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Techno-Commercial Feasibility analysis of Biogas plant in central India

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Abstract - In the fast growing world energy and climate is the most important concern. The world is using its conventional energy tremendously which have huge environmental impact. Energy from hydrocarbons contributes 2/3rd of the total world requirements which is exhaustive in nature. India have more dependency on the imports of petroleum which causes a heavy burden of Bill's for country.

India have such a wide growing economy which increases energy demand. This can be fulfilled by using the renewable energy. We call renewable technologies CLEAN and GREEN because they produce few of any pollutants. The development in BigCNG taking shape in the energy market which reduce conventional sources.

BioCNG can be produced from various sources such as animal waste , sewage treatment, cities wastes etc. These have huge methane potential. This paper proposes the sustainable model for biogas plant. Also provides the detailed techno-commercial analysis in Central India energy needs. It improves the environmental conditions of world and help in maintaining Earth's average temperature.

The NPV is found to be positive and payback period is 2.9years. The biogas is found to be 8.72% cheaper with CNG, 20.8% cheaper with domestic LPG, 146.4% cheaper with petrol, 117.19% cheaper with diesel, 7.3% cheaper with auto LPG.

Key Words: BioCNG, Financial analysis, Technical analysis, Social, Organic Fertilizer, MNRE, NPV, Anaerobic Digester, Emission, Payback Period.

1.INTRODUCTION

Energy is the lifeline of every society and country. It is the future wealth of any country. Due to scarcity of petroleum and coal it threatens supply of fuel throughout the planet also problem of their combustion results in research in several corners to urge access the new sources of energy, like inexhaustible energy resources. Solar energy, wind energy, different thermal and hydro sources of energy, biogas are all renewable energy resources. But, biogas is distinct from other renewable energies due to its characteristics of using, controlling and collecting organic wastes and at an equivalent time producing fertilizer and water for use in agricultural irrigation. Biogas doesn't have any geographical limitations nor does it requires advanced technology for producing energy, also it's very simple to use and apply [1].

1.1 Background

As study is focused on the outskirts of Bhopal it is important to introduce the current situation of this location concerning to the general characteristics and the management of Energy.

General Characteristics of DOB Village:

Village Dob is located in Bhopal District of Madhya Pradesh State which is the part of central India. It is located at a distance of (21- 28) km from its district headquarter. It is approximately 511m (1677 ft) above the sea level. It is located in Huzur Tehsil which is near the Bhopal Bypass. It comes under the sub urban area of Bhopal city. The maximum and minimum temperature of the area is 5.8^{0}C and 43.9^{0}C as respectively with an average temperature of 25.6^{0}C. The climatic condition of area is Humid-Sub Tropic. The people of this area area involved in the Agri Industries and Farming.

Figure 1 Satellite view of plant

2. BIOGAS

BIOGAS is produced by microbes through the bio-degradation of organic material under anaerobic conditions. Natural generation of biogas is an important part of bio-geochemical carbon cycle. It can be used both in rural and urban areas.

The philosophy of Biogas plant is based on the pronouncement that "Nothing should go waste" and that all organic waste products should be put to such a good use, so as to give you good returns in terms of Biogas and Organic manure.

We often call renewable energy sources "clean" and "green" because they produce few of any pollutants. This gas is useful as fuel to substitute firewood, cow-dung cake, petrol, LPG, diesel, & electricity, depending on the nature of the task, and local supply conditions and constraints.

3 OBJECTIVE

It is important to note that non-renewable resources are significantly depleted by human use, whereas renewable resources are produced by ongoing process that can sustain indefinite human exploitation. Therefore the dependency on the renewable resources i.e. biogas is rapidly increasing worldwide because it gives the conversion of waste into useful energy.

The main objective of the current work is to scrutinize the techno-economic feasibility of a plant involved in the production of Biogas, Organic Fertilizer and Insecticide with the treatment of Cow Dung.
To achieve these the following objectives are analyzed:

Evaluate the payback period of the plant.
Evaluate the feasibility of plant by NPV.
Compare the cost of BioCNG with other fuels.
Analyse the break even percentage for the plant.

4. METHODOLOGY

4.1 Anaerobic Digestion

Anaerobic Digestion can be process of decomposition of organic matter in absence of air. The products of Digester has Gas and Digestate. Digestate is the component which gets substrated in the process of the taking Biogas. In operation of AD, little or no heat is generated in divergance to aerobic decomposition (in presence of oxygen), like which is in the case of composting. The energy, which is chemically attached within the substrate, remains for the most part within the produced biogas, in sortage of methane. The system of biogas formation may be a result of joined process steps, during which the initial material is regularly weakening into smaller units. Particular groups of micro-organisms are involved in each individual step. These organisms successively breakdown the products of the previous steps. The simplified diagram of the AD process, shown in Figure 4.5, the four main process steps are: hydrolysis, acidogenesis, acetogenesis, and methanogenesis [56]. The speed of the entire decomposition process is decided by the slowest reaction of the chain. Within the case of biogas plants, processing vegetable substrates containing cellulose, hemi-cellulose and lignin, hydrolysis is that the speed determining process. During hydrolysis, relatively small amounts of biogas are produced. Biogas production reaches its peak during methanogenesis.

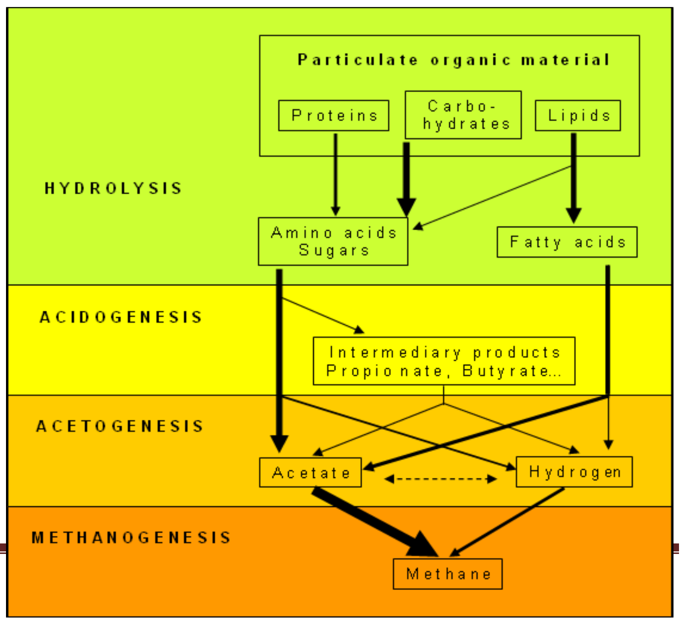

Figure 2 Steps of Anaerobic Digestion (AD)

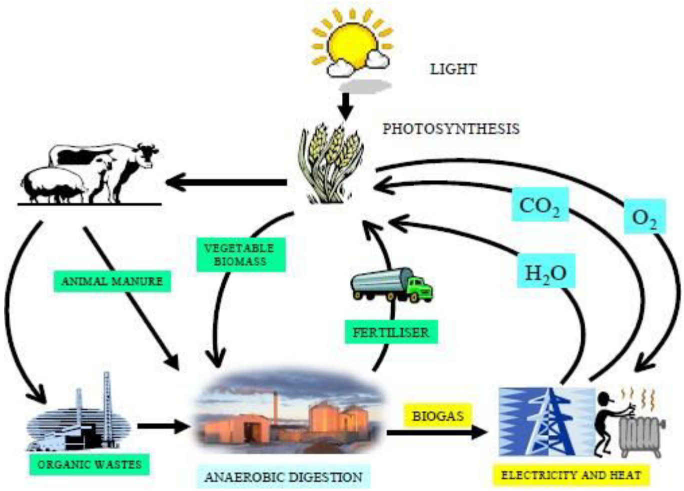

Figure 3 The sustainable cycle of biogas from AD

4.2 Technical Analysis

The technology which is more popular for the biogas enrichment is PSA (Pressure swing adsorption). This is a typical system which consist of the vessels in series that is capable of removing CO_2, H_2S, water vapour from the biogas series. After passing through the vessel the gas has attained the presence of Biogas CH_4 upto 95%.

Figure 4 PSA for BioCNG enrichment

5 ECONOMIC ANALYSIS

Table 1 Plant Specifications

Sl. No.	Parameter	Details
1	Capacity	$3000m^3$
2	Input of Plant	Cow Dung
3	Area of Plant	2 Acres
4	Total Employee	26
5	Composition of Gas	CH_4
6	BioCNG	1200Kg/Day
7	Bio Fertilizer	9T/Day

The investment cost is the sum total of money invested in the biogas plant. It will be the promoter capital and the amount borrowed. The lifespan of the system is taken to of 18 years which is average value for biogas plants. Cost of land and subsidy is excluded from the analysis.

The income of the plant is generated from the sales of the BioCNG, Fertilizer and Vermiwash. It is assumed that the cow dung supply can be maintained throughout the year and entire life of project. All the calculations are on the assumption of total plant capacity.

Table – 2 Project cost after subsidy

Fund Resources	Value in Rupees
Promoters Equity	100
Fin. Inst. / Bank Loan	251
MNRE Subsidy *	-60
Others	60
Total Project Cost after MNRE Subsidy	351

Table 3 Annual Cash Flow details.

Description	Value (Rupees)
Revenue	62086500
Expenditure	49986500
Net Cash Flow(Revenue-Expenditure)	12100000

$$NPV = \sum_{t=0}^{N} \frac{Rt}{(1+i)^t} \quad \text{Equation (1)}$$

Where,

i is the discount rate (%)

N is the total number of periods

Rt is the cash flow in year t

The discount rate is the interest which is used to calculate the present value of future cash flow. It reflects the risk.

The period time is the average life of biogas technology with proper scheduled maintenance.

The Discount rate is taken as 5%

The number of period is taken as 18 as the life of digester.

Table 4 Net present value (NPV)

Sl. No.	Undiscounted Cash Flow	Discount Factor	Present Value
1	35100000	1	-3510000
2	12100000	.952	11519200
3	12100000	.907	10974700
4	12100000	.863	10442300
5	12100000	.822	9946200
6	12100000	.783	9474300
7	12100000	.746	9026600
8	12100000	.711	8603100
9	12100000	.677	8191700
10	12100000	.645	7804500
11	12100000	.612	7405200
12	12100000	.585	7078500
13	12100000	.557	6739700
14	12100000	.530	6413000
15	12100000	.505	6110500
16	12100000	.481	5820100
17	12100000	.458	5541800
18	12100000	.436	5275600
19	12100000	.415	50215000
	NPV	(131028500-35100000) = 95928500	

Table 5 Comparision of cost of energy.

Fuel	Calorific Value	Fuel Cost*	Cost of Energy
CNG	52000kJ/kg	Rs. 63/kg	825kJ/ Rs.
BIO- CNG	52000kJ/kg	Rs. 58/kg	897kJ/ Rs.
Auto -LPG	46000kJ/kg	Rs. 55/kg	836kJ/ Rs.
LPG Domestic	46000kJ/kg	Rs. 62/kg	742kJ/ Rs.
Petrol	36000kJ/litre	Rs.99/litre	364kJ/ Rs.
Diesel	37200kJ/litre	Rs. 90/litre	413kJ/ Rs.

6. RESULT

The plant is in good condition as its payback time is estimated and found to be 2 years and 11months which is suitable for the biogas plant. Its investment will be recovered in this period and the investor will earn profit from this.

The NPV for the plant is found to be positive (Rs. 95928500) in nature which is a good sign for the investor because the project will be feasible in nature. If it is negative then it will be create a debt for the investor in this area.

The biogas is found to be 8.72% cheaper with CNG, 20.8% cheaper with domestic LPG, 146.4% cheaper with petrol, 117.19% cheaper with diesel, 7.3% cheaper with auto LPG.

The Average BEP in three years is 66.37% and it is decreasing in nature.

7. CONCLUSION

It is good for the farmers to generate the income by selling the dung of their cattle. It will be huge scope for the upcoming biogas projects in these areas.

The payback period of 2.9 (2 years and 11 months) is better of recovering the cost of investment comparison with the other scenario. The NPV is also positive (Rs. 95928500) which motivate the investor for the investment company may increase its revenue by introducing the other products in the market.

The technology selected for treatment of waste was the dome-shaped digester. This technology suits better the conditions of the area in comparison to the other availiable biogas technologies evaluated by analyzing the lifespan, the technical knowledge and skills, the structure and the investment costs benefits.

The model for the techno-economic analysis was defined based on the dome-shaped technology. The results from techno-economic analysis showed that implementation a biogas plant in the central India is economically feasible for the present scenario. It has to be mentioned that these results are estimated when organic fertilizer are commercially used for earning revenues.

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