IMPACT OF BIOGAS MICRO TURBINE BASED ELECTRICITY GENERATION ON SUSTAINABLE RURAL DEVELOPMENT - AN EMPIRICAL STUDY

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The performance and impact of a decentralized biogas micro turbine-based power generation system in electrifying villages have been discussed in this paper. The paper discusses the effect of biogas linked micro turbine based electricity generation, distribution and economics as most of the time electricity is not present in the villages. The system consists of a bio-gas based 2 units of 30 kW capacity of micro turbine generator system with all accessories. The biogas which is used as fuel has been locally produced by Mohan Dairy Purulia. Some portion of generated electricity has been used for internal lighting. The project has been model based, not functioning round the clock. The cost of electricity has been INR 4.5/ kWh. The by-product manure, of one year is of the value of INR 388800/- . The payback period of the overall system is 3.7 years for a 65kW capacity plant, without considering the CDM benefits. Local villages are very fortunate to get electricity from this micro turbine based power generation unit. The income level of these people has certainly gone up and the quality of life has seen a positive change. Utilization of cow dung has become very easy for Mohan Dairy. After in house consumption, the rest of the generated power is transmitted to the grid of a local village that is connected with the main grid.

Keywords : Bio-Gas Micro Turbine

INTRODUCTION

Access to electricity is essential for the all round development of the rural economy of India. But, since independence, only 44 percent of rural households have been electrified and that too with poor quality of electricity (in terms of low voltage and irregular power supply). As an alternative to grid electricity, among all the renewable energy sources, energy from biomass is the largest, most diverse and readily exploitable resource (World Bank 1996). The government of India has set a goal of providing per capita electricity availability of 1000 kWh by 2012. Even assuming that this goal is achieved by 2016, this would mean a generation capacity of 295,000 MW and supply levels of 1400 billion kWh/year. The long range planning indicates that by 2031-32, India will require a generation capacity of around 700,000 MW and supply levels of 3500 billion kWh/year.

As per the estimates of the Ministry of Power, government of India [1], there is a power shortfall to an extent of 8% in the country. It has planned to mitigate this shortfall by increasing the share of renewable sources in the energy portfolio. Renewable energy is also intended to be used in decentralized power generation systems in order to mitigate the power crises in the rural areas. This concept of decentralized power generation and distribution has been successfully demonstrated in Mohan Dairy This plant consists of a 2 X30 kW unit with a total of 60 kW capacity of power generation system, which is under the demonstration model presently in working condition.

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It is a well established fact that access to quality, reliable and affordable energy is critical for promoting socio-economic development in rural areas. We have to look into the present energy situation in rural India which is characterized by poor quality, low efficiency, less reliable type of electricity supply and access, leading to lower productivity from the use of land, water and human effort resulting in an inferior quality of life and environmental degradation [2]. This has strained the availability of power in rural areas. The fundamental approach of this programme is to strengthen power generation in the country by utilizing locally available resources in a sustainable manner. Another in-built strategy of decentralized power generation is the reduction of transmission and distribution losses. Therefore it opens up a huge potential for small scale distributed power generation systems. There is a realization of the need to search for decentralized and renewable energy based options to meet the rural energy needs in a sustainable way [2], [3, and [4]. Among the renewable resources, biogas based technologies are being explored for meeting rural electricity needs. At present, the exploitation of biomass resources is considered as a viable addition with respect to the use of fossil fuels and so a great deal of research is directed towards investigating the effective potential of such resources [5].

One such technology is biogas based micro turbine power generation system, which effectively utilizes the available cow dung to generate combustible bio-gases. This is important in a distributed grid-connected generation where erratic renewable energy sources, like solar photo-voltaic and wind, have proved to be inconsistent for network voltage and frequency stability [6, 7] and puts pressure on the existing energy system. Advantages in minimizing transmission, distribution losses and in end use energy in a decentralised electricity generation system is evident from Table 1.

Table 1 : Advantages of Decentralised Power Generation

Type of Supply	Generation		Transmission & Distribution Losses		End Use Energy	
	M W	Cost (Rs million)	M W	Cost Rs (million)	M W	Cost Rs million/MW
Centralised Grid	1	35 million	0.3	5	0.7	57
Decentralised Biomass gasification	1	35 million	0.1	1.5	0.9	44

Source: - www.desipower.com

Objectives : The basic objectives of this paper is to focus on the following points :

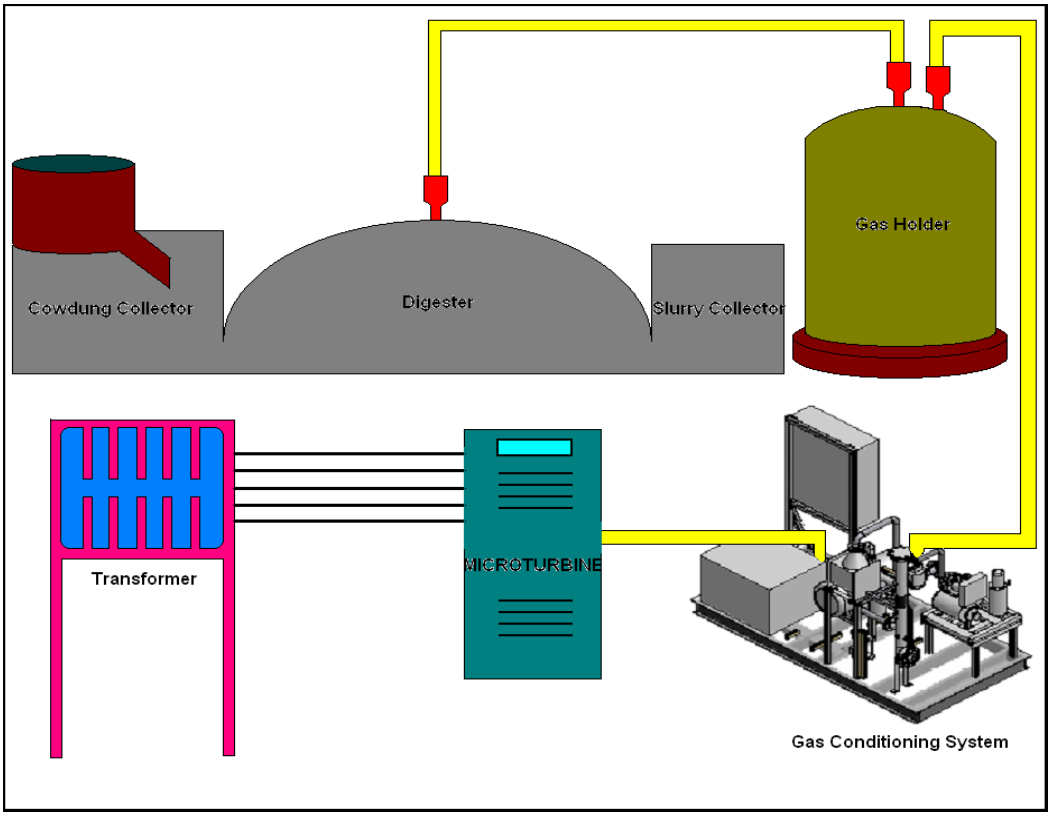
1. Impact of generation of power and its distribution to the grid.
2. To find out total economics and payback period.

Biogas Plant Description

This project has been funded by WEBREDA and USAID. This project is first in its kind to installed. It was commissioned on 31st October, 2006 at Mohan Dairy, Purulia district of West Bengal. This dairy has 250 to 260 cows. A total of 3 to 3.5 tonnes of cow dung is collected per day.

The micro turbine based power generation unit can be divided to three parts (a) Gas digester, (b) Gas cleaning, (c) Micro turbine. The technical scope of this project has not been covered in this article. The basic advantage of this system is that, firstly, it is a very efficient system; secondly, it can be spelt out as a technically standalone system which requires very little technical assessment or indulgence with the operator.

Fig 1 Diagram of the Biogas Plant



RESULT AND DISCUSSION

The proposed biogas turbine project is likely to provide power to the adjacent village (Ragapur) which is 5 kms from the site, comprising around 30 house single word holds. The distribution of farms in the village (Table 2) is given below. The impact of the generated power can bring a radical change in this village as sustainable rural development through electric power plays a vital role in all round development.

Table 2 , Distribution of Power to Different Farm size

Sl No	Type of Farms	Number
1	Marginal	17 (56.6)
2	Small	6 (20)
3	Medium	7 (23.3)
4	Total	30 (100)

* Parenthesis is in absolute percentage

From the table it is evident that 120 people of the village will benefit from the plant. Also, it is assumed that overall development can take place through regular supply of power.

Table 3, captures the overall running hrs of the system. Data for one year has been collected for

Generation and Distribution

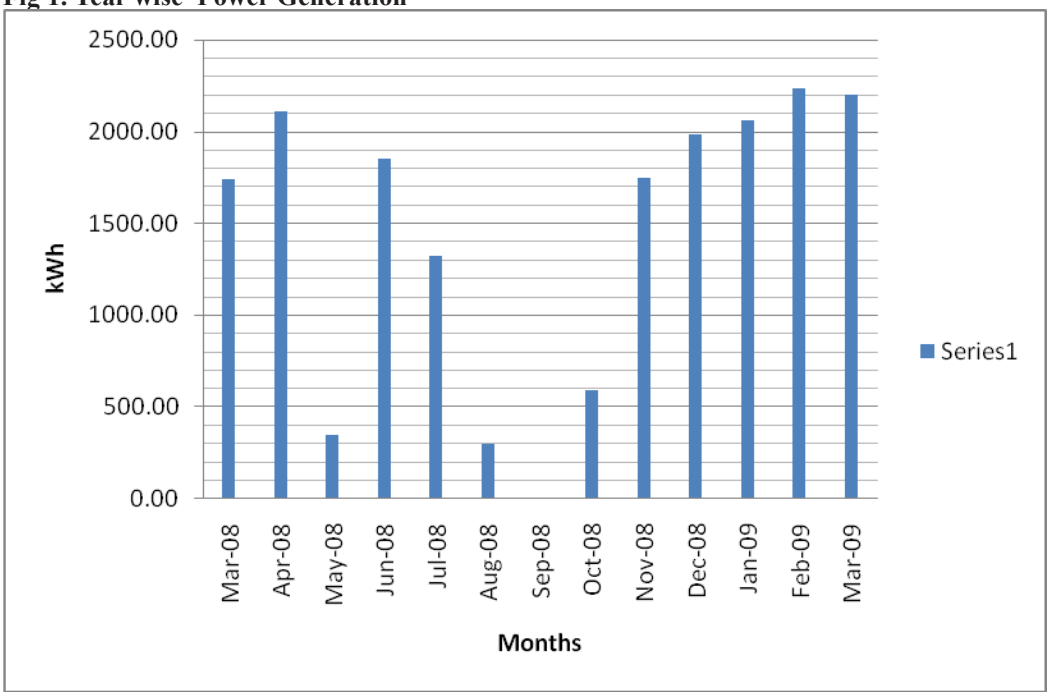
Table 3, Monthwise Power Generation in hrs per day at a Fixed Capacity of 25kW

Month /days	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09
1	2.00	1.5	System doesn't function because compressor is not working	2	4.5	0	System doesn't function because compressor is not working	0	3	2	3	4.5	3
2	2	0		5.5	1	0		0	2	2.5	3	1.5	2
3	2	0		0	2	0		0	2	2.5	3	3	3
4	2.5	0		3	0.3	0		1	2	2.5	3	3	2.5
5	2.5	3.5		4	2	6		0	1.5	2.5	3	3.5	3
6	3	3.5		3	5	1.5		0.3	2	2.5	2	3.5	3
7	2.5	4.5		3	4.5	2		1	2.5	2.5	5.5	3.5	3.5
8	3.5	4		3.5	2.5	1.5		1	2	2.5	3	3.5	3
9	3	2.5		3	3	1		1	2.5	2	3	3.5	3
10	3	4		4	3	0		1	2.5	2.5	2.5	3	3
11	3	3.5		3.5	1.5	0		1	2.5	2.5	3	4	3
12	3	4.5		4	1.5	0		1	2.5	1.5	3	4	1.5
13	3	4		1	2.5	0		0	2.5	2.5	3	2.5	3
14	3	3		3.5	2	0		0	2	3	2.5	3	2
15	2	4		1	2	0		0	2	3	3.5	3.5	2
16	1.5	4		1	2	0		0	2.5	2.5	0	4	3
17	2.5	4		2	2	0		0	2.5	3	0	2	3
18	3	4		1	2	0		0	2.5	2.5	5	4	3
19	2	4		2	2.5	0		0	2	2.5	3	3	3
20	0	3.5		3	2	0		0	3	3	2.5	2.5	3
21	0	3.5		3	1.5	0		0	2	3	3.5	3	3
22	0	4		0	2	0		0	2.5	3	2.5	3	3
23	0.5	3		0	1.5	0		0	2.5	3	3	3	3
24	3.5	2		0	0	0		0	2.5	3	2	3	3
25	3	4		2	0	0		3	2.5	3	3.5	2.5	3.5
26	4	4	3.5	5	0	0		3	2.5	3	2.5	3.5	3.5
27	2	1	2	3.5	0	0		3	2.5	2.5	3	3	3.5
28	2	1	0	1	0	0		4	2.5	3	3	3.5	2
29	2.5	0	4	3.5	0	0		1.5	2	3	3	0	4
30	3	0	4.5	3	0	0		2	2.5	3	0	0	4
31	2.5		1		0	0	0	1.5		3	0	0	3.5
Total hrs	69.5	84.5	14	74	52.8	12	0	23.8	70	79.5	82.5	89.5	88
Total in kW	1737.5	2112.5	350.0	1850.0	1320.0	300.0	0.0	595.0	1750.0	1987.5	2062.5	2237.5	2200.0

interpretation.

During the complete year, the plant did not function on 129 days due to some fault in the compressor.

Fig 1. Year wise Power Generation



System Cost and Payback Period

Table 4. System Cost for 30 kW Power Generation

Sl No	Component	Cost (Rs.)
1	Micro turbine	15,00000.00
2	Gas Conditioning System	10,00000.00
3	Control Panel	1,50000.00
4	Biogas Plant	15,00000.00
5	Installation & Commissioning	1,50000.00
6	Shipping of imported Items	1,50000.00
7	Other expenses	1,00000.00
	Total	45,50,000.00

Table 4, illustrates the over all system cost for the project. It is evident that the initial cost of these systems is very high, nearly Rs 45,50,000.00. The only item indigenously available is the gas conditioning system.

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Table 5 , Pay Back Period

Sl.No.	Description	Output
1	Power production capacity for 6 hrs at 25 kW/day at full load	54000 unit p.a
2	Revenue from Electricity = 54000 X 4.5 (unit price for electricity)	Rs. 2,43,000/- p.a.
3	Revenue from Manure	Rs 1,80,000
4	Total Revenue = Rs.2,43,000.00 + Rs.1,80,000.00	Rs.4,23,000/-pa
5	Investment required to set up a plant	Rs.45,50,000/-
6	Subsidy available(only for institution) MNRE	Rs.30,000/kW
7	Total Subsidy	Rs. 9,00000/-
8	Net Investment = Rs. (45,50,000/ - 9,00000/)	Rs.. 36,50,000/-
9	Payback Period ~	8.5 yrs

**CDM benefit will be additional*

A similar calculation for system cost and payback period for **65kW** capacity will lead to INR **73,50,000** and **3.7 yrs** respectively.

CONCLUSION

Through the study it is found that basic management of cow dung for Mohan dairy was very erratic in the earlier stage, when the power plant was not there. After this project, the accumulated cow dung was utilised by the plant for power generation. On the other hand, manure has become like hot cake for farmers who live in the vicinity of Mohan dairy. The proposed (Ragapur) village will get continuous power for five hrs through this power plant. This model project is a positive step in the area of biogas based micro turbine power generation. This type of project can be replicated throughout India in such similar dairy based locations.

NOTES :

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