Feasibility of a national programme on domestic biogas in Bangladesh

Final report

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Executive summary

This report presents the finding of a study conducted by the Netherlands Development Organisation (SNV) to assess the feasibility to set-up and implement a national programme on domestic biogas in Bangladesh. This study included a mission of three weeks in Bangladesh in March 2005 making use of the following methodologies:

- Field visits to get an impression on the performance of biogas plants and to collect more practical information on modalities of biogas projects implemented in Bangladesh so far.
- Interviews with informants and potential stakeholders.
- A half-day Workshop to present the findings of the field visits and interviews and to generate discussion among the stakeholders on a number of key-issues.
- Rating of key conditions for large-scale dissemination of biogas plants in Bangladesh.

A national programme on domestic biogas in Bangladesh looks feasible as:

- Bangladesh has already a rich history in domestic biogas with close to 24,000 units constructed throughout the country so far.
- The technical potential for biogas amounts to minimum one million units, while there are no strong limiting social factors.
- The financial analysis indicates that an amount of Taka 7,000 as investment subsidy is generally sufficient to attract potential farmers resulting in a satisfactory financial rate of return (FIRR) of 15 percent for the farmer. The actual FIRR realized by the farmer, however, is largely dependent on the actual financial price for biomass. This underlines the need for an effective micro-credit facility. The economic internal rate of return (EIRR) for the biogas plant is 17 percent in the base case.
- Bangladesh is endowed with an impressive number and variety of institutes, organisations and companies potentially able to participate in the implementation of a national programme. This organisational richness makes the establishment of a separate programme office unnecessary.
- There is a clear will and interest among (potential) stakeholders to be engaged in a national programme.

The tentative outline for the national programme with a longer-term vision to develop a commercial, sustainable biogas sector includes the production of 36,450 biogas plants up to 2009 and will cost about Euro 14.7 million. The biogas farmers, Directorate General for International Cooperation (DGIS), Netherlands Development Organisation (SNV) and the Government of Bangladesh (GoB) are the proposed financiers of the programme, to be supplemented by a provider of a refinancing facility for the credit requirements. The cost/benefit ratio of CDM financing still needs to be determined. It has been assumed that the GoB will fully support a national biogas programme and that (potential) stakeholders will agree to up-grade the quality of products and services. The long period required for the approval of an implementation plan is considered a risk, all the more since the dissemination of biogas plants has come to a standstill in June 2004.

The following are the main recommendations resulting from this feasibility study:

- To SNV: To start with immediate effect the process of registering SNV as an international INGO in Bangladesh.
- To SNV: To field a mission in July or August 2005 to select an implementing partner and sign a MoU with this partner for the formulation of a detailed implementation document.

- To SNV and selected implementing partner: To formulate the detailed implementation document in cooperation with all potential stakeholders in Bangladesh in the period September to December 2005.
- To SNV, selected implementing partner and other main involved stakeholders: To pursue approval of the detailed implementation document, to make the required preparations and to start implementation of the programme in 2006.

Table of Contents

Abbreviations

ADB	Asian Development Bank
AEC	Atomic Energy Commission
ASA	Association for Social Advancement
BARC	Bangladesh Agricultural Research Council
BARD	Bangladesh Academy for Rural Development
BARI	Bangladesh Agricultural Research Institute
BAU	Bangladesh Agricultural University
BBBB	Bangladesh Bureau of Biogas and Bio-technology
BBS	Bangladesh Bureau of Statistics
BCAS	Bangladesh Centre for Advanced Studies
BSCIC	Bangladesh Small & Cottage Industries Corporation
BCSIR	Bangladesh Council of Scientific and Industrial Research
BDT	Bangladesh Taka (1 Euro is equal to about 85 Taka)
BIDS	Bangladesh Institute for Development Studies
BIM	Bangladesh Institute for Management
BLRI	Bangladesh Livestock Research Institute
BPDB	Bangladesh Power Development Board
BPC	Bangladesh Petroleum Corporation
BPT	Biogas Practice Team (SNV)
BRAC	Bangladesh Rural Advancement Committee
BRDB	Bangladesh Rural Development Board
BRRI	Bangladesh Rice Research Institute
BSP	Biogas Support Programme (Nepal)
BSTI	Bangladesh Standards and Testing Institute
BUET	Bangladesh University of Engineering and Technology
CDM	Clean Development Mechanism (under the Kyoto protocol)
Cft	Cubic feet (28.3 litres)
CIRDAP	Centre on Integrated Rural Development for Asia & the Pacific
CMES	Centre for Mass Education in Science
COAST	Coastal Association for Social Transformation Trust
DAE	Department of Agricultural Extension
DANIDA	Danish International Development Agency
DGIS	Directorate General for International Cooperation (Netherlands)
DLS	Department of Livestock Services
DoE	Department of Environment
EIRR	Economic Internal Rate of Return
EPRC	Environment & Population Research Centre
ERD	Economic Relations Division (MoFP)
FIRR	Financial Internal Rate of Return
FY	Fiscal Year
GDP	Gross Domestic Product
GEF	Global Environment Facility
GI	Galvanised Iron
GOB	Government of Bangladesh
GS	Grameen Shakti
GTZ	German Technical Cooperation
HSD	High Speed Diesel
HYV	High Yielding Variations
IDA	International Development Association
IDCOL	Infrastructure Development Company Ltd.
IDF	Integrated Development Foundation

IFAD	International Fund for Agricultural Development
IFRD	Institute for Fuel Research and Development
IMED	Implementation Monitoring and Evaluation Division (MoFP)
INGO	International Non Governmental Organisation
IPP	Independent Power Producer
ISO	International Standard Organisation
KfW	Kreditanstalt für Wiederaufbau (German Development Bank)
kgOE	Kilogram Oil Equivalent
LA	Line Agency
LGED	Local Government Engineering Department (GOB)
MFI	Micro Finance Institute
MoA	Ministry of Agriculture (GOB)
MoFP	Ministry of Finance and Planning (GOB)
MoPEMR	Ministry of Power, Energy & Mineral Resources (GOB)
MoSICT	Ministry of Science, Information & Communication Technology (GOB)
MoU	Memorandum of Understanding
NGO	Non Governmental Organisation
NGOAB	NGO Affairs Bureau
PKSF	Palli Karma Sahayak Foundation
PO	Partner Organisation
PP	Project Proforma
PROSHIKA	Proshika Manobik Unnayan Kendra
PURE	Promotion of the Use of Renewable Energies (GTZ)
QC	Quality Control
RCC	Reinforced Cast Concrete
R&D	Research & Development
RE	Renewable Energy
REB	Rural Electrification Board
REDA	Renewable Energy Development Agency
REIN	Renewable Energy Information Network
REREDP	Rural Electrification and Renewable Energy Development Project
RET	Renewable Energy Technology
RNE	Royal Netherlands Embassy
SET	Sustainable Energy Technology
SEU	Sustainable Energy Unit (under MoPEMR)
SHS	Solar Home System
SKO	Superior Kerosene Oil
SNV	Netherlands Development Organisation
TAPP	Technical Assistance Project Proforma
TMSS	Thengamara Mohila Sabuj Sangha
UNDP	United Nations Development Programme
USAID	US Agency for International Development
USD	Unites States Dollar
WB	World Bank
WWF	World Wildlife Foundation

Exchange rate:	1 Euro = 78 Taka
(June 2005)	1 USD = 64 Taka

CHAPTER 1: Introduction and background

Based on positive experiences with the dissemination of domestic biogas in Nepal, the Board of Directors of SNV Netherlands Development Organisation decided in June 2004 to launch an initiative for up-scaling of domestic biogas in a number of Asian countries. This initiative received financial support by the Directorate-General for International Cooperation (DGIS) of the Dutch Ministry of Foreign Affairs in the framework of the Asia Biogas Programme. The People's Republic of Bangladesh was identified as one of the potential countries. A brief fact finding mission was conducted in November 2004 (Lam and Boers, 2005). This mission concluded that the circumstances in Bangladesh seem favourable to establish a national biogas programme and recommended commissioning of an in-depth study on its feasibility. The Terms of Reference for this feasibility study are provided as Annex 1.

This report presents the findings of the feasibility study conducted in March 2005 by two members of the Biogas Practice Team (BPT) of SNV, Wim van Nes and Willem Boers, and one independent local expert, Dr. Khurseed-Ul-Islam.

Chapter 2 describes the objective, methodology and limitations of the feasibility study. A brief background including the agricultural and energy sector of the Republic of Bangladesh is provided in Chapter 3. The history of domestic biogas in the country is summarised in Chapter 4. An assessment of the potential demand for domestic biogas including the financial and economic internal rates of return is presented in Chapter 5. An overview of potential stakeholders is provided in Chapter 6, while the functions required in a national programme and possible suitable actors are matched in Chapter 7. An outline for a national biogas programme including tentative budget and possible financiers is provided in Chapter 8. Main conclusions and recommendations of the study are mentioned in Chapter 9. More specific conclusions and recommendations are presented in the respective chapters. The references, finally, are included as Chapter 10.

CHAPTER 2: Objective, methodology and limitations

2.1 Objective

The objective of the study is to assess the feasibility to set-up and implement a national programme on domestic biogas in the Republic of Bangladesh.

2.2 Methodology and limitations

The following methodologies were used to achieve the objective of the study:

- Preparation of the mission to Bangladesh through analyses of secondary data including documents collected during the fact finding mission in November 2004. The programme of the mission is added as Annex 2, while the contact details of the informants and respondents are included in Annex 4.
- Field visits to get an impression on the performance of biogas plants and to collect more practical information on the different modalities of biogas projects implemented in Bangladesh so far. The mission team was facilitated by BRAC (one day), LGED (two days) and BCSIR (two days), see Annex 2 for information on the visited areas. A check-list was prepared for the collection of data during the field visits.
- Interviews with informants and potential stakeholders for a national programme on domestic biogas. To structure the interviews with the stakeholders, a check-list was prepared. The main findings of the interviews with the respondents are summarised in Annex 5.
- A half-day Workshop to present the findings of the field visits and interviews and to generate discussion among the stakeholders on a number of key-issues. A brief report on this Workshop including the list of participants is included as Annex 3.
- Rating of key conditions for large-scale dissemination of biogas plants in Bangladesh. These conditions are included as Annex 9.

Prior to the mission, it proved to be quite difficult to get into contact with the stakeholders already approached during the fact finding mission in November 2004. Hence, it was not easy to compose in advance the mission programme. After arrival in Dhaka however, the team received a maximum of cooperation from stakeholders and informants and the programme could be planned and implemented without any problem.

The results of the study were presented to the (potential) stakeholders in a second Consultative Workshop on 24 July 2005 at Dhaka, see Annex 10.

CHAPTER 3: Country background

Bangladesh, officially People's Republic of Bangladesh, borders on the Bay of Bengal in the south; on the Indian states of West Bengal in the west and north, Assam and Meghalaya in the northeast, and Tripura and Mizoram in the east; and on Myanmar in the southeast. Dhaka is the capital and largest city; the nation's other major city is Chittagong. A humid, low-lying, alluvial region, Bangladesh is composed mainly of the great combined delta of the Ganges, Brahmaputra, and Meghna rivers. Except for the Chittagong Hills along the Myanmar border, most of the country is no more than 90 m above sea level. Bangladesh is laced with numerous streams, distributaries, and tidal creeks, forming an intricate network of waterways that constitutes the country's main transportation system. Along the south-western coast is the Sundarbans, a mangrove swamp area with numerous low islands.

Figure 3-1 Map of Bangladesh with the capital Dhaka in the middle and Chittagong in the southeast of the country

Bangladesh has a tropical monsoon climate with a distinct dry season in the winter. It receives an average annual rainfall of about 2,000 mm, with most falling during the summer monsoon period; the Sylhet district in the northeast is the wettest part of the country, having an annual average rainfall of 3,560 mm. The low-lying delta region is subject to severe flooding from monsoon rains, cyclones, and storm surges that bring major crop damage and high loss of life. The cyclones of 1970 and 1991 and the monsoon floods of 1988, 1998, and 2004 were particularly devastating.

Bangladesh is one of the world's ten most populated countries with an estimated current population of 144 million and has one of the highest population densities (almost 1,000 people per sq km) with an annual growth of 1.7%. The great majority of Bangladesh's population is Bengali, although Biharis and several tribal groups constitute significant minority communities. About 88% of the population is Sunni Muslim and over 10% is Hindu. Bengali is the nation's official language, and English is used in urban centres. Bangladesh has a predominantly rural population, with over 60% of the workforce engaged in agriculture.

Bangladesh is one of the world's poorest nations, with overpopulation adding to its economic woes, and it is heavily reliant on foreign aid. The country's economy is based on agriculture. Rice, jute, tea, sugarcane, tobacco, and wheat are the chief crops. Fishing is also an important economic activity, and beef, dairy products, and poultry are also produced. Except for natural gas (found along its eastern border), limited quantities of oil (in the Bay of Bengal), coal, and some uranium, Bangladesh possesses few minerals.

Dhaka and Chittagong (the country's chief port) are the principal industrial centres; clothing and cotton textiles, jute products, processed food, steel, and chemical fertilizers are manufactured. In addition to clothing, textiles, jute, and jute products, exports include tea, leather, fish, and shrimp. Remittances from several million Bangladeshis working abroad are the second largest source of foreign income. Capital goods, petroleum, and textiles are major imports. Western Europe, the United States, India, and China are the main trading partners. Economic performance has been relatively strong in the past decade, with annual GDP growth averaging five percent. The gross national income per capita in 2003 amounted to USD 400 (World Bank, April 2005).

After its independence in 1971, Bangladesh is governed by the constitution of 1972 (amended several times). The president is chief of state, a largely ceremonial position, and the prime minister is head of government. There is a 330-seat national assembly, with most members popularly elected (30 seats are reserved for women). The major political parties are the Bangladesh Nationalist party, the Awami League, and the Jatiya party. The nation is per 2001 administratively divided into 6 divisions, 64 districts, 507 upazila's (sub-districts), 4,484 unions and 59,990 mouza's.

3.1 Agricultural sector

Bangladesh, a predominantly agrarian economy, is characterized by small-scale, fragmented farming. Though the country has achieved near self sufficiency, the majority of the population lack food security. Agriculture serves as the mainstay of the population contributing about half of the Gross Domestic Product (GDP) and employing over 60% of the total labour force. All the cultivable land is in use and the increasing population pressure dramatically reduced the average farm size holdings to less than a hectare. The role of agriculture in economic development is declining. From 1972/73 to 1993/94 (a 22 year span), the agricultural growth rate was about 3.1% while the industrial and service sector growth rates were much higher, 8.8% and 8.6%, respectively.

Though the basic aim of agricultural development policies over the last four decades remained at increased food production, the program components underwent vast changes shifting from one category to the other. In the early 1960s, flooding during the monsoon and lack of irrigation facilities during the dry periods were identified as the major constraints hindering use of modern agricultural inputs. As such, the government aimed at building large scale irrigation and drainage facilities. In the late 1960s, when major thrust was given in promoting "green revolution", the program strategies shifted from building large scale irrigation installations to more divisible and modern techniques of irrigation coupled with increased distribution of highly subsidized chemical fertilizer and HYVs of rice. In the early 1970s, HYVs of wheat were introduced. During the initial years until the early 1970s, HYVs of rice used to be imported directly. However, subsequently the Bangladesh agricultural research system adapted and indigenously developed different varieties of rice and wheat which were then multiplied and released for farm production.

Most of the farm households keep livestock but usually their quality is poor. Cattle and buffalo are fed principally on agricultural by-products, such as crop residues. They are grazed on natural pastures of non-arable land. During the day, they are allowed to graze on communal grazing land, natural pasture, homestead forest or fallow land. Sometimes, cows with calves are kept tethered just outside the house. Since no arable land is available for livestock feed production, non-arable land contributes most of the green fodder for ruminant animals. Using shrub and tree leaves, and tender shoots and twigs as fodder is traditional in the villages.

Figure 3-2 Most of the farm households keep cattle but usually their quality is poor

In rural Bangladesh, women are major but largely unrecognised contributors to agricultural and economic productivity. The involvement of rural women in decision-making activities (independently or as part of a group), in particular in decisions relating to feeding, breeding, management, veterinary health care and marketing products of dairy is considerable (Islam et al, 1999). Paul and Saadullah (1991) reported that women carry out 25% of crop, 17% of cattle, 21% of goat and 52% of milk sales.

Rearing of dairy cattle has been increasingly viewed as a means of alleviating poverty in Bangladesh and is believed to improve the livelihoods of landless and small households. Many non-governmental organisations (NGOs), such as Proshika Manobik Unnayan Kendra (PROSHIKA), BRAC (Bangladesh Rural Advancement Committee), Grameen Bank and Aftab Dairy, are involved in the promotion of micro-credit for small livestock enterprises including dairy cattle production.

As an input to cropping systems, dung continues to be an important link between crop and animal production in Bangladesh. The yearly total cattle dung production in Bangladesh in 2000 was estimated to be 80 million tonnes of which 68 and 52% is used as manure in rural and urban areas, respectively. The use of dung as fuel is mostly on small farms and represents 25% of total production (DLS 2000). Hossain (June 2003) mentioned somehow different figures on the use of dung: 46% as fertiliser, 34% as cooking fuel and 5% as building material, while 15% is not used at all.

Depletion of soil fertility in Bangladesh is mainly due to exploitation of land without proper replenishment of plant nutrients in soils. The problem is enhanced by intensive land use without appropriate soil management. The situation is more grave in areas where HYVs are being cultivated with little or no organic recycling. Depletion of organic matter is an important factor in the process of soil fertility decline. A good soil should have an organic matter of more than 3.5%. Most soils in Bangladesh have less than 1.7%, and some soils have even less than 1% organic matter. Crop residues and dung are widely used as fodder and fuel rather than fertiliser. Over the past 20 years, the average organic matter content of top soils (high land and medium highland situation) has gone down from 2% to 1%. Lower land might be less affected due to annual flooding.

3.2 Energy sector

Bangladesh has small reserves of oil and coal, but potentially very large natural gas resources. Commercial energy consumption is around 66% natural gas, with the remainder mostly oil and limited amounts of hydropower and coal. Only around 30% of the population (25% in urban areas and 10% in rural areas) has access to electricity, and per capita commercial energy consumption of about 200 kg of Oil Equivalent (kgOE) is among the lowest in the world.

The total recoverable reserves of natural gas are 439 billion m3 (i.e. 15.5 trillion cft) of which 110 billion m3 was produced up to June 2000. The gas is being used for the manufacturing of fertiliser, generation of electricity, for direct use in some industries and as cooking fuel in major urban areas. Economically, it will not be feasible to supply the gas to the rural areas through pipelines. Petroleum products like High Speed Diesel Oil (HSD) and Superior Kerosene Oil (SKO) are predominantly used for transport and rural lighting. The total consumption of petroleum in 2000 was 3.23 million ton, all of which was imported. The yearly consumption of coal in the country is over 1 million tonne, almost exclusively used for brick burning and met by imports. The total coal deposits located in North Bengal are 1.75 billion tonnes. Mining has started on a small scale by Baropukuria Coal Mines under Petrobangla, the national agency for exploration and production of oil, gas and minerals under the Ministry of Power, Energy and Mineral Resources (MoPEMR). The coal from this mine will be used in a power plant currently under construction. The total peat deposits of the country are about 150 million tonnes, but the costs of mining with the current technology are high. Bangladesh, being a rather flat country, is not very much endowed with hydro-electric potential. The total potential is estimated to be 755 MW with a total installed capacity of 230 MW.

Biomass or traditional fuels are estimated to account for over half (about 55%) of the country's energy consumption. They comprise of agricultural residues, mainly from rice and wheat plants, paddy hush and bran, bagasse, jute sticks; materials of tree origin like twigs, leaves and fuel wood; charcoal; and animal (cattle) dung. The total amount of biomass fuels consumed in the year 2000 was approximately 45 million tonnes. Most of the people in Bangladesh live in rural areas and use traditional stoves for cooking of three meals (morning, afternoon and evening) and other heating purposes. Biomass fuels are commonly available in and around the family compound. During the raining period (flooding), it becomes more difficult to collect sufficient quantities of biomass fuels making more well-to-do families to purchase firewood. The stove used for cooking is usually a mud-built cylinder with three raised points on which the cooking pot rests. One opening between these raised points is used as the fuel-feeding port and the other two for flue gas exit. The stove may be built under- or over-ground. In some cases, two potholes are joined together and a single fuel-feeding port is made for common use. The efficiencies of these stoves are quite low and vary between 5 and 15%.

Figure 3-3 Not only twigs and leaves are used as cooking fuel (left), but also dried dung sticks (right)

Dasgupta et al. (September 2004, October 2004) investigated indoor air pollution, more in particular respirable airborne particulates from cooking in Bangladesh. Biomass fuels caused as expected much more pollution than clean fuels like natural gas and kerosene. It also appeared however that household specific factors like cooking locations, construction materials and ventilation processes matter more than fuel choice in determining the concentration of the particulates.

Use of biomass fuels for cooking purposes rather than for its use as an organic fertiliser maintaining the fertility of the soil has obvious disadvantages. Biogas technology is therefore an attractive alternative for farmers keeping cattle in rural areas. In those areas, natural gas, coal and electricity do not qualify as cooking fuel for various reasons. Kerosene and LPG could be considered as alternatives as well, but are quite expensive (Taka 25 per litre respectively Taka 500 to 600 per cylinder depending on distance) and not everywhere and/or always available.

CHAPTER 4: History on domestic biogas in Bangladesh

Based on the field visits, interviews and publications, this Chapter provides a brief overview of the history of domestic biogas in Bangladesh with respect to number of plants installed and projects (paragraph 4,1), technical aspects (paragraph 4.2), benefits of biogas plants (paragraph 4.3) and financial aspects (paragraph 4.4). The overall conclusion is provided in paragraph 4.5.

4.1 Installations and projects

The Institute for Fuel Research and Development (IFRD) of Bangladesh Council of Scientific and Industrial Research (BCSIR) has been the main actor for the dissemination of domestic biogas plants in Bangladesh till date. Other organisations being involved at different stages have been BRAC, Local Government Engineering Department (LGED), Department of Environment (DoE), Grameen Shakti (GS), Bangladesh Agricultural University (BAU), Bangladesh Small & Cottage Industries Corporation (BSCIC), Danish International Development Agency (DANIDA) and Department of Livestock Services (DLS). In total, close to 24,000 family-sized biogas plants of different designs have been installed throughout Bangladesh so far. Due to termination of projects, installation of biogas plants has been stopped almost completely since June 2004. Table 4-1 presents a summary of the number of plants disseminated by the different organisations. A chronological narrative description is provided below this table.

Table 4-1 Organisations involved in the dissemination of biogas plants in Bangladesh and number of plants installed[1]

Organisation	Period	Number of plants installed
Bangladesh Council of Scientific & Industrial Research	1973-2005	22,100
Local Government Engineering Department	1985-2001	1,142
Department of Environment	1979-1983	260
Bangladesh Rural Advancement Committee	1987-2005	80
Department of Livestock	1988-1994	70
Grameen Shakti	1987-2005	70
Bangladesh Small & Cottage Industries Corporation	1983-1988	30
Bangladesh Agricultural Development Corporation	1983-1984	20
Danish International Development Agency	1982	4
Bangladesh Agricultural University	1971-1973	2
Housing & Building Research Institute	1981	2
Bangladesh Academy for Rural Development	1974	1
Bangladesh Commission for Christian Development	1978	1
Bangladesh Agricultural Research Institute	1983	1
Bangladesh Rice Research Institute	1983	1
Total	1971-2005	23,784

In 1972, BAU set up a first floating-drum plant in the University campus to study the characteristics of gas production, followed later by a plant that provided gas for cooking and lighting for a family of six members. In the campus of BCSIR, another plant was constructed by IFRD in 1976, followed by a plant at the KBM College in Dinajpur in 1980. As the construction costs were high and no subsidy available, only few plants (72) were constructed by well-to-do farmers with technical assistance by IFRD. In 1981, DoE started its programme through which about 150 floating-drum and 110 fixed dome plants were installed by contractors free of cost. Other efforts were undertaken by BSCIC (a number of plants), DANIDA (few trench and bag

[1] This table has been on request compiled by BCSIR. Some of the plants mentioned under BCSIR were installed by other parties like BRAC.

type digesters), LGED (over 200 plants) and DLS (about 70 plants). Also the Grameen Bank installed 17 plastic bag digesters. Under the “Fuel Saving Project” implemented from 1989 to 1991, IFRD trained local youths who constructed in total 146 plants in the premises of well-to-do farmers. The gas holder was supplied free of cost. In 1994, LGED supported the establishment of an ecological village (Amgram in Madaripur district) among others by converting 95 open latrines into family plants.

An important dissemination push was delivered by the “Biogas Pilot Plant (1st phase) Project” implemented by BCSIR in the period July 1995 to June 2000. In total 4,664 fixed dome plants were constructed throughout the country. BCSIR employed and trained 128 diploma civil engineers who were assigned responsibilities for motivation, installation and after sales service throughout the country. In addition, 898 youths were trained to support the project. The biogas farmers received an investment subsidy of Taka 5,000 under the project. MoUs were signed between BCSIR and several other institutes like BRAC, LGED and DLS for research, training and dissemination of the biogas technology. The cooperation with BRAC was the most successful as this organisation managed to motivate about 1,200 farmers. An interim evaluation report in 1999 reported 99% of the plants installed under the project in operation, while 91% of the owners could meet their household fuel demand through biogas. Bio-slurry from the biogas plants was used in horticulture, pisciculture and agriculture. The average saving per plant amounted to Taka 759 per month (BCSIR, June 2001).

As the 1st phase was successfully completed and the potential for biogas in Bangladesh considered huge, BCSIR implemented the 2nd phase of the Biogas Pilot Plant in the period July 2000 to June 2004. The target for this phase was put on 20,000 biogas plants, out of which 17,194 plants were finally realised. The investment subsidy for the owner was increased to Taka 7,500 per plant. In addition to the diploma civil engineers employed and paid on a monthly basis by BCSIR, an agency system was introduced on incentive basis. About 50 agencies were recognised in defined areas (mostly districts) and received a lump sum fee of Taka 5,000 per plant as service charge. About 1,000 masons and youths were trained under the project as well.

In the period from October 1998 to June 2003, the LGED implemented a parallel biogas project aiming to install 1,900 domestic plants. As the investment subsidy for this project amounted to Taka 5,000 only, it proved to be rather difficult to motivate farmers during the implementation of the 2nd phase of the Biogas Pilot Plant Project when BCSIR was providing a subsidy of Taka 7,500 to farmers. Therefore, the LGED project was terminated prematurely, after having constructed about 1,120 biogas plants. Under the Secondary Town Infrastructure Development Project-II, another 20 domestic plants were installed using human excreta only.

Of more recent date is the initiative of GS aiming to construct not less than 200,000 biogas plants within a period of five years. This initiative is still in the preparatory phase; at the time of the mission a total of 10 plants were installed or under construction. Agency holders also continued to construct plants without any subsidy in very limited numbers after the termination of the 2nd phase of the BCSIR pilot project in June 2004.

4.2 Technical aspects

All main categories of designs for domestic biogas plants have been applied in Bangladesh, but like in other Asian countries the fixed-dome digester has become the most popular design. The model promoted by BCSIR in both phases of the Biogas Pilot Project originates from a Chinese fixed dome model and has a manhole through the outlet, see Figure 4-1.

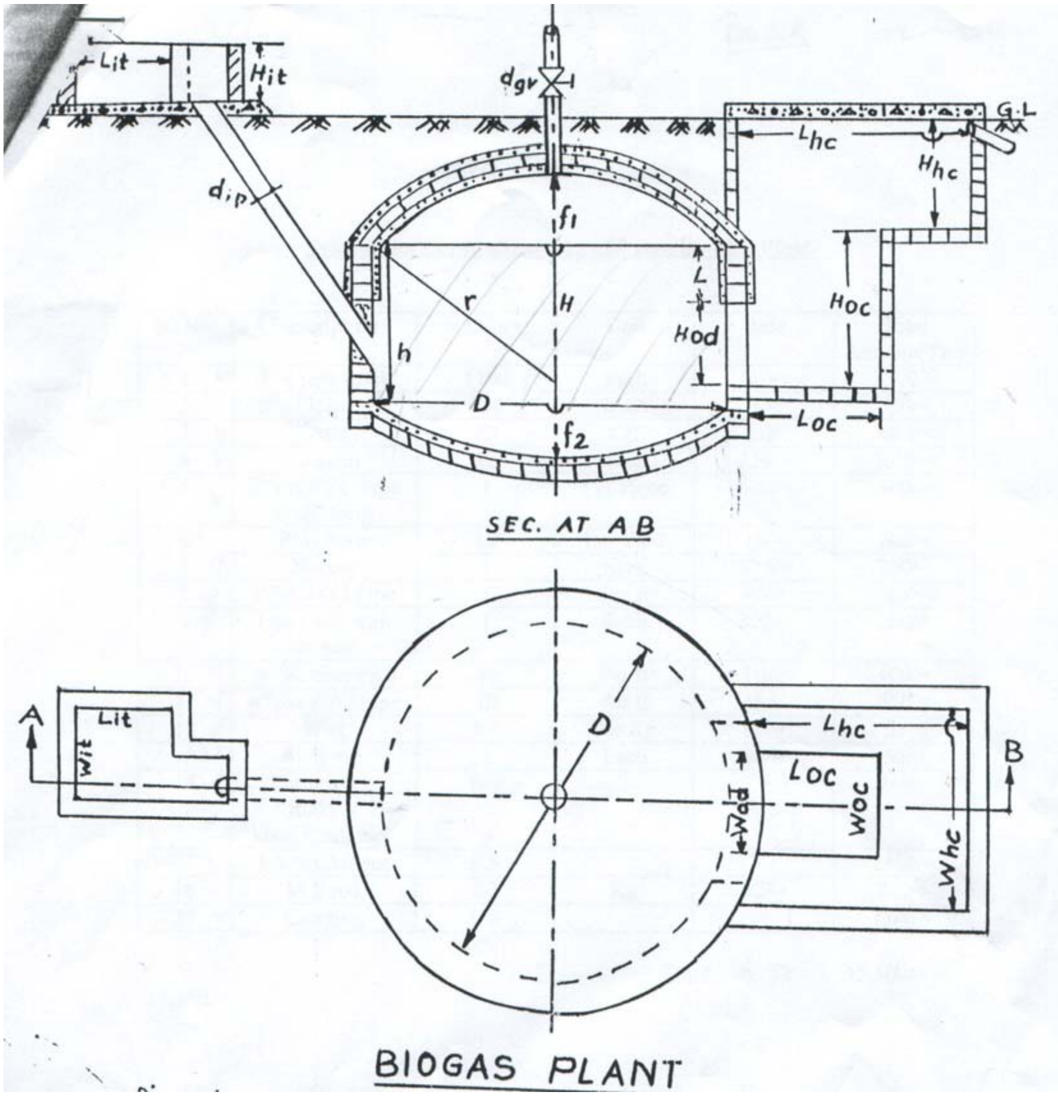

Figure 4-1 Drawing of the BCSIR biogas plant model

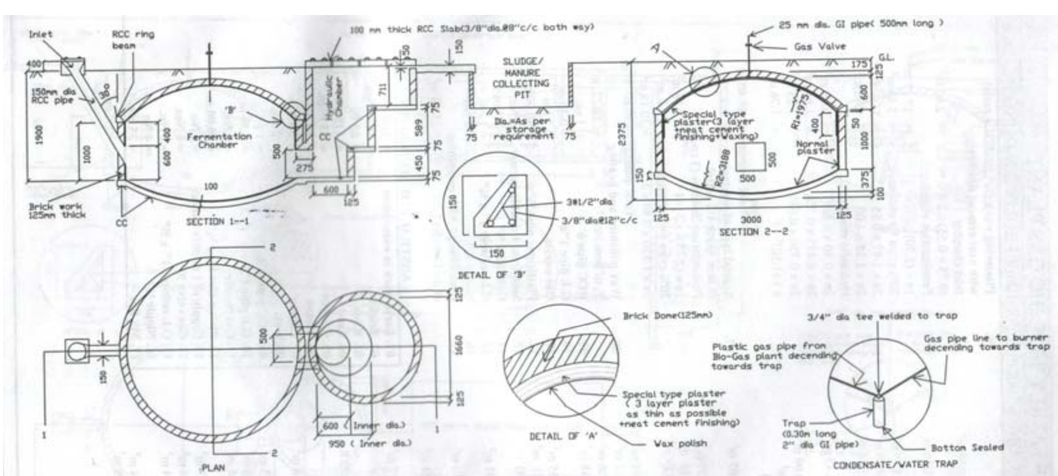

Figure 4-2 Drawing of the LGED biogas plant model

LGED made some modifications of the BCSIR model, among others by revising the shape of the outlet (from rectangular to round) and by putting a RCC ring beam, see Figure 4-2.

4.2.1 Size of the plants and retention time

So far, rather big domestic biogas plants have been promoted in Bangladesh. The minimum size is a plant with a daily gas production of 100 cft (2.83 m3) with an intended retention time of 40 days and a daily feeding rate of 60 kg of dung per day[2]. Respondents explained that this amount of gas would be required by the user to cook three meals a day. Such plants do require quite a large amount of dung for feeding, corresponding with the dung production of approximately six cows[3]. It may be considered:

- To increase the retention time from 40 to 50 days by increasing the digester (and gas storage) volume. This will increase the daily gas production and meet the demand for biogas by farmers rearing less heads of cattle. The negative effect will be an increase in the cost of the plant with a larger volume.
- To promote smaller-sized plants with a daily gas production of 2 m3 or even 1 m3. Such plants might not fully solve the cooking fuel requirements of the household, but if the farmers are provided with reliable information prior to their investment decision, such plants will meet their expectations to solve their fuel problem for at least 60 or 70% in a cost-effective manner. Smaller-sized plants could significantly increase the market for domestic biogas as many farmers in Bangladesh raise a more limited number of cattle.

4.2.2 Construction materials

Through the field visits and the interviews with different technical staff, an impression was gathered on the quality of the construction materials required for the construction of the biogas plant like cement, sand and aggregate. In Bangladesh, cement is easily available at local markets in both good quality and quantity. Sand is commonly available and in most cases supplied to the construction site. In very few cases, biogas farmers had shovelled up and transported sand by themselves. The observed sand was clean and of good quality. Natural stones and gravel are very scarcely available in Bangladesh and therefore 'khoa' is widely used as an acceptable substitute. This 'khoa' is produced by crushing class I clay bricks by hand or mechanically. Clean water for construction is commonly available through shallow wells and during flood period also available in local ponds. Water from these ponds might require basic treatment like filtering through a cloth. Also regular shaped bricks from good quality (class I) are commonly available at local markets and transported to the site by the supplier.

4.2.3 Inlet and inlet pipe

Inlet tanks observed during the field visits were constructed of bricks and finished with plaster. None of the inlets was equipped with a fixed mixing device. The dimensions of the inlets varied, most of them were rectangular or square shaped, while some of them had a small extension in which the inlet pipe was situated. This pipe could not at all times be penetrated with a stick or bamboo rod to de-block any solid matter. Also the height of the inlet varied and was in some cases inconvenient for the user while mixing dung and water. A self-made garden rake-a-alike device was sometimes used for mixing.

One RCC pipe with a diameter of 15 cm was installed to connect the inlet with the digester. It was not compulsory or common practice to install a second inlet pipe for (future) connection of a toilet to the digester. On technical drawings of both BCSIR and LGED model,

[2] This assumes a biogas production of 47 litres per kg of dung which is at the rather optimistic side.
[3] It is assumed that one cattle head produces about 10 kg dung per day that can be collected for biogas production.

the inlet pipe for the input of dung is positioned exactly on the longitudinal centre line of the biogas plant with no variation on this position referred to. However, during the field visits it was often observed that the position of the inlet pipe was approximately 90 degrees versus the centre line. By fitting the inlet pipe under such an angle, the hydraulic retention time might be shorter than intended.

Figure 4-3 Inlets were not equipped with fixed mixing devices. The position of the inlet pipe was sometimes found 90 degrees versus the centre line (right)

On the technical drawings of the LGED model, the position of the inlet pipe inside the digester seems to be higher than the top of the manhole at the outlet side. This would mean that excess gas will be released through the inlet pipe rather than the outlet. This assumption could not be verified during the field visits. Also, it could not be checked whether the end of the inlet pipe in the digester was level with the wall. It may be considered:

- To redesign the inlet by considering a round shape with an appropriate height and a mixing device for easy operation.
- To determine the optimum position of the inlet for dung input versus the longitudinal centre line of the digester.
- To position the level of the inlet pipe in the digester below the top of the manhole to ensure undisturbed flow of excess biogas.

4.2.4 Digester

Unfortunately, it was not possible during the field visits to inspect digesters from the inside. Hence, this paragraph is based on publications and interviews. The shape of the floor of both BCSIR and LGED model is spherical and seems appropriate for area with high water table like Bangladesh. There is however a difference in the materials to make the floor. In the BCSIR model both brickwork and cast concrete is used, while the LGED model prescribes the use of cast concrete only. The wall in both designs is made of bricks (125 mm thick).

Also the dome is spherical shaped and made of bricks. The outside of the dome is either finished with a layer of plaster (LGED model) or with a 5 mm layer of cast concrete (BCSIR model). At the edge of the dome of the LGED model, a RCC ring beam is placed for extra strength. A small GI pipe (25 mm) is fitted in the centre of the dome, but not protected by a turret on top of the dome. In most cases, this top is exposed and not covered with compacted earth. The inside of the dome is finished with three layers (cement/sand and waxing) to ensure complete gas tightness.

Figure 4-4 Domes were often not covered with compacted earth, outlets not covered with cast concrete slabs (right) and dome pipes always not protected

It may be considered:

- To review the materials used for the construction of the dome, making a choice between bricks (finished with a layer of plaster) or cast concrete. A combination of both materials like in the BCSIR model results in unnecessary costs.
- To review the wax method for making the dome gas tight, as this method is cumbersome for the mason. More labour-friendly methods are available, for example by using acrylic emulsion paint.
- To drop the RCC ring beam in the LGED model for small-sized digesters with a volume of maximum 20 m3.
- To double the diameter of the GI dome pipe to 50 mm making it possible to de-block this pipe with a bamboo stick, to protect this pipe on top of the dome with a turret and to cover the dome with a layer of minimal 20 cm compacted earth for protection and reduction of heat losses in the wintertime.

4.2.5 Outlet and slurry pit

The outlet wall towards the dome is constructed either on the dome (BCSIR model) or on top of a beam situated above of the manhole (LGED model). During the field visits, it was observed that the shape of the outlet varied from rectangular to circular. The circular shaped outlet is supposed to be less prone to cracks. On technical drawings of both BCSIR and LGED models, the long side of the rectangle of the outlet is designed parallel to the longitudinal centre line of the biogas plant. However, it was found in the field that the short side of the rectangle of the outlet was parallel to this centre line. No specific reference was made for the required position of the outlet overflow. During the field visits, this overflow was found positioned at will. This will increase the risk of ‘dead areas’ and thus sedimentation in the outlet.

The users were left with the responsibility to decide on putting a reinforced cast concrete outlet slab or a self made outlet cover. In most of the observed biogas plants, the farmers explained that they opted for an improvised cover as concrete slab would result in extra costs. A single slurry pit was observed in most cases. However, the dimensions of the slurry pit seemed to be too small to collect and compost all digested slurry. Also, the pits were not protected from direct sunlight and leaching.

Figure 4-5 Outlets were found rectangular (left) and circular (right) shaped

It may be considered:

- To review the shape and positioning of the outlet.
- To make it compulsory to put a reinforced concrete slab for covering of the outlet.
- To further increase awareness among biogas farmers on the relevance of a proper slurry pit.

4.2.6 Pipeline and appliances

During the field visits, various types and models of main gas valves were observed on top of the GI dome pipe. Teflon tape was commonly used to make this connection gas tight. On the other side of the main valve, a nozzle was fitted for easy connection of the plastic gas pipe, however without a hose clamp. Main gas valves were often wrapped in plastic and showed signs of natural wear, while in some cases the valve was turned black due to gas leakage.

Figure 4-6 Main gas valves were sometimes wrapped in plastic (left)

Biogas was transported to the point of application through flexible plastic gas pipes with a diameter of ¾ inch. Nearby trees and/or houses supported these pipelines, making condensed water at low points to block the pipeline in between the points of support. Although it is easy to take out the water form the pipeline, the recurring nature of this kind of maintenance will discomfort the user. The pipeline is hanging in the open air and is exposed to direct sunlight making the plastic brittle and prone to frequent replacement. The pipeline is vulnerable from damage for example from falling branches, storm and animals. The user him/herself, however, will be able to repair the damage or – if required – even to replace the entire pipeline.

Figure 4-7 Cheap flexible plastic pipes were used to transport biogas to the place of application, sometimes poorly supported (right)

Various types of gas stoves have been observed like stoves with (a) single or double burner(s) and stoves with double burners fitted in galvanised iron, metal or casted frames. Most of the stoves were manufactured in Bangladesh and supplied to the user by the organisation responsible for installing the biogas plant. Biogas stoves seemed not to be available at the local markets. Many users were not satisfied with the lifetime of the stoves. In one case, the user claimed he had to purchase a new stove every year. Corrosion of the burner head was found the main problem of the stoves seen during the field visits. Another common default was the malfunctioning of the gas-regulating knob (internal gas tap). It was also observed that the lit of the burner cup could not be removed for cleaning purposes. Burners were fitted with many small openings, without primary gas–air intake regulating device. The performance of the gas lamps could not be observed during the field visits.

Figure 4-8 Stoves were often manufactured in Bangladesh, but users complained often about their durability

It may be considered:

- To further increase awareness among biogas users on the importance of closing the main gas valve after having used the gas.
- To review the different methods of gas transport to the point of application including the installation of a water drain to optimise ease of use in relation to recurring costs.

- To review the design features of the current biogas stoves and identify areas of improvement in cooperation with users and manufacturers.
- To consider pre-qualification of biogas stoves to ensure a minimum quality.

4.2.7 Overall quality management

For the disbursement of the investment subsidy, name and location of the owner of the biogas plant were properly recorded. However, at the time of completion of the construction of the plant, no formal and recorded (technical) inspection and handing over formalities have been performed by the organisation responsible for construction. Records with (technical) information could not be observed during the field visits.

During or after construction, no independent quality control was conducted to monitor the compliance with specified quality standards. From both users and constructors, it was learnt that contact could be established between each other in case the plant was not functioning properly. After sale service was conducted by negotiation, not on the basis of already agreed terms and conditions for a specified period of time. It may be considered:

- To further standardise the design, construction and after sale service of biogas plants and to further enforce these standards by formal recording and independent quality control.

4.3 Benefits of biogas plants

Domestic biogas plants typically provide benefits (e.g. energy, gender, environment, health) at different levels (household, local, national and global). The LGED Project Proforma (2003) explains in this respect that "benefits may be divided into tangible and intangible benefits. Tangible benefits may be quantified only indirectly through compensation principle, prospective beneficiary being ready to pay towards the cost of the project for the psychological satisfaction, one would have to forego had the project been shelved. These are projects which provide only service benefits which can hardly be quantified. Such benefits may accrue either to an individual or to a community."

Figure 4-9 Women enjoy easy, clean and quick cooking on biogas (left) while bio-slurry is a potent organic fertiliser and fish feed

The evaluation of biogas plants established under the first and second phase of the Biogas Pilot Plant Project conducted by DPC Group (June 2004) is the most reliable source of for an overview of the benefits provided by biogas plants. A total of 620 plants were sampled for this evaluation, 400 being first phase plants and 220 second phase plants. The sources of primary data were the (male) owners and the (female) users of the plants. The study covered all six divisions of Bangladesh. The most significant positive and negative effects of biogas plants are summarised in Table 4-2.

Table 4-2 Positive and negative effects of biogas plants constructed under the Biogas Pilot Plant Project as evaluated by the DPC Group

Positive effects of biogas plants:

- Reduction in bad smell of raw materials presently fed to the biogas plant mentioned by 91% of the owners
- Produced biogas was used for cooking by 95% of the owners and for lighting by 10% of the owners. Most of the female users (88%) mentioned that the amount of gas was sufficient to meet the cooking needs. The other female users (12%) indicated they used wood, straw and leaves to meet the deficit in biogas supply
- Bio-slurry used by 81% of all biogas plant owners, mostly as fertiliser (77%), but also as fish feed (23%). Remaining owners drained the slurry (6%), sold it (6%) or gave it to others (7%). Those who sold the slurry, earned between Taka 325 (1st phase owners) and Taka 374 (2nd phase owners) per month.
- Increased crop production through use of bio-slurry was reported by 60% of the owners. They claimed an increase in crop production of 23% (1st phase owners) to 27% (2nd phase owners). The other owners (40%) did not notice an increase in crop production
- Increased fish production through use of bio-slurry was reported by only 9% of the owners. Most of them (62%) claimed an increase of 10%, while others (26% and 12%) claimed an increase of 20 and 30% respectively.
- Average saving in expenditures for cooking between Taka 661 (1st phase owners) and Taka 774 (2nd phase owners) per household per month as a result of the use of biogas for cooking and other household activities. Agency holders united in the BBBB estimated the monthly savings much lower, about Taka 400 per month.
- Biogas plants save time (mentioned by 66% of all female users) now spent especially on education of children (mentioned by 46% of all female users), household works (mentioned by 29% of all female users) and gardening (mentioned by 27% of all female users)
- Biogas plants save time of cooking (mentioned by 97% of all female users)
- No smoke during use of biogas stoves (mentioned by 17% of all female users)
- Cooking utensils do not become dirty (mentioned by 40% of all female users)
- Use of biogas for cooking is safe (mentioned by 13% of all female users)
- Biogas helps to keep the environment hazard free and hygienic
- Use of biogas helps to keep kitchen and clothes clean
- Use of biogas does not irritate eyes
- Biogas plants have encouraged people to rear more cattle heads
- Bio-slurry is used in sericulture
- Biogas plants save forests and trees

Negative effects of biogas plants:

- Problems with operation were reported by 10% of the owners, being shortage of raw materials to feed the plant, low gas production, gas leakage through the hydraulic chamber and filling of plant with small parts of snails and oysters requiring frequent cleaning
- Problems with operation were reported by 11% of the female users, being problems with the burner, blockage of the pipe, construction fault, insufficient feedstock, lack of manpower to feed the plant, gas leakage in the dome and filling of plant with small parts of snails and oysters requiring frequent cleaning
- Poultry as feedstock often blocks the plants
- Occasionally, the plant spreads bad smell
- It is difficult to charge the plant everyday
- Sometimes, the expected amount of gas is not produced
- Sometimes, the outlet help growth of flies and mosquitoes

Information collected during the field visits indicated that biogas stoves were used for 5 to 8 hours per day for cooking. Other sources of energy than biogas were required for cooking on special occasions only. Cooking with biogas was appreciated by all users being quick and clean, while the stoves did not soot the cooking pots and pans.

As all benefits of biogas plants have not yet been sufficiently investigated in a quantitative manner, also with respect of the application of bio-slurry, it may be considered:

- To conduct an independent and detailed biogas users' survey to collect quantitative information on the positive and negative effects of biogas plants installed in Bangladesh under the 1st and 2nd phase of the Biogas Plant Pilot Project.

4.4 Financial aspects

This paragraph provides an estimate of the investment costs of an average biogas plant as well as a consideration of the investment subsidy provided under the last phase of the Biogas Pilot Plant Project.

4.4.1 Investment costs

Quotations for a biogas plant with a gas production of 100 cft and a total plant volume of about 6 m3 have been collected from LGED, BCSIR and GS. These quotations exclude the costs of a cast concrete slab for the outlet and the fee for construction and after sale service. The total investment costs amount to Taka 15,500, see Annex 6. This figure was confirmed by the evaluation conducted by the DPC Group finding an average of Taka 15,768 for a sample of 220 biogas plants constructed during the 2nd phase of the Biogas Pilot Plant Project.

4.4.2 Investment subsidy

During phase II of the Biogas Pilot Plant project implemented by BCSIR, the biogas farmer was provided with a direct investment subsidy of Taka 7,500. In addition, agency holders constructing and maintaining biogas plants received a fee of Taka 5,000 per unit. Hence, the total investment subsidy amounted to Taka 12,500 for every biogas plant.

It may be considered:

- To include for reasons of transparency the fee for construction and after sale service in the quotation for the biogas plant.
- To limit for reasons of ownership by the biogas farmers the amount of investment subsidy to approximately 35% of the investment costs.

4.5 Overall conclusion

The history of domestic biogas in Bangladesh is rather rich. So far, BCSIR has been the main actor in the dissemination of biogas plants. In total, close to 24,000 family-sized biogas plants of different designs have been installed throughout the country. The fixed dome model has become the most popular design. A number of design aspects are eligible for revision to up-grade quality. Also more emphasis will be required to enforce quality of construction and after sales service. Due to ending dates of projects, installation of biogas plants has come to a standstill almost completely since June 2004.

The approach followed so far can be characterised as a single actor project approach. It appears to be the proper time now to initiate a multiple actor programme approach with the longer-term vision to develop a commercial, sustainable biogas sector.

CHAPTER 5: Potential demand for domestic biogas

A number of technical, social and financial factors were investigated to arrive at an estimate of the potential demand for domestic biogas in Bangladesh.

5.1 Technical factors

Climatic conditions for the production of biogas in Bangladesh are favourable, as rather high temperatures remain throughout the year. It is rather difficult to get up-to-date data about the number of farmers keeping sufficient heads of cattle for biogas production as the latest census in Bangladesh was conducted in 1996. By then, 8.17 million holdings (45.8% of all holdings) reported to keep 21.57 million of cattle (an average of 2.64 cattle per holding), while 0.27 million households (1.5% of all holdings) reported to keep 0.72 million of buffaloes (an average of 2.67 buffaloes per holding). The numbers of cattle in the agricultural census of 1983-84 (21.49 million) and 1977 (20.50 million) were slightly lower. It becomes not clear from the 1996 census data to which extent holdings with cattle also kept buffaloes. There was a positive correlation between the average number of cattle and buffaloes per holding and the size (acreage) of the holdings. An interesting classification of holdings with cattle is provided in Table 5-1 (Bangladesh Bureau of Statistics, June 2004, page 232).

Table 5-1 Classification of holdings with cattle in Bangladesh as per the 1996 census

	Number of holdings	Number of cattle	Average number of cattle per holding
Holdings with 1-2 heads	5,106,994	7,838,641	1.53
Holdings with 3-4 heads	2,111,498	7,198,421	3.40
Holdings with 5 heads and above	952,872	6,535,129	6.85
Total	8,171,364	21,572,191	2.64

About 950,000 holdings in 1996 kept five or more heads of cattle and could be regarded as potential biogas farmers. If all dung produced by minimum five heads of cattle could be collected, this amount would be sufficient to feed a biogas plant with a gas output of say 100 cft per day. The 2.1 million holdings keeping three or four cattle heads could be regarded as a bigger market segment, but as the amount of dung is limited to 30 to 40 kg per day, they would need to be supplied with smaller-sized biogas plants, e.g. with a gas output of 50 cft per day.

Figure 5-1 Cattle dung is the major feeding of domestic biogas plants in Bangladesh

It is not very clear what happened with the number of farmers keeping sufficient heads of cattle since 1996. Most of the informants interviewed during the feasibility study suggested that the cattle population is rather stagnant; with other words, the number of cattle nowadays will be more or less the same as in 1996. The number of holdings (assumingly also with cattle) however has increased over this period with about 20%, which means that the average number of cattle heads per holding has decreased with the same factor. Rough estimates by experts from Bangladesh Bureau of Statistics (BBS) and Bangladesh Agricultural Research Council (BARC) on the present number of households with three or more cattle heads range from 575,000 to 1,925,000. Gofran[4] made a small survey in Kazipur union of Patuakhali district in December 2003 and found 700 households keeping four or more cows. If this union would be representative for the whole country and assuming a total of 4,500 unions in the country, the total number of households keeping four or more cattle heads would amount to 3,150,000. The informants provided also the following qualitative information:

- Reduction in the keeping of cattle as draught animal has been caused by the massive introduction of power tillers and tractors.
- Reduction of the acreage for grazing caused by an increase in the number of households and an increase in the acreage used for cultivation of paddy. As a result, farmers face difficulties in the collection of fodder for the cattle.
- Increase in the number of dairy cattle, especially in the urbanised areas with an increasing demand for milk. Investment capacity in the rural areas is increasing due to the availability of credit facilities and income earned my migrant workers abroad.
- There is an inflow of cattle from India, estimated to be 700,000 to 800,000 heads per year, especially for slaughtering on the occasion of the festival called Qurbani[5].

A limiting factor for the technical potential of domestic biogas could be flooding as Bangladesh forms the largest delta in the world. The vast plain is washed by big rivers like the Meghna, the Padma, the Jamuna and the Karnafuli. Tropical monsoon rains drench the land and the rivers. Onrush of rain waters in summer (July and August) overflows their banks flooding low and outlying areas every year and could damage the structure of the plant or disturbing its operation through in-flow of water in the outlet. However, as households have already avoided building their homesteads in low and very low land, it is believed that flooding will not significantly reduce the technical potential. Proper site selection requires careful attention when constructing the plant. Due to high water tables, the season for construction might be limited to six or seven months only. On the positive site, flooding might also promote the installation of biogas plants as they provide fuel for cooking in a convenient manner, while collection or purchase of alternative (biomass) fuels in the flooding period is quite problematic.

Water required for mixing cow and/or buffalo dung prior to feeding into the biogas plant is in general not a problem in Bangladesh. Tube-wells form the main source of water in the rural areas.

5.2 Social factors

Biogas produced from cattle and buffalo dung is widely accepted as cooking fuel in Bangladesh. However, resistance exists to attach a toilet to the biogas plant as this will create hesitation among people to handle the bio-slurry. This phenomenon would need special attention in future extension and promotion campaigns. It may be considered to make the installation of a second inlet pipe to the digester compulsory, even if the biogas farmer does not (yet) consider attaching a latrine.

[4] Abdul Gofran, personal communication, 29 March 2005
[5] This festival remembers Abraham's sacrifice of his son Ishmael, celebrated with the slaughter of a cow, sheep or goat. During the week preceding the festival, open-air fairs do a brisk trade in cattle and goats.

As mentioned in paragraph 3.1, women have a say in the decision-making process at household level. This is important as the women are the main direct beneficiaries of the biogas plants.

5.3 Ability to pay

The latest household expenditure survey conducted in 2000 comprising a sample of 5,440 rural households provides figures on their average income and expenditure (Bangladesh Bureau of Statistics, March 2003). These figures might be suitable proxies for potential biogas farmers. The average income of a rural household in 2000 amounted to Taka 4,816 per month. Professional wages and salaries contributed for 27.7% to this income, followed by agriculture (25.5%) and business & commerce (22.4%). The average expenditure per rural household amounted to Taka 4,257 per month, out of which Taka 3,879 (91.1%) spent on consumption (of goods and services) and Taka 378 (8.9%) on non-consumption (taxes, pension and social security contributions and related insurance premium, gifts and other transfers). The average rural expenditure by household on food was equal to Taka 2,300 per month.

5.4 Financial analysis

The financial analysis is based on the data for a biogas plant with a daily gas production of 100cft. The investment cost is assumed to be Taka 25,000 to include the fee for construction and after sale service as well as measures to increase the quality of the biogas plant (caste concrete slab for the outlet, GI gas pipes, turret on top of the dome to protect the dome gas pipe and better quality of biogas appliances), see Annex 6.

The basic data for the financial analyses is presented in Annex 7. The benefits associated with the use of the biogas plant derive primarily from the savings in expenditures for biomass fuels. The base price for these fuels is assumed to be 1.0 Taka per kg. The value of the saved labour and the recovered nutrients in the biogas slurry are assumed to be zero. The base analysis indicates a financial internal rate of return (FIRR) of 15 percent. Figure 5-2 presents the results of a sensitivity analysis on the assumed price of biomass. The data indicates that the resulting FIRR is extremely sensitive to this price.

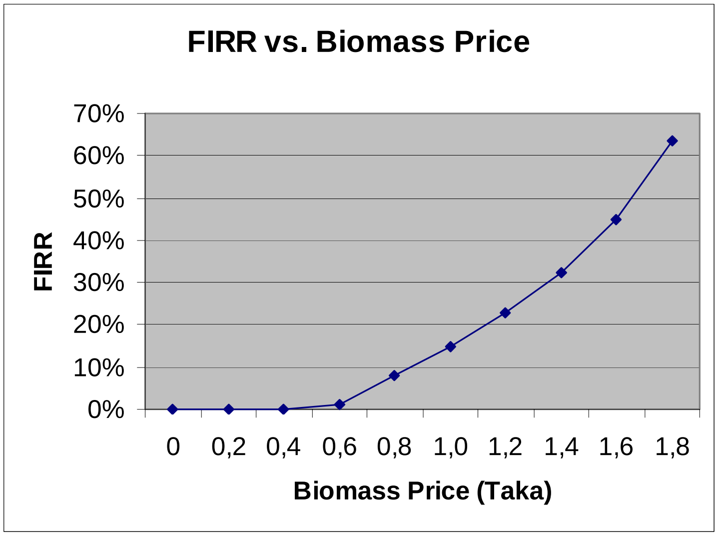

Figure 5-2 The Financial Internal Rate of Return (FIRR) is very sensitive to the price of biomass

The FIRR becomes negative when the price of biomass is below 0.4 Taka/kg and 64% when the price of biomass is 1.8 Taka/kg. The actual price of biomass in Bangladesh varies considerably from one area to another. The perception of many rural farmers is that the price of biomass is near zero since it can be collected by household labour which is not valued highly by the farmer.

A sensitivity analysis on the amount of the subsidy provided is presented in Figure 5-3. The data indicates that the FIRR is not as sensitive to the percentage change in the level of the subsidy as it is to the price of biomass. The FIRR becomes less than 10 percent when the subsidy is Taka 3,000 or lower per biogas unit and is 88 percent when the subsidy is Taka 17,000 per unit.

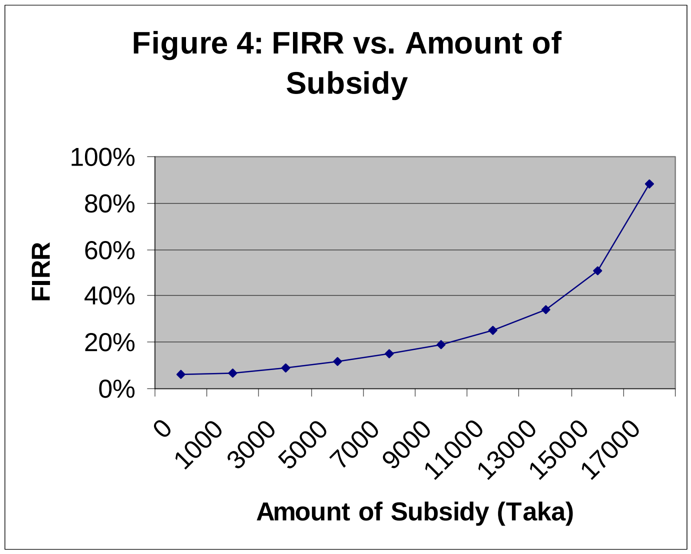

Figure 5-3 The Financial Internal Rate of Return (FIRR) is less sensitive to the amount of investment subsidy

The financial analysis indicates that an amount of Taka 7,000 as investment subsidy is generally sufficient to attract potential farmers while not being significantly excessive as to result in relatively high FIRRs for the farmer. The actual FIRR realized by the farmer is largely dependent on the actual financial price for biomass. It may be considered:

- To recalculate the FIRR and the required amount of subsidy after obtaining the results of the detailed biogas users' survey, see paragraph 4.3.

5.5 Economic Analysis

An economic analysis of a biogas plant with a daily gas production of 100 cft was undertaken to assess the benefits to society of the use of biogas plants. Due to the scope of this study, the economic analysis had to rely on data presented in a publication of a large-scale biogas programme in Nepal (Mendis and Van Nes, July 1999). These data provide a reasonable basis for the economic analysis.

The principal assumptions relate to the conversion from financial prices to economic prices. A summary of the conversion factors and resulting economic prices for the costs and benefits associated with the analysis is presented in Annex 8. Economic benefits resulting from improved sanitation through toilet attachment and employment generation were left out of consideration. The analysis is based on calculating the economic internal rate of return (EIRR) for the net annual benefits associated with the biogas plant. All investment costs for the plant were assumed to be expended in the first year and all maintenance costs and all resulting benefits were assumed to be constant over the 15 year life of the plant. A summary of the resulting EIRR for the biogas plant is presented in Figure 5-4. The EIRR for just the economic benefits derived from the savings of biomass that result from the use of a biogas plant is estimated at 17 percent. This EIRR, as in the financial case, is very sensitive to the assumption of the economic price for biomass. The economic price of biomass is assumed to be Taka 1.0 per kg. If the economic price of biomass is Taka 0.5 per kg, the resulting EIRR is 1 percent and if the price is Taka 1.5 per kg, the resulting EIRR is 32 percent.

Working with the base economic price for biomass of Taka 1.0 per kg and adding a saving of 1.0 hours a day of domestic labour valued at Taka 1.5 per day results in increasing the EIRR to 20 percent. Assuming an annual value of Taka 1,971 for the nutrients in the dung that are saved and returned to the land as a result of the biogas plant, the EIRR increases to 39 percent. When the economic value of smoke reduction is added at Taka 400 per year (Reid, 1986), the resulting EIRR increases to 43 percent. Finally, if the reduced carbon emissions associated with the use of a biogas plant are valued at US$ 5 per tonne CO2-eq., the resulting EIRR increases to 62 percent.

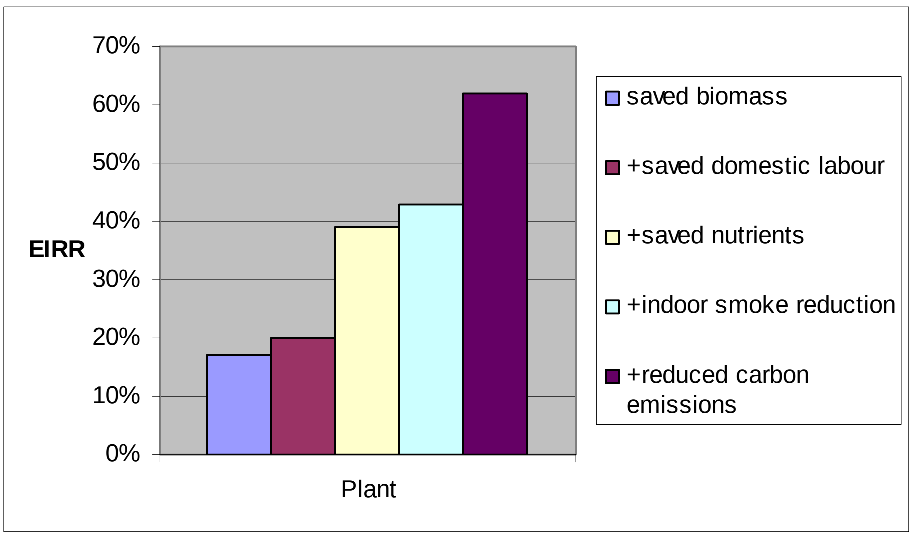

Figure 5-4 The Economic Internal Rate of Return (EIRR) varies between 17 and 62%, dependent on the benefits taken into account

Based on the assumptions used for this economic analysis, it is clear that there is an economic justification for the subsidy of Taka 7,000 per plant proposed in this study. Furthermore, it is unlikely that the Bangladeshi farmers would have sufficient financial incentives to adopt the biogas plants. The earlier financial analysis clearly indicated how sensitive the FIRR is to the price of biomass. As most farmers do not directly purchase biomass, their perception is that the price of biomass is at or near zero. As a result, their perceived FIRR is negative. Alternately, if the economic value of biomass is Taka 1.0 per kg, then the resulting EIRR for the biogas plant is 17 percent. When the other principal non-market benefits of the biogas plant are added, the EIRR rises to 62 percent. This provides an additional justification for the subsidy for the biogas plants. It may be considered:

- To recalculate the EIRR and the required amount of subsidy after obtaining the results of the detailed biogas users' survey, see paragraph 4.3.

5.6 Overall conclusion

Based on the number of households keeping sufficient number of cattle, there is a rather substantial technical potential of minimum one million biogas plants in Bangladesh. To further increase this potential, it is important to promote smaller-sized biogas plants. Flooding will not be a strong limiting factor, but site selection needs to be done very carefully. High water table will limit the construction season to six to seven months per year. Apart from hesitation to attach a toilet to the digester, there are no limiting social factors for domestic biogas. The ability of most farmers to invest in a biogas plant with a total cost of say Taka 17,000 will be limited due to their low income. This underlines the need for an effective credit facility in a future national programme on domestic biogas. The financial analysis indicates that an amount of Taka 7,000 as investment subsidy is generally sufficient to attract potential farmers while not being significantly excessive as to result in relatively high financial rate of return (FIRR) of 15 percent for the farmer. The actual FIRR realized by the farmer, however, is largely dependent on the actual financial price for biomass. The economic internal rate of return (EIRR) for the biogas plant is 17 percent in the base case.

CHAPTER 6: Overview of (potential) stakeholders

This Chapter provides a brief overview of the main (potential) stakeholders for a national programme on domestic biogas in Bangladesh, divided into government, civil sector and private sector organisations. Bangladesh is endowed with an impressive number and variety of institutes, organisations and companies. Besides these described below, many more could be called upon to participate in the implementation of a national programme on domestic biogas. This organisational richness can be regarded as a very positive starting point for such a programme and makes the establishment of a separate programme office unnecessary.

6.1 Government organisations

6.1.1 Bangladesh Council of Scientific and Industrial Research

The Bangladesh Council of Scientific and Industrial Research (BCSIR, www.bcsir.org) was established in 1973 with its head office at the Dhaka Laboratories campus. In 1983, the Institute for Fuel Research and Development (IFRD) was established under BCSIR. The Council is part of the Ministry of Science, Information and Communication Technology (MoSICT).

BCSIR is conducting R&D in 38 main areas among which biogas technology since 1976. Through the Biogas Pilot Plant Projects (1st and 2nd phase) implemented since 1995, BCSIR also played a very central role in the dissemination of biogas plants, see Chapter 4.

6.1.2 Local Government Engineering Department

The Local Government Engineering Department (LGED, www.lged.org) of the Ministry of Local Government, Rural Development & Cooperative is playing a pivotal role in rural infrastructure development in Bangladesh. The main functions of LGED are to provide technical support to the rural and the urban local government institutions and to plan and implement infrastructure development projects in rural and urban areas. Almost all the bilateral and multi-lateral development partners operating in Bangladesh are involved with the development projects of Local Government Engineering Department (LGED).

Training has been widely recognized as an essential means to acquire knowledge, skill and motivation. As such, LGED has given due importance to training. All the training programmes of LGED are coordinated and implemented through the LGED HQ Training Unit and 10 Regional Training Centres at District level. About 30 types of courses are offered to different categories of LGED officials/staff. The courses include technical, managerial, financial, environmental and socio-economic issues. In addition, training courses are also offered to the contractors, representatives of the local government institutions, project beneficiaries, community groups etc.

The Chief Engineer acts as the chief executive of LGED. He is assisted at the headquarters by two Additional Chief Engineers, six Superintending Engineers (SE), six Executive Engineers (XEN) including one Executive Engineer (Mechanical), one Assistant Chief Engineer and four Assistant Engineers (AE) including one Assistant Engineer (Mechanical). Including these engineers a total number of 89 employees are working at the

LGED headquarters. The total number of employees at the district level is 762 including the Executive Engineer and one Assistant Engineer in each district and one Assistant Engineer (Mechanical) in each greater district. 8,785 persons including 469 Upazila Engineers are working at the sub-district level. At present, LGED's total number of employees is around 9,347 under the revenue budget. Besides, there are six more Superintending Engineers at regions and ten District Training Engineers at ten regional training centres under the revenue budget.

LGED was involved in the dissemination of more than 1,100 domestic biogas plants in the period from October 1998 to June 2003, see Chapter 4.

6.1.3 Ministry of Power, Energy and Mineral Resources

The Ministry of Power, Energy and Mineral Resources (MoPEMR) has overall responsibility for the country's energy sector, with policy formulation and investment decisions under its control. This Ministry has two distinct divisions, the Power Division and the Minerals Division.

The Bangladesh Power Development Board (BPDB) is an agency under the Power Division of MoPEMR responsible for generation and transmission of electricity in the country. This agency distributes also to urban consumers through other GoB agencies like the Dhaka Electric Supply Company (DESCO). Distribution of electricity to rural consumers is planned, implemented, operated and managed by the Rural Electrification Board (REB).

The Minerals Division of MoPEMR deals not only with the exploration, production, transport and distribution of natural gas, petroleum, coal and other minerals available in the country, but also with the import, refining and distribution of crude oil and petroleum products including LPG. The corresponding implementing agencies are Petrobangla (with several companies working under this corporation) and Bangladesh Petroleum Corporation (BPC). There are three state-owned oil marketing companies under BPC: Jamuna Oil Company Limited former CALTEX), Meghna Petroleum Company Limited (former ESSO Eastern Inc.) and Padma Petroleum Company Limited (former Burmah Eastern Limited)[6].

Within MoPEMR, the "Power Cell" acts as a single point of contact to facilitate the electricity reform and restructuring process including formulation, implementation and monitoring of GoB policy as well as promotion and monitoring of private power generation by Independent Power Producers (IPPs). Power Cell is also charged with the responsibility to further develop renewable energy sources in the country. It is planned by GoB to establish a rather autonomous apex body called Renewable Energy Development Agency (REDA), but until its formation the Power Cell will look after all issues related to renewable energy.

The Bangladesh Rural Electrification Program under the MoPEMR was founded with a Presidential Ordinance in October 1977 that established the Rural Electrification Board (REB) as the semi-autonomous government agency reporting to the Ministry. Since its inception, the purpose of the program has been to use electricity as a means of creating opportunities for improving agricultural production and enhancing socio-economic development in rural areas. Today there are close to 70 operating rural electric cooperatives called Palli Bidyuit Samity (PBS).

So far, the MoPEMR has not been involved in the dissemination of biogas plants in Bangladesh.

[6] These companies were nationalised following the independence of Bangladesh.

6.1.4 Infrastructure Development Company Limited

The mission of Infrastructure Development Company Limited (IDCOL, www.idcol.org) is to promote economic development in Bangladesh by encouraging private sector investment in infrastructure projects. IDCOL was created by the Government of Bangladesh (GOB) with assistance from International Development Agency (IDA). IDCOL was registered as a public limited company under the Company's Act 1994 and licensed by the Bangladesh Bank as a non-bank financial institution in January 1998. IDCOL's share capital is fully subscribed by the GOB.

Its specific development objectives are the following:

- Participate in the financing of privately-owned infrastructure projects by providing structured finance in the form of senior and subordinated loans;
- Mobilise third-party limited resource lending to privately-sponsored infrastructure projects, either at financial closing, or post-commissioning stages, of project development;
- Provide investment advisory services to developmental projects that are led by private Bangladeshi developers;
- Provide refinancing for small infrastructure projects implemented by non-governmental organizations (NGOs)/microfinance institutions (MFIs) and other private entities;
- Arrange technical assistance for private sponsors and executing agencies promoting small infrastructure and renewable energy projects.

IDCOL is managed by an independent Board of Directors. The Board of Directors of IDCOL comprises senior government officials and prominent entrepreneurs from the private sector nominated by the shareholders of the Company, and an appointed full time Chief Executive Officer.

IDCOL had initial access to resources of US$ 225 million, which was provided by the GOB and the World Bank and of which an amount of USS$ 154 million has been reallocated for the rehabilitation of infrastructure damaged by 2004 floods. In addition, IDCOL has access to another US$20 million (divided into IDA credit and Global Environment Facility (GEF) grants) to channel grant and provide refinancing for promotion of renewable energy under the Rural Electrification and Renewable Energy Development Project (REREDP). Under this Project, IDCOL promotes photo-voltaic solar home systems (SHSs). These SHSs are to be purchased by households and business entities in the rural areas of Bangladesh. All the stakeholders have to contribute their shares in the purchase of SHSs, such as, households are required to put an upfront payment and NGOs/MFIs have to finance the remainder of the cost of SHSs in the form of micro-credit. IDCOL channels GEF grants to buy down the SHSs cost as well as supports the operational costs of NGOs/MFIs promoting SHSs, provides the latter a refinancing facility in local currency, and puts in place other related arrangement, designed to promote conditional sales of SHSs. IDCOL intends to finance an estimated 50,000 SHSs over the period January 2003 to June 2008. As of 30 April 2005, ten NGOs/MFIs have already installed about 40,000 SHSs in rural areas over Bangladesh.

So far, IDCOL has not been involved in the dissemination of biogas plants in Bangladesh.

6.1.5 Bangladesh Agricultural Research Institute

Bangladesh Agricultural Research Institute (BARI) is an autonomous organisation under the Ministry of Agriculture and responsible for conducting research on all crops except rice, jute, sugarcane, and tea for which there are separate institutes. It was established in 1908 as

Agricultural Research Laboratory, Bengal at Dhaka. In 1968, the Department of Agriculture was bifurcated into two separate directorates, namely, the Directorate of Agriculture (Extension and Management), and the Directorate of Agriculture (Research and Education). The latter was converted to Bangladesh Agricultural Research Institute (BARI) in 1976. During the early sixties, BARI was shifted to Joydebpur to allow rebuilding of its research facilities. The shifting was completed in 1980. In addition to the central station of Joydebpur with an area of 165 ha, BARI has six regional stations and 24 sub stations. The institute has six crop-based research centres (Tuber Crops Research Centre, Wheat Research Centre, Horticultural Research Centre, Pulse Research Centre, Oil Crops Research Centre, Spice Research Centre) to ensure a multi-disciplinary approach. The number of mandated crop in these centres exceeds 100; variety improvement and production have received priority. It has made good contribution towards the development of wheat, potato, mustard and vegetables. The institute has released 172 improved varieties of different crops. The overall management of the institute is vested on a 12-member Board of Management. The chief executive of the institute is the Director General, assisted by three Directors who are specifically responsible for three main areas of activities, namely, research, support services, and training and communication.

BARI could play a role in a national biogas programme through conducting applied R&D on the proper use of bio-slurry.

6.1.6 Department of Agricultural Extension

The Department of Agriculture Extension (DAE, www.bangladeshgov.org/moa/dae) is part of the Ministry of Agriculture (MoA) and responsible for carrying out extension services at the grassroots level throughout the country. The main functions of DAE are:

- To motivate and help farmers in adopting improved production practices to increase their productivity, meet national consumption requirements, maximise export and minimise import.
- To provide farmers with the latest results of research and farm techniques for their socioeconomic betterment.
- To help develop self-reliance and cooperation by training local leadership for organised group action.
- To provide channels for service and information from the MOA and its different departments to the farm people and in turn relay the problems and needs of the farmers that require national level intervention.
- To provide an effective linkage between the various research institutes and the farmers so that along with the flow of technology to the farmers, the farmer's level problems are also brought to the relevant research institutes for investigation and solution.
- To serve as liaison agency between farmers and other organizations, both public and private concern with overall socio-economic development of rural people, including the credit and input supply agencies.

At present the Department provides its services through eight wings. The Field Services Wing is responsible for providing extension services to farmers throughout the country and maintains offices at regional, district, upazila and block level. The total number of employees of DAE amounts to about 24,000.

DAE could play a role in a national biogas programme through extension on the proper use of bio-slurry to farmers operating a biogas plant.

6.2 Civil sector organisations

Besides these described in this paragraph, many other civil sector organisations in Bangladesh could play a role in a national biogas programme like COAST, CMES, SRIZONY and TMSS.

6.2.1 BRAC

BRAC (www.brac.net), formerly known as Bangladesh Rural Advancement Committee, was established as a relief and rehabilitation organisation in 1972 after the Bangladesh Liberation War by Mr. Fazle Hasan Abed. Over the years BRAC has gradually evolved into a large and multifaceted development organisation with the twin objectives of alleviation of poverty and empowerment of the poor with over 26,000 regular staff and 34,000 part time teachers, working in 60,627 villages in all the 64 districts of Bangladesh. Related companies and institutes are among others BRAC Bank, BRAC University and BRAC Industries Ltd. The projected annual expenditures for 2003 amounted to USD 174 million out of which 18% to be financed by donors.

BRAC was involved in the dissemination of about 1,200 domestic biogas plants as part of the 1st phase of the Biogas Pilot Plant Project, see Chapter 4.

6.2.2 Grameen Shakti

Grameen Shakti (GS, www.grameen-info.org/grameen/gshakti/), an organization of the Grameen family of companies, has been working as a company in the renewable energy sector in Bangladesh since 1996 aiming at:

- Popularising and delivering renewable energy to the rural households.
- Marketing solar, biogas and wind energy on commercial basis, focusing on rural areas.
- Providing services that alleviate poverty and protect environment through applied research and development of renewable energy based technologies.
- Undertaking a project to progressively manufacture and market efficient and affordable household based photovoltaic systems.
- Implementing projects to generate electricity from wind in the coastal belts and offshore islands; operate mini and micro hydro-plants in the hilly areas.
- Developing and implementing special credit, savings and investment programs for generation, storage, and utilization of renewable energy for the benefit of rural people.
- Testing the new and appropriate technologies to provide more cost effective energy services at affordable price to the non-electrified areas.
- Providing capital, technology and management services to energy enterprises.

GS has established a large network in Bangladesh with over 100 offices and 400 field staff, mostly engineers, covering 54 out of 64 districts.

Recently, GS has launched an ambitious initiative aiming to construct 200,000 biogas plants within a period of five years. At the time of the mission, a total of about 10 plants were under construction or completed. For biogas farmers, GS has introduced a soft financing system for the customers consisting of three different options:

- Option 1: The customer has to pay 25% of the total price as down payment. The remaining 75% of the cost are to be repaid within 24 months with 10% service charge.
- Option 2: The customer has to pay 20% of the total price as down payment. The remaining 80% of the cost are to be repaid within 36 months with 14% service charge.
- Option 3: Biogas farmer has to pay Taka 1,000 for supervision and technical assistance by GS, but constructs for the remaining the plant on his/her own cost.

It still remains to be seen in future whether these options will fully recover the costs incurred by GS. The very ambitious initiative of GS is encouraging, but is typically a single actor project approach. The challenge is to incorporate the ambitions of GS in a national programme, in which this company could play a significant role, especially with respect to the functions of construction, after sales service and provision of credit, see Chapter 7.

6.2.3 Bangladesh Centre for Advanced Studies

Bangladesh Centre for Advanced Studies (BCAS, www.bcas.net) is an independent, non-profit, non-government, policy, research, and implementation institute working on sustainable development at local, national, regional and global levels. BCAS addresses sustainable development through four interactive themes: (a) environment-development integration, (b) good governance and people’s participation, (c) poverty alleviation and sustainable livelihoods, and (d) economic growth and public-private partnership. It was established in 1986, and over the years has grown to become a leading institute in the non-government sector in Bangladesh and South-Asia. It works on the above issues using interactive approaches and multiple methodologies. BCAS has been registered with Social Welfare Department as well as NGO Affairs Bureau of Government of Bangladesh.

BCAS has a core management unit guided by a board of directors, two dozens of senior professionals and scientists and more than three dozens of mid-level professionals and researchers.

BCAS being an independent institute could play a role in a national biogas programme through conducting external monitoring and evaluation.

6.2.4 PKSF

Palli Karma Sahayak Foundation (PKSF, www.pksf-bd.org) has been working since its inception in 1990 as an apex micro-credit funding and capacity building organisation for eradicating poverty by providing micro-credit to the poor through its Partner Organisations (POs). PKSF, in English, means “Rural Employment Support Foundation”. However, PKSF has expanded its operation to urban areas also. PKSF’s vision is to alleviate poverty and improve the quality of life of the poor – the landless and the assetless people by providing them with resources for creation of employment for enhancing economic conditions. The major objectives of PKSF are:

- To provide various types of financial help and assistance to POs, so that they can undertake activities that generate income and employment opportunities among the economically most disadvantaged groups in the society.
- To assist in strengthening the institutional capacity of POs, so that they can manage their programme in a sustainable manner.

PKSF reaches its target groups – the landless and the assetless people – through its POs, it does not directly lend money to its target people. PKSF provides loanable funds to its 199

POs, 3 big, 189 small and medium, and 7 pre-PKSF POs. PKSF gives special emphasis on micro-enterprise development with the goal of making micro-credit more growth-oriented.

Legally PKSF is a “company limited by guarantee” meaning “company not for profit” and is registered under the Companies Act of 1913/1994 with the Registrar of Joint Stock Companies. The legal structure of PKSF allows flexibility, authority and power to take programmes and implement them throughout the country and managing its affairs as an independent organisation. The PKSF mandate authorises PKSF management to mobilise funds in the forms of grants, loans and contributions from a wide variety of sources which include the Government of Bangladesh (GOB), private individuals and organisations, foreign governments, international donors and lending agencies and capital markets. So far PKSF has received funds from the GOB, the IDA/World Bank, the USAID, the Asian Development Bank (ADB) and the International Fund for Agricultural Development (IFAD).

So far, PKSF has not been involved in the dissemination of biogas plants in Bangladesh.

6.3 Private sector organisations

6.3.1 Agency holders

The 2nd phase of the Biogas Plant Pilot Project aimed to establish approximately 50 agencies for the marketing, construction and after sales service of biogas plants. These agencies worked under the direct control and supervision of the Project Director from BCSIR. The evaluation reported by the DPC Group in June 2004 as well as the field visits have made clear that some of these agency holders have done a very good job. The owners of the agencies engaged officers and workers to conduct the activities. The agency holder employed at Dhaka and Narayanganj district engaged 18 motivators and managed to construct 277 plants in FY 2001/02, 386 plants in FY 2002/03 and more than 500 plants in FY 2003/04. In Comilla district, the holder with the help of 10 motivators, 25 masons and one motor-cycle constructed more than 500 plants within two years. In Gazipur district, the agency holder constructed 59 plants in FY 2001/02, 221 plants in FY 2002/03 and 165 plants in FY 2003/04 and engaged five motivators and 20 masons. In total, all agency holders constructed 9,776 biogas plants in the 2nd phase of the Project, being 2,349 units (31%) more than the number constructed by the civil engineers directly employed by BCSIR.

Agency holders originating from the Pilot Project have united themselves in the Bangladesh Bureau of Biogas and Bio-Technology (BBBB). After the closure of the project, construction activities have come almost to a standstill and in this respect they are eager to continue their businesses through participation in a national biogas programme.

CHAPTER 7: Required functions and suitable actors

National programmes require multiple actors to conduct distinguished functions in a coordinated manner, see Figure 7-1, rather than single actors conducting all functions on their own.

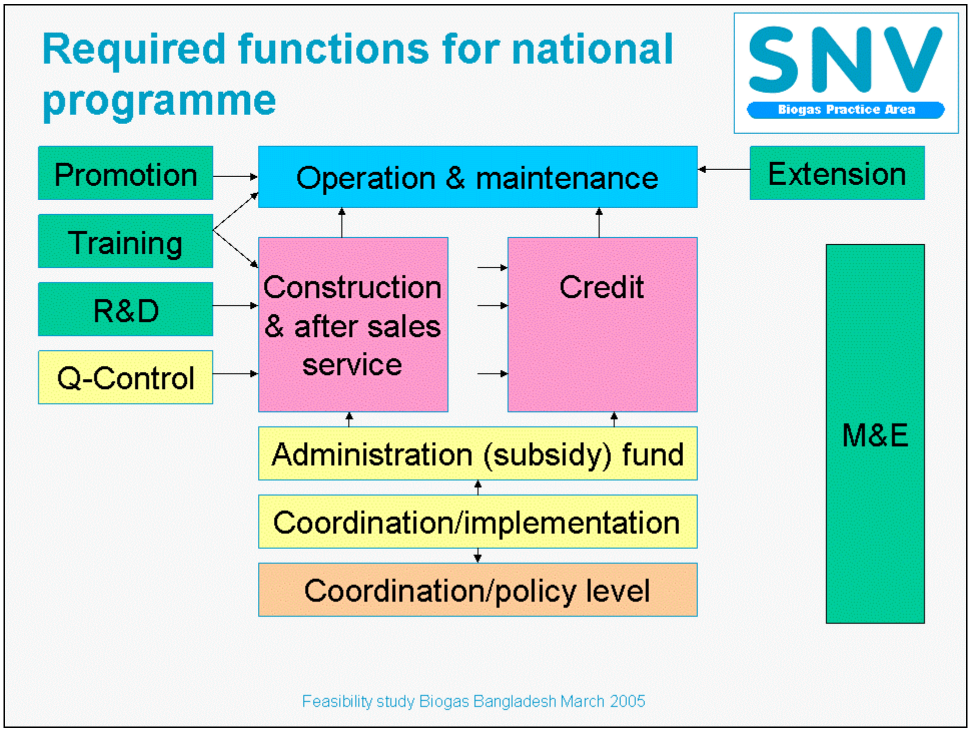

Figure 7-1 Functions required to be executed in a national biogas programme

During the interviews, selected stakeholders were invited to propose suitable actors to conduct these functions, see Annex 5. In this chapter, a provisional match between required functions and suitable actors is presented. Some of the functions are supposed to be conducted by one actor only; others by multiple actors only, with a third category of functions that could be executed by both single or multiple actors, see Table 7-1.

Table 7-1 Suitable actors proposed by respondents to execute functions in a national biogas programme

Function	Suitable actor(s)
Operation & maintenance (multiple actor)	Eligible farmers having sufficient cattle dung at their disposal will operate and maintain the biogas plants.
Promotion (single/multiple actor)	Various actors from the government and civil society sector at central and local level will be able to promote the use of biogas including the dissemination of reliable information on the costs and benefits of biogas plants towards eligible farmers. One respondent suggested a newly to be established Biogas Programme Office (BPO) to conduct this function, but it is preferred to make use of already existing capable institutions.

Construction & after sales service (multiple actor)	Based on a level playing field enabling fair competition, different kind of actors could very well construct and service biogas plants like private companies including agency holders and NGOs like BRAC and GS. Though LGED and BCSIR were mentioned as possible actors as well, it is not recommended to involve government organisations in conducting this function.
Provision of credit (multiple actor)	NGOs like BRAC and GS as well as scheduled banks could very well provide loans to eligible farmers to finance the installation of biogas plants. It is not likely that these actors will be able to refinance these loans by their own sources and therefore a refinancing facility might be required. PKSF was also mentioned as a possible provider of credit to farmers, but being an apex organisation this would not qualify.
Administration of (subsidy) fund (single actor)	IDCOL was most often suggested to be the most appropriate institute to handle the administration of investment subsidy, with respondents often referring to their current role in the SHS programme. Also the BPO was mentioned in this respect, but again it is preferred to make use of already existing capable organisations
Quality control (single actor)	Quality control is closely related to the administration of investment subsidy which was perhaps the reasons that also for this function IDCOL was most often suggested. Independent consultants were mentioned as well, but even these need to be assigned by the responsible actor.
Training (multiple actor)	Various actors could be involved in conducting training activities, depending on the kind of training. Some of the required trainings are (female) user training, mason training, supervisor training, business development training and loan officer training. Possible actors most often mentioned by respondents were BCSIR and LGED.
Extension on use of bio-slurry (single/multiple actor)	Proper use of bio-slurry needs to be promoted through extension programmes to be executed at local level. Extension agents from the DAE or NGOs could be well placed to provide these services.
Applied R&D (single/multiple actor)	Also with applied R&D, various actors could be involved in executing activities, depending on the nature of the R&D. BCSIR was most often mentioned, but also BUET and BARI were proposed for agricultural research.
Monitoring & evaluation (single/multiple actor)	Multiple actors could qualify for execution of monitoring & evaluation activities on the condition that they are independent. Private consultants and BCAS were most often mentioned as potential actors.
Coordination at implementation level (single actor)	Only one single actor could be involved for the day-to-day coordination or management of the national programme. A newly to be established BPO was most often mentioned, but it is preferred to make use of already existing capable organisations. IDCOL respectively LGED were mentioned next and could both qualify despite being very different organisations. BCSIR and the MoPEMR were not preferred by the respondents due to unsuitable mandate (BCSIR is a R&D institute) respectively motivation (MoPEMR looks at commercial energy only).
Coordination at government/policy level (single actor)	For the coordination at government/policy level, the establishment of a separate steering committee with broad representation from all sectors was proposed most often. This committee could be facilitated by the coordinating body at implementation level.

The suitable actors are presented in Figure 7-2. Eligible farmers will operate and maintain biogas plants constructed and serviced by private sector and NGOs, while NGOs and scheduled banks provide them – if required – with a micro-credit. Promotion, training, R&D, extension and M&E are functions that will be conducted by various institutes. IDCOL and LGED are identified as possible suitable organisations to coordinate the programme at implementation level, to administer public funds and likely also to arrange for quality control. A Steering linked to the national government will need to be established to coordinate the programme at policy level.

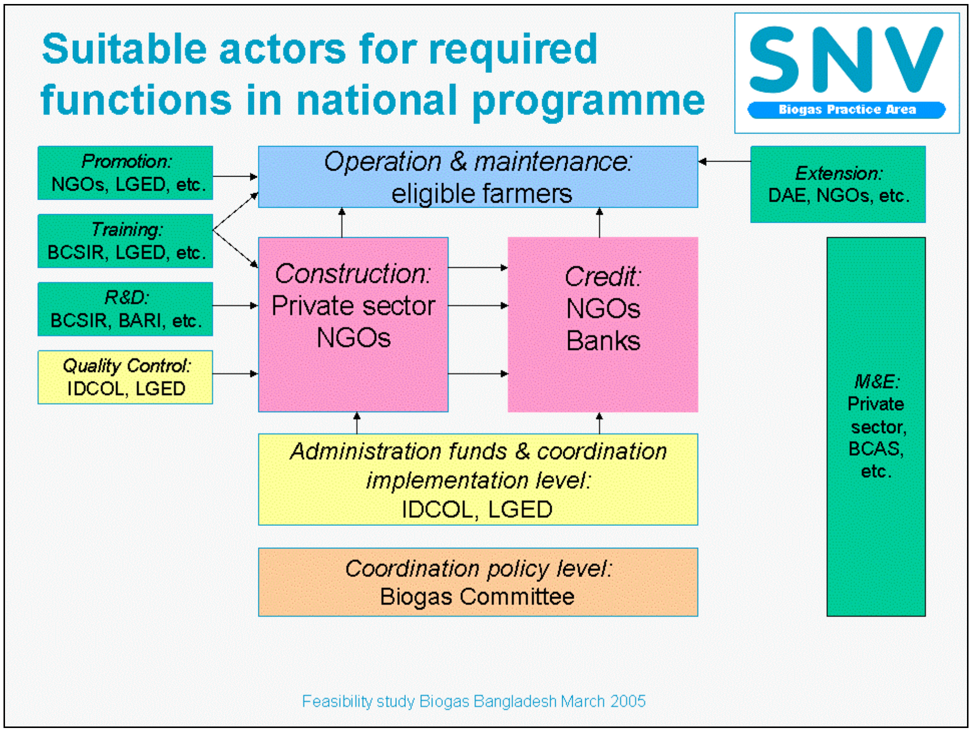

Figure 7-2 Summary of suitable actors to execute functions required in a national biogas programme

CHAPTER 8: Outline for a national biogas programme

This Chapter provides a rough outline for a national programme on domestic biogas. The majority of the conditions for large-scale dissemination of biogas plants in Bangladesh are fully or just met (see Annex 9), with a few other conditions doubtful, not (yet) met or falling short. The latter conditions need attention during the formulation of a detailed implementation plan. Also respondents mentioned a number of constraints for a national programme. These are first of all dealt with in paragraph 8.1.

8.1 Constraints for a national programme

Stakeholders mentioned in the interviews a big number of constraints for a national programme on domestic biogas, see Annex 5 and Table 8-1. This table also provides possible manners to address these constraints in a national programme. Most of the constraints can be effectively addressed through properly designing and implementing a national programme.

Table 8-1 Constraints for a national biogas programme as mentioned by stakeholders and possible manners to address these constraints

Type of constraint	Constraint (number of times mentioned by respondents)	Possible manners to address this constraint
Technical	Lack of after sales service (4x)	In the quotation of constructors a fee for specified after sales service could be included, and a strict observance of this service could be enforced
	Insufficient dung available and decreasing cattle number (4x)	The technical potential number of biogas plants is still minimum one million. Potential customers could be provided with reliable information prior to taking an investment decision
	Lack of training and trained manpower (1x)	A national programme could cater for well trained manpower
	Technical failures (1x)	Enforced quality standards could reduce the number of technical failures
Financial and economic	Lack of funds for grants and credit (4x)	A national programme could be fully financed
	High investment cost (2x)	A national programme could have a facility to provide credit to biogas farmers
	Early adopters not taking care of plant operation (2x)	Such customers could be less if (investment) subsidies are reduced to reasonable levels
	Lack of cost recovery by constructors and credit providers (2x)	Constructors and credit providers could include all costs including a profit margin in their prices
Social	Hesitation among farmers to handle dung and to use biogas (1x)	Farmers could be provided with reliable information, but should never be forced to install a biogas plant
	Preference of male heads of households to invest in other things than a biogas plant (1x)	Both male and female members of potential customers could be provided with reliable information, but are of course free in their final investment decisions
Promotional	Lack of awareness (4x) and promotion (2x)	A national biogas programme could create awareness and cater for effective promotional activities
	No critical mass achieved (1x)	A national biogas programme could be a first step to achieve a critical mass
Institutional	Wrong type of organisation engaged in dissemination (3x)	Most functions could be executed in competition by multiple actors on a level playing field, while few functions could be executed by one, carefully

		to be selected single actor only
	Lack of dedicated institute (2x)	See above
	Lack of institutional arrangements (1x)	A national programme could formulate and enforce effective institutional arrangements
	Time consuming procedures of GOB (1x)	Unnecessary delays could be limited as much as possible by proper planning
Political	Lack of political commitment and will (3x)	A national programme could be properly linked to national policies through a national biogas committee
	Technology felt outdated by the politicians (1x)	Effects and impacts of biogas plants could to be reliably documented and presented to politicians
	Interference by politically backed businessmen (1x)	Important decisions could to be taken by committees rather than individuals
Programmatic	Lack of monitoring and follow-up (1x)	A national programme could cater for sufficient monitoring and follow-up, see Figure

8.2 Objectives of the programme

The overall objective of the proposed national programme is to further develop and disseminate domestic biogas in rural areas of Bangladesh. The specific objectives contributing to its overall objective are:

- To develop a commercially viable, market oriented biogas industry.
- To further strengthen institutions for sustainable development of the biogas sector.
- To stimulate internalisation of all benefits of the biogas plant.
- To increase the number of quality biogas plants by 36,450[7].
- To ensure the continued operation of all biogas plants installed under the programme.
- To conduct applied Research and Development (R&D) in order to optimise plant operation and use of bio-slurry.

8.3 Initial geographical coverage

In order to firmly found and test the modalities and institutional arrangements of the national programme, it was proposed to the stakeholders to limit the geographic coverage initially to say 16 districts (25% of all districts). Such approach was found very reasonable, but it was advised for political reasons to include districts from all six divisions. Criteria proposed by the stakeholders for the selection of the districts are high cattle population, small risk of flooding, high income of farmers, good availability of construction materials and easy communication. Other mentioned, sometimes contradictory criteria were the remoteness of the district and the absence of a connection to the electrical grid, see Annex 5.

8.4 Implementing partner

Despite being very different organisations, see Table 8-2, both IDCOL and LGED have come out from Chapter 7 as potential implementing partners for SNV.

Table 8-2 Comparison of some characteristics of LGED and IDCOL

	LGED	IDCOL
Registration and management	Department under the Ministry of Local Government , Rural Development & Cooperative	Public limited company under the Company's Act 1994, managed by an independent Board of Directors

[7] This rather detailed number originates from the proposal for the Asia Biogas Programme and is used here as an indication for the production rate of a national biogas programme in Bangladesh. This rate might be revised during the formulation of the implementation plan.

Function	To provide technical support to the rural and urban local government institutions and to plan and implement infrastructure development projects	To promote economic development by encouraging private sector investment in infrastructure projects
Organisational structure and size	Offices at national, regional, district and sub-district level with over 9,300 employees	One office in Dhaka with about 15 employees
Leadership	Chief Engineer, supported at the headquarters by two Additional Chief Engineers, six Superintending Engineers and other engineers	Chief Executive Officer
Relevant experience and success record	Project for production and use of biogas and organic fertiliser for maintaining environmental balance with mixed results	Renewable energy development project very successfully disseminating SHSs in a programmatic approach and with proper institutional arrangements
Interest shown to participate in the national programme	Positive	Positive

Based on the current data and information, IDCOL is slightly preferred above LGED based on their effective role in and experience with the SHS-project. Also the small size of IDCOL allowing more flexibility might be an advantage at one side, though its personalised leadership might be a risk at the other side.

It may be considered:

- To field a short mission to Bangladesh in July or August 2005 to select either IDCOL or LGED as a partner for the implementation of the programme. A Memorandum of Understanding (MoU) needs to be formulated between this partner and SNV for the preparation of the programme, in particular the formulation and approval of the detailed implementation document.

8.5 Production, budget and financing

It is proposed to have two different phases of the national biogas programme, a preparation and an implementation phase. The preparation of the programme could start after the approval of this feasibility report and would include the formulation and approval of a detailed implementation plan. This phase would also include the installation of a limited number of biogas plants (2,100) already in 2006. The implementation phase could run for a period of three years from 2007 up to and including 2009 and aim at the construction of another 34,350 plants. Hence, the total production of the programme would amount to 36,450 biogas plants.

The total indicative budget for the national biogas programme amounts to Euro 14.7 million, see Table 8-3.

Table 8-3 Indicative budget for the national biogas programme

Total indicative budget (in Euro)	2005	2006	2007	2008	2009	
	Preparation phase (start end 2005/15 months)		Implementation phase			
Year	0	I	II	III	IV	Total
Production	0	2,100	4,200	12,150	18,000	36,450
Subsidy Component (Euro 85 per plant)	0	178,500	357,000	1,032,750	1,530,000	3,098,250
Credit Requirement (Euro 200 per plant)	0	420,000	840,000	2,430,000	3,600,000	7,290,000
Down payment (Euro 35 per plant)	0	73,500	147,000	425,250	630,000	1,275,750
Programme Cost	118,580	427,458	442,045	649,090	724,655	2,361,828
Technical Assistance by SNV	35,000	175,000	175,000	175,000	175,000	735,000
Total	**153,580**	**1,274,458**	**1,961,045**	**4,712,090**	**6,659,655**	**14,760,828**

The cost/benefit ratio of CDM financing needs to be determined during the formulation of the implementation plan. Based on experiences to mobilise carbon credits for large-scale biogas programmes in Nepal and Vietnam, it might be possible by that time to estimate the cost/benefit ratio for a smaller-scale programme in Bangladesh.

It may be considered:

- To finance the subsidy component and the programme cost out of the budget allocated by DGIS for the Asia Biogas Programme. In addition, the Government of Bangladesh will need to be requested to provide an appropriate contribution to the financing of the subsidy component and/or programme cost.
- To finance the SNV technical assistance out of the core subsidy provided by DGIS to SNV.
- To explore the availability of funds, in-country and abroad, required to refinance the credit requirements of the programme.

8.6 Assumptions and risks

It will be of great importance for the national biogas programme to get the full support from the Government of Bangladesh (GoB). So far, representatives of different stakeholders showed a clear interest and will to participate and/or support such a programme, and thus it is assumed that the GoB support will materialise also formally. The multiple benefits of the proposed biogas programme have clear linkages to the poverty reduction strategy (Government of the People's Republic of Bangladesh, March 2003) and the attainment of the millennium development goals (World Bank, February 2005) envisioned by the GoB.

Another assumption is that the (potential) stakeholders will agree to upgrade and standardise the quality of products and services. Once the potential user has decided to install a biogas plants, he/she needs to be ensured to get the stipulated quality with respect to construction, after sales service and also financing.

A risk not yet mentioned in this report will be the period of time required to start implementing the national programme. First of all, SNV needs to be registered in Bangladesh as an INGO. The process required for such registration could take about six months. At the same time, the formulation of the detailed implementation plan could be already carried out for a period of four months, starting from September 2005. The approval of this plan by the GoB might take another nine months, making it likely that the first biogas plants under this programme can be only constructed in the last quarter of 2006, more than two years after the end of the Biogas Pilot Plant Project. It will also take time to arrange for a likely required refinancing facility that could fulfil the credit requirements of the programme. It is assumed, however, that this arrangement can be made within the 13 (4+9) months preparation time indicated above.

It may be considered:

- To start the registration process of SNV as an INGO in Bangladesh from July 2005 onwards.

CHAPTER 9: Main conclusions and recommendations

This Chapter only presents the main conclusions and recommendations. One is referred to the various chapters for more specific conclusions and recommendations.

9.1 Main conclusions

A national programme on domestic biogas in Bangladesh looks feasible as:

- Bangladesh has already a rich history in domestic biogas with close to 24,000 units constructed throughout the country so far.
- The technical potential for biogas amounts to minimum one million units, while there are no strong limiting social factors.
- The financial analysis indicates that an amount of Taka 7,000 as investment subsidy is generally sufficient to attract potential farmers resulting in a satisfactory financial rate of return (FIRR) of 15 percent for the farmer. The actual FIRR realized by the farmer, however, is largely dependent on the actual financial price for biomass. This underlines the need for an effective micro-credit facility. The economic internal rate of return (EIRR) for the biogas plant is 17 percent in the base case.
- Bangladesh is endowed with an impressive number and variety of institutes, organisations and companies with a large potential to participate in the implementation of a national programme. This organisational richness makes the establishment of a separate programme office unnecessary.
- There is a clear will and interest among (potential) stakeholders to be engaged in a national programme.

The tentative outline for such a programme with a longer-term vision to develop a commercial, sustainable biogas sector includes the production of 36,450 biogas plants up to 2009 and will cost about Euro 14.7 million. The biogas farmers, DGIS, SNV and GoB are the proposed financiers of the programme, to be supplemented by a provider of a refinancing facility for the credit requirements. The cost/benefit ratio of CDM financing still needs to be determined. It has been assumed that the GoB will fully support a national biogas programme and that (potential) stakeholders will agree to up-grade the quality of products and services. The long period required for the approval of an implementation plan is considered as a risk, all the more since the dissemination of biogas plants has come to a standstill in June 2004.

9.2 Main recommendations

The following are the main recommendations resulting from this feasibility study:

- To SNV: To start with immediate effect the process of registering SNV as an international INGO in Bangladesh.
- To SNV: To field a mission in July or August 2005 to select an implementing partner and sign a MoU with this partner for the formulation of a detailed implementation document.
- To SNV and selected implementing partner: To formulate the detailed implementation document in cooperation with all potential stakeholders in Bangladesh in the period September to December 2005.

- To SNV, selected implementation partner other main involved stakeholders: To pursue approval of the detailed implementation document, to make the required preparations and to start implementation of the programme in 2006.

CHAPTER 10: References

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Annex 1: Terms of Reference

1. Introduction and background

In the framework of its Asia Biogas Programme co-financed by DGIS, SNV aims to set-up a large-scale biogas programme in the Republic of Bangladesh. A brief fact finding mission was conducted in November 2004 and reported in February 2005. The mission report concluded that the circumstances in Bangladesh seem favourable to establish a national biogas programme and recommends commissioning an in-depth study on its feasibility. This document presents the Terms of Reference (ToR) for this study.

2. Objective of the study

The objective of the study is to thoroughly assess the feasibility to set-up and implement a national biogas programme in the Republic of Bangladesh.
More specifically, the study will address the following areas:

- Country background including agricultural & livestock sector, energy demand and supply, energy policy and plans;
- History of domestic biogas;
- Potential demand for domestic biogas;
- Possible supply of services for domestic biogas; and
- Outline for a national programme on domestic biogas.

3. Activities and methodologies

The following activities and methodologies are proposed:

A. Preparation of a mission to Bangladesh by using the fact finding mission report, collecting secondary information, contacting key respondents and informants in Bangladesh and abroad, and drafting checklists for biogas plant visits and interviews;

B. Mission to Bangladesh to visit biogas plants constructed by various programmes in the past, to meet key respondents and informants for interview and discussion. The mission shall include a workshop to discuss with the main stakeholders the roles of the different actors in Bangladesh and the outline of a possible national biogas programme;

C. Formulation of the draft study report and submission for comment to SNV/Nepal and members of the Biogas Practice Team (BPT) of SNV;

D. Submission of the final study report by incorporating the comment from SNV/Nepal and members of the BPT.

4. Time schedule

The mission to Bangladesh shall be completed within a period of three weeks in March 2005. The draft report shall be submitted before 15 April 2005. SNV/Nepal and members of the BPT will provide within 10 working days comment on the draft report. After that, the final study report will be presented within five working days.

5. Budget

The costs of this study will mainly consist of expenses for travelling and DSA of the team members, a consultancy fee for a local expert and some other local expenses if deemed required for example for the collection of baseline data. All costs will be borne by the budget for the up-scaling of biogas in Asia.

6. Expected output

The report on the feasibility study shall be well-structured and clearly written not exceeding 50 pages excluding annexes and provide informed recommendations on the possibilities for SNV to set-up a national biogas programme in Bangladesh.

7. Composition of the team

The mission team shall consist of three members: a team leader, an engineer and an independent, external local or regional expert. The team leader and the engineer will be members of the BPT of SNV, while the external expert will be recruited in the region.

8. Further arrangements

Prior to the mission to Bangladesh, the team leader will come up with an itinerary for the mission to Bangladesh. The mission team is free to discuss any matter concerning the assignment with any institution or individual, but is not authorised to make any official commitments on behalf of SNV.

9. References

[1] Jan Lam and Willem Boers, *Report (draft) on the First Fact Finding Mission for a Biogas Support Programme in the Republic of Bangladesh*. SNV, February 2005.

Annex 2: Programme of the mission

Thursday, 10 March 2005:		
	Arrival of Wim van Nes and Willem Boers in Dhaka by air	
Friday, 11 March 2005:		
	Preparation	
Saturday, 12 March 2005:		
09.30-11.15	Meeting with possible local team member	
	Preparation	
Sunday, 13 March 2005:		
	Preparation	
11.00-13.00	Meeting with Mr. Md. Nurul Islam	LGED, Superintending Engineer
11.30-12.15	Meeting with possible local team member	
15.00-17.00	Meeting with Mr. Otto Gomm and Mr. Syed A.F.M. Sajedul Huq	GTZ, Coordinator PURE GTZ, Senior Renewable Energy Specialist
Monday, 14 March 2005:		
09.30-12.45	Meeting with Mr. Kazi Aktaruzzaman	BCSIR, Project Director & Principal Scientific Officer
13.30-15.00	Meeting with Engr. B. Rahmatullah and Dr. A.K.M. Masood	Director Power Cell, MoPEMR Director General Power Cell, MoPEMR
Tuesday, 15 March 2005:		
09.00-17.00	Field visit with Mr. Sudip Kumar Saha to biogas plants in Gazipur district	BRAC, Engineer (Solar)
Wednesday and Thursday 16 and 17 March 2005:		
09.00-17.00	Field visit with Mr. Md. Sharful Anam Khan and Mr. Shamaresh Ghosh to biogas plants in Manikganj, Faridpur and Madaripur district	LGED, Assistant Engineer LGED, Biogas Specialist
Friday and Saturday 18 and 19 March 2005:		
09.00-17.15	Field visit with Mr. Kazi Aktaruzzaman, Mr. Jafora Shabbir Ahmed, Mr. Jasim Uddin Chowdhury, and Mr. Mosammel Hoque Mollah, to biogas plants in respectively Narayanganj, Comilla and Gazipur district	BCSIR, Principal Scientific Officer Agency holder, Narayanganj district Agency holder, Comilla district Agency holder, Gazipur district
Sunday, 20 March 2005:		
10.00-12.45	Meeting with Mr. Dipal C. Barua, Mr. Abser Kamal, Mr. Abdul Gofran, Engr. Md. Quamrul Haque, Mr. Khandaker Nazmul Hoque, and Mr. Kazi Mahmud Ullah	GS, Managing Director GS, General Manager, GS, Biogas Consultant GS, Assistant General Manager GS, Sub-Assistant Engineer GS, Assistant General Manager
14.00-16.00	Meeting with Mr. Md. Nurul Islam, Mr. Shamaresh Ghosh and Mr. Saleh Ahmed	LGED, Superintending Engineer LGED, Biogas Specialist LGED, Assistant Engineer (Environment)
Monday, 21 March 2005:		
10.00-11.30	Meeting with Dr. M. Fouzul Kabir Khan and Ms K. Farah Nayer Zabeen	IDCOL, Executive Director & CEO IDCOL, Investment Officer
12.30-14.15	Visit to IFRD of BCSIR	
15.00-17.00	Meeting with Dr. M. Eusuf, Dr. Moinul Islam Shariff and Mr. Khandaker Mainuddin	BCAS, Senior Fellow BCAS, Fellow BCAS, Fellow

Tuesday, 22 March 2005:		
12.00-13.30	Meeting with Dr. M.A. Rashid Sarkar	BUET, Professor
15.00-16.00	Meeting with Mr. Gunendu K. Roy and Mr. Sudip Kumar Saha	BRAC, Coordinator Developm. Programme BRAC, Engineer (Solar)
Wednesday, 23 March 2005:		
09.00-17.00	Preparation of Workshop	
Thursday, 24 March 2005:		
09.30-14.00	Consultative Stakeholders Workshop at LGED	See Annex 4 for brief report and list of participants
15.00-15.30	Meeting with Mr. Zahir Uddin Ahmad	RNE, Advisor Water Management Sector
Friday, 25 March 2005:		
	Departure of Willem Boers from Dhaka by air	
09.00-17.00	Recapitulation and reporting	
Saturday, 26 March 2005:		
	Reporting	
Sunday, 27 March 2005:		
09.30-10.45	Meeting with Dr. Bilqis Amin Hoque and Mr. Md. Shoriful Islam	EPRC, Executive Director & Head Research EPRC, Programme Manager
13.00-14.00	Meeting with Mr. Habibur Rahman	KfW, Local Expert
Monday, 28 March 2005:		
10.30-11.30	Meeting with Mr. Md. Abdus Sobhan Miah and Dr. Khan Shahidul Huque	BLRI, Additional Director BLRI, Chief Scientific Officer & Head Animal Production Research Division
12.30-13.00	Meeting with Mr. A.K.M. Musa	BBS, Director General
14.00-14.30	Meeting with Dr. Jahangir Alam	BARC, Member Director
14.45-15.30	Meeting with Mr. Abul Kalam Azad and Mr. Mohammed Walid Hossain	NGOAB, Director NGOAB, Assistant Director, Registration
15.45-16.30	Meeting with Mr. M. Khaliquzzaman	WB, Environmental Scientist (Consultant)
Tuesday, 29 March 2005:		
09.30-11.00	Meeting with Mr. Abdul Gofran	GS, Biogas Specialist
15.15-15.45	Meeting with Dr. Kazi Aktaruzzaman	BCSIR, Project Director & Principal Scientific Officer
16.00-16.45	Meeting with Mr. Gazi Nasir Uddin Borham and several agency holders	BBBB, Coordinator
Wednesday, 30 March 2005:		
08.30-09.15	Meeting with Dr. M. Fouzul Kabir Khan	IDCOL, Executive Director & CEO
09.45-11.15	Meeting with Mr. M. Nurul Islam and Mr. Md. Sharful Anam Khan	LGED, Superintending Engineer LGED, Assistant Engineer
16.00-16.30	Meeting with Dr. M. Eusuf and Dr. A. Atiq Rahman	BCAS, Senior Fellow BCAS, Executive Director
20.00-21.30	Dinner with Dr. Khurseed-Ul-Islam and Mr. Md. Shah Alam	Independent local expert of Mission Team UNDP, National Consultant
Thursday, 31 March 2005:		
	Departure of Wim van Nes from Dhaka by air	

Annex 3: Brief report on the Consultative Stakeholders Workshop

Date : 24 March 2005, 09.30-14.00h
Place : LGED, Dhaka

In line with the ToR, it was felt useful by the Mission Team to organise a Consultative Stakeholders Workshop on the feasibility of a national programme for domestic biogas in Bangladesh. Invitees were representatives of the major stakeholders also been involved in the field visits and interviews. In total 22 persons participated in the Workshop, see the list of participants included at the end of this Annex. Dr. M. Eusuf (BCAS) and Mr. Saroj Kumar Sarker (LGED) acted as the Chairman, respectively Co-Chairman of the Workshop.

After registration, the Chairman officially opened the Workshop saying that biogas did not need introduction as all participants had some background in this respect. Biogas was introduced in the country in 1973, had its ups and downs, but to date about 25,000 plants have been constructed. A small number though compared to the 20 million households living in the country. After this opening, all participants were invited to introduce themselves.

Willem Boers and Wim van Nes from SNV delivered the following presentations also provided to the participants in the form of hand-outs: Background and objective of the Workshop, domestic biogas in Nepal, impressions from the field visits and findings of the interviews. After the coffee and tea break, some central questions for the plenary discussion were proposed, being the proposed actors for the required functions in a national programme and the maximum level of investment subsidy.

In the plenary discussion, Mr. Gofran explained that GS has started a pilot on domestic biogas on cost recovery basis, except a subsidy for establishment. Quality control and after-sales-service will be important requirements in the follow-up of the pilot. Dr. Aktaruzzaman narrated the history of biogas in Bangladesh including the difficulties to promote the application of an un-known technology. He is of the opinion that a future programme can only be designed and implemented by using the experience gained in the past, while a dedicated apex body with single goal oriented staff is very much required. The Chairman posed the question whether the national programme would need a newly to be established apex body. Mr. Islam preferred to look for an existing agency to take the lead, as establishment of a new body will take precious time. Requested by the participants, Mr. Van Nes explained that in Nepal the coordination at implementation level was done by the programme office of SNV up to June 2003. Since then, this office has been transformed into an independent Nepali NGO (BSP-N). In addition, an apex body was established in 1996 under the name of the Alternative Energy Promotion Centre (AEPC) to undertake the coordination at policy and government level. He also explained that SNV would very much prefer to make use of already existing institutes in Bangladesh by strengthening their capacities rather than to establish its own programme office. Mr. Saleh Ahmed suggested firstly determining the required characteristics of an apex body. Concluding at this issue, the Chairman invited SNV to take up the coordination at implementation level for the first years to come.

On the issue of the level of investment subsidy, Mr. Mainuddin considered an investment subsidy of Tk. 7,000 on a total investment cost of say Tk. 21,000 sufficient, provided this amount would really reach the farmer. This opinion was shared by Mr. Saha and Mr. Ghosh, while Dr. Aktaruzzaman said that the subsidy should not be abolished.

Two agency holders, Mr. Mollah and Mr. Shabbir Ahmed, narrated their experience with the promotion of biogas in phase II of the BCSIR pilot project. They are of the opinion that the private sector has a valuable role to play in a national programme. With some support and after some time, this sector can become sustainable by undertaking the function of construction & after-sales-service.

At the closing of the Workshop, Mr. Van Nes concluded that a lot has been done already in respect of domestic biogas in Bangladesh from which many valuable lessons can be learned. Coming from the project approach in the past, the next logical step would be now an integrated programme approach leading on the longer term to the development of a whole sector on domestic biogas in Bangladesh. He thanked everybody for the full cooperation in the field visits, interviews and Workshop. Mr. Boers expressed his confidence that though the biogas flame does only simmer at present, a beautiful big blue flame will soon appear in Bangladesh. Dr. Islam argued that the poor are paying the highest price for energy. The Co-Chairman, Mr. Sarker, said that irrespective of the subsidy, the challenge will be to show the benefits of biogas to the eligible farmers. Quality of construction and maintenance will be very important in a national programme. Also credit needs to be looked into, as bankers might not be interested in such small loans. Finally, biogas needs to be compared with other fuel options. The Chairman, Dr. Eusuf, said that renewable energy is very much required for Bangladesh and the sooner we get it, the better. He thanked SNV for its efforts to come to Bangladesh for this study, the participants for their input and closed the Workshop. All participants were invited for the lunch.

List of participants:

SN	**Name**	**Organisation and function**
1.	Dr. M. Eusuf	BCAS, Senior Fellow, Chairman of the Workshop
2.	Mr. Saroj Kumar Sarker	LGED, Add. Chief Engineer, Co-Chairman of the Workshop
3.	Mr. Otto Gomm	GTZ, Coordinator PURE
4.	Mr. Syed A.F.M. Sajedul Huq	GTZ, Sr. RE Specialist
5.	Dr. M.A. Rashid Sarkar	BUET, Professor
6.	Mr. Md. Nurul Islam	LGED, Superintending Engineer
7.	Mr. Shararesh Ghosh	LGED, Biogas Specialist
8.	Mr. Saleh Ahmed	LGED, Assistant Engineer (Environment)
9.	Mr. Tazmilur Rahman	LGED, Project Manager REIN
10.	Ms. K. Farah Nayer Zabeen	IDCOL, Investment Officer
11.	Dr. Kazi Aktaruzzaman	BCSIR, Principal Scientist
12.	Mr. Jafora Shabbir Ahmed	Agency Holder, Dhaka and Narayanganj district
13.	Mr. Mosammel Hoque Mollah	Agency Holder, Gazipur district
14.	Mr. Ismail Hossain	Agency Holder, Jessore and Jhinaidah district
15.	Mr. Khandaker Mainuddin	BCAS, Fellow
16.	Mr. Abdul Gofran	GS, Biogas Consultant
17.	Engr. Md. Quamrul Haque	GS, Ass. General Manager
18.	Mr. Gazi Nasir Uddin Borham	BBBB, Coordinator
19.	Mr. Sudip Kumar Saha	BRAC, Engineer (Solar)
20.	Dr.Engr. Khursheed-Ul-Islam	Independent Expert, Member of Mission Team
21.	Mr. Willem Boers	SNV, Member of Mission Team
22.	Mr. Wim J. van Nes	SNV, Leader of Mission Team

Annex 4: Contact details of informants and respondents

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Mr. Jasim Uddin Chowdhury	Agency, Comilla district	0188155926 (m)
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Mr. M. Khaliquzzaman	WB, Environmental Scientist	8159015 (o), dkhaliquzzaman@worldbank.org
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Annex 5: Findings of interviews with stakeholders

Main constraints for a national programme on domestic biogas:
Technical: • Lack of maintenance and after sales service (4x) • Insufficient dung available and decreasing cattle number (4x) • Lack of training and trained manpower (1x) • Technical failures **Financial and economic:** • Lack of funds for grants and credit (4x) • High investment cost (2x) • Early adopters not taking care of plant operation (2x) • Lack of cost recovery by constructors and credit providers (2x) **Social**: • Hesitation among farmers to handle dung and to use biogas (1x) • Preference of the male heads of the households to invest in other things than a biogas plant (1x) **Promotional**: • Lack of awareness (4x) and promotion (2x) • No critical mass achieved (1x) **Institutional**: • Wrong type of organisation engaged in dissemination (3x) • Lack of dedicated institute (2x) • Lack of institutional arrangements (1x) • Time consuming procedures of GOB (1x) **Political**: • Lack of political commitment and will (3x) • Technology felt outdated by the politicians (1x) • Interference by politically backed businessmen (1x) **Programmatic**: • Lack of monitoring and follow-up

Possible suitable actors for functions (excluding operation & maintenance) in national programme:	
1. Promotion	• NGOs including GS, BRAC, TMSS (8x) • GOB: LGED (2x), BCSIR (2x), SEU (1x), BUET (1x), AEC (1x) • Biogas Programme Office
2. Construction & after sales service	• Private companies (4x), individual masons (2x), agency (1x) • NGOs (7x) • LGED (2x)
3. Provision of credit	• NGOs (9x) • Scheduled banks including Krishi Bank (4x) • PKSF (2x) • SEU under contracts with various banks
4. Administration of investment subsidy	• IDCOL (5x) • Biogas Programme Office (4x) • BRAC Bank (2x) • PKSF (2x) • Grameen Bank • SEU under contract with various banks • LGED
5. Quality control	• IDCOL (3x) • Independent consultant (2x) • Biogas Programme Office • BCSIR • Institute of Appropriate Technology • BSTI • LGED • Neutral NGO
6. Training	• BCSIR (5x)

	• LGED (4x) • BUET (2x) • Grameen Shakti (2x) • BRAC (2x) • Universities • Rural Electric Cooperatives • DAE • BIM • BARD-Comilla • New RE Training Institute
7. Extension (use of bio-slurry)	• Ministry of Agriculture or DAE (5x) • NGOs (4x) • REB • LGED • BARC • BRDB • GS (users groups)
8. Applied R&D	• BCSIR (7x) • BUET (2x) • BARI (2x) • Universities • BRRI • Institute of Appropriate Technology • BAU • BARD • Chittagong Engineering University • CIRDAP • Biogas Programme Office
9. Monitoring & evaluation	• Private consultants (4x) • BCAS (3x) • PSL • Individuals • Neutral NGOs • BUET • IMED • BIDS
10. Coordination at implementation level	• Biogas Programme Office (4x) • IDCOL (3x) • LGED (2x) • Power Cell of MoPEMR • REDA (in future) • SEU • Consortium
11. Coordination at government/policy level	• Steering Committee on domestic biogas (4x) • MoSICT (2x) • Power Cell of MoPEMR • REDA (in future) • SEU • LGED • BCSIR

Most suitable design for domestic biogas plant:
• LGED adapted Chinese dome design, because of round expansion chamber (better than rectangular) and of precautions (reinforced ring beam, earth-filling and thickness of walls (5” in stead of 3”) • Smaller plants than F1-size (40 kg dung/day) should not be promoted as the gas production might not match the cooking requirements • Appliances, especially stoves, need to be improved • Study required on most appropriate design (LGED/BCSIR/Dheenbandu/Janata/BORDA/Chinese fixed dome) • Fixed dome model (2x) • BCSIR model with further developments

Criteria for the selection of the first lot of domestic biogas districts:
• Districts with high cattle population • Districts not affected by floods • Districts with relatively well-to-do farmers • Districts with good availability of construction materials • Districts without connection to the electrical grid • Remote districts • Districts with easy communication • Districts evenly distributed over the country

Annex 6: Investment costs of biogas plants

Quotations for a biogas plant with a gas production of 100 cft and a total plant volume of about 6 m3 have been collected from LGED, BCSIR and GS. These quotations exclude the costs of a cast concrete slab for the outlet and the fee for construction and after sale service. The total rounded costs as shown in the table below amount to Taka 15,500:

Quotation	LGED F2				BCSIR				Grameen Shakti			
	Unit	**Qnt**	**BT**	**BT**	**Unit**	**Qnt**	**BT**	**BT**	**Unit**	**Qnt**	**BT**	**BT**
A Construction Materials												
Bricks/Stone	Piece	1275	3.00	3825	Pcs	1100	3.00	3300	Pcs	1300	3.00	3900
Sand	cft	60.0	8.00	480	cft	80.0	6.00	480	cft	70.0	10.00	700
Khoa	cft	45.0	25.00	1125	Pcs	250.0	3.00	750	cft	10.0	30.00	300
Gravel 4x6	cft				cft				cft			
Reinforcement M.S. rod (8mm)	Kg				Kg				Kg			
Reinforcement M.S. rod 3/8"	Kg				Kg	20.0	42.00	840	Kg	3.0	40.00	120
# 8 GI Wire									Kg	2.0	70.00	140
Cement @ 50kg p/bag	Bag	20	250.00	5000	Bag	12	250.00	3000	Bag	11	290.00	3190
Sub Total Construction mat				***10430***				***8370***				***8350***
B Unskilled Labour Cost												
Labours	Days	15	70.00	1050	Days				Days			
Earth work					L/S	1	750.00	750	cft	700	1.50	1050
Sub Total Un Skilled				***1050***				***750***				***1050***
C Pipes and Fittings												
RCC pipe 6"	pcs	1	700.00	700	pcs				pcs		700.00	
GI Pipe 1 "	pcs	1	38.00	38	pcs				pcs	1	80.00	80
Gas nozzle	No	1			No				No			
Plastic gas pipe 3/4"	meter	30	15.00	450	meter		15.00		ft	50	5.00	250
Gas valve 3/4"	pcs	1	200.00	200	pcs	1	200.00	200	pcs	1	120.00	120
GI reducer 1" x 3/4"	pcs	1	16.00	16	pcs				pcs		16.00	
Nipple 3/4"	pcs	1			pcs				pcs			
GI Pipe 1/2"	meter				ft	1	40.00	40	meter			
PVC Pipe 6"	pcs				pcs	1	400.00	400	ft	6	40.00	240
1/4" rubber pipe	pcs				pcs				ft	40	10.00	400
4" PVC pipe	pcs				ft	10	45.00	450	pcs			
Sub total Pipes				***1404***				***1090***				***1090***
D Appliances Cost												
Double burner	Set	1	700.00	700	Set	1	700.00	700	Set	1	650.00	650
4" Brash	Set				Pcs	1	50.00	50	Set		50.00	
Wax	kg	2	70.00	140	kg	1.5	60.00	90	kg	2	60.00	120
Sub total Appliances				***840***				***840***				***770***
Sub total A B C D				***13724***				***11050***				***11260***
E Construction Charge												
Construction									m/days			
Mason	m/days	15	120.00	1800	L/S	1	2500.00	2500	m/days	10	200.00	2000
Mason									m/days	12	180.00	2160
Pipe Installation									m/days			
Logistics Transport					L/S	1	1500.00	1500	fixed		260.00	
Fixed												
				1800				***4000***				***4160***
Grand Total				***15524***				***15050***				***15420***

Inclusion of the fee for construction and after sale service as well as measures to increase the quality of the biogas plant (caste concrete slab for the outlet, GI gas pipes, turret on top of the dome to protect the dome gas pipe and better quality of biogas appliances) will increase the investment costs with about Taka 9,500 to Taka 25,000 as shown in the following table:

Quotation	LGED F2				BCSIR				GS			
	Unit	***Qnt***	***BT***	***BT***	***Unit***	***Qnt***	***BT***	***BT***	***Unit***	***Qnt***	***BT***	***BT***
A Construction Materials												
Bricks/Stone	Piece	1275	3.50	4463	Pcs	1100	3.50	3850	Pcs	1300	3.50	4550
Sand	cft	66.0	15.00	990	cft	86.0	15.00	1290	cft	76.0	15.00	1140
Khoa	cft	45.0	30.00	1350	Pcs	300.0	3.00	900	cft	40.0	30.00	1200
Reinforcement M.S. rod (8mm)	Kg	15.0	10.00	150	Kg	15.0	10.00	150	Kg	15.0	10.00	150
Cement @ 50kg p/bag	Bag	14	300.00	4200	Bag	14	300.00	4200	Bag	13	300.00	3900
Sub Total Construction mat				***11153***				***10390***				***10940***
B Unskilled Labour Cost												
Labours	Days	1	300.00	300	Days	1	300.00	300	Days	1	300.00	300
Earth work	L/S	1	1000.00	1000	L/S	1	1000.00	1000	L/S	1	1000.00	1000
Sub Total Un Skilled				***1300***				***1300***				***1300***
C Pipes and Fittings												
Inlet Pipe PVC Pipe 6"	pcs	1	400.00	400	pcs	1	400.00	400	pcs	1	400.00	400
GI pipe 1/2"	Meter	20	79.50	1590	Meter	20	79.50	1590	Meter	20	79.50	1590
GI Socket 1/2"	Pcs	3	7.00	21	Pcs	3	7.00	21	Pcs	3	7.00	21
GI T1/2"	Pcs	2	12.00	24	Pcs	2	12.00	24	Pcs	2	12.00	24
GI Elbow 1/2"	Pcs	6	11.00	66	Pcs	6	11.00	66	Pcs	6	11.00	66
GI Nipple 2"	Pcs	3	11.00	33	Pcs	3	11.00	33	Pcs	3	11.00	33
GI Nipple 6"	Pcs	1	11.00	11	Pcs	1	11.00	11	Pcs	1	11.00	11
Teflon Tape (TT) (?)	Roll	4	15.00	60	Roll	4	15.00	60	Roll	4	15.00	60
Brass Union (?)	Pcs	1	50.00	50	Pcs	1	50.00	50	Pcs	1	50.00	50
Sub total Pipes				***2255***				***2255***				***2255***
D Appliances Cost												
Double burner	Set	1	700.00	700	Set	1	700.00	700	Set	1	700.00	700
4" Brash	Set	1	50.00	50	Set	1	50.00	50	Set	1	50.00	50
Mixture	Set	1	700.00	700	Set	1	700.00	700	Set	1	700.00	700
Paint (Acrylic Plastic Emulsion)	Litre	1	125.00	125	Litre	1	125.00	125	Litre	1	125.00	125
Dome gas pipe 2.5" GI	Pcs	1	375.00	375	Pcs	1	375.00	375	Pcs	1	375.00	375
Main Valve: SANWA	Pcs	1	150.00	150	Pcs	1	150.00	150	Pcs	1	150.00	150
W/Drain	Pcs	1	170.00	170	Pcs	1	170.00	170	Pcs	1	170.00	170
Gas Tap	Pcs	1	245.00	245	Pcs	1	245.00	245	Pcs	1	245.00	245
Rubber hosepipe	Meter	2	40.00	80	Meter	2	40.00	80	Meter	2	40.00	80
Sub total Appliances				***2595***				***2595***				***2595***
Sub total A B C D				***17303***				***16540***				***17090***
E Construction Charge												
Construction/Service Charge	L/S	1	4000.00	4000	L/S	1	4000.00	4000	L/S	1	4000.00	4000
Mason	L/S	1	3500.00	3500	L/S	1	3500.00	3500	L/S	1	3500.00	3500
Pipe Fitting	L/S	1	750.00	750	L/S	1	750.00	750	L/s	1	750.00	750
Logistics Transport	L/S	1	260.00	260	L/S	1	260.00	260	L/S	1	260.00	260
				8510				***8510***				***8510***
Grand Total				***25813***				***25050***				***25600***

Annex 7: Basic Data for the Financial Analysis of Biogas Plant with a Daily Gas Output of 100 cft

The data in this Annex provides the information on the costs and savings associated with a biogas plants with a daily gas production of 100 cft. The investment cost of this upgraded plant (2005) is assumed to be Taka 25,000, see the second table in Annex 6. The annual maintenance costs are assumed to be two percent of the investment costs. The base subsidy is put at Taka 7,000. A down-payment of 10 percent of the gross cost by the farmer is assumed and the remaining costs are financed at 17 percent annual interest over a four-year term.

The savings associated with the use of the biogas plant derive primarily from the savings in expenditures for biomass. The base price for biomass is assumed to be 1.00 Taka per kg. The resulting annual savings for biomass amount to 3,500 Taka/year. The value of the saved labour, the recovered nutrients in the biogas slurry and the reduced GHG emissions are assumed to be zero for the financial analysis. The financial analysis is carried out over a 15-year period, which is the assumed minimum life of the biogas plant.

Costs	Taka	Remarks
Investment costs	25,000	
Annual maintenance costs	500	2% of investment costs
Subsidy	7,000	
Net costs	18,000	
Down payment	2,500	10% of investment costs
Loan amount	15,500	
Annual loan payment	5,650	17% interest, 4 years term

Annual savings	Unit	Taka/unit	Total Taka
Biomass (kg)	3,500	1.00	3,500

Annex 8: Basic Data for the Economic Analysis of Biogas Plant with a Daily Gas Output of 100 cft

The data in this Annex presents the information on the economic costs and benefits associated with a biogas plant with a daily gas output of 100 cft. The financial data are based on the upgraded biogas plant as reflected in the second table of Annex 6.

Cost/Benefit Breakdown	Financial	Economic factor or Shadow value	Economic
Costs:	(Taka)		(Taka)
Cement	4,200	0.60	2,520
Materials	8,445	0.75	6334
Labour	5,550	0.75	4162
Appliances	2,595	0.90	2336
Fees & charges	4,210	1.00	4210
Total investment costs	25,000		19,562
Annual maintenance costs (2%)	500		391
Benefits:			
Biomass savings	3,500	1.00	3,500
Nutrient savings	0	(1.00)	1,971
Domestic labour savings	0	(0.75)	411
Reduced CO2-eq	0	(1.00)	1,600
Toilet attachment	0		0
Indoor smoke reduction	0	(1.00)	400
Employment generation	0		0
Total annual benefits	3,500		7,882

Summary of the EIRR:

EIRR for benefits from just biomass = 17%
EIRR with the value of saved domestic labour added = 20%
EIRR with the value of nutrients saved added to all of the above = 39%
EIRR with the value of smoke reduction added to all of the above = 43%
EIRR with the value of reduced carbon added to all of the above = 62%

Annex 9: Key conditions for large-scale dissemination of biogas plants in Bangladesh

This Annex presents the findings of the Mission Team with respect to key conditions to be met for large-scale dissemination of biogas plants in Bangladesh. The majority of the conditions are fully or just met, with a few other conditions doubtful, not (yet) met or falling short. Especially the latter conditions need attention during the formulation of a detailed implementation plan.

Key conditions for large-scale dissemination of biogas plants	**Findings**
(++ fully met; + met; -+ doubtful; - not (yet) met; -- falls short)	
Technical factors	
Even, daily temperatures over 20^0 C throughout the year	++
Full stabling (zero-grazing) of animals (cows and pigs)	+
At least 20 kg dung per day available per plant	++
Availability of water	++
Biogas plant can be well spaced in the compound of the farmer	+
Performance of existing biogas plants	+
Financial factors	
Use of organic fertilizer is traditionally practiced	-+
Dairy farming is the main source of income	-+
Farmers are owners of the farm and live on the farm	+
Farm products are the main source of income	++
Moderate pricing of the plant in relation to the farmer's income	-+
Economically healthy farms open for 'modernisation'	+
Insufficient and expensive supply of fossil sources of energy	++
Building materials and gas appliances locally available	++
Availability of potential masons	+
Potential users have easily access to credit	-
Social factors	
Biogas plant can be integrated into the normal working routine on the farm	++
Operation of the plant can be easily done by the members of the household	+
Regular demand for biogas	++
Awareness on biogas technology by potential users	-+
Willingness among potential users to attach a toilet to the plant	-
Willingness among potential users to invest in biogas plants	-+
Awareness among potential users on non-financial costs and benefits of biogas	-+
Role of women in decision making	+
Organisational and institutional factors	
Availability of organisations having access to potential users	++
Possibilities to engage private sector organisations	+
Organisational experience with dissemination of biogas plants	+
Institutional experience with dissemination of biogas plants	-+
Political will of the Government to support biogas technology	-+
Government policy on renewable energy	-+
Government policy on practical gender needs (reduction of workload for women)	+
Willingness of stakeholders to develop a biodigester sector	++

Annex 10: Brief report on the 2nd Consultative Stakeholders Workshop

Date : 24 July 2005, 09.30-13.30h
Place : LGED, Dhaka

During a mission in July 2005, it was felt useful to organise a 2nd Consultative Stakeholders Workshop to present and discuss the results of the feasibility study on a national programme for domestic biogas in Bangladesh. Invitees were representatives of the major (potential) stakeholders to be likely involved in such national programme. In total 29 persons participated in the Workshop, see the list of participants included at the end of this Annex. Dr. M. Eusuf (BCAS) and Mr. Saroj Kumar Sarker (LGED) acted as the Chairman, respectively Co-Chairman of the Workshop.

After registration, the Chairman invited the Director of SNV/Nepal, Mr. Matthias Moyersoen to officially open the Workshop. He was saying that SNV/Nepal has initiated the process of registration as an international NGO in Bangladesh. In addition of biogas, activities might also be started in the area of pro-poor tourism and watershed management. As biogas has been very successfully disseminated in Nepal, SNV is eager to support programmes in Bangladesh as well. In his welcome, Dr. Eusuf expressed to be optimistic on the outcome of the Workshop. He requested the participants to introduce themselves.

Mr. Wim van Nes delivered the presentation on the results of the feasibility study, referring also to the 2nd draft report of which every organisation would be provided with a copy. At the end, he presented the proposal for four steps to be taken on short term: Conclusion of a Memorandum of Understanding (MoU) with an implementing partner for the formulation of a detailed Implementation Plan (July-August 2005), formulation of a detailed Implementation Plan including survey and reviews in consultation with relevant stakeholders (September-December 2005), exploration of funds (grants or loans) required to refinance the credit requirement of the programme (September-December 2005) and registration of SNV as an international NGO (July-December 2005). Also he requested the participants to frankly provide comments and suggestions during the plenary discussion and to forward (detailed) comments on the 2nd draft report, if possible before the 1st of August 2005.

As he had to leave during the break, the Co-Chairman of the Workshop, Mr. Saroj Kumar Sarker provided a few comments. He underlined the need for a survey among the existing plants, also focussing on the reasons for non-functioning plants. He also remarked that time saving due to biogas might be useless in economic terms if this time could not be utilised elsewhere. LGED has some positive experience with plants running on human excreta. While drawing-up budgets, SNV should be careful in putting the operational costs not too high. Finally, he assured that LGED is ready to provide further support, if required.

After the coffee and tea break, the Chairman opened the floor for discussion, requesting the participants not too deviate too much from the steps spelled out in the presentation. Dr. Kazi Aktaruzzaman (BCSIR) agreed with the estimate of the potential demand and the multi-actor approach. He questioned the number of 36,450 plants and warned for the defaulting of biogas loans by farmers. He was of the opinion that most farmers would go for a one-stop service (both construction of the plant and provision of loan) and suggested that NGOs like BRAC and GS could perform quality control. Mr. Wim van Nes replied that the number of 36,450 is just coming from the proposal on the Asia Biogas Programme and that it can be adjusted or installed in a shorter period. Internal quality control needs to be performed by the market parties, but external quality control is required to get an independent picture.

Mr. Khaliquzzaman (WB) wondered whether carbon financing was considered, also to make the programme more independent from donors. Payments can be even made up-front. Mr. Wim van Nes replied that carbon financing would indeed be a possible source of income for the programme, but that transaction costs need to be worked out to see get the cost/benefit ratio for a rather small programme.

Mr. Otto Gomm (GTZ) explained that there is no duplication at all between the activities of GTZ related to biogas production of commercial poultry farms and the efforts of SNV to set-up a national programme on domestic biogas. He wondered whether the report included a clear picture on the constraints for a national programme. At least affordability and strengthening of the supply structure need to be addressed to get the services sufficiently close to the farmers. Mr. Wim van Nes explained that barriers have been addressed in paragraph 8.1 of the report which included indeed the two constraints mentioned by Mr. Otto Gomm. A budget will be available under programme costs to capacitate the supply side for example through training.

Dr. Moinul Shariff (BCAS) recommended developing a monitoring plan that can be used at the same time for the purpose of CDM.

Mr. Abdul Gofran (GS) was of the opinion that IDCOL would be the proper implementing partner for SNV. Though they lack biogas expertise, they have clearly shown their ability in the SHS programme to be successful. Subsidy might decrease over the years to grow towards sustainability. A survey among existing biogas plants is very useful and needs to look into the reasons for non-functioning as well.

Dr. Kazi Aktaruzzaman recommended SNV to establish a biogas programme office rather than to team-up with IDCOL. Mr. Wim van Nes replied that sufficient organisational capacity will be available in Bangladesh and that SNV would prefer to address organisational and institutional development rather than to open up its own office. The intervention by SNV will be of temporary nature anyhow. This was confirmed by Mr. Matthias Moyersoen.

Mr. Otto Gomm questioned the assumed level of subsidy in the FIRR, being Taka 7,000. Mr. Wim van Nes explained that the level of subsidy in the last phase of the Biogas Pilot Project of BCSIR (Taka 12,500) was unacceptable high. A final proposal will be made on the basis of the results of the survey, as by then there is a better picture on the benefits for the average farmer in monetary terms. Mr. Mainuddin added here that the survey needs to include questions on the willingness among farmers to pay.

Mr. Khalequzzaman (ECS) wondered whether the assumed increase in investment costs would indeed result in a longer lifetime of the biogas plant. He thinks that there is still a good demand for biogas among farmers, but that they wait to see whether an investment subsidy will become again available. He would prefer to indirectly provide the investment subsidy. He suggested that GTZ and the national programme could cooperate when it comes to training. Finally, he stressed the need for coordination, as this is usually lacking in Bangladesh.

Mr. Mahmud Ullah (GS) expressed that GS has signed a MoU with BCSIR for applied R&D on domestic biogas. GS is for sure also interested to be involved in social and financial research and in training. He also was in favour of indirect investment subsidy like in the SHS programme.

Dr. Fouzul Kabir Khan (IDCOL) was very much comforted by the opinion of many stakeholders that IDCOL could well function in a national biogas programme. IDCOL is a financing institute, had first no expertise about SHS and has also no expertise about domestic biogas. IDCOL is a transparent organisation, is ready to act with others who can supply the necessary skills and has built up considerable reputation. All in all, IDCOL looks forward to cooperation with SNV.

Dr. Eusuf closed the Workshop concluding that all steps proposed by SNV were found agreeable. There is a tremendous potential for biogas and with collaborate efforts this potential could be tapped. We are however just at the beginning.

Mr. Wim van Nes again thanked all participants for participation and support, LGED for the provision of the Workshop facilities and invited all to enjoy the lunch.

List of participants:

SN	Name	Organisation and function
1.	Dr. M. Eusuf	BCAS, Senior Fellow, Chairman of the Workshop
2.	Mr. Saroj Kumar Sarker	LGED, Add. Chief Engineer, Co-Chairman of the Workshop
3.	Mr. Otto Gomm	GTZ, Coordinator PURE
4.	Mr. Matthias Moyersoen	SNV/Nepal, Country Director
5.	Mr. Rajendra Shakya	SNV, Coordinator Administration & Services
6.	Mr. Md. Nurul Islam	LGED, Superintending Engineer
7.	Mr. Shararesh Ghosh	LGED, Biogas Specialist
8.	Mr. Md. Baaque Billah	BREMADCO, Project Engineer
9.	Mr. Kazi Mahmud Ullah	GS, Ass. General Manager
10.	Mr. S.M. Mamun Ay Rashid	IDCOL, Electrical Engineer
11.	Dr. Kazi Aktaruzzaman	BCSIR, Principal Scientist
12.	Mr. Jaffor Shabbir Ahmed	Agency Holder, Dhaka and Narayanganj district
13.	Mr. Mosammel Hoque Mollah	Agency Holder, Gazipur district
14.	Mr. Ismail Hossain	Agency Holder, Jessore and Jhinaidah district
15.	Mr. Khandaker Mainuddin	BCAS, Fellow
16.	Mr. Md. Shamsul Islam	Nuria Engineering Co. Ltd. (appliance manufacturer)
17.	Mr. Alam	Nuria Engineering Co. Ltd. (appliance manufacturer)
18.	Dr. Moinul Islam Shariff	BCAS, Fellow
19.	Mr. J.S. Ahmed	BCSIR
20.	Mr. M. Khaliquzzaman	WB, Environmental Scientist
21.	Mr. Abdul Gofran	GS, Biogas Consultant
22.	Engr. Md. Quamrul Haque	GS, Ass. General Manager
23.	Mr. Abser Kamal	GS, General Manager
24.	Mr. Gazi Nasir Uddin Borham	BBBB, Coordinator
25.	Mr. Sudip Kumar Saha	BRAC, Engineer (Solar)
26.	Dr.Engr. Khursheed-Ul-Islam	Independent Expert, Member of Feasibility Study Team
27.	Dr. M. Khalequzzaman	Energy Consulting Services, Energy & Power Plant Expert
28.	Mr. Wim J. van Nes	SNV, Biogas Practice Team Coordinator
29.	Dr. M. Fouzul Kabir Khan	IDCOL, Executive Director & CEO