

POULTRY FARM BASED BIOGAS POLICY IN BANGLADESH

M. N. H. Khan¹, M. S. Zahan², M. T. Anower³

Dept of Electrical and Electronic Engineering, Uttara University
House-4 & 6, Road-15, Sector-6, Uttara Model Town, Uttara, Dhaka-1230.

Phone: 58952280, 58951116, 58955794

Fax: 58952047

Email: nomanxp76@gmail.com¹, salimzahan91@gmail.com², taosif123@yahoo.com³

Abstract: *Renewable Energy (RE) sources are experiencing rapid proliferation throughout the world, with the developed countries of the world having already implemented state of the art energy generation systems. The developing nations are quickly catching up, as many innovative and novel methods of extracting energy from renewable sources are being developed. Among the multitude of applications, a significant portion of the generated energy is being used for supplying power to the national grid, transportation and generic household applications such as cooking and air/water heating. The latter being of paramount importance to rural household.*

This paper undertakes a quantitative and comprehensive analysis of energy production from biogas consisting of methane and carbon-dioxide; the aforementioned biogas being extracted through the exclusive anaerobic digestion of waste collected from poultry waste. A parallel economic feasibility study consisting of load calculation of the concerned poultry farm was also conducted on the very poultry farm whose waste is being considered for. An overall comparison is then drawn between the energy generated and energy consumed with the ultimate goal being to develop a completely self-sustaining poultry farm. It is also suggested through extensive comparative studies and literature review of similar implementation, a large scale adaptation of the biogas energy generation system in Bangladesh.

Key words: *Renewable Energy (RE), Methane, Poultry farm, Electrification, Inverter, Battery, Generator.*

1. Introduction

In our life the most essential and vital elements are Water and energy where the energy is not only for development purposes, but they also play a

fundamental role in the aspect of economic growth, automation and modernization in industrial sector where the renewable energy is going developed and increasingly viable as technology costs decrease and advances [1] especially solar [2-5], wind [6, 7], hydro [8, 9], biomass [10] and biogas [11-14] have been taking the good position with non renewable energy. The researchers are playing the part and parcel role through their hard working work for fulfilling the energy demand where the demand of global energy is growing up about 88% [5, 12]. The increasing challenge of today's is to make the development as a sustainable development. For achieving the sustainable development, both the choices and the way of implementation of the energy sources are really important. Hence, the consumption of global energy is seemed to be increased faster than the population growth [15] where the biogas energy is clean and renewable form of energy, could augment conventional energy sources. Produced through an aerobic fermentation, biogas consists of between 40% and 70% methane, with the remainder being carbon dioxide, hydrogen sulphide and other trace gases. Biogas energy has some advantages over other energy sources. Successful use of biogas technology can result not only in energy generation and bio-fertilizer production, but also other social and ecological benefits including sanitation, reforestation and reduction of imported fuel oil [1]. In future as well as today's, the most prominent sources to get biogas is from wastes, residues, and energy crops. Biogas which is well known versatile renewable energy source, which is used as a replacement of the fossil fuels in power as well as heat production, and it used also as gaseous vehicle fuel. For producing the chemicals and materials, Methane-rich biogas (biomethane) can replace to natural gas. Throughout the biogas production by

anaerobic digestion which offers noteworthy advantages over other forms of bio energy production. In the bio-energy production, biogas is the most energy-efficient and environmentally beneficial technology which can drastically reduce GHG emissions compared to fossil fuels through utilization of locally available resources. The digestate is an enhanced fertilizer in term of its commonly to crops that can substitute mineral fertilizer. In the Europe, the production of biogas energy is reached 6 million tons of oil equivalents (Mtoe) in 2007 which is yearly increase of around more than 20%. In order to largest biogas production, Germany takes the first position where at the end of 2008, around four thousand agricultural biogas production units that were operated on German farms. In the European Union based on agricultural, 1,500 million tons of biomass could be digested an aerobically each year, and half of this potential is accounted for by energy crops [12]. In below draw a figure in figure 1 where has been shown the biogas production in different areas of the world from 2012 to 2022. Here it's clearly seen that the North America takes the leading position from the beginning to future where still now the biogas production is same with nearly 0.5ktoe y-1 for Middle East/Africa and it will be increased in future gradually.

Bangladesh is known to have a good potential for renewable energy, but so far no systematic study has been done to quantify this potential for power generation [16]. In the meantime, the demand of renewable energy especially, solar, biomass, wind, and mini-hydro power is gradually increased where nearly 70% of total energy consumption comes from traditional biomass sources.

In 2005, the government of Bangladesh announced its ambitious goal to provide electricity for all by the year 2020 [17]. The government targets of electricity generation by renewable energy technologies (RETs) are 5% of the total power generation by 2015 and 10% by 2020i. In Bangladesh, Biomass is taken good position day by day where it provides basis energy requirements for cooking which is consumed about 90% of energy in the developed households and heating in rural households where Biogas is a substitute for firewood, rice husks, jute stick and cattle dung that

can meet the energy needs of the rural population [13, 16, 18].

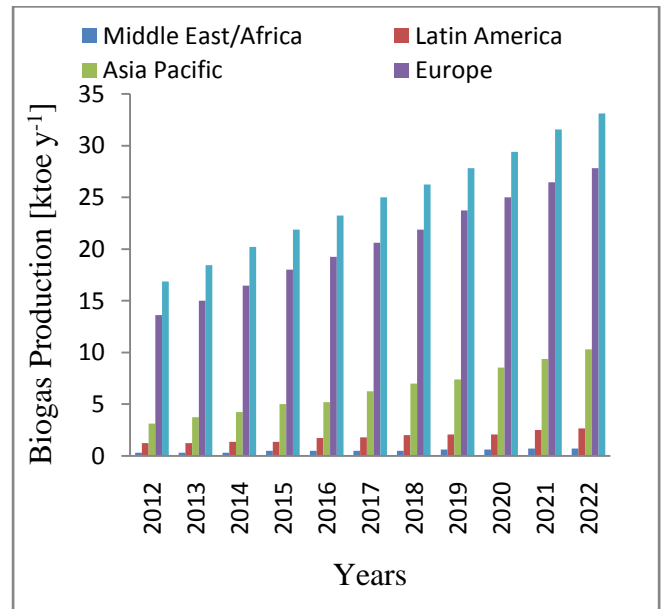


Figure 1: Different areas biogas production from 2012 to 2022 [11]

Around 45,000 biogas plants are already in operation in Bangladesh; most of them small domestic systems fueled by cow dung, for example, and used for cooking. The Dhaka City Zoo has also installed one large and three smaller biogas plants that use the animal dung and slaughterhouse waste produced in the zoo.

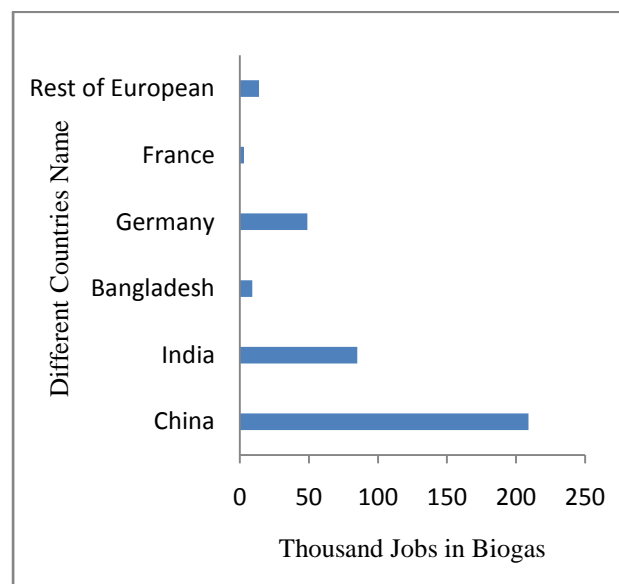


Figure 2: Different countries job side through Biogas plant

However, the Sustainable Energy for Development (SED) Program, working with several partner organizations, has been working to promote the use of larger (gas production of more than 4.8 cubic meters per day) biogas plants by dairy and layer poultry farms. As a result, about 1500 biogas plants in Bangladesh today use cow dung or poultry litter to produce biogas on a commercial scale [18, 19]. In the industry sector, there are some direct and indirect jobs side by side by biogas plants where China takes the leading position and Bangladesh takes the second last position with 9000 that shown by figure 2 [20]. On the other hand, the Grameen Shakti (GS) which is a sister wing of Grameen Bank. It is one of the biggest contributor POs under Infrastructure Development Company Limited (IDCOL) for both solar home systems and the National Domestic Biogas and Manure Program project in Bangladesh. GS has adopted the IDCOL model as an integrated and sustainable model for extending biogas programs. The program is functioning well with a market based approach. The users pay back the credit on 25% of the total cost as a down payment and the remaining 75% of the cost is to be repaid through 24 installments with an 8% service charge (flat rate) within two years. This repayment schedule is strictly maintained by GS [19, 21].

This paper is about the biogas renewable energy which is alternation of non renewable energy especially natural gas. Biogas production is gradually increased in different countries. Biogas production can be increased by poultry farm where Bangladesh is going rapidly high. Electricity production through is spread up day by day in different countries with various policy where cost effect can be reduced to produce electricity in non developed countries especially Bangladesh. In rural areas, the electrification problem can be solved by producing electricity through poultry farm waste that actually escalate highly which is compared with Main Distribution Board (MDB) of Bangladesh.

2. Biogas Technique for electrification

Biogas technology is a sustainable process for managing biodegradable waste material for producing electricity [22] where biogas combined with methane (50-75%), carbon dioxide (25-50%),

nitrogen (< 1 - 2%) hydrogen (0-1%), hydrogen sulfide (0-2%) and Oxygen content in all three gases was <1%.that has been shown in table 1 [23].

Table 1: Percentage of constituent for biogas

Serial No.	Constituent	Chemical formula	Percentage
1	Methane	CH ₄	55-70
2	Carbon dioxide	CO ₂	30-45
3	Hydrogen Sulfide	H ₂ S	1-2
4	Nitrogen	N ₂	
5	Hydrogen	H ₂	
6	Carbon monoxide	CO	

For improving their fertilizer qualities, reducing odors and pathogens and producing a renewable fuel, anaerobic digestion of animal manure and slurries is part and parcel. In additionally, given in figure 4(a) a block diagram of anaerobic process involved with three types of bacteria [23-25] where can easily understand the real steps of getting biogas from different sites such as manure, Poultry farm waste, green waste, food waste, fish waste, cow dung and sewage [22, 26, 27].

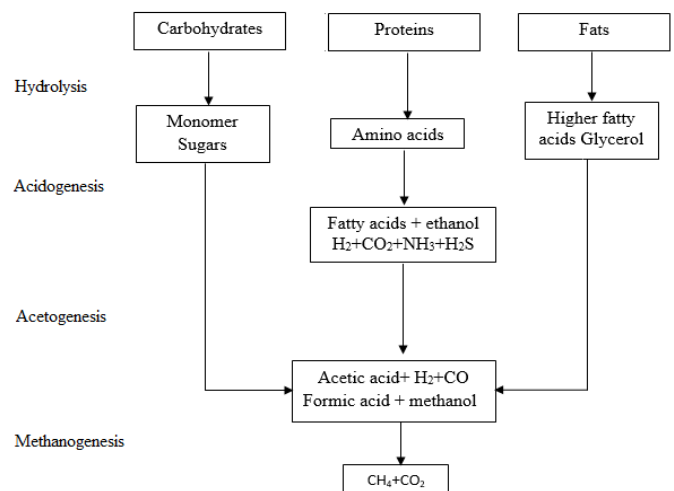


Figure 4 (a): The block diagram of anaerobic process [14, 28-30]

The contenting of the highest methane gas that occurred through the sewage digester whiles the lowest methane and highest nitrogen contents that have been found in the landfill gas during winter semester. In landfill gas, farm biogas and in

smaller amounts in the sewage digester gas, Hydrogen sulphide and other sulphur compounds occurred.

On the other hand, organic silicon compounds had been found in the landfill as well as sewage digester gases [33]. In the case of rural areas of Bangladesh, the biogas technology is very ideal process because it is simple to build and input is available where the achieving output is profitable in rural household [23]. Now from the biogas to electricity production can be done after completing some necessary steps. In addition, figure 4(c) is clearly shown the block diagram of getting electricity from generator through AC/DC converter, Battery and Inverter [4].

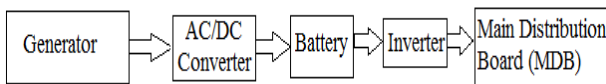


Figure 4(c): the block diagram generator to MDB [4, 34].

3. Biogas policy

Renewable contributed around 19% to humans' global energy consumption where around 22% to their generation of electricity in 2012 and 2013 [35]. Meanwhile, renewable energy can be a cost-effective solution to reaching the energy poor in many situations. In clean energy has been estimated US\$243 billion in 2010 which is increased highly from 2008 and yearly around US\$50-170 billion escalation will be going on until 2030 where developing countries are benefited whereas affecting the poor disproportionately. In addition to being unsound, the current energy system is also highly unbalanced where around 1.4 billion people lives electricity less and around 2.7 billion dependent on traditional biomass for cooking. Moreover, indoor air pollution from using traditional biomass and coal is responsible for more than 1.5 million premature deaths each year, half of them children under the age of five, the rest women, in developing countries. Ensuring access to electricity for all requires US\$756 billion – or US\$36 billion per year – between 2010 and 2030, according to estimates by the IEA, UNDP and

UNIDO [1]. In below figure 5 is shown the Investment of new renewable capacity annually from 2008 to 2014 where 2011 had maximum invested which is approximately same nearby until 2014. In the mean time, the production of biogas has been increased gradually since 2008 where it increased 33×10^9 liters at 2014 [36-39].

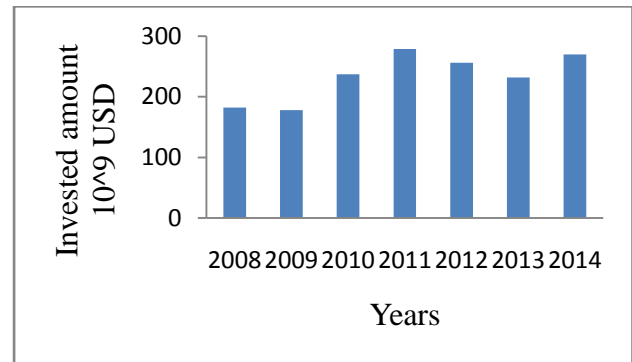


Figure 5: Investment of new renewable capacity annually

The estimated potential of biogas plants in India is 12,339,300 units where in December 2009, the cumulative achievement has been 4,185,442 units. As a result, implementing approximately 34% of the estimated potential has been indicated by the Ministry of New and Renewable Energy (MNRE) at 2010. The latest figures for 2009-2010 suggest a similar success rate, with 34% of family-type biogas plants being implemented. While India has progressed well in initiating renewable energy program in general, increasing renewable energy (electricity) share from 2% (1628 MW) in 2002 to 11% (18,155 MW) in 2010 [40, 41].

On the other hand, Figure 6 shows the increasing nature of biogas technology adoption in Bangladesh where around 50% improvements will be seen at 2016 [21, 42, 43].

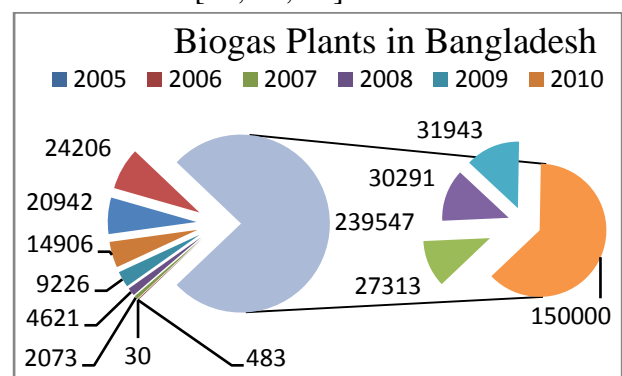


Figure 6: yearly improvement number of biogas plant in Bangladesh

Two 200- 300 KW biomass power plant have been already installed by Infrastructure Development Company Limited (IDCOL) using poultry litter. By using organic city waste and poultry litter, studies indicated that up to 800 MW of electricity could be produced in Bangladesh. Now with the financial support by IDCOL, 12 gasification-based biogas plants equivalent to 5 MW are being considered to implement. More than 15.000 tons of waste is produced in Bangladesh each day with this enormous amount waste more mega range power plant can be implemented. In 2025 it is expected that 47.000 tons of waste will be produced in Bangladesh each day. Rice husk is another major raw material for biomass production from the thousands of rice mills .Studies show that up to 400 MW of electricity could be produced from using rice husk alone. Renewable energy is rapidly growing; different donors are interested in behind this form of energy production. Government has taken a number of initiatives to encourage sustainable energy by awarding foreign investors and technology supplier like prioritized access to loans and soft loans, land and other resources. Bangladesh Government vision is to generate about 20% power by sun, wind, biomass and biogas by 2020 [44].

4. Load calculation of the poultry farm

Data Table for electricity consumed in the farm

Table 2: selected places and used load

Selected places	No. of fan	No. of lights	Total Load
In shed (for 250 sheds)	0	750 (each having 40w)	30,000watts(4 hours)
In office (for 7 room)	7(each having 60w)	9(Each having 40w)	780watts

In table 2 has been given total number of sheds in the farm is 250 (each having 4 bulbs of 40w) and the total number of lights is 750.The lights are used for 4 hrs/day which consumed 10,000 watts of electricity. The farm has 7 office rooms. The

total number of lights and fans are 7 respectively which consumed 780 watts of electricity. So the total electricity consumed in the farm is 30780 watts or 30.780kw.

Table 3: amount of poultry waste collected per day

Selecte d places	No. of chicken s (each shed)	Total no of chicke ns	Waste collected from each chicken	Total waste collection
In shed (for 250 sheds)	1000	250*1000=250000	100gm	250000*0.1=25ton

Parameters of Digester:

The Fixed dome type digester is used. The ratio of waste to water is 1:1.The retention time is 30days. The density of the poultry waste is 3828 kg/m³.

Digester size (m³) =Daily feed-in (m³/day) * Retention time

(day).....(1)

Daily feed-in=Volume of poultry waste + Volume of water

$$= \left(\frac{m}{\rho}\right) \text{waste} + \left(\frac{m}{\rho}\right) \text{water}$$

$$= \frac{25000 \text{ kg}}{3828 \text{ kg/m}^3} + \frac{25000 \text{ kg}}{5000 \text{ kg/m}^3} = 6.5308+5 = 11.5308$$

m³

From equation (1) we have,

$$\text{Digester size} = 11.5308 * 30 = 345.924 \text{ m}^3 \dots\dots\dots (2)$$

The digester is of cylindrical shape and the diameter (d) to depth (l) ratio is 2:1.

$$\text{Volume of the digester} = \pi r^2 l \dots\dots\dots (3)$$

Assume depth of the digester (l) = x m and diameter (d) = 2x or radius(r)=x

Now,

From equation (2) and (3) we have,

$$345.924 = \pi r^2 l$$

$$\text{Or, } 345.924 = \pi x^2 * x$$

$$\text{Or, } x = 4.8\text{m (approximate)}$$

So the parameters of the digester are given below,

1. Depth-4.8m
2. Dia-9.6m

The building material of the digester is concrete and the capacity is about 750 ton. The pH inside

the digester is 7 and the temperature always kept above 35⁰.

Cost Analysis:

Initial cost:

1. Biogas Generator (50kw) - 80,00,000tk (Assume)
2. Pump (5kw) - 120,000tk (Assume)

Table 4: Construction components of digester

Element	Bricks	Cement	Sand
Quantity	39,000	120bags	
Cost	39000*5tk=195000tk	120*500tk=60,000tk	25,50,00tk

Other cost=100,000tk

Total cost (Biogas Generator, Pump, Digester and maintenance cost)=

$$80,00,000+120,000+25,50,00+100,000$$

$$=84,75,000tk$$

Table 5: Initial cost

Cost materials name	Amount
Holding tank-	1,00,000tk
Hydrogen sulfide removing unit-	2,00,000tk
Cooler-	2,00,000tk
Hot Water tank-	1,50,000tk
Biogas Generator, Pump, Digester and maintenance cost	84,75,000tk
Total initial cost	91,250,00tk

Replacement cost:

Digester cleaning

$$50,000tk/2years \text{ (Bangladesh Perspective)}$$

$$25,000tk/1year$$

Pipe replacement-60,000tk/year (BD Perspective)

Total replacement cost per

$$year=60,000tk+25,000tk=85,000tk$$

Maintenance cost:

Employee salary-/month

Table 5: Employee salary (BD Perspective)

Operator	20,000tk/month
Engineer	30,000tk/month
Other	10,000tk/month
Total	60,000tk/month

In 1 year, 60,000*12=7,20,000tk

Generator maintenance cost:

Major over hauling cost= 2,00,000tk /73000hr

$$=20,000tk/7300hr \text{ or per}$$

year (Generator runs 20hr/day)

Top overhauling cost=1,00,000tk/36500hr

$$=20,000tk/3650hr \text{ or per year}$$

Total maintenance cost of generator per

$$year=20,000tk+20,000tk=40,000tk$$

Total maintenance cost per

$$year=7,20,000tk+40,000tk=7,60,000tk$$

Payback period:

Electricity consumed in the farm per

$$day=50kw*4hr=200unit$$

$$Cost/unit=4.73tk$$

(Source: Bangladesh Power Development Board,

Cost of 200 unit=200*4.73tk=946tk (commercial bill)

Electricity that could be supply per

$$day=50kw*16hr=800unit$$

$$Cost/unit=7tk \text{ (BD Perspective)}$$

$$Cost of 800 unit=800*7tk=5600tk$$

Total amount of electricity per day=1000unit

$$Total cost per day=946tk+5600tk=6546tk$$

$$Total cost per year=6546tk*365=23,89,290tk$$

$$Income/year=23,89,290tk$$

$$Net annual cash inflow=23,89,290tk-7,60,000tk-$$

$$85,000tk=15,44,290tk$$

$$Payback period = \frac{\text{Investment required}}{\text{Net annual cash inflow}} = \frac{9125000}{1544290}$$

$$=5.91 = 6years \text{ (Approximate)}$$

Net present value (NPV):

Table 6: Life time for 20 years

Item	Years	Amount of cash flows	10% Factor	Present value of cash flows
Investment	0	91,25,000tk	0	91,25,000tk
Annual net cash inflow	1-20	1544290tk	8.514	13148085.06
Net present value				=40,23,085.06 tk

As the net present value is positive so, the project is acceptable.

Internal rate of return:

Factor of internal rate of return=

$$\frac{\text{Investment required}}{\text{Net annual cash inflow}} = \frac{9125000}{1544290} = 5.91$$

The factor 5.91 represents a rate of internal return

$$= 17\%$$

5. Conclusion

The popularity of using biogas production is going high rapidly in Bangladesh. In the electrification issues of rural areas can be reduced through the high production electricity that can be partially solved by biogas energy. Biogas production through poultry farm waste is very effective and cost reduction technique for electricity production. In this paper discusses about different countries renewable energy systems for electrification especially for biogas production. Furthermore, how the biogas production can be converted to electricity through generator and biogas policy in various countries and the importance of biogas in Bangladesh. Indeed, the using of poultry farm waste for producing electricity where the cost can be reduced compared with Bangladesh Power Division Board.

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