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Importance of Biogas Utilization as Alternative Source in an Energy Deficit Economy

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Abstract: *Statistics has shown that the use of biogas for power generation will be the next biggest deal in the entire world. Various countries have started designing various biogas plants to generate the needed methane gas. Families in Africa have started to feel energy shortages, traditional fuels such as wood biomass and coal are harder to obtain and the fuel far expensive. The federal government of Nigeria through the ministry of environment intends to install more biogas plant in different part of the country. Since statistic has shown that the number of cows in Nigeria and the amount of dung generated will equate enough amounts to generate the needed energy to power the country's household and facilities. justification for the need for biodigester will be mentioned and potential in Nigeria not forgetting the steps other African countries have taken and the need for Nigeria to key into this projects. Knowing fully well that the cattle and material needed for the generation of biogas are fully available in Nigeria and the huge gains that Nigeria stands to benefit if we get fully involved in production of biodigester. Comparison of dung and crude oil with respect to their present cost availability and production variables to justify the need for the use of cow dung. To confirm if cow dung has the necessary microbes to generate the said biogas, microbial analysis of dung collected from our local cows will be done to confirm that biogas can be generated hence the use of the said dung. It has been revealed statistically that the use of biogas will be more beneficiary in terms of better economic usage both in power generation and environmental friendliness.*

Keywords— Importance of Biogas; Alternative Source of Energy; Biogas Utilization; Deficit Economy

1. INTRODUCTION

Biogas has succeeded in meeting the energy needs in several countries in the world including Africa. In China over 7.5 million people have benefitted in the rise of biogas while over 3million has also benefitted in India. In Nepal, in spite of their size over 3700 biogas digester have been installed from 1992 to 1998 (1). Most recently developing countries have been making use of gas generated from landfilled waste and other agricultural and animal for firing of boilers or fuel CHP (Combined Heat and Power) plant. The gas generated can be used to generate vehicle grade fuel, provided the traces and CO2 are eliminated.

Belgium has designed a bio-plant that can handle 58,000 tons of waste every year, while a plant in Germany can equally process about 36,000 ton of waste every year generating the range of 3,000,000cm3 of gas and about 15,000 tons of composite (1).

Back in Africa, good progress in design and installation of biogas plant has been held back because of lack of infrastructures in many African countries, though many has joined the in the use of bio plant in their textile development company. The plant was designed suing the Chinese model and over 60 (sixty) of such plant are still functioning till date (2).

The huge amount of money spent in developing oil facilities and getting them to start production can be used to install several biogas plants and their energy production will be found to be more profitable if compared in terms of funds.

Back in Nigeria, the NABDA has mandated among other things to develop conservation strategies to route sustainable utilization of the country's huge biological resources and to facilitate the speedy evaluation and utilization of the process and product of biotechnology while ensuring environmental stewardship. In spite of the low knowledge of biogas in Nigeria, some recognition has started developing in Ibadan, a local NGO and a community based organization has joined with technology innovators from Thailand with sustainable project tagged (UN – HABTIAT Program) to install a biogas plant that will collect all the abattoir meat and generate power with it using the biogas plant. This will help in managing the pollution attributed to the abattoir and so mitigate greenhouse gas emission, the plant is estimated to have a production of life 15 years with initial investment of 3 years (3).

Biogas introduction has gain lots of acceptance even in the advance countries. The production of biofuel to replace oil and natural gas in active development, the US department of energy efficiency and renewal energy, has stated that biofuel currently provides for approximately 15% of energy consumption worldwide mainly developing countries, biogas is odorless and burns with a clear blue flame without giving out smoke, its flame temperature is up 800^{o}C and it has a calorific value of 565Keel per cubic meter (2)

It is estimated that the construction of biogas plant can also generate lots of employment if seriously implemented. Statistics have shown that millions of workers have been engage in the construction and process of biogas usage in India. Most of these jobs notable, the clearing and dung cake making jobs are not decent but they are mostly informal and the working conditions are hazardous. Some of these jobs are part-time jobs combining diary activities with dung collection and farm cleaning. However, with the right policies these jobs can be transformed into green jobs.

In addition, more green jobs could be created by promoting the productive use of the currently underutilized dung should the collected dung be increased. It has been estimated that commercial available dung increase from 880 tons in 2007 to 1million tons in 2012 alone with a conservative estimated 2 percent annual growth of the dairy industry. Accordingly for 2012 it is assumed that 200 million diary animal produce dung of 1million tons per day for commercial use. The power generation potential is thus estimated at 5000MW. Assuming this potential being 1-1.2MW plants which supports around 70 jobs in operation, 350,000 jobs could be created, adding 120 jobs needed for turning the slurry into compost, the total job creation is estimated at 470,000 (4)

India whose statistics is discussed above have almost same amount of cattle as Nigeria, so one can imagine the number of jobs that will be created in Nigeria if the above statistics is applicable to Nigeria. Employment can be further created from non-commercial dung through small biogas construction and maintenance. It is estimated that 30man/days are needed to build a $2m^3$ plant and 5man/days required for proper maintenance. Assuming a total of 1million plant is plan to be built in the 36states of Nigeria evenly distributed constructed per year over the next 10years, 140,000 full time permanent jobs can be created in construction and maintenance. This would necessitate a massive and ambitious step up target in the current 11th and following 12th five year plan. It requires increasing the target number for small biogas plant to 5million plants for the next five years and an additional five million plants in the consecutive years totaling 10million plant in 2022.

The exact number of plants installed in Africa is unknown but most plants were installed in Tanzania and Kenya. In other African countries only a few up to hundreds biogas plants have been installed (5). However, most of biogas plants installed in the African continent are small-scale plants, and the development of large-scale AD technology in Africa is still embryonic. Unfortunately, it is estimated that 60% of plants installed in Africa failed to stay in operation, although other plants show the success in providing benefits to the users over a number of years and the evidence on the reliability of the technology if properly operated (5). In most cases, in order to promote the biogas technology some demonstration projects were introduced usually free of cost by governmental structures. It is assumed that the demonstrated benefits of running the biogas plants would stimulate people to adopt this technology automatically. However, it seems that this approach has not caused widespread promotion and the market of biogas technology failed to develop. Moreover, most of the installed plants are abandoned eventually. Generally speaking, the government expects to disseminate the biogas technology over Africa based on a market-oriented approach, but it has not achieved to date. An only exception may be Tanzania, where most of the plants have been installed on a semi-commercial basis, but a large-scale dissemination is still not achieved (5).

WHY WE THE NEED FOR BIOGAS PLANT.

The challenge at the present day is that even though new source of energy such as solar hydro, wind and other form technology has emerge their economical investment and technical power to operate, which seems to be very difficult for the developing countries like Nigeria. In the present moment biogas energy can be one and only reliable, easily available and economically flexible source of alternative and renewal source which can be managed by locally available source and simple technology for rural villages.

A biogas plant when installed successfully is an appropriate and sustainable method to deal with human or animal waste where biogas and slurry is generated.

The use of biogas for cooking and power generation reduces the strain on the environment by decreasing production of greenhouse gasses.

Biogas system are highly friendly to the environment and hence the need for its use. Process of biogas uses all form of waste to generate power thereby eradicating the process of transportation of various form of waste to borrow pits., which most times percolate into soil and subsequently contaminating the ground water if not properly address.

The global energy demand is increasing rapidly, and about 88% of this demand relies upon fossil fuels to date (6). The energy demand will continue to grow during this century. However, GHGs emissions have become one of the most severe environmental problems. Use of fossil fuels is one of the main reasons for these emissions. According to the report of Intergovernmental Panel on Climate Change (IPCC), GHG emissions must be reduced to less than half of global emission levels of 1990 in order to minimize climate change impacts and global warming. Besides, the energy supply is another important global challenge, because some continents such as Africa are already faced with an energy crisis but most of the known conventional oil and gas resources are concentrated in politically unstable regions. Today, there is a lot of research focusing on renewable energy resources. The development of renewable energy technology can help to reduce the dependence on the non-renewable resources and the problems of environmental degradation related to fossil fuels (7). Biogas which is a renewable energy resource from wastes, residues, and energy crops will play an important role in future. The production of biogas from anaerobic digesters has significant advantages compared with other forms of bio-energy production. Firstly, biogas production

has been considered as one of the most energy-efficient and environmentally beneficial ways to produce renewable energy. Secondly, it can use locally available and cheap resources to produce biogas, and it drastically reduces GHGs emissions compared to fossil fuels. Thirdly, the digestate associated with the biogas production is considered as an improved fertilizer that could partly substitute for mineral fertilizers. The factors contribute to this increase include the growth in population, energy demands from various domestic sectors and the demand for improving quality of life. In order to meet the Millennium Development Goals (MDGs), especially MDG1—reducing by half the percentage of people living in poverty by 2025, it is required to improve the quality and magnitude of energy services in developing countries (7). In eastern and southern Africa it is estimated that energy use significantly relies on traditional biomass energy technologies but hardly takes modern, sustainable energy technologies. Due to the current economic situation in most African countries and the shortage of commercial modern energy, it is almost unlikely that the fossil fuels substitute for biomass (7). The fossil energy resources distribute on the African continent unevenly, which leads 70% of countries in Africa rely on imported energy resources. The problems of traditional biomass fuels and non-sustainable fossil fuels have caused widespread research on the production and application of new and renewable energy resources, such as biogas, bio-fuels, and biodiesel. It is necessary to develop the renewable energy technologies, in particular biogas technology, because it helps to reduce the dependence on non-sustainable resources and the environmental degradation problems caused by the fossil fuel. Compared with other renewable energy production systems such as biodiesel and bio-ethanol, biogas production systems are not complicated and can be built and operated at both small and large scales in urban and rural areas. Moreover, the biogas technology does not compete with food production but biodiesel and bio-ethanol technologies do (7). According to global experience, biogas technology is a relatively simple technology in term of the requirements of construction and management. It has been considered as an appropriate, adaptable and locally acceptable technology in Africa (7). Various international organizations and foreign aid agencies have made a lot of efforts through their publications, meetings and visits to promote the biogas technology and stimulate the interest of biogas technology in Africa. To date, some digesters have been constructed in several sub-Saharan countries. Various wastes are used as feedstock for biogas production, such as wastes from slaughterhouses, agricultural wastes, industrial wastes, animal dung and human excreta.

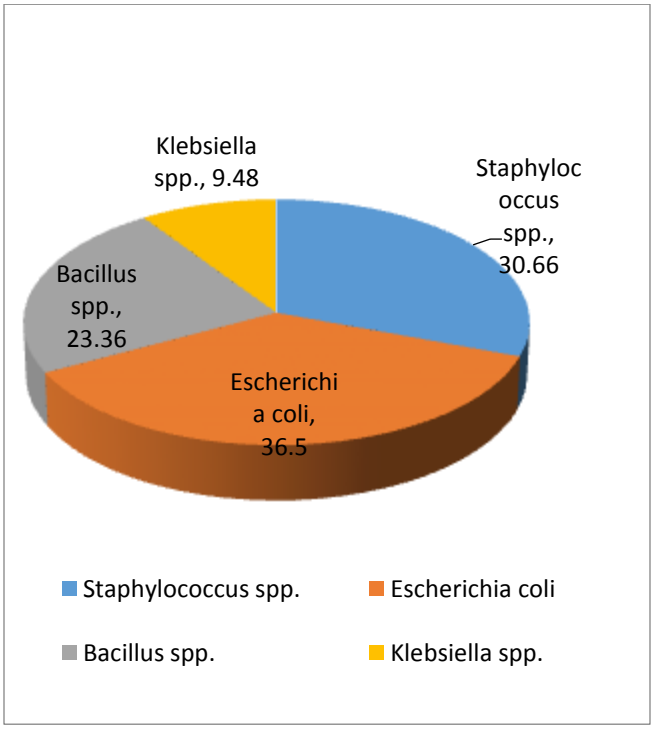
Table 1: Average Composite of Biogas

Composition	Percentage
Methane (CH_4)	50-70
Carbon dioxide (CO_2)	30-40
Hydrogen (H_2)	5-10
Nitrogen (N)	1-2
Water vapour (H_20)	0.3
Hydrogen sulphide (H_2S)	Traces

Table 2: Percentage Methane Content of Biogas from Different Feed Material

Feed materials	Methane component
Cattle manure	65
Poultry manure	60
Pig manure	52
Farm yard manure	55
Straw	59
Grass	70
Leaves	58
Kitchen waste	50
Algae	63
Water hyacinth	67

2.0 JUSTIFICATION FOR THE USE OF COW DUNG FOR BIOGAS GENERATION



Percentage of occurrences of the bacterial isolate in the cow dung

Table 3: Microbial Count analysis of cow dung with dilution factor

S/N	Parameter	Unit	Dilution Factor	Plate 1	Plate 2	Average	Cfu/g
1	THBC	Cfu /g	10^4	14	16	15	$1.5x 10^6$
2	THFC	Cfu	10^2	4	6	3	3x10

		/g					^{3}
3	Total coliform count	Cfu /g	10^2	20	16	18	1.8x 10^4
4	Total staphylococci count	Cfu /g	10^2	30	26	28	2.8x 10^4
5	Total vibrio sp count	Cfu /g	10^2	00	00	00	0
6	Shigella and Salmonella counts	Cfu /g	10^2	00	00	00	0
7	Total pseudomonas count	Cfu /g	10^2	00	00	00	0

Key THBC = Total heterotrophic bacterial count, THFC = Total heterotrophic Fungal count

Table 4: Microbial Count analysis of cow dung without dilution factor

SN	Parameter	Counts (Cfu/g)	Count (Log_{10}cfu/g)
1	THBC	$1.5x10^6$	6.17
2	THFC	$3x10^3$	3.47
3	Total coliform count	$1.8x10^4$	4.25
4	Total staphylococci count	$2.8x10^4$	4.45
5	Total vibrio sp count	0	0.0
6	Shigella and Salmonella counts	0	0.0
7	Total pseudomonas count	0	0.0

TABLE 5: Countries in Africa that Uses Biogas Plant

S/N	Countries	Number of Digesters	Capacity of Digesters
1	Nigeria	Very Few	Medium
2	Rwanda	Several	Large
3	South Africa	Several	Large
4	Sudan	About 180	Medium
5	Senegal	About 80	Medium
6	Botswana	Over 100	Small
7	Burkina Faso	About 25	Small/Medium
8	Burundi	Over 185	Medium
9	Egypt	Over 2oo	Medium
10	Ghana	About 105	Small/Medium
11	Morocco	Over 158	Small/Medium
12	Tunisia	About 45	Medium
13	Uganda	About 30	Small
14	Malawi	Few	Medium
15	Cote D' Ivoire	About 46	Medium
16	Ethiopia	Over 100	Small/Medium
17	Tanzania	Over 600	Medium
18	Kenya	Over 400	Small/Medium
19	Swaziland	About 120	Small/Medium
20	Lesotho	About 30	Small

Source: Fulford (8)

The table above clearly shows Nigeria is among the countries in Africa that is yet to benefit from this biogas activities considering the fact that we have the entire necessary requirement for the biogas project. All the countries that "several" is indicated after their names is believed to have more than 1000 biodigester spread around the country.

Considering the present cost in petroleum product, cow dung will be preferred soon, since power can also be generated using the said dung. Statistics taken from 1990 to 2010 in Nigeria has shown that the price of a barrel of oil compared to an equivalent amount of dung cake was more expensive

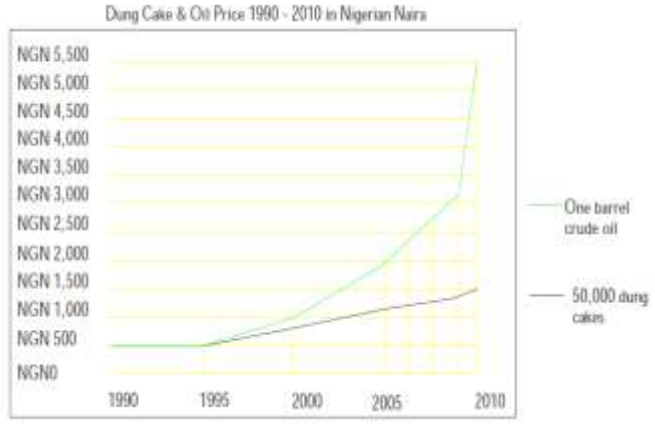


Figure 1: Showing Prices of Dung Cake and Oil Price 1990 - 2010, and Equivalent Power Generated

The table above clearly showed the various cost comparison of crude oil to dung cakes, which elaborates the fact that one barrel of crude will generate an equivalent power that 50,000 dung cakes can generate. The comparative cost in the Table shows there is a great price different of 1,500 NGN (dung cake) as compared to 3,000 NGN (crude oil). A huge cost will be saved if more emphasis in biogas production is been laid.

3.0 Theoretical Background

Finding shows that 1kg of cow dung can generate a biogas of $0.03m^3$ (though some literatures have argued that $0.05m^3$ is amount of biogas that can be generated by same 1kg of dung), we are going to use $0.03m^3$ for the purpose of this calculation. And it has been revealed statistically that the average cow can generate 10kg of dung everyday which give 1kg X $0.03m^3$ = $0.03m^3$ of gas every day.

Assuming Nigeria have a total of 1,000,000 cows that produces 10kg of dung and collection is put at 60% a total of

300million tons of dung will be generated, one can imagine the amount of biogas that will be generated.

4.0 Important Conversion of Biogas

To appreciate the proper use of the biogas, some important technical conversion will be needed. 1000 litres of human waste will generate 700 litres of human biogas which can subsequently be converted to animal biogas either by dividing the human waste i.e **1000/4.6 = 219.75m^3** or multiplying the 700 liters i.e.

$7000 \times 0.3139 = 219.75m^3$. 70% of biogas can be produced from any given mass of human waste (Marchain, 1992). Therefore, 70% of 219.75m^3 will give153.83m^3 of cow dung biogas.

If we intend to use above biogas 153.83m^3 to generate we will divide by 0.21kg/Kwh (Standard). Mathematically expressed as:

$153.83m^3/0.21kgkw/h = 736.95kw/h$

To know the number of hours the said biogas can run divide by the capacity of generator that will be used i.e 5kva or 2kva.

$Assuming\ 5kva$: $736.95kwh/5kva = 147.39va/h$

$147.39va/h/24h = 6.1\ days$

Hence, 153.83m^3 of biogas will generate power for 6days using 5kva generator.

5.0 Conclusion

Nigeria is in advantageous position for adopting and popularizing biogas because of the stable climate and availability of plant, materials and animal waste (cow dung). Lack of bio-plant in Nigeria has led to a huge portion of the dung produced about millions from herds of cattle in Nigeria is either wasting or burnt away. Statistics showed that about 80,000 – 90,000 of cattle are slaughtered per day with the bulk of it coming from Lagos state, one can imagine the amount of biogas that can be generated in a day, if we take the advantage to fullest.

Statistics also showed average production of 10kg of dung per animal per day could generate millions of tons of humus huge manure, research has also shown that 7million tons of kerosene oil is the country's consumption in a year, which is far below 20million tons the biogas can generate in a year.

The continuous use of woods and coals is harder to obtain and fuel is too expensive for most households and the smoke coming out from the use of wood can lead to respiratory ailments which is one of the biggest killers in children. Therefore, the need for both renewable energy and improved sanitation, will be meet effectively in a home biogas plant. It is also expected the Government should show more commitment and seriousness so that the renewable energy will come to stay and more employment and environmental issues finally addressed.

References

[1] Doelle, H.W. (2015): Socio-economic microbial process strategies for sustainable development using environmentally clean technologies: Sagopalm a renewable resources. Livestock research for rural development, 10 (1), 212 - 219.

[2] Agbogu, V. N., & Mbaeyi, I. E. (2018). Biogas production: Family economic empowerment opportunities: paper presented at the 7th Annual National Conference of the Home Economics Research Association of Nigeria (HERAN), at the University of Nigerian, Nsuka Sep. 6-9,2006

[3] Gneedr (2017). Cows to Kilowatts . Global Network for Environmental and economic development research, Nigeria. Sulfur hexafluoride (SF6) tracer and chamber techniques. American diary science association, J. Diary Sci. 90(27): 55-66.

[4] Karki, A. (2016). From Kitchen Waste to Biogas: An Empirical Experience. In: BNRM, No. 75.

[5] Van Nes and Nhete, (2007) Biogas for better life, Renewable Energy World, July – August 2007

[6] Weiland, P. (2010). Production and Energy use of Biogas from Energy crops and waste in Germany. *Applied Biochemisty and Biotechnology, 109*

[7] Parawira, W. (2009). Biogas technology in sub –sahara Africa; Status Prospect and cnstraints. Review. *Environmental Science and Biotechnology, 8, 187- 200*

[8] Fulford, D. (2014). Biogas Technology: Success Projects in Asia and Africa, being a paper presentation at Kingdom BioEnergy.