efforts can also be attractive under the Clean Development mechanism (CDM) because of the high global warming potential of this gas, and which can be used to earn carbon credit. There should be policy measures for the various systems of biomass energy technologies. The thrust of the policy should be the incorporation of biomass energy devices into as many spheres of the economy as possible. The strategies for this include.
6. Continues active support of research and development activities to cater for specificity of designs of biomass energy devices for all parts of the country.
7. Support of demonstration and pilot projects to ensure that the general public (especially Bida residents) becomes aware of the potentials of biomass energy technologies which will as well assist in creation of markets for biomass energy systems.
8. The provision of financial incentives to encourage the use of biomass energy systems particularly in rural and semi-urban areas where the greatest potential exist.
9. The introduction of regulatory measures to encourage and protect local capabilities. Furthers, it should be emphasized that fuel wood consumption rate

should be significantly reduced. A strategy for this is the aggressive adoption of efficient wood-burning stoves should be vigorously pursued.

10. Systematic cultivation of fast growing trees needs to facilitate the regeneration of forests.
11. The active introduction of biogas digesters to cater for the cooking energy needs and electricity generation around Bida of especially large households and institutions like boarding schools, hospitals, barracks, prison house etc.
12. There should be policy measures for the various systems of biomass energy technologies. The thrust of the policy should be the incorporation of biomass energy devices into as many spheres of the economy as possible.

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APPENDIX I

POSTGRADUATE SCHOOL

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

Research Questionnaire

Dear Sir/Madam.

I am a postgraduate student of Federal University of Technology, Minna. I am conducting a research work on Sustainable Urban Energy Planning in Bida Municipality. I solicit your kind assistance to give answer to the following scheduled interview questions in your candid opinion. By so doing, you would be helping in providing valid information for this research work which is in partial fulfillment for the requirement of award of Master Degree in Environmental Management.

Every information provided will be treated in confidence as they will be used solely for academic purpose.

1. Which are the most predominant sources of energy in Bida Municipality?

(a) Fuelwood (b) Petroleum products: kerosene, diesel, cooking gas (c) fuel from biomass materials such as sawdust, municipality waste, agro-waste (d) Electricity.

2. Are your sources of energy cheap or expensive? (a) Yes (b) No

3. Would you accept any alternative source of energy in Bida when it comes?

   (a) Yes (b) No

4. What do you understand by biomass energy technology?

5. Do to think that biomass energy technology can be achieved in Bida Municipality through: (a) Government policies and programmes alone

6. (b) Joint efforts from the community.

7. Do you think that biomass energy technology can be jointly or wholly funded by:- (a) Community efforts (b) Bida Local Government and the State (c) Other donor agencies such as the GEF, World Bank etc.

8. What effort do you think can be made to ensure capacity building for biomass energy?---

9. How can necessary funds be generated for the biomass technology in Bida Municipality?---

10. How can market for the biomass energy strategy be developed in Bida Municipality?---