POSSIBLE ELECTRICITY GENERATION AND FINANCIAL ANALYSIS OF A BIOGAS PLANT FOR A POULTRY FARM

A Project and Thesis submitted in partial fulfillment of the requirements for the Award of Degree of Bachelor of Science in Electrical and Electronic Engineering

By

Name: Md. Atik Mallik

(ID: 172-33-523)

Supervised by

DR. MD. ALAM HOSSAIN MONDAL

Associate Professor

Department of EEE

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

FACULTY OF ENGINEERING

DAFFODIL INTERNATIONAL UNIVERSITY

January, 2021

Certification

This is to certify that this project and thesis entitled "**Possible Electricity Generation And Financial Analysis Of A Biogas Plant For A Poultry Farm**" is done by the following students under my direct supervision and this work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering. The presentation of the work was held on January 2021.

Signature of the candidates

____

Name: Md. Atik Mallik
ID: 172-33-523

Countersigned

____

Name: Dr. Md. Alam Hossain Mondal

Associate Professor

Department of Electrical and Electronic Engineering

Faculty of Science and Engineering

Daffodil International University.

The project and thesis entitled **Possible Electricity Generation And Financial Analysis Of A Biogas Plant For A Poultry Farm"** submitted by **Md.Atik Mallik**, ID No: 172-33-523 Session: summer 2017 has been accepted as satisfactory in partial fulfillment of the requirements for the degree of **Bachelor of Science in Electrical and Electronic Engineering** on January 2021.

BOARD OF EXAMINERS

Name: External Member
Designation:

Name: Internal Member
Designation:
Department of EEE, DIU

Name: Internal Member
Designation:
Department of EEE, DIU

Dedicated to

My Parents

CONTENTS

LIST OF FIGURES

LIST OF TABLES

List of Abbreviations

FY	Fiscal Year
TS	Total Solid
LGED	Local Government Engineering
GS	Grameen Shakti
HRT	Hydraulic Retention Time
IC	Internal Combustion
NGO	Non-Government Organization

List of Symbols

√	Root
%	Percent
$	Dollar
°c	Degree Celsius
=	Equal
CUM	Cubic Meter
KWh	Kilowatt hour
Sq. Km	Square kilometer
BDT	Bangladeshi Taka

ACKNOWLEDGEMENT

First of all, we give thanks to Allah or God. Then we would like to take this opportunity to express our appreciation and gratitude to our project and thesis supervisor **Dr. Md. Alam Hossain Mondal, Associate Professor** of **Department of EEE** for being dedicated in supporting, motivating and guiding us through this project. This project can't be done without his useful advice and helps. Also thank you very much for giving us opportunity to choose this project.

We also want to convey our thankfulness to **Dr. Md. Shahid Ullah, Professor and Chairperson** of the **Department of EEE** for his help, support and constant encouragement.

Apart from that, we would like to thank our entire friends for sharing knowledge; information and helping us in making this project a success. Also thanks for lending us some tools and equipment.

To our beloved family, we want to give them our deepest love and gratitude for being very supportive and also for their inspiration and encouragement during our studies in this University.

ABSTRACT

In a poultry farm consist of 6000 chicken can produce up-to 600 kg of waste per day and a lot of energy is stocked in these waste. Usually, we have to dump these waste and can become burden day by day. This study, focuses on extracting the energy from the waste as electrical energy using bio gas plant. A digester of diameter 5.5 meter and height 2.2 meter is considered in this study for the bio gas plant that can produce up-to 44.4 m^3 gas per day. Thus, 62 KWh of energy can be produced using 4KW Generator. For the biogas plant the installation cost could be approximately BDT 537787. The paybak period of the plant will be 3.5 years.

CHAPTER – 1

INTRODUCTION

1.1 Background

Global energy need is rising day by day and to level up with this rising need, renewable energy has to contribute more and more in the develop country also in the develop country. Also, as developing country Bangladesh is confronting serious energy crisis due to decreasing gas reserves and lack of proper use of existing energy resources and other resources. With the increasing fall of gas reserve, Bangladesh government is heavily trying to develop coal fired power stations to produce electric energy which can be supplied to the grid areas. Nearly 62% of the people live in areas that are not connected to grids and have no connection to the grid electricity. As Bangladesh is blessed with good geographical location for solar pv energy and perfect weather condition for Biomass energy, we only can think of biogas energy as alternative for the areas out of grid connection. Though, solar home system (SHS) is getting preference in the non-grid locations of Bangladesh, however per unit cost of such electricity is relatively high (nearly 50 cents). This solar system is quite become expensive for poor households. In addition to that, in Bangladesh poultry farms are becoming popular choice for many entrepreneurs and they all have to face difficulties dealing with the waste of the farm. These farm waste can be grate resources for energy production and thus, can contribute to country for dealing with the rising electricity demand and can meet their energy requirement for the farm. Also, Biogas plant can be installed in rural areas in smaller size to meet their daily energy consumption. In this thesis study I tried to determine possible electricity generation and cost analysis of a biogas plant if installed in a poultry farm.

1.2. Objectives

- Determining the electrical power generated from a poultry farm waste consists of 6000 chickens;
- Determining the installation cost of the biogas plant for the farm;
- Determining the Payback period of the biogas plant.

1.3 Limitations

- Calculation of the operation cost was not possible
- No case study was possible

1.4 Methodology

The main goal of the study is to calculate the energy production and installation cost of the biogas plant. Firstly, the size of the poultry farm was considered and then waste produced from the farm is determined. After that, calculation for the digester of the biogas plant was conducted and the size of the biogas plant is determined. Then, the gas production per day was calculated. Thus, the possible energy production rate is determined. After that installation cost is determined.

1.5 Thesis Outline

This Project/thesis is organized as follows:

Chapter 1 Introduces the thesis background and gives an overview of the thesis.

Chapter 2 Describes the present situation of power sector and biogas in Bangladesh.

Chapter 3 Explain the technology for biogas plant in Bangladesh.

Chapter 4 Includes the plant Research and cost analysis.

Chapter 5 presents the result and its discussions.

Chapter 6 concludes the thesis

.

CHAPTER - 2

Bangladesh Background

2.1. Geography

Figure 01: Bangladesh Map [1]

People's Republic of Bangladesh, a nation in South Asia. It is the eighth-most crowded nation within the world, with a population surpassing 162 million people. In terms of landmass, Bangladesh positions 92nd, spanning 147,570 square kilometers (56,977 sq mi), making it one of the foremost populated nations within the world. Bangladesh shares borders with India to the west, north, and east, Myanmar to the southeast, and the Inlet of Bengal to the south. It is barely isolated from Nepal and Bhutan by the Siliguri Passage, and from China by Sikkim, within the north, individually. Dhaka, the capital and biggest city, is the nation's financial, political, and social center. Chittagong, the biggest seaport, is the second-largest city. [2]

2.2 Demography

According to population census 2018, total population of the country is 162 million of which 50.6% male. The annual population growth rate is 1.1% and average household size is 4.2%.The density of the population is 1106 per sq.km. The most of the people i.e. 63.6% of the total population live in rural areas. (According to religion majority of the people are Muslim. Of the total population 88.23% are Muslim, 10.69% are Hindu, 0.6% are Buddhist, 0.37% are Christian and the rest 0.11% people follow other religions) [3]

2.3 Land use pattern

Approximate land use pattern of the country is: -

Forests Land: 17.5%, Agricultural: 64%, Human Settlement: 8.5%, Water and other:10%

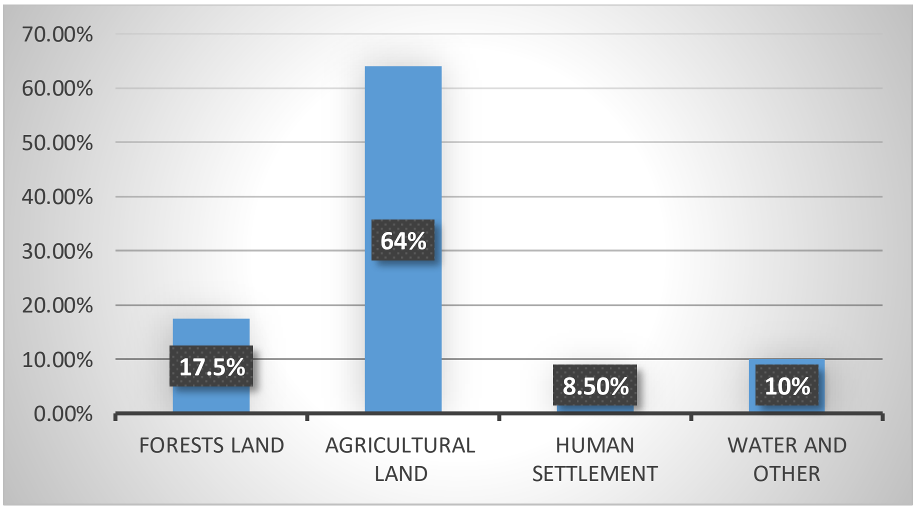


Figure 02: Land use pattern

2.4 Energy scenario in Bangladesh

Different types of indigenous energy sources have been considered in meeting future energy needs of the country are: traditional, commercial and renewable energy sources. Traditional energy sources include biomass fuels, animal power. Commercial energy sources include coal, peat, crude oil, natural gas. Renewable energy sources comprise solar, wind, biogas and mini-hydro.

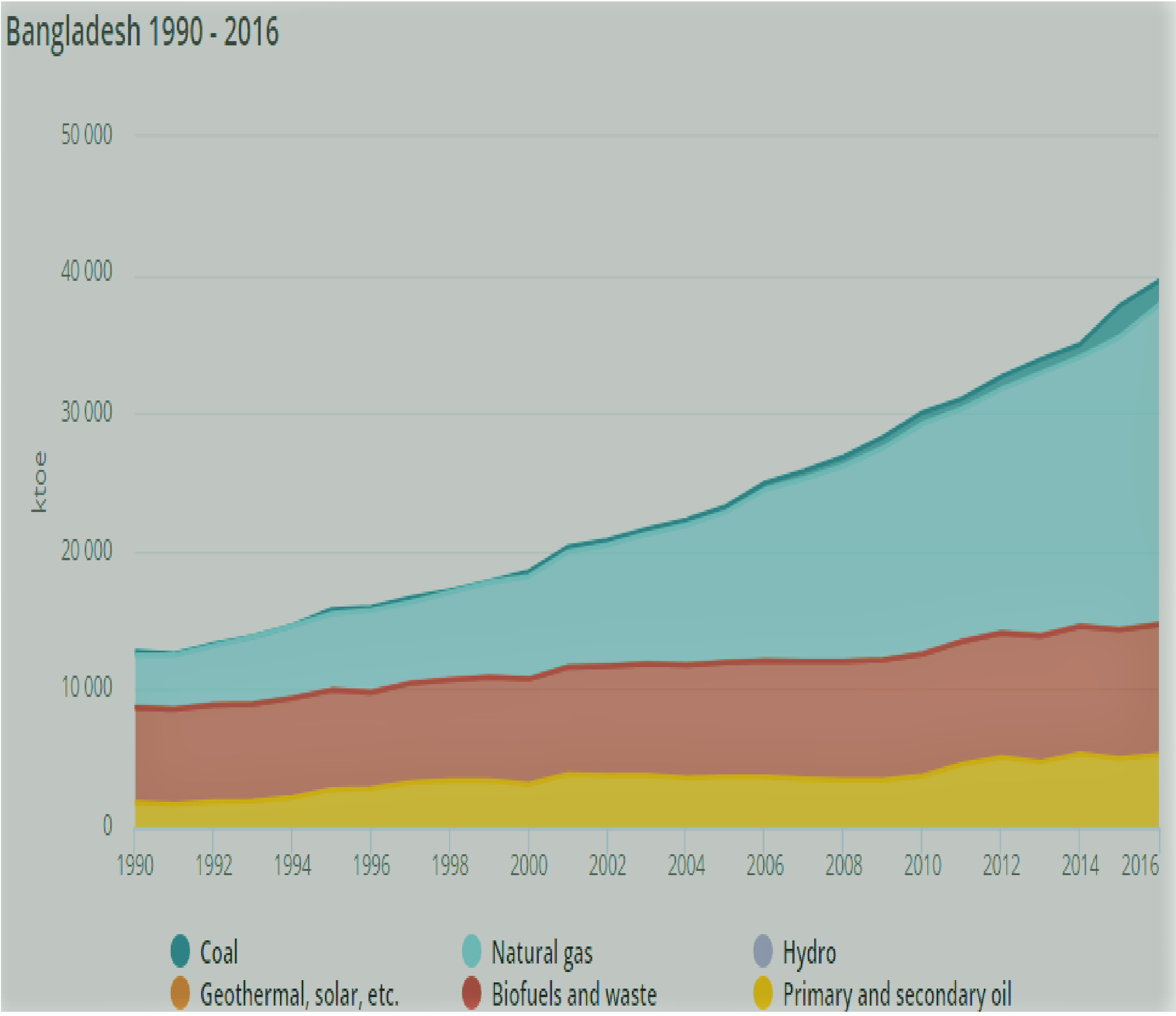
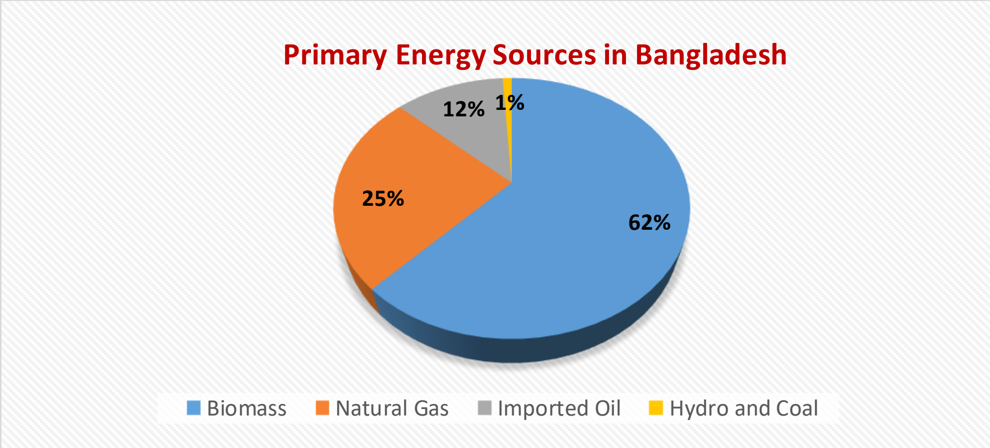


Figure 03: Bangladesh's Total Primary Energy Supply by Source 1990-2016 (IEA, 2018) [4]

About 62% of the nation's total energy supply comes from traditional fuels, such as fuel wood, crop residuals and animal biomass, 25% from natural gas, 12% from imported oil and coal and about 1% from hydro-power.The majority of fuel wood is used for domestic cooking, and the remaining in industrial or commercial sectors



Source:(IEA- 2018) Figure 04: Primary energy sources in Bangladesh

2.5 Generation installed Capacity:

Overall installed capacity was 18,961 MW which includes 6,503 MW IPP/SIPP, 1,540 MW Payment Power Plant, 251 MW below REB (for PBS) then 1,160 MW Power Import as of India. The maximum peak generation was 12,893 MW which was 17.66% higher than to in the previous year. The Generation Capacity mix up is shown below

Table 01: Generation Installed Capacity by Plant & Fuel Type (2018-19)

By type of plant		**By type of fuel**	
Hydro	230 MW (1.21%)	Hydro	230 MW (1.21%)
Gas Turbine	1607 MW (8.48%)	Gas	10877 MW (57.37%)
Steam Turbine	2344 MW (12.36)	Furnace oil	4770 MW (25.16%)
Combined Cycle	6364 MW (33.56%)	Diesel	1370 MW (7.23%)
Power Import	1160 MW (6.12%)	Power Import	1160 MW (6.12%)
Reciprocating Engine	7226 MW (38.11%)	Coal	524 MW (2.76%)
Solar PV	30 MW (0.16%)	Solar PV	30 MW (0.16%)
Total	18961 MW(100%)	Total	18961 MW(100%)

Source: BPDP annual report (2018-19)

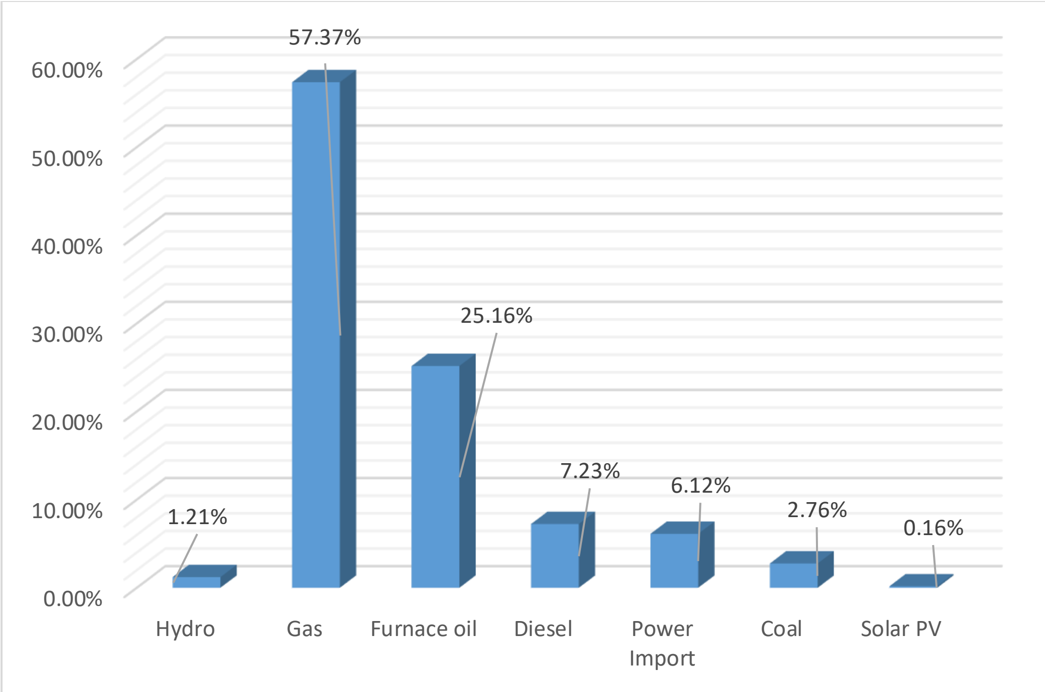


Figure 05: Installed Capacity (National) By Fuel Type with Comparison (FY 2018 -19)

2.6 Energy Access in Bangladesh

After Bangladesh's freedom in 1971, just 3% of the total people had access to electricity. This ratio has go up to 62% in 2014, and 76% by 2016 and almost 85% by 2018 .79% of the grid-connected people suffer load-shedding, and 60% suffer low-voltage supply.

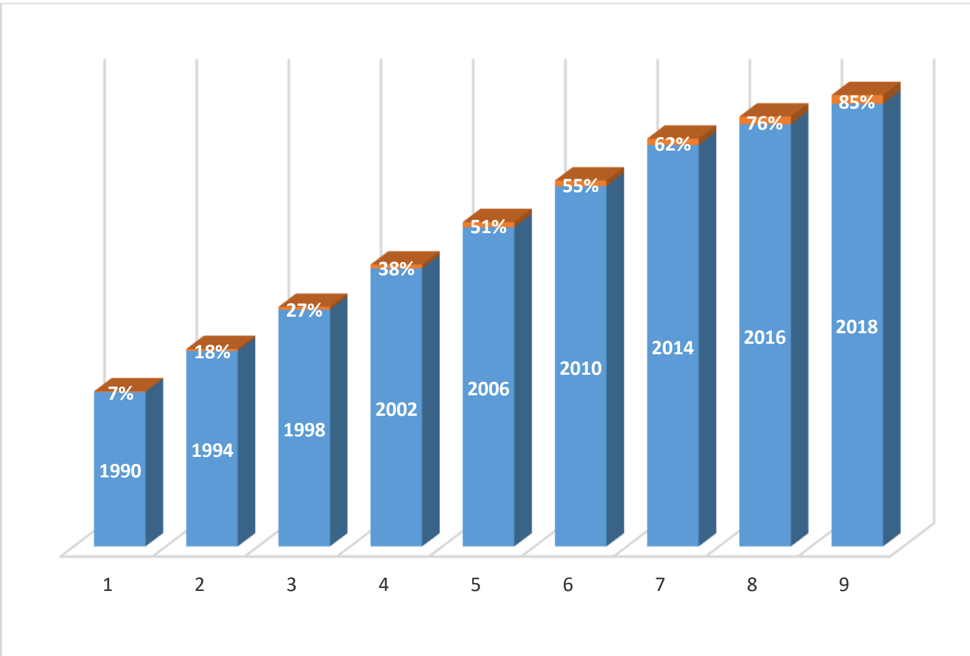


Figure 06: Population with Access to Electricity, 1990-2018 (Total %)

The country has on 1.5 billion people who lack energy access, according to IEA's 2008 estimates, representing almost 20% of the total population. Also, approximately 96.2 million people in the country still even without access to a nearby electrified city. 52% of the total populace are with partial energy access, while only 10-15% of the rural population have energy access that barely meets limited usages: light, ceiling fans, refrigeration, in addition to irrigation.

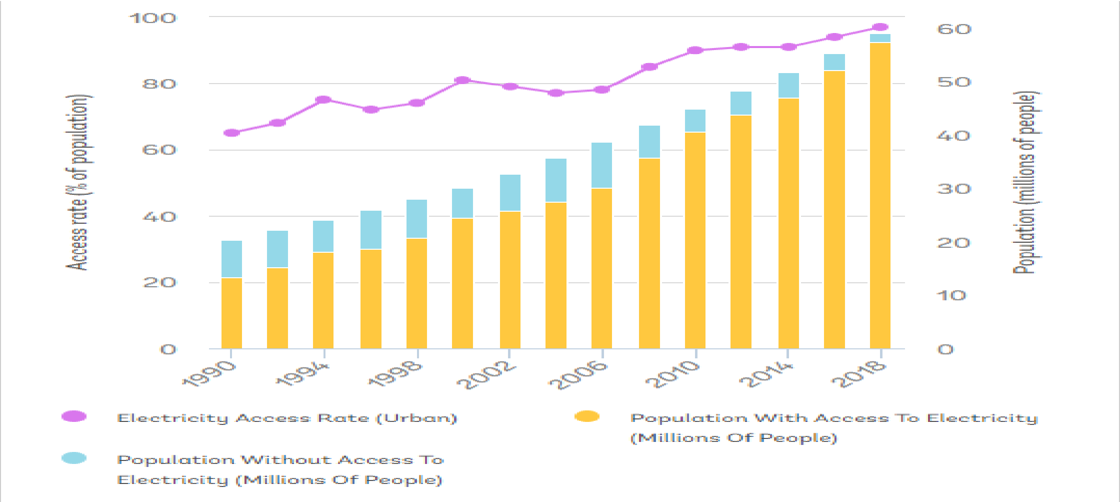


Figure 07: Access to electricity, 1990-2018 (Urban) [5]

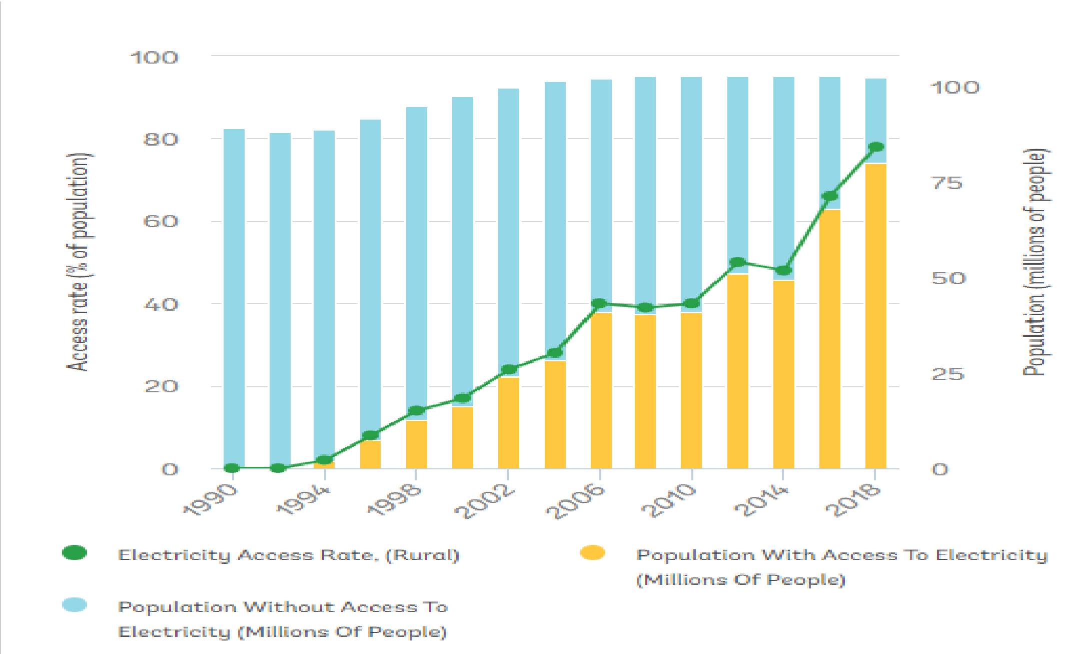


figure 08: Access to electricity, 1990-2018 (Rural) [5]

The Bangladeshi government has set a vision of achieving 100% electricity access 2021,thus by integrating more solar PV and biomass sources, as the country is rich with these two specific ones.

Bangladesh suffers a emergency of regular power outages, for approximately 4-6 hours/day in rural areas, reaching up to 6-8 hours during summer times. Currently only about 52% of Bangladesh's total population are connected to the main grid, while almost 75% of rural population are not connected to it. only 32% of Bangladesh total househoulds have access to electricity.

Table 02: Electricity Access in Bangladesh

	Total Access						Urban Access	Rurlar Access
Year	2000	2006	2010	2014	2016	2018	2018	2018
(% Population)	32	51	55	62	76	85	97	78

Bangladesh's electrification rate in rural areas is still poor, since only 38% of rural households are with access to electricity. Despite the fact that the Bangladeshi government is cooperating with other 30 partner organizations for improving the electricity access situation in the rural areas, yet the pace is still too slow.

In 2016, Bangladesh had an electrification rate of 76% and almost 85% by 2018. In the cooking field, Bangladesh's reliance on biomass will continue for several decades. A mere 6% of the entire population has access to natural gas, primarily in urban areas. Biomass fuels, collected mainly from the local environment only two decades ago, are fast becoming a marketed commodity as access to local biomass becomes ever more difficult. The stark reality is that many rural residents are dependent on such fuels as agricultural residues, dung, and even leaves and grass for cooking

2.7 Livestock population of bangladesh (in lakh number) (2019 – 2020)

Table 03: Livestock population of bangladesh in lakh number (2019-20)

Cattle	Buffalo	Sheep	Goat	Chicken	Duck
243.91	14.93	36.07	264.35	2966.02	597.16

Therefore, Bangladesh has a wonderful climate for biogas production. The ideal temperature for biogas is around 35°C.

The temperature in Bangladesh usually varies from 6°C to 40°C. But the inside temperature of a biogas digester remains at 22°C-30°C, which is very near to the optimum requirement. An estimate of the total biogas potential in the country is presented below.

2.8 Renewable energy scenario and biogas potential in Bangladesh. [6]

Renewable technologies offer opportunities to provide electricity, cooking gas and heating in areas not served by domestic energy grids. However, due to technological, political and economic restraints, at present the contribution of renewable energy to overall power generation

in the country is less than one percent. The Ministry of Power and Energy has decided to harness the enormous potential of renewable energy to generate 5% of total electricity (about 800 MW from baseline scenario, Power System Master Plan-PSMP 2010) from renewable energy by 2015 and 10% (about 2000 MW) by 2020. Table 4: summarizes the main targets by energy source.

Table 04: Renewable energy potential for installed electricity capacity in Bangladesh

Renewable energy	Techinical (MW)	Potential Achivement (MW) in January 2015	Target (MW) by 2015-2020
Solar	3000-5000	165	200-800
Wind	100 (resource mapping required)	2	200-500
Biomass and biogas	1200	18-20 (mostly cooking gas) 6MWe	90-255
Mini and micro hydro	200	0.06-0.08	15-40
Tidal	5	0	1-2

CHAPTER - 3

DEVELOPMENT OF BIOGAS TECHNOLOGY IN BANGLADESH

3.1 Historical Background [7]

In 1972 Bangladesh entered into the arena of biogas technology through the first demonstration biogas plant by Dr. M A Karim at Bangladesh Agriculture University (BAU), Mymensingh campus. This plant was floating-dome type and the size was 3 cubic meter. Later on, another plant was constructed (6 cum digester volume) to serve the purpose of lighting and cooking for a family of 6 members.

In 1974, another plant was constructed at Bangladesh Academy for Rural Development (BARD), Comilla.

In 1976, IFRD constructed a family-size biogas plant at BCSIR campus at cost of TK 12,000.

In 1980, another plant was setup in KBM College, Dinajpur at a cost of TK 15,000.At the request of the owners, the experts of IFRD help set up the plants, the entire cost being borne by the owners. Over seventy gas plants of this model were installed entirely at the cost of the owners.

In 1980, in order to extend bio-gas technology, a department named Environmental Pollution Control Department (EPCD) was established.

In 1981, Department of Environment (DOE) started the programme under a government grant and installed 110 plants of fixed-dome model and over 150 plants of floating - dome type through hired contractors.

In 1985, Local Government Engineering Department (LGED), under the initiative of its Chief Engineer Quamrul Islam Siddique, started study, research, development and extension of biogas technology.

In 1986, LGED constructed its first bio-gas plant at Kurigram and arranged a seminar there which was attended by about 300 engineers, scientists and interested persons from different places.

In 1992, the IFRD of BCSIR in collaboration with Dhaka City Corporation built an experimental biogas plant of 85 cubic meter digester volume at Dholpur for treatment of city garbage. Charging of 52.5 tons of garbage produced 57 cum biogas/day on the average over a period of two months and 40 tons of residue (biofertilizer) rich in plant nutrients. The residue had no odor.

In June 1992, LGED constructed first Chinese-type fixed-dome model bio-gas plant in Karimpur village of Begumgonj, Noakhali. In the same year LGED also constructed the first biogas plant from night soil at Faridpur Muslim Mission.

In 1993, LGED constructed the first biogas plant from water hyacinth at Madaripur.

In 1994, LGED constructed the first biogas plant from poultry droppings at Utter Khan, Dhaka and garbage-based biogas plant at 10 towns. At the end of 1994, LGED constructed about 200 biogas plants out of which eight were floating-dome type and the rest were fixed – dome type. Among the plants 73 were based on night soil, one based on water hyacinth, two based on poultry droppings, 23 based on garbage and the rest were based on cow dung.

3.2 Grameen shakty

Grameen Shakti (shakti meaning "energy" in Bengali) was created in 1996 as a not-for-profit company under the Grameen Bank. The goal of Grameen Shakti is to promote and supply renewable energy technology at an affordable rate to rural households of Bangladesh. Recently, GS also works as a partner organization of IDCOL for construction of small family size biogas plants i.e. 1.6 - 4.8 m3 of gas production per day. They have constructed over 13,000 biogas plants as partner organization under IDCOL's program. GS has constructed 26,298 biogas plants up to 31 August, 2013. Grameen Shakti future plan is to install 6,000 biogas plants in 2013; 8,000 in 2014 & 12,000 in 2015. At present there are about 200 biogas based generators in the country of size 1KW to 1MW and among them Grameen Shakti alone has about 100 biogas based generators. As a pilot project Grameen Shakti imported 10 fiberglass digesters from China and installed them in different customers' households.

3.3 Institutions name Included In Biogas Technology

Biogas technology within Bangladesh has come of age. The success is achieved because of different activities of the following organizations name –

1. (LGED)- Local Government Engineering Department
2. (GS)-Grameen Shakti
3. (BSCIC)-Bangladesh Small & Cottage Industries Corporation
4. (BAU)-Agricultural Chemistry Department of Bangladesh Agricultural University
5. (BARD)- Bangladesh Academy for Rural Development
6. (IFRD) Institute of Fuel Research & Development, (BCSIR) of Bangladesh Council of Scientific & Industrial Research.
7. (DOE)- Department of Environment
8. (DANIDA)- Danish International Development Agency
9. (DLS)- Department of Livestock
10. Some NGOs

3.4 Most popular biogas plant in Bangladesh

Biogas is a kind of fuel gas obtained from anaerobic decomposition of organic matter such as cow dung, poultry (chicken) dropping human excreta, agricultural residue, water hyacinth, garbage,

etc. Biogas technology in the form of two basic designs-the fixed dome (Chinese) and floating cover (Indian KVIC) has been in use in Bangladesh. The fixed dome design is very popular in Bangladesh

Two types biogas plant

1. Fixed dome type biogas plant
2. Floating – top biogas plant

1. fixed dome biogas plant –

A fixed dome plant consists of a digester with a fixed non-movable gas holder, which sits on top of the digester. When gas production starts the slurry is displaced into the compensation tank.

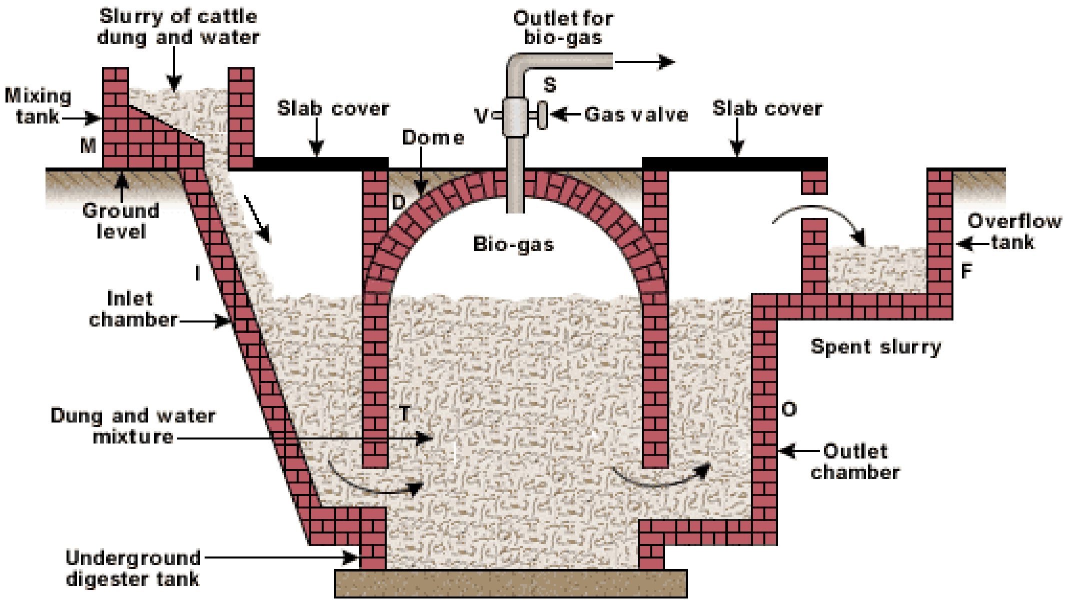


Figure 09: Fixed dome type biogas plant.

Advantages

- There are also no rusting steel parts and hence a long life of the plant (20 years or more) can be expected.
- The costs of a fixed-dome biogas plant are relatively low. It is simple as no moving parts exist.

- The plant is constructed underground protecting it from physical damage and saving space.

3.5 Uses of Biogas and its Residue

Use of Biogas

 Cooking as natural gas

 Irrigation by pump

 Vehicle drive

 Generation of electricity

Use of Biogas Residue

 Fertilization of gardens

 Paddy Cultivation

 Fish Culture

 Earthworm cultivation

3.6 Benefit of biogas

Energy Benefit: Biogas contains mainly CH_4 (60% - 70%), which is the same energy carrier as in natural gas. So, biogas and natural gas can be used for same application. Methane can be burnt for cooking or lighting the house. It can also be used to power combustion engines to drive a mechanical motor or generate electricity.

Economic Benefit: Biogas has two types of economic benefits one is it saves the energy cost to be purchased and on the other hand extra money can be earned by selling biogas to the neighbors.

In a conscious way, we can say that Large scale biogas Plant development in Bangladesh could bring significant environmental benefits. These are:

- Reduce agricultural chemical runoff
- Outlining sustainable land use and improved air quality
- Improve air quality and reduce acid erosion.
- Reduce higher level of deforestation.
- Reduce net greenhouse gas emission.
- Improve soil quality and reduce erosion.
- Reduce land filling by adding value to residues.
- Improve sanitation condition.
- Improve habitat for native wildlife and improve biodiversity.
- Outlining sustainable land use and improved air quality.

•

CHAPPTER 4

Plant Sizing and Financial analysis

4.1 Background

Based of Cattle and Poultry populace, more than one biogas plant can plan instead of one in arrange to form more efficient.(Maintenance, deficiency of crude materials). Now I arrange to plan one Digesters for chicken with (6000 chickens) .

Table 05:- poultry waste energy calculation

Animal type	Waste per day (kg)	Amount of biogas produce from 1 kg waste (m^3)	Amount of biogas for 1 kw electricity generation (m^3)
Poultry chicken	0.1	0.074	0.71

The solid and liquid content discharge per day, TS value of fresh discharge and water to be added to make favourable TS condition some common fermentation materials.

4.2 Design of digester for 6000 chickens

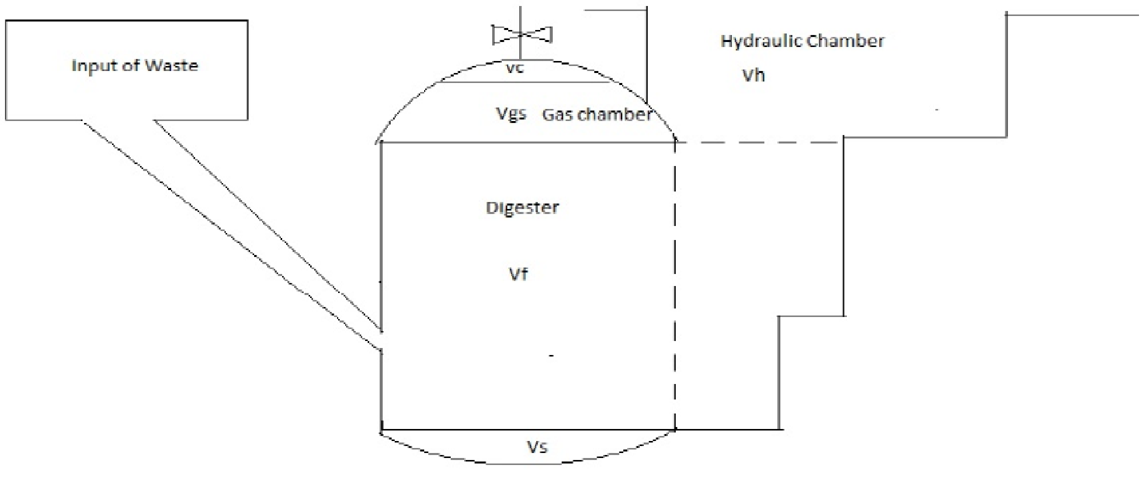


Figure 10: Layout of Digester

Design of Digester:

A Digester Design for 6000 poultry bird:

Digester Type: Fixed Dome [For low cost]

Waste: Water = 1:2

Waste=0.1Kg/bird/day

Total Waste= 6000×.01=600Kg/day

Digester designe according to LGED:

- Vc = Vol. of gas collecting chamber
- Vgs = Vol. of gas storage chamber
- Vs = Vol. of gas sludge layer
- Vh = vol. of gas hydraulic chamber
- Vf = Vol. of gas fermentation chamber

Total volume of digester V = ($V_c+V_{gs}+V_f+V_s$)

Relations between the Parameters

Diameter of Digester, $D = 1.3078 \times V^{1/3}$ [8]

Vgs = Vh

Height of the upper parabolic shape $\mathbf{f}_1 = D/5$

Height of the lower parabolic shape $\mathbf{f}_2 = D/8$

Volume of upper parabolic portion $\mathbf{V}_1 = 0.0827 \times D^3$

Volume of lower parabolic Portion $\mathbf{V}_2 = 0.05011 \times D^3$

Volume of the cylindrical portion $\mathbf{V}_3 = 0.3142 \times D^3$

$$R_1 = 0.725 \times D$$

$$R_2 = 1.0625 \times D$$

$$S_1 = 0.911 \times D^2$$

$$S_2 = 0.8345 \times D^2$$

$$\mathbf{V}gs+\mathbf{V}f = 80\%\ V$$

Total volume of digester V = (Vc+Vgs+Vf+Vs)

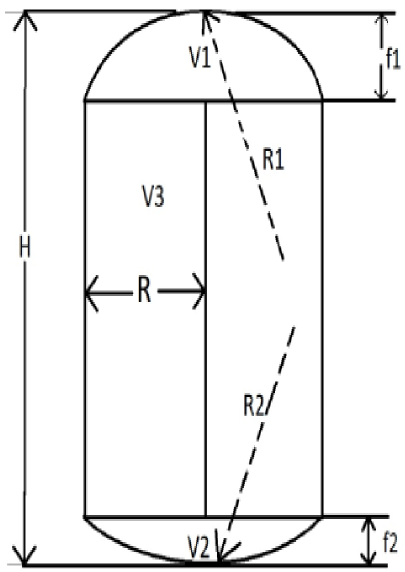


Figure 11: Various parameters of a digester

4.3 Volume calculation of digester for M. A. poultry farm

Volume calculation of digester chamber-size

A Digester Design for 6000 poultry [HEN] chickens,

Digester Type: Fixed Dome [For low cost]

Waste: Water = 1:2

Waste=0.1Kg/hen/day

Let, HRT = 40 days [For Temp. 30°C] [8]

Total Waste = 6000×0.1 = 600Kg/day

Total solid (TS) for poultry waste = 20%, [See appendix-A]

In 8% concentration of [to make favorable condition] [8]

8 kg solid poultry waste =100 kg influent

1 kg solid poultry waste =100/8 kg influent

120 kg solid poultry waste = $\frac{100\times120}{8}$

=1500 kg influent

∴ Total influent required Q =1500 kg

Water to exist additional to make the discharge 8% concentration of TS.

= 1500 kg – 600 kg

=900 kg

Working volume of digester = $V_{gs} + V_f$

$$V_{gs} + V_f = Q.\ HRT$$

$$= 1500 \times 40\ day$$

$$= 60000\ kg \qquad [1m^3 = 1000\ kg]$$

$$= 60\ m^3$$

From geometrical assumptions,

$$V_{gs} + V_f = 0.80\ V$$

$$60 = 0.80\ V \qquad [\text{ putting value, } V_{gs} + V_f = 60\ m^3]$$

$$V = 60/0.80$$

$$V = 75\ m^3$$

In Bangladesh fixed dome cylindrical digester desing is used.

$$\text{Diameter of digester , } D = 1.3078 \times V^{1/3}$$

$$= 1.3078 \times (75)^{1/3}$$

$$= 5.5\ m$$

For the cylindrical shape, V_3

$$V_3 = [(3.1416 \times D^2 \times H)/4]$$

$$H = \frac{4 \times 0.3146 \times D^3}{3.1416 \times D^2} \qquad \text{[putting, } V_3 = 0.3146 \times D^3\text{]}$$

$$H = \frac{4 \times 0.3146 \times (5.5)^3}{3.1416 \times (5.5)^2} \qquad \text{[putting, } D = 5.5\ m\text{]}$$

$$H = 2.20\ m$$

So, Diameter of the digester $= 5.5\ m$

Height of the digester $= 2.20\ m$

$f_1 = (D/5)$

$= (5.5/5)$

$= 1.1\ m$

$f_2 = (D/8)$

$= (5.5/8)$

$= 0.68\ m$

$V_1 = (0.0827 \times D^3)$

$= (0.0827 \times (5.5)^3)$

$= 13.75\ m^3$

$\mathbf{V}_2 = 0.05011 \times D^3$

$= 0.05011 \times (5.5)^3$

$= 8.4\ m^3$

$\mathbf{V}_3 = 0.3142 \times D^3$

$= 0.3142 \times (5.5)^3$

$= 52.30\ m^3$

$R_1 = 0.725 \times D$

$= 0.725 \times (5.5)$

$= 3.98\ m$

$R_2 = 1.0625 \times D$

$= 1.0625 \times 5.5$

$= 5.84\ m$

$V_c = 0.05 \times V\ m^3$

$= 0.05 \times 75\ m^3$

$= 3.75\ m^3$

$V_s = 0.16 \times V\ m^3$

$= 0.16 \times 75\ m^3$

$= 12\ m^3$

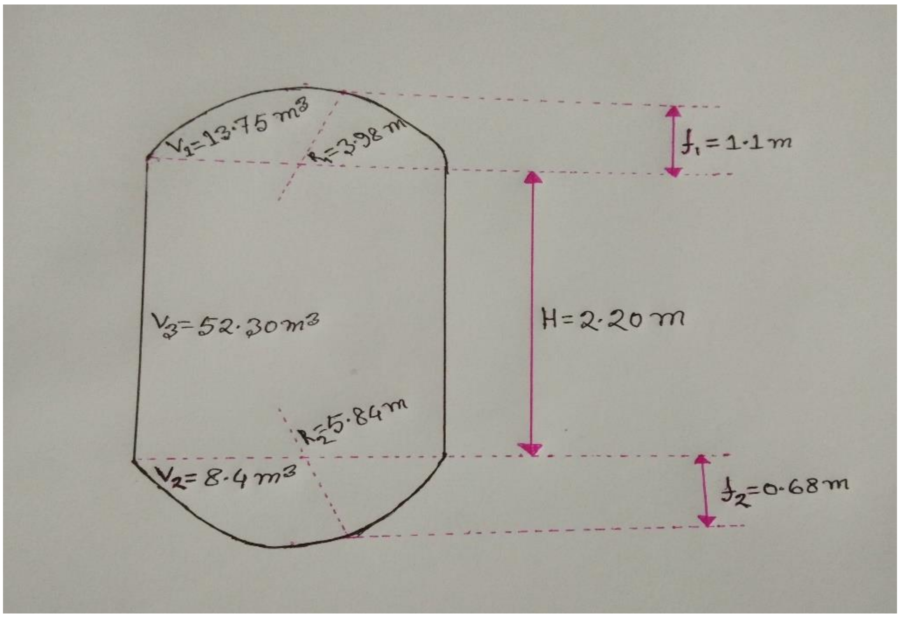


Figure 12: Different Measurement of Digester (6000 chickens)

V_{gs} = 50% of daily gas yield,

$= (0.5 \times TS \times K$ gas producing rate per kg TS) [where k = 0.28m^3]

$= 0.5 \times 120 \times 0.28\ m^3/kg\ Ts$

$= 16.8\ m^3$ ……………(A)

From (A) Let, $V_{gs} = 16.8\ m^3$

$V_{gs} + V_c = 16.8\ m^3 + 3.75\ m^3$

$= 20.55\ m^3$

Again , $V_1 = [(Vgs + Vc) - (\pi D^2 H_1)/4]$

$(\pi D^2 H_1)/4 = (Vgs + Vc) - V_1$

$$H_1 = \frac{(Vgs + Vc) - V_1}{\pi D^2} \times 4$$

$$H_1 = \frac{20.55-12.45}{3.1416\times(5.5)^2} \times 4$$

$H_1 = 0.286\ m$

Depth of the soil , $h_3 = f_1/2$

$= 1.1/2$

$= 0.55\ m$

Again, we know that

Diameter of the hydraulic chamber = D_h

$$V_{gs} = V_h$$

$$(\pi \times D_h^2 \times h_3)/4 = V_{gs}$$

$$D_h^2 = \frac{V_{gs} \times 4}{\pi \times h_3}$$

$$D_h^2 = \frac{16.8 \times 4}{3.1416 \times 0.55}$$

$$D_h^2 = 38.90\ m$$

$$D_h = 6.24\ m$$

Table 06: Calculation of gas production

Number of poultry [hen]	6000
Total waste kg	6000 × 0.1 = 600 kg
Daily gas production (m^3)	600 × 0.074 = 44.4

Result : - M.A. POULTRY FARM One day gas production = 44.4 m^3

4.4 The energy demand of farm

A farm named M. A. Poultry Farm of 6000 chicken was visited and below datas were collected.

Table 07: Energy demand of the visited (M . A . POULTRY FARM)

LOAD	NUMBER	WATT	TOTAL POWER	WORKING HOUR	UNIT (Kw-h)
motor	1	750	750	1	0.750
Light	20	32	640	4	2.56

Light	15	26	390	4	1.56
Light	8	5	40	7	0.280
Ceiling fan	10	75	750	8	6.00
Ceiling fan	8	75	600	4	2.40
Stand fan -24”	4	120	480	4	1.92
			Total = 3.65 kw		Total = 15.47(kw-h)

Daily Unit Energy consumption = 15.47 kw-h

(M . A . POULTRY FARM) max demand = 3.65 kw

M . A . poultry farm Generator Selection.

M.A poultry farm’s maximum demend is 3.65 KW

So, a 4 KW gas generator can be used to supply to enough electricity to the farm.

4.5 M. A. POULTRY farm electricity generation model

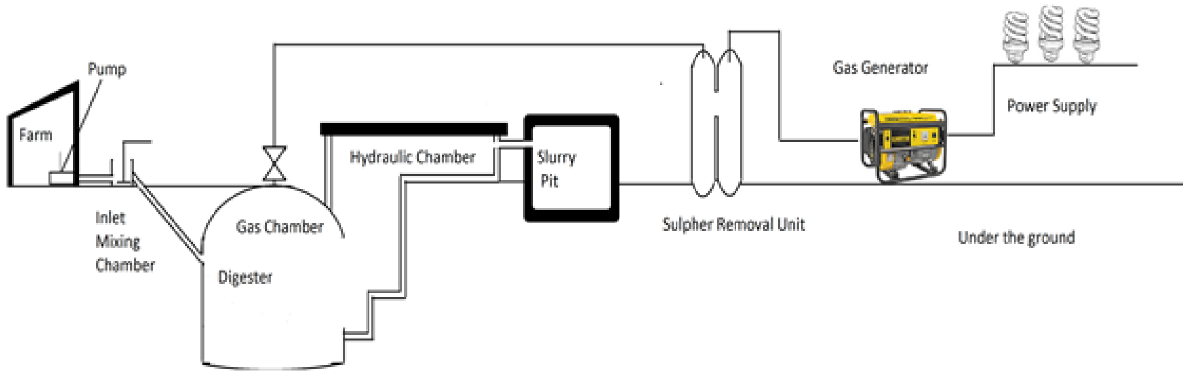


Figure 13: M. A. POULTRY farm electricity generation model

Receiving Tank/ Inlet: The waste is 1st taken to the receiver and mix-up with water to make the favorable total solid (TS) value of the waste. The waste wait in the receiver tank for 4-5 days and then it is send to the digester.

Digester: - Digester is the main part of a biogas plant. The process of gas generation called fermentation process occurs in the digester. The design of the digester should be such that no air can enter in to the digester. The generated gas in the digester gather in the upper part of the digester called gas collected chamber.

Outlet: - Due to the pressure of gas in the gas collection chamber some of waste goes out from the digester every day. They exit through the outlet.

Sulphur removal unit : - Bio-gas contains about 55-75 % methane. It also contains moisture, hydrogen sulphide and some other impurities. The main purpose of the gas purification unit is to remove these impurities.

Gas Generators: - Gas generators are internal combustion (IC) gas engines. They internally burn the biogas and convert the prospective energy of the biogas to mechanical rotation which next convert into electrical energy. The electrical energy is used to operate the electrical loads.

4.6 M. A. poultry farm daily electricty generation Calculation.

M . A . poultry farm one day gas production = 44.4 m^3

Generator Capacity (kw) = 4 kw

1 kw power generation require = 0.71 m^3

Solution ,

$$1 \text{ kw power generation require} = 0.71 \text{ m}^3 \text{ gas}$$

$$4 \text{ kw power generation require} = 4 \times 0.71\, m^3 \text{ gas}$$

$$= 2.84 \text{ m}^3 \text{ gas}$$

$$2.84 \text{ m}^3 \text{ gas produce} = 4 \text{ kw}$$

$$1 \text{ m}^3 \text{ gas produce} = \frac{4}{2.84}$$

$$44.4 \text{ m}^3 \text{ gas produce} = \frac{4 \times 44.4}{2.84}$$

$$= 62.53(\, kw\text{-hr}\,)$$

Existing Energy for sell = (62.53 – 15.47) kw-hr

= 47 kw-hr

4.7 Financial analysis

The following table contains detailed data of required initial investment for biogas plant:

Table 08: Total Investment for the Proposed Model

Capital cost item	Price	
	BDT	USD
Hydraulic chamber + Inlet	55000	647.15
RFL Pump (2HP)	15000	176.50
Slurry pit	86900	1022.50
Sulphur removal unit	44000	517.72
Pipeline & other	40000	472
Gas generator (4KW)	99850	1174.72
Sub-total cost	340750	4020.85
Transmission and protective circuit (5% of STC)	17037	201.03
Digester	180000	2117.94
Total Cost	537787	6345.88

After installing the biogas plant it requires maintances and it has to be oparated properly. So, there will be some expenses every year. The following table contain the operation and maintanance cost in detail.

Table 09: Opration & Maintenance cost

Cost factor	BDT/annual	USD
Digester cleaning	6000	70.8
Pipe Replacement	6000 (15% of piping cost table-08)	70.8
Generator overhanuling and repair	9000	106.2
Variable operating cost	6000	70.8
Technician cost	12000	141.6
Total cost	39000	460.2

The following table contains the annual income calculation for the plant from total electricity generation. The rate of electricity is considered to be BDT 9.24 per unit electricity.

Table 10: Annual income

Income	BDT/Month	BDT/Annual	USD/Annual
Electric Bill	$62.53 \times 30 \times 9.24 = 17333$	$62.53 \times 365 \times 9.24 = 210888$	2488.48

CHAPTER 5

Result and Discussion

5.1 Inroduciton

Biogas has great potential to cover a variety of markets, including electricity, heat, transportation fuels and also to use the gas for direct combustion in household stoves and gas lamps. However, in this chapter the findings of the study and financial evaluation are conveyed.

5.2 Results

Afer extensive research and anlysis it is found that the farm will produce **600 kg of waste** everday, using these waste a biogas plant of **75 m^3 digester** can be built to producd **44.4 m^3 of gas** everyday. Using a 4 KW gas generator 62.53 unit electricity can be genereated everyday which is more than the farm energy deman. So, after fulfilling the energy deman of the farm more energy can be sold.

FINANCIAL EVALUATION

The following data includes all the cost and annual income which can be genrated from the energy produced. The payback period of the investment can be calculated from these data.

Total investment cost	BDT 537787
Annula operation and meintanance cost	BDT 39000
Annual income from total energy production	BDT 210888

Net annual cash inflow = Annual Income - Opration & Maintenance cost

$$= 210888 - 39000$$

$$= 171888$$

Payback period = Investment required/Net annual cash inflow

$$= 537787/171888$$

$$= 3.12$$

$$\approx \mathbf{3.5\ year}$$

5.3 Summary

The result shows a promissible data for a profitable plant. These data can be further used to determine the net profit from the plant. Moreover, this study can be a guide for any biogas plant for any farm.

Chapter-6

Conclusion

6.1 Conclusion

Lack of awareness and motivation are resons for some unseuccessfull biogas plant in bangladesh. So, it is neccesary to develop awareness among the people and spread motivatio that can eventually produce many successful biogas plant and meet their dayily need of energy and also contribute to the counry to reduce carbon emmision and waste problem created by farms. Thus, playing great role in sucuring a safe environment for all.
Moreover, this idea of installling biogas plant for poultry farm can benefit the farmer in many ways economically and environmentally.

6.2 Future Scopes of the Work

The study can be further extended to dtermine the profit of the plant after the paybacke period.

REFERENCES

[1] [Online]. Available: https://geology.com/world/bangladesh-satellite-image.shtml.

[2] [Online]. Available: https://en.wikipedia.org/wiki/Bangladesh.

[3] [Online]. Available: https://en.wikipedia.org/wiki/Freedom_of_religions in Bangladesh 2016.

[4] [Online]. Available: https://www.iea.org/countries/Bangladesh.

[5] [Online]. Available: https://trackingsdg7.esmap.org/country/bangladesh.

[6] M. E. M. A. R. Khan, "Review of biogas digester technology in rural Bangladesh.," *DiVA,* 2016.

[7] M. Ali, The Use and Status of Biogas Plants of Pabna District in, Germany, March 2005.

[8] G. B. F. A. Rabiul Islam, "Design and Benefit Analysis of Biogas Plant for Rural Development in Bangladesh," *International Journal of Engineering and Advanced Technology (IJEAT),* vol. 3, no. 3, February 2014.

[9] S. M. N. H. S. M. A. H. M. R. N. Md. Nurul Islam1, "Prospect of rural electrification through biogas in Bangladesh-design & feasibility study of biogas based electricity facility of a poultry farm," in *Rcsearchgate*, Rajshahi, Bangladesh, 2017.

[10] [Online]. Available: https://www.iea.org/data-and-statistics/charts/total-primary-energy-supply-by-fuel-1971-and-2018.

[11] [Online]. Available: https://ourworldindata.org/energy-access. [Accessed september 2019].

[13] [Online]. Available: https://geology.com/world/bangladesh-satellite-image.shtml.

[14] [Online]. Available: https://www.iea.org/countries/Bangladesh.

Appendix -A

Matterial	Body weight(Kg)	Discharge per day kg	TS Value of fresh discharge(% by wt)	Water content	Water to be added with fresh discharge to make the TS value 8%(Kg)
Chikens	1.5	0.1	20	80	0.15
Cow	200	10	16	84	10
Human	50	0.5	20	80	0.75