Report on the Feasibility Study for a Biogas Support Programme in the Republic of Rwanda

Guy Dekelver
Silas Ruzigana
Jan Lam

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It was a pleasure to conduct this study on the feasibility of a Rwandan national biogas programme. We received full cooperation during the interviews, field visits and workshop, providing us with valuable information and opinions. We like to extend our gratitude to all respondents and informants for their constructive contributions and hope the outcome of this assessment will serve its purpose.

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ABBREVIATIONS AND ACRONYMS

BP	Biogas Project
BPO	Biogas Programme Office
BPT	Biogas Practice Team
CDM	Clean Development Mechanism
CITT	Centre for Innovations and Technology Transfer
COPEC	Coopératives d'épargne et de crédit
DRC	The Democratic Republic of Congo
FAO	Food and Agricultural Organisation
FIRR	Financial Internal Rate of Return
FRw	Rwandan Franc
GDP	Gross Domestic Product
GHG	Green House Gasses
GI	Galvanized Iron
IMF	International Monetary Fund
IRST	Institut de Recherche Scientifique et Technologique
KfW	German Development Bank
KIST	Kigali Institute of Science and Technology
LWF	Lutherian World Federation
MDG	Millennium Development Goal
MFI	Micro Finance Institutes
MINAGRI	Ministry of Agriculture
MINALOC	Ministry of Local Governments
MININFRA	Ministry of Infrastructure
MINIRENA	the former Ministry of Energy, Water and Natural Resources
MINITERE	Ministry of Environment and Natural Resources
NGO	Non Governmental Organisation
NRM	Natural Resources Management
PIN	Project Idea Note
PL	Liberal Party
PSD	Democratic Socialist Party
R&D	Research and Development
RMF	Rwandan Micro Finance Forum
RPF	Rwandan Patriotic Front
SNV	Netherlands Development Organisation
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
WB	World Bank

Exchange rates	1 Euro = 700 FRw
	1 USD = 550 FRw

I INTRODUCING SNV

SNV, Netherlands Development Organisation, is a Netherlands based international non governmental organization. SNV's overriding goal is to alleviate poverty by strengthening the capacity of local organizations and institutions. To reach this goal, SNV provides capacity development services regarding institutional development and organizational strengthening in the fields of natural resources management, private sector development and local governance.

In terms of renewable energy, about two billion people worldwide lack clean and safe cooking fuel. To improve their lives, they need access to sustainable energy services. Therefore, SNV provides advisory services regarding programme management and technology for biogas sector development. Based on its practices in Nepal and Vietnam, SNV firmly believes that domestic biogas programmes, if properly embedded in society, can serve the basic energy needs of millions of people, bringing them significant and far reaching benefits. To that end, SNV has been active in the biogas sector in Asia (Nepal and Vietnam) for the past 15 years. Currently, within Asia, SNV is extending its biogas activities to Laos, Cambodia and Bangladesh.

Current commitments include:

- Nepal: involved in development/formulation & implementation of and advisory support to the Biogas Support Programme since 1992. The programme is now in its fourth phase (2003-2009), aiming to increase the total number of plants constructed under the programme to 320,000 units. Currently over 140,000 installations have been completed. Documents have been prepared for a CDM (clean development mechanism) project, in cooperation with Winrock and Eco-Securities, and submitted to the World Bank (Community Development Carbon Fund) for financing;
- Vietnam: involved in development/formulation of and advisory support to the Biogas Project (BP) since 1999. Current phase I (BP I, 2003-2006) is supporting the construction of 12,000 fixed dome biogas plants in 12 selected provinces over the country. A PIN for BP phase II, covering 150,000 to 180,000 biogas plants, has been submitted to the German Development Bank (KfW). BP II is currently being formulated;
- Cambodia: involved in development/formulation of and advisory support to a national biogas/renewable energy programme together with the Ministry of Agriculture, Forestry and Fisheries. Intentions are that a national biogas programme will be operational at the beginning of 2006. The first phase of this programme will run till 2009 and foresees in the construction of 17,500 biogas plants. A PIN document for this programme has been accepted by the WB.
- Laos and Bangladesh: involved in development/formulation of and advisory services to a national biogas/renewable energy programme. Intentions are that nationwide biogas/renewable energy programmes in these countries will be operational before the end of 2006.

SNV worldwide employs over 600 advisors in 26 countries. SNV's biogas team currently consists of 6 senior advisors. For further information please contact:

- SNV, Bezuidenhoutseweg 161, 2594 AG den Haag, http://www.snvworld.org
- for general information on the SNV biogas practice:
  Mr. Wim van Nes (wvannes@snvworld.org)
- for specific information on the Rwanda programme:
  Mr. Guy Dekelver (gdekelver@snvworld.org)

II SUMMARY OF FINDINGS

This report presents the findings of a study conducted by MININFRA and SNV to assess the feasibility to set-up and implement a national programme on domestic biogas in Rwanda.

Households in rural Rwanda depend for more than 90 % on fuel wood to meet their energy needs. For many of these households it becomes increasingly difficult to satisfy their daily domestic energy requirements, due to the high population pressure and stringent legislation designed to reduce (fuel)wood consumption.

The majority of households own two or more cattle, used for milk, meat and dung production and for financial security. Legislation is in place that prohibits the free roaming of cattle. Almost all cattle is kept in stables overnight, while a growing part is kept on zero grazing. At farms where stabling is practiced, farmers have access to water.

Most farmers till plots to satisfy the families need for vegetables and staple foods like banana, sorghum and beans. The quality of the arable land is mostly poor due to the high cultivation intensity. Due to the consequent need for fertilizers, the composting of dung is commonly practised to maintain or improve the soil fertility. The climatic conditions in Rwanda are favourable to operate biogas plants all year round.

Socially spoken, livestock keepers are active members of and well represented in associations. There are also no restrictions for women to be involved in domestic decision making and the operation of biogas plants.

Over 110,000 Rwandan families (6 % of all Rwandan families, MINAGRI, NKEZABAHIZI, D., January 2005) have the technical potential for biogas plant installation and use, a number that is expected to rise with the continuing enforcement of zero grazing legislation. When access to credit is made available to farmers on reasonable terms, a substantial portion of these households is able and willing to invest in the technology. A technology that can play an important role to improve the quality of life for these rural households, especially for women, by reducing indoor air pollution and the daily workload and as a tool to improve production by using the full potential of digester effluents.

Main recommendations for a national programme

- Memorandum of Understanding
  During the first half of October 2005, MININFRA and SNV/Rwanda shall sign a MoU for the establishment and the implementation of the first phase of a Rwandan national biogas programme that helps to develop a socio culturally acceptable, commercially viable and environmentally sustainable market oriented biogas sector and that aims to increase the number of quality biodigesters with 15,000 by December 2010.

- Formulation of a detailed business (implementation) plan
  This plan, to be formulated in cooperation with all potential stakeholders in Rwanda, will address issues that were not yet tackled by the feasibility study. In order to do so, MININFRA and SNV will recruit three consultants (one on management, a technical person and an extension specialist) to assist the personnel they have assigned to the national biogas programme.

- Pursue approval of the implementation plan
  MININFRA and SNV will pursue approval of the detailed implementation document, to make the required preparations and to start implementation of the programme in 2006. This includes looking for international sources of financial support to develop a national biogas programme in Rwanda.

- Programme set-up
  By the end of 2005, a national Biogas Programme Office (BPO) needs to be established to initiate and coordinate the different activities that need to be undertaken. The Department of Energy and Communication under the Ministry of Infrastructure, will host this office. The participation of other line ministries, non governmental organisations (NGOs), financial and research institutes is indispensable and organizations active at the national level need to be represented in a BPO steering committee.

- Technology
  To gain market confidence in the technology, there must be a strong focus on quality. This includes quality of information, construction and after-sales service. During the programme initiation phase, a final choice for a plant model must be made, based on a study for the most appropriate design for mass dissemination in Rwanda. Applied research is necessary to come to an enforceable national standard for biodigesters.

- Finance
  A mechanism needs to be established to make finance for domestic biodigesters available under reasonable conditions. Preferably, this finance has to be channelled through existing and regulated banking institutes and/or programmes. These institutes are operating under the umbrella organisation 'Rwanda Micro Finance Forum'. Provision of subsidy will be an important marketing tool and must be linked to predefined quality standards.

- Commercialisation
  For the actual construction and the after sales service of biodigesters, the establishment of local biodigester enterprises must be encouraged.

- Integrated farming
  Research on the use of the full potential of digester effluent and dissemination of the research results must be an integrated and substantial part of the programme.

- Role of SNV
  SNV, with its experience with this type of programme and sector development, will provide capacity development services to the programme and to the various actors in the biogas sector, aiming at capacity building of the respective organizations (government, civil society, private sector).

- Role of MININFRA
  MININFRA will host the Rwandan National Biogas Programme and provide the working conditions to achieve the programme's objectives.

1 INTRODUCTION AND BACKGROUND

Besides programmes in Asia, SNV aims to set-up a large-scale programme for domestic biogas in one or two countries in Africa and South America. Interest for a biogas programme in Rwanda was first of all expressed by Mr. Sam Nkusi, the former Minister of State for Energy and Communications, during the Energy for Development conference in Noordwijk, The Netherlands, in December 2004. This request was followed up by the current Minister of State, Mr. Albert Butare, showing the continued political will from the Government to support a national biogas programme. Another request was made by Mr. Guy Dekelver, Natural Resources Management (NRM) advisor from the Netherlands Development Organisation (SNV) in Rwanda. This request was supported by the Portfolio Coordinator of SNV in Kigali, Mr. Emmanuel Ruzibiza. A brief fact finding mission was conducted in February 2005 to assess the possibilities of a national biogas programme (Lam, March 2005). This mission concluded that the circumstances in Rwanda seem favourable to establish a national biogas programme and recommended commissioning of an in-depth study on its feasibility. The Terms of Reference and the itinerary for this feasibility study are provided in annex 1 and 2 (see annex 1 and 2).

This report presents the findings of the feasibility study conducted in March 2005 by a member of SNV's Biogas Practice Team: Jan Lam, the SNV Rwanda NRM advisor, Guy Dekelver and the head of the Biomass Section at the Ministry of Infrastructure, Energy and Communication (MININFRA), Silas Ruzigana.

Chapter 2 describes the objective, methodology and limitations of the feasibility study. A brief background of Rwanda, including the agricultural and energy sectors 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 the functions required in a national programme and possible suitable actors is provided in Chapter 6. An outline for a national biogas programme including tentative budget and possible financiers is provided in Chapter 7. Main conclusions and recommendations are mentioned in Chapter 8.

2 OBJECTIVE, METHODOLOGY AND LIMITATIONS OF THE FEASABILITY STUDY

The overall objective of the mission is to assess the feasibility to set-up and implement a national biogas programme in Rwanda.

More specifically, the study addressed the following areas:

- country background: agricultural & livestock sector, energy demand and supply, energy policy and plans;
- history of domestic biogas (present activities on household biodigester development and dissemination);
- potential demand for domestic biogas;
- possible supply of services for domestic biogas;
- outline for a national programme on domestic biogas (recommendations for set-up and implementation).

The methodology was the following:

- collecting secondary information;
- visit domestic biogas plants;
- meet farmers and key respondents;
- discuss the roles of different actors in Rwanda and the outline of a possible national biogas programme;
- presentation of the preliminary findings and discussion on a possible programme outline during a one day consultative workshop;
- formulation of draft study report and submission for comments to SNV and the Rwandan Government;
- submission of the final study report.

During the study, gacaca or village courts on the genocide were taking place all over the country. As a result of this, the study team found, on several occasions, the potential respondents not available because they had to attend the courts.

The main limitation of this study was the difficulty to find written data, documents and publications to refer to. In Rwanda, very few studies and written documents/data exist on household decision making, energy demand and supply, role of women in livestock keeping, ... As a result of this, we had to base our findings mainly on the inputs of knowledgeable reference persons (at the district and provincial levels) and own observations. While formulating the detailed business (implementation) plan and where necessary, more in depth data will be gathered and detailed studies conducted!

3 COUNTRY BACKGROUND

3.1 Geography

The Republic of Rwanda is located in central Africa, just south of the equator with the Democratic Republic of Congo at its western border, Uganda in the north, Tanzania in the east and Burundi in the south. The total surface area is 26,340 km^2 of which 1,400 km^2 is water. Kigali, the capital and largest city, is located at the centre of the country. The terrain is mostly grassy uplands and hills and the relief is mountainous with a declining altitude from the west to the east. The highest point is Mount Karisimbi (4,519 m), the lowest the Rusizi River (950 m). (See map 1)

Due to the combination of a tropical location and high altitude, most of Rwanda has a year-round temperate climate. Generally, temperatures range between a low of 15°C at night to a high of 30°C by day with fairly insignificant seasonal variations in temperature. The exceptions are the chilly upper reaches of the Virunga Mountains and the low-lying border area of Akagera National Park. Most parts of Rwanda receive annual precipitation in excess of 1000 mm. The driest months are usually July - September, the wettest February - May.

At present, there are 12 provinces: Butare, Byumba, Cyangugu, Gikongoro, Gisenyi, Gitarama, Kibungo, Kibuye, Kigali Rurale, Kigali-ville, Umutara and Ruhengeri. The provincial administration is headed by a centrally appointed Governor. The 12 provinces are divided into 106 districts with a mayor at the helm. In the near future, the number of provinces will be reduced to five though and the number of districts to 30.

Map 1: Rwanda

3.2 Demography

The Rwandan population grows at 2.8 % per year (www.rwandagateway.org) and currently stands at 8,162,715 (48 % male, 52 % female) for an area of 26,340 km^2, which corresponds to a density of 310 inhabitants per km^2. Keeping in mind that the effectively useful surface only amounts to 18.740 km^2, this corresponds to a population density of 433 inhabitants per km^2. Table 1 gives an insight in the resident population and their density by Province/City in 2002 (see table 1).

Table 1: the resident population and its density by Province/City

PROVINCE/CITY	POPULATION (number of inhabitants)	DENSITY (number of inhabitants per km^2)
RWANDA	**8,128,553**	**309**
Ruhengeri	891,498	538
Gisenyi	864,377	422
Gitarama	856,488	400
Kigali Ngali	789,330	284
Butare	725,914	388
Byumba	707,786	418
Kibungo	702,248	237
Cyangugu	607,495	321
Kigali City	603,049	1,927
Gikongoro	489,729	248
Kibuye	469,016	268
Umutara	421,623	100

(Census of population and housing, 2002)

3.3 Recent history

In 1959, three years before independence from Belgium, the majority ethnic group, the Hutus, overthrew the ruling Tutsi king. Over the next several years thousands of Tutsis were killed, and some 150,000 driven into exile in neighbouring countries. The children of these exiles later formed a rebel group, the Rwandan Patriotic Front (RPF) and began a civil war in 1990. The war, along with several political and economic upheavals, exacerbated ethnic tensions culminating in the 1994 genocide of roughly 800,000 Tutsis and moderate Hutus. The Tutsi rebels defeated the Hutu regime and ended the killing in July 1994, but approximately 2 million Hutu refugees -many fearing Tutsi retribution- fled to neighbouring Burundi, Tanzania, Uganda and the Democratic Republic of Congo (DRC). Since then most of the refugees have returned to Rwanda. Despite substantial international assistance and political reforms -including Rwanda's first local elections in March 1999- the country continues to struggle to boost investment and agricultural output and to foster reconciliation. A series of massive population displacements, a nagging Hutu extremist insurgency, and Rwandan involvement in two wars over the past four years in the neighbouring DRC continue to hinder Rwanda's efforts.

The Chief of State is President Paul Kagame (since 22 April 2000) who was elected president in the first direct popular vote with 95 % of the votes. The Head of Government is Prime Minister Bernard Makuza. The Council of Ministers, the cabinet, is appointed by the president. Rwanda has a bicameral National Assembly with 102 seats (70 deputies and 32 senators). The parliamentarians are elected by direct vote. Last held elections were on 29 September 2003 with the following results: RPF with Maj. Gen. Kagame as leader 40 seats, Democratic Socialist Party (PSD) 7 seats and the Liberal Party (PL), 6 seats, plus representatives of women, youth and handicapped groups.

3.4 Economy

Rwanda is a poor rural country with about 90 % of the population engaged in (mainly subsistence) agriculture. It is the most densely populated country in Africa, landlocked with few natural resources and minimal industry. Respiratory illnesses come second after malaria in terms of causes of morbidity in health facilities (p.22, Rwanda PRSP, 2002). Primary foreign exchange earners are coffee and tea. The 1994 genocide decimated Rwanda's fragile economic base, severely impoverished the population, particularly women, and eroded the country's ability to attract private and external investment. However, Rwanda has made substantial progress in stabilizing and rehabilitating its economy to pre-1994 levels, although poverty levels are higher now. Gross Domestic Product (GDP) has rebounded and inflation has been curbed. Export earnings, however, have been hindered by low coffee and tea prices, depriving the country of much needed hard currency. Despite Rwanda's fertile ecosystem, food production often does not keep pace with population growth, requiring food imports. Rwanda continues to receive substantial aid money and was approved for the IMF-World Bank Heavily Indebted Poor Country debt relief initiative in late 2000. An energy shortage and instability in neighbouring states may slow growth in 2005, while the lack of adequate transportation linkages to other countries continues to handicap export growth.

Table 2: an overview of the most important socio-economic indicators

Life expectancy at birth (years)	Adult literacy rate (% ages 15 and above)	Combined gross enrolment ratio for primary and secondary schools	GDP per capita (US$)	Human Development index	Overall rating on a list of 177 countries
38.9	69.2	53 %	1270	0.431	159

Source: UNDP Human Development Report 2004

3.5 Position/Justification of SNV/Rwanda Biogas Programme Support

As indicated in the former paragraphs, Rwanda faces one of the highest human population densities in Africa with most of the population relying on subsistence farming for their livelihoods. As this population increases further, land and other resources become scarce and pressure on these resources increases, leading to unsustainable use and destruction. Vision 2020 identifies the reduction of soil productivity and arable land per capita as a main constraint to the development of Rwanda (Vision 2020, June 2003).

Picture 1: land use pushed to the limits

In its strive to improve governance and reduce poverty in the Republic of Rwanda, the setup of a biogas support programme is a valuable intervention for SNV Rwanda. SNV, through experiences in similar programmes, has the technical potential to support such programmes. It is framed within its Renewable Energy practice area and opens opportunities for access to funds (Congo Basin Programme, etc.). It contributes to reaching the Millennium Development Goals (MDGs) and it opens up future opportunities to tap into CDM funds, since it contributes positively to the final goals of sustainable development: socially (improve quality of life, alleviate poverty and improve equity), economically (provide financial returns, transfer of new technology) and environmentally (reduce Green House Gas (GHG) emissions, conserve local resources, reduce pressure on the local environment, provide improved health and other environmental benefits).

3.6 Position/Justification of MININFRA as Biogas Programme host

MININFRA's mission is to create favourable conditions allowing the population to have access to basic infrastructure for sustainable development. MININFRA consists of 5 units: (1) planning, (2) public works, (3) transport, (4) information and communication technology and (5) energy. So, MININFRA is the Government agency designated for leading and managing the energy sector. The national policy goal in this regard is to meet the energy challenges and needs of the Rwandan population to effectively contribute to the growth of the national economy and thereby improve the standards of living for the entire nation in an environmentally sound and sustainable manner.

The mission of the energy division is to create conditions for the provision of safe, reliable, efficient, cost-effective and environmentally appropriate energy services to all sectors on a sustainable basis. For this to happen, combined strategies stated in the Energy Policy for Rwanda consist of:

- sustainable management of existing resources by improved carbonisation techniques and improved stoves dissemination;
- substitution fuels development, e.g. biogas, briquettes from crops and papyrus, peat carbonisation and methane gas;
- tree planting (MINITERE being the lead institution).

The setup of a national biogas programme fits in with the second strategy. Based on successful experiences from other countries, most conditions to undertake biogas activities are fulfilled.

Furthermore:

- the 2002 Rwandan PRSP defines the promotion of biogas in rural areas as a priority activity;
- rational and sustainable management of national space, of the environment and natural resources, land, water, energy sources and biodiversity is one of the major aspirations of the Vision 2020. In terms of energy it states that *Rwanda will be producing enough energy required for economic and social development, while avoiding the degradation of the environment. The country will have considerably reduced the role of wood in the national energy use while expanding electricity, solar energy, methane gas, wind energy and other forms of energy*. One of the indicators in this context being that the consumption of wood energy in the national energy consumption reduces from over 90 % to 50 % by the year 2020 (Vision 2020, June 2003);

- Vision 2020 also indicates that, as a matter of priority, particular attention should be paid to labour and job creation in all the sectors of the national economy. At a modest level, the set-up of a national biogas sector can contribute to this;
- the Rwandan energy policy (October 2004) acknowledges that energy services have an impact on all rural economic activities. Addressing energy requirements in the rural areas will ensure improvement of the welfare of the rural population and the attainment of sustainable economic growth. The policy also stresses the need to have affordable and reliable energy supplies country wide and to enhance the development and utilisation of indigenous and renewable energy sources and technologies. Some relevant policy statements in this context:
    - *Introduce appropriate rural energy development, financial, legal and administrative institutions;*
    - *Establish norms, codes of practice, guidelines and standards for renewable energy technologies, to facilitate the creation of an enabling environment for sustainable development of renewable energy sources;*
    - *Promote efficient biomass conversion and end-use technologies in order to save resources, reduce rate of deforestation and land degradation, and minimise threats on climate change;*
    - *Support research and development in renewable energy technologies;*
    - *Promote application of alternative energy sources other than wood and charcoal for cooking, heating, cooling, lighting and other applications, in order to reduce deforestation, indoor health hazards and time spent by rural women and children in search for firewood;*
    - *Promote entrepreneurship and private initiative in the production and marketing of products and services for rural and renewable energy;*
    - *Encourage energy education in school curricula*;
- a cabinet retreat in December 2004 recommended to direct more efforts to the energy sector and to overcome the triple crisis of electricity shortage, woodfuel resources depletion and increasing oil product prices. In all these efforts, community based organisations will play a key role, especially regarding female ownership and participation in domestic energy programmes**.**

Continued commitment of MININFRA to the programme has been shown by: (1) requesting SNV for its capacity development services; (2) the availing of money to kick of the programme and for the subsidy component of the programme and (3) the provision of office space for the biogas programme.

For extra information on MININFRA: www.mininfra.gov.rw

4 HISTORY OF DOMESTIC BIOGAS

4.1 History

The first record of the construction of domestic biogas plants dates back to 1982. On the invitation of the FAO, a biogas consultant from Nepal constructed 4 plants ranging in size from 8 to 20 m^3 at the '*Projet Développement du Petit Elevage*' at Kabuye. At the same time a biogas training course was organised for technicians. Following this course and with support from SNV Rwanda, plants were constructed in Rwesero near Lac Muhazi and at the PADEC project in Murambi. The plants proved to be successful but discussions between SNV and the General Directorate of Energy within the Ministry of Public Works, Water and Energy on a biogas dissemination programme did not lead to anything.

According to an international biogas survey published by BORDA in Bremen, some hundred domestic biogas plants of the fixed dome model have been constructed, at the end of 1990, in schools and barracks by the Ministry of Public Works and Energy and by the International Association for Rural Development (AIDR). Some others have been constructed for religious organizations and rich families.

4.2 Current state of affairs

There are no ongoing programmes aimed at the large scale dissemination of domestic biogas plants in Rwanda. The following organisations with ongoing activities in the biogas sector were identified and contacted:

4.2.1 Centre for Innovations and Technology Transfer (CITT)

The CITT is part of the Kigali Institute of Science and Technology (KIST). This institute was established in 1997 as Rwanda's first technological institute for higher education. The institute is supported by the Ministry of Education, UNDP Rwanda, GTZ and the Governments of Japan and The Netherlands.

CITT is a centre for applied research leading to environmentally friendly technological innovations and the subsequent transfer of these technologies to the rural areas. In the renewable energy field the centre has the following activities:

- solar energy, both thermal (for water heating and crop drying) and photovoltaic (for lighting purposes);
- fuel saving, wood fired bread ovens, and;
- biogas production through waste water management systems.

The centre has installed a number of large institutional biogas systems at prisons and some schools in collaboration with the Ministry of Energy, Water and Natural Resources (MINERENA). These systems range in size from 75 to 1000 m^3 and are primarily meant for treatment of waste. Also a smaller 35 m^3 plant has been constructed at the site of an NGO, Send a Cow, who has a dairy demonstration and training farm. This plant is fed with cow dung only.

4.2.2 Institut de Recherche Scientifique et Technologique (IRST)

The IRST is a research centre allied to the National University of Rwanda in Butare. The centre has the following research departments:

- Applied Biochemistry, notably production of fertilisers (NPK) with locally available raw materials;
- Local Construction Materials;
- Seismology and Environment;
- Applied Mathematics;
- Didactical Materials (Pedagogical Support), and;
- Renewable Energy.

At the institute's compound the renewable energy department is conducting experiments with solar drying, water heating and solar stills, improved wood stoves, gasification through pyrolysis and small biogas plants. Furthermore it is conducting studies on the use of methane gas from the Kivu Lake, rural electrification through SHS's and micro-hydro plants.

At the 10 m^3 fixed dome plant installed at the institute's site, experiments have been conducted with different feeding materials and the use of slurry as fertiliser.

A small number of plants have been installed at schools as an energy source for the school kitchen. The aim of the institute is to spread the use of plants at schools and it is working together with the Ministry of Education to achieve this goal. A concrete programme has not yet been developed though.

According to the institute, the cost of a small brick made fixed dome plant is about FRw 90,000 per m^3.

4.2.3 Ministry of Infrastructure (MININFRA)

The Minister of State is heading the departments of communications and energy within the Ministry of Infrastructure. Biomass is a section of the energy department.

Within the framework of a technical cooperation agreement between Rwanda and China, two technical training courses were conducted in 2004 in Kigali. Each course was attended by 17 participants and lasted for 5 weeks. As part of the training, two domestic biogas plants were constructed at dairy farms in the vicinity of Kigali.
The participants invited for the courses were civil servants, engineers and technicians, working for schools, hospitals, prisons and army camps in the provinces. The idea behind this selection procedure was that the participants will gain the technical know-how and become motivated to introduce biogas technology in their working environment.
Besides the two domestic plants, one 100 m^3 decentralised waste water treatment system (DEWATS) was installed during the trainings at the Kigali Institute of Education. The biogas produced by this system is used for lighting 8 lamps and fuelling one stove.

No further biogas collaboration with the Chinese is currently planned.

The Minister of State for Communications and Energy is of the viewpoint that enough technical know-how on domestic biogas plants is available and that further research is not required. It is now time to use this know-how to start with the mass dissemination of the technology among the rural population. More efforts will be displayed in training more people on decentralized entities who will serve as shift workers for biogas extension and bio-slurry utilization.

Picture 2: a biogas plant constructed with Chinese assistance. A 3-chamber inlet reduces the risk of short chopped fodder, which is spoiled in the dung, from entering the digester. This reduces the risk of scum formation.

Picture 3: the chopping of fodder grass is common practice on the larger farms.

5 CONDITIONS FOR MASS DISSEMINATION OF BIOGAS PLANTS

5.1 Household energy situation

Throughout the entire country, the main sources of lighting energy are oil (64 %), wood (17.5 %) and kerosene (10 %). Even in Kigali city, only 37 % of the households use electricity. (2002 population and housing census)

Firewood and charcoal are practically the sole providers of cooking energy in the rural areas. Firewood covers 90.4 % of the demand and charcoal 7.4 %, the remaining 2.2 % is mainly covered by agricultural residues. Even for the urban households firewood (52 %) and charcoal (39.5 %) are by far the main sources of energy used, other sources being gas and kerosene. (2002 population and housing census)

Picture 4: firewood collection and sales

This dependency on firewood and charcoal creates an unsustainable situation as the demand (1,93 kg/capita/day, MININFRA, 2005) largely surpasses the production (0,46 kg/capita/day, MININFRA, 2005) as is shown in the table below (see table 3).

Table 3: wood reserves and consumption (Republic of Rwanda, MINITERE, 2005)

	1960	1970	1980	1990	1996	1999	2000	2004
Population	**2694990**	**3763259**	**4831527**	**7157551**	**6167500**	**7165108**	**7497644**	**8162715**
Natural forest surface (1000 ha)	**634000**	**591000**	**513600**	**451160**	**383660**	**221200**	**?**	**?**
Planted forest surface (1000 ha)	**24500**	**27160**	**80000**	**247500**	**232500**	**252000**	**282563**	**282563**
Sustainable wood production (1000 m^3)	**368**	**407**	**1200**	**3713**	**2790**	**2268**	**2261**	**2261**
Wood demand (1000 m^3)	**2695**	**3763**	**4832**	**7158**	**6784**	**7882**	**8249**	**8979**
Balance (1000 m^3)	**-2327**	**-3356**	**-3632**	**-3445**	**-3994**	**-5614**	**-5987**	**-6718**

The government is trying to curb the rate of deforestation amongst others by banning the felling of trees without a permit. This rule applies to all trees including the ones in privately owned production forest. However, it is doubtful whether this measure will help without the availability of energy alternatives and fuel efficient woodstoves.

Within the SNV biogas practice team a list of basic conditions required for the mass dissemination of biogas plants was identified (see annex 3). The paragraphs 5.2 to 5.5 here below list these conditions and the subsequent findings.

5.2 Technical conditions

Requirement 1: daily ambient temperature should be above 20 °C throughout the year.
Finding: biogas plants can operate in the whole country throughout the year.

Requirement 2: availability of at least 20 kg dung per day at a large number of farms.
Finding: semi intensive cattle farming (stabling during the night) is common practice while zero grazing is on the increase. Because of the need of fertilizer and integrated farming, dung collection happens on a regular basis. In some cases cow dung can be supplemented with pig manure.

Table 4: livestock distribution

Province	(MINAGRI/FAO, 2002)				Study Findings*)		Increase of head of cattle (%)
	Head of cattle	Number of HH with cattle	Number of pigs	Number of HH with pigs	Head of cattle	Number of HH with cattle	
Ville de Kigali	34.855	5.731	2.633	899			?
Kigali Ngali	85.654	35.269	17.630	11.843	104.000	38.000	21
Gitarama	131.059	69.857	44.473	32.330	180.000	70.000	37
Butare	61.534	25.117	36.546	29.142			?
Gikongoro	55.959	25.642	40.080	31.433			?
Cyangugu	29.653	17.005	22.384	16.199			?
Kibuye	50.445	25.174	11.730	8.603			?
Gisenyi	44.098	20.229	26.414	17.907	60.000	22.000	36
Ruhengeri	61.675	36.285	40.941	27.161	68.000		10
Byumba	47.325	20.150	10.227	6.905			?
Umutara	189.955	17.591	3.589	2.068	300.000	40.000	58
Kibungo	58.652	16.047	9.227	6.981	83.000	31.000	42
Rwanda	**850.864**	**314.097**	**265.874**	**191.471**			

*) Findings based on interviews with Province officials like Veterinary Officers and Officers in charge of Economic Development and Environment

The number of households practicing zero grazing varies from region to region. Of the visited provinces, zero grazing is best established in Gitarama where all cattle farmers have stables in which the cattle are kept at least overnight, if not permanently. In Umutara province stabling is least practiced but is also on the increase. Here the cattle have to be brought to watering points on a daily basis.

Picture 5: stabling is on the increase

Picture 6: zero grazing is being enforced

Of the visited provinces on average 70 % of the cattle owning households practice semi-intensive cattle farming. Dung is collected at the stables and half has more than 20 kg a day. This implicates that of the 315,000 cattle owning households in Rwanda (Republic of Rwanda, MINAGRI, 2005) some 110.000 farmers have sufficient dung to operate a biogas plant. With the enforcement of the zero grazing rule and the increasing need for fertiliser, this number will grow rapidly during the coming years.

Requirement 3: availability of water since dung needs to be mixed with an equal amount of water and/or urine before feeding into a biogas plant.
Finding: at farms where stabling is practiced farmers have access to water. Often rainwater harvesting is introduced when stables are constructed. In Umutara province cattle is taken to watering points.

5.3 Economic conditions

Requirement 1: use of organic fertilizer is practiced and integrated farming systems are common.
Finding: heavy pressure on arable land for food crop production leads to land degradation and the need for fertilisers. Composting is therefore common practise on most farms, with the exception of Umutara province. Despite this fertiliser use, one of the main reasons why incomes in Rwanda have fallen since the mid 1980's is the decline in agricultural productivity and in order to reverse this trend, to transform agriculture into a productive, high value, market oriented activity (Vision 2020, June 2003) farmers need to have access to inputs (p.18, Rwanda PRSP, 2002).

Requirement 2: scarcity of traditional fuels like firewood and charcoal.
Finding: the restrictions on the harvesting of firewood are a big problem for many households. Fuelwood prices at rural markets vary between 15 and 30 FRw/kg while the daily requirement for an average family is 10 kg. Often firewood is supplemented by agricultural residues.

Requirement 3: access to credit for farmers on reasonable terms.
Finding: there are presently some 250 micro finance access points scattered over the country. Most of the investments made are in commerce with repayment periods of 2 years and annual interest rates varying between 18-36 %. The number of agro-investments is low because:

- banks find it difficult to liquefy collateral in case of repayment default;
- traditionally the rural economy is not a monetary economy, many farmers practice subsistence farming;
- there are many special programmes that offer agro-credit on favourable conditions.

The loan requirement for an average biogas plant will be around FRw 134,776, equivalent to 51,7 % of the total investment (see table 6). Discussions with micro-credit institutions indicated that special biogas arrangements could be made with a repayment period of 4 years and an annual interest rate of 20-22 %.

5.4 Social conditions

Requirement 1: an active role of women in domestic decision making.
Finding: although the man is the official head of the household, decisions seem generally to be taken in consultation with the partner. Besides, Rwanda counts 35 % of female headed households, due to the genocide which widowed many women while many men are jailed on genocide charges (National Census, 2002).

Requirement 2: the role of women in livestock keeping and dung handling. As women are the main users and beneficiaries of biogas plants, they will be most motivated to keep the plant in good working order.
Finding: women participate more in subsistence agriculture than men (Vision 2020, June 2003). Cleaning of the stables, composting of manure and fetching water is usually the woman's chore. There are therefore no obstacles for her to operate the plant. There are also no barriers to participate in local training programmes or to receive technicians on the farm.

5.5 Institutional conditions

Requirement 1: political will from the Government to support a national biogas programme.
Finding: according to the Organic Law determining the modalities of protection, conservation and promotion of the environment in Rwanda (law N° 4/2005 of 08/04/2005), the State is obliged to promote the use of renewable energy and to discourage wastage of sources of energy in general and particularly that derived from wood. The feasibility study for a national biogas programme is undertaken on the request of the Minister for Energy and Communication. Furthermore, all province and district officials that were consulted applaud the initiation of such a programme particularly because of the scarcity of firewood. Besides the public servants, also the NGO's active in rural development projects that were contacted, expressed their interest to participate in a national programme.

Requirement 2: existence of farmers unions like dairy co-operations.
Finding: there are some 300 cattle farmers associations active in the country. Their activities include: the establishment of milk collection centres; stable improvement; livestock improvement through artificial insemination; livestock disease control programmes like thick spraying; etc.

Picture 7: milk collection

Requirement 3: accessibility of farmers through NGO's
Besides the above-mentioned associations, a large number of farmers participate in NGO initiated livestock development projects which makes that farmers are easy to access through associations, NGO's or both.

Table 5: an overview of key conditions and findings

Key Conditions for dissemination of Biodigesters	Observations & Findings
Technical Factors	
Even, daily temperatures over 20 ^{0}C throughout the year	+++
Full stabling of animals (zero-grazing) (cows & pigs)	++
At least 20 kg/day dung available per plant	++
Availability of water	+
Economic Factors	
Use of organic fertilizer is traditionally practiced	++
Scarcity of traditional cooking fuel, fuelwood & charcoal	+++
Dairy farming is the main source of income	+
Users have access to credit	-
Social Factors	
Role of women in domestic decision making process	+
Role of women in livestock keeping and dung handling	++
Participation of women in training programmes	++
Institutional Factors	
Political will from the Government to support a national biogas programme	+++
Existence of farmers associations like dairy cooperatives	++
Accessibility of farmers through NGO's	++

6 POTENTIAL STAKEHOLDERS SUPPLYING SERVICES FOR DOMESTIC BIOGAS

The functions required in a national programme and possible suitable actors, are:

- **Lead organisation**
  MININFRA Energy Division
- **Administration (of the investment subsidy)**
  Biogas Programme Office (BPO)
- **Promotion and extension**
  BPO, Provincial veterinary and Agricultural Services, Provincial Forestry and Environmental services, NGOs (Heifer International, LWF, Pro-Femmes/Twese Hamwe[*] …), farmers associations
- **Marketing, construction, maintenance and after sales service**
  the private sector through the assistance of Fédération Rwandaise du Secteur Privé
- **Subsidy and credit**
  members of Rwanda Micro Finance Forum
- **Quality control**
  BPO & CITT
- **R&D**
  CITT & IRST
- **Training**
  CITT (technical), IRST, Fédération Rwandaise du Secteur Privé (management), private companies (user training)
- **Monitoring and evaluation**
  BPO with the support of local consultancy companies
- **Organisational strengthening and institutional development**
  SNV

The organisations as listed above have been contacted during the study and have responded positively on the initiative of a National Biogas Programme and their active role within. They have also participated in a one day workshop on the feasibility and possible structure of such a programme. A copy of the workshop report is attached in annex 4 (see annex 4).

Besides MININFRA and SNV there are other organisations/institutions who are essential for the implementation of the programme who need some more in-depth description in the feasibility report, these organisations and institutions are: farmers associations, financial institutions and the private sector.

Farmers associations

Farmers associations fulfill several roles: marketing of milk, contact with veterinary services, contacts with livestock development organizations, etc. Dairy farmers associations can play a key role in the awareness creation and the dissemination process of biogas technology as they create an entry towards the farmers with the technical potential.

[*] Umbrella of Rwandan Organisations for Promoting Women, Peace and Development

In the example of Gitarama (a province in Central Rwanda, divided in 10 districts and 146 sectors), there is a minimum of one association in every sector and there are over 200 associations in the province.

An interview held with Mr. Musengwana Theophile, vice president of the '*Association Provinciale des Eleveurs'* gave us the following insights.

Some 4,000 of the total of 45,000 cattle farmers in the province (an under estimation of the real figure, see table 4) are member of an association and that this number is growing daily. The tasks of these associations consist of:

- training farmers in modern livestock rearing techniques like zero-grazing, fodder crop growing, stable construction and artificial insemination;
- organisation of veterinary services like vaccination campaigns, sales of items (salt lick blocks);
- collection and marketing of milk: milk is collected at numerous points so they are near to all farmers. From there they go to central collection points and from there on to the Nyanza Dairy Cooperative where the milk is treated, packed and distributed to the market. The farmers receive FRw 180 per liter milk.

Main problems facing the associations are: the improvement of the Ankole race (lack of improved livestock and/or seamen); veterinary services are not sufficiently developed to cover all the needs (there are parasite problems) and the lack of education amongst members (most are illiterate).

Almost all livestock farmers have a stable but zero grazing is not yet fully established. Those farmers who still let their cattle graze outside do so for approximately 4 hours per day so the cattle spends 20 hours in the stable where they receive supplementary feeding. The common farmer has 3-4 cattle which, after deduction of his own consumption, will produce 8-10 liters of milk per day.

Dung is collected on compost heaps and used to fertilise the land. This compost also has a commercial value and is sometimes traded amongst farmers. The average farmer will collect about 30 kg of dung per day.

The respondent, whose household consists of 7 members and who has no problems accessing water, has heard about biogas and is very interested to have a biogas plant installed at his house. The main problem is financing the plant, nevertheless he is willing and able to pay FRw 150,000 for a plant since he spends FRw 8,000 per month on firewood.

In the Northern part of the country (Ruhengeri Province) an interview was conducted with Japhet Ntahobari, Vice President of a larger local livestock farmers association 'Zirakamwa', covering 6 districts and counting 450 members with improved cattle. The smallest farmers have 2 head of cattle, the largest 10. Their main purpose for improving the Ankole cattle population is to increase the milk production. This is done through the introduction of Frisian and Jersey cattle. In the whole province there are, according to the respondent, 70,000 head of cattle of which about 10,000 are improved. All improved cattle are permanently kept in stables and fed with specially cultivated fodders crops and maize stalks. Of the 60,000 traditional cattle some 20,000 are now on zero-grazing. The main reason for keeping the animals permanently in a stable is the need for cow dung. There are about 30,000 livestock farmers in the province of which half have permanent stables while 10,000 collect at least 20 kg of dung per day. The respondent estimates that half of them are able and willing to invest in biogas and ended his conversation by indicating that the association is keen to work with a national programme to promote biogas use.

Financial institutions

Only few of the farmers who have the technical potential (more than 20 kg dung/day) will have enough cash at hand to make the necessary investment for a biogas plant. Therefore the access to reasonable credit is an essential part of the programme. The participation of (micro)finance institutes has to be ensured.

- The Rwanda Micro-finance Forum (RMF) has 250 service points throughout the country. At present investments are mainly done for small businesses (commerce) with loan durations of 6 months. There are some investments in agriculture with durations of 1-3 years and an average investment of FRw 500,000. In terms of credit conditions, interest rates vary between 18 and 24 % per year. As a collateral real property like houses and banana plantations are used, furthermore between 10-30 % of the loan amount has to be kept on a savings account. RMF is fully convinced of the need for a biogas programme and seems eager to participate in a national biogas programme. They require the mobilization of credit funds and training of bank staff;
- special credit programmes for agriculture exist like in the Rural Development Programme in Ruhengeri. It is funded by the Dutch Embassy and provides credits to farmers through existing MFI's ranging between FRw 100,000 and 500,000 for a 16 %/annum interest rate and a duration of 3 years;
- funding through bilateral aid from WB and USAID for Banque Populaire;
- COPEC issues loans for cash crops like coffee, rice and pyrethrum.

There are some constraints though for agro-loans, being:

- the educational level of the population (low alphabetisation levels);
- an instable climate with drought periods that can affect the return of an agricultural investment;
- the low development stage of a monetary economy (barter trading is still common) which makes it difficult to issue loans because of the lack of a saving component;
- difficulties in liquidating collateral of non-performing loans;
- lack of funding.

Private sector

The Rwanda Private Sector Federation is an umbrella organisation for private sector associations. The mandate of the federation is mainly private sector advocacy and consultation at Presidential and Ministerial levels. It works towards the improvement of the business climate and supports entrepreneurs, a.o., through management workshops. It has a national network with offices throughout the country and is willing to participate in a national biogas programme. It considers as a possible role, the identification of interested and capable construction entrepreneurs and the organisation of workshops.

7 OUTLINE FOR A NATIONAL PROGRAMME ON DOMESTIC BIOGAS

7.1 Objectives, output targets and programme duration

The overall objective of the National Biogas Programme will be to develop a commercial and structural deployment of biogas technology, resulting in the reduction of biomass resource depletion and a significant improvement in the quality of life of the families concerned.

The specific objectives, contributing to the overall objectives, will be:

1. to develop, strengthen and facilitate a commercially viable and market oriented Rwandan biogas sector;
2. to increase the number of family sized, quality biogas plants with 15,000 in the country;
3. to ensure the continued operation of all biodigesters installed under the biogas programme;
4. to maximize the benefits of the operated biodigesters, in particular the optimum use of digester effluent.

In the context of Rwanda, the advantages of biodigesters include the replacement of firewood for domestic cooking requirements, improved local environment and health conditions, waste management and utilisation of bio-slurry for increased crop production.

7.2 Required tentative budget and financing

7.2.1 Financial analysis of a biogas plant

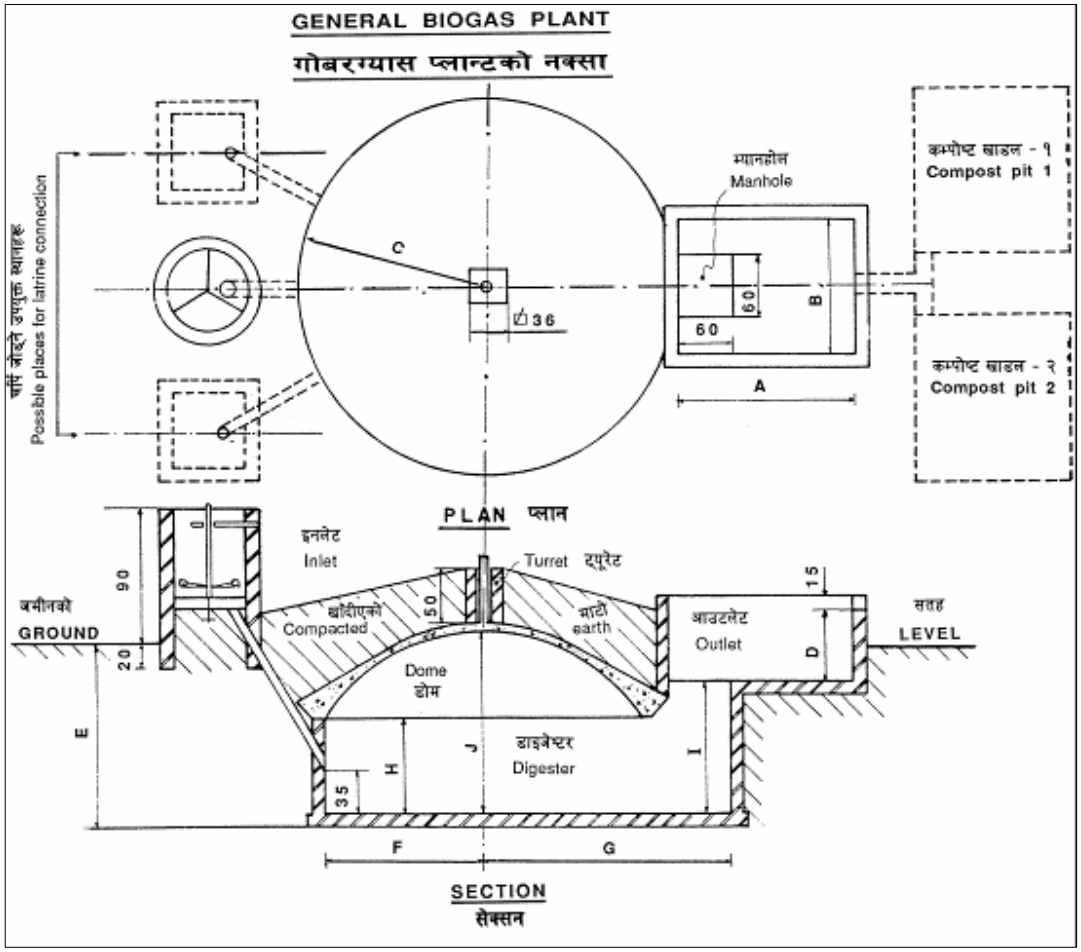
Given the distribution figures of the national herd over the rural households together with the gathering practices of dung and the climate, 6 m^3 will presumably be the most common plant size to be constructed over the first years. With a feeding of 40 kg/day, such a plant will produce on average 1.5 m^3 gas per day. Given that not always all gas is used and for various reasons the plant might not be used every day the whole year round, the analysis is based on a 6 m^3 plant with a used gas production of 1.2 m^3/day. Most families are now cooking on traditional 3 stone-ovens, meaning that the daily replacement value of the biogas amounts to 6 kg/day or 2190 kg/year.

The plant model used for the analysis is the GGC2047 model from Nepal (see drawing 1). The plants built under the programme will be fixed dome models and the GGC2047 is a good candidate for Rwanda because it requires less bricks than plants with a brick made dome (the restrictions on firewood use have made bricks increasingly expensive) and the construction technology can easily be adopted by semi skilled masons. Included in the plants costs are the unskilled labour component (digging, etc.), fee for construction and after-sales service as well as GI pipes and appliances. Annex 5 provides the cost calculation of a 6 m^3 plant (see annex 5). During the programme initiation phase, a final choice for a plant model must be made, based on a study for the most appropriate design for mass dissemination in Rwanda.

Picture 8: 3 stone stove

Picture 9: brick making

Drawing 1: drawing and sizes for the GGC2047 fixed dome biogas plant model



Size (cm)	4 m^3	6 m^3	8 m^3	10 m^3	15 m^3	20 m^3
A	140	150	170	180	248	264
B	120	120	130	125	125	176
C	135	151	170	183	205	233
D	50	60	65	68	84	86
E	154	155	172	168	180	203
F	102	122	135	154	175	199
G	185	208	221	240	261	288
H	86	92	105	94	115	115
I	112	116	127	124	132	137
J	151	160	175	171	193	203

The basic data for the financial analysis are presented in table 6 (see table 6). The benefits associated with the use of biogas plants are derived essentially from the savings in expenditures from biomass fuels. This can be done because fuelwood is traded in every village. Prices vary from 15 to 30 FRw per kg. The base price for fuelwood in the analysis is assumed to be 20 FRw/kg. The value of saved labour and the recovered nutrients from bio-slurry are assumed to be zero because they do not yield an immediate financial return.

Table 6: basic data for financial analysis

Costs	**FRw**	**US$**			
Investment costs	260862	475	See annex 5 for calculation		
Ann maintenance costs	10434	19	4 %	of investment costs	
Subsidy	100000	182			
Net cost	160862	292			
Down payment	26086	47	10 %	of investment cost	
Loan amount	134776	245	22 %	Ann. Int.	4 yrs term
Ann loan payment	-54048				
Annual savings	**Unit (kg)**	**FRw/unit**	**Total FRw**		
Biomass	2190	20,00	43800		

The base analysis indicates a financial internal rate of return (FIRR) of 19 %. Figure 1 below presents the results of a sensitivity analysis on the assumed price of fuelwood. The FIRR becomes negative when the price of fuelwood is below 12 FRw/kg and is 47 % at 28 FRw/kg.

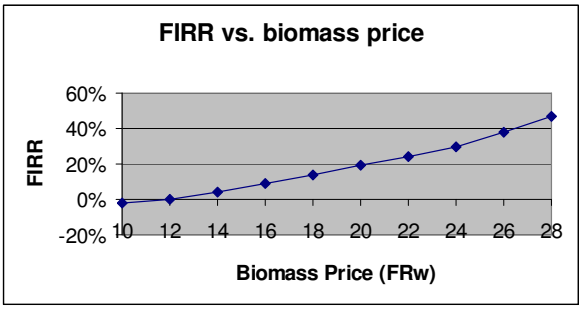


Figure 1: the Financial Internal Rate of Return (FIRR) depending on the price of firewood

A sensitivity analysis on the amount of the subsidy provided is presented in figure 2. The data indicate that the FIRR is not as sensitive to the percentage change in the level of the subsidy as it is to the price of fuelwood. The FIRR becomes less than 12 % when the subsidy is below 70,000 FRw per plant and becomes 25 % when the subsidy reaches FRw 120,000.

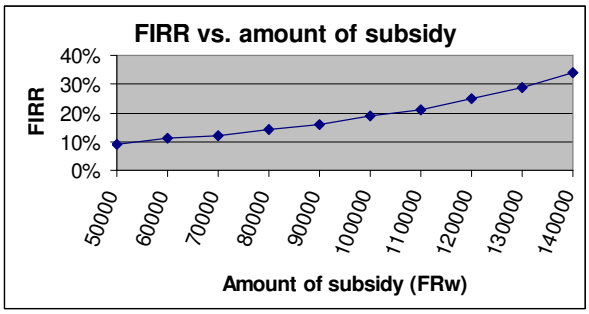


Figure 2: the Financial Internal Rate of Return depending on the subsidy level

Besides lowering the financial threshold for farmers who have the technical potential but little financial means the subsidy serves as an important promotion tool and provides a tool to safeguard quality standards on plant construction and after sales service.

An investment subsidy of FRw 100,000 (US$ 182) is considered sufficient to attract potential farmers while not being significantly excessive as to result in relative high FIRRs for the farmers.

At present, a hard economic analysis is not yet possible due to the lack of data. Based on similar installations though, functioning in a similar economy (Nepal), we can say that the economical internal rate of return value rises in proportion with the amount of factors taken up in the analysis (indoor air pollution, toilet attachment, soil fertility, working hours saved, …).

7.2.2 Programme estimated expenditures and proposed financing

The overall cost consists of programme running costs and subsidy costs. The running cost will be born by the donor and MININFRA in the form of adequate office accommodation.

Subsidy cost will be fixed at FRw 100,000 (US$ 182) per plant for the 15,000 plants to be constructed in the 1st phase. The subsidy cost will be born for 75 % by the donor and 25 % by the Rwandan Government. The subsidy will be fixed for the duration of the programme phase unless the local currency will devaluate sharply over this period. This is not foreseen, the Rwandan Franc has lost 20 % versus the US$ over the last 5 years. Disregarding devaluation, the total required subsidy amount in line with the projected production as presented in table 7 (see table 7) amounts to US$ 2,730,000: US$ 2,047,500 for the donor and US$ 682,500 for the Rwandan Government.

Table 7: projected production of biogas plants

2005	2006	2007	2008	2009	2010	
Preparation phase		Implementation phase				
(start Oct. 2005/15 months)						
0	I	II	III	IV	V	Total
Growth %	0 %	120 %	100 %	82 %	40 %	
	500	1100	2200	4000	7200	15000

Considering that a concrete or brick dome plant will cost near to FRw 260,862 leaving, after subsidy (100,000 FRw) and down payment (26,086 FRw in labour), a financing requirement of FRw 134,776 (US$ 245) per plant or 3,675,000 US$ for the first phase of the programme. On top of this amount the detailed implementation plan should foresee a provision for optional loans of about 55 US$ to be used by the farmers for stable and kitchen improvement.
The Rwanda Micro Finance Forum, a combination of 40 MFI's, has expressed its interest in credit provision for biogas construction but has also indicated it is in need of funding.

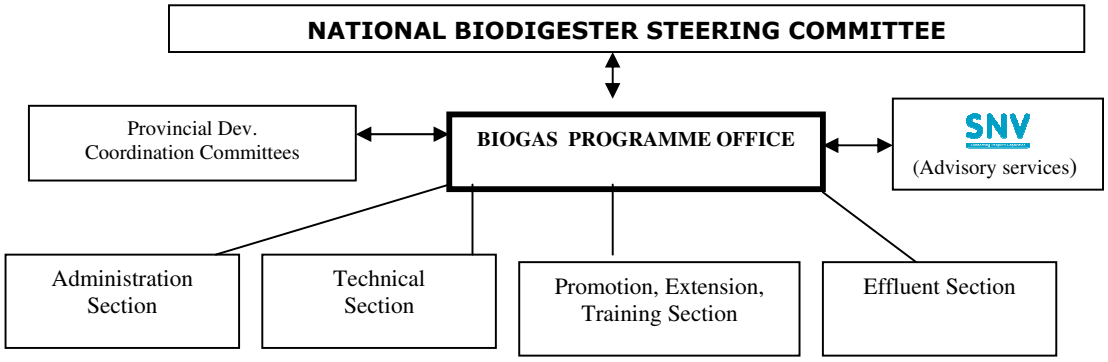
Adding programme costs (2,066,477 US$, see annex 6) and the costs for technical assistance (990,000 US$, see annex 7) amounts to a total financial requirement of US$ 9,461,306 (see table 8).

Table 8: total financial requirement

	2005	2006	2007	2008	2009	2010	
	Preparation phase (start Oct. 2005/15 months)		Implementation phase				
Year	0	I	II	III	IV	V	**Total**
Production	0	500	1 100	2 200	4 000	7 200	15 000
Subsidy Component (US$ 182/-p/p)	0	91 000	200 200	400 400	727 927	1 310 400	2 729 927
Credit Requirement (US$ 245/- p/p)	0	122 500	269 500	539 000	979 902	1 764 000	3 674 902
Programme Cost	108 899	372 991	347 031	336 591	418 651	482 315	2 066 477
Technical Assistance	65 000	185 000	185 000	185 000	185 000	185 000	990 000
Total Financial requirement in US$	**173 899**	**771 491**	**1 001 731**	**1 460 991**	**2 311 480**	**3 741 715**	**9 461 306**

7.3 Proposed programme management structure

Figure 3: programme outline on national level



An appointee from MININFRA, the lead organisation that chairs the Steering Committee, will be appointed National Coordinator (part-time) for the programme. Together with a Programme Co-ordinator, who is to be recruited from the labour market, they will have joint responsibility for the proper implementation of the programme. This team will be assisted by a Biogas/NRM and a Renewable Energy Advisor, both provided by SNV and making full use of the experiences gained so far in other national biogas programmes. The running of the office will include accounting, financial procedures and staff management. This will be done according to the Programme's rules and regulations. Reporting to the Rwandan Government will be done through the lead organization and according to Government rules and regulations. The office will draft Annual Programme Plans in accordance with the objectives as set down in the Business (implementation) Plan. It will also initiate, co-ordinate and monitor the activities within the biogas sector. The office will have to work with different sections, private and public, of society bearing in mind that an objective of the programme is to develop a durable biodigester industry by mobilizing the private sector.

Coordination of biogas activities on provincial and district levels will be incorporated in the respective Development Committees. There will be no BPO staff permanently based in the provinces.

7.4 Tentative schedule for the National Biogas Programme Rwanda

Both at SNV and MININFRA level (50/50), funds are there to kick-off the programme while we wait for donors to fund the programme as from January 2006!

Table 9: Biogas Programme planning September – December 2005

ACTIVITY	Responsible	Sept. 2005				Oct. 2005				Nov. 2005				Dec. 2005			
Finalise feasibility report	Jan, Silas, Guy	August 2005															
Take 'go/no go' decision on the Biogas Programme, e.g. ratify the feasibility report!	SNV management & MININFRA	X	X														
Formulate and sign an MoU between SNV and MININFRA to prepare an implementation document	Silas, Guy, SNV Regional Director & Minister Butare		X	X													
Recruit SNV biogas advisor as well as Biogas Programme coordinator (at MININFRA level)	SNV & MININFRA			X	X	X	X										
Set up a National Biogas Programme Office	Silas, Guy, Renewable Energy Advisor				X	X	X	X									
Set up a National Biogas Steering Committee	Silas, Guy, Renewable Energy Advisor					X	X	X	X								
Contact stakeholders, consulting them on their role in the programme	Silas, Guy, Renewable Energy Advisor and Programme Coordinator					X	X	X	X	X							
Formulate a detailed implementation plan for the National Biogas Programme (including the choice of pilot regions and the need for regional Biogas Programme Offices)	Silas, Guy, Renewable Energy Advisor and Programme Coordinator							X	X	X	X						
Secure funding for the implementation of the Biogas Programme, e.g. look for and contact donors (DGIS, KfW (German Development Bank), ADB, …)	MININFRA, SNV Rwanda and HO and Programme Coordinator					X	X	X	X	X	X	X	X	X	X	X	X
Sign agreement on the implementation of the biogas programme with partners	Biogas Programme and partners											X	X				
Start implementation of the biogas programme	Biogas Programme Office	January 2006															

After signing a tripartite agreement (Government, SNV, Donor) by the end of 2005, latest early 2006, the pilot – preparation phase can start in 2 provinces with the construction of 500 biogas plants by the end of 2006, followed by implementation phase I (2007 – 2010) with a projected construction of 14,500 biogas plants.

7.5 Assumptions and risks

Although there are many Rwandan biogas experiences at the institutional level (prisons, schools), the absence of a history of domestic biogas is a risk for the proposed biogas programme. Yet, assuming stability in the region of the Great Lakes, all the conditions for people to accept the technology and to establish a successful national biogas sector in Rwanda are met. Nevertheless, the process of actual acceptance made us to take into account a slow start and to adopt modest production targets.

The success of the programme will largely depend on innovative farmers willing to take a risk by investing in a biogas plant. In analogy with what happened in other countries, it is expected that these initiatives will have a trigger effect by convincing others to accept the technology.

It is important to get full support from different actors in the sector. 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 their support will also materialise formally.

There has been a delay in finalising the feasibility report and consequent delays in ratifying the document, signing the MoU, recruiting an extra SNV advisor and consultants to develop the implementation plan and the sourcing for funds. This delay might spill over into 2006.

8 CONCLUSIONS AND RECOMMENDATIONS

- In the rural areas, more than 90 % of the population uses firewood as domestic energy source. There is **scarcity of traditional fuels** (firewood and charcoal) and this, combined with the restrictions on the harvesting of firewood, is a big problem for many households. Fuelwood prices vary between 15-30 FRw/kg while the daily requirement for an average family is 10 kg;
- some 110,000 households are estimated to have sufficient dung to operate a biogas plant. Semi intensive cattle farming (stabling during the night) is common practice while zero grazing is on the increase. Because of land degradation due to the heavy pressure on arable land and the consequent **need for fertilizers** and integrated farming, **dung collection happens on a regular basis** and composting is common practise on most farms;
- **climatic conditions** in Rwanda allow biogas plants to operate in the whole country throughout the year;
- at farms where stabling is practiced, farmers have **access to water**. Often rainwater harvesting is introduced when stables are constructed;
- in terms **of domestic decision making**, decisions seem generally to be taken in consultation with the partner even though the man is the official head of the household. In terms of **livestock keeping**, cleaning of the stables, composting of manure and fetching water is usually the woman's chore. There are therefore no obstacles for her to operate the plant, nor are there any barriers to participate in local training programmes or to receive technicians on the farm;
- there are some 300 **cattle farmers associations** active in the country. Their activities include, amongst others, stable improvement and the establishment of milk collection centres. Besides the associations, a large number of farmers participate in NGO initiated livestock development projects;
- in terms of **access to credit for farmers on reasonable terms** there are presently some 250 micro finance access points scattered over the country. Most of them work with a repayment period of 2 years with annual interest rates varying between 18-36 %. The loan requirement for a biogas plant is estimated at around FRw 135,000 and it must be possible to make special biogas credit arrangements so that these loans can be repaid over a period of 4 years with an annual interest rate of 20 %. It must be mentioned in this context that a biogas programme does not target the poorest farmers who practice subsistence farming without rearing cattle;
- Since there is no history on domestic biogas in Rwanda, its success depends on innovative farmers, willing to take a risk to reap the benefits of domestic biogas.

Main recommendations for a national programme

- Memorandum of Understanding
  During the first half of October 2005, MININFRA and SNV/Rwanda shall sign a MoU for the establishment and the implementation of the first phase of a Rwandan national biogas programme that helps to develop a socio culturally acceptable, commercially viable and environmentally sustainable market oriented biogas sector and that aims to increase the number of quality biodigesters with 15,000 by December 2010.

- Formulation of a detailed business (implementation) plan
  This plan, to be formulated in cooperation with all potential stakeholders in Rwanda, will address issues that were not yet tackled by the feasibility study. In order to do so, MININFRA and SNV will recruit 3 consultants (one on management, a technical person and an extension specialist) to assist the personnel they have assigned to the national biogas programme.

- Pursue approval of the implementation plan
  MININFRA and SNV will pursue approval of the detailed implementation document, to make the required preparations and to start implementation of the programme in 2006. This includes looking for international sources of financial support to advocate for, promote and develop a national biogas programme in Rwanda.

- Programme set-up
  By the end of 2005, a national Biogas Programme Office (BPO) needs to be established to initiate and coordinate the different activities that need to be undertaken. The Department of Energy and Communication under the Ministry of Infrastructure, which also hosts the biomass energy section, will host this office. The participation of other line ministries, non governmental organisations (NGOs), financial and research institutes is indispensable. Organizations active at the national level need to be represented in a BPO steering committee.

- Technology
  To gain market confidence in the technology, there must be a strong focus on quality. This includes quality of information, construction and after-sales service. During the programme initiation phase, a final choice for a plant model must be made, based on a study for the most appropriate design (reliability, availability of materials, …) for mass dissemination in Rwanda. Applied research is necessary to come to an enforceable national standard for biodigesters.

- Finance
  A mechanism needs to be established to make finance for domestic biodigesters available under reasonable conditions. Preferably, this finance has to be channelled through existing and regulated banking institutes and/or programmes. These institutes are operating under the umbrella organisation 'Rwanda Micro Finance Forum'. Provision of subsidy will be an important marketing tool and must be linked to predefined quality standards.

- Commercialisation
  For the actual construction and the after sales service of biodigesters, the establishment of local biodigester enterprises must be encouraged. This includes management support and training of technicians by the programme.

- Integrated farming
  Research on the use of the full potential of digester effluent and dissemination of the research results must be an integrated and substantial part of the programme.

- Role of SNV
  SNV, with its experience with this type of programme and sector development, will provide capacity development services to the programme and to the various actors in the biogas sector, aiming at capacity building of the respective organizations (government, civil society, private sector).

- Role of MININFRA
  MININFRA will host the Rwandan National Biogas Programme and provide the working conditions to achieve the programme's objectives.

ANNEX 1 TERMS OF REFERENCE FEASIBILITY STUDY

1. Introduction and background

In the framework of its up-scaling of the Biogas Programme, SNV aims to assist in the setting-up of a large-scale biogas programme in Rwanda. A brief initial visit was conducted and reported in March 2005. The conclusion of this visit was that the circumstances in Rwanda 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 Rwanda. 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 including an analysis of the used technology;
- 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:

- preparation of a mission to Rwanda by using the initial visit report, collecting secondary information, contacting key respondents and informants in Rwanda and drafting checklists for farmer and NGO/project visits and interviews;
- mission to Rwanda to visit domestic biogas plants constructed in the past, to meet farmers and key respondents (representatives of farmer associations and rural development programmes) for interview and discussion. The mission shall include a workshop to discuss with the main stakeholders the roles of the different actors in Rwanda and the outline of a possible national biogas programme;
- formulation of the draft study report and submission for comments to SNV Rwanda, the Rwandan Ministry of Infrastructure and members of the Biogas Practice Team (BPT) of SNV;
- submission of the final study report by incorporating the comments from SNV Rwanda, the Rwandan Government and members of the BPT.

4. Time schedule

The mission to Rwanda shall be completed within a period of three weeks in April 2005. The draft report shall be submitted before 27 May 2005. SNV Rwanda, the Ministry of Infrastructure 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 and possibly 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.
The salary cost of the team members will be born by the respective employers of the members, see paragraph 7.

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 assist in the setting-up of a national biogas programme in Rwanda.

7. Composition of the team

The mission team shall consist of three members: a member of the BPT, the NRM Advisor of SNV Rwanda and the Head of the Biomass Unit of the Ministry of Infrastructure.

8. Further arrangements

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

Jan Lam. Report on the first biogas visit SNV, March 2005.

Jan Lam
Winssen, 22 March 2005

ANNEX 2 ITINERARY FOR BIOGAS FEASIBILITY STUDY

Day	Date	Study Team
Monday	4-apr	Gather data MININFRA, MINALOC, …
Monday	4-apr	Preparations & meetings
Tuesday	5-apr	MINAGRI, MINITERE, MINALOC
Wednesday	6-apr	Field visit Kigali Ngali Province
Thursday	7-apr	Genocide Memorial Day
Friday	8-apr	Field visit Gitarama Province
Monday	11-apr	Field visit Kibungo Province
Tuesday	12-apr	Field visit Umutara Province
Wednesday	13-apr	Field visit Gisenyi Province
Thursday	14-apr	Field visit Gisenyi-Ruhengeri Provinces
Friday	15-apr	Visit organizations and associations in Kigali (Heifer International, Women Network, …)
Monday	18-apr	Visit Micro Finance Institutions in Kigali
Tuesday	19-apr	Preparation of consultative workshop
Wednesday	20-apr	Consultative workshop
Thursday	21-apr	Report and wrap up

ANNEX 3 CONDITIONS FAVOURING WIDE SPREAD DISSEMINATION OF DOMESTIC BIOGAS PLANTS

To launch a large scale domestic biogas programme based on a commercially viable, market oriented basis, a number of pre-conditions have to be met.

Technical conditions

- Daily ambient temperature above 20°C throughout the year. The biological process in a digester is temperature dependent. The optimum temperature is 35°C, below 15°C the process comes practically to a stand-still;
- availability of at least 20 kg cattle and/or pig dung per day at a large number of farms. Cattle should be at least kept in a stable during the night. 10 kg of dung yields enough gas to operate a normal sized kitchen stove for 1 hour, to make an investment remunerative a minimum of 2 stove hours per day are required;
- availability of water. Cattle dung fed into a plant needs to be mixed with water on a 1:1 ratio.

Economic conditions

- Use of organic fertiliser is traditionally practised and integrated farming systems are common. Often it is not the saved firewood but increased crop production from the use of bio-slurry that generates additional income;
- traditional cooking fuels like firewood and charcoal are difficult (time consuming) to gather or expensive. If firewood is cheap and easy to come by, it will be difficult to motivate farmers to make the necessary investment;
- farmers should have access to (micro) credit on reasonable terms, and have the possibility to invest, e.g. by having the title deeds of their farms as collateral. Even with the use of subsidies, farmers still have to make a considerable investment.

Social conditions

- Role of women in domestic decision making. Women are the main direct beneficiaries of the biogas plant, they spend less time on fuel collection, cooking and cleaning of cooking utensils. Furthermore, as there is far less indoor air pollution, they will suffer less from eye and respiratory ailments. Therefore women should be accessible for extension services and have a say in the decision making process at household level;
- role of women in livestock keeping and dung handling. As women will be the users of the gas, they will be most motivated to keep the plant in good operational order. There should be no cultural barriers for them to operate the plant or to participate in local training programmes.

Institutional conditions

- Political will from the Government to support a national biogas programme. Preferably a Governmental institution should act as a national coordinating body for the programme and governmental extension services should be involved in promotion and on farm training;
- the existence of farmer unions, like dairy cooperatives, is not essential but will be very helpful.

ANNEX 4 REPORT CONSULTATIVE BIOGAS WORKSHOP

April 20th, 2005, Novotel Kigali, Rwanda

WELCOME ADDRESS

A welcome address was presented by Hon. Eng. Albert Butare, State Minister for Energy and Communications, Ministry of Infrastructure Rwanda.

The Chairman of the Workshop,
Workshop Participants,
Distinguished Guests,
Ladies and Gentlemen,

May I take this opportunity to thank the organisers of this workshop for inviting me to participate in the opening ceremony of this important gathering.

On behalf of the Government of Rwanda, and the Ministry of Infrastructure in particular, I wish to extend my profound gratitude to the Royal Netherlands for their willingness to support our efforts in raising the quality of life of our people, through application of bio-digesters in a substantial scale in the country.

I am pleased to learn that, SNV, the Netherlands Development Organisation will team with local organisations and personnel to make National Biogas Programme a reality in Rwanda, as it is happening in Nepal and Vietnam – where they operated before.

As you may know, the energy situation in Rwanda is characterized by low household incomes and low purchasing power of consumers. As a consequence, the situation has prevented trading of commercial forms of energy.

On the other hand, the population connected to electricity in Rwanda is only 2.5%. As a result, use of firewood and charcoal is over 95% of energy consumed in the urban and rural areas, since other potential sources of energy like natural gas, biogas, and hydropower remain underdeveloped.

The situation has resulted into serious erosion and decreased agricultural productivity; and in turn, heightening poverty.

Yet, we have animal wastes, which could be fed into bio-digesters to supply biogas as alternative fuel; and obtain manure, of even higher quality!

A search for firewood wastes energy and productive time; but construction of bio-digesters creates energy and employment.

Well, we have been given a discussion paper; I don't know if you have looked sufficiently into it, but when you look through it, you will notice among other items that, the objective of the Biogas Programme is to improve the quality of life of our people through a set of activities.

You might wonder where are we going to begin, because I don't think we want to delude ourselves that we are going to solve all of the country's fuel and fertilizer problems in half a day; not even with installation of 10,000 bio-digesters!

But begin we must, because if we don't start somewhere, we shall not have a direction to march to; and as the adage goes, we can only beat our way by walking on it.

That is why we are emphasizing this whole issue of working together, because development cannot be and will never be the preserve of just one arm of the community. It cannot be the preserve of the government. It cannot be the preserve of the private sector or of the NGOs. It is every body, collectively working together.

At different capacities – of individuals, individual governments, and of the international community at large, we need to move from being enumerators and historians of our problems, to being champions and agents of change.

I believe we can all make a difference, but we need more than just words to bring about a transformation. We need commitment and we need action.

Mr. Chairman, this workshop is a good example of the partnership that exists between governments and their institutions, NGOs, the private sector and the general public.

Let me commend all those who are on the ground improving the quality of life of our people, through various development programmes and those already having the determination to be part of the solution.

Again, we are grateful to all of you for taking time from your busy schedules to come and network with your colleagues for what I believe is going to be a historic occasion.

I wish you fruitful deliberations, and the Government of Rwanda is always ready to work with you in this initiative.

I now have the pleasure to declare your workshop officially opened, and I thank you all for your attention.

This welcome address was followed by 4 presentations:

1. SNV biogas mission
2. Biogas facts and figures
3. Objectives feasibility study
4. Study findings

SNV BIOGAS MISSION

- Domestic biogas plants have a direct positive effect on rural peoples' energy supply, environment, health and agricultural production.
- SNV supports the formulation and implementation of national programmes on domestic biogas in some developing countries.
- In these programmes, multiple actors at different levels cooperate on the basis of proper institutional arrangements to provide access to sustainable energy for households raising livestock.
- SNV advises these actors in developing a commercially viable, market oriented biogas sector.

BIOGAS FACTS AND FIGURES

What is Biogas?

- A source of renewable energy that originates from methane producing bacteria in the process of bio-degradation of organic material under anaerobic conditions.
- A mixture of gasses, composed of methane (50-70 vol.%), carbon dioxide (30-50 vol.%) and some others including hydrogen (0-1 vol.%) and hydrogen sulfide (0-3 vol.%).
- The calorific value of biogas is about 6 kWh/m^3. This corresponds to about 5.5 kg of firewood.

The benefits of biogas technology

- Production of energy in rural areas;
- Transformation of organic material in high quality fertiliser;
- Improvement of hygienic conditions;
- Reduction of workload;
- Natural resource protection:
  - combat soil depletion;
  - reduce deforestation;
  - reduce erosion;
  - reduce harmful emissions;
- Micro-economical benefits:
  - energy and fertiliser substitution;
  - additional income sources;
  - increasing yields in animal husbandry and agriculture;
- Macro-economical benefits:
  - decentralised energy generation;
  - import substitution (fossil fuels and fertilizers);
  - job creation.

Conditions to contribute to development & conservation

- Mature technology: reliable, durable and user-friendly.
- Appropriate design, adapted to:
  - climatic and soil conditions;
  - the quality and quantity of the feeding material;
  - the capital available;
  - the availability and cost of different construction materials;
  - the availability of skills.
- Official policy support:
  - a need for energy alternatives;
  - a felt burden of deforestation and soil depletion;
  - a supportive legal framework.
- The ‘critical mass’ of biodigester systems.

Physical appearances of biogas plants

Three main types of simple biogas plants exist of which the fixed dome plant is most suitable for the Rwandan conditions.

Advantages:
- relatively low construction cost;
- a long life span (no moving and steel parts);
- underground construction (saves space and protects the digester);
- provides opportunities for skilled local employment.

Disadvantages:
- risk of heavy gas losses if the construction is not properly done;
- gas pressure fluctuates substantially depending on the volume of gas stored and the height of the slurry level in the outlet chamber.

Biogas compared with other fuels

Fuel	Unit (U)	Calorific value (kWh/U)	Application	Efficiency (%)	U/m^3 biogas
Cow dung	kg	2.5	cooking	12	11.11
Wood	kg	5.0	cooking	12	5.56
Charcoal	kg	8.0	cooking	25	1.64
Hard coal	kg	9.0	cooking	25	1.45
Butane	kg	13.6	cooking	60	0.40
Propane	kg	12.0	cooking	60	0.39
Diesel	kg	12.0	engine	30	0.55
Electricity	kWh	1.0	motor	80	1.79
Biogas	m^3	6.0	cooking	55	1

This table indicates that 11.11 kg of cow dung provide us one cubic meter of biogas which provides us an amount of energy equivalent to 5.56 kg of firewood.

Gas production

The daily biogas production per kg of fresh material:

- cattle dung: 40 litres;
- pig dung: 50 litres;
- chicken droppings: 60 litres;
- human faeces: 50 litres.

The daily gas production per live animal weight:

- cattle & chicken: 1.5 litres biogas per kg;
- pigs & humans: 3 litres biogas per kg.

Cost of a biogas plant

- Construction costs: excavation work and construction of digester;
- Operation and maintenance costs: wage and material cost for:
  - collection and transportation of the substrate;
  - water supply;
  - feeding and operation of the plant;
  - supervision, maintenance and repair of the plant;
  - storage of the effluent.
- Capital costs: redemption and interest for the capital taken up to finance the construction costs.

Bio-Fertiliser

25-30% of fresh dung dry matter is converted into biogas while a residue of 70-75% digested slurry (effluent) is pushed out by the plant.

Effluent characteristics:

- odourless and does not attract insects (repels termites);
- reduces weed growth with about 50%;
- greater fertilising value than farm yard manure or fresh dung.

Factors affecting the nutrient level of digested effluent:

- species, age and condition of the animal from which the dung is drawn;
- type of food fed to the animals;
- use of animal urine instead of water for mixing purposes;
- use of an attached toilet to the biogas plant;
- the way the effluent is stored, treated and applied to the field.

Effect of effluent compost on crop production:

- improved physical soil structure;
- increased soil fertility & water-holding capacity;
- enhanced activity of soil micro-organisms;
- 10-30 % increased cereal crop production (vs. farm yard manure);
- increased wheat (33 %) and maize (37 %) yields through the application of liquid effluent;
- increased wheat (67 %) and tomato (21 %) yields through compost application (versus non application);
- the most responsive crops to effluent compost are vegetables like root crops (carrots), potatoes, fruit trees and rice.

OBJECTIVES FEASIBILITY STUDY

Assess the feasibility to set-up and implement a national biogas programme in Rwanda.

More specifically, the study addresses the following areas:

- country background: 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;
- outline for a national programme on domestic biogas.

Activities

- Collecting secondary information;
- visit domestic biogas plants;
- meet farmers and key respondents;
- discuss the roles of different actors in Rwanda and the outline of a possible national biogas programme;
- formulation of draft study report and submission for comments to SNV and the Rwandan Government;
- submission of the final study report.

STUDY FINDINGS

Technical conditions

- Daily ambient temperature above 20°C throughout the year
  - *Biogas plants can operate in the whole country throughout the year*
- Daily availability of at least 20kg dung at a large number of farms
  - *Semi intensive cattle farming is common practice*
  - *Zero grazing is on the increase*
  - *Dung collection happens on a regular basis*
  - *In some cases cow dung can be supplemented with pig manure*
- Water availability: dung needs to be mixed with an equal amount of water and/or urine before feeding into a biogas plant
  - *At farms where stabling is practiced farmers have access to water*
  - *Often rainwater harvesting is introduced when stables are constructed*
  - *In Umutara province cattle is taken to watering points*

In 2002 some 300,000 households owned cattle. 200,000 of these households raise their cattle in a semi intensive way or practices zero grazing. 100,000 of these households collect at least 20 kg of dung on a daily basis. Add 10 % of livestock population increase and we can safely state that some 110.000 households have sufficient dung to operate a biogas plant.

Economic conditions

- Use of organic fertilizer is practiced and integrated farming systems are common
  - *Composting is common practise on most farms*
  - *The exception is Umutara province*
- Scarcity of traditional fuels like firewood and charcoal
  - *Government restrictions on firewood harvesting*
  - *Fuel-wood prices vary between 15 and 30 FRw/kg*
  - *The daily requirement for an average family is 10kg*
  - *Often firewood is supplemented by agricultural residues*
- Access to credit for farmers on reasonable terms
  - *250 micro finance access points*
  - *Most investments are in commerce*
  - *The number of agro-investments is low because:*
  - *The loan requirement for a biogas plant is around FRw 200.000*
  - *With a repayment period of 3 years, annual interest rates vary between 18-24 %*

Social conditions

- An active role of women in domestic decision making
  - *the man is the official household head*
  - *decisions seem generally to be taken in consultation with the partner*
- Role of women in livestock keeping and dung handling
  - *Stable cleaning, composting of manure and fetching water is usually the woman's chore*
  - *There are no obstacles for her to operate the plant*
  - *No barriers to participate in training programmes or to receive technicians on the farm*

Institutional conditions

- Political will to support a national biogas programme
  - *Study requested by the Minister for Energy & Communication*
  - *Province and district officials applaud the initiative*
  - *NGO's active in rural development projects expressed their interest*
- Existence of farmers unions
  - *300 active cattle farmers associations:*
  - *A large number of farmers participate in NGO initiated livestock development projects*

The findings are summarized in the following table:

Key Conditions for dissemination of Biodigesters	Observations & Findings
Technical Factors	
Even, daily temperatures over 20 ^{0}C throughout the year	+++
Full stabling of animals (zero-grazing) (cows & pigs)	++
At least 20 kg/day dung available per plant	++
Availability of water	+
Economic Factors	
Use of organic fertilizer is traditionally practiced	++
Scarcity of traditional cooking fuel, fuelwood & charcoal	+++
Dairy farming is the main source of income	+
Users have access to credit	-
Social Factors	
Role of women in domestic decision making process	+
Role of women in livestock keeping and dung handling	++
Participation of women in training programmes	++
Institutional Factors	
Political will from the Government to support a national biogas programme	+++
Existence of farmers associations like dairy cooperatives	++
Accessibility of farmers through NGO's	++

GROUP DISCUSSIONS

Presentations were followed by an introduction to a National Biogas Program

Objectives of a pilot biogas programme

The overall objective is to develop a commercial and structural deployment of biogas technology, resulting in the reduction of biomass resource depletion and a significant improvement in the quality of life of the families concerned.

Specific objectives:

- to develop a commercially viable and market oriented biogas sector;
- to increase the number of family sized biogas plants with 15000 (first phase of 4 years);
- to ensure the continued operation of all installed bio-digesters;
- to maximise the benefits of the operated bio-digesters (effluent use);
- technical and promotional capacity development;
- to strengthen and facilitate establishment of institutions for the continued and sustained development of the biogas sector.

Target group

Farmers having at least a daily amount of 15 kg of animal waste at their disposal. This amounts to the daily dung production of 2 average and stall fed head of cattle or 4 adult pigs.

GROUP DISCUSSIONS

After this brief introduction to the program the group discussions were introduced and conducted.

Questions for discussion

- Main constraints for national domestic biogas programme
- Possible actors per required function
- Possible programme organisation chart
- Required subsidy level

Methodology

- Introduction (10 min.)
- Group discussions (80 min.)
- Plenary presentations (flipchart, 10 min./group, 3 groups)
- Conclusion (30 min.)

Group discussions results

Results from the 3 groups were compiled per discussion point!

Main constraints for a national domestic biogas program

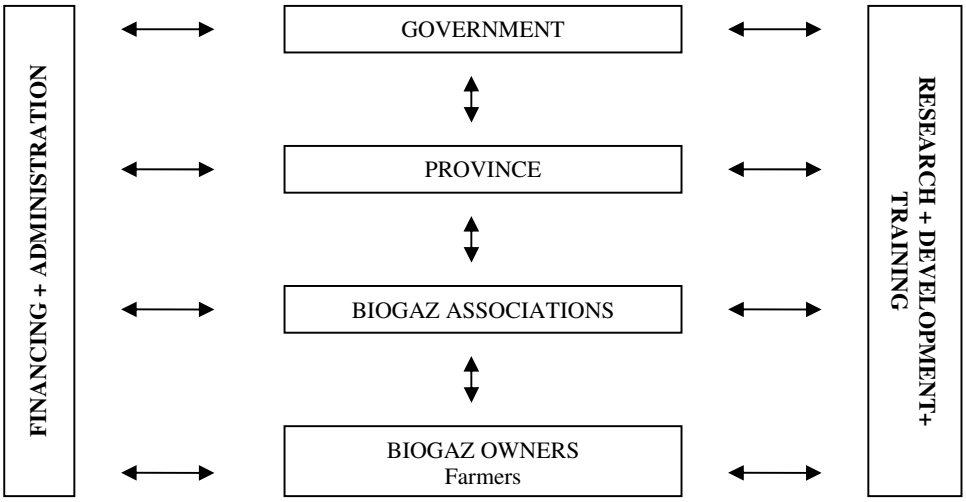
- New technology in Rwanda that requires an attitude change, people might not accept it directly (x3)
- A mentality change is needed: traditionally people practice extensive cattle keeping. Zero grazing is not well established yet because of restrictions in water availability, access to fodder for zero grazing and improved cattle breeds (x3)
- Credit limitations, access to credit. Few households have the required amount of money and biogas is not considered as an income generating activity (x3)
- It should be a community initiative, the population should be consulted
- Farmers are limited in number, it is difficult to find 15 kg of dung
- Difficult to find construction technicians
- Absence of an institute for monitoring
- Great government effort is needed,
- Lack of qualified extension/dissemination personnel
- No sufficient capacities in the rural setting to access the technology

Actors per required function

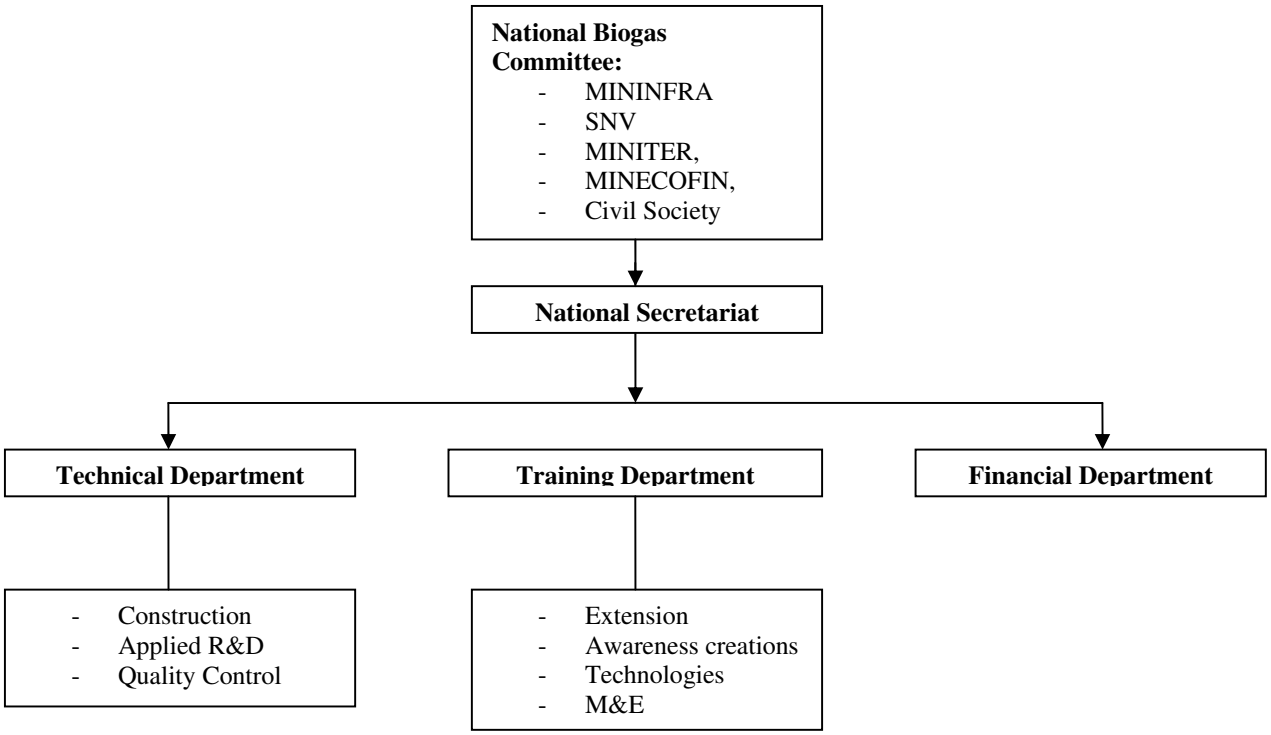
- Promotion: the State (x3), private sector, local NGOs (x2), beneficiaries, associations, civil society (x2)
- Construction: trained technicians, KIST, specialized and interested private enterprises (x2)
- Credit: banks (x2) with donor support, micro finance institutions (x2), NGO, the State
- Administration: a committee of associations, an independent coordination desk, administrative council
- Quality control: IRST, KIST (x2), SNV, ministries, technical department
- Training of trainers: MININFRA, SNV (x2), consultants
- Extension: MININFRA, public sector, civil society (x3), private sector
- R&D: KIST (x3), IRST (x2), ISAE, the State
- M&E: MININFRA, SNV (x2), KIST, donors, banks, external editor
- Coordination at implementation level: local authorities, bureau de coordination (MININFRA, SNV, MINITER, MINICOFIN)
- Coordination at national level: MININFRA (x3), SNV

Possible programme organisation charts

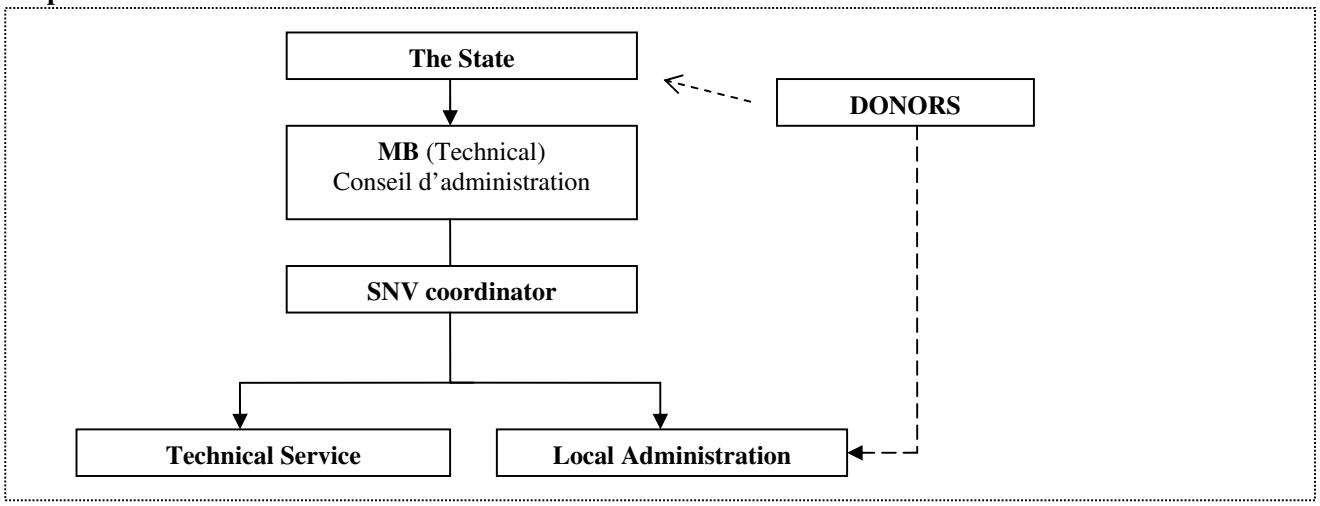
Proposal 1



Proposal 2



Proposal 3



Required subsidy level

- 70 %
- 80 %
- Farmer delivers animals, builds stable and provides manpower while all the rest is to be provided by organizations involved.

QUESTIONS

- In Tanzania, 1000 biogas plants have been built over a period of 10 years while we want to put 15000 in 4 years in Rwanda. Aren't we too ambitious? *No, since the Tanzanian program took the technology on center stage, while this program will focus on the client in developing a vibrant sector*
- Total cost of the program? *Overhead limited to 25 % of the total construction cost*
- Definition of final setup? *Will be done in the next step*
- Input partners in draft feasibility study report? *Would delay us too much, inputs will be taken into account in the elaboration of the final program plan/document.*

CONCLUSION AND CLOSING REMARKS

A brief was given on the future steps to undertake:

- Internal meeting SNV-Ministry
- June 2005: mission report containing recommendations
- When the recommendations are accepted, a memorandum of understanding to start a biogas program will be signed (MININFRA – SNV) and a biogas expert will be recruited
- October 2005, a program implementation plan will be ready and a tripartite agreement can be signed (MININFRA - SNV - donor)
- By December 2006, 500 plants will be operational in 1 or 2 provinces
- 2007 – 2010: national implementation: 15000 biogas plants constructed

PARTICIPANTS

Name	Organisation	Designation	Contact
1. RUBAKISIBO James	LWF RWANDA	Gitarama Project Manager	562759 lwf-git@rwanda1.com
2. NKOMATI J Willis	Province Kigali Ngali	Agri and Animal resources	08859726
3. Fiacre MUREKEZI	Rwanda Microfinance Forum	Secrétaire Exécutif	08427846 rmforum@yahoo.fr
4. Shema Xaverine	PROFEMME T.H.	Présidente KIGALI	08530444 cookercolarwanda@yahoo.fr
5. NTAHOBARI Japhet	ASS. ZIRAKAMWA	Président RUHENGERI	08670430 dufatucam@yahoo.fr
6. BAGABO Eriazel	HEIFER INT. RWANDA	FIN/ADMIN HPI RWANDA	08474871 bagabobea@yahoo.com
7. AINEA KIMARO	KIST	Consultant	08562165
8. MUKAMA Léopold	Fédération du Secteur privé	Consultant	08307851 leopmuka@yahoo.fr
9. Yvette MUKARWEMA	Fédération du Secteur Privé	Dép. Appui aux associations	yvetterwema@yahoo.fr
10. KASAIJA Vincent	LWF	Projetct Manager	084141786 kib@rwanda1.com
11. UWIMANA P.Claver	Province GITARAMA	Environnement et Forêts	08481202
12. NYIRABAHIRE Vénantie	Province GITARAMA	V/P Butare	08524570
13. Nathalie Schager	Student		nvshagen@hotmail.com
14. MUKWIYE Martin	Province KIBUNGO	Environnement et Forêts	08444410 – 08444420
15. BAZIGA Joseph	Province GITARAMA	Vétérinaire Ville Gitarama	08620238
16. RUTAGANDA Védaste	AEBTP	S/Exéc. De AEBTP	08533335 vrutaga.da@yahoo.fr
17. MUKABUKURU Goretti	PROFEMME T.H.	Région Nord Est	08836101
18. NYIRANKUNDIZANYE Thaciana	PROFEMME T.H.	Région Nord Ouest	08470220 nkundizanye@yahoo.fr
19. MUKANKUSI Julienne	PROFEMME T.H.	Secrétariat Ex. National	08864087/518480
20. KAMANZI François	Province GISENYI	Directeur Unité Dévelop.	08511428
21. TUMWINE Alphonsine	Gako Organic Farming T.C.	Director Training Centre	08471083/08306668
22. NDENGEYINKA J.B.	Gako Organic Farming T.C	Training Officer	08877800
23. IYIKIRENGA M.Remy	U.C.T.	Chef de Dép. Operation et Trans.	08566757 renza@yahoo.fr
24. HABYARIMANA Gilbert	Bureau d'appuji aux initiatives rurales	Chargé de Prgramme Microfinance	08648471 haberimana@yahoo.fr
25. RWIBOGORA Manasseh	FRSP kigali Ngali	Comité	08510360
26. UWAMARIYA Julienne	SNV RWANDA	Coordinatrice de Programme	08305944 julienne.uwamaria@snv.co.rw
27. RUZIGANA Silas	MININFRA	Département Energie	08434030 ruziganasi@yahoo.fr
28. HAKIZIMANA Cyprien	IRST BUTARE	Chef Dép. de recherche en energie renouvelable	08512492 hakizacyp@yahoo.fr
29. TUYISENGE Vénéranda	CLEAM IRAMIRO	Comptable	08498505/563053/562173
30. RWIGEMA Alfred	New Energy Technology	General Manager	08838522 arwigema@hotmail.com
31. KAYUMBA Charles	Heifer International	Country Director	085004808 kayumbachar@yahoo.com
32. Guy Dekelver	SNV Rwanda	NRM advisor	08679867 guy.dekelver@snv.co.rw
33. Jan Lam	SNV Biogas Practise Team	Senior Biogas Advisor	+31 (0)6 30832478 jlam@snv.nl

ANNEX 5 COST CALCULATION 6 m^3 GGC2047 PLANT

	Unit	Qnt	FRw	US$	FRw	US$
A Construction Materials						
Bricks/Stone	pcs	1400	39	0,07	53900	98,0
Sand	cum	2,1	1650	3,00	3465	6,3
Gravel 1x2	cum	1,1	3520	6,40	3696	6,7
Reinforcement rod (8mm)	kg	10,5	413	0,75	4331	7,9
Cement	bag	10	6765	12,30	67650	123,0
Sub Total Construction mat					***133042***	***242***
B Unskilled Labour Cost						
Labours	days	15	1100	2,00	16500	30,0
Sub Total Un Skilled						***30***
C Pipes and Fittings						
GI pipe (21mm dia.)	meter	25	1210	2,20	30250	55,0
PVC pipe (100mm dia.)-outlet	meter	2	1238	2,25	2475	4,5
GI pipe fittings 21 mm	pcs	12	413	0,75	4950	9,0
Sub total Pipes					***37675***	***69***
D Appliances Cost						
Stove	set	1	8250	15,00	8250	15,0
Mixer	set	1	5500	10,00	5500	10,0
Paint	litre	1	1320	2,40	1320	2,4
Inlet Pipe	meter	4	770	1,40	3080	5,6
Dome gas pipe	pcs	1	2750	5,00	2750	5,0
Main Valve: SANWA	pcs	0	2750	5,00	2750	5,0
W/Drain	pcs	1	1210	2,20	1210	2,2
Gas Tap	pcs	1	1815	3,30	1815	3,3
Rubber hose pipe	meter	1	220	0,40	220	0,4
Sub total Appliances					***26895***	***49***
E Construction Charge						
Construction	days	8	3300	6,00	26400	48,0
Pipe Installation	days	2	3300	6,00	6600	12,0
Sub total Construction					***33000***	***60***
Fees and Charges					***13750***	***25***
GRAND TOTAL					***260862***	***474***

1 U$ = 550 FRw
1 bag = 30 l = 0.03 cum

ANNEX 6 TENTATIVE PROGRAMME BUDGET DETAILS

Programme Management

	2005	2006	2007	2008	2009	2010	
	Preparation phase (start Oct. 2005/15 months)		Implementation phase				
Year	0	I	II	III	IV	V	**Total**
Estimated production		500	1100	2200	4000	7200	15000
No. of provinces involved	0	2	12	12	12	12	
Promotion & marketing	5000	7500	10000	10000	10000	10000	52 500
Quality control		2 500	4 400	6 600	8 000	10 080	31 580
R&D and standardization	30 000	35 000	20 000	15 000	15 000	15 000	130 000
Effluent programme (R&D, extension, training)	5 000	15 000	30 000	30 000	30 000	30 000	140 000
Training	4 000	36 580	51 220	43 580	94 240	187 580	417 200
Monitoring and evaluation	0	5 000	15 000	15 000	15 000	15 000	65 000
Institutional support	9 000	9 000	9 000	9 000	9 000	9 000	54 000
Programme Management National BPO	55 899	232 411	207 411	207 411	207 411	205 655	1 116 197
External evaluation		30 000			30 000		60 000
Sub - Total in US$	108 899	372 991	347 031	336 591	418 651	482 315	**2 066 477**

Promotion and marketing budget breakdown

2005	2006	2007	2008	2009	2010	
Preparation phase		Implementation phase				
(start Oct. 2005/15 months)						
0	I	II	III	IV	V	**Total**
5000	7500	10000	10000	10000	10000	**52500**

Quality control budget breakdown

	2005	2006	2007	2008	2009	2010	
	Preparation phase		Implementation phase				
	(start Oct. 2005/15 months)		0				
	0	I	II	III	IV	V	Total
	Percentage QC	25%	20%	15%	10%	7%	
Production		500	1100	2200	4000	7200	15000
Total no inspections		*125*	*220*	*330*	*400*	*504*	*1579*
Cost per digester		20	20	20	20	20	
Total		**2500**	**4400**	**6600**	**8000**	**10080**	**31580**

Research, development, standardization budget breakdown

	2005	2006	2007	2008	2009	2010	
	Preparation phase		Implementation phase				
	(start Oct. 2005/15 months)						
	0	I	II	III	IV	V	**Total**
Standardisation	10 000	10 000	7 500	5 000	5 000	5 000	42 500
Plant R&D	10 000	15 000	5 000	5 000	5 000	5 000	45 000
Appliance R&D	10 000	10 000	7 500	5 000	5 000	5 000	42 500
Total	**30 000**	**35 000**	**20 000**	**15 000**	**15 000**	**15 000**	**130 000**

Training budget breakdown

		2005		2006		2007		2008		2009		2010			
		Preparation phase			Implementation phase										
		0		I		II		III		IV		V		Total	Total
	Rate per Trg	#	Cost	#	Cost	#	Cost	#	Cost	#	Cost	#	Cost	#	Cost
	US$		2		2		10								
Programme staff National BO					6000		6000		6000		6000		6000		30000
Study visit main stakeholders Np	12000				12000										12000
Programme staff Provincial Dev Com	2000		4000		4000		20000		0		0		0		28000
Mason	25		0	100	2500	220	5500	360	9000	1680	42000	3900	97500	6260	156500
Mason refresher	25			0	0	100	2500	220	5500	360	9000	640	16000	1320	33000
Supervisor	30		0	20	600	44	1320	72	2160	336	10080	780	23400	1252	37560
Supervisor refresher	30			0	0	20	600	44	1320	72	2160	336	10080	472	14160
Management companies	60			8	480	40	2400	40	2400	40	2400	40	2400	168	10080
Bank staff	20			20	400	60	1200	60	1200	60	1200	60	1200	260	5200
Technician training	150		0	4	600	16	2400	36	5400	36	5400	36	5400	128	19200
NGO staff	25		0	20	500	20	500	20	500	20	500	20	500	100	2500
Government staff	25		0	20	500	20	500	20	500	20	500	20	500	100	2500
User training	3			500	1500	1100	3300	2200	6600	4000	12000	7200	21600	15000	45000
Curriculum Development	lumpsum				7500		5000		3000		3000		3000		21500
Total			**4000**		**36580**		**51220**		**43580**		**94240**		**187580**		**417200**

Programme management National Biogas Programme Office budget breakdown

	Point of view	Monthly unit cost	2005	2006	2007	2008	2009	2010	
			Preparation phase		Implementation phase				
	salary + 35% taxes		(start Oct. 2005/15 months)						
			0	I	II	III	IV	V	Total
Salary nation coordinator		200		2 400	2 400	2 400	2 400	2 400	12 000
Salary programme coordinator	1800	1333	5 399	21 595	21 595	21 595	21 595	21 595	113 372
Salary administrator	1238	917		14 855	14 855	14 855	14 855	14 855	74 277
Salary sen. technician	1238	917		14 855	14 855	14 855	14 855	14 855	74 277
Salary effluent specialist	1238	917		14 855	14 855	14 855	14 855	14 855	74 277
Salary QM officers (3)	1125	833		40 484	40 484	40 484	40 484	40 484	202 419
Salary data officer	900	667		10 805	10 805	10 805	10 805	10 805	54 027
Data entry	563	417		6 755	6 755	6 755	6 755	6 755	33 777
Salary office assistant	338	250		4 050	4 050	4 050	4 050	4 050	20 250
Salary driver	563	417		6 755	6 755	6 755	6 755	5 000	32 022
Purchase computer		0	5 000	10 000	1 500	1 500	1 500	1 500	21 000
Purchase car	25000		25 000						25 000
Vehicle running cost	12000			10 000	10 000	10 000	10 000	10 000	50 000
Purchase motorbikes	3 units			10 000					10 000
Motor bike running cost				6 000	6 000	6 000	6 000	6 000	30 000
Office utilities	7024	500	1 500	3 000	3 000	3 000	3 000	3 000	16 500
Furniture	667		1 000	5 000	2 000	2 000	2 000	2 000	14 000
Office rent		1000	6 000	12 000	12 000	12 000	12 000	12 000	66 000
Communication			3 000	6 000	6 000	6 000	6 000	6 000	33 000
Other office cost			4 000	4 000	4 000	4 000	4 000	4 000	24 000
Computer consultant				5 000	1 500	1 500	1 500	1 500	11 000
TADA/NBO staff			5 000	20 000	20 000	20 000	20 000	20 000	105 000
Annual audit	4000/year			4 000	4 000	4 000	4 000	4 000	20 000
			55 899	**232 411**	**207 411**	**207 411**	**207 411**	**205 655**	**1 116 197**

ANNEX 7 TECHNICAL ASSISTANCE BUDGET DETAILS

	2005	2006	2007	2008	2009	2010	
	Preparation phase (start Oct. 2005/15 months)		Implementation phase				
Year	0	I	II	III	IV	V	**Total**
International TA SNV	50 000	160 000	160 000	160 000	160 000	160 000	850 000
Flex SNV Advisors	15 000	25 000	25 000	25 000	25 000	25 000	140 000
Sub-total cost (US$)	65 000	185 000	185 000	185 000	185 000	185 000	**990 000**

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