



# Report on the Initial visit

for a

## Biogas Support Programme in the Republic of Rwanda

Jan Lam

**March 2005**

## **I Summary of findings**

- The need for domestic energy and fertilisers in the present rural household situation is identified as the main prospect to further the dissemination of biogas in Rwanda.
- An ever increasing population results in a growing demand for firewood and the consequent depletion of forest resources makes access to fuel wood depletion of forest resources and the growing demand will make access to fuel wood increasingly difficult.
- A high percentage of rural households are small farmers who are using the dung produced by their animals for fertilising their soil.
- The technical conditions in Rwanda, like soil texture and temperature, are very well suited for anaerobic digestion, however, in some regions the availability of water can be a constraint.
- Fixed dome biogas technology is well introduced in Rwanda and reasonably documented. With some minor modifications and adjustments, this technology can be used for widespread dissemination.
- Among the visited organisations in Rwanda who have biogas related activities, there is willingness to establish a national programme along the same lines as the Nepal programme.
- In the rural areas the presence of entrepreneurs is limited. However, there are many organisations active such as, dairy cooperatives and other farmers associations. Furthermore, there are numerous permanent rural development organisations like church based institutions. Such organisations can play a crucial role in the introduction of the technology.

## **II Conclusions**

- Given the above mentioned findings, the execution of an in-depth feasibility study to explore the possibilities to establish a market oriented, commercially viable biogas sector is recommendable.
- In line with the arrangements made between SNV Rwanda and the Ministry of Infrastructure, this study should take place in April 2005. The study team will be comprise of the head of the biomass section of the Ministry, the Natural Resources Management advisor of SNV Rwanda and a member of the Biogas Practice Team.
- The Department of Energy and Communications under the Ministry of Infrastructure might be the most suitable lead organization for a national programme. Linkages with other Government organizations and NGO's need to be further identified and established.
- The costs and efforts to establish a national biogas programme are only justifiable if the potential market for domestic biogas plants is sufficiently large. Therefore the study should establish if there is enough potential to realise 10,000 plants over a 5 year period.

### III Content

I	Summary of Findings	2
II	Conclusion	2
III	Content	3
IV	Abbreviations and Acronyms	3
1.0	Introduction	4
1.1	Objectives	4
1.2	Methodology	4
2.0	Position/Justification of an SNV/Rwanda Biogas Programme	4
3.0	Rural Population Characteristics	5
3.1	Household Energy Situation	5
3.2	Potential Number of Beneficiaries	6
4.0	Experiences with Biogas in Rwanda	6
4.1	History	6
4.2	Current State of Affairs	6
4.2.1	Centre for Innovations and Technology Transfer	6
4.2.2	Institut de Recherche Scientifique et Technologique	7
4.2.3	Ministry of Infrastructure	7
5.0	Technical Factors	9
5.1	Dung Availability	10
6.0	Social Factors	10
7.0	Overview of Key Conditions	11
8.0	Conclusions and Recommendations	11
Annexes		

### IV Abbreviations and acronyms

BORDA	Bremen Overseas Research and Development Association
BPO	Biogas Programme Office
BPT	Biogas practice Team
CDM	Clean Development Mechanism
CITT	Centre for Innovations and Technology Transfer
DED	German Development Service
DGIS	General Directorate International Cooperation
DNA	Designated National Authority
FAO	Food and Agricultural Organization
GTZ	German Technical Cooperation
HRT	Hydraulic Retention Time
ICS	Improved Cooking Stove
INGO	International Non Governmental Organization
IRST	Institut de Recherche Scientifique et Technologique
KIST	Kigali Institute of Science Technology & Management
MFI	Micro Finance Institution
MoU	Memorandum of Understanding
NGO	Non Governmental Organization
NPK	Nitrogen (N), phosphorus (P) and potassium (K)
NRM	Natural Resource Management
R&D	Research and Development
RE	Renewable Energy
RET	Renewable Energy Technology
SHS	Solar Home System
SNV	Netherlands Development Organization
UNDP	United Nations Development Programme

## **1.0 Introduction**

Besides programmes in Asia, SNV aims to set-up a large-scale programme for domestic biogas in one maximum 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 of Energy and Communications, during the Energy for Development conference in Noordwijk in December 2004. Another request was made by Mr. Guy Dekelver, 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. To quickly assess the possibilities of a national biogas programme, it was decided that a member of the Biogas Practice Team (BPT) of SNV would pay an initial visit to Rwanda. This document presents the outcome of this initial visit.

### **1.1 Objectives**

The overall objective of the mission is to make an inventory of the present activities on household biodigester development and dissemination in Rwanda and to give recommendations on the possibilities to set-up and implement a national domestic biogas programme.

### **1.2 Methodology**

The methodology used consisted of two activities: (1) Data collection from studies, reports and databases, (2) interviews with –potential- stakeholders.

## **2.0 Position/Justification of an SNV/Rwanda Biogas Programme<sup>1</sup>**

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.

In its strive to improve governance and reduce poverty in the Republic of Rwanda, the setup of a biogas support program is a valuable intervention for SNV Rwanda. It contributes to reaching the MDG 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 GHG emissions, conserve local resources, reduce pressure on the local environment, provide improved health and other environmental benefits).

---

<sup>1</sup> This paragraph is contributed by the NRM Advisor of SNV Rwanda

### 3.0 Rural Population Characteristics

Of a total population of 8,160,000 inhabitants, 83% or 6,800,000 people live in rural areas. With an average household size of 4.5 persons, this means that about 1,510,000 households are populating the rural areas.

Farming and other agricultural sector professions occupy the bulk of the active population in Rwanda, in the rural areas 95% of the economically active population is listed as 'farmers and qualified labourers'.

Almost 80% of the persons active in the agricultural sector are self-employed while most of the remaining 20% fall into the category of unpaid family workers. This indicates that almost all households are small peasant farmers.

(source: 3<sup>rd</sup> census of population and housing, National Census Service)

### 3.1 Household Energy Situation

Lighting:

Over 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.

Cooking:

Firewood and charcoal are in the rural areas practically the sole providers for cooking energy. Firewood is covering 90.4% of the demand and charcoal 7.4%. The remaining 2.2% is mainly covered by agricultural residues.

Even in the urban areas firewood and charcoal are by far the main sources of energy. Firewood is used by 52% of the urban households and charcoal by 39.5%. Other sources in the cities are gas and kerosene.

This dependency on firewood and charcoal creates an unsustainable situation as the demand largely surpasses the production as is shown in the table below.

	1960	1970	1980	1990	1996	1999	20000	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 prod. (1000 m3)	368	407	1200	3713	2790	2268	2261	2261
Wood demand (1000 m3)	2695	3763	4832	7158	6784	7882	8249	8979
Balance (1000 m3)	-2327	-3356	-3632	-3445	-3994	-5614	-5987	-6719

(Source: Institut de Recherche Scientifique et Technologique)

The government is trying to curb the rate of deforestation a.o. by banning the felling of trees without a permit. This rule applies to all trees including privately owned production forest. However, it is not clear how this measure will help without the availability of energy alternatives and fuel efficient woodstoves.

### **3.2 Potential Number of Beneficiaries**

As indicated in the table on national livestock population, there is a large and growing national livestock herd. However, during the short visit no figures were obtained on the distribution of the national livestock herd over the rural households. Also there are no data yet on the livestock rearing practices, particularly for cattle and pigs, and on the daily quantity of dung which is or can be collected by individual households.

Therefore a feasibility study for a national biogas programme must focus on this aspect. To make a national programme worth while, at least 10.000 families should be reached over an initial 5 year period.

## **4.0 Experiences with Biogas in Rwanda**

### **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 20m<sup>3</sup> at the 'Projet Developpement 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, at the end of 1990 some hundred domestic biogas plants of the fixed dome model must have been constructed. However, where they were constructed and by whom is not mentioned.

### **4.2 Current State of Affairs**

There are no programmes ongoing aimed at the dissemination of domestic biogas plants in Rwanda at a larger scale. During the initial visit 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 Technology and Management (KIST). This institute was established in 1997 as Rwanda's first technological institute of 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 PV 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. These systems range in size from 75 m<sup>3</sup> to 1000 m<sup>3</sup> and are primarily meant for treatment of the prison's waste. Also a smaller 35 m<sup>3</sup> plant has been constructed at the site of a 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 (N.P.K.) 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 Lake Kivu, rural electrification through SHS's and micro-hydro plants.

At the 10m<sup>3</sup> 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 further the use of plants at schools and it is working together with the Ministry of Education to achieve this goal but a concrete programme has not yet been developed.

According to the institute, the cost of a small brick made fixed dome plant is about RWF 90,000 per m<sup>3</sup>. The conversion rate of the Rwandese Franc to the Euro is about 700.

#### **4.2.3 Ministry of Infrastructure**

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

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 are civil servants, engineers and technicians, working for schools, hospitals, prisons and army camps in the provinces. The idea behind this selection procedure is that the participants will gain the technical know-how and become motivated to introduce biogas technology at their working environment.

Besides the two domestic plants, one 100 m<sup>3</sup> 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

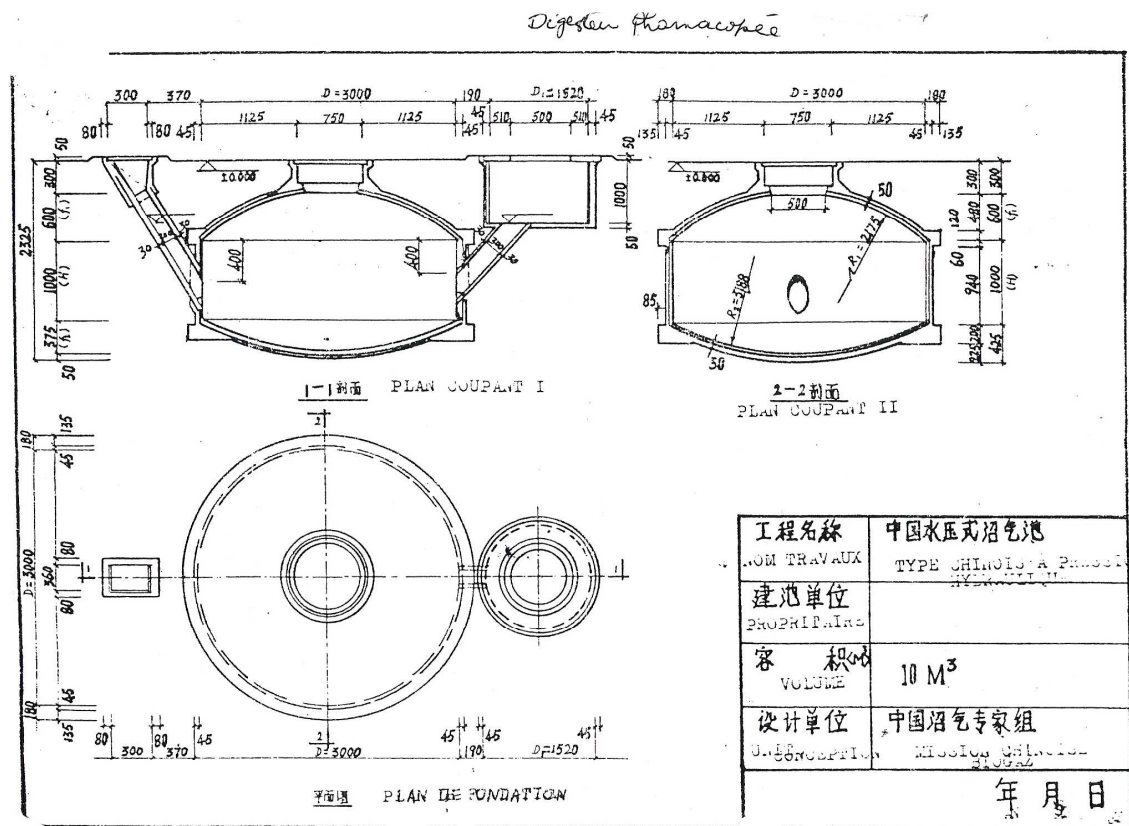
The Minister of State for Communications and Energy is of the viewpoint that enough technical know-how on domestic biogas plants is available and that further research is not required. Much more it is now time to use this know-how to start with the mass dissemination of the technology among the rural population. To this extent the Minister has invited SNV Rwanda to conduct a feasibility study regarding the possibilities to initiate a domestic biogas programme (see annex 3).

SNV Rwanda has replied favourably to this letter with the remark that this study will be the joint effort of SNV Rwanda, the Ministry and the SNV Biogas Practice Team (see annex 4)

### 5.0 Technical Factors

Predominantly brick made fixed dome model has been introduced in Rwanda. This seems to be a logical choice given its reliability, its replicability and cost vs. floating drum models.

The Chinese model used by IRST and the Ministry of Infrastructure is shown below



Temperature wise, plants can be constructed throughout the country. At higher and therefore colder altitudes it might be necessary to use a longer hydraulic retention time of the dung in the digester.

There are no occurrences of flooding but in some regions the availability of water can pose a problem.

To curb the excessive firewood use, the government has posed a ban on the use of traditional field brick kilns. As an alternative cement and lime bricks can be used but it is not yet established whether these bricks are suitable for the dome construction of a biogas plant.

## 5.1 Availability of dung

The table below gives the national livestock population growth over the last 5 years.

	2000	2001	2002	2003	2004
cattle	755.123	814.124	960.450	991.697	1.003.721
pigs	177.220	197.081	207.783	211.918	226.652
goats	756.502	916.753	919.785	1.270.903	1.263.962
sheep	232.724	266.539	300.600	371.766	469.979
fowls	1.277.706	1.055.644	2.432.449	2.482.124	2.841.399
rabbits	338.616	495.290	488.629	498.401	520.057

(source: Ministry of Agriculture)

Cattle and pigs are the most likely sources for dung to be used in domestic biogas plants. They both show considerable growth figures over the past years.

As observed in paragraph 2.0, most of the rural population consists of small farmers. Most farmers are agriculturists who also have cattle for milk and beef production. The use of cattle for draft power is rare. Further information is needed on the distribution figures of the national herd over the farming households and on dung gathering & composting practices.

## 6.0 Social Factors

There are no indications that biogas generated from cow dung will not be widely accepted as cooking fuel.

There is no information yet on the role of women in the domestic decision making process. Women, however, play an important role in the daily farming activities, both in agriculture as well as in livestock keeping. There are no cultural barriers for women to host biogas technicians at the farm or to participate in biogas awareness activities and plant operation training programmes

## 7.0 Overview of Key Conditions

Key Conditions for dissemination of Biodigesters	Observations & Findings
<b>Technical Factors</b>	
Even, daily temperatures over 20 <sup>0</sup> C throughout the year	+++
Full stabling of animals (zero-grazing) (cows & pigs)	?
At least 20 kg/day dung available per plant	?
Availability of water	+/-
<b>Economic Factors</b>	
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	++
<b>Social Factors</b>	
Role of women in domestic decision making process	+
Role of women in livestock keeping and dung handling	++
Participation of women in training programmes	++
<b>Institutional Factors</b>	
Political will from the Government to support a national biogas programme	+++
Existence of farmers associations like dairy cooperatives	+/?
Accessibility of farmers through NGO's I	++
CDM	Not yet relevant

## 8.0 Conclusions and Recommendations

The pressures on traditional fuel sources as well as the degradation of arable land make the large scale dissemination of domestic biodigesters a wanted development.

However no hard figures could be extracted during the initial mission on the availability of dung and water at a large number of farms. In regions like Umutara, ample cattle dung is available but water might be a problem. In other regions the inverse situation can exist. A feasibility study must focus on this matter.

An in-depth feasibility study to explore the possibilities to establish a market oriented, commercially viable biogas sector is recommended.

The scope of the feasibility study shall include:

- Assessment of the national potential, both technically and financial-economically, for the construction of domestic biogas plants.
- Assessment of the constraints for domestic biogas dissemination.
- An outline for a national programme on domestic biogas including construction targets and provisional budget for a five year period.
- Verification and assessment of the Ministry of Infrastructure as the most suitable candidate to coordinate a national domestic biogas programme.

- Verification of the current biogas technology in Rwanda and propose a technology most suitable for mass dissemination.
- Conduct an Institutional Analysis Workshop with potential stakeholders with the objective to identify roles and responsibilities.
- A debriefing to relevant stakeholders with the objective to share findings of the feasibility study and to have consensus on a long term National Biogas Programme for mass dissemination of domestic biogas.

## ANNEXES

### ANNEX I Programme for the initial visit

Date	Activities, meetings
February 27-28	– Travel to Kigali
February 28 Afternoon	– Mr. Ainea Kimaro, Advisor to the Centre for Innovations and Technology Transfer – Field visit to 35m <sup>3</sup> biogas plant installed at NGO 'Send a Cow' training site
March 1	– Minister of State for Communications and Energy, H.E. Albert Butare – SNV Rwanda Portfolio Managers – Ministry of Finance and Economic Planning, National Census Service – Royal Dutch Embassy, Mme. Anthe Vrijlandt – Guy Dekelver, NRM Advisor SNV Rwanda
March 2	– Travel to Butare – IRST, Prof. Fidèle Rurihose – Travel back to Kigali
March 3	– Mr. Silas Ruzigana, Head of Biomass Section Ministry of Infrastructure – Mme. Françoise Murorunkwere, Ministry of Agriculture – Minister of State for Communications and Energy, H.E. Albert Butare
March 4	– Travel to Amsterdam
March 5	– Travel to Amsterdam (one day delay due to bad weather in AMS)

## **ANNEX II Terms of Reference**

### **Initial visit to Rwanda to assess the possibilities of a national domestic biogas programme**

#### **1. Introduction and background**

Besides programmes in Asia, SNV aims to set-up a large-scale programme for domestic biogas in one maximum 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 of Energy and Communications, during the Energy for Development conference in Noordwijk in December 2004. Another request was made by Mr. Guy Dekelver, 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. To quickly assess the possibilities of a national biogas programme, it was decided that Mr. Jan Lam, member of the Biogas Practice Team (BPT) of SNV would pay an initial visit to Rwanda following his participation of the FINESSE workshop organised by the African Development Bank in Tunis on 23 and 24 February 2005. This document presents the Terms of Reference (ToR) for this initial visit.

#### **2. Objective of the visit**

The objective of the visit is to quickly assess the possibilities to set-up and implement a national domestic biogas programme in Rwanda.

#### **3. Activities and methodologies**

The following activities and methodologies are proposed:

- A. Meetings with key-respondents and informants from among others the following institutes:
  - Ministry of Energy, possibly also with Mr. Albert Butare, the current Minister of Energy;
  - Kigali Institute for Science and Technology (KIST);
  - Centre for Innovations and Technology Transfer (CITT);
  - Royal Netherlands Embassy (RNE);
  - Netherlands Development Organisation (SNV).
- B. Visit to some biogas plants constructed by various institutes or projects.

#### **4. Time schedule**

The visit to Rwanda shall be conducted from 28 February up to 3 March 2005 (four days). The draft visit report shall be submitted before 9 March 2005. SNV/Rwanda and members of the BPT will provide within two working days comment on the draft report. After that, the final visit report will be presented within five working days.

#### **5. Budget**

The costs of this study will mainly consist of expenses for travelling and DSA of Jan Lam and possibly some local expenses. All costs will be borne by the SNV budget for the up-scaling of domestic biogas.

## **6. Expected output**

The report on the visit shall be clearly written not exceeding 10 pages excluding annexes and provide informed recommendations on the possibilities for SNV to set-up a national biogas programme in Rwanda.

## **7. Further arrangements**

The BPT member, Mr. Jan Lam, 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.

Wim J. van Nes  
Leiden, 25 February 2005

**ANNEX III** Scan of letter Ministry of Infrastructure (410/S/B.B&C/05)



**MINISTRY OF INFRASTRUCTURE**  
**P.O. BOX 24 KIGALI**

Mr Gerard Nieuwe Weme  
Regional Director  
SNV East&South Africa  
**KIGALI**

Dear Sir,

**Re : SNV Proposal for technical assistance**

Following our discussions on Tuesday 01 March 2005 regarding the possibility of initiating family based biogas programme in the country, I kindly request your support in providing technical expertise from the Netherlands/SNV that will help conduct a feasibility study of the said program.

Please accept my sincere gratitude for the existing cooperation between the Government of Rwanda and the Dutch Government and I am looking forward to your favourable response.

Yours Sincerely,

Eng. Albert BUTARE  
Minister of State in charge  
of Energy and Communications

Cc:  
Honourable Minister of Infrastructure  
KIGALI



**ANNEX IV:** Reply of SNV Rwanda to MoI

Hon. Eng. Albert BUTARE  
Minister of State in Charge  
of Energy and Communications

Date: 10 March 2005  
Reference: RW-05/8.RPG/202  
Subject: Biogas Programme

Dear Sir,

It is with a great pleasure and honour that we reply favourably to your reply for technical expertise in conducting a feasibility study on the possibility of initiating a family based biogas programme in Rwanda.

The feasibility study is planned for April probably starting on 4<sup>th</sup> April. As agreed during our Thursday 03/03 meeting, Silas Ruzigana from your Ministry will be the contact person and will be part of the team made up by Jan Lam and Guy Dekelver from SNV. This team will carry out the feasibility study. We hope that Silas will be available for that period.

Any other suggestion is welcome.

Looking forward to our cooperation, I send you my kindest regards.

For Gerard Nieuwe Weme  
SNV Regional Director

Emmanuel Ruzibiza  
Portfolio Coordinator  
SNV East and South Africa  
Rwanda