RENEWABLE ENERGY AS AN ALTERNATIVE ENERGY SOURCE FOR POULTRY FARM SETTLEMENTS IN EKITI METROPOLIS, NIGERIA

BY

OGBEBOR, ALEX EHIEDU
(MATRIC NO: MEE/11/0411)

A PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING (B.ENG) DEGREE IN MECHANICAL ENGINEERING

TO

**DEPARTMENT OF MECHANICAL ENGINEERING,
FACULTY OF ENGINEERING,
FEDERAL UNIVERSITY OYE EKITI.**

SEPTEMBER 2016.

CERTIFICATION

This is to certify that this project work was carried out by OGBEBOR, ALEX EHIEDU with matriculation number MEE/11/0411 a student of Mechanical Engineering. Faculty of Engineering, Federal University Oye Ekiti.

DR. A.E ADELEKE

(Project Supervisor)

Signature and Date

DR. A.E ADELEKE

(Head of Department)

Signature and Date

DECLARATION

I hereby declare that this research project was carried out by me, **OGBEBOR, ALEX EHIEDU** with matriculation number MEE/11/0411 and submitted to the Department of Mechanical Engineering, Federal University Oye Ekiti in partial fulfilment for the award of Bachelor of Engineering (B.ENG) degree in Mechanical Engineering.

MEE/11/0411

OGBEBOR, ALEX EHIEDU

Matric No. & Name of Student

Signature and Date

DEDICATION

I dedicate this project to God Almighty my creator, my strong pillar, my source of inspiration, wisdom, knowledge and understanding. He has been the source of my strength throughout this program and on His wings only have I soared. I also dedicate this work to my lovely parent; Sir and Lady F.C OGBEBOR who has encouraged me all the way and whose encouragement have made sure that I give it all it takes to finish that which I have started.

ACKNOWLEGEMENTS

My deepest gratitude goes to God who has provided all that was needed to complete this project and the program for which it was undertaken for. There was never lack or want. Throughout this entire study, He took care of everything that would have stopped me in my tracks and strengthened me even through my most difficult times.

My endless appreciation goes to my able, purposeful and dynamic supervisor Dr. A. E. Adeleke for supervising me during this research and always available to provide his support when needed. the Director of ICT Professor B.O Bolaji one of the simplest people I have met and who has been of tremendous help to me all through this program; thank you Sir. I won't forget to thank all my Lecturers who in one way have impacted knowledge in me during my program, I say a big thank you.

To my wonderful siblings Charles, Noye, Andy, Vera and Emmanuel. And to all my friends Precious Ezeike, Andrew .A, Obinna .O, ThankGod, Paul .O, Mummy Jesulayo and so on, who have been there in every way possible in this quest of greatness. Thank you. My love for you all can never be quantified. God bless you.

ABSTRACT

Poultry farming is the raising of domesticated birds such as chickens, ducks, turkeys and geese for the purpose of farming meat or eggs for food. The poultry farm equipment requires electrical energy supply to function effectively and efficiently. This work studied and analysed the annual cost of the existing energy source used by some poultry farms in Ekiti metropolis such as use of diesel generator and connection to the national grid and proposed the use of biomass as the alternative source of energy. The cost analysis of existing and proposed energy source was carried out based on the capital investment cost, operation and maintenance cost. The comparative study was carried out to access the economic viability of biomass as alternative energy source. The result of this study shows that the biomass as a renewable energy source should be encouraged to power the poultry farm.

Table of Contents **PAGE NO**

LIST OF FIGURE

LIST OF TABLES

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Energy, which is very important in the economy, political, social and environmental aspects of any nation has become one of the most discussed issues globally. The industrialization of the world and technological developments brought a higher energy need for the entire world. However, the amounts of reserves of traditional energy resources differ from one country to another. Thus, this has resulted in major environmental concerns, serious political conflicts, unavoidable economical dependency and important social consequences. The existing situation and the future estimations for energy requirements make people to find alternative energy resources.

In Nigeria located on the west coast of Africa, lack of access to wide range of modern energy services has remained a major barrier to improving key indicators of human development (Onafeso, 2006). Presently over 60% of the country population depends almost entirely on fire wood for cooking, heating and agro-processing activities. Petroleum products such as gasoline and kerosene are marked by acute shortages and mounting price, with the product sold over 300% above the official pump price (Anonymous, 2008). Additionally, electricity which is the foundation of modern economies is non-available and if available is of poor quality or better still unreliable as less than 4,000 MW of the 7,876 MW installed electricity capacity is been generated (Sambo et al., 2010).

1.2 CATEGORIES OF ENERGY

There are two prominent categories of energy, renewable and non-renewable energy

- **Non-renewable energy** comes from sources that will run out or will not be replenished in our lifetimes. Non-renewable energy sources come out of the ground as liquids, gases, and solids. Most of it energy sources are fossil fuels: coal, petroleum and natural gas. Carbon is the main element in fuel fuels.

- **Renewable energy** is the energy generated from natural resources. The energy sources can be replenished or recreated when they are used. They are generally less-polluting and cannot be exhausted, this energy comprises of heterogeneous class of technologies. Various types of renewable energy can supply electricity, thermal energy and mechanical energy, as well as produce fuels that are able to satisfy multiple energy service needs, they include solar energy, hydropower, biomass, wind, water waves, and geothermal.

  This project addresses the energy been utilized in poultry farms for different operations.

1.3 POULTRY FARM ENERGY NEEDS

Poultry farming is the raising of domesticated birds such as chickens, ducks, turkeys and geese for the purpose of farming meat or eggs for food. Poultry farm varies in size and requirements of electricity supply, hence a reliable electricity supply is needed.

1.3.1 Poultry Farm Equipment Using Electrical Energy

The poultry farm equipment can be grouped into different categories

1. Incubation equipment: This equipment include setter, hatcher compressed air system
2. Egg handling equipment: such as hatching egg transfer machines
3. Egg Candler
4. Electrical heaters (heating rods or coils)
5. Feeding equipment: like automatic feeder
6. Electrical brooder: this includes artificial lights, Infra-red bulbs
7. Water equipment: Water heaters, water pump and Water softeners and filters
8. Power Ventilation Fans

It is important for poultry farmers to know their current energy usage in order to determine the magnitude of energy being consumed by the farm. The energy consume varies among different farms, hence amount of electricity used is converted to per unit weight of broiler produced. Farms raising heavier birds tend to incur higher annual electricity than those raising lighter birds.

1.4 PROBLEM STATEMENT

Energy is a key instrument in accelerating economic growth, alleviating poverty and creating employment opportunities. Epileptic power failure has resulted in an over-dependence on generators driven by fossil fuel. Apart from this, fossil fuel is non-renewable and fast depleting and contributes to ecological degradation. Due to the endemic power shortage in the country, it is highly appropriate to research on the use of renewable energy to produce an alternative source of energy from the available resources in the country such as sun, wind, water and biodegradable wastes.

1.5 SIGNIFICANCE OF THE STUDY

This study will give the poultry farmers a new direction to a more cost effective energy source which can reduce the energy crisis of the country significantly. This will help to reduce the dependency on fossil fuel to meet up the energy demand of the country.

1.6 SCOPE OF PROJECT

The scope of the project covers the annual cost assessment of renewable energy, for use in poultry farms in Ekiti metropolis. During the period of the project, a survey would be carried out on different poultry farms in the region to determine the energy usage of each farm by conducting an energy audit and also questionnaire would be available to the farmer to get in sight on which renewable energy would be best preferred, information gather from the farm would be analysed and evaluated to determine which energy source would be suitable for the farms. Therefore providing a basis for poultry farmers to approach the usage of renewable energy, and hopefully to invest in this technology.

1.7 AIM AND OBJECTIVES

The primary aim of this research is to evaluate the economic potential of electricity generation from renewable energy for poultry farms in Ekiti metropolis to help substitute or reduce the use of fossil fuel.

The objectives are:

1. To carry out an energy audit in order to determine the amount of energy been utilized in each of the surveyed poultry farm
2. To estimate the cost requirement of the existing energy source used in the surveyed poultry farm.
3. To perform cost analysis of establishing a biomass power plant for the poultry farms compared to the operation of the existing diesel generator.

CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION

Electricity supply in Nigeria dates back to 1886 when two small generating sets were installed to serve the then colony of Lagos. In 1951 Electricity Corporation of Nigeria (ECN) was established by act of parliament, and in 1962, the Niger Dams Authority (NDA) was also established for the development of hydroelectric power. In 1972, the two bodies were merged to form National Electric Power Authority (NEPA). The 2005 power sector reforms led to the unbundling of the sector to form Power Holding Company of Nigeria (PHCN). The unbundling resulted in eleven distribution firm, six generating firms, and a transmission company (Anonymous, 2008). Electricity generation in Nigeria varies from gas-fired, oil-fired, coaled fired and hydroelectric power stations. The generating plants consist of 3 hydro-plants and 11 thermal plants (gas/steam). The national grid is made up of 4,889.2 km of 330 KV line and 6,319.33km of 132 KV. Presently less than 4000 MW of the total installed capacity of 7,876 MW is actively been utilized due to a number of factors ranging from technological deficiencies, loss through transmission (estimated to be between 30 and 35% of power generated), lack of modern standardization components and qualified maintenance staff (Ikeme, 2005).

2.2 TRADITIONAL POWER TECHNOLOGY

2.2.1 DIESEL GENERATOR SETS

Blankinship .S.A (2002) evaluated diesel generator sets as the most common source of electric power in rural areas in developing countries. The reason that diesel generator sets are so common is probably that they are inexpensive to purchase and they can be installed at almost any place that can be accessed. Disadvantages with diesel generator sets are high operation costs and maintenance problems.

2.2.1.1 ENVIRONMENT ASPECTS

The environment effects of diesel generator are more or less obvious, diesel is a fossil fuel, which means that combustion leads to pollution of carbon dioxide, nitrogen oxides and sulphur oxides. It must though be stated that the pollution from one diesel generator can be compared with the pollution from a truck, and therefore should a few diesel generator not be a major threat to the local environment. However, since all combustion of fossil fuels contributes to global warming, if all rural areas in developing countries were to be electrified with diesel generator, taken all in all could diesel generator be a problem.

The sound levels within power plants with diesel generator are usually high, which can be a problem for the staff, especially if ear protection is not available. Another environmental disadvantage is the lubricant oil, which in many cases is not taken care of, but left in holes in the ground.

2.2.1.2 COSTS

Amelin, M & Hersoug, .E (1997) generally describe the investment cost for installing a diesel generator is low. The maintenance costs are also comparatively low, but the operation costs are high. The operation costs mainly consist of costs for diesel and lubricant oil. Thus the operating cost depend primary on the local diesel price, which in its turn depend on taxes, transportation costs and world market price.

2.3 SMALL SCALE RENEWABLE ENERGY TECHNOLOGY.

Though many provinces in Nigeria have been producing hydroelectric power, the oil crises of the 1970s ignited a strong interest in some other forms of renewable energy. With its extensive geography, Nigeria has vast renewable energy resources (Islam, et. al., 2004). Renewable-energy technologies that are already or nearly commercialized include solar, small-scale biomass power generation and small scale off-grid wind power.

Renewable energy potential depends on geographic resources such as wind speeds, solar radiation, and biomass residues from agriculture and other industries. If good geographic resources are present, several applications offer plentiful opportunities for cost-competitive commercial or near-commercial renewable energy (Martinot and McDoom, 2000).

2.3.1 SOLAR PV SYSTEMS

The technical feasibility of an off grid standalone solar photovoltaic systems for rural lighting system was studied by Mohanlal .K.K. (2002) has analysed the economic viability of a standalone solar photovoltaic system with the most likely conventional alternative system i.e. a diesel powered system for energy demand through sensitivity analysis of life cycle cost computation. The analysis has been carried out for the energy demand for different key parameters, such as discount rate, diesel fuel cost, diesel system lifetime, fuel escalation rate, solar insolation, PV array cost and reliability. The result showed that the PV powered systems could be a cost effective option at a daily energy demand up to 15 kWh even under unfavourable economic conditions.

Hamid M. A. (2001) studied the feasibility of photovoltaic technology for power generation and presented comparative economic analysis of power generation with a conventional gas turbine. The results indicate that the solar photovoltaic systems are not economical as compared with a conventional gas turbine. However, it was concluded that PV systems could become economical when the system cost reduces to below \$2.50 per peak Watt with conversion efficiency above 20%.

Bates et al (2009), at Westchester Polytechnic Institute, conducted a study on feasibility and the use of solar power for a church. What they evaluate in their study is the start-up costs, operating costs, revenue projections, and financing options installing a solar system. With all things being considered, a cash flow analysis and net present value calculations were determined. Based on current prices, a solar panel system installed at Wesley United Methodist church would have a nineteen-year payback period. The study determined the break-even point by figuring out when the discounted value of future earnings is equal to the initial investment, in this case, the down payment. In the study, they decided that the church would pay the price of the system without any investors, incentives, or leasing options. Their study resembles the results of many other studies being done at this time.

Several Solar PV installations have been carried out in different parts of the country and abroad with the aim of meeting energy demand by harnessing solar resources within such areas.

Ismail et al. (2012) embarked on performance assessment and cost analysis of installing a 4.5kW Solar PV system in Oke-Agunla area of Ondo State in Nigeria. The results from their assessment indicated that the Solar PV systems were underutilised due to system faults and reduction in efficiency as a result of poor maintenance, and technical defects being handled by fledgling project managers and also they found out that the capital cost required for the installation of the system is huge but will later result to a minimal cost operation during the life cycle of the system.

Borenstien S. O. (2008) found that the primary cost was installation (parts and labour), which represents the majority costs of the system. After installation, the largest cost the owner of a solar photovoltaic system is expected to face is replacing the inverter. The average life expectancy of an inverter is anywhere from five to ten years. These issues need to be considered when making calculations on the net present value of a photovoltaic system. There are some other factors that Borenstien says are needed to be considered; the first is the aging effect. Photovoltaic cell production declines over time, with the best estimates in the range of one percent of original capacity per year.

Lee et al (1994) have discussed about the design and implementation of hybrid air-electricity storage system for a PV system. This design gives a correct matching of the performance of PV, battery and air storage pump. The demonstration of the above system yields satisfactory results. Also, a mathematical model was created to determine the economic feasibility and break-even points using different financing options.

Schmitt .F.A (2007) found that the installation price of photovoltaic to support an entire ranch would be $592,500. The cost of interest was ultimately the determining factor. If the family could pay for the installation without a loan, the panels would pay for themselves in twenty years and give the family a return of approximately $6,000 per year. This information is useful because it gives an idea of how long it will take owners to see the benefits of solar panels.

The above related works on solar PV systems by different authors has shown the different application and potential economic cost values of installation and running cost of a PV system which is related to the proposed research in this study.

2.3.2 WIND SYSTEMS

Jill .O.M, (2006) presents recommendations for the design and construction of a feasible 50kilowatt wind turbine power generating system for domestic use in residential homes. This project addresses the following topics and issue; permitting, land acquisition, turbine foundation design and construction, operations and maintenance and cost estimation. The significant part of this project methodology was to determine the specific electricity needs of the community in order to determine the desired size of the wind system, grid and diesel integration, and system costs

Aydogan et al (2001) have analysed and presented a case study on wind energy utilization in a house in Izmir, Turkey. The developed model determines the number of batteries needed for continuous energy supply, for each wind turbine taking into account of the economic aspects. It was found that the wind battery hybrid system was not economical in the areas of low wind potential.

Baigarin et al (2001) have discussed about the potential of wind energy resources available in central Asia farm lands to reduce the cost of energy being consumed from the national grid. The equations used for determining the distribution of wind energy output, energy density, energy cost and efficiency have been discussed in detail, they were able to derived that from the installation of a wind turbine system on the various farm .

Suresh et al (2001) have developed a model to investigate the optimum sitting of wind turbine generators based on site and wind turbine type. The methodology of analysis was based on the accurate assessment of wind power potential of various sites. The analytical computation of annual and monthly capacity factors has been carried out by using the weibull statistical model employing cubic mean cube root of wind speeds. A judicious choice of potential sites and wind turbine generator systems can be made using the model proposed.

2.3.3 BIOMASS SYSTEMS

Sheikh, .A.U (2007) review the potential of electricity generation from poultry waste in Bangladesh which would be reused in the farm as a renewable energy. Data was collected by interviewing poultry farmers with structured questionnaire, visiting poultry farms, discussions and interviews with key personnel and visiting different concerned institutions. For financial analysis, the technology used in GTZ flagship project at Raj Poultry Farm in Faridpur district was considered. Two different scenarios were considered in the analysis based on the time duration for which the poultry farms can produce electricity, On the basis of different scenarios NPV, IRR and Payback Period were calculated for different poultry farms with the sizes of birds. The discount rate was considered at 8% and the life of the project was considered 20 years. NPV, IRR and Payback Period were calculated for each size of poultry farms under both Scenarios I & II for four different cases. The calculation was done to find out the minimum sizes of poultry farms which could produce electricity with financial viability.

Bhanu D.O, (2010) in his thesis explored the opportunities to reduce energy demand and access biomass renewable energy feasibility at an off-grid science community called the Experimental Lakes Area (ELA) in Ontario. Being off-grid, ELA is completely dependent on diesel and propane fuel supply for all its electrical and heating needs, which makes ELA vulnerable to fluctuating fuel prices. As a result, the thesis showed how promising biomass power energy source help reduce the diesel and propane consumption at ELA and also derived the shortest payback period in terms of cost.

Rezaur R.H. (2014), analyses the feasibility of wood based energy plants in the off-grid Brochet community in Manitoba were analysed by survey, interviews and document review in this research. Four areas were explored to assess the suitability of biomass energy generation, namely: the community's perspective, resource assessment, technology availability, and cost attractiveness. A heat only plant is considered to be the best choice for biomass plant establishment in Brochet, followed by combined heat and power plants. A cost analysis showed that a biomass plant at Brochet is more economical than the current planned investment in the diesel power facility.

2.4 ADVANTAGES AND DISADVANTAGES OF DIFEERENT RENEWABLE ENERGY

Although renewable energy is a mature technology, obvious drawbacks exist which has been clearly stated by Hanley & Nevin (1999). Below are the list of the important advantages and disadvantages of renewable energy technology with regards to remote off-gird locations.

2.4.1 SOLAR POWER

Solar energy has a wide range of advantages and disadvantages which are listed below.

Advantages

1. Solar energy systems are virtually maintenance free and will last for decades. Once installed, there are no recurring costs.
2. Solar energy systems operate silently, have no moving parts, do not release offensive smells and do not require you to add any fuel and more solar panels can easily be added in the future when the need arises.
3. Solar energy systems can operate independently without a connection to a power grid at all. Systems can therefore be installed in remote locations, making it more practical and cost-effective than the supply of utility electricity.

Disadvantages

1. The initial cost of installing a solar energy system is high because of the expensive cost of the semi-conducting materials required for it.
2. The efficiency of the system also relies on the location of the sun, which is overcome by the installation of motors to change the direction of the solar panel.
3. The production of solar energy is influenced by the presence of clouds or pollution in the air

2.4.2 WIND POWER.

Wind energy has a wide range of advantages which are listed below.

Advantages

1. Wind energy does not release carbon dioxide, nitrogen oxide, sulphur dioxide or mercury into the atmosphere like many traditional forms of electrical generation does therefore contributes in decreasing GHG emissions
2. Each megawatt-hour of electricity generated by wind energy helps to reduce 0.8 to 0.9 tonnes of greenhouse gas emissions that are produced by coal or diesel fuel generation each year.

Disadvantages

1. The wind speed is not constant, varying from zero meters/sec to storm force, which means that wind turbines do not produce the same amount of electricity all the time and there will be times when they produce no electricity at all.

2. Maintenance is a problem in remote regions without qualified personnel to perform annual or seasonal maintenance checks on the tower and turbine

2.5.3 BIOMASS POWER

Advantages

1. Sources are commonly available, locally produced and variable including: wood, wood chips, switch grass, wheat straw etc.

2. Carbon neutral technology in the case that new plants are grown to replace the ones harvested for fuel

Disadvantages

Maintaining a steady supply of waste can be difficult, therefore, need masses of storage space and sheds for waste storage for continuous operation.

CHAPTER 3
METHODOLOGY

3.1 AREA OF STUDY

The studied poultry farms were located in Ekiti state, a south western part of Nigeria. It was conducted among four different poultry farms which are;

1. Afebabalola Livestock Centre.
2. Gbobo Farm.
3. Ado-Poly technic poultry farm
4. Ekiti state University poultry farm (EKSU).

3.2 OVERALL APPROACH

The research was used to assess the potential for renewable energy applications to the poultry industry by surveying four poultry farms in Ekiti state. During the survey, an interview was conducted to assess the poultry farmer on which of the proposed renewable energy solution would be best preferred, three out of the four farm selected biomass from their poultry dropping based on different consideration. Also, site analysis was conducted which includes data collection in the forms of interview, questionnaire and energy audit of each of the poultry farm. Using this data, the amount of electrical energy potentially utilized and the existing power source which was mainly diesel generator and grid source electricity from BEDC were cost estimated. Cost analysis was then performed by evaluating the total annual cost of each existing power sources used on the poultry and the proposed biomass energy from poultry droppings. After which a cost comparison table of the proposed biogas system with the existing energy source on the poultry farms was established and used to determine the best energy source solution for the poultry farms.

The methodology of this research includes but not limited to the following:

a) The four poultry farms located in Ekiti state, Nigeria were visited and the load demand was assessed in a form of load audit.

b) A cost analysis using Annual cycle cost was carried out to evaluate the economics of the each of the existing energy source system available and the proposed biogas generator energy system.

c) Finally cost comparison of diesel generator set, National grid supply and Biogas system was carried out.

3.3 DATA COLLECTION

Various types of data were collected related to the study from different types of sources. Secondary data was collected from different organizations, relevant literature and internet searching. Primary data was collected by using a questionnaire in the different poultry farms.

3.3.1 SECONDARY DATA COLLECTION

Different concern organizations were contacted and internet searching conducted to collect necessary information for the study. Biogas related data and information was gotten from **BCAS,** 20014**:** Report on Feasibility Study on Biogas from Poultry Droppings, Bangladesh Centre for Advance Studies. Diesel and gas generator prices related data where gotten from Mikano International limited Nigeria. Energy from national grid related data were collected from Benin Electricity Distribution Company (BEDC) website.

Besides the details mentioned above, information were ascertained through discussions with official, and the relevant literatures, documents, publications and internet searching was done and various relevant files from different web sites were downloaded.

3.3.2 PRIMARY DATA COLLECTION

Primary data was collected by means of a questionnaire survey (a copy of this is attached as Appendix A) and interview with the poultry farmers. Questions were asked to know about the present energy consumption, deficit of energy supply, size of backup system and running hours of the backup system, the problems facing with the technology, the interest of the farmers to produce electricity from renewable energy, what type of renewable energy is preferable, and the barriers to disseminate the technology. Data concerning the load demand was also ascertained through an inventory of the different poultry farms.

3.4 ELECTRICITY CONSUMPTION

It was necessary to gather energy data from the poultry farms in form of a load audit by carrying out an inventory on all the equipment and machine used in the poultry farms and their hourly usage of this equipment, in order to gain a better understanding of what size of the proposed biogas system would be considered for each of the poultry farms. Previous electric bills and meter reading contained the number of kilowatt hours consumed by the various poultry farms, as well as the price paid for these hours. Using this data, we were able to summarize the trend in cost of energy usage over the course of the year.

3.5 COST ANALYSIS

The cost consideration of the following system where considered for analysis over the period of a year.

I. National grid electricity energy supply from BEDC
II. Existing Backup system a diesel generator.
III. Proposed Biogas energy generating system.

A major factor in accessing the overall potential for the application of implementation, and benefits that each alternative energy source offers is their overall cost. In order to estimate the total cost of each of the alternative energy source, as much information as possible was gotten from different resources regarding the costs of components, installation, site preparation, maintenance and operational fees. A manufacturer such as Mikano international limited was contacted to determine capital cost, installation and maintenance, and operation costs of a diesel and gas generator. The costs of maintenance and operation of the each system was determined by case studies and factored into an annual cost analysis for each of the poultry farm. An accurate estimate of the actual cost of each option was ascertained to provide the poultry farm's management with a realistic estimate.

3.6 CATEGORIES OF COSTS

As far as costs are concerned there are two major categories considered in the analysis:

1. **Operation and maintenance costs (running costs):**

   The operation cost of the diesel generator was consider to be the cost of diesel at a fix price of ₦190/litre and maintenance cost was estimated at 5% of the initial cost of the generator which would be carried out at a working interval of 250hours. Biogas gas generator operational cost was considered to be zero, because the fuel source which is the biogas would be generated from the poultry farms waste while the annual biogas maintenance cost include the generator, biogas plant and H2S and moisture removal unit.

2. **Capital costs:**

   For the biogas generator the capital cost estimate where made on the cost of the whole system which are biogas plant, generator, H2S and Moisture removal unit, compressor for regeneration process for the different size of the farm, while the cost of diesel generator and installation also consider.

CHAPTER FOUR
RESULT AND ANALYSIS.

4.1 ENERGY CONSUMPTION STATUS IN THE POULTRY FARMS

During the research survey of the different poultry farms, information gathered was use to analysed the energy consumption of the four farms visited.

Farms surveyed are;

1. Afebabalola livestock centre.
2. Ekiti state University poultry farm.
3. Ado-Polytechnic poultry farm.
4. Gbobo farm.

These poultry farms in Ekiti state are covered by the national electricity grid. Benin Electricity Distribution Company (BEDC) a rural electrification Company that is responsible for the commercial operation of electricity in the State. Almost all the surveyed poultry farms are grid connected, just a single farm was not connected to the grid (Gbobo farm). There is a huge power shortage in the study area as well as in the country. For uninterrupted power supply all the poultry farms use back up system such as diesel generator. The daily energy consumption pattern in poultry farms varies according to the sizes of the farm, but the electrical consuming appliances and machines are almost similar. Usually, the farms consume less energy in the day time and consume more in the evening. However, the farms using energy efficient lamps use less electricity in the evening than day time. None of the poultry farms in the district has a renewable energy powering system. The details of utilization of different types of energy in the poultry farms are discussed in this chapter.

4.2 ENERGY CONSUMPTION OF MAJOR ELECTRICAL APPLIANCES USED

Electricity is used in the surveyed poultry farms mainly by lamps to provide proper lighting in the poultry shed, fans to maintain the required temperature, Incubator which are used for maintaining the temperature of the eggs, water pumps to supply water and other miscellaneous equipment include mixer, grinder and electric heater.

The following are the details of the status of electricity use for the main machines and appliances in the poultry farms.

1. ENERGY USAGE ANALYSIS FOR AFEBABALOLA POULTRY FARM.

The farm has a capacity of 5820 birds and a double poultry house. This facility consists of a number of equipment which consumes energy. The average energy usage per month/year is about 916.2/11,147.2 kilowatt-hour of electricity which are based on the equipment inventory and measurement of electricity consumption on a daily basis.

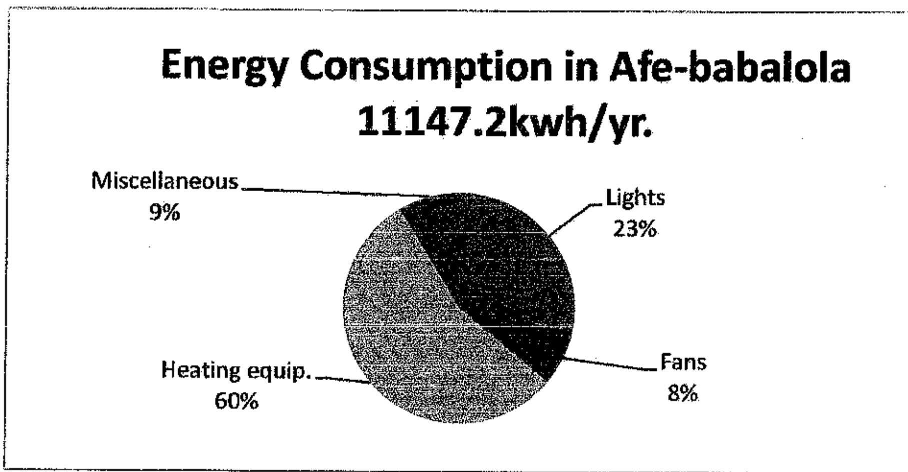


Figure 4.1: Annual Electricity Load Demand in Afebabalola poultry farm

The pie chart above represents the light, fan, heating equipment and miscellaneous equipment used in the farm. It can be seen that the heating equipment consumes a greater portion of energy and fan consumes lesser energy. More details on the equipment inventory and energy analysis of Afebabalola poultry farm can be found in appendix B.

2. ENERGY USAGE ANALYSIS IN EKITI STATE UNIVERSITY POULTRY FARM.

The facility consists of an office and 3 poultry houses with a total no of 4500 birds. Due to the poultry farm size and daily activities, it is no surprise that EKSU poultry farm out of the four farm visited uses the highest average amount of electricity in a year/month which is about 31,645.5/2601 kilowatt-hour of electricity per year/month.

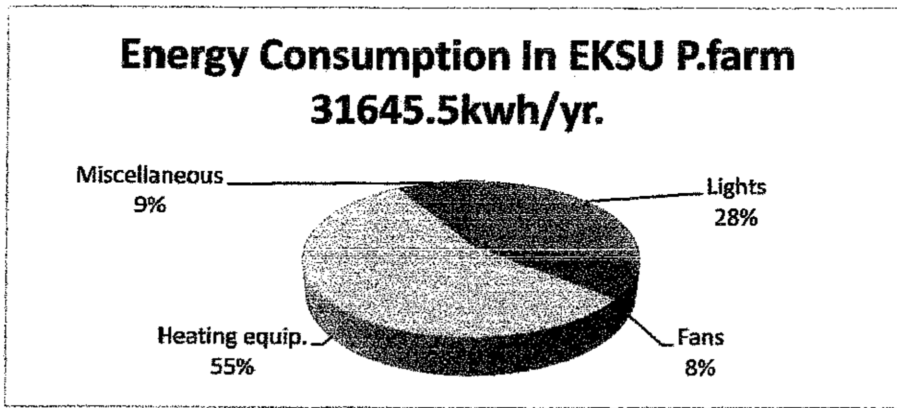


Figure 4.2: Annual Electricity Load Demand in the EKSU poultry farm

The Pie Chart represents the light, fan ventilation, Electric Water Heater, Mixer Grinder and miscellaneous. More details on equipment inventory and energy analysis of the EKSU poultry farm building can be found in Appendix B.

3. ENERGY USAGE ANALYSIS FOR GBOBO POULTRY FARM.

The facility holds a capacity of 700 birds. The existing energy usage in gbobo poultry farm is the least out of all the farms visited with an average electricity usage of 635.4/7730.7 kilowatt-hour per month/year. The estimation was ascertained using and inventory of the equipment and the hourly usage of the equipment.

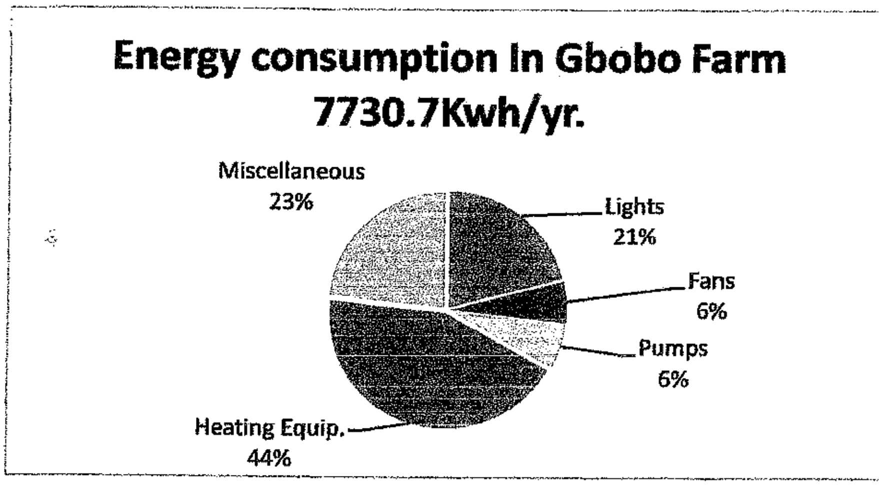


Figure 4.3: Annual Electricity Load Demand in Gbobo farm

The pie chart above represents the energy usage of the different farm ranging from the different equipment used. More details on equipment inventory and energy analysis can be found in appendix B.

4. **ENERGY USAGE ANALYSIS FOR ADO POLYTECHNIC POULTRY FARM**

   The facility has a total of 2250 birds, the estimated average energy consumption of the farm is 19,309/1590 kilowatt-hour per year/month. This farm holds the second highest energy consumption for the surveyed farms

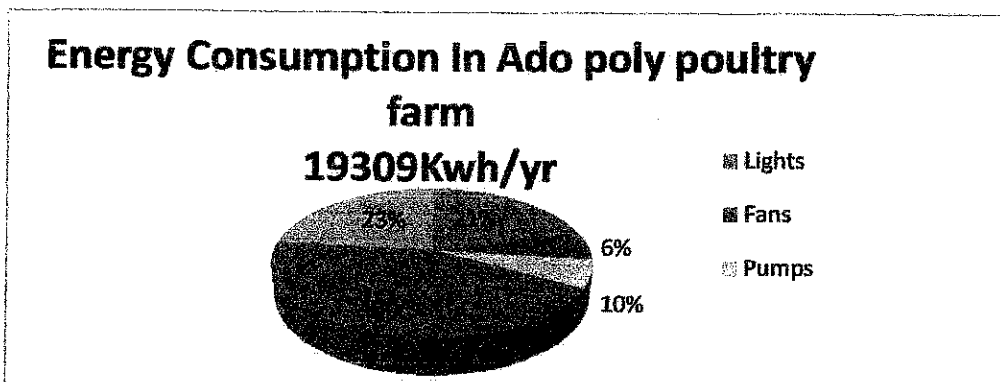


Figure 4.4: Electric Energy Use in the Ado Poly poultry farm

The pie chart above represents the energy usage of the different farm ranging from the different equipment used. More details on equipment inventory and energy analysis can be found in appendix B.

4.3 ELECTRICITY COST FOR POULTRY FARMS CONNECTED TO THE GRID

From the survey of the poultry farms visited, it shows that majority of the farms are connected to BEDC for electricity supply only just one of the poultry farm was not connected. It was also ascertained that power outage is a regular phenomenon in the different poultry farms. The poultry farms face enormous power outage every day, all of the poultry farms experience the power outage. However, the duration of power outage varies from fifteen hours to eighteen hours in a day. It can happen any time throughout the day.

4.3.1 ANALYSIS OF GRID SUPPLY (BEDC) FOR EACH POULTRY FARM

The cost per kWh of electricity from BEDC is ₦24.00 and the vat rate is 5% of the electricity bill. Considering the cost of electricity for each poultry farm depends on their hourly usage and the total load consumed by each of the farm, this data were available during the survey of the farms.

Table 4.1: Cost of Electricity for each poultry farm connected to the Grid Source.

Poultry farm	Average hours of Electricity	Monthly energy use (KWh)	Monthly Cost of electricity from BEDC	Annual Cost of electricity from BEDC
Afebabalola	6	621	₦15,649	₦187,788.00
Ado poly technic	6	834	₦21,017	₦252,204.00
EKSU	8	1615.2	₦40,703	₦488,438.00

During the analysis Gbobo farm was not considered this because the poultry farm doesn't make use of the convectional power source from the national grid.

4.4 THE COST OF DIESEL GENERATOR AS A BACK UP SYSTEM FOR THE POULTRY FARMS.

All the surveyed farms visited have installed diesel generator as a backup system due to power outage from their electricity provider BEDC, diesel generator was the only backup system recorded during the survey. The sizes of the diesel generator range between 10-35KVA capacities.

The Capital cost of the generator could not be ascertained from the poultry farms during the survey but an interview with a staff at Mikano international limited was used to determine the Capital and installation cost of the generator.

Table 4.2: Details of Diesel generator.

Poultry farm	Afebabalola poultry farm	EKSU poultry farm	Gbobo farm	Ado-poly Farm
Diesel generator size	35KVA	30KVA	10KVA	20KVA
Daily Average Usage	9-10hrs	6-8hrs	2-3hrs	5-7hrs
Fuel Consumed	8litre/hr.	6litre/hr.	2litre/hr.	6litre/hr.

4.4.1 ANNUAL COST USAGE OF DIESEL GENERATOR FOR THE POULTRY FARMS.

The following are criteria for the cost analysis of using a diesel generator for the poultry farm as a backup system. This analysis would be considered under annually basis.

1. Capital Generator Cost
2. Operating and Maintenance cost

I. Fuel cost

II. Routine Service.

3. Total operating cost

To assess the annual costs of diesel generators, the following assumptions based on estimates provided by Wade and others (2016) are used:

• Capital generator purchase and installation costs: ₦186, 000/KVA.

• Operation and Maintenance costs: 5% of Capital costs for maintenance at 250hours interval and operational cost is the amount of diesel consumed.

• Price of diesel is taken as ₦190/litre

1. AFEBABOLA POULTRY FARM

Afebabalola poultry farm uses a 35KVA generator backup system during power outage. The generator has an average daily usage of about 9-10hrs on a daily basis and also consumes about 8litre/hr. of diesel when running on full load.

- **Capital Cost of Generator.**

  The capital cost for the 35KVA generator set include purchasing and installation = **₦6,510,000.00**

- **Operating and Maintenance cost.** Base on the operation and maintenance cost, the annual cost of diesel for the generator based on the daily usage would be considered, estimated hour of use is 9-10hrs and also the routine service cost. Taking the current price of diesel at ₦190/litre

Annual Diesel Cost =

Generator diesel consumption (litre/hr) X Mean Daily Usage X No. operation Days in year X Cost of diesel per litre

ADC = 8.00Lt/hr x 9.5hr x 365 x ₦190/litre

ADC= **₦5, 270,600.00 per/year**

Routine Service Cost.

The routine service cost involves the maintenance operation performed on the generator to increase it life span.

Annual routine service cost which is 5% if generator set price = **₦325, 500.00**
Routine is to takes place every 250 hours of operation according to standard generator manual. We have 14 times of routine service per year, which was calculated through the daily average usage.

Annual Service cost ASC = 325500 x 14 = ₦4, 557,000:00

ASC = ₦4, 557,000:00

- Total Annual Maintenance & Operating Cost

  Annual Service Cost + Annual Diesel Cost = 4,557,000+5,270,600

  TACM&O = **₦9, 827, 600**

  Table 4.3: Annual Cost of power for a 35KVA Diesel used in Afebabalola Poultry Farm

Total Cost per year	Total per year (₦)
Capital Generator Cost	₦6 510,000.00
Annual Service Cost	₦4, 557,000:00
Diesel Cost	₦5, 270,600.00
Total Cost	**₦16,337,600.00**

2. EKSU POULTRY FARM

EKSU poultry farm uses a 30KVA generator as backup system during power outage. The generator has an average daily usage of about 6-8 on a daily basis and also consumes about 6litre/hr. of diesel when running on full load. Considering the listed factor above we can get the total cost per year

Annual Cost of Power for A 30KVA Diesel Generator in EKSU

- **Capital Generator Cost.**

  The capital cost for the 30KVA generator set include purchasing and installation = **₦5,580,000.00**

Operating and Maintenance cost. Base on the operation and maintenance cost, the annual cost of diesel for the generator based on the daily usage would be considered, when ascertained the generator runs about 6-8hrs per day and also the routine service cost. Taking the current price of diesel at ₦190/litre.

ADC = 6.00Lt/hr. x 7hr x 365 x ₦190/litre

ADC= **₦2, 912,700.00 per/year**

Routine Service Cost.

The routine service cost involves the maintenance operation performed on the generator to increase it life span.

Annual routine service cost which is 5% if generator set price = **₦279, 000.00**

Routine is to takes place every 250 hours of operation according to standard generator manual. We have 10times of routine service per year, which was calculated through the daily average usage.

Annual Service cost ASC = 279000 x 10 = ₦2, 790,000:00

ASC = ₦2, 790,000:00

- Total Annual Maintenance & Operating Cost

  Annual Service Cost + Annual Diesel Cost = 2,790,000+2,912,700

  TACM&O = **₦5, 702,700**

Table 4.4: Annual Cost of power for a 30KVA Diesel used in EKSU Poultry Farm

Total Cost per year	Total per year (Naira)
Capital Generator Cost	₦5,580,000.00
Annual Service Cost	₦2, 790,000:00
Annual Diesel Cost	₦2, 912,700.00
Total Cost	**₦11,282,700.00**

3. ADO-POLYTECHNIC POULTRY FARM.

Table 4.5: Description of the diesel Generator at Ado polytechnic poultry farm

S/N	DESCRIPTION	VALUES
1	Capacity Of Generator.	20KVA
2	Fuel Consumption Per Hour	5litre/Hr
3	Daily Usage Per Day	5-7hr

Annual Cost of Power For A 20KVA Diesel Generatoı in Ado polytechnic poultry farm

- **Capital Generator Cost.**
  The capital cost for the 30KVA generator set include purchasing and installation = **₦3, 720,000.00**
- **Operating and Maintenance cost.** Base on the operation and maintenance cost, the annual cost of diesel for the generator based on the daily usage would be considered, when ascertained the generator runs about 5-7hrs per day and also the routine service cost. Taking the current price of diesel at ₦190/litre.

  ADC = 6.00Lt/hr. x 6hr x 365 x ₦190/litre

  ADC= **₦2, 496,600.00 per/year**

- **Routine Service Cost.**
  The routine service cost involves the maintenance operation performed on the generator to increase it life span.

Annual routine service cost which is 5% if generator set price = **₦279, 000.00**

Routine is to takes place every 250 hours of operation according to standard generator manual. We have 9times of routine service per year, which was calculated through the daily average usage.

Annual Service cost ASC = 279000 x 9 = ₦2, 511,000:00

ASC = **₦2, 511,000:00**

- Total Annual Maintenance & Operating Cost

  Annual Service Cost + Annual Diesel Cost = 2,511,000+2,496,600

  TACM&O = **₦5, 007,600**

Table 4.6: Annual Cost of power for a 20KVA Diesel used in Ado-polytechnic Poultry Farm

Total Cost per year	Total per year (Naira)
Capital Generator Cost	₦3,720,000.00
Annual Service Cost	₦2, 511,000:00
Annual Diesel Cost	₦2, 496,600.00
Total Cost	**₦8,727,600.00**

4 GBOBO FARM.

Table 4.7: Description of the diesel Generator at Gbobo poultry farm.

DESCRIPTION	VALUES
Capacity Of Generator.	10kva
Fuel Consumption Per Hour	2litre/Hr
Daily Usage Per Day	2-3hr

- Capital cost of generator

  The Capital cost of the generator and installation = **₦1, 860,000.00**

- Operation and Maintenance Cost

  The O&M cost for the generator includes

- **Annual diesel cost**

  ADC = 2.00Lt/hr. x 3hr x 365 x ₦190/litre

  ADC= **₦ 416,100.00 per/year**

- **Annual routine service Cost**

  Annual routine service cost which is 5% if generator set price = **₦93, 000.00**

Routine is to takes place every 250 hours of operation according to standard generator manual. We have 4times of routine service per year, which was calculated through the daily average usage.

Annual Service cost ASC = 93,000 x 4 = ₦372, 000:00

ASC = ₦372, 000:00

- **Total Annual O&M Cost**

  Annual diesel cost + Annual routine service cost= 372,000+416,000

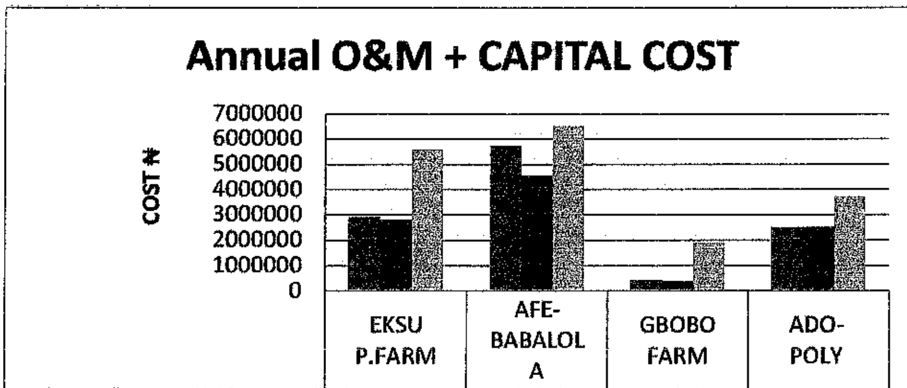
  TAO&M Cost=**₦788,000.00**

Table 4.8: Annual Cost of power for a 10KVA Diesel used in Gbobo Poultry Farm

Total Cost per year	Total per year (Naira)
Capital Generator Cost	₦1,860,000.00
Annual Service Cost	₦372,000.00
Annual Diesel Cost	₦416,100.00
Total Cost	**₦2,648,100.00**

4.4.2 SUMMARY OF O&M AND CAPITAL COST OF DIESEL GENERATOR.

The cost of acquiring the generator is a fixed cost which must be consider and also the maintenance cost after installation are consider fixed costs because they are generally incurred over fixed time interval with consideration to annual operating hours. The standard operating hours for which maintenance are carried out is 250hours which was used in the analysis above. The energy price [₦] includes the one-time Capital investment [₦/KVA] for the generator, routine service cost and the running cost of fuel [litre/hr] on hourly usage. The running cost is evenly divided across the time duration of power production. Operating cost are driven by the diesel costs, efficiency of the machines and the numbers of hours of operation, there is a range of diesel consumption rate of the various generators which was stated in the table 4.2. In this analysis, the price of the burned fuel (diesel) is based on the market price which is ₦190/litre.



	EKSU P.FARM	AFE-BABALOLA	GBOBO FARM	ADO-POLY
Annual diesel Cost	2912700	5720600	416100	2,496,600
Annual Routine Service Cost	2790000	4557000	372000	2511000
Initial cost of generator	5580000	6510000	1860000	3720000

Fig 4.5: Annual Cost of O&M and Capital cost of the generator.

The graph above shows the annual maintenance and capital cost for the various poultry farms varies because of the different size of generators utilized. The capital investment cost for the generator is smaller compared to the O&M cost for utilizing a generator over the running years. The case studies report show that the operation and maintenance cost ranges between ₦788,100-₦10,277,600. This range of cost is significant and it is driven by the extent of hourly usage over the years and size of the diesel generator for each poultry farm.

4.5 BIOMASS ANALYSIS.

At present none of the poultry farms visited uses a biogas energy for generating electricity or thermal energy during the survey of the farms. Biomass power is of different types, this analysis would consider biogas energy from poultry waste.

4.5.1 TECHNOLOGY CONSIDERED

In this system the biogas from the digester passes through a H_2S removal unit where the H_2S content in the biogas is reduced to an acceptable limit (250 ppm). After the H_2S removal unit, the gas passes through a moisture removal unit where the gas is freed from moisture. Then the gas enters into the generator. It also considered a regeneration system to regenerate the material used in the H_2S removal unit and moisture removal unit. For regeneration the system uses the exhaust gas of the generator.

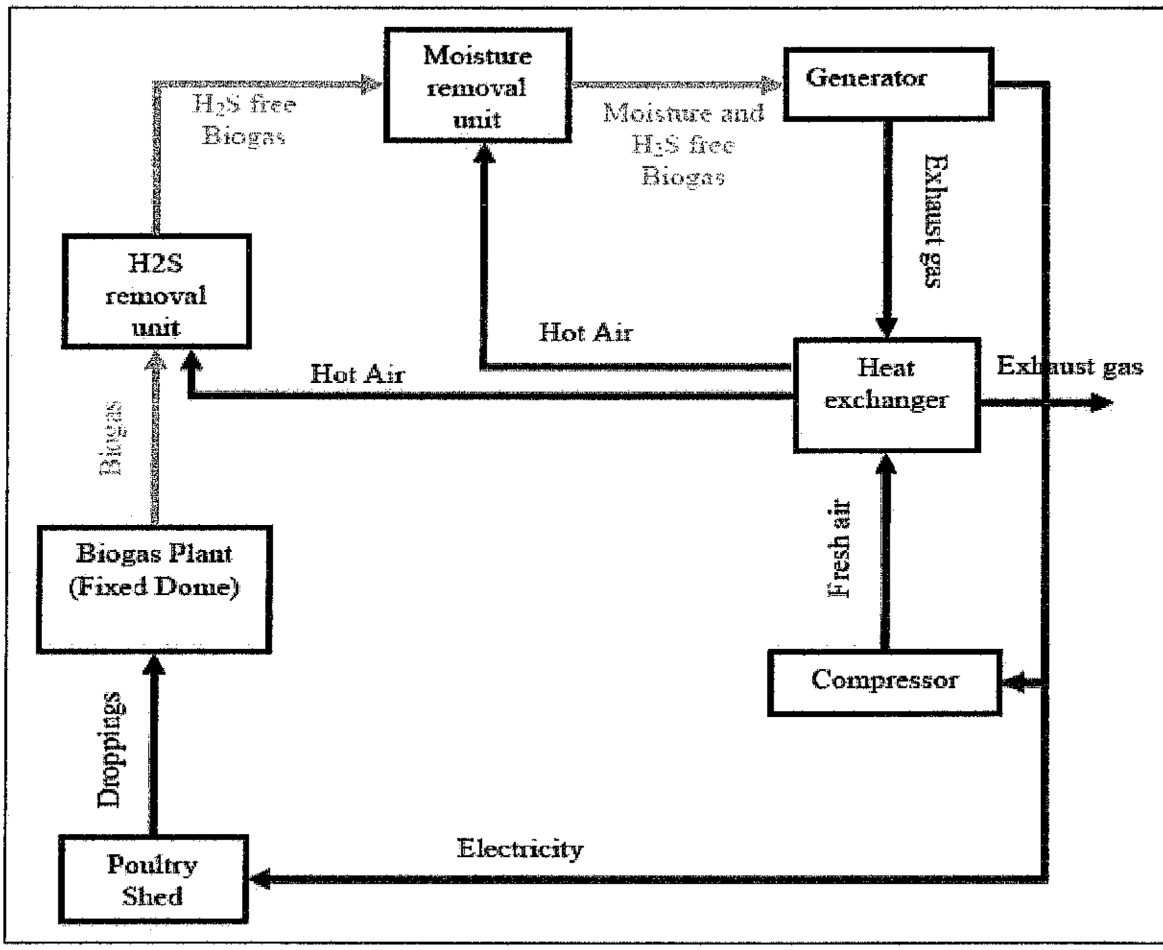


Fig 4.6: The flow diagram considered to produce electricity from poultry waste.

4.5.2 ANALYSIS FOR BIO-GAS GENERATION FOR THE POULTRY FARMS

From the survey of the different poultry farms, information on the number of the poultry birds raised in each farm was ascertained which would be used to estimate the potential generation of biogas from poultry waste.

Table 4.9: Parameters consider for energy generation. (Sheikh, 2007)

Litter/ droppings production	0.1 kg/ day per bird
Biogas production per kg of droppings	0.063 m3/day at 30° C
Amount of bio gas required to produce electricity	0.75 m3/ kWh
Cost of acquiring poultry waste	₦10/kg

Estimates for the amount of waste gotten from the different poultry farms varies base on the number of birds raised in the farm. The amount of litter/droppings production per day excreted by a bird per day is 0.1kg for a layer and broiler birds (Sheikh, 2007), this standard would be used to evaluate the amount of dropping from the surveyed farms.

Table 4.10: Estimate of bio-gas and electricity production from the surveyed farms.

Poultry farm	Afebabalola	Gbobo	Ado-poly	EKSU
No. of bird	5820	700	2250	4450
Litter/dropping production (kg /day per bird)	0.1	0.1	0.1	0.1
Amount of dropping per day (kg)	582	70	225	445
Bio-gas production per day	$36.7m^3$	$4.4\ m^3$	$14.2m^3$	$28m^3$
Biogas to electricity evaluation per day (kWh)	27.5 kWh	3.3 kWh	11 kWh	21 kWh
Biogas to electricity evaluation per year	100378 kWh	1205 kWh	4015 kWh	7665 kWh

On the basis of different parameter considered, the table 4.10 above estimated the following; Amount of drooping (kg), Biogas production per day, Biogas to Electricity evaluation per day were calculated for different sizes of poultry farms..

From the table, the range of electricity that could be generated per day from the bird dropping is (3.3kWh-27.5kWh) for the different population of birds of the different farm.

1. **Cost of small scale biogas plant**

The construction costs of different sizes of biogas plant are shown in Figure 4.7.

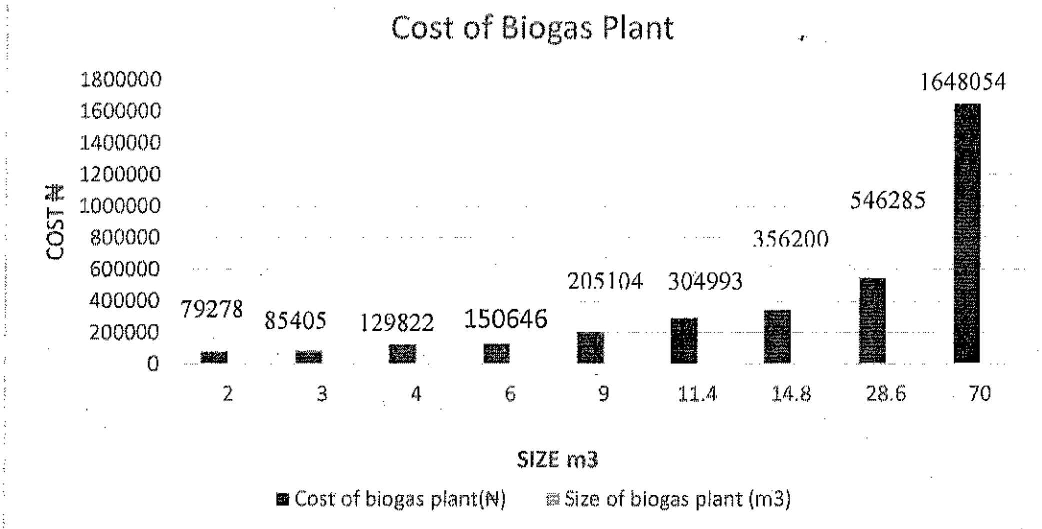


FIG 4.7: Cost of different sizes of Biogas plant.

Source: Compiled and translated by author, based on quote in BCAS, 2014,

The cost of the biogas plant depend on the size, the different poultry farms visited has different size estimate of biogas produce per day as calculated above. Hence the construction of biogas plant varies for each farm.

Table 4.11: Cost of biogas plant for the poultry farms

Name of poultry farm	**Estimated Biogas plant size**	**Cost of biogas plant(₦)**
Afebabalola poultry farm	$40m^3$	₦764,034.00
Gbobo farm	$8m^3$	₦200,861.00
Ado-poly poultry farm	$20m^3$	₦483,888.00
EKSU poultry farm	$32m^3$	₦753;405.00

Source: Compiled and translated by author based on BCSIR, 2008 as quoted in BCAS, 2014

The table 4.11 shows the cost of the biogas plant for the different poultry farms. The estimated plant size varies from the one calculated above because of the added $4m^3$ for each farm, which might be useful if any change arises in the number of bird raised in the farm.

2. **Operation and Maintenance (O & M) cost of bio gas plant**

Operation cost consists of Labour cost and cost of poultry litter and maintenance cost is considered as the cost of changing valves, gas pipe etc.

I. **Operation Cost:** The labour cost for charging the droppings into the biogas plant is considered zero in the analysis as the poultry farm would construct a drainage system around the poultry shed which is connected to the inlet chamber of biogas plant and the charge can flow into the inlet chamber due to gravity.

II. **Maintenance cost of biogas plant:** Maintenance cost of biogas plant is considered as the placement cost for valves, socket, gas pipe etc. It was considered that valves, gas pipe etc. has to be replaced every year due to leakage. For a 6 m3 biogas plant the cost is considered as **₦8,800** (Grameen Shakti, 2006, p. 27). For a larger size of biogas plant the replacement cost of valves, gas pipe etc. would not vary too much. Therefore the cost of maintenance for all the biogas plant that would be used in all the poultry farms is considered the same at **₦8,800.**

3. **Cost of biogas generator**

The sizes of the gas generator to be used for the different poultry farms vary depending on the load consumption of each farm. Information regarding the cost of the gas generator can be found below. Capital generator purchase and installation costs is considered at ₦195,000/KW

Table 4.12: Cost of Biogas Generators

Poultry Farm	**Required Size (kW)**	**Cost (₦)**
Afebabalola poultry farm	30	₦5,850,000.00
Ado-poly poultry farm	20	₦3,900,000.00
Gbobo poultry farm	5	₦975,000.00
Eksu poultry farm	20	₦3,900.000.00

Source: Compiled by author based on interview with Mr Mohammed Katee 20.08.2016 at Mikano international Limited.

I. **Maintenance cost of generator:** The annual maintenance cost generator was considered as 10% of its investment cost.

II. **Operation cost of generator:** The operation cost of generator was considered zero as biogas is free of cost for the generator.

4. **Cost H2S and moisture removal unit**: For each size of plant the cost would be different. For the simplicity, the cost for H2S and Moisture removal unit was

considered as per kW which is drawn from a GTZ flagship project at a rate of 1 kW plant the cost ₦7000.

Table 4.13: Cost for H2S and moisture removal unit for each farm.

Poultry farm	Size of plant(kW)	Cost of H2S (₦)
Afebabalola poultry farm	30	₦210,000
Ado-poly poultry farm	20	₦140,000
Gbobo poultry farm	5	₦35,000
Eksu poultry farm	20	₦140,000

5. **Maintenance/ operation cost of moisture removal unit:** Maintenance cost for moisture removal unit was also derived from GTZ flagship project. The cost is considered for 1 kW plant at ₦1500 per year.

Table 4.14: Maintenance/ operation cost of moisture removal unit for each farm per year.

Poultry farm	Size of plant(kW)	Cost of O&M for moisture removal unit (₦) per year
Afebabalola poultry farm	30	₦45,000
Ado-poly poultry farm	20	₦30,000
Gbobo poultry farm	5	₦7,500
Eksu poultry farm	20	₦30,000

6. **Cost of compressor for regeneration process:** Estimate for a 10 kW plant the cost of compressor was ₦25,300 .For other sizes of power plant it was considered proportionally. Similarly, the cost of a 30 kW plant compressor would be considered as the summation of three 10 kW plant compressor.

Table 4.15: Cost of Compressor for regeneration process for each poultry farm.

Poultry farm	Size of plant(kW)	Cost of Compressor for regeneration process (₦)
Afebabalola poultry farm	30	**₦75,900**
Ado-poly poultry farm	20	**₦50,600**
Gbobo poultry farm	5	**₦12,650**
Eksu poultry farm	20	**₦50,600**

4.5.3 OVERVIEW OF THE COST ANALYSIS RESULT FOR BIOGAS USE IN EACH OF THE POULTRY FARM.

On the basis of the different estimation made above, the different parameters considered were used to calculate for the cost of different sizes of biogas for electricity purpose in the poultry farms.

The following would be considered for analysing the cost of using biogas as a source of electricity.

I. **Capital cost of biogas systems:** The Capital cost of the biogas system include the overall cost which are cost of biogas plant, generator, H2S and Moisture removal unit, compressor for regeneration process.

II. **Cost of O&M of the systems:** The cost of poultry droppings is considered zero as the electricity will be generated in individual poultry farms from their own poultry droppings, maintenance cost is provided for the generator, biogas plant and H2S and moisture removal unit.

Below is the estimate made for each of the poultry farm considered in this study.

.Table 4.16: Biogas Cost consideration for each poultry farm

Poultry farm	Capital cost	Annual Maintenance Cost	Total Cost (Maintenance+Capital cost)
Afebabalola	₦6,899,934	₦638,800	₦7,538,734
Eksu	₦4,844,005	₦428,800	₦5,272,805
Gbobo	₦1,223,511	₦113,800	₦1,337,311
Ado-poly technic	₦4,574,488	₦428,800	₦5,003,288

4.6 COMPARISON OF THE EXISTING POWER SOURCES VS PROPOSED BIOMASS POWER

Table 4.17: Comparison of energy Source

	AFEBABALOLA POULTRY FARM			EKSU POULTRY FARM			ADOPOLY POULTRY FARM		
Technology Parameter	Grid	Biomass (Proposed) 30KW	Diesel Gen (Existing) 35KW	Grid	Biomass (Proposed) 20KW	Diesel Gen (Existing) 30KW	Grid	Biomass (Proposed) 20KW	Diesel Gen (Existing) 20KW
Reliability	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
Availability	20~25%	<95%	<80%	30~35%	<95%	<80%	30~35%	<95%	<80%
Capital cost (₦)	-	6,899,934	6,510,000		4,844,005	4,580,000		4,574,488	3,720,000
Annual Operation Cost (₦)	187,788	Nil	5,270,600	488,438	Nil	2,912,700	252,204	Nil	2,496,600
Annual Maintenance Cost (₦)	Nil	638,800	4,557,000	Nil	428,800	2,790,000	Nil	428,800	2,511,000

In the Comparison of the final result, Gbobo poultry farm was excluded reason because the farm does not have an electricity sources from the national grid.

4.7 RESULTS DISCUSSION

From the result in audit analysis chat above for the different poultry farms it was observed that the annual power consumption for Afebabalola, EKSU, Ado polytechnic and Gbobo are **11147.2kWh, 31645.5kWh, 19309kWh and 7730.7kWh per year** respectively.

Also, the economic viability of the existing power technology system was done carefully using Annual Cycle Cost analysis calculation of diesel generator set for 35KVA, 30KVA, 20KVA and 10KVA and National grid System. The cost of both nonrecurring (first cost) recurring costs that occur over the annual cycle of the system, with future sum converted to their present worth values. Table 4.17 shows that the capital cost of generator set for Afebabalola, EKSU, Ado polytechnic and Gbobo are ₦6,510,000, ₦4,580,000, ₦3,720,000 and ₦1, 860,000.00 respectively. Table 4.17 show that the cost of fuel for running generator set is ₦5, 270,600, ₦2, 912,700, ₦2, 496,600 and ₦416,100 respectively which is depend majorly on the hourly usage of the generator in the poultry farms . The price of fuel may even go higher in the scarcity and pilfering of product. The gaseous emission arising from the combustion of the fuel in the generator affects the environment adversely.

Estimate made for the proposed biomass power from poultry waste shows that the different poultry farms Afebabalola, EKSU, Ado polytechnic and Gbobo can generate biogas of about 36.7m^3, 28m^3, 14.2m^3 and 4.4 m^3 respectively for powering the different capacity of the biogas generator, the operation cost of the biogas generator is consider zero as the the biogas would be generated from the poultry dropping in the different farm. Biogas system would require maintenance, the maintenance cost which was also calculated for Afebabalola, EKSU, Ado polytechnic and Gbobo are ₦638,800, ₦428,800, ₦428,800 and ₦113,800 respectively.

Finally, of the three power source analysed, biomass was found to be more economically and environmentally feasible than diesel generator and more reliable and available than convectional grid power for BEDC for poultry farms in the Ekiti. A biomass system would reduce annual energy costs per year from the national grid if incorporated. This is direct cost saving from mitigated diesel and propane fuel consumption annually and also GHG emissions will be mitigated.

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5.1 CONCLUSIONS

Demand for electrical energy continues to grow each year and current power stations available in the country are unable to keep up with the demand, therefore causing load shedding, so there needs to be investigation in to new energy supplies. For the environment and the future, looking in to renewable energy sources to meet this demand is the best possible solution for the poultry farms. Renewable energies however have a high capital cost and many have fluctuations in the supply, Biomass energy as describe in this research is readily available can be integrated easily with the electricity from the national grid during the load shedding period. The four poultry farms have resource of biomass energy that can be harnessed from their poultry drooping and waste to provide energy during the load shedding period.

The study has revealed the cost estimate to produce electricity from poultry waste is quite expensive at the initial cost but has a lower cost over the years after installation, this show that there is greater payback period over the life cycle of the system of the three technologies analysed.

Also, the benefits of biogas electricity installations are numerous, ranging from green stewardship to reducing the poultry farm's carbon footprint, and from building a strong public image for the farms, to reducing the poultry farm's monthly electricity bills. The potential application of the biogas system is determined by a financial analysis alone. Based on current prices, a biogas generator system installed at the different poultry farms would have a greater year payback period, than the existing backup diesel generator system been utilized.

5.2 RECOMMENDATION

On the basis of findings and analysis of the study the following recommendation where made:

1. Installation of biogas plant in the poultry farms should be made mandatory to avoid the environmental hazards and should be integrated in the national policy document.
2. Awareness development program is required to build up the knowledge about the benefit of using renewable energy source as a source of electricity in poultry farms and the world at large.
3. Awareness development program is required to make the poultry farmers aware about the use of energy efficient appliances which can reduce the electricity consumption of the farm.
4. After installation of the system in poultry farms, the farmers should be properly trained for regular maintenance of the system otherwise it will incur additional cost to hire a technician.
5. Some enterprises can be established to serve the poultry farmer in case of necessity regarding the technology used for electricity production.
6. Further study is required for the dissemination of the technology at mass level.
7. Further study can be done to find out the potential of producing electricity from poultry waste through a centralized system to feed on to the grid.

REFERENCES

Anonymous (2008). Power sector reform overview. Federal Republic of Nigeria Bureau of Public Enterprises. Retrieved from http://www.bpeng.org/en/companies/power/background.htm Accessed 9/8/2016

Amelin, M. & Hersoug, E. (1997). Options for Rural Electrification in Developing Countries. A Case Study in Kasulu, Tanzania. *Diploma thesis, B-EES-9705*, Department of Electric Power Engineering, Royal Institute of Technology, Stockholm

Aydogan, O., Yildiz, H. & Sar, O. (2001) Wind Energy Utilization In A House In Izmir, Turkey. *International Journal Energy Resource*, Vol 25(1) 61-65.

Baigarin et al., (2001) Opportunities for Renewable Energy Sources in Central Asia Countries. The Potential of Wind Resources Available In Central Asia. *The Energy Journal* Vol 29(3) 131-151

Bates, B.D. et al, (2009). Solar Panel Feasibility Study at Wesley United Methodist Church, Worcester. *Qualifying Project Report*, Worcester Polytechnic Institute.Vol.1 (1), 1-126.

BCAS, (2005): Report on Feasibility Study on Biogas from Poultry Droppings. Bangladesh Centre for Advance Studies Vol. 27(6), 521-530.

Bhanu, D.U (2010). Analysing Biomass Energy Opportunities for a Small Scale Off-Grid Facility: A Case Study at Experimental Lakes Area (ELA) Ontario, *Renewable and Sustainable Energy Reviews,* Vol. 18(2), 205-221.

Blankinship, S.A (2002) Conversion Package Aims at Cleaning Up Stationary Diesel Gen-Sets; *Power Engineering Literature* Vol.1 (2) 106, 52.

Borenstien, S.O (2008). The Market Value and Cost of Solar Photovoltaic Electricity Production. Centre for the Study of Energy Markets (CSEM). University of California Energy Institute. WP 176.

Hamid, M.A (2001) A Comparative Analysis of Energy Costs of Photovoltaic, Solar Thermal, and Wind Electricity Generation Technologies. *Renewable energy Review*, Vol 15, 2322–2329

Hanley, N., & Nevin, C. (1999). Appraising renewable energy developments in remote communities: Advantages and disadvantages of power technology. *Energy Policy*, Vol 27(9), 527 547

Ibitoye, F.I. and Adenikinju, A. (2007), Future demand for electricity in Nigeria. *Applied Energy Journal*, Vol. 3(5) 492-504

Ikeme, J. (2005). Nigeria's electric power sector reform: what should form the key objectives. *Energy Policy* 33:1213-1221

Ismail, O.S., Ajide, O.O. and Akingbesote, F. (2012), Performance assessment of installed solar PV system: A case study of Oke-Agunla in Nigeria. Engineering, Vol 4(1), 453-458.

Islam, M., Fartaj, A., & Wale, D. S. (2004). Current utilization and future prospects of emerging renewable energy applications in Nigeria. *Renewable and Sustainable Energy Reviews,* Vol 8(6), 493-519.

Jill, O.M. (2006), Design and construction of a feasible 50kilowatt wind turbine power generating system. *A report submitted to the School of Urban and Regional Planning*, Queen's University, Kingston, Ontario.

Lee, A.F., Sims, R. E. H., Rogner, H., & Gregory, K (1994). Design and Implementation of Hybrid Air-Electricity Storage System for a PV System. *Energy, 25*(10), 1005-1020.

Martinot, .E and McDoom, O. (2000). Promoting energy efficiency and renewable energy: GEF climate change projects and impacts. Retrieved from http://66.102.1.104/scholar?hl=en&lr=&q=cache:7DAQ1yGYfeIJ:www.martinot.info/Martinot_McDoom_GEF.pdf+ Accessed 9/5/2016.

Mohanlal, K.A., et al. (2002) Economic viability of stand-alone solar photovoltaic system in comparison with diesel-powered system for India. *Energy Economics Reviews*, Vol 24(2) 155-165.

Onafeso, S.O. (2006), On energy for sustainable development in Nigeria. *Renewable and Sustainable Energy Reviews*, 16(5):2583-2598.

Rezaur, R. A. (2014). Feasibility analysis of wood-biomass energy generation for the off-grid community of Brochet in North-west Manitoba, Canada. CRC Press, Retrieved from http://www.nariphaltan.org/gasbook.pdf Accessed 20/6/2016.

Sambo et al., (2010), Energy efficiency survey in Nigeria: A guide for developing policy and legislation. *Community Research and Development Centre.* pp.3-37

Suresh et al. (2001). A model to investigate the optimum sitting of wind turbine generators. Alternative energy source. Energy Industries Research Institute of Canada. *Advantage report*, Vol 2(4) 83-102.

Sheikh, A.U (2007), The potential of electricity generation from Poultry Waste in Bangladesh. A Case Study of Gazipur District. *M.Sc. thesis*, SESAM, Institute of International Management, University of Flensburg, Germany (Unpublished).

APPENDICES

APPENDIX A: Questionnaire

FEDERAL UNIVERSITY OYE-EKITI, EKITI STATE.
Faculty of Engineering, Department of Mechanical Engineering

Survey *Questionnaire* on Poultry Farm Energy Consumption

Dear Respondent,

This document contains a list of questions relating to the energy consumption of the above poultry farm which would be required in carrying out a test analysis for determination of the use of a renewable energy in the farm.

Your sincere an accurate rating of the information in this questionnaire would be highly appreciated and any information given would be treated with absolute confidentiality and used only for research purposes.

Thanks

Signed

ALEX .E.OGBEBOR

GENERAL INFORMATION

Kindly provide the following information by completing the blank space.

Name of the poultry farm: ....

Address: ....

SET A: QUESTION ABOUT THE POULTRY FARM AND OFFICES

A-1 How many bird are currently being raised in your farm? ....

A-2 What type of bird raised ☐ 1Broiler ☐ 2Layer ☐3 Both

A-3 How many staff works on your farm? ________________

A-4 Is there an office in the vicinity? If there are how many ____________________

SET B: PRESENT ENERGY CONSUMPTION STATUS.

B-1 What is the name of your electricity provider?

☐ 1BEDC (Benin Electricity Distribution Company)

☐ 2IBDD (Ibadan Electricity Distribution Company)

☐ 3EEDC (Eko Electricity Distribution Company)

☐ 4Others (please specify) ________________

B-2 What was the average monthly cost for electricity over the past 12 months?______________

B- On an average scale, how many hours of energy do you receive from your electricity provider daily (hours/day)? Please specify________________

B-3 Do you have any back up system?
☐ 1Yes, go to question
☐ 2No, go to question

B-4 What type of backup system do you have?
☐ 1Diesel Generator
☐ 2Natural Gas Generator
☐ 3Biogas generator
☐ 4 Solar
☐ 5Wind
☐ 4Grid
☐ 5Others (Please specify) ____________________

B-5 What is the capacity of your back up systems? ____________________________

B-6 Do your farm make use of a fuel powered generator for power supply? (a) Yes (b) No
B-6i What is the average fuel consumption of the generator on a daily basis in litres per hour

____

B-6ii How many hours in a day do you use the generator
SET C: RENEWABLE ENERGY
C-1 Do you know what Renewable Energy Sources are?
☐ Yes
☐ No
☐ Not Sure
C-2 Which of the below renewable energy do prefer?
☐1 Solar
☐2 Biomass
☐3 Wind
☐4 Hydro
Are you interested to produce electricity from your renewable energy?
☐ 1Yes.
☐ 2No.
C-3 Why are you interested to produce electricity from your own poultry waste?

____

Please specify the reasons
C-4 What capacity of energy do you intend to generate from renewable energy in KW.

____

C-5 How much money are you willing to invest into renewable energy

____

APPENDIX B: AUDIT RESULT

AFE BABALOLA UNIVERSITY

S/N	ELECTRICAL EQUIPMENT/APPLIANCES	QTY	TOTAL POWER WATTS	AVERAGE USE HOUR PER DAY	TOTAL ENERGY PER YEAR KWH	TOTAL ENERGY PER MONTH KWH	TOTAL ENERGY PER DAY KWH
1	LIGHT(FLUORESCENT)	2	40	9	262.8	21.6	0.72
2	FAN	2	100	9	657	54	1.8
3	MIXER	1	1200	1	438	36	1.2
4	BULB(INCANDESCENT)	20	100	6	4380	360	12
5	BORE HOLE PUMP	1	1100	1	401.5	33	1.1
6	INCUBATOR	2	300	20	4599	378	12.6
7	SCRAPPER MOTOR	1	560	2	408.9	33.6	1.1
	TOTAL		**5740W** **5.74KW**		**11147.2**	**916.2**	**30.52**

EKSU POULTRY FARM.

S/N	ELECTRICAL EQUIPMENT/APPLI-ANCES	QTY	TOTAL POWER WATTS	AVERAGE USE HOUR PER DAY	TOTAL ENERGY PER YEAR KWH	TOTAL ENERGY PER MONTH(KWH	TOTAL ENERGY PER DAY KWH
1	LIGHT(FLUORESCENT)	3	40	9	394.2	32.4	1.1
2	FAN	4	70	9	919.8	75.6	2.52
3	MIXER	2	1200	1	876	72	2.4
4	BULB(INCANDESCENT)	26	100	9	8541	702	23.4
5	INCUBATOR	4	600	20	17520	1440	48
6	VENTILATOR	2	300	7	1533	126	4.2
7	GRINDER	1	250	1	91.25	7.5	0.25
8	REACTOR	1	350	1	127.75	10.5	0.35
9	REFRIGERATOR	1	500	9	1642.5	135	4.5
	TOTAL		**9500W** **9.5KW**		**31645.5**	**2601**	**86.72**

GBOGO FARMS

S/N	ELECTRICAL EQUIPMENT/APPLIANCES	QTY	TOTAL POWER WATTS	AVERAGE USE HOUR PER DAY	TOTAL ENERGY PER YEAR KWH	TOTAL ENERGY PER MONTH KWH	TOTAL ENERGY PER DAY KWH
1	LIGHT(FLUORESCENT)	5	30	12	1642.5	135	4.5
2	FAN	2	70	7	357.7	29.4	0.98
3	MIXER	1	800	2	584	48	1.6
4	BORE HOLE PUMP	2	1200	4	3504	288	9.6
5	GRINDER	2	1500	3	1642.5	135	4.5
	TOTAL		**6490W** **6.49KW**		**7730.7**	**635.4**	**21.15**

ADO POLYTECHNIC POULTRY FARM.

S/N	ELECTRICAL EQUIPMENT/APPLIANCES	QTY	TOTAL POWER (WATTS)	AVERAGE USE HOUR PER DAY	TOTAL ENERGY PER YEAR(KWH)	TOTAL ENERGY PER MONTH(KWH)	TOTAL ENERGY PER DAY(KWH)
1	LIGHT(FLUORESCENT)	3	30	8	262.8	21.6	0.72
2	FAN	3	120	8	1051.2	86.4	2.88
3	MIXER	1	1350	2	985.5	81	2.7
4	BULB(INCANDESCENT)	15	100	9	4927.5	405	13.5
5	BORE HOLE PUMP	1	1500	2	1059	90	3
6	INCUBATOR	3	500	19	10402.5	855	28.5
7	WATER HEATER	1	700	1	255.5	21	0.7
8	VENTILATION FAN	2	250	2	365	30	1
	TOTAL		**7500W** **7.5KW**		**19309**	**1590**	**53**