**Proceedings of the**
**International Conference on Mechanical Engineering and Renewable Energy 2017**
**(ICMERE2017) 18 – 20 December, 2017, Chittagong, Bangladesh**

**ICMERE2017-PI-323**

# HYBRIDIZATION OF HUMAN DROSS ENERGY TO RENEWABLE ENERGY

**S.M. Iftakharul Islam[1,*], Sheikh Ahmad Imtiyaz[2], Md. Mahbub Hasan[3]**

[1]Department of Civil Engineering, Bangladesh Army University of Engineering & Technology, Qadirabad Cantonment-6431, Natore, Bangladesh
[2,3]Department of Electrical & Electronic Engineering, Bangladesh Army University of Engineering & Technology, Qadirabad Cantonment-6431, Natore, Bangladesh
[1,*] smii.jilani@gmail.com, [2]imtiyaznafi11@gmail.com, [3]xsobuz@outlook.com

***Abstract-*** *Human dross energy (HDE) is that kind of energy by which human abandons can be easily and frugal costly transformed into renewable fuel energy. By this project biogas can be produced from dwelling house and other institutions' septic tanks' solid wastes. In case of large institutions' separate septic tanks will be connected to a common septic tank for producing large amount of biogas, which can be able to bear a satisfactory amount of required usable fuel energy. Resulting amount of biogas from this project can be usable as generator's fuel like fossil fuel. Not only in urban areas but also in rural areas during construction of house holdings or other institutions septic tanks can be used as HDE project's mainframe. HDE based project mainly helpful for rural areas to satisfy the minimum demand of electricity.*

**Keywords:** Renewable Energy; Human Solid Waste; Septic & Filter Tank; Rural & Urban Purposes; Cost & Maintenance.

## 1. INTRODUCTION

Now-a-days for continuously flourishing population to satisfy the minimum requirement of fuel is becoming a titanic challenge. For a developing country like us it is a burning issue. With a view to satisfy the future demand of fuel and reduce the dependence for rapidly growing population some developed countries from Asia and Europe have given priority to the renewable energy. And most of them have succeeded in this sector. Though Bangladesh is a developing country, we are lack behind in renewable energy, where it is very necessary to cope up with the demand of fuel with respect to continuously rising population. Cost of petrol, octane including fossil fuel's price is constantly rising which creates bad effects in economy. It is almost difficult to bear those costing for general people. In our country it's been running from earlier to produce biogas as renewable energy by using cow dung and household rotting wastes. But it's practice is only limited within the rural and remote areas. Moreover, to establish a biogas plant extra space is required. This kind of extra space is also insufficient in urban areas. The Government has taken solar panel projects to satisfy the demand of electricity. But due to the excessive high price of modified solar panels this project can't able to extent properly. As a result the demand of fuel and electricity can't be satisfied [1]. On the contrary the problem has risen gradually. In the circumstances stated above, HDE project is commenced. By this project using human solid waste, renewable energy (Biogas) can be produced. For producing biogas human solid is a easily obtainable raw material. Usually human solid waste is stored in house holdings' or institutions' septic tank. As a result, there is no necessity to establish an external plant. Predominately the actual motive of this project is to produce biogas from human solid waste from septic tank and transform them to be utilized. Hence, this project can be applicable for both urban and rural areas. Which is frugal than any other projects and it can gratify the demand of minimum amount of fuel and electricity for house holdings including different institutions.

## 2. WHY RENEWABLE ENERGY IS PERFECT FOR BANGLADESH

Renewable energy is energy generated from natural resources - such as sunlight, wind, rain, tides and geothermal heat which are renewable (naturally replenished). Renewable energy technologies range from solar power, wind power, hydroelectricity/micro hydro, biomass and biofuels for transportation [1]. It is a clean source of energy, meaning, it has low or zero carbon and greenhouse emission. Fossil fuels emit high levels of greenhouse gas and carbon dioxide, which are greatly responsible for global warming, climate change and degradation of air quality [2]. Fossil fuels also contribute to sulfur emission to the atmosphere leading to acid rains. Acid rains can cause damage to buildings. Human dross energy considered eco-friendly because they emit zero toxic gases to the environment. The use of renewable energy dramatically reduces the dependence on fossil fuel as a source of energy, hence, cutting back on air pollution. Secondly, septic tank usually is constructed

during the construction of building. So, it is not necessary to build any external biogas plant. Hence, the cost of construction is negligible. Now, focusing on our power transmission & distribution sector. Demand of electricity is rising gradually with a view to upgrading economic activities in our country with GDP growth. The maximum demand in Fiscal Year 2016 was 11,405 MW (as per PSMP-2010) [3]. Our total installation capacity is 12,365 MW including 2974 MW IPP/SIPP, 2,028 MW Rental Power Plant & 251 MW REB (for PBS) and 600 MW power which is imported from India [3]. Our maximum peak generation in 2015-16 was 9036 MW which was 15.59% higher than previous year [3]. The strong reasons which are mainly responsible for lower peak generation with respect to generation capacity are as follows: (1) - some plants are out of operation for maintenance, rehabilitation and overhauling. (2) – Capability of some plants decreased due to aging and (3) – gas shortage [3]. Population across our country is increasing rapidly day by day. Demand of power or electricity has also gradually risen. To satisfy this amount of power or electricity we need more power plants. If we concentrate on the relationship between demand of power and year we can find the curve which is given below. If we focus on the statistics we can find following information.

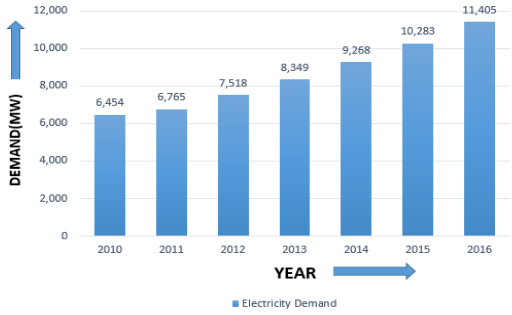


Fig 2.1: Electricity demand curve

Moreover, for more power plants we need more fuel. But for last four or five years cost of fuel has rapidly increased. The following curve shows us relation between four types of fuels which are mainly used in the power plants of our country. And, this curve represents that fuel price has increased gradually.

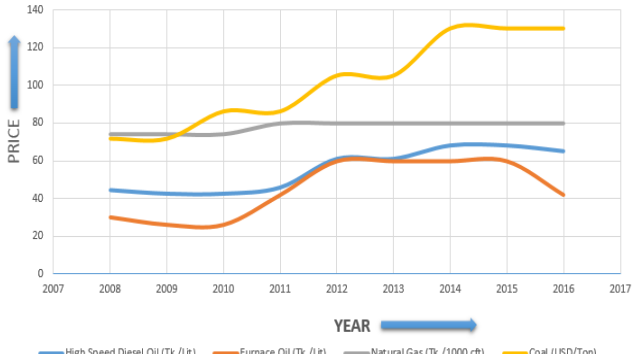


Fig 2.2: Increment of fuel price with respect to year

Renewable energy applications usually need less patronage than conventional generators. Their fuel being executed from natural and accessible resources reduces the cost of performances. Which is more, renewable energy produces barely waste products like as carbon dioxide or other chemical pollutants, so has minimal influence on the environment. Renewable energy based projects can also fetch economic benefits to many native areas. As so many perspectives it is clear that, renewable energy is fit for Bangladesh.

## 3. THEORITICAL BACKGROUND & METHODOLOGY

Human waste, further acquainted as human excreta, which is a misuse type usually used to refer to byproducts of assimilation, like as feces and urine. There are so many various ways in which human solid waste can be gathered, managed and reused, depending on the sanitation system. This project explores human solid waste as feedstock in a septic tank (bioreactor) to produce methane gas for producing energy [4-9]. We are interested in the practicability of structuring a household reactor which instead utilizes human solid waste as the project's initial input. When organic element (consisting human feces, urine) is pickled by microorganisms in the non-appearance of oxygen (anaerobic) a gas is released comprising of 60% methane and 40% carbon dioxide [4]. This gas is generally named biogas and because it can be intoxicated, may be used as a cooking and heating agent. Assimilated to animal waste, human feces and sanitary waste have been used for producing methane gas in limited scale in most of the developing countries. Human solid waste include pathogens and has invective smelling. Anaerobic assimilation mitigates a number of other natural attention. The solid and liquid remainders from the anaerobic assimilation process can be used as a source of energy [5]. Methane is produced by the bacterial aberration of organic elements in the non-appearance of oxygen [5]. Biogas is a flammable gas generated by anaerobic fermentation of organic elements by the operation of methanogenic bacteria. This gas is mainly composed of methane (50 to 70 percent) and carbon dioxide (30 to 40 percent). Mean formation of bio-methane is pointed below in Table 3.1.

| Element | Beacon | Percentage |
|---|---|---|
| Methane | $CH_4$ | 50-70 |
| Carbon dioxide | $CO_2$ | 30-40 |
| Hydrogen | $H_2$ | 5-10 |
| Nitrogen | $N_2$ | 1-2 |
| Water Vapor | $N_2O$ | 0.3 |
| Hydrogen Sulphide | $H_2S$ | Traces |

Table 3.1: Average formation of Bio-methane

There are four original biological and chemical period of anaerobic assimilation: (i) Hydrolysis, (ii)Acidogenesis, (iii) Acetogenesis, (iv)Methanogenesis. [5]

In maximum cases, biogas is produced from large organic polymers. In anaerobic digesters these large

chains must be broken down into their smaller components for the bacteria to access the energy potential of the element. The method of breaking these chains and dispersing into smaller molecules fluidity is called hydrolysis [5]. This is why hydrolysis is necessary in the first step in anaerobic assimilation. Breaking down of the remaining elements by acidogenic bacteria which is known as acidogenesis [5]. The next step is acetogensis. In acidogensis phase simple molecules are created which are further digested by acetogens. And hugely produce acetic acid which is composed of carbon dioxide and hydrogen [5]. The final stage of anaerobic assimilation is Methanogenesis. In this stage, methanogens use the intermediate products of the previous stages and transform them into methane, water and carbon dioxide. These elements make the majority of the biogas cast down from the system. Methanogenesis occurs between pH 6.5 and pH 8. The simplified chemical reaction in particular procedures is illustrated in equation 3.1

$$C_6H_{12}O_6 \longrightarrow 3CO_2 + 3CH_4 \ldots\ldots\ldots (3.1)$$

## 4. SYSTEM DESCRIPTION

Our total system mainly embedded in septic tank. Unlike other biogas projects we don't need to construct an external plant. We need to add some essential components in septic tank for producing biogas and transform the gas to energy [4][8].

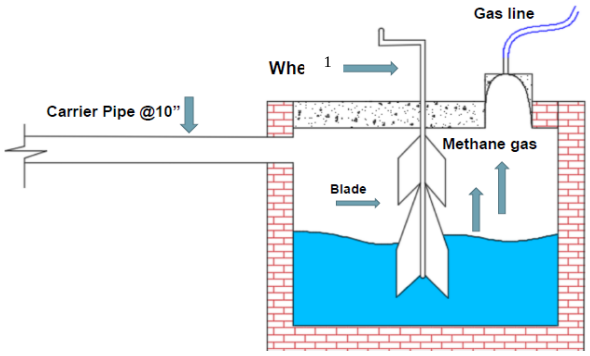


Fig 4.1: Primary components connected with septic tank

For our project the required components are as follows: firstly a carrier pipe is connected to the septic tank. Next, wheel 1 including a blade is connected to the septic tank. Here, wheel 1 is connected in outside or upper portion of septic tank and blade is connected in inner portion of the septic tank. Gas line 1 is connected in the upper portion.

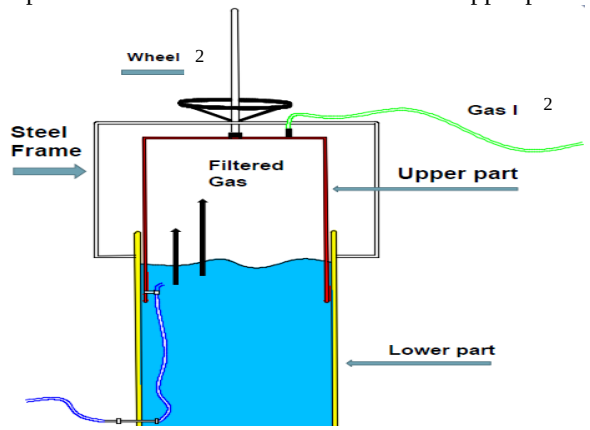


Fig 4.2: Secondary components of HDE

A steel frame from upper part is attached with filter tank which has lower part including a gas pipe. Wheel 2 is connected in the upper portion and it's for increasing inner pressure. Unrefined methane gas which arrives through gas line 1, will be purified through the gas pipe in water of lower part of the filter tank. Lower part of filter tank is filled with 85% of water. Gas line 2 is also connected in upper portion for gathering output biogas.

## 5. SYSTEM OVERVIEW DIAGRAM

The proposed project can be separated into four principle parts. The four operating parts are as follows: (i)- Lavatory, (ii)- Carrier pipe, (iii)- Septic tank, (iv)- Filter tank. The block diagram of the total HDE project is illustrated in the following figure.

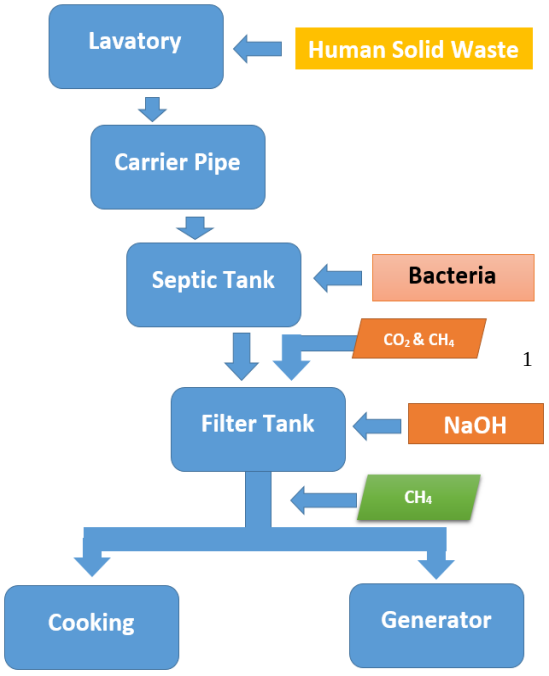


Fig 5.1: Block diagram of HDE project

Firstly, human solid wastes from lavatory fell down into septic tank through carrier pipe. Septic tank reserve the solid waste. Next, with presence of septic tank's inner bacteria human solid wastes will begin to decompose gradually. Since we need more fuel for running generator or for cooking, we need to add more bacteria manually and by rotating wheel 1 we can acquire more gas in output. Methane, carbon dioxide and a few amount of some other gases can be found through gas line 1 which is 65.5% pure. From gas line 1 methane gas needed to be purified. To purify methane gas from other gases, gas line 1 needs to be entered into lower part of filter tank. We need to add Sodium hydroxide in lower part of filter tank for removing excessive amount of Carbon dioxide. After purifying the gas, we will find at least 90% pure Methane gas as output from gas line 2. This output gas is usable for cooking or transforming power from generator.

## 6. PROJECT OUTCOME ANALYSIS

HDE project's mainframe is divided into two main parts. First one is primary part (septic tank) and another one is secondary part (filter tank). Septic tank needs to be modified with wheel 1 with steel blade, gas line 1 and valve. Constructing the HDE project for 5 to 6 members, primary part (septic tank) modifications are as follows:
Wheel 1 and 20 kg of blade = (68 BDT×20) = 1360 BDT. For a 15 ft. gas line = (40 BDT×15) = 600 BDT. For 4 pieces valve = (60 BDT×4) = 240 BDT.
Secondary part (filter tank) needs to be modified with lower part (steel sheet), upper part (tank) and wheel 2 with frame and gas line 2. Secondary part (filter tank) modifications are as follows:
Lower part (steel sheet of 0.65 cm thickness) = (160 BDT×96) = 15360 BDT. Upper part (tank) = (160 BDT × 94) = 15040 BDT. Wheel 2 with frame of 10 kg = (68 BDT × 10) = 680 BDT. Gas line 2 ( 2cm of diameter) = (35 BDT×20) = 700 BDT. Labor cost = 2500 BDT. In total = (1360+600+240+15360+15040+680+700+2500) BDT = 36480 BDT

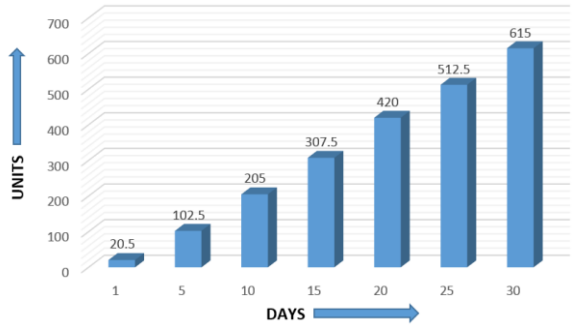

Fig 6.1: Units consumed from national grid

On the contrary, constructing cost of other or traditional bio gas plants is as follows for standard purose:
Brick (1000 pcs) = (8 BDT×1000) = 8000 BDT. Cement (15 bags) = (400 BDT×15) = 6000 BDT. Sand (110 cft) = 1700 BDT. R.C.C pipe (12 ft) = 970 BDT. Gas line (pipe) = 1500 BDT. Labor costing = (8800 BDT×7) = 61600 BDT. Others = 3000 BDT. In total = (8000+6000+1700+970+1500+61600+3000) BDT = 82770 BDT
A consumer's (a family of 5/6 members) hourly costs:
When they use 3 fans (3×80 wt.) = 240 wt. 3 lights (3×40 wt.) = 120 wt. 1 refrigerator = 370 wt. 1 television = 75 wt. Other electronic devices = 50 wt.
In total = (240+120+370+75+50) wt. = 855 wt. and unit per hour = 0.85 kwh.
For 1 day, total unit = (0.85×24 hours) = 20.5 units
For 30 day, total unit = (20.5×30) = 615.6 units
It exceeds 600 unit range and as per tariff order prescribed by Bangladesh Energy Regulatory Commission, the price of per unit is 9.98 BDT [6], [3].
Cost for 615.6 unit = (615.6×9.98) = 6143.6 BDT
On the contrary, by using generated power from HDE project:
For 4 hours = (0.8×4 hours) = 3.2 units
For 1 day = 3.2 units
For 30 days = (3.2×30) = 96 units
Cost for 96 units = (96×9.98) = 958.08 BDT
By using HDE project a consumer needs to pay = (6143.6 – 958.08) = 5185.52 BDT.
So, 958.08 BDT can be saved.

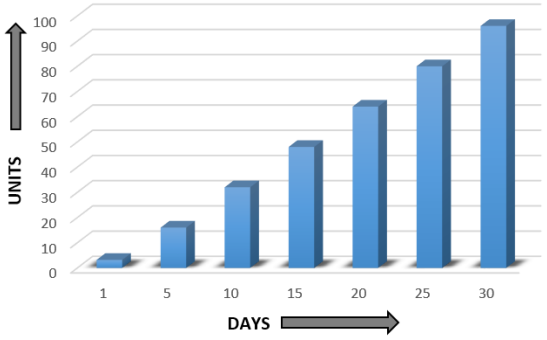

Fig 6.2: Units saved by HDE project

Sources of renewable energy, human solid waste is one of major elements for producing fuel for generating power. The production of energy from wastage is not a recent idea, though it is a sector which requires pragmatic attention [7]. Numerical energy conversion technologies are obtainable. This HDE project is closely effective as 958.08 BDT has been reduced.

## 7. CONCLUSION

Figuring out all the steps of generating power, Bangladesh should focus on this type of energy generation system's applications because our country has titanic resources of bioenergy that are not still exploited. For a developing country like us this kind of project is very helpful for satisfying minimum demand of power [10]. There are some conventional, diplomatic and financial interruptions but these can be executed. This project has efficient perversion and developed technological applications. Moreover, it also includes environmental advantages too. It reduces pathogen altitudes, greenhouse gas discharge etc. But, there is also some limitations. While converting the output gas to electrical energy, a considerable amount of energy losses as heat and several mechanical losses which is system loss applied by electrical generator. So, this project can be an alternative power generation plan when supply or generation is not available from national grid.

## 8. ACKNOWLEDGEMENT

We, the authors are very obliged to Engr. Md. Momtazur Rahman, Assistant professor, Department of Electrical & Electronic Engineering, Bangladesh Army University of Engineering & Technology for his remarkable support and guideline during the progress of this work.

## 9. REFERENCES

[1] Khairul Anam, Husnain-Al-Bustam, "Power Crisis & Its Solution through Renewable Energy in Bangladesh", Cyber Journals: Multidisciplinary Journals in Science & Technology, *Journal of Selected Areas in Renewable and Sustainable Energy (JRSE)*, and September-2011.
[2] Govinda Prasad Devkota, "Large size and cost effective biogas plants for commercial uses", Biogas

Experience Sharing Event, Organized by World Bank, Kathmandu, Nepal June, 2014.
[3] Bangladesh Power Development Board, Annual report 2010-2016.
[4] Paul Andrew Cook, "Design of a Household Human Waste Bioreactor", Stanford University, September 2010.
[5] Kayode Feyisetan Adekunle, Jude Awele Okolie "A Review of Biochemical Process of Anaerobic Digestion"
[6]http://bd.bpdb.gov.bd/download/tariff/Tariff%20order.retail_9.1.2015.pdf
[7] Memorie, A.(2013) Global Conference on Rural Energy Access: A Nexus Approach to Sustainable Development and poverty Eradication Economic Comission for Africa. Sustainable energy for all: UN-Energy. Addis Ababa, Ethiopia.
[8] S.N. Naik, V.V.G., Prasant K. Rout, Ajay K. Dalai, *Production of first and second generation biofuels: A comprehensive review.* Renewable and Sustainable Energy Reviews, 2010. 14(2010): p. 578-597.
[9] Sunil Kumar*, S.A. Gaikwad, A.V. Shekdar, P.S. Kshirsagar, R.N. Singh, "Estimation method for national methane emission from solid waste landfills", National Environmental Engineering Research Institute (NEERI) (Accepted) February 2004.
[10] Tarek A. Hamad, Abdulhakim A. Agll, Yousif M. Hamad, John W. Sheffield "Solid waste as renewable source of energy: current and future possibility in Libya"