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# Determination of the Cost of Production from the Raw Dung to the Final Output of Biogas.

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**ABSTRACT**
*This research work is on the determination of the cost of production from the raw dung to the final output of biogas. The main objective of this work is to obtain the amount that will be spent for the production of the biogas. The materials used include the following: digester tank, raw cow dung, outlet valve, inlet valve, pressure gauge, thermometer, bolts and nuts, burner, hose and water. The procedure exploited in the production of biogas cow dung is through anaerobic digestion. The result obtained showed that about thirty thousand Naira was spent to produce one hundred and fifty (150) litres of biogas. In order words, a litre costs six Naira. In conclusion, private sectors should embrace the production of biogas from cow dung as an alternative energy for domestic cooking because it is cheaper than any other energy usually used for cooking and doing some other things. Also, the raw material that is cow dung is readily available in some places.*

***KEY WORDS:*** *Biogas, cow dung, anaerobic digestion, Alternative energy, and Biomass.*

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## I. INTRODUCTION

### 1 Background of the Research.

Production of biogas through anaerobic digestion of organic materials provides a versatile carrier of renewable energy. Biogas can be used in replacement of fossil fuels in generation of heat and power, thus contributing to cutting down emissions of greenhouse gasses and slowing down climate change. Biogas is a flammable gas produced by microbes when organic materials are formulated in certain range of temperature, moisture content, acidified and under air tight condition (Potivichayanon et al., 2011). The gas has wide range of applications including its use for lighting, driving automobiles, powering farm machinery, heating and cooking (Eze, 2010). Anaerobic bio-digestion is a process through which organic materials are decomposed by bacteria in the absence of air to produce biogas (Adelekan and Bamigboye, 2009). The most important reason for the choice of anaerobic digestion as a treatment method are the feasibility to treat waste with a high organic load (Saev *et al.,* 2009; Kara *et al,. 2009 and Karellas* eta al., 2010). The aerobic treatment of such waste require biological purification system with high construction and operational costs (energy consumption), besides which stabilization of the biological reactions is not assured (activated-sludge tanks), or the waste(s) causes clogging of installations such as aerobic biological filters and biodiscs. The organic substance such as food wastes, oil, or fat, animal manure, chicken swine or cow manure can be digested and used to produce useful energy for the world (Potivichayanon *et al.,* 2011*;* Widodo and Hendriadi, 2005)

The country's economy mainly depends on the energy resources available and utilized energy has been exploited since the prehistoric times. With the advent of industrial revolution, use of fossil fuels began growing and increasing till date. The dependence on revolution, use of fossils fuel as primary energy source has led to global climate change, environmental degradation and human health problems. With increasing prices of oil and gas the world looks towards alternative and green energy resources. In 21 sub-Saharan African countries, less than 10% of the populations have access to electricity (Mshandete and Parawira, 2008). The need for alternative renewable energy sources from locally available resources cannot be over-emphasized. This need has forced the search for other alternative sources of energy. But unfortunately the new alternative energy sources like solar, hydro and wind require huge financial outlay and technical power to operate, which seem to be very difficult for the developing countries like Nigeria. In the present moment, biogas energy can be the reliable, easily available sources and economically source of alternative and renewable energy. This is due to its locally available sources and its simple technology for rural villages.

## II. LITERATURE SURVEY

**Biogas Composition**

The composition of biogas varies depending upon the origin of the anaerobic digestion process. Landfill gas typically has methane concentration around 50%. Advanced waste treatment technologies can produce biogas with 55-75% methane, which for reactors with free liquids can be increased to 80-90% methane using in-situ gas purification techniques [www.adelaide.edu.au/biogas] As-produced, biogas also contains water vapor. The fractional volume for water vapor is a function of biogas temperature; correction of measured gas volume for both water content and thermal expansion is easily done via a simple mathematic algorithm [www.kolumbus.fi] which yields the standardized volume of dry biogas.

In some cases, biogas contains siloxanes. These siloxanes are formed from the anaerobic decomposition of materials commonly found in soaps and detergents. During combustion of biogas containing siloxanes, silicon is released and can combine with free oxygen or various other elements in the combustion gas. Deposits are formed containing mostly silica ($SiO_2$) or silicates ($Si_xO_y$) and can also contains calcium, sulfur, zinc, phosphorus. Such white mineral deposits accumulate to a surface thickness of several millimeters and must be removed by chemical or mechanical means. Practical and cost-effective technologies to removed siloxanes and other biogas contaminants are currently available.

**Biogas Utilization**

Biogas can be used for variable energy services; the question is which the best use for biogas is? Traditionally, biogas has been used as fuel for boilers but generally the best usage depends on several factors such as amounts of biogas produced, energy cost, energy demand of the plant and incentives. Normally in the biogas plants, during the digestion process, more gas is generated than need in order to support the process. This excess biogas is a potential to use for other functions.

**(i) Biogas for Health:** Utilization of heat produced from the biogas has a direct effect on the economy of a biogas plant. The gas burns with a clean, clear flame. No soot and slag are present in boilers and other equipment, and the plant last longer. The heat could be used for: heating swimming pools, industrial plants and greenhouses, warmth transformation in cold, treatment of products, cleaning and disinfection of the milking equipment and heating stables as for the breeding of young animals.

**(ii) Biogas for Electricity Generation:** Power generation is the most common use of biogas. This electricity can be used for operation of plant, for sale or credit for the local power utility. Electricity generation with biogas can be produced from engine generators, tribune generators, micro tribunes and fuels cells (Khanal, 2008)

**(iii) Biogas as Vehicle Fuel:** Petroleum fuels will gradually become extinct and these will have to be replaced by sustainable fuels. Replacement of petroleum fuels with bio fuels has been addressed by the European Commission in the directive 2003/30/EG where the following targets were set: 2% bio-fuels by the end of 2005 and 5.75% bio-fuels by the end of 2010.

Biogas must be transformed to natural gas quality for use in vehicle. This process requires the removal of particulates, acrbondioxide, hydrogen sulfide, moisture and other contaminants (Khanal, 2008). When biogas is used as vehicle fuel, it gives the lowest emissions of carbon dioxide and particles of all the fuels currently on the market (http://www.energymap.dk).

**(iv) Biogas for Cooking:** The biogas produced from anaerobic digestion of waste stream can be used through conventional low pressure gas burners for cooking (Eze, 2010). The advantages of biogas over wood as cooking fuel: Less labour than tree felling, trees can be retained, biogas is a quick, easily controlled fuel, no smoke or smell (unless there is a leak) so reduced eye/respiratory irritation, clean pots and sludge is a better fertilizer than manure or synthetic fertilizer (and is cheaper than manufactured products) also reduced pathogen transmission compared to untreated waste.

**Biogas Digester**

A biogas is a structure designed to create anaerobic conditions for the decomposition of organic substrates and to safely store the resulting biogas produced in some way. The specific microbes (methanogenes) that are responsible for the creation of biogas, can only do so in the absence of oxygen, hence the anaerobic conditions. Preferably the design should allow for the biogas to be stored under pressure, making the application of the biogas so much easier

**Suitable Locations for Installation of Biogas Digester:** Hotel premises, army/big establishment canteens (private / government), residential schools/colleges, housing colonies, religious places / temple trust, hotels, sewage treatment plants villages etc.

**Storage of Biogas**

Methane can only be liquefied at temperatures lower than -82.5$^{o}$C (critical point), therefore, the suitable form for storing methane or biogas is in a gas from that needs large space. A biogas plant generally includes a gas storage system for balancing out the fluctuations in gas production, quality and consumption. For economical, reasons, the volume of the gas holders is usually limited to daily production of biogas.

The gas storage device can be classified according to their running pressure. In low pressure gas holders, the gas is kept below the maximum of 50 mbar. A common example for low pressure gas holder is a gas bag and digester head space with foil the gas storage devices can be classified according to their running pressure. Their volume capacity ranges between 1 and 1000 $m^3$ (Edelman, 2001). High pressure gas holders (separate gas cylinder or tanks) are usually used when biogas has to be compressed and used as fuel. In 30 to 50 liter cylinders biogas can be compressed to a pressure of 200 to 300 bar (Edelman, 2001). Moreover, a drastic purification of the biogas is necessary to avoid the corrosive action. A floating digester cover can also be used for gas storage as well as for collection. This is simply a pontoon cover which floats on the liquid surface and has skirt plates extending down into the liquid to provide a seal. The weight of the floating cover provides a pressure head and allows the gas to be withdrawn as it is needed membrane.

## III. METHODOLOGY

**Experimental Procedure**

The following s taken steps were carried out for the production of biogas cow dung.

i. 18kg of the substrate (cow dung) was weighed and then mixed thoroughly with about 36kg of water for optimum gas production.
ii. This mixture was then poured to the digester which is ¾ volume of the digester.
iii. The digester was subjected to periodic shaking to ensure intimate contact between the micro organism and substrate, in order to enhance complete digestion of the substrate.
iv. The pressure and temperature of the biogas yielded were measured on a daily basis, using pressure gauge and thermometer respectively.
v. The volume of the biogas yielded was determined on a daily basis, using the values of the pressure and temperature reading respectively.
vi. The experiment was monitored for about 7 weeks.
vii. During this period, daily ambient temperature was measured
viii. During this period also, combustion time for the reaction was observed.

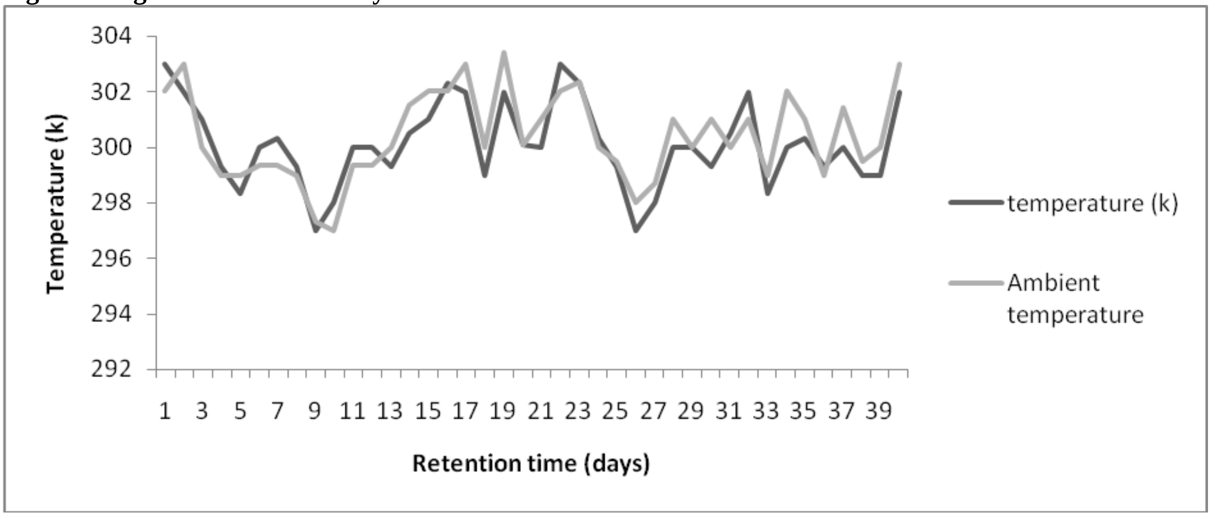
**Plate 4.5 Testing of biogas**

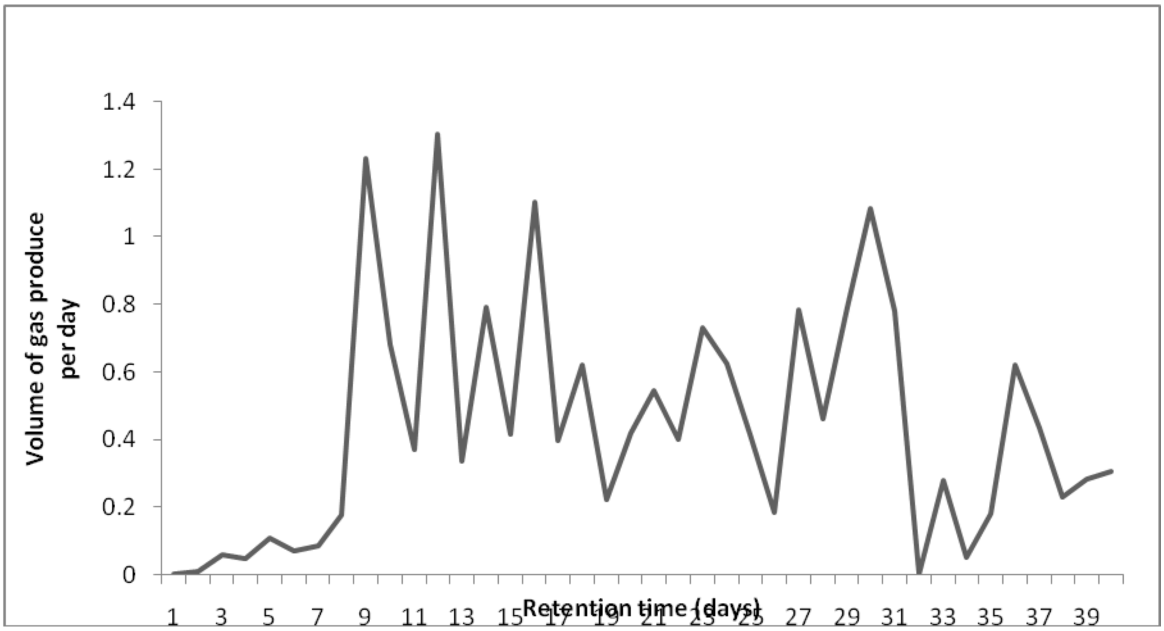
Source: Fieldwork, 2013

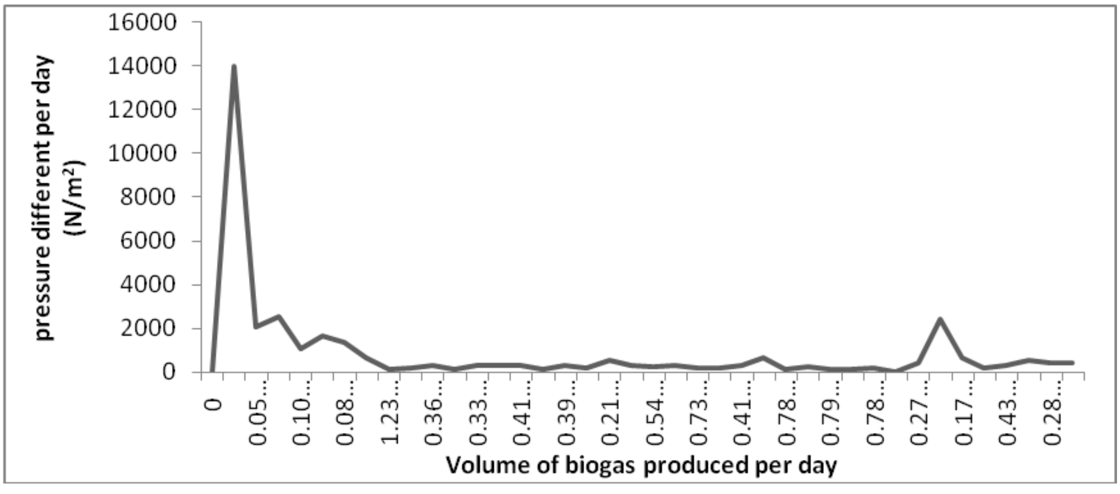
**4.1.10 Precautions taken during the Experiment**

(i) A proper sealing of the digesters were ensured, in order to avoid leakage of slurry and gas.
(ii) The digesters were positioned properly and rigid, in order to withstand the load.
(iii) The amount of water added to the substrate was appropriate, so that the slurry will not be too diluted.
(iv) The digester outlet value was closed before loading. Indigestible materials that can impede the generation of biogas were removed while loading the digester.
(v) After loading, the inlet value was tightly sealed to avoid air into the digester.
(vi) Before testing for combustion of the gas, any inflammable materials or objects was removed from the surrounding.
(vii) The pressure gauge and thermometer were tightly fixed on the digester to avoid any leakage.
(viii) To prevent any health hazard due to the offensive odour of the substrates, nose muff was used to protect our nose while loading the digester.
(ix) Restriction notice was pasted at the location of the digesters, to prevent any damages.

**Fig 4.4: Biogas Produced Per Day**



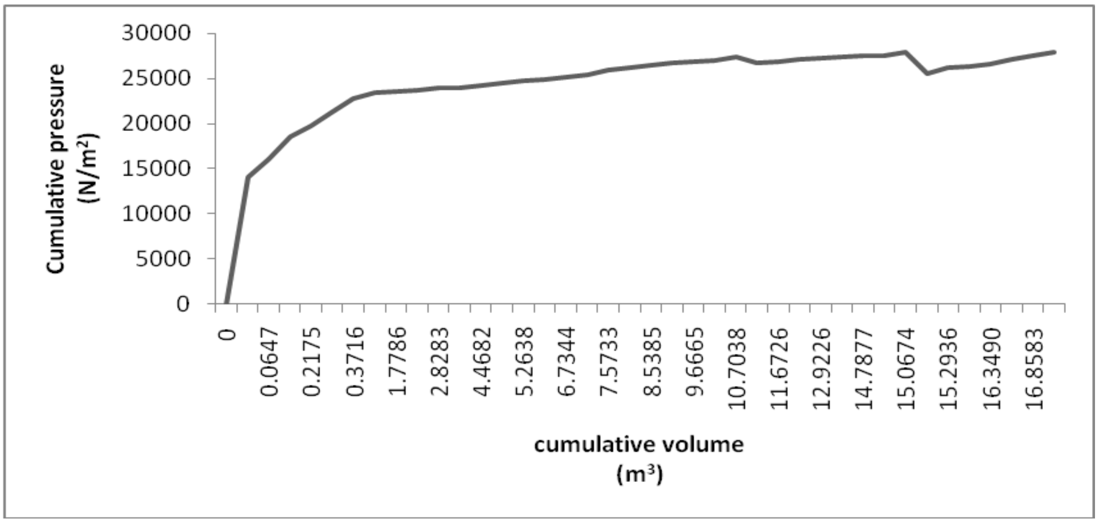



**Table 4.2: Cost Estimation of Biogas Production**

| S/N | COMPONENTS | MATERIAL | QUANTITY/ UNIT | COST/UNIT IN NAIRA | TOTAL UNIT IN NAIRA |
|---|---|---|---|---|---|
| 1. | Digester Tank | Mild steel | 2 | 2,000 | 4,000 |
| 2. | Outlet Valve | Standard | 2 | 1,500 | 3,000 |
| 3. | Inlet valve | Standard | 2 | 3,000 | 6,000 |
| 4. | Pressure gauge | Standard | 2 | 2,000 | 4,000 |
| 5. | Thermometer | Standard | 3 | 1,000 | 3,000 |
| 6. | Outlet pipe | Mild steel | 1 | 500 | 500 |
| 7. | Bolt and Nut | Standard | 4 | 200 | 200 |
| 8. | Burner | Standard | 2 | 1500 | 3000 |
| 9. | Hose | Standard | 2 | 200 | 400 |
| 10. | Field collection of cow dung | Workmanship | 1 | 500 | 500 |
| 11. | Mixing of dung (slurry) with water | Workmanship | 1 | 500 | 500 |
| | **Sub Total** | | | | **25,100** |
| | **Contingency** | **5% of sub total** | | | **1,255** |
| | **Total** | | | | **26,355** |

Source: Author's Fieldwork, 2013.

## IV. ESTIMATION OF AN AVERAGE HOUSEHOLD CONSUMPTION OF BIOGAS.

In estimate for an average household consumption of biogas, various steps were taken into consideration as highlighted below; that is the number of time an household cooks per day, others means of cooking, availability of cooking materials, effect of cooking materials on monthly income. And estimation of volume of biogas consumed by an average household.

### 4.5.1 Number of Time the Respondents Cook Per Day

The numbers of time the respondents from the focus group discussed cook per day are highlighted in table 4.9 below. The respondents that cooked once for maximum number of 2 people per day, while twice is maximum number of 3 people, twice is maximum number of 5 people and more than twice is maximum number of 4 people. The interview revealed that majority of the people from the focus group discussion cooked thrice per day. This may be as a result of their nature of work which is farming and petty trader (selling cheese and fresh milk from cow). One woman who was interviewed said "*I need to wake up early and cook for my husband before going out for grazing and for my children after school in the afternoon and for the entire family at night; this is why I must cook thrice per day*". Another said "*women duty is to cook for the family only a bad woman will refuse to cook everyday*". Somebody said "*I love cooking especially with cow milk every day and my husband love women who cook for him and his children as many time he wanted*".

**Table 4.9: Number of Time the Respondent cook per day.**

| Number of time the respondent cook per day | Minimum | Maximum | Mean |
|---|---|---|---|
| Once | 1 | 2 | 1.17 |
| Twice | 1 | 3 | 2.33 |
| Thrice | 2 | 5 | 3.83 |
| Above thrice | 1 | 4 | 1.92 |

Source: fieldwork 2013.

### 4.5.2 Availability of Cooking Resources Every time

Table 4.10 probed into knowing the availability of cooking resources every time, according to information gathered from 72.5 percent of respondents, cooking resources are available every time while on the contrary, 25.5 percent of respondents said cooking resources are not always available.

**Effect of Cooking Materials on Monthly Income**

The table 4.12 shows how to obtain the cooking materials affect the monthly income of the respondents' in the focus group discussion. That is, maximum number of 5 people were affected very high, while maximum number of 5 were low, while maximum number of 5 were very low and maximum number of 5 were not affected. This result showed that they are averagely affected, 5 numbers of people were very highly, highly, low and none affected. This shows that they are equally affected; this may be as a result of the location of the kraal, they were very close to the bush.

**Table 4.12: Effect of Cooking Materials on Monthly Income**

| Availability of cooking materials | Minimum | Maximum | Mean |
|---|---|---|---|
| Very High | 1 | 5 | 3.25 |
| High | 1 | 5 | 2.83 |
| Low | 1 | 5 | 1.92 |
| Very Low | 1 | 5 | 1.75 |
| Not at all | 1 | 5 | 1.30 |

**Source: Fieldwork, 2013.**

**COST OF BIOGAS PRODUCTION**

The table shows the cost of production of biogas from cow dung

**Table 4.15 Cost estimation of Biogas Production**

| S/N | COMPONENTS | MATERIAL | QUANTITY/ UNIT | COST/UNIT IN NAIRA | TOTAL UNIT IN NAIRA |
|---|---|---|---|---|---|
| 1. | Digester Tank | Mild steel | 2 | 2,000 | 4,000 |
| 2. | Outlet Valve | Standard | 2 | 1,500 | 3,000 |
| 3. | Inlet valve | Standard | 2 | 3,000 | 6,000 |
| 4. | Pressure gauge | Standard | 2 | 2,000 | 4,000 |
| 5. | Thermometer | Standard | 3 | 1,000 | 3,000 |
| 6. | Outlet pipe | Mild steel | 1 | 500 | 500 |
| 7. | Bolt and Nut | Standard | 4 | 200 | 200 |
| 8. | Burner | Standard | 2 | 1500 | 3000 |
| 9. | Hose | Standard | 2 | 200 | 400 |
| 10. | Field collection of cow dung | Workmanship | 1 | 500 | 500 |
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| | **Sub Total** | | | | **25,100** |
| | **Contingency** | **5% of sub total** | | | **1,255** |
| | **Total** | | | | **26,355** |

Source: Author's Fieldwork, 2013.

## V. FINANCIAL IMPLICATION OF COMMERCIALIZING BIOGAS PRODUCTION.

The capital needed for commercializing biogas production is relatively cheaper compare to other means of cooking, but the problem is the awareness of people about biogas. Government and NGO should come in place by empowering people, produce the digester and all material needed and train up people on production of biogas from cow dung. Training could be organized with available capital in form of loan to individual who show interest in commercializing biogas. This can serve as poverty alleviation and employment opportunity for many people. During the FGD, somebody sad *"how I wish our government could embrace something like this and empower people to commercialize biogas production"*. Another said *"if I can give money, I will my son and tell him to go and learn more about biogas production and start selling it to people, he will become a rich man"*.

The findings shows that, majority of the people support biogas production (90.2%) while few people (5.9%) do not support biogas production as an alternative source of energy for domestic cooking. Majority of the people in the study area embrace the production and utilization of biogas, they grab it as an employment opportunity, poverty alleviation and waste reduction and some see as conversion of waste to wealth, also, it will promote neat, clean and healthy environment.

## VI. CONCLUSION

The result of this research on the potentialities of production of biogas from cow dung, shown that flammable biogas can be produced from this waste through anaerobic digestion for biogas can be used as a source of fuel if managed properly. The study revealed further that cow dung as animal waste has great potentials for generation of biogas and its use should be encouraged as an alternative cooking resource. Also in this study, it has been found that cow dung might be one of feedstock for efficient biogas production and waste treatment and depletion of forest wood as fuel wood which is against the principles of forest conservation and sustainable ecology will be reduced.

Local GHG emissions will be reduced (by sustainable treatment of bio-waste by reduced reliance on energy intensive inorganic fertilizers, and by displacement of fossils fuels for cooking). Benefits will be realized to industry to taxpayers and to the nation as a whole when top-level decision maker get the message and put in place incentives that will enable local authorities and other stakeholders to make the significant capital investment that will be required and give a wider publicity on production of biogas from animal waste (cow dung).

This study revealed that biogas is not significantly embraced as an alternative cooking resource among the people in the study area because of their lack of knowledge about it and their level of illiteracy. Majority of the people have no knowledge about biogas but after various interactions discussion, teaching and interview developed their interest in biogas production and enlighten them and making them to support production of biogas as an alternative means of cooking. The result obtained showed that about thirty thousand Naira was spent to produce one hundred and fifty (150) litres of biogas. In order words, a litre costs six Naira. In conclusion, private sectors should be encouraged to embrace the production of biogas from cow dung as an alternative energy for domestic cooking because it is cheaper than any other energy usually used for cooking.

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