Mission Report on Design Selection of Domestic Biogas Plant for the Uganda Domestic Biogas Programme

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June 2009

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ABBREVIATION

ABC	: Arusha Bio-Contractors Company Ltd
ABPP	: African Biogas Partnership Programme
AEATREC	: Agricultural Engineering and Appropriate Technology Research Center
BGP	: Biogas Plant
CAMARTEC	: Centre for Agricultural Mechanisation and Rural Technology
DGIS	: Directorate General for International Cooperation
GHG	: Green House Gas emissions
HH	: Household
HIVOS	: Humanist Institute for International Development Cooperation
HIU	: Heifer International Uganda
HRT	: Hydraulic Retention Time
M&E	: Monitoring and Evaluation
NARO	: National Agricultural Research Organization
PID	: Programme Implementation Document
QC	: Quality Control
R&D	: Research and Development
REO	: Renewable Energy Option Ltd
SNV	: Netherlands Development Organisation
USh	: Uganda Shilling
ToR	: Terms of References
UBCA	: Uganda Biogas Constructors Association
UBPO	: Uganda Biogas Programme Organisation
USD	: United States Dollar

ACKNOWLEDGEMENT

The final success of the mission in selecting the most appropriate domestic biogas digester design and the range of sizes for the Uganda Domestic Biogas Programme was only possible thanks to the received assistance and advice from the various professionals involved in the Uganda Biogas Sector.

Some words of special thanks to Ms. Patience Turyareeba, Biogas Advisor with SNV Uganda and to the retired but not yet tired veteran of the Uganda Biogas Sector Mr. Christopher Kato. They made it possible for the mission to meet with a number of main biogas actors situated in Kampala, organised various field visits to a good number of farmers whom are using different designs of biogas digesters and they took care for all the logistics before and during the Constructors Workshop. All in all, they contributed to the effectiveness of this mission and provided additional feedback and deeper insights in the Ugandan Biogas Sector.

Sincere acknowledgements are due to Mr. Athanasius Beinempaka and Mr. Patrick Nalere of Heifer International Uganda, Mr. George Nyakairu of the Chemistry department of the Makarere University and to Mr. Saasa A. Richard and Mr. Okurat Samuel of Agricultural Engineering and appropriate Technology Research Center (AEATREC) which is under the National Agricultural Research Organisation (NARO) whom all provided their time, experiences and views while visiting their respective offices and during the field visits to farmers with biogas plants constructed by their institutions.

The mission highly appreciated the general warm welcome by the Ugandan farmers whom we were able to meet while visiting the biogas plants. They eagerly shared their views, challenges and perceptions of the daily use of the biogas plants which helped us to better understand their daily energy needs and patterns and daily operation of the biogas plants.

All the participants during the Constructors' Workshop are thanked for their time and active and lively contributions. The outcome of this workshop is not only the expected selection of an appropriate model and sizes but turned out to be en excellent opportunity to share on the outlines and way of operations of the new National Domestic Biogas Programme.

In closing the mission likes to express the SNV Uganda team for their efforts to make this mission a success.

Peter Bos
Sanford Kombe

Arusha, June 2009

1. Introduction and Background

A few years ago, a number of Ugandan stakeholders with defined interest in domestic biogas were encouraged by the framework of the "Biogas for Better Life - an African Initiative" and took up the challenge to prepare and implement a large-scale domestic biogas programme in Uganda.

Referring to the history of former biogas initiatives in Uganda, the present increasing need for renewable and environmental friendly energy sources and the mainly positive outcome of the feasibility study conducted by Winrock International of May the 29th of 2007, Ugandan stakeholders aim to facilitate:

1. The selection of an appropriate design for domestic biogas installations to be supported by the proposed programme;
2. The selection of an appropriate and accepted "National Implementing Agency" (NIA) to initiate and coordinate all programme functions of the proposed programme, and;
3. The formulation of a detailed Programme Implementation Document (P.I.D.) for the proposed programme, outlining character and scope of functions and activities, actor constellation and budget for the period 2009 – 2012.

The Winrock International feasibility study identified a technical potential for domestic biogas in Uganda in excess of 200,000 installations.

In December 2008, the Directorate General for International Cooperation (DGIS) approved a proposal for the African Biogas Partnership Programme (ABPP). In this programme, DGIS in a public private partnership with two development NGOs, HIVOS and SNV aim to support the implementation of the National Biogas Programmes in six African countries through funding (DGIS), fund management and overall coordination (HIVOS); and, capacity building and knowledge management (SNV). Uganda is among the six targeted countries.

HIVOS and SNV undertook a joint mission to Uganda from 2nd to 6th March 2009. During this mission biogas constructors met and agreed to form an association and work together on the selection of the most appropriate biogas design. Note that during an earlier stakeholder meeting, it had already been agreed that a fixed dome digester was to be disseminated.

The selection of an appropriate design for domestic biogas installations will be incorporated in the PID.

2. Rationale

The overall objective of the proposed national programme on domestic biogas is to further develop and disseminate domestic biogas in rural and semi-urban areas offering the Ugandan population the benefits derived from the use of clean biogas for cooking and lighting and using the bio-slurry to increase agricultural yields with the ultimate goal to establish a sustainable and commercial biogas sector in Uganda.

The tentative specific objectives contributing to its overall objectives are:

- To develop a commercially viable, market oriented biogas industry in Uganda;
- To further strengthen involved institutions for sustainable development of the biogas sector;
- To provide low cost, clean and environmental friendly energy for cooking and lighting and reduce respiratory and eye diseases caused by indoor pollution from smoke inherent to traditional cooking;
- To improve the sanitary conditions of farm yards as well as the larger environment;
- To reduce the workload of (mainly) women and children related to fuel wood collection and cooking;
- To create rural employment related local biogas enterprises providing biogas services to households;

- To improve soil nutrition and texture –and therewith agricultural yield- through the application of organic bio-slurry, and;
- To reap the environmental gains based in forest conservation reducing the use of firewood and charcoal and reduced Green House Gas emissions (GHG) resulting from the use of biogas.

3. Objective of the Mission

The main objective of this assignment is to facilitate the selection of an appropriate design for domestic biogas installations to be supported by the proposed programme in Uganda, whereby the facilitation shall take into account both the Ugandan experience in construction of domestic biogas installations, including skill level of local masons and cost structure of required materials, as well as the experience of SNV in the construction of biogas installations in Asia and Africa.

More in particular, the assignment will address the following in detail:

1. Propose the criteria for the selection of the most appropriate technology (performance factors);
2. Overview of prices of (un-) skilled labour and construction materials in those locations suitable and potential for biogas promotion;
3. Propose, in close cooperation with the Uganda Biogas Constructors Association (UBCA), an appropriate design for domestic biogas plants to be supported under the proposed programme;
4. Propose, in close cooperation with the UBCA, an appropriate plant-size range for domestic biogas installations to be supported under the proposed programme;
5. Develop, or have developed, in close cooperation with the UBCA, detailed construction drawings for the proposed design in its proposed sizes;
6. Develop, or have developed, in close cooperation with the UBCA, a detailed Bill of Quantities for the proposed design in its proposed sizes, and;
7. Provide, in close cooperation with the UBCA, a complete plant-costing overview for the proposed design in its proposed sizes, with a clear indication which costs can be born by the participating households in kind.

4. Activities

The following activities and methodologies were applied:

1. Study the feasibility study report prepared by Winrock International and other relevant documents;
2. Linking with -and incorporating initial lessons from- ongoing national domestic biogas initiatives in line of the „Biogas for Better Life" an African Initiative and subsequent ABPP;
3. Meet with a number of relevant stakeholders involved in biogas construction;
4. Conduct a survey to identify prices of needed materials, agree on performance factors and match appropriate existing plant designs with the performance factors as preparation for the constructors workshop;
5. The field visit findings were presented to a workshop which groups all identified biogas constructors both of the public, private or development institutions.
6. Facilitation of the 2-days workshop with invited biogas constructors to select a standard appropriate design, plant size range and define the investment costs for household based on agreed criteria and performance factors.
7. Preparation and submitting a final report of the mission findings, recommendations and conclusions, including technical drawings, specifications, Bill of Quantities and costing of the proposed biogas plant design for its proposed sizes

5) The Biogas Contractors Workshop:

The Biogas Model selection Workshop was officially opened by Ms. Patience Turarebya welcoming the participants and facilitated the introduction. Participants represented mostly private sector Constructors Companies as also NGOs and Research & Development Institutes. As in most countries, the dominance of men within the sector and complete absence of women participants will need us to stimulate actively women presence in the national biogas programme.

Although women and girls predominantly spend their active time and energy on providing daily energy needs for cooking and to a lesser extent ligting, and therefore are the main beneficiaires of biogas introduction, within the respective national biogas programmes they are mostly absent. We have to find the right mecanisms to have more women involved in the various aspects of the biogas programme including construction!

After the formal opening, Ms Patience equally presented the Workshop objectives to be achieved in the coming 2 days as follows;

1. Select an appropriate biogas model for the Uganda domestic biogas programme.
2. Agree on an appropriate size range to be promoted under the programme.
3. Increased understanding of quality control within the programme.

Ms. Patience gave a short presentation on the ABPP domestic biogas programme as most participants were already familiar with this new initiative by DGIS, HIVOS and SNV to promote domestic biogas in 6 African countries.

Hereafter Mr. Sanford Kombe, as member of the mission team presented the most salient findings from the 3-days field visit prior to the Workshop.

Observations he made are based on the different types/designs of biogas plants constructed including appliances manufactured by HIU and AEATREC. He made the following category of the respective findings:

- Planning
- Financing and model/type of BGP.
- Technical related issues and
- Operation and Maintenance.

From Planning point of view, the mission observed the following;

- In average the number of cows in most small holder farmers ranged between 2 to 3 cows.
- Stables were suitable with sloping concrete floor.
- Of the visited plants most of them are over-sized and under-fed.
- BGPs are under utilized.
- In- sufficient after sales service.
- None of the plants visited had toilet connection though some farmers expressed willingness to connect the toilet.

On Financing and model / type of BGP, the following were observed:

- Sizes ranged between 6 and 16 cum. for most of the domestic plants.
- Most of the biogas plants were 12 cum. and of the CAMARTEC design/model.
- Except for the HIU plants most of other plants were fully financed by owners!
- No subsidy component in most plants

Related to Technical issues;

- Except in few cases the quality of the biogas plants constructed were found to be satisfactory.
- Wrong positioning of plants at the farmers' site.
- Leakage of gas through the lid found to be a problem in a number of plants.
- Cracks in the neck to some of the biogas plants.
- The efficiency of biogas appliances especially burners was found to be very low. A great need to look into the appliances issue is very necessary.
- Gas piping fitted without water traps or was fitted after plant operation
- Gas piping leakages, piping done from improper sealing material, no hose clamps in some connections.

The following observed on Operation and Maintenance;

- Poor operation and maintenance to some plants. Cow dung piled up, improper mixing of dung, lack of qualified masons to do after – sales – service.
- Many of the visited clients reported that gas production from their biogas plants was enough for the daily cooking. A HH energy survey could testify this statement as the mission members expect this to be exaggerated.
- In most kitchens cooking/simmering of matoke (bananas) is done on firewood or charcoal
- Irregular feeding to some of the biogas plants.
- Some farmers have not done much on slurry utilization, absence of slurry pits

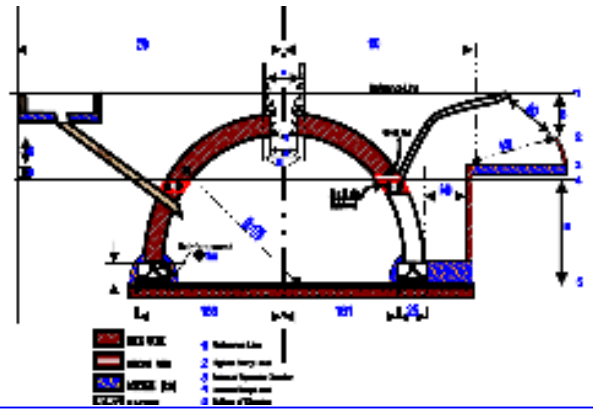
After sharing the findings during the 3-days field visit, the actual work started by Mr. Kombe introducing the following 3 digester models. He reminded the present constructors that during previous meetings of Ugandan Biogas Stakeholders, they had already expressed their preferance for a fixed dome model of bio-digester to be selected within the future national domestic biogas programme. Similar choice is also mentioned within the feasibility study by Winrock!
Therefore we excluded other models like Indian floating drum and plastic tubular design which corresponded with the general feelings and opinions of the Constructors present in the Workshop and our findings during the field visits.

The following 3 models were proposed to be analysed for selction;

1) The traditional CAMARTEC model
2) Modified CAMARTEC model
3) GGC Rwanda model

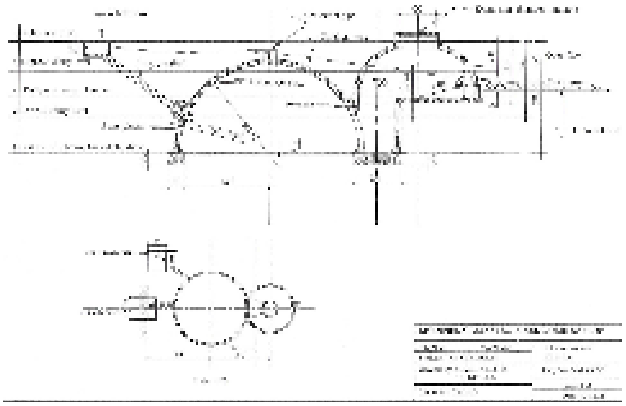
1) **The traditional CAMARTEC model**

CAMARTEC



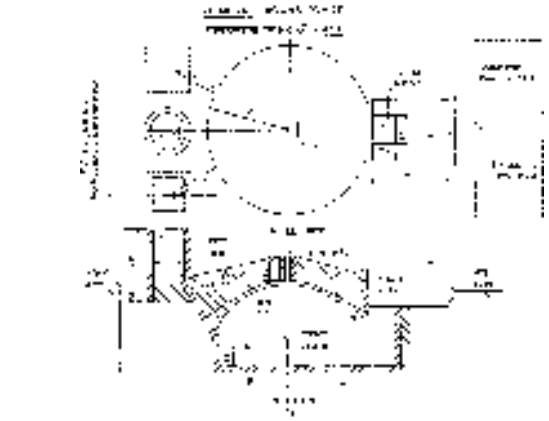
2) **Modified CAMARTEC model**

Modified camartec



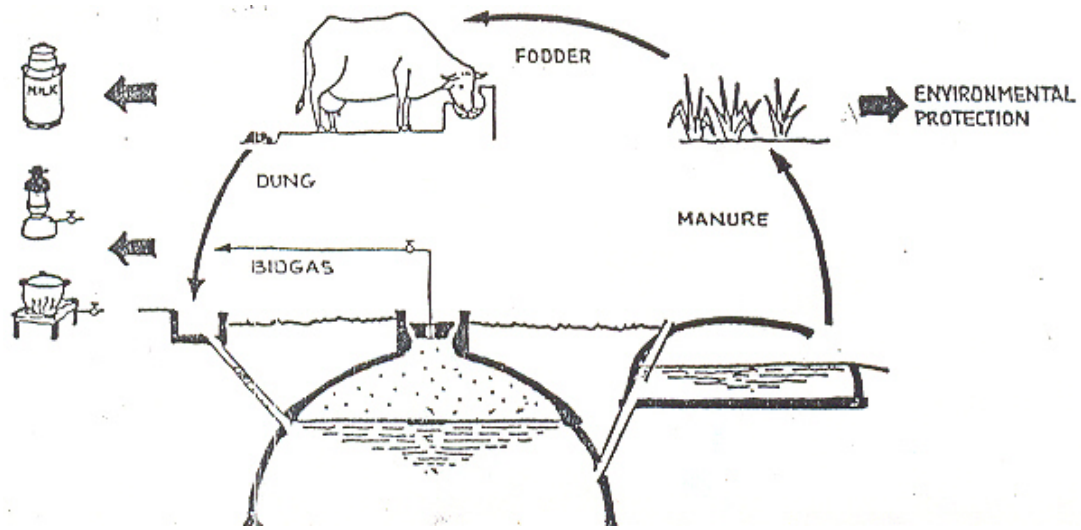
3) **GGC Rwanda model**

GGC



Mr. Kombe expressed the importance to see the biogas digester as a wider concept in the farmers yard, (1) connection with a well established cowshed, (2) collection and utilisation of the bioslurry for increased agricultural production and fodder for the animals to feed and produce milk and dung and (3) the piping of the gas to the kitchen to be used for cooking and lighting. See following overview.

Biogas digester environment



To allow participants to analyse the performances of the proposed 3 fixes dome digesters, the following criteria were proposed and accepted.

By filling in the evaluation sheet score card, results of the scoring by the 3 groups are presented in annex-3, participants analysed and scored the features of each model to the agreed criteria.

Based on the outcome of the scoring, all the 3 groups preferred the modified CAMARTEC model as the most appropriate model.

Therefore the present constructors opted for the modified CAMARTEC model as the most appropriate model to be promoted in the national domestic biogas Programme for Uganda.

Range of sizes:

After selection the model, the next topic of discussion was the establishment of various sizes of the modified CAMARTEC model to be promoted to farmers.

The following factors were mentioned in the presentation by Mr. Kato as added by the participants during the lively discussion on this subject;

- cost of materials
- length of the hydraulic retention time (HRT)
- availability of substrate mostly cow dung

- productivity of the local cows to provide dung on a daily basis
- zero-grazing and overnight stabling
- energy needs of households
- households will likely continue using firewood or charcoal for sizzling food like matoke.
- Reduction of number of cows to cover other needs like school fees.
- Have 2 inlet pipes to enable toilet being connected.

To provide more insight in the technical calculations relating to sizing, herewith the following example of a 6cum digester: VD= Vs x HRT

6m3= Vs x 60 days
Vs = 100 kg
Vs dung = 50 kg (1:1 ratio dung and water)

1 cow provides 15 kg of dung, needed around 3 cows for optimum feeding of the plant

1 kg of cow dung ±40 litres of gas / 50 kg = ± 2cum of gas
1 hr of lamp requires ± 120 litres of gas / 4 hrs of lamp = 480 litres
1 hour of stove use – 350 litres of gas

A farmer with a 6cum plant has an estimated daily use of gas for 4 hours of cooking + 4 hours of lamp use!

The Participants agreed to have the following range of sizes; the 6cum, 9 cum and 12 cum of modified CAMARTEC digesters to be constructed within the Uganda domestic biogas programme!

Participants discussed the aspects of the Bill of Quantities and the various prices of materials and labor.

Importance of use of good cement quality, Portland cement is mostly available in the bigger town and rarely found in the rural areas and close to the farmers. This will increase the price with additional transport cost.

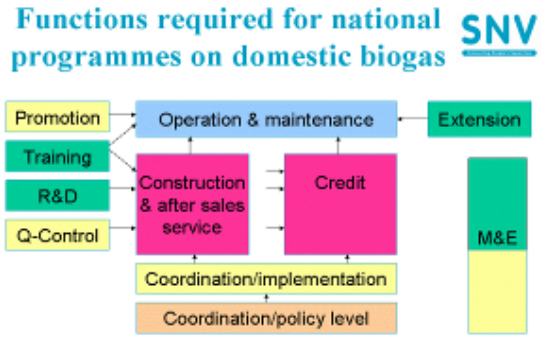
Related to the use of subsidy in order to reduce the initial investment costs for farmers and stimulate the demand, the following 3 aspects are important;

1) the amount of subsidy
2) will the subsidy provided as a flat range or as a percentage on the expected investment costs
3) will the subsidy provided to the farmer or to the constructor

The PID will have to provide clarity on these three aspects.

6) Quality Control

A short power point presentation was provided by Peter Bos on the general aspects of Quality Control within the future Ugandan domestic biogas programme.



The institutional framework of each national domestic biogas programme integrated the following functions;

- Non-functioning and poorly working biogas plants are a capital waste and will have a negatively influence on the reputation of the biogas technology, therefore Quality Control is the prime concern of the national domestic

biogas programme. Satisfied users are the main and effective promoters of the technology.

- Quality control is related to all the functions within the institutional set up of the programme;
  - Design of the biogas plant
  - Training and capacity building
  - Promotion and extension works
  - Construction
  - Operation and maintenance
  - After-sales services
  - Financial and administrative procedures.

- The importance of the QC system is explained by the following;
  - Maximize performances, reliability and lifetime of every biogas plant
  - Maximize value for money – quantity of gas and bio-slurry
  - Minimize risks of accidents or damage
  - Maintain reputation and credibility of the biogas programme.

- The role of the national programme on QC is the following;
  - Formulate and control the quality standards & targets;
  - Plant size and site selection
  - Construction materials & appliances
  - Workmanship of construction (plant) and installation (piping and appliances)
  - User instruction
  - After sales services
  - Develop QC mechanisms in order to encourage installers to comply with the Quality standards.
  - Make Database on QC inspection findings.
  - Learn from these findings to improve.
  - To achieve a recognised level of excellence / benchmarks.
  - Find a compromise between cost and performance.

- The national programme can apply QC while doing the following;
  - QC visits to plants under construction before filling.
  - QC visits completed / providing gas
  - QC visits on after sales / maintenance visits
  - QC on administrative processing

Some other points / issues discussed during the Constructor Workshop:

- ✓ Noted that biogas would not replace 100% of cooking needs
- ✓ Households indicated that they were using slurry in the gardens although we didn't have an opportunity to visit the gardens
- ✓ How would the programme handle quack operators
- ✓ Failure to get right type of construction materials (bricks, cement etc)
- ✓ After sales services are limited due to budget limitations and few technicians
- ✓ How to deal with taxation by the biogas companies
- ✓ Possibility to ake use of biogas for milk coolers

Biogas companies should recommend the size of a BGP based on the daily dung collection and not on the HH gas needs. Farmer should collect cow dung during 1 week to have a good estimate of the dung production of the cows.

7) WAY FORWARD

SN	Activity	By when	By who
1	Refresher training for masons / technicians	August 2009	UBPO (HU)
2	BoQ for 6, 9 and 12m3	Mid of June 2009	SNV / Consultant
3	Technical drawings for the modified CAMARTEC model	Mid of June 2009	SNV / Consultant
4	Work done will be used in writing PID	July + 2009	UBPO / SNV
5	National level workshop to share this information	September 2009	UBPO / SNV
6	Demonstration plants	August 2009	UBPO / contracters / clients
7	Identification of potential vocational training institutes to train masons.	July 2009	UBPO (Hu) / SNV
8	Having the ToT for the trainers and supervisors	August 2009	UBPO (HU)

ANNEX-1

African Biogas Partnership Programme (ABPP)

Biogas Model Selection Workshop

Venue: SNV IDP

Date: 22nd to 23rd May 2009

Day 1		
Time	**Activity**	**Person Responsible**
9.00 -10.30 am	Opening a. Introduction of participants b. Objectives c. Introduction by organizations	Patience Turyareeba
10.30 – 11.00am	Coffee/Tea Break	
11.00am – 12 noon	Findings of field visit Discussion	Sanford Kombe
12.00 – 12.30pm	Criteria for selection of a model - present proposal for criteria - agree on adding or reduce criteria	Peter Bos
12.30 – 1.30pm	Potential fixed dome models - CAMRTEC - Modified CAMRTEC - GGC Nepal/Rwanda/Ethiopia	Sanford Kombe
1.30pm – 2.30pm	Lunch	
2.30pm – 3.30pm	Selection and choice Presentation	Participants
3.30pm-4.30pm	Range of sizes	Chris Kato
Day 2		
9.00 – 10.00am	Prices – materials, labour	Chris Kato
10.00-10.30am	Subsidy	Peter Bos
10.30 – 11.00 am	Coffee/Tea Break	
11.00 – 12 noon	Quality Control	Peter Bos
12.00 – 12.30 pm	Way Forward	Patience
12.30 – 1.00pm	Closing	Patience

ANNEX-2

List of participants to Constructors Workshop

SN	Name	Designation	Organisation	e-mail address / mobile
1	Peter Bos	Biogas Advisor	SNV-Arusha	pbos@snvworld.org 255-787333889
2	Kato Chris	Director	REO (U) Ltd / UBA	chrisekwadahkato@yahoo.com 0772-495000
3	Okurat Samuel	Research Engineer	NARO-AEATRAC Namalere	S_okurut@yahoo.com 0772-323594
4	Saasa A.Richard	Engineer	NARO-AEATREC Namalere	arsaasa@yahoo.com 0772-327256
5	Godfrey Mabuda	Engineer	Express Impact Ltd / MUK	0772530150
6	Filanu Saturday	Engineer	Contrageni	0772409694
7	Francis Nturanabo	Engineer	BTN Technology Ltd	mpazi@tech-mak.ac.ug fmpazi@yahoo.com 0752-652026
8	Ouma Kenneth	Builder	B-Gas Technology	0781456171
9	Sunday Were	Builder	B-Gas Technology	0774389405
10	Beinempaka A	Extension Service Coordinator	HPI (U)	0712-805038
11	Namakola J.	Technicien	HPI (U)	0772-973382
12	Byamugisha G.	Coordinator	Contrageni	0772-425369
13	Sanford Kombe	Consultant	ABContractors Arusha	
14	Patience Turyareeba	Biogas Advisor	SNV Central Portfolio	pturyareeba@snvworld.org
15	Joel S. Mugwisa Only 1st day	Biogas Advisor	SNV Central Portfolio	
16	Richard Kizito Only 2nd day	Engineer	Appropriate Technology Energy	0754140199 Kiziro-ric@yahoo.com

ANNEX-3

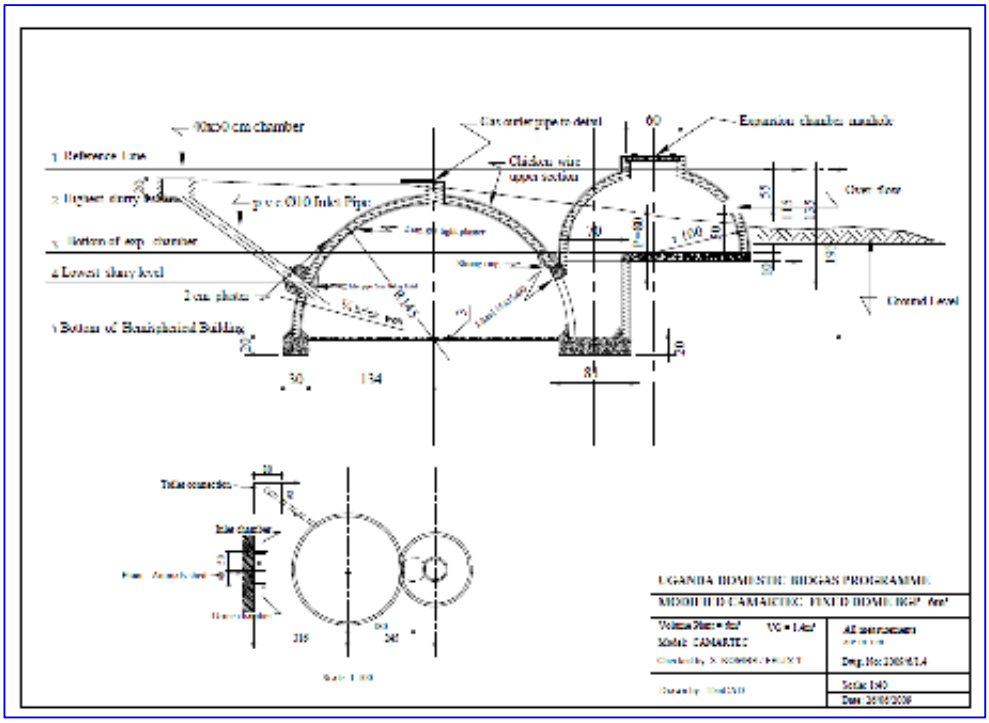
Table 1 : Biogas Plant Model Score sheet and evaluation results

SN	*Evaluation Criteria*	*CAMARTEC*			*Modified CAMARTEC*			*GGC model RWANDA*		
		Gr.1	*Gr.2*	*Gr.3*	*Gr.1*	*Gr.2*	*Gr.3*	*Gr.1*	*Gr.2*	*Gr.3*
1.	**Climatic and Geological Conditions**	**XXX**			**XXX**			**XXX**		
1.1	Ambient temperature	3	5	1	3	5	1	3	5	1
1.2	Type of soil	5	5	3	3	5	3	3	5	1
1.3	Water Table	3	3	3	5	5	3	5	5	1
1.4	Sunshine and humidity	3	5	2	5	5	4	3	3	1
2	**Structural durability and functioning**	**XXX**			**XXX**			**XXX**		
2.1	Inlet chamber and inlet pipe	3	5	3	3	5	3	3	5	3
2.2	Digester	5	1	2	5	5	5	3	5	1
2.3	Gasholder	1	1	1	5	5	5	1	5	1
2.4	Outlet tank	3	1	3	5	5	2	1	5	1
3	**Method of construction**	**XXX**			**XXX**			**XXX**		
3.1	Requirement of area for construction	3	3	4	3	1	4	1	1	1
3.2	Digging of pit	5	3	3	3	1	4	3	1	1
3.3	Construction of base	5	3	4	3	3	4	3	3	1
3.4	Construction of digester	3	1	3	3	3	4	5	3	2
3.5	Construction of gas holder	5	1	1	5	5	4	3	3	3
3.6	Inlet and outlet tanks	3	1	1	3	5	4	5	5	3
4	**Operation and maintenance**	**XXX**			**XXX**			**XXX**		
4.1	Operational activities	1	1	2	5	5	4	3	5	1
4.2	Maintenance activities	1	1	2	3	5	4	5	5	1
4.3	Top-filling and protection of plants	1	3	3	5	5	3	3	1	3
4.4	Applicability in different geographical context. / locally construction material available	3	3	2	3	3	2	3	5	4
4.5	Sharing of technical information and	5	5	4	5	3	3	1	1	1

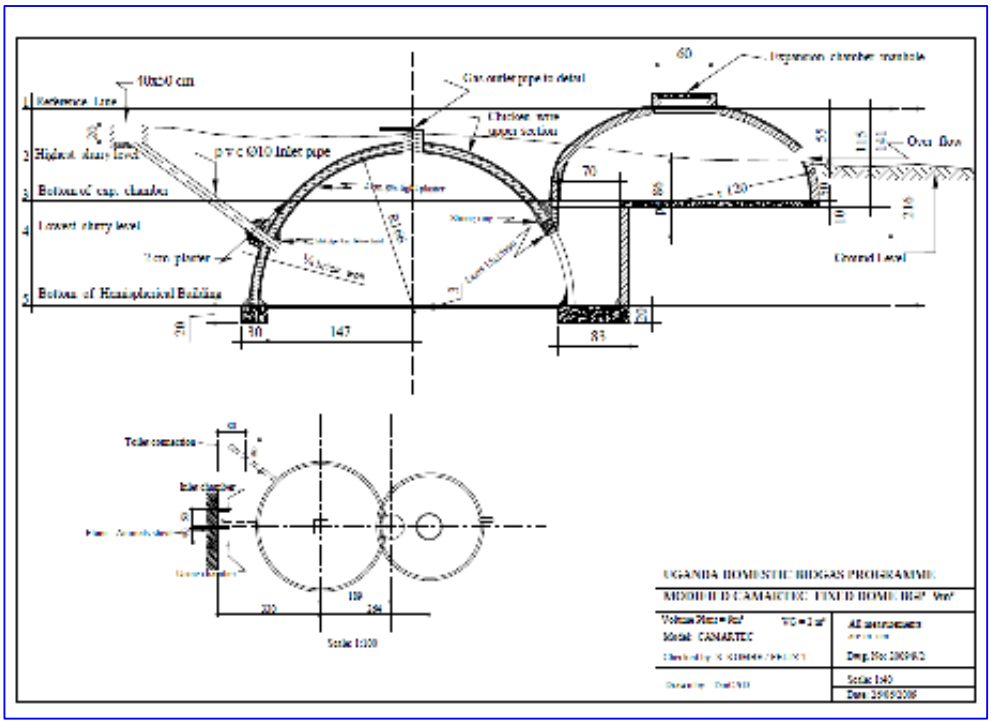
	know-how									
5	**Affordability of Farmers to install biogas plants**	**XXX**			**XXX**			**XXX**		
5.1	Availability of construction materials	3	1	3	3	3	3	3	5	3
5.2	Availability of human resources	5	5	3	5	3	3	1	1	2
5.3	Cost of installation	1	1	2	5	3	4	3	5	3
5.4	Operation and maintenance costs	1	1	1	3	5	3	5	3	2
5.5	Transportation facilities	3	1	2	3	3	4	3	5	1
6	**Performance of existing digesters**	**XXX**			**XXX**			**XXX**		
6.1	Existing physical status and functioning	5	1	-	5	5	-	1	3	-
6.2	User satisfaction	5	1	-	5	5	-	1	3	-
6.3	Quality and quantity of available feeding material	3	3	3	3	3	3	3	3	3
7	**Others**	**XXX**			**XXX**			**XXX**		
7.1	Environmental issues		1			5			5	
7.2	Slurry utilization			1			2			4
	Total	**91**	**66**	**64**	**99**	**114**	**87**	**73**	**102**	**49**

ANNEX-4: Drawing of Modified CAMARTEC Design

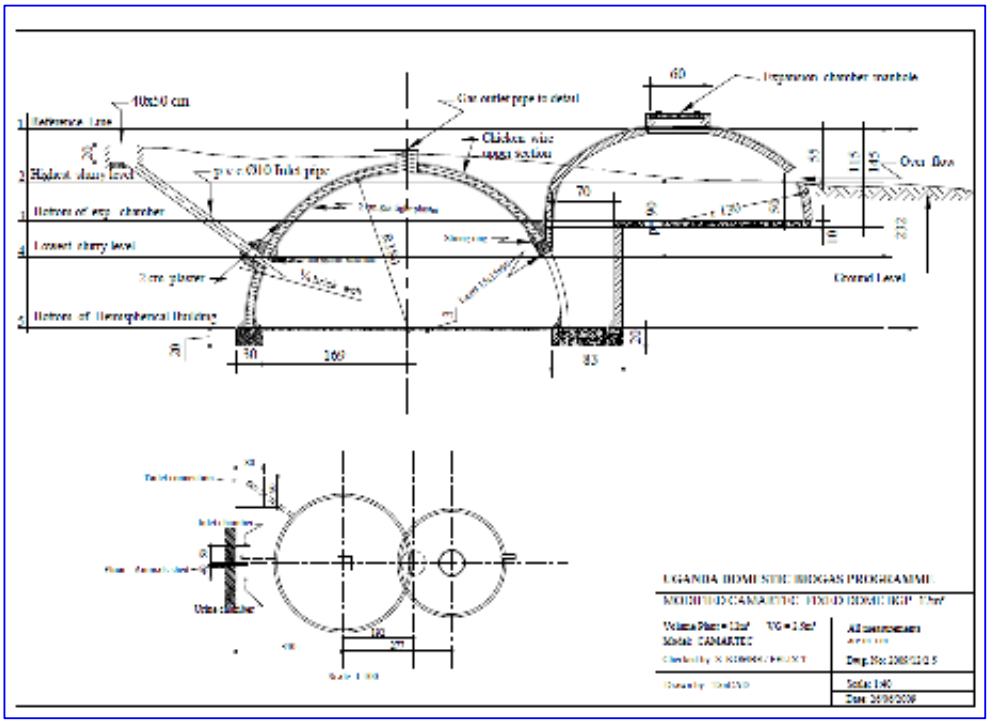
Modified Camartec 6m³



Modified Camartec 9m³



Modified Camartec 12m³



ANNEX-5: Bill of Quantity 6cum, 9cum and 12 cum Digester Sizes Modified CAMARTEC Design

Modified CAMARTEC Model: Uganda Domestic Biogas Programme

Construction/Investment Costs

		Sizes	6 m^3 digester		
	Description	Unit	qty	costs	total
1	**Contribution by farmer in kind**				
1.1	Unskilled labour	mandays	12	12.500.00	150.000.00
1.2	River Sand	tons	2.5	32.000.00	80.000.00
1.3	Lake sand	tons	2.5	32.000.00	80.000.00
1.4	Gravel 1/4"	tons	2	20.000.00	40.000.00
1.5	Stones	tons	1	40.000.00	40.000.00
1	**Total farmer contribution**				**390.000.00**
2	**Supplied materials**				
2.1	Cement	bags	12	30.000.00	360.000.00
2.2	Burned bricks	pieces	650	140.00	91.000.00
2.3	Lime	bags	2	15.000.00	30.000.00
2.4	Cement waterproofing	kg	4	3.000.00	12.000.00
2.6	PVC pipe dia. 4"	6m	1	5.000.00	30.000.00
2.7	Gas line pipes HDPE 3	30m	1	70.000.00	70.000.00
2.8	Assorted fittings	set price	1	100.000.00	100.000.00
2.9	Chicken mesh	3m	1	6.000.00	6.000.00
2.10	Single burner stove	set price	1	50.000.00	50.000.00
2.11	Lamp	no.	1	140.000.00	140.000.00
2.12	Steel bars 10mm	2m	1	10.000.00	10.000.00
2.12	Transportation costs				100.000.00
2	**Total materials**				**999.000.00**
3	**Technical services**				
3.1	Supervision	mandays	4	25.000.00	100.000.00
3.2	Mason	mandays	12	15.000.00	180.000.00
3.3	Porters/helpers	mandays	12	9.000.00	108.000.00
3.3	Annual maintenance fe	mandays	2	20.000.00	40.000.00
3	**Total services**				**428.000.00**
4	**Constultants fee**				
4.1	Overhead	mandays	2		50.000.00
4.2	Risk coverage	share of 2	0.05		49.950.00
5	Company profit	share of 2+3	0.15		214.050.00
4	**Total company fee**				**314.000.00**
5	**Programme fee**				
5.1	Participation fee	once			–
5	Total programme fee				–
	Total investment: UG.SHS.				**2.131.000.00**
	EURO				**690.00**

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2. If their system is applied to determine the amount of costs for labour then the prices entered above will be less than indicated figures.

3. A withholding tax of 6% of the Total Cost is charged by Contractors

4. Brick sizes in Uganda differs in size from one place to another. This calculation is based on a brick size of 4"x5"x9" (100 x 127 x 230 mm).

Modified CAMARTEC Model: Uganda Domestic Biogas Programme

Construction/Investment Costs -		Sizes	9 m^3 digester		
	Description	Unit	qty	costs	total
1	**Contribution by farmer in kind**				
1.1	Unskilled labour	mandays	16.00	12.500.00	200.000.00
1.2	River Sand	tons	4.00	32.000.00	130.000.00
1.3	Lake sand	tons	4.00	32.000.00	130.000.00
1.4	Gravel 1/4"	tons	3.00	20.000.00	60.000.00
1.5	Stones	tons	1.00	40.000.00	40.000.00
1	**Total farmer contribution**				**560.000.00**
2	**Supplied materials**				
2.1	Cement	bags	15.00	30.000.00	450.000.00
2.2	Burned bricks	pieces	950.00	140.00	133.000.00
2.3	Lime	bags	3.00	15.000.00	45.000.00
2.4	Cement waterproofing	kg	5.00	3.000.00	15.000.00
2.6	PVC pipe dia. 4"	6m	1.00	5.000.00	30.000.00
2.7	Gas line pipes HDPE 3	30m	1.00	70.000.00	70.000.00
2.8	Assorted fittings	set price	1.00	100.000.00	100.000.00
2.9	Chicken mesh	3m	1.00	6.000.00	6.000.00
2.10	Single burner stove	set price	1.00	50.000.00	50.000.00
2.11	Lamp	no.	1.00	140.000.00	140.000.00
2.12	Steel bars 10mm	2m	1.00	10.000.00	10.000.00
2.12	Transportation costs				140.000.00
2	**Total materials**				**1.189.000.00**
3	**Technical services**				
3.1	Supervision	mandays	5.00	25.000.00	125.000.00
3.2	Mason	mandays	16.00	15.000.00	240.000.00
3.3	Porters/helpers	mandays	16.00	9.000.00	144.000.00
3.3	Annual maintenance fe	mandays	2.00	20.000.00	40.000.00
3	**Total services**				**549.000.00**
4	**Constultants fee**				
4.1	Overhead	mandays	2.00		50.000.00
4.2	Risk coverage	share of 2			59.450.00
5	Company profit	share of 2+3			260.700.00
4	**Total company fee**				**370.150.00**
5	**Programme fee**				
5.1	Participation fee	once			–
5	Total programme fee				–
	Total investment: UG.SHS.				**2.668.150.00**
	EURO				**864.00**

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Modified CAMARTEC Model: Uganda Domestic Biogas Programme

Construction/Investment Costs -		Sizes	12 m^3 digester		
	Description	Unit	qty	costs	total
1	**Contribution by farmer in kind**				
1.1	Unskilled labour	mandays	20.00	12.500.00	250.000.00
1.2	River Sand	tons	5.00	32.000.00	160.000.00
1.3	Lake sand	tons	5.00	32.000.00	160.000.00
1.4	Gravel 1/4"	tons	4.00	20.000.00	80.000.00
1.5	Stones	tons	1.00	40.000.00	40.000.00
1	**Total farmer contribution**				**690.000.00**
2	**Supplied materials**				
2.1	Cement	bags	20.00	30.000.00	600.000.00
2.2	Burned bricks	pieces	1.250.00	140.00	175.000.00
2.3	Lime	bags	4.00	15.000.00	60.000.00
2.4	Cement waterproofing	kg	6.00	3.000.00	18.000.00
2.6	PVC pipe dia. 4"	6m	1.00	5.000.00	30.000.00
2.7	Gas line pipes HDPE 3	30m	1.00	70.000.00	70.000.00
2.8	Assorted fittings	set price	1.00	100.000.00	100.000.00
2.9	Chicken mesh	3m	1.00	6.000.00	6.000.00
2.10	Single burner stove	set price	1.00	50.000.00	50.000.00
2.11	Lamp	no.	1.00	140.000.00	140.000.00
2.12	Steel bars 10mm	2m	1.00	10.000.00	10.000.00
2.12	Transportation costs				170.000.00
2	**Total materials**				**1.429.000.00**
3	**Technical services**				
3.1	Supervision	mandays	6.00	25.000.00	150.000.00
3.2	Mason	mandays	21.00	15.000.00	315.000.00
3.3	Porters/helpers	mandays	21.00	9.000.00	189.000.00
3.3	Annual maintenance fe	mandays	2.00	20.000.00	40.000.00
3	**Total services**				**694.000.00**
4	**Constultants fee**				
4.1	Overhead	mandays	2.00		50.000.00
4.2	Risk coverage	share of 2			71.450.00
5	Company profit	share of 2+3			318.450.00
4	**Total company fee**				**439.900.00**
5	**Programme fee**				
5.1	Participation fee	once			–
5	Total programme fee				–
	Total investment: UG.SHS.				**3.252.900.00**
	EURO				**1.053.00**

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