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Economic viability of biogas and green self-employment opportunities

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ABSTRACT

To analyze economic viability of the biogas plants in Bangladesh six case studies are carried out in some selected upazilas of greater Sylhet district in Bangladesh where NGOs like Grameen Shakti (GS) and Rural Services Foundation (RSF) are delivering and servicing biogas plants. Economic viability of the biogas plants are measured by comparing prior expenditure (before implementing biogas plant) for firewood, kerosene, and other conventional sources. Economic viability refers to an estimator that not only seeks to maximize the effectiveness of financial viability but also considers environmental externalities. Economic viability for six different cases of biogas plants provides information about relative performance of the product in six different situations. A sensitivity analysis is performed using artificial neural network (ANN) model. Although economic viability of biogas is sensitive to kerosene price, firewood availability, this study reveals that biogas is economically more attractive when women could render their saved cooking time for other income generating green jobs. Biogas plant results a number of income generating new green employments for the rural community in Bangladesh.

Contents

1. Introduction

Worldwide, 2.7 billion people or over 40% of the global population rely on using traditional biomass (wood, dung and agricultural residues) and coal to meet their energy needs for cooking, among

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them 82% of the population live in the rural areas in developing countries [1,2]. In Bangladesh, over 90% of the population is using biomass to meet their energy requirements and it is estimated that 39 million tons of biomass matters are burnt away every year [3]. As usual, this situation is even worse in rural areas where around 75% of the population resides, 78% of them have no electricity and natural gas connection in Bangladesh [4]. Overall, only 7% of urban people of eastern parts of the country use natural gas for their cooking [5], among them 3% use natural gas delivered by pipeline [6]. The shares of different types of fuel consumption are as follows in Bangladesh: natural gas 12.2%, oil 10.1%, coal 1.8%, electricity 2.8 and biomass fuels 73.1% [7]. The biomass energy is supplied mainly from three sources: forest, agricultural crop, livestock and poultry. A major share of biomass energy is supplied from designated forest areas, which are the real forests, homestead trees and road side trees and other social forests. As a result of this, a large amount of deforestation is going to happen every year to meet energy demand. According to a statistics during the last 30 years, 35–45% of the total forest area has been decreased in Bangladesh [4]. As a result supply of fuel wood is also decreasing and it is becoming scarce and fuel price is increasing day by day.

As an alternative fuel, biogas could become a potential source of green energy for cooking as well as for conserving natural resources. Easy availability of cattle dung is an important source of biogas in Bangladesh. There are about 22 million cattle in Bangladesh, which produce about 0.22 million ton of wet dung daily [4]. However, the microeconomic feasibility study is needed to understand the nexus between private financial feasibility and environmental concern, which is calculated in this paper by introducing environmental and social cost in private financial calculation. As discussed, economic analysis also considers home environment which relates to health outcome, housewives are cooking meals using traditional biomass fuels that cause serious indoor air pollution for fume-contaminated air. According to a report of the World Bank, concentration of respirable airborne particles (PM10) for using traditional biomass fuels in Bangladesh is found to be 300 $\mu g/m^3$ or greater [8], the standard for annual recommended average for PM10 in Bangladesh is 50 $\mu g/m^3$ [9]

As a result, a great number of people suffer from acute diseases and 46,000 people dies of them, of which children's share is almost 70% in Bangladesh [10]. Therefore, use of biogas could reduce extreme dependency on conventional fuel sources, cooking with biogas does not generate harmful gases emissions in indoor air [11] and thus ensure health quality of its household. One biogas plant in Nepal could save about 250 kg of firewood per month. Thus saving of firewood from each household per year is about 3 t. Similarly the saving of cow dung being directly burnt is 48 kg per month. Every biogas system in Nepal can avoid nearly 4.5 t of carbon emissions per year by reducing the use of firewood in the kitchen [12]. Generally renewable energy technologies reduce carbon emission and generate employment and income. This includes jobs that help to protect ecosystems and biodiversity; increase energy efficiency, de-carbonize the economy; and minimize waste and pollution. Therefore green jobs are associated with sustainable development via inexhaustible energy sources [13]. Green job can be created by a biogas plant in two different ways: self-employed in domestic biogas plant or generating other sort of employment using biogas technology, paid-up employment in biogas plants. This research focused green employment in a way to be self employed using biogas plants directly or indirectly.

2. Biogas plant

In Bangladesh, three types of biogas plants (floating gas-holder, fixed dome, bag system) were being tried. Of them, fixed dome digester shown in Fig. 1 is the most popular and widely used in Bangladesh.

The fixed dome plant shown in Fig. 1 employs a mixing tank with inlet pipe and sand trap (1), a digester (2), compensation and removal tank (3), gasholder (4), gaspipe (5), entry hatch, with gastight seal (6), accumulation of thick sludge (7), outlet pipe (8), reference level (9), supernatant scum, broken up by varying level (10).

Since the dome is fixed, this gas plant is known as fixed dome type. The digester is normally constructed using bricks and mortar and ends with a solid fixed dome in the shape of an igloo. This type of digesters works on principle of constant volume, changing pressure. When gas production starts, slurry is displaced into the compensation tank. Gas pressure increases with volume of gas stored and height difference between the slurry level in the digester and the slurry level in the compensation tank. When the rate of gas production is higher than that of gas consumption, pressure inside the digester rises and expels some digester contents into the outlet compartment. The gas is captured in the gasholder and the slurry is displaced in the compensating tank. The more gas is produced, the higher the level at the slurry outlet will be [14]. The fixed dome digester is relatively inexpensive and a lifespan could be expected up to 20 years [15]. The plant is constructed underground, protecting it from physical damage and saving space. The construction of fixed dome plants is labor-intensive, thus creating local employment.

3. Service providers in Bangladesh

Infrastructure Development Company Limited (IDCOL), established on 1997 is playing a major role in bridging the financing gap for developing medium and large-scale infrastructure and renewable energy projects in Bangladesh. The company now stands as the market leader in private sector energy and infrastructure financing in Bangladesh. Since its inception, IDCOL's stakeholders include the government, private sector, NGOs, to provide renewable energy in the village level in Bangladesh. Among the Non-Governmental organization, Grameen Shakti and Rural Service Foundation are two most active and operating in large scale in Sylhet division.

Grameen Shakti (GS) has one of the most successful market based bio gas programs with a social objective for popularizing the program including other renewable energy technologies to millions of rural villagers. GS's biogas program is the first market based program in Bangladesh and have become popular among the rural people and show an accelerating trend in Fig. 2 [16].

GS has developed an integrated and sustainable model for expanding biogas program. GS plays the role of a facilitator, not of a provider. GS provide soft micro loans [16], which makes biogas plants affordable to the villagers. They also offer service including monthly visits by GS engineers for two to three years. They also

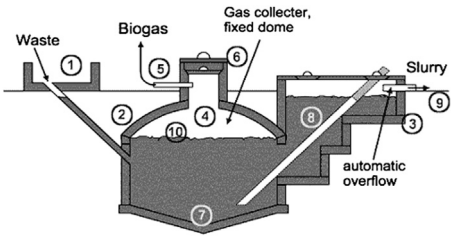

Fig. 1. Typical elements of a fixed dome plant for biogas systems. *Source*: http://energypedia.info/images/0/03/Nicarao_biogas.gif [accessed on January 18, 2012].