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# BIOGAS FOR DEVELOPING COUNTRIES WITH COLD CLIMATES

*Addressing the challenge of biogas production in cold regions*

By

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WECF | Women in Europe for a Common Future

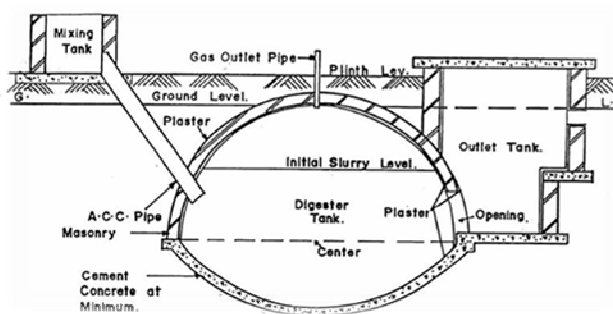


## 1. INTRODUCTION

Domestic biogas production is one of the most promising uses of biomass wastes because it provides a source of energy while simultaneously resolving ecological and agrochemical issues. The provision of bio-energy tackles both energy poverty and the reliance on polluting and non-renewable fuels. The implementation of domestic biogas plants is however limited in regions with cold climates since low prevailing temperatures have a detrimental impact on the biogas production rate. This paper addresses the challenge to overcome this detrimental impact by reviewing a number of affordable and implemented solutions. A case study of biogas in Georgia provides an interesting example of biogas in a country with cold winters (a separate print-out).

## 2. BIOGAS PRODUCTION

Biogas is produced under anaerobic conditions; the process is denominated as anaerobic digestion. The major constituent of biogas is methane (55-70%), CO<sub>2</sub> (30-45%) and some traces of gases such as H<sub>2</sub>S and ammonia. Common digester feedstock (feeding material) is cow, buffalo and pig manure. A typical family needs at least 1 m<sup>3</sup> biogas per day to satisfy fuel demand for cooking. To produce this amount of biogas the manure of at least 3 cows' or 2 buffaloes' or 8 pigs' is required. The picture on the right shows a typical underground built domestic biogas plant.



A TYPICAL DOMESTIC BIOGAS PLANT (MODEL: DEENBANDHU)

## 3. BENEFITS

The benefits of anaerobic digestion are not confined only to private benefits; there are significant spillovers to the local, national and the global environment.

### 1. PRIVATE BENEFITS

A biogas installation tackles a great number of problems, such as access to sanitation (3,4 billion people lack access to sanitation), a shift from the reliance on traditional fuels to a modern fuel, biogas, thereby making a leap on the energy ladder. In addition, since women in particular benefit most from the biogas plant, the procurement of a biogas installation empowers women and reduces gender inequality. Furthermore, biogas can be utilized to meet several services next to cooking such as lighting and fuel for an internal combustion engine for mechanical shaft power or electricity generation.



“The new stove is cleaner, faster and more reliable. Before, smoke used to irritate my eyes, and nose and lungs, and I had less energy. Now I don't have any of these problems. Before, I used to spend three hours preparing a meal. With the new stove I spend half that time. Now I can use that extra time to do other things at home.” Punyadumari Sanjel, age 70

### The most common direct private benefits

Benefits	Descriptions
On site house energy production	Time expenditure and the drudgery of wood gathering are avoided or revenues are saved if fuels were otherwise bought for cooking or other energy services.
Latrines	Commonly a latrine is attached to a digester. The addition of human waste to the process will increase gas production, improves local sanitation and hygiene and reduces the incidence of disease.
Reduction in pollution	Kitchen smoke is the main factor in indoor air pollution. Using biogas as cooking fuel dramatically reduces indoor air pollution.
Lower incidence of disease	Installing latrines and biogas fuelled stoves will lower the incidence of common diseases such as eye infections, respiratory diseases, smoking-induced coughs, diarrhoea, dysentery, and parasites among both adults and children.
Improved agricultural yields	Applying bio-slurry, the by product of biogas production will improve soil fertility and increase agricultural output. The side benefits are reduced use of chemical fertilizers, avoided expenditures and clean environment.
Time saving for women	Biogas plants reduce women's need to collect fuel wood and thus their workload. An evaluation of the biogas program in Nepal showed that women save three hours daily per household using biogas for cooking versus cooking with collected fuel wood.
Reduction in firewood consumption	The biogas fuel for cooking results in reduced pressure on native forests for fuel wood and leaves the forests' services intact.

## **2. LOCAL BENEFITS**

The main local benefits are spillovers from private benefits; the positive externalities which occur at local scale. The dissemination of biogas technology creates job opportunities in the rural areas, for instance the construction of digesters require masonry workers (both skilled and unskilled), technicians and employment in the financial sector. Widespread use of biogas reduces the pressure on the forests. Forests delivers a multiple of goods and services, such as spiritual and religious services; fodder, timber, medicines; non-timber forest products (fish, game, rattan, bird's nest); recreational sites and (eco) tourism opportunities and are therefore, an important asset to people.

Mr. Babubhai was barely able to make a living with farming for his family in a village in India. He attended a masonry training program for biogas plant construction and started working as a biogas mason. As a result his annual income almost doubled. During the lean season he used his newly acquired skills to work on other projects, such as house construction. Over the years he acquired a house and commodities such as a television and a bicycle. Now he is living comfortably with his family.

*From the Indian NGO experience with biogas*

## **3. NATIONAL/GLOBAL BENEFITS**

National benefits arise from the sheer number of private and local benefits, such as reduced health costs, healthier and more productive population and reduced fuel imports. Another important benefit, which affects us all, is the mitigation of greenhouse gas emission. A biogas plant mitigates GHGs via three pathways:

1. **Change in manure management modality:** The release of methane from feedstock is captured and destroyed (utilized for energy services) and release to the atmosphere is therefore prevented
2. **Fuel switch:** The displacement of non renewable biomass and fossil fuels by biogas
3. **Chemical fertilizer substitution:** The production and application of chemical fertilizers results in considerable GHG emission.

#### 4. BIOGAS IN COLD CLIMATES

Large areas in the developing countries are highlands or have a continental climate with warm summers but with cold winters. The low ambient temperature in these regions decreases microbial activity and hence the rate of biogas production. To overcome this, either the digester volume or the temperature of digestion has to be increased. In India for instance, the retention time of the feedstock in the tropical south is 30 days and in the north 50-55 days, hence the digester volume is around (55/30) 1,8 times larger. With this solution a digester functions well at an average temperature of 15°C. At lower temperatures heating is required. Next a number of promising low cost solutions for digester heating are discussed.

##### **Bolivia – ProAgro/GTZ – Biogas at the Altiplano**

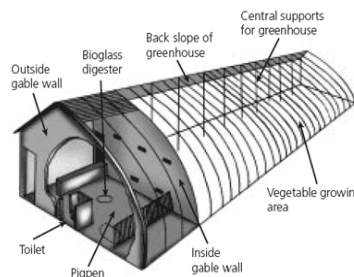
In Bolivia inexpensive plastic tubular biogas plants are being popularized in the Altiplano, a barren plateau at an altitude of 4000 meter. By capturing solar irradiation with a solar canopy (greenhouse covering), by hot charging, an increased retention time and finally by inertia (the sand walls have a high thermal mass which avoids rapid cooling of the system during the night), the digester remains at 10 °C compared to 0°C ambient (from Jaime Marti Herrero)



PLASTIC BIOGAS PLANT WITH SOLAR CANOPY

##### **Integrated solutions – The use of a multifunctional greenhouse**

By the utilization of heat from a greenhouse system to enhance agricultural produce, digester and stable/house warming creates both income generation opportunities and a niche for biogas. A complete integrated solution would also connect a toilet for access to sanitation. BSP Nepal has constructed some of these systems with success at a height of 2600-3000 meter and SNISD in Yunnan China at an altitude of 2800 meter.



THE INTEGRATED SOLUTION OF SNISD AND BSP NEPAL TO THE RIGHT

##### **Heap composting (BSP Nepal)**

A completely different approach is the utilization of aerobic heat resulting from composting of organic matter. It proved possible to increase the temperature of digestion to 8-11°C at an ambient temperature of -3°C. At the moment when the growth season starts, the compost is available as fertilizer (from Prakash Lanichhane).



HEAP COMPOSTING ON THE DIGESTER TOP

## **Other approaches**

A solar assisted biogas plants consist of a solar collector to capture solar heat for digester heating. This solution was on a limited scale practice in Georgia and received a fair amount of discussion among Indian scientists in the late 1980s. A solar assisted biogas plant is a relatively robust but expensive technology, cost deductions are possible by utilizing local skills and expertise, WECF and the partners have considerable experience with this.

## **5. FINANCING THE TECHNOLOGY**

A domestic biogas plant is an expensive technology, \$400-\$800, a significant investment barrier. The running and fuel costs are however negligible and since a well built plant has a lifespan of over 20 years, the technology in general has a high internal rate of return. Tackling the investment barrier requires the combination of several solutions:

### **1. Investment subsidies**

In Cambodia \$150 are refunded from the total investment by the families, the necessary funds are provided by donors. Carbon finance could also be utilized for this.

### **2. Micro financing** – setting up a special biodigester credit

Provision of affordable credit which reflects a realistic payback period

### **3. Income generating activities** – Extension programs to enhance and commercialize agricultural produce

Farmers are able to repay the credits as the investment pays off, i.e. the avoidance of purchasing fuels, time savings and improved agricultural production. NBP Cambodia estimates that around \$12 per month is saved in Cambodia. As before mentioned, a biogas plant mitigates the emission of GHGs. These carbon offsets have a value under the clean development mechanism and the voluntary carbon market. A review of the registered biogas programs showed that on average around 4,4 tCO<sub>2</sub> is claimed per household digester and this amounts to an estimated carbon rebate €22-66 per digester per year for a credit period of either 10 or 7 years. To fully exploit the financial opportunities arising from a biogas plant, it is imperative that activities are undertaken to generate additional income, such as a bio-slurry extension program and commercialization of agricultural produce along with capacity building.

## **6. REPLICATION & DISCUSSION**

Biogas technology is marginally implemented in cold regions. Most projects are of pilot scale in specific niches, all learning by doing, and it is therefore impossible to extract a best practice. We should however, not look at experiments for biogas alone since there is significant learning from the experiences with greenhouse construction and passive solar housing at high altitude regions. The results from these experiences could be combined to design an integrated system, which tackles a wide range of problems among poor households about the lack of sanitation, energy poverty, dependence on non-renewable polluting biomass, low income and the short growth season of crops. An integrated approach is the best solution to tackle poverty from the grass roots level, as it both reduces fuel costs and increases income. Financing biogas a program requires an approach that is aimed at both decreasing the investment barrier (microfinance,

subsidies) and on providing the means to increase household income (capacity building and extension programs).