Effective Technological Method of Producing Bioenergy

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Abstract

This study appraises techno-economic viability for bio-energy production in Dhinnapatti village using different tools for data collection. Since there was no waste management energy generation system in the village, the habitant threw household waste in the streets and used the animal waste as the fertilizer. This waste scan be utilized to generate bio-energy that can be a renewable substitute for natural gas as natural gas is becoming scarce in our country and is suitable for home use in cooking and heating purposes. The biogas-driven engine and generator are off-the-shelf items, and therefore the period of construction of a biogas-based electric power plant is determined by the time needed to construct the biogas reactor. Because a biogas reactor takes on about six months to build, it has been assumed that the entire expenditure is incurred at the commencement of the project. The items involved in the capital expenditure are the biogas reactor, piping, sand filters, engine, generator, accessories and tools, and engine room.

Keywords: *Biogas, Renewable energy economics, Animal waste and Bio-energy etc.*

INTRODUCTION

For this comparison to be on the same terms, it is essential that the lifetime of the biogas project be extended to match the longest-life central-station electricity project which is about 25 years. This matching can be achieved by making repeated installations of the components of the biogas-based system that have shorter life spans until the standard 25 year central-station life is attained. The longevity of the biogas reactor, generator, and all other items except the engine are assumed (with proper maintenance) to be 25 years, which means they are already matched to the central station.

In contrast, the life of a biogas-driven engine is only 5,000 hours, after which its life can be extended by 5,000 hours per overhauling up to three overhauling. To extend the life of the biogas project further, the engine must be replaced. Obviously, the number of replacement engines (including over haulings) required to keep the system going for 25 years depends on the average number of hours that the system operates each day. Large-scale bio-energy systems can also improve rural livelihoods; their impact is usually indirect or limited to rural job creation.

In contrast, smaller-scale systems of up to say 500 kW capacity, enough to energize a village containing some small commercial or industrial enterprises – can meet the goal of poverty reduction directly and effectively1. The unit cost of power and the unit cost of energy from the biogas-based electricity system also depend on the load factor, which is the average number of hours of operation per day which shows that the unit cost of power increases linearly with the average number of working hours per day of the biogas-based system biomass one might reasonably expect an electrical output of about 20 MHz from each hectare committed to growing biomass for power generation – 120 times less than the PV system2.In a review of un-mechanized production in the Indian state of Uttar Pradesh3.

ESCOs first emerged in a substantial way in the 1980s in urban areas of industrialized countries, where their activities focused on energy efficiency improvements. More recently, ESCOs are also found in rural areas of developing countries (Shivakumar, Rajan & Reddy1998)4. One is the international program FINESSE – Financing Energy Services for Small Scale End-users, established by the World Bank, the UN Development Programme, and the US and Dutch Governments.

A major FINESSE objective is to use the financial resources of multilateral lending institutions to make "wholesale" loans to intermediary organizations such as commercial banks, utilities or NGOs, who on-lend them to small-scale energy users at market rates. A second example is the Grameen Shakti loan programme5.At present, the Dhinnapatti system is operated for only about 4.2 hours per day, which corresponds to a dung input of 291 kilograms per day.

EXPERIENCE BIOENERGY GENERATION

1. Disaggregation of the Costs Of Biogas Electricity

By disaggregating the unit cost of energy for 15.1 hours of operation per day into its components, it can be seen (see figure 1) that, unlike centralized generation plants, a substantial percentage of the expenditures are incurred locally. This means that the system stimulates local prosperity.

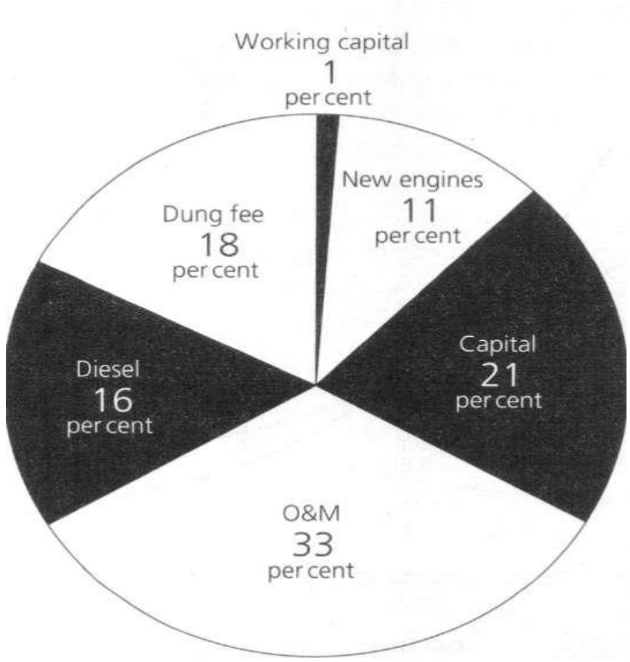

Figure1- Components of the $0.12 per kWh cost of electricity from the Dhinnapatti biogas electricity system.

2. EQUIVALENT GENERATION-END COSTS OF BIOGAS ELECTRICITY

In order to compare the costs of electricity from a biogas-based system with those from a central-station power plant, it is necessary to ensure that the costs are computed at the same location. Doing so is necessary because biogas electricity is generated at the consumption end (in a village), whereas central-station electricity is generated far from the village and then transmitted through a grid.

A comparison is made assuming the cost of the grid is a sunk cost. To convert the unit cost of power of biogas-based electricity at the consumption end to the unit cost of power at the generation end, it is necessary to correct for 1) the grid's transmission and distribution (T&D) loss factor, 2) the ratio of the capacity factors of the biogas and central-station plants, and 3) the ratio of consumption by auxiliaries in the two plants.

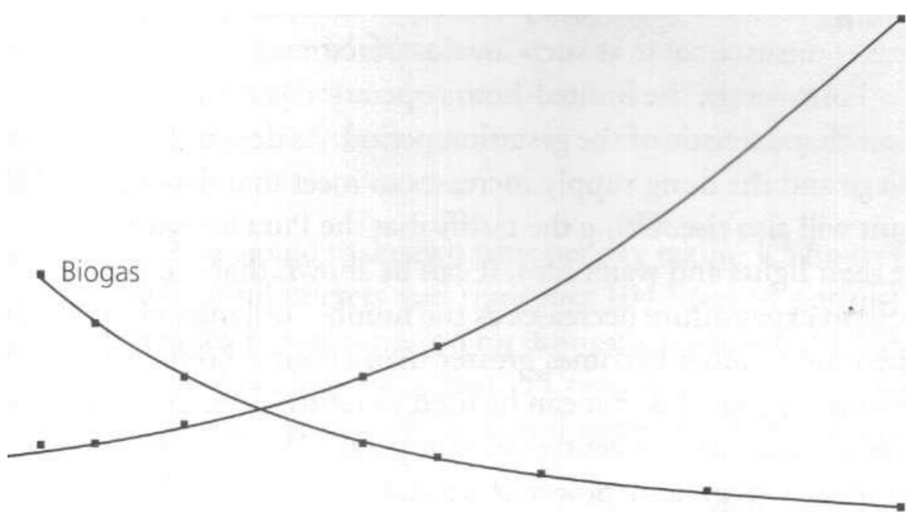

Figure2 - Variation with interest rate of the unit cost of electric power from a biogas plant and from a central-station plant via the grid.

Karnataka's T&D losses of 21.5 percent mean that 1 kWh generated at the consumption end is equal to 1.27 kWh at the generation end or, equivalently, the unit cost of energy from village-level biogas- based electricity is actually 21.5 percent less when it is compared with central-station electricity. Since the capacity factors of the biogas and central-station plants are considered equal (62.8 percent) and the consumptions by auxiliary equipment within the plants are 1 and 10 percent, respectively, it turns out that 1 kilowatt generated by the biogas-based system at the consumption end is equivalent in Karnataka to the generation of 1.40 kilowatts at the generation end.

3. COMPARISON OF BIOGAS AND CENTRAL-STATION ELECTRICITY

When the unit costs of power from the biogas-based electricity system and from central-station power plants are plotted (see figure 2), two interesting results emerge:

- At interest rates greater than about 7.5 percent, the unit cost of power from the biogas-based system is less than that from the central-station power plant.
- The cost advantage of the biogas-based electricity system over the central-station plant increases with interest rate.

The interest rate reflects the scarcity of capital—the greater the scarcity of capital, the higher the interest rate. Hence, in capital-starved developing countries, such as India, high interest rates should be used for investment decisions. For such interest rates, the unit cost of power clearly favors biogas-based electricity systems rather than central-station power plants.

4. ECONOMIC VIABILITY OF BIOGAS ELECTRICITY GENERATION

In assessing the viability of electricity generated from village-level biogas plants, it is clear that the current limited-hours operation of only about 4.2 hours per day leads to a high unit cost of energy of more than $0.25 per kWh. In addition, current income from the biogas system (from lights and private water taps) can meet only about half of the recurring expenses of the plant while making no contribution to the capital investment charges.

Hence, a subsidy would be required to operate the biogas system at its present low-load factor of less than 20 percent. Though such a subsidy seems to be a pattern for urban water and electric utilities, it means that widespread replication of biogas electricity generation systems is unsustainable at such low load factors.

Fortunately, the limited-hours operation can be viewed as a transitional situation characteristic of the gestation period. As demand for electricity builds in the village and the dung supply increases to meet that demand, the income from the plant will also rise. Using the tariffs that the Dhinnapatti households are currently paying for their lights and water taps, it can be shown that the deficit of income with respect to expenditure decreases as the number of hours of operation increases, and when the number becomes greater than about 6 hours per day, the system starts generating a surplus that can be used to return the capital investment. And at the same load factor as a central-station plant (15.1 hours per day), the unit cost of electrical energy and power is actually lower than that from a central-station plant.

Hence, after a gestation period, the biogas system does not require subsidies and in fact is economically preferable to central-station plants supplying electricity to the village via a grid.

5. DECENTRALIZED BIOGAS-BASED ELECTRICITY SYSTEMS

Thus, the above cost results argue in favor of decentralized electricity systems (based on biogas in the context of this paper but also on producer gas, small hydroelectric plants, etc., as shown by separate analyses) for rural electrification. But rural electrification via centralized generation plants (for instance, hydroelectric, coal-based thermal, and nuclear power plants) and grid transmission and distribution has already progressed almost to completion in many parts of India. Despite such developments, it might make economic sense to keep the grid as a standby and provide rural electricity through decentralized systems instead. In addition, quite apart from the economic aspects, there is no doubt that decentralized electricity systems strengthen self-reliance and, therefore, advance rural development efforts.

6. ADVANCED BIOGAS PLANTS OF THE FUTURE

The case for decentralized village-level biogas-based electricity generation systems should become even more attractive as the present generation of biogas plants gives way to plants based on advanced technology. A Dhinnapatti-type traditional biogas plant has an energy conversion efficiency of around 27 percent, yet biogas technologies now exist that can achieve conversion efficiencies of around 60 percent.

The first step toward attaining efficiency increases is to operate the plant at optimum, instead of ambient, temperatures. Whereas average ambient temperatures in Dhinnapatti are around 26°C, the optimum temperatures for the mesophilic bacteria responsible for biogas production are about 35°C, and operation at these temperatures can almost double the gas production rate. Still greater improvements can be obtained with advanced biogas technologies that are now being used to process industrial wastes. These advanced technologies represent achievable goals and may well be adapted some day for handling animal, rather than industrial, wastes.

CONCLUSIONS

Traditionally, a family in Dhinnapatti would make two trips per day taking 1.5 hours (45 minutes per trip) to cover 1.6 kilometers and transport 104 liters (4 pot fuels) to obtain an average per capita water consumption for domestic purposes of 17 liters per day. Moreover, although Dhinnapatti was electrified, 55 percent of the households were not electrified and had to rely on inefficient and expensive kerosene open-wick-lamps and chimney lanterns for lighting. Comparing the present biogas plant system with this traditional system shows that the households are winners on all counts, having gained the following:

- Better water than what was available from the open tank.
- Less effort expended to get this improved water.
- Better and more reliable illumination than the traditional kerosene lamps or unreliable Low-voltage grid electricity.
- Cheaper illumination of households compared with costlier kerosene

lamps—a 20 watt fluorescent tube light costs $0.40 per month compared with about $0.80 per month for the approximately 3 liters per month of kerosene for kerosene lamps generating 0.02 less lumens.

- Improved biogas sludge fertilizer that has double the nitrogen content of farmyard manure and is less susceptible to the growth of weeds.

- A dung delivery fee to those (mainly women and children) who deliver the dung to the plant and take back the sludge.

- In addition, the village (as a collective) through its grama vikasa sabha (village development society) has gained the following:

- Training and skill upgrading for two of its youths in the operation and maintenance of the biogas system.

- Revenue for the village when the total payment received for household electricity and water exceeds the expenses for diesel and dung delivery fees. A morbidity and mortality study has not yet been carried out, but the women of Dhinnapatti assert that the health status of their children with respect to technical problems has improved noticeably. Their observation is understandable because deep bore-well water is far less contaminated than surface sources. In the evening peak hours, the voltage or the grid supply, which is supposed to be 220 volts, goes down to as low as 150 volts so that the fluorescent tube lights do not start. A powerful mechanism to initiate and sustain village-scale cooperation.

- Distinct improvement in the quality of life with regard to water (and therefore health)
And illumination.

- A small but significant advance in self-reliance, thanks to the realization that the current status and future development of the energy system can be decided and implemented by the village.

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