



# SNV

Connecting People's Capacities



## **Report on the Feasibility Study**

for a

## **Biodigester Support Programme in the Kingdom of Cambodia**

Jan Lam  
Willem Boers

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## I Introducing SNV

SNV is a Netherlands-based International non-governmental organization (INGO) and provides advisory services regarding institutional development and organizational strengthening (ID/OS), programme management and technology for biogas sector development. SNV's overriding goal is to alleviate poverty by strengthening the capacity of local organizations and institutions. To reach this goal, SNV provides advisory services in the fields of natural resource management, private sector development and local governance.

SNV is convinced that provided programmes are conceived and implemented in harmony with existing conditions and practices, domestic biogas installations can bring significant and far reaching benefits to millions of people. 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 developing/formulation, implementation and advisory capacity in the Biogas Support Programme (BSP-N) since 1989. The programme is currently in its fourth phase (BSP IV, 2003-2009), aiming to increase the total number of plants constructed under the programme to 330,000 units. Currently over 130,000 installations have been completed. For the Nepal biogas programme, SNV developed a Clean Development Mechanism, Project Idea Notes and Project Development Documents (CDM, PIN and PDD) in cooperation with Winrock and Eco-Securities.
- Vietnam: Involved in developing/formulation and advisory capacity in the Biogas Project (BP) since 1999. Current phase I (BP I 2003-2006) supporting the construction of 12,000 fixed dome biogas plants in 12 selected provinces over the country. A PIN document for pre-BP II has been submitted for comments to the World Bank. BP II is currently being formulated.
- Laos, Cambodia, and Bangladesh: SNV is involved in development/formulation and advisory services of a national biogas/renewable energy programme in these three countries. Intentions are that nation-wide biogas/renewable energy programmes in these countries will be operational before the end of 2006.

SNV worldwide employs over 600 advisors in some 26 countries. SNV's biogas team includes currently 6 senior advisors, with expected expansion to approx. 15 experts by 2006.

For further information please contact: Netherlands Development Organization (SNV), Bezuidenhoutseweg 161, 2594 AG den Haag, <https://www.snvworld.org>, or Willem Boers, [wboers@snv.org.np](mailto:wboers@snv.org.np) or Jan Lam [lam@tref.nl](mailto:lam@tref.nl).

Worldwide, about two billion people lack clean and safe cooking fuel. To improve their lives, they need access to sustainable energy services. Based on its practices in Nepal and Vietnam, the Netherlands Development Organization (SNV) firmly believes that domestic biogas – if properly embedded in society – can serve the basic energy needs of millions of people.

## II Summary of findings

The households in rural Cambodia depend for more than 90% on fuel wood to meet their energy needs. For many of the households it becomes increasingly difficult to satisfy their daily domestic energy requirements, the consumption of over 14 kgs per household per day is not balanced by the sustainable production of fuel wood.

The majority of the households own two or more cattle used for draft power and for financial security. The average farmer will also own some pigs for income generation.

Most farmers till small plots of land to satisfy the families need for rice and vegetables. The quality of the arable land is mostly poor; the average rice yield per hectare is 1.3 tonnes compared to 3 tonnes in the neighbouring countries.

Biodigester technology can play an important role to improve the quality of life for the rural households, especially for women, by reducing indoor air pollution and reducing the daily workload, and as a tool in an integrated farming system by using the full potential of digester effluents.

A conservative estimate of the technical potential for domestic biodigesters in the 6 selected provinces amounts to 224,000 units.

### **Main recommendations for a national programme:**

- Programme set-up

A national Biodigester Programme Office (BPO) needs to be established to initiate and coordinate the different activities that need to be undertaken. The most appropriate ministry should host such an office with direct linkage to the target population and with the most extensive infrastructure, i.e. the Ministry of Agriculture, Forestry and Fisheries (MAFF).

The participation of other line ministries, NGOs, financial and research institutes is indispensable and nationally active organizations need to be represented in a BPO steering committee.

- Technology

To gain the confidence of the market in the technology, there must be a strong focus on quality. This includes quality of information, construction and after-sales service. Brick dome digesters appear to be the most suitable design when it comes to reliability and possible use of CDM revenues. The availability of material allows for the introduction of such digesters.

Applied research is necessary to come to an enforceable national standard for biodigesters.

- Finance

A mechanism needs to be established to make reasonable finance available for domestic biodigesters. Preferably, this finance has to be channelled through existing and regulated banking institutes, i.e. Association of Cambodian Local Economic Development (ACLEDA) and the Micro Finance Institution AMRET. Provision of subsidy will be an important marketing tool and must be linked to pre-defined quality standards.

- Commercialization  
For the actual construction and for the after-sales service of biodigesters, the establishment of local biodigester enterprises must be encouraged. This includes training of technicians and management support.
- Integrated farming  
Research on the use of the full potential of digester effluent and dissemination of the research results must be an important and integrated part of the programme.
- Role of SNV  
SNV, with its experience with this type programme development should ensure the provision of technical assistance to the programme and to the various institutes, aiming at capacity building of the respective organizations.

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## **IV Abbreviations and acronyms**

ACLEDA	Association of Cambodian Local Economic Development Agencies
ADB	Asian Development Bank
ADESS	Agricultural Development Support Project to Seila
ADRA	Adventist Development Relief Agency International
AFD	Groupe Agence Francaise de Development
AMRET	MFI (Sanskrit word for prosperity, durability and happiness)
ARECOP	Asian Regional Cook Stove Program
ASA	ACLEDA Staff Association
AusAID	Australian Agency for International Development
BPO	Biodigester Programme Office
BSP-N	Biogas Sector Partnership Nepal
CBRDP	Community Based Rural Development Project
CCCO	Cambodian Climate Change Office
CCRD	Credit Committee for Rural Development
CDCs	Commune Development Committees
CDM	Clean Development Mechanism
CEDAC	Centre d'Étude et de Développement Agricole Cambodgien
CFSP	Cambodian Fuel wood Saving Project
CRCD	Cambodian Research Centre for Development
CRDT	Cambodian Rural Development Team
DANIDA	Danish International Development Assistance
DATE	Development and Appropriate Technology
DED	German Development Service
DET	General Department of Technology
DfID	United Kingdom Department for International Development
DGIS	Directorate Internationals Development Cooperation
DNA	Designated National Authority
EIA	Environmental Impact Assessment
EMT	MFI (Ennastien Moulethan Tchonebatt or local rural credit)
FAO	Food and Agricultural Organization
FLD	Farmers Livelihood Development
FMO	Netherlands Development Finance Company
GEREs	Groupe Energies Renouvelables et Environnement
GGC	Gobar Gas Company (Pty.) Ltd.
GTZ	German Technical Cooperation
HRT	Hydraulic Retention Tone
ICS	Improved Cooking Stove
ID	Institutional Development
IDRC	International Development Research Centre
IFAD	International Fund for Agricultural Development
INGO	International Non Governmental Organization
KfW	German Development Bank
KNCED	Khmer National Community Economic Development
LDC	Least Developed Country
LIFDCS	Low-Income Food-Deficit Countries
LMB	Lower Mekong Basin
LWF	Lutheran World Federation
MAFF	Ministry of Agriculture, Forestry and Fisheries

MEKARN	Research Company
MFI	Micro Finance Institution
MIME	Ministry of Industry, Mines and Energy
MODFIAC	Ministry of Foreign Affaires and International Cooperation
MoE	Ministry of Environment
MoU	Memorandum of Understanding
MRD	Ministry of Rural Development
MWA	Ministry of Veterans and Women Affaires
NBC	National Bank of Cambodia
NBSC	National Biodigester Steering Committee
NEDO	New International Energy Development Organization, Japan
NGO	Non Governmental Organization
NIS	National Institute of Statistics
NPK	Nitrogen (N), phosphorus (P) and potassium (K)
NTFP	Non Timber Forest Products
OS	Organizational Strengthening
PADEK	Partnership for Development of Kampuchea
PBPO	Provincial Biodigester Programme Office
PBSC	Provincial Biodigester Steering Committee
PDD	Project Development Document
PIN	Project Idea Note
PRA	Participatory Rural Assessment
R&D	Research and Development
RCSA	Rural Children Saving Association
RE	Renewable Energy
RET	Renewable Energy Technology
SCALE	Integrated Aquaculture Project
Seila	Decentralization programme (Khmer for foundation stone)
SIDA	Swedish International Development Agency
SNV	Netherlands Development Organization
SNV/BSP	SNV/Biogas Support Programme
SPFS	Special Program for Food Security
TELEFOOD	FAO programme funded by media based people
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCC	United Nations Framework Convention on Climate Change
UNTAC	United Nations Transition Authority Cambodia
UTA	University of Tropical Agriculture
UV	Ultra violet
VACVINA	Vietnam's National Gardener's Association
VDC	Village Development Committee
VLA	Village Livestock Agent
VSF	Vétérinaires sans Frontiers
WB	The World Bank
WC	Water Column
WENetCam	Wood Energy Network, Cambodia
WFP	World Food Program



## 1.0 Introduction

At the Conference for Renewable Energy, Bonn, June 2004 contacts were established between the Cambodian delegation and SNV. In April 2004 Cambodian Fuel wood Savings Project (CFSP) initiated the construction of four concrete digesters in the quest to reduce the use of fuel wood. The report "Review and Recommendations for Household Digesters in Cambodia" was presented in September 2004. The potential for biodigesters in Cambodia is seen as an untapped potential for inclusion under CDM. Through the Cambodian Climate Change Office (CCCO) under the MoE there is a keen interest to develop CDM as a co-financer for a National Biodigester Programme. SNV committed itself to develop an Asian Biogas Programme and identified Cambodia as a country with great potential for the installation of biodigesters. Further communication was established during the SNV first identification mission to Cambodia from 4 - 7 July 2004.

Based on these developments and on the recommendation of the first SNV identification mission, a feasibility study on a Biodigester Support Programme was commissioned by SNV.

The team members of the feasibility study:

- Mr. Sok Bunheng, Institutional Consultant, MIME, (4 days)
- Ms. Bridget McIntosh, CDM and Sustainable Energy Advisor (2 days)
- Mr. Rogier van Mansvelt, Project Coordinator and a local team of students, (5 days)
- Mr. Jan Lam, Senior Biogas Advisor, SNV (24 days)
- Mr. Willem Boers, Biogas Advisor, SNV (24 days)

### 1.1 Country Background

The Kingdom of Cambodia is mostly low with flat plains, and over 88% of the population lives in rural areas. Its economy is mainly based on agriculture, tourism

Land Area: 181.040 km<sup>2</sup>  
Population: 13.4 million (2004)  
Gross Domestic Product:  
US\$ 25 billion (2004) source - World Bank  
Per Capita GDP: US\$ 1900 (2001)  
Currency: Riel (1US\$ = 3.851 Dec 2004)

and the clothing sector. In 2001, agriculture contributed to about 36% of GDP, while services and industrial sectors contributed about 36% and 28% respectively. Cambodia's climate is dominated by tropical climate with the monsoon from July till October. Floodings in Cambodia are

80% caused by rainfall in upper regions of the mehkong and not due to local rainfall directly. Cambodia is a traumatized country still suffering the results of the Khmer Rouge (1975-1979) and was for a long period under foreign dominance (France; Vietnam 1979-1991; UNTAC, 1991-1994). Cambodian society is open about its history and open about the problems it faces. Despite the presence of a formal governance structure including free elections at different levels, it is still characterized by typical post conflict administration. Many NGOs are operating in Cambodia; around 80 INGOs and more than 500 Cambodian NGOs. A general feature is that most (I)NGOs are not specialized and work on fairly isolated projects rather than integrated programmes.

## **1.2 Ethnic diversity**

In none of the available databases, like the statistical yearbook, is reference made to the ethnic make-up of the rural society. It can be assumed that the ethnic rural fabric is homogeneous Khmer. The largest minority in Cambodia are the ethnic Vietnamese who came in the wake of the overthrow of the Pol Pot regime by the Vietnamese army. As Vietnam is much more dense populated there is an overflow of Vietnamese into Cambodia with which they share a long border as well as the Mekong River is a big funnel of transport of goods and people. Besides urban centres, many Vietnamese live in semi permanent floating communities everywhere along the rivers and on the Tonle Sap lake.

According to the Statistical Yearbook 2003, 96% of the population adheres to the Buddhist faith.

## **1.3 Energy Resources and Consumption**

Cambodia has few exploitable energy sources available other than biomass. Wood accounts for more the 80% of the total national energy consumption. The natural forest, the main source of fuel wood, has been severely degraded due to widespread logging and forestland conversion. Fossil fuels, mainly diesel and heavy oil, are imported for electricity production. A medium sized hydropower dam is under construction. There is also a serious plan to dam the Mekong near Kraie to have hydropower. There are also other small hydro dams under study in various parts of Cambodia. Ratanak Kiri Banlung capital has a small hydropower plant that supplies to the town most part of the year. The exploitation of offshore natural gas fields will not commence within the next five years.

## **1.4 Objectives**

The overall objective of the study is to assess the possibilities to design a programme to stimulate the emergence of a national biodigester sector programme in Cambodia. The study is divided into two main parts:

- 1) Fact finding on the key elements concerning a national biodigester programme.
- 2) Formulating an outline for a national biodigester support programme in Cambodia.

## **1.5 Methodology**

The methodology used consisted of six activities: (1) selection of a Pilot area, a local consultant was hired to support the SNV team, (2) Data collection from studies, reports and databases, a local consultant was hired to support the SNV team, (3) interviews with –potential stakeholders, a local consultant was hired who facilitated the SNV team, (4) field visits, CFSP and FAO/SPFS facilitated these field visits, (5) presentation on biogas at a national workshop, the SNV team was invited to present the outline of national programmes in Nepal and Vietnam and SNV regional biogas programme, (6) debriefing on mission findings, on the 4<sup>th</sup> of November the mission team presented the findings to the sector stakeholders. The stakeholders discussed the outline for a national biodigester programme. This design and implementation of a future programme is presented in the second part of this report, Design and Implementation.

Field visits have been conducted in:

- Kampong Speu Province where Cambodia Fuel wood Savings Project (CFSP) is active in biodigester construction;
- Kampong Cham Province to visit farmers assisted through Ministry of Agriculture Forestry and Fisheries/FAO-Special Programme for Food Security (SPFS);
- Takeo province to visit the provincial offices of MAFF, Ministry of Rural Development and Ministry of Women Affairs as well as the extension team of SFPS.

### Limitation

The mission team received a very generous and good cooperation. The team focussed on issued related to biodigesters and the other RET were hardly looked into. The main reason being that PV is well established with in MIME and that the dissemination of ICS and other wood savings technologies are well covered by CFSP. The team concluded that at this junction no valuable input could be given to these programmes. Due to the coronation of the new king of Cambodia, King Norodom Sihamoni, Government offices were closed for several days.

### **1.6 Acknowledgement**

The mission team wishes to thank all key informants for their willingness to provide time and information to make this feasibility study a success. In particular, we would like to thank Mr. Iwan Basroko, CFSP staff for facilitating field visits, and appointments with stakeholders, making office facilities available and providing the opportunity to make a presentation on SNV achievements at the workshop on biodigesters organized by CFSP. In the same fashion, we would like to thank Mr. Kean Sophea of SPFS for his support and encouraging enthusiasm to make this mission a success. Special thanks to Bridget McIntosh, her expertise on the current status on biodigesters in Cambodia and advise to the SNV team contributed greatly to the success of this mission. She further provided excellent general support and backstopping during the discussions the debriefing session. Last but not least, we were inspired by, and highly appreciate, the warm welcome we received from farmers with and without biodigesters installed.

Note: The December 2004 version of this report has been submitted to MAFF and Foreign Affairs as support document to the letter of intend between MAFF and SNV. The December 2004 version of this report has been distributed to Cambodian based stakeholders namely; MAFF, MIME, ALCLEDA, FAO, MWVA, Partnership for Development, CFSP, Bridget Mc Intosh, Rogier van Mansveldt. After debriefing to stakeholders in January 2005 additions have been made to the (absolute) December 2004 version of this report.

## **FACTS FIGURES AND ANALYSIS**

### **on the present state of affairs for Biodigesters in Cambodia**

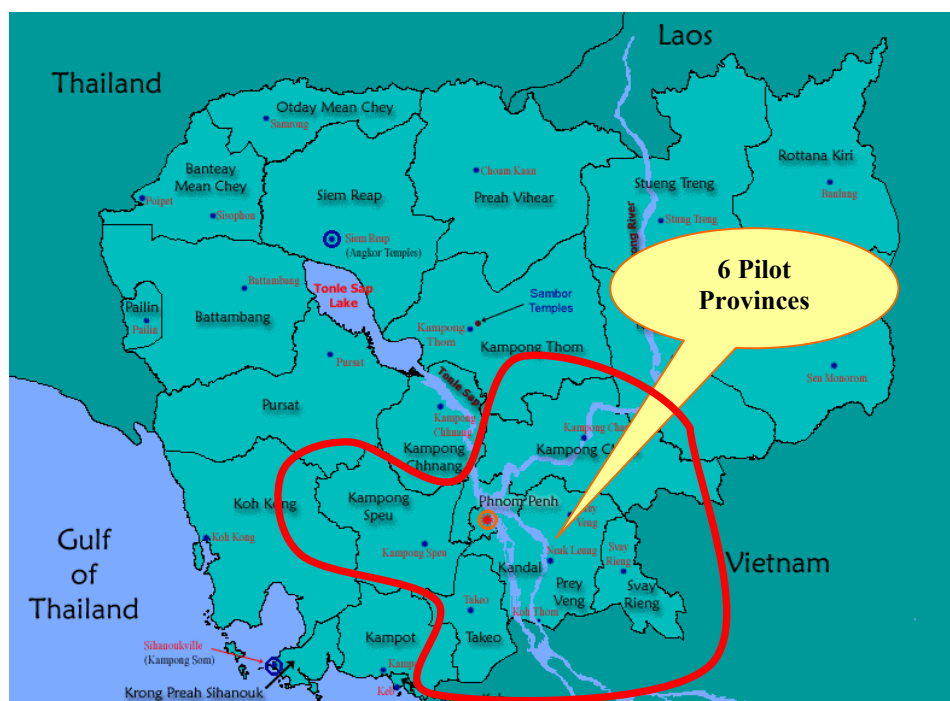
## 2.0 Selection of a pilot area

A new national biodigester programme will have to start with a pilot to gain experience and to fine-tune the programme set-up. Such a pilot has the highest chance of success in provinces most suitable for biodigester dissemination. It was decided to select these provinces by means of a matrix where the most important factors, livestock numbers, availability of fuel wood, economic standards, number of house holds and livelihood are compared. The outcome of this exercise is given in the table below.

**Selection Matrix - Provincial Rating for Characteristics Related to Biogas Usage**

Province	Demo-graphics	Dung Availability	Fuel Availability	Spending Ability	Access to Water	Flooding	Total	Overall Rank
	No Rural House holds	Number of Livestock	Forest Cover	Motorbike Ownership	Access <150m	Flood Rating		
<b>Rating of Individual Characteristic</b>								
Kampong Cham	1	1	6	7	3	11	29	1
Svay Rieng	10	5	4	3	1	9	32	2
Prey Veng	2	2	2	10	2	15	33	3
Kampong Speu	7	4	8	5	8	3	35	4
Takeo	4	3	3	5	10	13	38	5
Kandal	3	8	5	2	13	7	38	6
Phnom Penh	15	14	1	1	12	2	45	7
Kampong Chhnang	11	9	7	12	6	4	49	8
Siem Reap	6	6	12	16	5	8	53	9
Kampot	9	7	11	12	15	5	59	10
Kratea	13	13	14	6	9	6	61	11
Kampong Thom	8	10	10	15	7	12	62	12
Sihanouk Ville	14	15	15	14	4	1	63	13
Battambang	5	11	9	8	16	14	63	14
Pursat	12	12	13	13	11	10	71	15
Kep	16	16	16	9	14	-	71	16

Based on rating, all equally weighted, per Province: where 1 represents the Province with the most favourable conditions for biodigesters. There are 24 Provinces in Cambodia. Provinces more than 6 hours by road from Phnom Penh were screened out due to poor access. Six provinces in the vicinity of Phnom Penh have been selected for the feasibility study i.e. Kampong Cham, Svay Rieng, Prey Veng, Kampong-Speu, Takeo and Kandal.



## **2.1 Data collection from studies, reports and databases**

A local consultant leading a team of students was hired to collect reports and studies on biodigester related topics from Government offices in the capital and in the selected provinces, from project offices and (I)NGOs.

The list of defined topics is given below.

### Demand side:

- Demographic figures per province, numbers of rural households;
- Energy use per household, availability or scarcity of energy carriers;
- Data on crop cultivation, landholding and manuring (composting) practices;
- Data on gender roles in common farming systems;
- Data on distribution of biodigesters and experiences gained so far from the user's perspective (biodigester user surveys);
- Data on health (common ailments) in selected provinces.

### Technical data:

- Data on livestock distribution in selected provinces;
- Data on livestock rearing practices in selected provinces (purpose for which livestock is held, stabling and feeding practices);
- Data on water availability the year round;
- Data on meteorology in selected provinces, average monthly temperatures, flooding, (rain) water shortages;
- Data on building material availability and prices in selected provinces, bricks, sand, cement;
- Data on commercial enterprise in selected provinces notably number and size of registered construction companies.

### Financial and economical data:

- Data on economic activities, (un) employment and income distribution per household in selected provinces;
- Data on (micro) saving and credit availability and their conditions in selected provinces;
- Data on credit facilities from the user's perspective (user surveys).

### Institutional data:

- Data on the presence and roles of Government agencies in selected provinces;
- Data on the presence and roles of NGOs in selected provinces.



### 3.0 Living conditions of rural households

#### 3.1 Gender aspects of biodigesters, specifically the workload of women and children

The 'Food Security Assessment Report for Svay Rieng and Takeo Province' prepared by Oxfam November 2002, indicates the following gender based workload division in rural households:

	Agriculture:	Domestic	Gathering
Men	Ploughing; water supply (irrigation); rice seeds.	Men do little work at home, but do go out to find work for additional income.	Collecting firewood and other forest products (crabs, frogs, wild potatoes).
Boys	Looking after grazing cattle, vegetable growing; grass cutting for animals.	Fetching water; looking after brothers and sisters.	Collecting firewood and other forest products (crabs, frogs, wild potatoes).
Women	Broadcasting and replanting rice; weeding; vegetable planting; raising animals and composting; taking care of farm tools.	Taking care of the children; cooking; washing; fetching water.	Collecting firewood and other forest products (crabs, frogs, wild potatoes).
Girls	Rice broadcasting and replanting; grass cutting for animals.	Fetching water; looking after brothers and sisters.	Collecting firewood and other forest products (crabs, frogs, wild potatoes).

The report states that women especially perceive poor soil conditions and the lack of good rice seed as a problem.

No quantified data could be found, but it is obvious that in addition to the challenges that rural people have to contend with, women face extra difficulties. They tend to align their own interests with those of the family, doing housework in addition to the other work done for the family's food and income. Based on the experiences from other countries it can be expected that the introduction of biodigester technology will significantly reduce the workload on women. The Head of the Department of Women Affairs in Takeo Province who has monitored the effects of 15 biodigesters on women confirmed this expectation.

#### 3.2 Household Energy Sources by Province

According to a study by the NGO Cambodian Women for Peace and Development (CWPD- Rural Women Survey Cambodia, 2001), the utilization of biomass-based energy (wood, charcoal and agro-residue) is with over 90% of all energy use, highest in the province of Takeo, Siem Reap and Kampot. With 60% biomass based energy use urban Phnom Penh has the lowest figure. Other energy carriers are LPG, kerosene and electricity. The amounts used are marginal and vary from province to province depending on the availability of the energy sources and the financial means of the population

### **3.3 Fuel wood**

Until now, there is no very reliable average estimations of domestic fuel wood consumption in Cambodia. A CFSP inquiry found an average rural household consumption of 1.2 *steres*<sup>1</sup> of wood/month or 14.4 *steres*/year (Social Energetic Study, 1998). This is equivalent to 14.4 kg of wood/household/day, or 2.57 kg/capita/day (average family size is 5.6 people).

Former surveys in Cambodia (MIME, 1996), carried out in other provinces, give 9.56 kg/household/day or 1.7 kg/capita/day for rural domestic wood consumption. A FAO survey carried out in Siem Reap province, near Tonle Sap big lake (FAO, 1998 -2) finds an average firewood consumption of 14 *steres*/household/year, which is a data very close to CFSP estimate. CFSP current estimates come from user interview; CFSP is planning to start soon with field measurements for confirmation.

According to a survey of the FAO (November 2000), the quantity of wood required to satisfy people's basic energy needs for one year in rural Cambodia amounts to: 0.46 tonnes of wood and 0.12 tonnes of charcoal per person per year. Given that 1 kg of charcoal is equivalent to 3.7 kg of wood, the wood consumption is 2.5 kg/day. This figure is very near to the CFSP figure.

### **3.4 Fuel wood collection**

For rural domestic sectors, household consumption and domestic palm sugar production, fuel wood is collected directly by users in their surrounding environment which may consist of nearby forests, woodlands or shrub lands depending on settlement location. In the southern provinces where fuel wood resources become increasingly scarce, fuel wood is also bought from commercial rubber palm plantations.

Commercial fuel wood that flows along trading channels mainly comes from more dense ecosystems that are evergreen upland forest, deciduous, mixed, and flooded forests. Some woodcutters in those forests are farmers who sell fuel wood as an additional income generating activity only during the dry season (November - June). For other cutters, fuel wood trading seems to be their main income generating activity made during the whole year.

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<sup>1</sup> **Stere** = 1 cubic metre of stacked wood. 1 stere equals 360 kg of air dried wood when firewood 1 stere = 450 kg of wood when processed into charcoal

### 3.5 Potential number of beneficiaries, number and size of biodigesters to be constructed based on available dung

The table below gives the number of households in the selected provinces.

Province	No. of rural households	Total no. households	% of rural hh
Kampong Cham	338,909	356,746	95%
Kampong Speu	120,167	129,212	93%
Kandal	203,949	226,610	90%
Prey Veng	211,076	222,185	95%
Svay Rieng	105,801	109,073	97%
Takeo	167,750	167,750	100%
<b>Total</b>	<b>1,147,652</b>	<b>1,211,576</b>	<b>95%</b>

Source: Seila 2003 Commune Database <http://www.seila.gov.kh/> Database, Total Number of Families

### 3.6 Perspectives on the use of digester effluents

Limited information is documented on animal waste management at household level. The assessment that follows is based on the observation of the team, information from interviews and a household survey recently carried out by CFSP.



Pigs are commonly kept in a pigsty nearby the farmhouse. For households without a biodigester installed, the waste from the pigsty is either stored in an open pit or drained to a nearby stream or canal. No composting practice has been observed. About a third of the farmers use the manure as fertilizer for their paddy fields. Due to the bad smell and flies, the open pit is a major concern for family health and environmental pollution.

In households where biogas is installed the manure from the pigsty is flushed with a large quantity of water through an inlet channel into the digester. From the outlet, the waste is stored in an open pit or directly fed into a nearby stream. Farmers with biogas installed often apply the liquid effluent directly on the land.

Cattle are commonly kept for meat production and draught power. During the dry season animals range freely and return to the farm at night. During the wet season animals are kept at the farm and are not normally put out to graze. It is a common practice that cow dung is collected from the stable and at the farm compound and deposited at a central place. When sufficient dung is collected it is applied to the field as organic fertilizer. No cow and buffalo manure flows directly into the water. No composting methods have been observed.

The national average rice yield per year is 1.3 tonne/hectare. In the selected provinces, the average yield is 2.03 tonne/hectare (CARDI). On average, 76% of farmers in the selected provinces use chemical fertilizer to some extent. On average farmers use one to two bags of fertilizer per year at the cost of US\$16 per bag.



Digesting waste material and dung in a biodigester will minimise surface and groundwater contamination as well as bad smell and nuisance from flies. By converting waste material and dung into a more convenient and high-value fertiliser ('bio slurry'), organic matter and plant nutrients are more readily available for agricultural purposes, thus protecting soils from depletion and erosion. The effect of compost on crop production depends upon the type and condition of the soil, the quality of the seeds,

climate and other factors. However, application of compost will bring the following changes to the soil:

- Improvement of the physical structure of the soil;
- Increased soil fertility;
- Increased water-holding capacity of the soil;
- Enhanced activity of the microorganisms in the soil.

Effluent compost, if stored and applied properly, improves the soil fertility and increases cereal crop production by 10-30% as compared to farmyard manure (FYM). The application of liquid effluent on paddy, wheat and maize has increased the yield by 10%, 33% and 37% respectively. Compost application versus non-application has given a yield increase of 80% in cauliflowers, 67% increase in wheat and 21% in tomatoes. The most responsive crops to effluent compost are vegetables like root crops (carrots and radishes), potatoes, fruit trees and rice (Kharif, India-1988).

### **3.8 Land ownership**

Coming from a long period of civil war and social upheaval, the ownership of many small farms is contested. The families who work and live on these farms do not have official ownership documents and land disputes are not uncommon. Not only does the absence of land title deeds create a problem when applying for a loan, it also makes farm occupants reluctant to invest in the farm.

## 4.0 Experiences with biodigesters In Cambodia

### 4.1 Experiences gained with biodigesters perceived by the users

Since the installation of what is probably the first biodigester in Cambodia, at the provincial agricultural station in Prey Veng in 1986, over 400 plants have been built. Most of the plants have been built through NGO initiated projects (B. McIntosh September 2004). The table below gives the history of biodigesters installed in Cambodia until September 2004.

Organization/ Donor	Number Installed	Location	Year
Unknown	1	Provincial Agricultural Station, Prey Veng	1986
ADRA	>10	Siem Reap	early 1990s
VSF	>3	Bap Phnom, Prey Veng	1994
JRS, Experiment	2-3	Battambang, Svay Rieng	mid 1990s
PADEK	25	Prey Veng, Svay Rieng, Kampong Speu, Siem Reap	1995, 1996
Unknown, advised by KNCED	75	Battambang	1995
LWF	>100	Takeo	1995
UTA	10	Chamcar Daung, Kandal	1998
UTA Thesis Kean Sophea	5	Tayeung Village, Takeo	2000
Oxfam Quebec	1	Pursat	2002
Local Piggery	1	Takmaoh, Kandal	2001
FAO TELEFOOD	58	Takeo, Kampot, Siem Reap	2002
Takeo Farmers (after seeing TELEFOOD project)	10	Takeo	2002
Heifer International, supported 3 NGOs	10	Svay Rieng	2002
Huotruco Piggery	1	Takmao, Kandal	2002
Jumpah Orphanage	1	Kampong Speu	2002
Sunshine Orphanage	1	Kampong Speu	2002
UTA/MEKARN	8	New site, Takmao	2003
RCSA – Ford Foundation Grant	8	Koh Kong	2003, 2004
CRDT	30	Takeo	2003, 2004
WFP – School Curriculum	2		2004
FLD for World Vision	7	Battambang, Kampong Channang	2004
CFSP – Concrete Digesters	4 10 under construction	Takeo and Kampong Speu	2004
<b>TOTAL</b>	<b>&gt;443</b>	<b>11 provinces</b>	<b>1990-2004</b>

Most of the biodigesters installed have been plastic tube digesters, usually with a volume of between 5 to 8 m<sup>3</sup>.

To date, biodigester activities have been isolated and are without a strategy for long term and wide spread dissemination.

## 4.2 Previously conducted user surveys

There is little information available from user surveys. Of the 58 plants constructed under the FAO TELEFOOD project it is known that 28 are broken and out of operation. Two organizations, Lutheran World Federation (LWF) and Partnership for Development in Kampuchea (PADEK) have stopped the promotion of biodigesters due to their belief that the plastic digesters are not sustainable.

The University of Tropical Agriculture Foundation (UTA) undertook a biodigester survey in June 2000. The survey team was composed of 5 persons who spent a total of 9 days in the villages. The methodology for the fieldwork consisted of completion of a questionnaire through individual interviews and direct observations on the availability of the resources. In total 44 families were surveyed.

### The perceived advantages include:

- Replacing the use of firewood, dung and rice husks for cooking. Almost all households used firewood and/or a combination of firewood and dung or rice husks for cooking before installing biodigesters. This resulted in:
  - Less time spent collecting cooking fuel, particularly for children and women. This can allow more time for children to attend school and women to use their time productively tending vegetables or other activities, such as weaving. Research indicated that the women are responsible for collecting the wood in 66% of the households, either alone (36%) or shared with the children and husband. Children alone accounted for 12% and husbands alone for 10% and together 10% of the time.
  - Reduced cost for those farmers buying fuel wood and charcoal. Firewood was purchased in 25% of the cases in the UTA (2000) research.
  - Less pressure on trees and forest resources from families gathering firewood.
- Improved local environment and health conditions. The provision of a latrine resulting in better disposal of human waste, better disposal of animal waste, improvement in drinking water quality and health, particularly in areas that experience flooding. Kean Sophea (2001) cites an example in Takeo, where children previously became itchy from bathing in the pond where animal and human waste drained directly. After the installation of the biodigester, there was an improvement in the health condition of their families. Farmers also boiled water more frequently, presumably due to easier availability of cooking fuel.
- Improved health conditions due to cleaner cooking fuel, resulting in fewer problems with smoke and pollutants previously caused by burning fuel wood, dung and plastics used to start a fire. Women and children will benefit the most from improved cooking conditions.
- Cleaner cooking conditions, with less pots and kitchens blackened by smoke.
- Reduction in smell and flies from pigsties and waste discharge areas.
- Provision of a cheap and environmentally positive fertilizer. This increased the yield of vegetables, as well as reduced costs in buying chemical fertilizers. The treated waste effluent as fertilizer has been shown to improve soil conditions and improve productivity yields by 11%-20% (Marchaim, 1992 in Sophea, 2001), unlike chemical fertilizers that damage soil structure and require constant external inputs. This was demonstrated in Tamong village, where the growth of vegetables was significantly faster than without the effluent.



### **4.3 User observations and interviews during the mission**

During the mission 3 provinces, Kampong Speu, Kampong Cham and Takeo, were visited for observation of the constructed biodigesters, interviews with users and with NGO and provincial government staff.

The plants in Kampong Speu were built through the intervention of the Cambodian Fuel wood Saving Project (CFSP). The model used is the Vacvina concrete digester with external gasholder. The digesters are directly linked with medium size pigsties (approx. 15 animals), no other dung was used.

The main reason for the families to install a biodigester is waste management. The pig keeping activities result in a daily production of pig dung. This dung is either stored in a pond near the pigsty or drained away to (irrigation) canals. The result is persisting bad smell, inconvenience because of flies and complaining neighbours. After the installation of the digesters the smell and flies have largely disappeared and therefore the prime reason for installation achieved. The produced gas is largely sufficient for use in the kitchen, in one case there was enough gas to also cater for the neighbours' requirements. However, fuel wood is still used to cook pig feed and for domestic liquor stills. The effluent of the plants is not used but directly drained away. The families using these plants could afford them because of their regular income from the pig keeping. The results from the first eight plants installed in the village seemed to create much interest from other pig farmers.

The plants in Kampong Cham were installed through the FAO/MAFF-Special Programme for Food Security. Together with the plastic tube digester, the farmers received two improved sows for pig breeding. One family, which was named as typical for the region, provided the following statistics:

- The family consists of 4 adults and 4 children. For their own consumption rice and vegetables are grown on 0.5 hectare of land, cash income comes from the sale of piglets; this amounts to about US\$400 per year.
- Fuel use: 1 litre of kerosene per week for lighting purposes at a cost of 2000 riel (0.5US\$). For cooking in the kitchen, only biogas is used. Wood from rubber trees is bought from a rubber plantation and used for the cooking of pig feed. The costs amount to US\$50 per year. The family used to collect fuel wood but because of increasing scarcity, it is now buying only.
- The effluent of the plant is used in a liquid form as fertilizer on the paddy field and vegetable garden. Besides bio-fertilizer, 1.5 bags of chemical fertilizer are used annually.

The advantages of the biodigester were prioritized as follows:

- 1- Energy supply
- 2- Fertilizer supply
- 3- Sanitation, no smell from pig dung and the connected latrine

The disadvantages mentioned were:

- 1- Water problems during the dry season
- 2- The absence of technical support

In Takeo where some 15 biodigesters were installed under the /MAFF-Special Programme for Food Security, key departments of the provincial administration were interviewed. Remarkable here was the input of the Head of the Women Affairs Department. She knew the families where the plants were installed and according to her the following advantages, especially for women, were experienced:

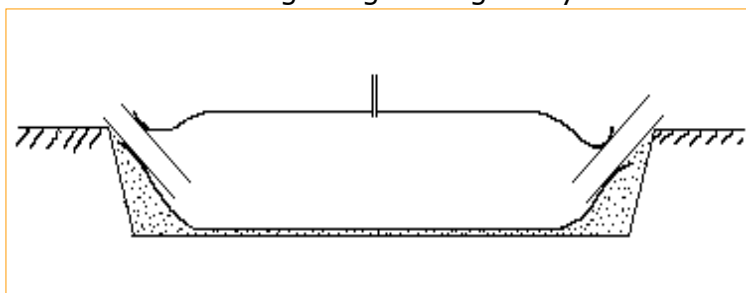
- 1- Improved household economy because of savings on firewood and increased agricultural output;
- 2- Cleaner household environment due to plant connected latrines and reduced indoor air pollution;
- 3- Time saving because of the reduced need for wood collection and cleaner cooking utensils.

None of the people interviewed considered the use of gas from human and animal waste as a problem. Any initial hesitation on the use of biogas was quickly overcome by demonstrating the advantages and because burned gas is odourless.

#### 4.4 Evaluation of current biodigesters

##### 4.4.1 Plastic tube biodigester

A plastic tube digester consists of a bag made from of Poly Ethylene (PE) in size of 5-10 cubic meters acting as digester space. The gas is stored in a separate storage bag. When required the gas is pushed out of the storage bag through a system of ropes and weights.



The plastic tube digester is the most common biodigester model installed in Cambodia. More than 443 digesters have been installed, mostly plastic bag digesters, in 11 provinces from 1986 until today. Within two years of installation more than 50% of these digesters are not working. Common defaults observed are: holes in the gas reservoir and digester tube caused by roaming livestock and human intervention; damage caused by flooding; deterioration of the plastic bag caused by extensive sun exposure; damage caused by rodents. Farmers do not replace the damaged plastic bags due to (high) additional cost for replacement. The main agencies involved in the construction of plastic bag biodigesters (more than 10) are: ADRA, LWF, PADEK, Heifer Int., FAO/TELEFOOD/MAFF, CRDT, FLD and UTA. Most of the users received financial support for the installation of the plastic digesters. Agencies operated under their own programme implementation. No national strategies are in place addressing the mass dissemination of biodigester technology.

Under these programmes the biodigesters are not covered by a guarantee scheme or an after sales service programme. After installation, farmers are responsible for repair and maintenance. The plastic bag digester does not provide the users the benefits that can be expected from a well-constructed biodigester. The low investment cost remain attractive but



calculated over a period of twenty year the farmer would have to spend a considerable amount to keep the digester in operation. In fact, most farmers discontinue their investment after a breakdown and stop using the biodigesters. The low operational rate of the plastic digester is harmful to the reputation of the biodigester technology and would pose a threat to any further initiative.

The present design of plastic tube digester is not recommended for large-scale dissemination under a national biodigester programme. Through additional Research and Development the durability of a plastic bag model can be improved and can then be considers for large-scale dissemination.



Advantages: Low initial capital cost. Further, this model can be prefabricated, is easy to transport and quick to erect, can be easily cleaned and emptied and is easy to maintain.

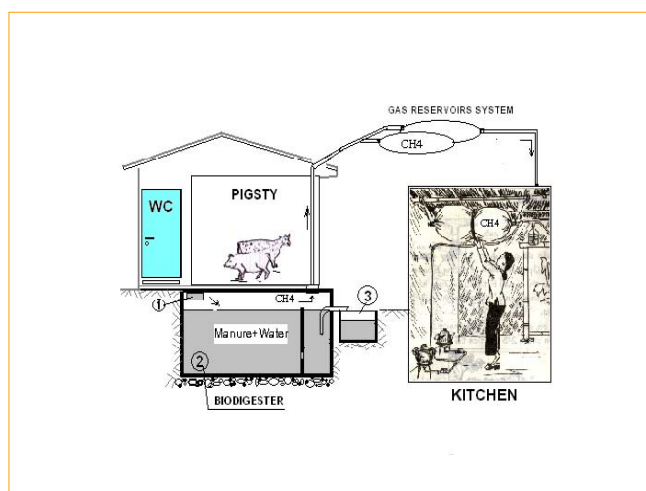
Disadvantages: The plastic bag has a short lifetime; it deteriorates under the influence of UV sunlight and is easily damaged by playing children or farm animals. A large earth surface is needed for the installation of the digester. The connection of the bag to pigsty and toilet is difficult. Compared to fixed dome models, it offers little creation of local employment. Because of the short life expectancy of this type of digester, it is unlikely they will qualify for CDM financing.

#### 4.4.2 Concrete digesters

UTA and FLD have installed a small number of concrete underground digesters. Due to gas leakage, these models have never worked successfully. It is not know what type of digester was installed.

##### VACVINA biodigester

In 2004, CFSP started with the construction of the VACVINA biodigester. This model is promoted by CCRD/VACVINA in Vietnam. CCRD/VACVINA provided a two-month training course for CFSP staff and during this period, four demonstration models were constructed. Ten additional digesters are currently under construction. The VACVINA biodigester is a rectangular box made of bricks and covered by a concrete flat slab. Through a collection channel, pig waste is flushed into the digester and a toilet is connected. By placing the inlet above the scum level, the fresh added dung is claimed to break the scum layer automatically. Through a  $\frac{3}{4}$  inch pipe, the gas is transported to a plastic bag gasholder situated in the kitchen. From the gas holder a connection is made to the gas stove. The slurry is deposited into a nearby channel. Composting has not been practiced yet.



**Advantages:** Easy construction of walls, durable, underground construction thus little space is needed, easy operation and maintenance.

**Disadvantages:**

- The walls of the digester are treated with five layers of sand and cement to prevent leakage. This treatment is unnecessary. Minor leakage through the floor or wall will over time be clogged by the sludge inside the digester. This treatment adds unnecessary cost.
- The roof inside (cover slab) of the digester is not treated to prevent gas leakage; the reason given being the low gas pressure inside the gas-holding compartment. As the quality of casting on site cannot be guaranteed, it is recommended that the five layers treatment is applied on the gas holding area inside the digester.
- The rectangular shaped digester has an unfavourable surface/volume ratio when compared to a spherical shaped digester.
- Gas is transport to the gas holding plastic bag through the open air and is exposed to excessive sunlight. Within two years, the quality of the PVC piping will deteriorate significantly and cause gas leakage. To extend the lifetime of the piping preventative measures are recommended like burying the pipeline or covering it with suitable material.
- The pipeline has many unnecessary fittings thus increasing the chances of leakage as well as the cost.
- The flow dynamic of a rectangular shaped digester is far from optimal as there will be 'dead' areas in the corners.
- The position of the inlet in relation to the outlet is not standardized. As a result, the inlet can be positioned directly opposite the outlet. As a result, the HRT is short and most of the digester content is 'dead' area.
- By placing the inlet above the scum layer the fresh material is not 'forced' to mix through with the existing slurry.
- The inlet siphon is located at the highest point in the gasholder and functions as a gas lock. The correct positioning of the inlet siphon is difficult and may cause faulty operation i.e. gas leakage or the entrance of air into the digester.

The VACVINA biodigester model is newly introduced in Cambodia and no information is available on its performance. It is recommended to monitor the performance of these digesters.

#### **4.5 The need for quality**

The importance of correct overall quality of the biodigesters for the success of the introduction of the technology as a generally accepted source of energy and waste management is found in:

- Safeguarding the investment of the farmer and so increasing confidence in the technology;
- Levelling the playing field amongst the competing companies in order to create a healthy commercial environment;
- Safeguarding the reputation of biogas technology as a whole to create a "self-promoting" atmosphere for this new technology.

A proper understanding of this quality concept thus implies that maintenance and further improvement of product-quality is a condition for the creation of an indigenous, sustainable, market-oriented biogas sector through which the

technology can be further disseminated. With less than 50% of the plastic biodigesters in regular use of two years after installation and no proven track record on the performance of concrete digesters, it is evident there is a need for standardization and quality management for the sector. Issues related to the quality of the design, quality of construction, quality of operation and maintenance of the plant by the user, the quality of after sales service provided, as well as the quality of appliances is a priority when setting up a National Biodigester Programme.

#### **4.6 The need, quality and production of appliances related to biodigester operation and biodigester use**

High quality appliances are essential for faultless operation and minimizing repair and maintenance cost. Where possible, readily available appliances are procured from existing market outlets. If suitable appliances are not available, they will have to be manufactured through local workshops. Through training and business opportunities, local workshops will be encouraged to manufacture standardized biodigester appliances.

Biogas stoves are manufactured in Phnom Penh by a workshop at the request of CFSP. These stoves are copies of a VACVINA design and only suitable for use at low gas pressure (8 cm water column). Because of the low gas pressure, they have no primary air intake. Dirt can easily accumulate in the burner cup and is difficult to clean. This type of stove is not suitable for higher gas pressure as is the case with fixed dome biodigesters.

Biodigesters fed by dung from the pigsty receive excessive water as farmers flush the manure with plenty of water inside the digester. The recommended water/dung ratio is one to one for optimum gas production. The development of a device or method is needed to separate the excessive water and ensure the correct feeding water/dung ratio of the digester.

Biodigesters fed by cow dung require a mixing tank where water and dung can be mixed into a homogenous mixture. The mixing tank is constructed with brick and the mixing device is made out of galvanized metal. These mixing devices are not available, as the team has not observed the use of cow dung for biodigesters. Most likely this type of mixers can be manufactured locally.

Commonly available PVC taps are used to regulate the gas flow to the stove. There are currently no records available on the performance of these taps.

To regulate the pressure in the digester, a safety valve device is installed in the pipeline. The safety valve ensures that in case of over pressure in the digester (>10 cm water column), gas can escape into the atmosphere. The safety device is made out of a waste plastic bottle filled with water. In case of incorrect water levels in the safety valve, i.e. because of evaporation, gas will escape. The device requires regular maintenance by the users and its design is not durable. This device is not required in a fixed dome design.

A PVC water drain is positioned at the lowest point of the pipeline to remove excess water in the pipeline. There are no records on the performance of this type of water drain. There are currently no records on the performance of appliances. Through regular monitoring and quality control, more insight will be obtained about the user-friendliness of the device and durability.



## 5.0 Technical Factors

### 5.1 Availability of animal dung

Veterinaires Sans Frontiers (VSF) has conducted an extensive study in 3 of the 6 selected provinces. In the provinces Svay Rieng, Prey Veng and Takeo over 1000 rural households were interviewed on the number of pigs and cattle they own. Extrapolating the outcome over the 6 provinces gives the following results:

Table: Extrapolation of average percentage of cows and buffaloes for Cambodia and for Kampong Cham, Kampong Speu, Kendal, Takeo, Prey Veng and Svay Rieng province. The six selected provinces have 51% of Cambodia's cows, buffaloes and pigs.

There is little information available on livestock rearing practices. Pigs are kept in confined places that vary widely in quality, ranging from the animals being tied with a rope to a tree or pole to covered pigsties with a hard floor. Pig dung is considered a waste product as it is usually disposed of in surface water. Pigs are sold for slaughter when they are about 100 kgs. The average weight of the pig population can be estimated at 60 kgs i.e. the average pig will produce about 3.5 kgs of dung per day. This has the potential to produce of 180 litres of biogas per day.

Cattle are kept for beef, for draft power and as safekeeping of financial resources. There are no dairy cattle. There is a great variety in the size, condition and breed of the cattle population. It is common practice during the paddy-growing season to keep the cattle at the farmyard; this lasts for about 6 months. During the rest of the year the cattle are roaming free during the day and kept at the farmyard during the night. The dung produced at the farmyard is collected to be used as fertilizer.

Estimated Distribution of cattle over rural households					
# of animals p/hh	%	# cows/buff Pilot	# cows/buff National	# families Pilot	# families National
0	9.6%			339,064	339,064
1	11.8%	235,911	464,825	235,911	464,825
2	30.8%	614,085	1,209,957	307,043	604,979
3	20.9%	417,227	822,080	139,076	274,027
4	15.7%	312,223	615,186	78,056	153,796
5	5.6%	111,978	220,635	22,396	44,127
6	3.1%	61,568	121,310	10,261	20,218
7	1.2%	24,308	47,896	3,473	6,842
8	0.6%	11,218	22,103	1,402	2,763
9	0.3%	5,977	11,778	664	1,309
10	0.2%	4,782	9,422	478	942
		1,799,277	3,545,190	1,137,823	1,573,827
estimated Total # of families with cow/buffalo for biodigester				798,759	1,573,827



It can be safely concluded that at least 25% of rural families have enough raw material available to feed a biodigester. The average size will be small, between 4 to 8m<sup>3</sup>; also because of the favourable temperatures the year round which allows for a relatively short hydraulic retention time (HRT) of 30 days. Based on the VSF survey this amounts to 224,000 families. However, to get data that are more accurate, in-depth field study will be required. There is little information available on livestock rearing practices. Cattle are kept for beef, for draft power and as financial security.

Estimated Distribution of pigs over rural households					
# of animals p/hh	%	# animals Pilot	# animals National	# Families	National
0	17.3%			186,315	363,820
1	32.0%	419,035	818,256	419,035	818,256
2	20.7%	270,286	527,792	135,143	263,896
3	9.9%	128,863	251,634	42,954	83,878
4	5.1%	66,983	130,798	16,746	32,700
5	3.2%	41,472	80,983	8,294	16,197
6	1.9%	25,119	49,049	4,186	8,175
7	1.7%	22,764	44,451	3,252	6,350
8	1.2%	16,092	31,422	2,011	3,928
9	1.2%	15,307	29,889	1,701	3,321
10	1.0%	12,690	24,780	1,269	2,478
11	1.1%	14,522	28,357	1,320	2,578
12	0.7%	9,158	17,883	763	1,490
13	0.9%	11,774	22,992	906	1,769
14	0.4%	5,495	10,730	392	766
		1,059,557	2,069,016	824,288	1,609,601
estimated Total # of families with > 4 pigs				<b>40,841</b>	<b>79,751</b>

## 5.2 Available construction materials

Construction materials used in the digester construction such as cement, sand, aggregate etc. must be of good quality, and otherwise the quality of the digester will be poor even if design and workmanship involved are excellent. A brief description on the specifications and findings follows.

The cement to be used in the digester construction has to be of high quality Portland cement from a brand with a good reputation. In Cambodia, cement is easy available in both good quality and lesser quality. The Thai brands use animals and symbols (elephant, tiger and diamond) to show the different cement classes. Cement is transported from small towns to the project sites.

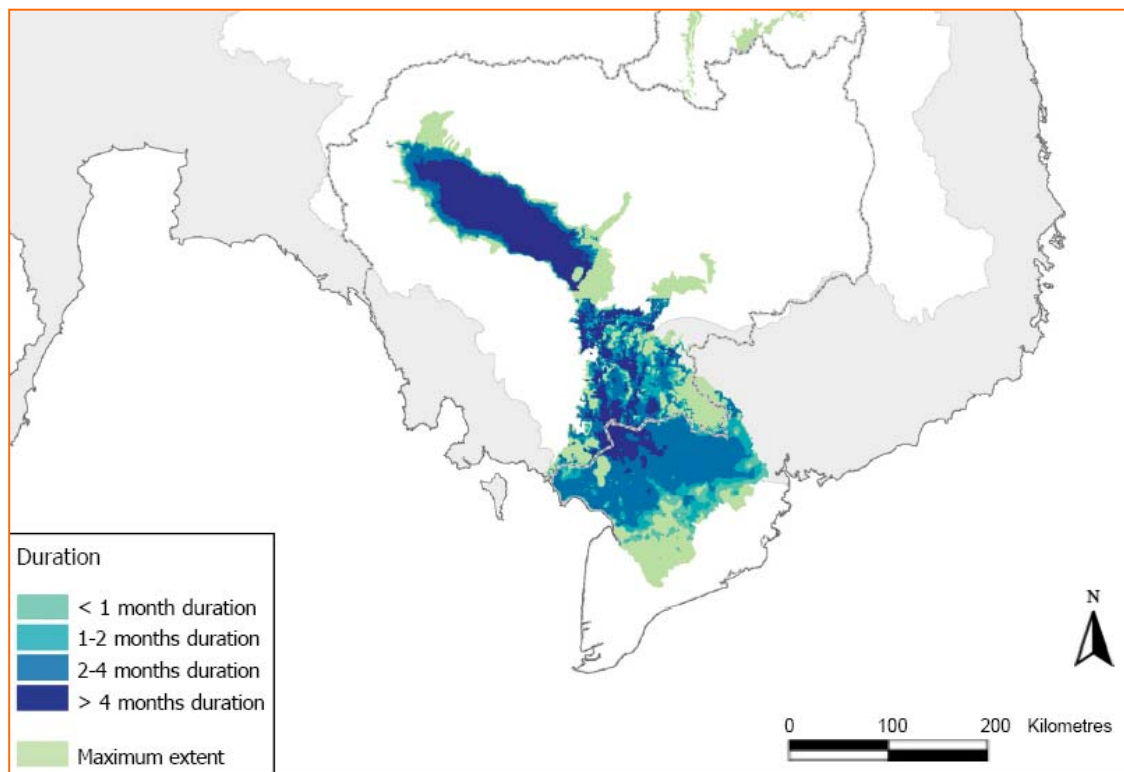
Sand and gravel for construction purposes are commonly available and are supplied to the construction site. In a few cases, users are able to self-supply sand and gravel. The observed sand is of good quality and clean.

The availability of clean water for construction purposes varies widely. Sometimes, access to clean water is limited and there is shortage during the dry season. Rainwater harvesting methods are commonly used and a fair number of families make use of (shallow) wells. During the wet season, water is easily available in local ponds. The water from these ponds requires basic treatment i.e. filtering the water through a cloth, before use for construction purposes. However, water for construction purposes is limited and water as such is nowhere a problem in Cambodia.

Bricks are commonly available at the nearest town centre and are transported to the site by the supplier. The bricks that have been observed by the team are regular shaped and are of good quality. There are three types of bricks and two types of baked clay string press brick, the small and compact type and larger and perforated type. Concrete blocks are also used for construction purposes. Natural stone is not commonly used as building material.

### 5.3 Flooding

The biggest constraint for large-scale dissemination of biodigesters is probably the frequent occurrence of flooding. Flooding is a part of the natural cycle of the Mekong River. The annual monsoon rains flow down the river with such force that the Mekong pushes the Tonle Sap River backwards to expand the Great Lake to approximately four times its dry season size. Further, downstream, the Mekong spills over its banks in the Delta, flooding large areas for several months at a time. In the northern parts of the LMB, flash floods that rise and fall quickly are common on the Mekong mainstream and its tributaries. In the lowlands around the Great Lake and the Delta, large areas are inundated for between one and four months. The most affected of the selected provinces are Kampong Cham and Prey Veng. See map below.



In addition, when the land is not flooded the high water table for a large part of the year makes subsoil construction difficult. Applied research during the pilot phase of an eventual programme must have a strong focus on this problem.

## **6.0 Social Factors**

According to provincial extension workers and NGOs presently involved in the dissemination of biodigesters there is little or no objection to the use of gas generated from animal and human waste. Any initial objection by potential plant owners might disappear once the actual use of the gas is experienced at demonstration plants or at plants nearby. More problematic might be the composting of plant effluent when latrines are attached. At the moment little importance is given by the various organizations to the composting part, the emphasis lies with waste management and energy. Given that the bulk of the farms are small with some livestock and agricultural land, the use of plant effluent will have to play an important part of an eventual programme.

## **7.0 Institutional Factors**

### **7.1 Government Institutions**

The main institutions involved in the Energy sector in Cambodia are the Ministry of Industry, Mines and Energy (MIME), Ministry of Economy and Finance (MEF), Electricité du Cambodge (EDC), the Electricity Authority of Cambodia (EAC), Provincial Electricity Utilities and private sector. EDC is owned and controlled by MIME and MEF. [Cambodia Energy Sector Strategy]

#### 7.1.1 Ministry of Industries Mines and Energy (MIME)

The main objectives of the energy policy formulated by MIME in 1995 address the electrification of urban and rural Cambodia. Reference is made to biogas on an industrial scale only as an efficient means of cogeneration or combined Heat and power generation. No specific reference is made to biogas as a renewable energy source for cooking and/or lighting for rural households. Under C-2 Wood Energy Strategy: "The substitution of wood fuel by other biomass, wood residue and agricultural residues" is the best reference in the energy policy to the dissemination of domestic biodigesters to rural households.

The General Department of Energy (DET) of the Ministry of Mines and Energy, and the Cambodian Fuel wood Saving Project (CFSP) signed an agreement for the implementation of CFSP Phase 2, covering six provinces from September 2002 to August 2006. Under this agreement CFSP's objectives are to disseminate and implement R&D on Improved Cooking Stoves (ICS) and other wood energy saving devices, engage in institutional development to promote sustainable wood energy use, facilitate technology exchange and support the Government of Cambodia to establish a national wood energy policy.

#### Strengths:

- National Policy development for electrification including rural identification.
- Preparedness of MIME to cooperate in the development of a national biogas programme.
- MIME established partnership with the World bank, NEDO, CGD, etc.
- MIME developed technical standards for electrification.
- MIME established in cooperation with programme partners a rural electrification fund managed through an inter-ministerial committee.
- MIME installed two small Industrial biodigesters (@35kW) in operation for co-generation of rural electricity.

#### Constraints:

- MIME's main focus is on the implementation of urban and rural electrification, limited scope on other RET.
- MIME has no direct affiliation with rural households.
- Although MIME has an office in every provincial capital, it has limited presence in the districts.

Renewable Energy Technologies (RET) with electricity as output fall under the mandate of MIME. From both outputs of the biodigesters; bio slurry and biogas no electricity can be generated due to the limited capacity of the biodigester.

#### 7.1.2 Ministry of Agriculture Forestry and Fishery (MAFF)

MAFF has 12 Departments, including Fisheries, Forestry and a range of agricultural departments of agro-industry, animal health and production, agricultural extension and agricultural legislation.

On provincial and district level the ministry has offices in the fields of agronomy, animal health and production, extension services, fisheries and forestry.

Besides the departments, which seem to be quite vertically structured, there are also programmes that fall directly under the minister's responsibility. One of them is the FAO funded Special Programme for Food Security (SPFS). This programme provides farm inputs and training to contribute to food security in 4 provinces, 26 districts and 56 villages. It was established in 1997 and has 80 staff members. This programme is comprised of staff from various departments including Agro-Industry, Animal Health and Production; Fisheries and Agricultural Extension, as well as staff from the Ministry of Water Resources and Meteorology. They have formed teams at the National, Provincial and District levels while at national level it has a Steering Committee chaired by a MAFF Secretary of State. Both current and previous National Co-ordinators of the SPFS programme have been involved in biodigesters in Cambodia (SPFS, 2002).

With funding from a FAO TELEFOOD project, the programme installed 58 plastic tube biodigesters in 4 provinces in 2002. The objective of the project was to use human and animal waste to produce gas for cooking and effluent for organic fertilizer with the aim to increase family income through the integration of farm components.

Since August 2003 the programme is under national ownership and MAFF is fully responsible for SPFS. A steering committee oversees the SPFS programme and comprises a Chairperson and deputy Chairperson (MAFF) and representatives of each department within MAFF working with SPFS. On occasions where further collaboration and integration is needed membership may expand to include membership from the Ministry of Women Affairs and Veterans, Ministry of Health and Ministry of Rural development.

**Strengths:**

- MAFF/SPFS staff are knowledgeable and experienced with the installation and application of plastic tube biodigesters.
- MAFF/SPFS implements extension programmes in 5 provinces and 4 districts with 80 programme staff of various disciplines.
- MAFF/SPFS expressed interest to be involved in extension activities for the dissemination of biodigesters.
- Through MAFF/SPFS agricultural training centers, awareness raising and users training can be facilitated.
- MAFF/SPFS conducts ongoing activities on waste management of pig manure and the introduction of improved pig pens.
- MAFF has the standing and authority to lead the involvement of other Governmental institutions in a given programme.
- MAFF has presence in almost all rural areas of the country.

**Weaknesses:**

- A high percentage of biodigesters is not working due to lack of guarantee and after sales service.
- Limited information on the impact of biodigesters on households.

7.1.3 Ministry of Environment (MoE)

There are 6 main departments in the Ministry of Environment, involving EIA, Nature Conservation, Pollution Control, Education and Planning. The office most relevant to biodigesters is the Climate Change Office in the Department of Planning. Their mandate is to support activities that reduce greenhouse gas emissions and adapt to climate change. The office is supportive of the use of biodigesters to reduce methane emissions, as methane is a strong greenhouse gas.

On 15 July 2003 the Climate Change Office of the MoE was appointed the interim Designated National Authority (DNA) for Cambodia and will coordinate Clean Development Mechanism (CDM) related activities on behalf of the MoE.

7.1.4 Ministry of Rural Development (MRD)

Since the overthrow of the Khmer Rouge regime, MRD, together with the Ministry of Interior, has been responsible for the re-establishment of local institutions such as Village Development Committees. Since then 8070 VDCs have been established out of approx 13000 villages. VDCs are responsible for the planning of their own activities and responsible for resources mobilization. VDCs are assisted by NGOs in planning and implementation activities.

In February 2002, Cambodia elected its first decentralised government bodies, the commune councils. There are 1,621 communes with a total of 11,261 elected councillors. Besides tasks delegated by the central government authorities, the commune councils have the responsibility to promote good governance by managing and using existing sources in a sustainable manner to meet the basic needs of the commune. Specific duties include:

- Maintenance of security and public order;
- Arranging for necessary public services such as water sanitation, road construction, health, education, waste management;
- Promotion of social and economic development;
- Protection and conservation of the environment and natural resources.

Each council prepares annually an Investment Programme.

At the provincial level, the Provincial Governor is responsible for mobilizing and coordinating provincial departments of line ministries to support and supervise the Commune Councils. The Governor is also responsible for establishing a development planning and support system with provincial department staff (including Department of Planning; Department of Local Administration; Department of Rural Development; Department of Economy and Finance and Provincial Treasury). This process is coordinated through a committee (currently called the Provincial Rural Development Committee).

To support the decentralization process, the Seila programme was established in 1996 (Seila means foundation stone in Khmer language). The Seila programme focuses on developing and strengthening local institutions and providing grant finance for investments in locally managed infrastructure and public services (identified through the participatory process at both the provincial and commune levels). The Seila programme, with a 2004 budget of \$US 40m, is supported financially by the UNDP, SIDA, DfID and the World Bank (World Bank, 2003). Nowadays the Cambodian Government puts the largest party of the Seila budget on the table.

Agricultural programmes that relate to the decentralisation process and may be relevant to biodigester activities include ADESS and CBRD. ADESS (Agricultural Development Support Project to Seila) is a national sector programme for agricultural and rural infrastructure development operated through Seila in selected provinces funded by IFAD and co financed by UNDP and AusAID (World Bank, 2003). It targets over 60,000 poor families in Banteay Meanchey, Battambang, Pursat and Siem Reap, including rural savings and credit services and technical and management training (IFAD, 2004). CBRDP (Community Based Rural Development Project) focuses on establishing sustainable sources of food and income in rural poor communities in Kampong Thom and Kampot funded by IFAD and co financed by GTZ, WFP and AusAID, including farmer-based extension and a demonstration programme to transfer better agriculture technologies, rehabilitation of small and medium irrigation and water-control schemes to improve water availability for crops, improvements to roads and drinking water. (IFAD, 2004)



#### 7.1.5 Ministry of Women's and Veterans Affairs (MWVA)

The mandate of the Ministry of Women and Veterans Affairs is to promote the status of women through integration of gender equality issues in policies and programmes. MWVA implements a credit programme in 17 provinces to assist poor families especially women. Credit groups are formed at village level. The credit is mainly used for agricultural activities, small businesses, handicraft and food processing. In 2002 the total loan outstanding was  $\sim 1.5 \cdot 10^9$  riel ( $\sim 375000$  US\$) and 53000 persons borrowed with a monthly interest rate of 3%. On both national and provincial level staff of MWVA are aware of the benefits and advantages of a biodigester. It was confirmed that it is increasingly difficult for rural households to find wood fuel and that access to nearby forests is increasingly difficult due to imposed environmental restrictions. MWVA is interested to promote the dissemination of biodigesters and to promote training of female masons.

### **7.1 Credit Institutions**

#### 7.2.1 History of Micro Credit in Cambodia

During the 1980s, some international organizations and NGOs started focusing on relief-oriented programs. UNICEF had then set up a project for providing credit/grants for economic activities. Many NGOs and international organizations started microfinance activities in the early 1990s and although there was no legal framework for microfinance at that time, this did not hinder the growth of semi-formal microfinance. The 1990s saw some key developments in terms of the legal and political environment for microfinance.

In 1995, the Credit Committee for Rural Development (CCRD) was established to improve the efficiency of rural credit and to mobilize foreign aid to support microfinance institutions in developing rural credit programmes. In 1998, the Rural Development Bank was established with a capital of US\$ 5 million. One of the bank's main activities is to provide wholesale lending to microfinance institutions and credit operators. In January 2000, the National Bank of Cambodia (NBC) issued a law on licensing microfinance institutions. This law stipulates that all NGOs, associations and MFIs engaged in credit services with more than 1,000 clients should be licensed with the NBC. Today, Cambodia counts about 90 credit operators including licensed MFIs and NGOs that provide credit services. At year-end 2002, about 40 credit operators were serving 351,055 clients for total loans amounting to US\$ 60 million. According to a study by Uniconsult in 1999, rural credit demand in Cambodia is estimated at US\$ 125 million, thus indicating a shortage of supply close to US\$ 65 million.

#### 7.2.2 KfW/Vietnam

Following up on our initial Bonn discussion, the German Development Bank (KfW) has been seriously considering regional funding modalities to accommodate Renewable Energy (RE) project financing. However, from a practical point of view there seem to be many obstacles. Therefore, they currently tend to favour a country approach. It is important to know that KfW is seriously looking into expanding its RE financing portfolio. KfW would prefer channelling funds through banks. In this respect, they have good experience in Cambodia with the ACLEDA investment bank.

### 7.2.3 ACLEDA Bank Plc.

ACLEDA was established in January 1993, as a national NGO for micro and small enterprises development and credit. From its earliest days, it enjoyed the support of a number of major international development agencies. Two factors, namely expansion of its network to cover 21 of Cambodia's 24 provinces/towns and its ability to operate at a profit to ensure its sustainability, led both the board and the international partners to conclude that it should be transformed into a commercial bank.

Under the commercialization process, the original NGO has transferred its assets and on-lent its liabilities (long term loans from donors) to the new ACLEDA Bank. In return, it has received 44.91% of the bank's capital of US\$ 4 million; the ACLEDA Staff Association (ASA), a trust established to give its staff an equity interest, has purchased 6.09% and the remaining 49% has been taken up in equal parts by four foreign investors, namely the International Finance Corporation (a division of the World Bank), DEG/KfW Bankengruppe (Germany), FMO and Triodos Bank (The Netherlands.) It is intended that ACLEDA Bank will seek a listing on a stock exchange at some time in the future.

On 1 December 2003, ACLEDA Bank obtained a license as a commercial bank after it tripled its capital to US\$ 13 million, and is now named ACLEDA Bank Plc.

ACLEDA Bank provides Micro Business loans to individuals (up to Euro 384) or groups (up to Euro 375 per group member). The repayment period is of maximum one year with an interest rate varying from 2% - 4.5% per month. ACLEDA is proactive to attract customers and provides training to new users on how to obtain micro credit. ACLEDA staff assists clients with the processing of the application form and within three working days, the loan is completed. Currently ACLEDA is not familiar with providing credit for the installation of biodigesters or other Renewable Energy Technologies (RETs). ACLEDA is planning to extend its present network and can in the near future accommodate micro credit created for the RET/biodigesters under the condition that favourable terms and conditions for RET/biodigesters credits are created i.e. extend repayments period of more than one year.

### 7.2.4 AFD (French Development Agency) and AMRET

The Agence Française de Développement Group, the main operator for the French bilateral development assistance system, is involved in more than 60 countries in Africa, the Pacific, Asia, the Indian Ocean, the Mediterranean and the Caribbean as well as the region of the Guyanese Plateau. It conducts missions in these areas on its own behalf and on the behalf of the State. In Cambodia, AFD has been active in the development and support of the Micro Finance Institution 'AMRET'. AMRET's mission is "to provide financial services that are suitable for the needs of most of the rural population while ensuring AMRET's long term sustainability". AMRET is an actual word in Sanskrit; it simultaneously conveys the notions of prosperity, durability and happiness. The interest rates range from 3% to 4% per month. In addition to existing partners, Rural Development bank, Dexia and the Micro Alliance Fund, new partners have been attracted: Calvert Foundation, Triodos and Sicav Nord-Sud (annual report 2003).

## 7.3 NGO Sector

### 7.3.1 The Cambodian Rural Development Team (CRDT)

The Cambodian Rural Development Team is a community organization, formed to undertake development projects, which seek to improve the living standards of the most vulnerable, in subsistence communities throughout rural Cambodia. Its activities include the installation of 35 plastic tube biodigesters, farmers training in integrated farming techniques and set-up of demonstration plots and fish ponds.

#### Strengths:

- CRDT is experienced in conducting training at village level;
- CRDT is experienced in Training of Trainers programmes in new technologies;
- CRDT maintains good contact with end users;
- CRDT is willing to act as contractor to deliver biodigesters;
- CRDT has established partnership with Government agencies/UTA/FLD.

#### Weakness:

- Lack of proven capability of impact monitoring of activities
- Limited outreach to rural communities
- CRDT dependency on expatriate involvement for funding and management
- CRDT's wide scope of activities and informal status, registration as NGO is pending

### 7.3.2 Cambodian Fuel wood Savings Project(CFSP)

The Cambodian Fuel wood Saving Project was established in 1997 by GERES (a French INGO. To date, the main focus of their activities has been on establishing markets and distributors for the dissemination of improved cook stoves. Recently, they have expanded their activities to focus on wood energy policy, production of wood vinegar, solar cookers and biodigesters. The main programme components are: technical facilitation, dissemination and programme administration.

CFSP is formally registered as an NGO with Ministry of Foreign Affairs and International Cooperation (MOFAIC) and is formally linked to Department of Energy Technologies of MIME.

A national level CFSP, in coordination with relevant Government Ministries (MAFF/MoE/MRD/WA/MIME) is in the process of formulating a national energy strategy and wood policy. Other activities are: planning and coordination of R&D, sector wide planning and target setting, mobilization of resources, elaboration on regulatory frameworks (standards, criteria for registration, licensing), monitoring and evaluation, coordination with related national programmes from the NGO sector.

At the provincial level CFSP is responsible for local promotion and marketing, extension services, selection, recruitment and supervision of ICS and biodigester building teams (BBT), credit facilitation, liaison with local programmes (NGOs).

In 2004 CFSP facilitated a training session to transfer Vietnamese underground concrete digester technology where 16 people attended the training. In May 2004 CFSP installed the first VACVINA biodigesters.

In September 2004, CFSP commissioned a survey on biodigesters in Takeo, Kendal, Phnom Penh, Kampong Speu, Prey Vang and Svay Reng. The objective of the study was to identify the demand for biodigesters and affordability of the technology. The study concluded that more than 90% of small-scale pig breeders are willing to invest in biodigesters. In October 2004 CFSP organized a one-day information workshop on biodigesters.

**Strengths:**

- CFSP runs a well-established office and maintains an excellent network with (I)NGOs and Government agencies;
- CFSP has a leading coordination role in the ICS sector;
- CFSP has a strong focus on dissemination, is output oriented and has highly motivated staff;
- Focus on capacity development;
- CFSP could develop into a strong partner in a National Biodigester Programme.

**Weakness:**

- CFSP activities depend on external donor funding and are project focused;
- Absence of long-term government commitment to implement wood savings activities, absence of a national policy on wood savings;
- Weak institutional linkage with government agencies on national and provincial level.

### 7.3.3 Farmer Livelihood Development Organization (FLD)

Localizing the SCALE programme created Farmer Livelihood Development. SCALE was established by Southeast Asian Outreach (SAO) in 1991 and commenced operations as a fish-focused food security project. However, it successfully expanded its operations and developed into a programme running several integrated rural development projects.

FLD's vision is for "Healthy, well-fed communities" and its mission is "To contribute to sustainable improvement in nutrition, food security and income in subsistence rural farming communities by promoting farmer-proven diversification of livelihood activities based on traditional knowledge."

FLD undertakes rural development projects surrounding food security involving: integrated farming, farmer training, rice intensification, village aquaculture, small livestock and vegetable production, and small scale credit schemes. As such, World Vision engaged FLD to assist with the delivery of a food security and income generating rural development project. As part of this development, villagers were trained in a number of farming techniques, including plastic tube biodigesters with latrines. Subsequently 5 villagers installed biodigesters.

FLD use low cost materials for the plastic tube digesters, including a unique gas cooker made from a can and traditional cook stove; as well as using flexible tubing for the pipes, rather than the rigid PVC pipes. They claim to be able to install systems for US\$18-25 (Rotha, 2004).

**Strengths:**

- FLD's previous relation with international agencies and access to excellent baseline data and PRA documentation;
- FLD's outreach to more than 1050 households in project area;
- FLD's experience with biodigesters and biogas training to farmer; 400-600 farmers have been trained;
- FLD promotes integrated farming practices;
- FLD operated a small scale Micro Credit scheme at village level (maximum amount 10-15 US\$ with months interest rate of 3%-3.5%) covering 45 villages.

**Weakness:**

- Despite the large number of farmer trainings on biogas, few biodigesters have actually been constructed;
- No monitoring records on the performance of these biodigesters and impact on users.

7.3.4 Cambodia Women for Peace and Development (CWPD)

The Cambodia Women for Peace and Development is a non-Governmental organisation established in 1999 with roots in the Women Association Cambodia with up to 2 million members. The objectives of CWPD are to reduce poverty through economic activities, improve healthcare, promote women's rights and increase women's participation in governance. Through a network with more than 1600 communes, CWPD is in an excellent position to promote and create awareness on the use of biodigesters.

7.3.5 Centre for Livestock Development and Agricultural Development, University of Tropical Agriculture (UTA)

The University of Tropical Agriculture Foundation (UTA) was established in Vietnam in 1996, at the University of Agriculture and Forestry (now the Nong Lam University), Ho Chi Minh City. The aim was to offer a wider range of opportunities to learn and do research about sustainable agriculture for tropical conditions. The first ecological farm was set up in Vietnam, where UTA carried on activities in research and training until 1999. From 1999 to 2002, UTA's activities were based in Cambodia. Since January 2003 UTA's base is on an Ecological Farm in South Santander, Colombia.

From 1997 UTA conducted training courses on biodigester technology resulting in the further installation of plastic tube biodigester through SPFS, FLD, RCSA and UTA. UTA carried out research on biodigesters, i.e.; i) Effluent from biodigesters with different retention times for primary production and feed of Tilapia (*Oreochromis niloticus*), ii) Effect of retention time on gas production and fertilizer value of biodigester effluent.

At the time of the visits to the centre, no documentation was available on the activities of UTA. Reference was made to the UTA and MEKARM websites.

The UTA Research Centre is situated 30 minutes outside Phnom Penh. The centre is used for research on and extension of agricultural practices. The centre is equipped with training facilities, dormitories and a laboratory.

## **7.4 Private sector**

The private sector has not been involved in the construction of biodigesters in Cambodia. The main organizations involved in construction of biodigesters are (I)NGOs and one Government agency.

In Kampong Speu 14 construction-companies are registered and there are 37 construction-companies in Takeo Province. No information is available on the type of construction work by these companies. In rural Cambodia 63344 men and women (13.5%) are working in the construction sector, 10580 are self-employed and 51303 are employees (National Institute of Statistics, 2001). Carpenters are self-employed in most villages in Cambodia. With additional training, these artisans could acquire other construction skills like the construction of biodigesters.

Water harvesting, whereby water is stored in cement jars, is a commonly applied by household in Cambodia. In the past, numerous artisans have been trained in jar making who now have established their own micro enterprises. These jar makers are a potential group that could be trained in the construction techniques for biodigesters.

In Cambodia 34 Technical and Vocational Training Centres are registered and one school is specialized in construction training. No information is available on the activities of the School of Construction and from 1996-2002 there are no enrolment figures for this school available. Vocational training centers in Cambodia are often established by NGOs and have the widows from the Pol Pot regime as a target group. The trainings are mainly focused on income generating skills (sewing, nail polishing, small machine repair, etc).

Artisans in the rural areas are trained on the job through apprenticeships while the workers on the larger construction sites in urban areas are mainly of Vietnamese origin.

### **Recommendation:**

- Training of technical staff is initially (phase I) the responsibility of the National Biodigester Programme.
- For the training of technical staff in Cambodia, assistance is required from countries with extensive expertise in technical training (Nepal and Vietnam).

The National Biodigester Programme will initiate the establishment of formal technical training of biodigester technicians.

### **7.4.1 iLi-Consult**

iLi-Consult is an engineering consultant that specializes in architectural and civil engineering design. iLi-Consult is experienced with site supervision on behalf of (international) clients, and has the technical capacity to develop drawing and technical documents. The company's director has an interest in and experience with household biodigesters



## **7.5 Multilateral Development Agencies**

### **7.5.1 Food and Agriculture Organization of the United Nations (FAO), Special Programme for Food Security (SPFS)**

The main objective of the SPFS is to help Low-Income-Food-Deficit-Country (LIFDCs) to improve food security both at national and at household levels- through rapid increases in food production and productivity, by reducing year-to-year variability in production - on an economically and environmentally sustainable basis and by improving people's access to food.

The Special Programme is founded inter alia on the concepts of national ownership, participatory and multidisciplinary approach, poverty alleviation, economic and environmental sustainability and social and gender equity.

FAO is budget holder on behalf of international organizations including DANIDA, DfID, AusAID, ADB and SIDA. The budget management rates charged by the FAO range from 7% to 13% annually.

## **8.0 Financial And Economic Factors**

### **8.1 Credit availability**

The most common source for credit is village moneylenders. Their interest rates are very high, between 8% and 12% per month, but they are easily accessible. This type of loan is mostly used in cases of emergency i.e. illness.

There are almost 90 microfinance organizations and projects operating in Cambodia, which are not regulated by the National Bank of Cambodia. In addition, credit from regulated sources is expensive, between 3% and 4.5% per month with a maximum duration of 18 months. The reasons given for the high interest rates are:

- The required funding needs to be borrowed by the financial institutions from the international money market at high rates because of their credit rating.
- Money is acquired in US dollars but the loans are given out and are repaid in Cambodian Riel.
- Small loans in the rural areas are considered to be high-risk loans.
- Of all official small rural loans provided, less than 25% went into farm improvement. Most loans went to light manufacturing, small agro-processing and market trading (AFD).



## **8.2 Financial and Economic factors**

There is very little direct capital available among the farming households who otherwise fulfil the criteria for biodigester installation. The difficulty to get reasonable credit, with less than 20% interest annually and more than 2 years payback period, has also led to the cheap plastic tube digesters as the preferred model so far. Official financial institutions offer small credit at rates of 3% - 5% per month while repayment periods are usually less than 1 year. Reasons for the high rates are:

- Most farmers practice subsistence agriculture with high risks of natural disaster such as droughts and flooding.
- Irrigation systems are poorly developed or non-existent.
- Most farmers have no formal land title.

Local moneylenders offer credit at 8%– 12% per month. These loans are usually obtained in cases of emergency such as illnesses. It is common practice that loans are repaid with other credit at lower interest.

To achieve a successful biodigester programme the availability of credit with lower interest rates is necessary. The existing rural financial infrastructure can be used to channel credit (and subsidy) to the farmers. However, to make interest rates and payback periods interesting, it will be necessary to provide the existing financial institutions with the required capital to reduce their cost and risks.

## **8.3 Cost - benefit analysis**

The main benefits of mass dissemination and operation of biodigesters include benefits in the fields of sustainable energy use, environment, human development, agriculture, global warming and rural employment. Quantification of these benefits proves sensitive to the value of the underlying assumptions. As an example, assumptions for energy production and traditional fuel include estimates for the energy content of feeding material and the fuels it is replacing, the mix of the replaced fuels, efficiency of the stoves used and actual amount of feeding to the plant.

Following the above assumed parameter values, quantified programme benefits would include:

- Reduction of the workload of households –mainly women and girls- of approx. 3 hours per day per household;
- Reduced pressure on the environment due to reduced firewood consumption;
- Savings on kerosene;
- Reduction of Greenhouse Gas emissions;
- Production of bio-compost, containing plant nutrients (NPK) of Nitrogen (N), Phosphorous (P) and Potash ( $K_2O$ ), of which approx. 10% are direct savings as a result of not burning dung-cakes;
- Improvement of rural sanitation by connecting toilets (approx. 50% connection rate) to biogas plants;
- Reduction of indoor air pollution and the resulting Acute Respiratory Illness (ARI) and eye illnesses, thus especially benefiting women and children;
- Generation of employment in rural areas.

As the intrinsic benefits of the technology to a large extent are to the advantage of women, biogas at micro-level creates the necessary preconditions for addressing gender issues in the rural community.

The tangibility of the benefits of biogas is diffuse. Benefits extend over three levels, and have an impact both on the informal as well as the formal section of the economy. The table below underlines the issue. As a result, the yield of the investment will be different at various levels, and may even show a situational variation.

From the cost-benefit calculation, comparing the current designs under consideration in Cambodia for pre-qualifications under a National Biodigester Programme the financial and the expected financial impacts are predicted. However, as mentioned before, the final decision by the farmers family will not solely depend on the financial implications and non tangible factors might override the financial factors in the decision making process.

	<b>MICRO</b>	<b>MESO</b>	<b>MACRO</b>
<b>IN-FORMAL</b>	<ul style="list-style-type: none"> <li>• Reduced indoor smoke-induced illnesses.</li> <li>• Reduced poor-sanitation induced illnesses.</li> <li>• Reduced drudgery from fuel wood collection.</li> <li>• Reduced pressure for illegal forest encroachment.</li> <li>• Reduction drudgery from weeding fields.</li> <li>• Reduced workload for food-preparation.</li> <li>• Reduced soil degradation.</li> <li>• Improved opportunity for education.</li> </ul>	<ul style="list-style-type: none"> <li>• Improved forest quality and quantity.</li> <li>• Reduced pollution of surface water.</li> <li>• Reduced pollution of the environment as a result of uncontrolled dumping of animal waste.</li> </ul>	<ul style="list-style-type: none"> <li>• Reduction of illness-induced production losses.</li> <li>• Improved biodiversity.</li> <li>• Increased non-marketable non-timber forest product availability.</li> <li>• Increased efficient productivity.</li> <li>• Reduced mortality.</li> <li>• Improved human resource base.</li> <li>• Reduced global warming effects.</li> </ul>
<b>FORMAL</b>	<ul style="list-style-type: none"> <li>• Increased efficient productivity.</li> <li>• Reduced direct medical costs.</li> <li>• Reduced fuel wood &amp; kerosene expenditures.</li> <li>• Reduced chemical fertilizer expenditures.</li> <li>• Increased opportunity for (small-scale) organic agriculture.</li> <li>• Improved agricultural yields.</li> <li>• Increased family income.</li> </ul>	<ul style="list-style-type: none"> <li>• Improved employment opportunities and income generating opportunities.</li> <li>• Development of markets for organic agricultural produce</li> </ul>	<ul style="list-style-type: none"> <li>• Reduced (foreign exchange) cost on medication.</li> <li>• Reduced health system expenses.</li> <li>• Reduced (forex) costs on chemical fertilizer.</li> <li>• Reduced (forex) costs on kerosene.</li> <li>• Increased availability marketable (NT)FP.</li> <li>• Increased agricultural production.</li> <li>• Increased tax revenues.</li> <li>• Generating CDM revenues.</li> </ul>

Currency US\$												
Description of Cost	GGC 2047 6 cum			VACVINA 7 cum			KT1 6 cum			Plastic Tube 5-8 cum		
Construction Materials	109			163			87			11		
Un skilled Labour	23			23			0			5		
Pipes & Fittings & Storage	28			33			33			56		
Appliances & protection	36			11			17			38		
Subtotal	196			229			137			110		
Construction Charges	64			71			75			5		
<b>Total</b>	<b>260</b>			<b>300</b>			<b>212</b>			<b>115</b>		

Cost Benefit	Year			year			Year			Year		
	1	2-6y	7-15y	1	2-6y	7-15y	1	2-6y	7-15y	1	2-5y	6
Full Cost (incl Programme Cost)	291.00	45.20	9.20	335.00	46.00	10.00	238.20	44.24	8.24	131.50	51.50	131.50
Partial benefits	109.77	109.77	109.77	109.77	109.77	109.77	109.77	109.77	109.77	109.77	109.77	109.77
<b>Benefits - costs</b>	<b>(181.23)</b>	<b>64.57</b>	<b>100.57</b>	<b>(225.23)</b>	<b>63.77</b>	<b>99.77</b>	<b>(128.43)</b>	<b>65.53</b>	<b>101.53</b>	<b>(21.73)</b>	<b>58.27</b>	<b>(21.73)</b>
NPV	\$385			\$339			\$439			\$148		
IRR	39%			31%			54%			267%		

Cost Benefit with Subsidy	Year			year			Year			Year		
	1	2-6y	7-15y	1	2-6y	7-15y	1	2-6y	7-15y	1	2-5y	6
Full Cost (incl Programme Cost)	195.61	45.20	9.20	235.61	46.00	10.00	147.61	44.24	8.24	50.61	51.50	50.61
Partial benefits	109.77	109.77	109.77	109.77	109.77	109.77	109.77	109.77	109.77	109.77	109.77	109.77
<b>Benefits - costs</b>	<b>(85.84)</b>	<b>64.57</b>	<b>100.57</b>	<b>(125.84)</b>	<b>63.77</b>	<b>99.77</b>	<b>(37.84)</b>	<b>65.53</b>	<b>101.53</b>	<b>59.16</b>	<b>58.27</b>	<b>59.16</b>
Year	\$471			\$430			\$521			\$561		
Costs	78%			54%			174%					

### Notes to biogas IRR values

- The calculations show extremely high returns for NPV and IRR. Although biogas plants prove viable investments in general, extreme NPV and IRR values are not realistic. In practice, benefits are not always tangible for the investor in financial terms, traditional fuel is not always priced and bio-slurry does not always replace bought chemical fertilizer.
- Benefits at micro level in the fields of workload reduction, general improvement of health and increase of agricultural production are not included. These benefits are normally intangible to the investor, and moreover, sound financial data is hardly available.
- Environmental benefits in the field of avoided waste treatment facilities; improved flora and fauna etc. are not included in this calculation. Here too, relevant economic data is rare.
- In general, slow dissemination of domestic biogas plants, despite its high NPV/IRR values, can be contributed to some or all of the following issues: lack of awareness of biogas benefits in rural areas, lack of access to credit, uncoordinated programme support, unstable incentive arrangements, and undeveloped biogas supply structure.
- For all digester models full investment cost are used for Net Present Value (NPV) and Internal Rate of Return (IRR) calculation.
- The Lifespan of VACVINA, KT1, and GGC 2047 are assumed at 15 years; the lifespan of the Plastic bag digester estimated at 5 years.
- Construction cost of KT1 and KT2 are very similar, therefore the costs of KT1 model are considered in this report.
- Interest rate is 48%; repayment period is 2 years
- Benefits on energy and fertilizer are equal for all models.
- Management cost: 10% added to investment cost and maintenance and service charge added

Detailed cost calculations for the different digester models under current Cambodian conditions are given in Annex I of this report.

## 9.0 Conclusion

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	+
Biodigester plant can be well spaced in the compound	+++
<b>Economic Factors</b>	
Use of organic fertilizer is traditionally practiced	+++
Dairy farming is the main source of income	---
Farmers are owners of the farm and live primary on the farm	--
Farm product are the main source of income	++
Operating the biodigester plant can be integrated into the normal working routine of the house and the farm, no extra time required	+++++
Gas utilization and attendance of the plant can be clearly regulated within the household	++
Moderate pricing of the plant in relation to the income	---
Economically healthy farms open for 'modernization'	-+
Insufficient and expensive supply of fossil sources of energy	+++++
Building materials and gas appliance available locally	+++
Qualified mason / Private Sector	--
Users have access to credit	----
Cost of plant installation is affordable	---
<b>Social Factors</b>	
Regular gas demand	+++++
Awareness on Biodigester Technology by users	--
Socio-Cultural Acceptance of Biodigester	+++
Willingness of potential users to invest in biodigester users	+++
Performance of existing biodigester plants	--
Peoples awareness on non-financial costs and benefits of biodigester	--
Peoples awareness on environmental and health and sanitation issues	+++
Role of women in decision making	++
<b>Institutional Factors</b>	
(Government) Organization having access to potential users	+++++
(Govern.) Organization with good cooperation to the private sector	++
(Govern.) Organization with experience in biodigester dissemination	+++++
Political will of the Government to support biodigester technology	+++++
Secured financing of the Biodigester sector	+++
Government Policy on RET	+++
Government Policy on reduction on workload for women	+++
Willingness of stakeholders to develop a biodigester sector	+++++

### Summary of major prospects

- The potential of full integration of biodigester in the present household structures is identified as one of the main prospects to further dissemination of biodigesters Cambodia.
- In the six selected provinces the estimated potential for biodigesters is more than 200,000.
- The depletion of forest resources will make access to fuel wood requirements increasingly more difficult.
- A high percentage of rural households own livestock.
- Affordable technology and programme modalities are available. With some minor modifications and adjustments, this technology and an implementation modality can be introduced in Cambodia.
- The Cambodian government has acknowledged the importance of the establishment of a national biodigester programme.
- Opportunity to integrate a national biodigester programme at provincial and district level.

### Summary of major constraints

- Lack of qualified masons and other technical staff for the construction of biogas plants.
- Absence of private sector for marketing and construction of biogas.
- Absence of credit facilities / subsidy policy for biodigesters and renewable energy in general. High interest rate (3%-5% p/month).
- NGO's have limited capacity and experience with large-scale dissemination of biodigesters.
- Flooding and large areas with high water table make sub-soil construction difficult.
- Lack of documentation of land ownership.

Based on the analysis of the present situation the mission team concluded that the circumstances and conditions in Cambodia are favourable to establish a national biodigester programme.

## **DESIGN AND IMPLEMENTATION**

### **Outline for a National Biodigester Programme in Cambodia**



## 10.0 Selection of digesters for mass dissemination

### 10.1 Fixed-dome digester

A fixed-dome digester comprises a closed digester with a fixed, non-moving gas space and a compensating tank. The gas is stored in the upper part of the digester. Gas production increases the pressure in the gas space of the digester and pushes the slurry into the compensating tank. When the gas is extracted, a proportional amount of the slurry flows back into the digester.

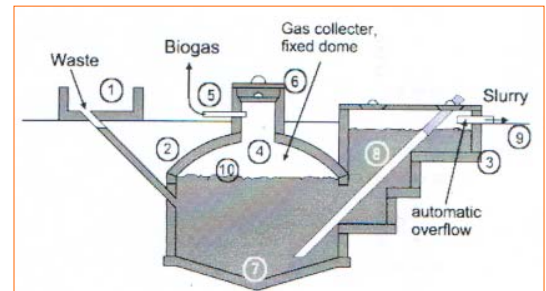


Figure 1: Fixed dome plant Nicarao design: 1. Mixing tank with inlet pipe and sand trap. 2. Digester. 3. Compensation and removal tank. 4. Gasholder. 5. Gaspipe. 6. Entry hatch, with gastight seal. 7. Accumulation of thick sludge. 8. Outlet pipe. 9. Reference level. 10. Supernatant scum, broken up by varying level.  
Source: TBW

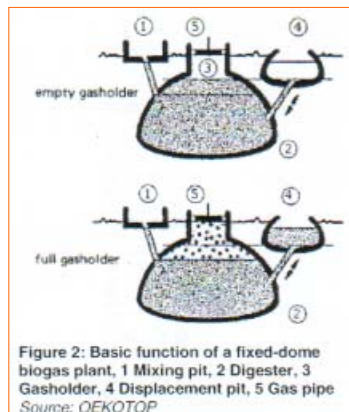


Figure 2: Basic function of a fixed-dome biogas plant, 1 Mixing pit, 2 Digester, 3 Gasholder, 4 Displacement pit, 5 Gas pipe  
Source: OEKOTOP

**Advantages:** are the relatively low construction cost, the absence of moving parts and the absence of steel parts that may rust. If well constructed, fixed dome plants have a long life span. The underground construction saves space and protects the digester from climatic disturbances. The construction provides opportunities for skilled local employment.

**Disadvantages:** are mainly risks of losses of gas through leaks in the gasholder if the construction is not properly done. Fixed dome plants are therefore recommended only when an experienced biogas technician can supervise the construction. The gas pressure fluctuates substantially depending on the volume of the gas stored.

### 10.2 Technology from Vietnam

There are two main designs that have been developed in Vietnam since 1985. The first developed by Can Tho University has the cylindrical digester made of ferrocement. The second developed by the Institute of Energy has a spherical digester built of brick. They have gradually replaced the floating gasholder digester type.

**The KT.1** model of the Institute of Energy is a further development of its 1984 design for a fixed dome biogas digester. This model has been promoted over the past 10 years, particularly in the Red-River delta.



**The KT.2** digester is a further development of the TG-BP model designed by a Thai-German project. The semi spherical dome on top of the conical bottom makes the digester more resistant against the upward forces of high groundwater levels. The digester is therefore particularly suitable for the Mekong delta. For both installations, the standard design allows for 7 different digester volumes (6 to 12m<sup>3</sup>) and three gasholder/digester ratios are available to adjust the retention time to the specific conditions. Given the conditions in Cambodia with often high water tables and the availability of good quality bricks, the KT2 can be successfully introduced in Cambodia.

Advantages: Can be constructed in flood areas, proven technology, reliable, nearly maintenance free, easy to operate and maintain, accepted technology for CDM.

Disadvantages: Need for skilled labour.

### 10.3 Technology from Nepal

Since the inception of the Biogas Support Programme in 1992, one single model has been pre-qualified for construction. The GGC 2047 biodigester is a fixed dome model. The holding tank can be constructed with bricks or stones (for the mountains areas). The dome is cast concrete and is treated to prevent gas leakage. Biogas is piped underground to the family kitchen. The slurry leaving the digester is composted and the compost is applied as organic fertilizer.

Advantages: Robust, can be constructed in all terrain in Nepal (flood areas and mountains, reliable, nearly maintenance free. easy to operate and maintain, accepted technology for CDM.

Disadvantages: High initial investment cost, need for skilled labour.



## 11.0 Objectives of a Pilot Biodigester Programme

The overall objective of the programme will be to develop a commercial and structural deployment of biodigester 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:

- To develop a commercially viable and market oriented biogas sector;
- To increase the number of family sized, quality biogas plants with 17,500 in selected provinces;
- To ensure the continued operation of all biodigesters installed under the biogas programme;
- To maximise the benefits of the operated biodigesters, in particular the optimum use of digester effluent;
- Technical and promotional capacity development for further wide scale deployment of biodigester technology in Cambodia;
- To strengthen and facilitate establishment of institutions for the continued and sustained development of the biodigester sector.

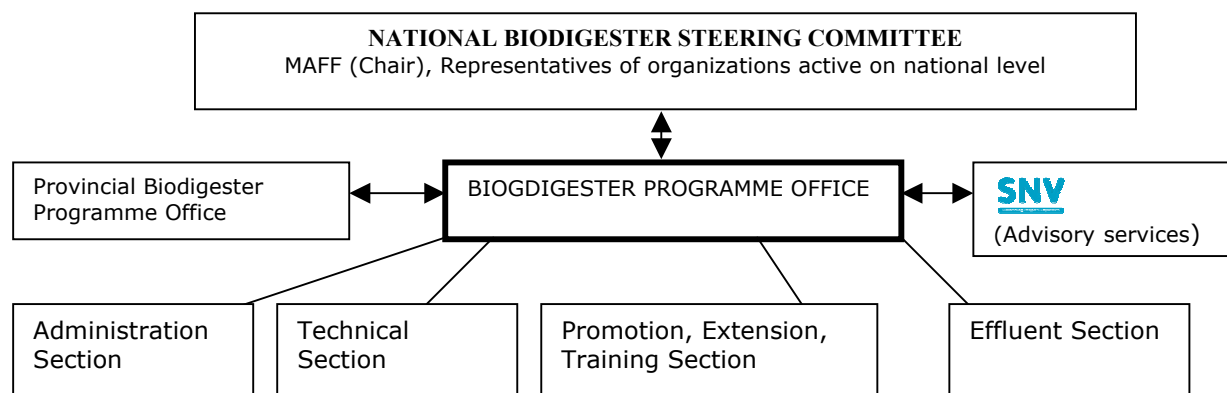
The target group (market) for the programme are farmers who have on a daily basis a minimum of 15 kg of animal waste at their disposal. This amounts to the daily dung production of 2 average head of cattle or 4 adult pigs.

## 12.0 Production Targets and Programme Period

Projected Production					
2005	2006	2007	2008	2009	
Preparation phase		Implementation phase			
(start mid 2005/18 months)					
0	I	II	III	IV	Total
~Growth %	0%	100%	50%	30%	
province 1	500	1000	1500	2000	5000
province 2	500	1000	1500	2000	5000
province 3		500	1000	1500	3000
province 4		500	500	500	1500
province 5			500	1000	1500
province 6			500	1000	1500
<b>Total</b>	<b>1000</b>	<b>3000</b>	<b>5500</b>	<b>8000</b>	<b>17500</b>

## 13.0 Institutional Setup at The National and Provincial Level

### 13.1 Programme outline on national level



#### 13.1.1 Biodigester Programme Office (BPO)

An appointee from MAFF, the lead organization that chairs the Steering Committee, will be appointed National Director (part-time) for the programme. Together with a Project 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 Senior Advisor provided by SNV making full use of the experiences gained so far in other national biodigester programmes. The running of the office will include accounting and financial procedures and staff management. Reporting to the Cambodian 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 Plan. It will also initiate, co-ordinate and monitor the activities within the biodigester sector. The office will have to work with different sections, private and public, from of society bearing in mind that an objective of the programme is to develop a durable biodigester industry by mobilizing the private sector. The office consists of four sections: Administration; Technical; Training, Promotion and Extension; and Effluent Use. The main tasks for each sector are as follows:

##### Administration

- Registration of new constructed plants;
- Registration of annual after-sales service visits;
- Channelling of subsidy funds;
- Certification of construction groups and companies;
- Contracting of organizations for tasks as stipulated in the annual plan;
- Administration of the Biodigester Programme Office;
- Monitoring.

##### Technical:

- Selection of appropriate design and development of quality standards for this design; regulations for standardization.
- Development of quality standards for plant guarantee and after-sales service;
- Quality control on construction and after-sales service;
- Applied research and development on plant design and appliances;
- Private enterprise development, rules and standards for contracts/contracting.

### Promotion, Extension, Training:

- Development of curricula for user training, extension staff training;
- Technician, supervisor and management training;
- Identifying appropriate training organizations and venues;
- Conducting training of trainers courses;
- Identifying, training and supporting extension services;
- Developing national and local promotional material;
- Co-ordination of promotional activities.

### Slurry programme

- Applied research on appropriate use of the plant's effluent as fertilizer, fish or pig feed;
- Developing training and extension methods for these uses;
- Co-ordination of the training and extension efforts.

### 13.1.2 National Biodigester Steering Committee (NBSC):

The NBSC will consist of representatives of the main actors in the biodigester programme at a national level. The representative from the lead organization that hosts the BPO, chairs the committee.

The Steering Committee will be set up to co-ordinate and guide developments in the biodigester sector as well as liaise with the Government. Specifically, the functions of the steering committee will include:

- Analysis of policy issues and advice on policy matters (subsidy, price, taxation policies, R&D policy);
- Co-ordination with other sectors and Ministries;
- Review/approval of the BPO annual work plans and reports;
- Approval of regulatory frame works: setting of sector-wide standards and guidelines, criteria for registration and licensing of companies, etc.;
- Mobilization of funds and liaison with donors;
- Monitoring of developments in the biogas sector as a whole and of the implementation of specific projects;
- Organization and/or participation in programme and project evaluations.

### 13.1.3 Profile of the Lead Organization

The lead organization is a key organization that hosts the BOP and provides the National Director for the programme.

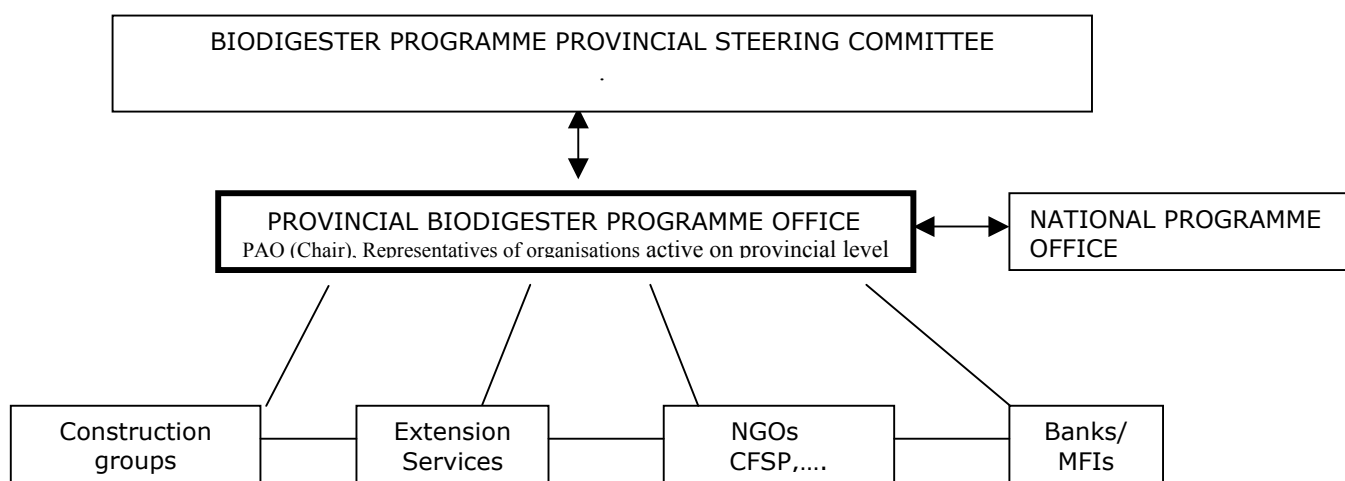
This organization should fulfil the following criteria:

- A Government organization (Ministry) of high prominence and influence.
- Direct link with the interests of the rural households (farming families).
- Having (access to) an extensive rural network reaching the farming community.

MAFF fulfils the above-mentioned requirements and is willing to act as the lead organisation in such a programme.



## 13.2 Programme Outline on Provincial Level



### 13.2.1 The Provincial Biodigester Programme Office (PBPO)

This office will be responsible for the daily running of the programme in the province. An appointee from the Provincial Agricultural Office, endorsed by the Provincial Biodigester Steering Committee (PBSC) and the BPO, will manage it with the assistance of a technical advisor assigned by the BPO as and when needed. The PBPO will provide quarterly progress reports to the PBSC and the BPO. It will draft the Provincial Annual Plan of Activities, which needs sanctioning by the PBSC and the BPO. It will also identify suitable partners for the different activities and draft working contracts for these partners. The contracts will be signed for the programme side by the BPO, which means that no separate accounting section will be necessary on provincial level. The PBPO however, will co-ordinate, facilitate and monitor the activities of the partners active on provincial level.

### 13.2.2 Provincial Biogas Steering Committee (PBSC)

Similar to the national level, all biogas activities will be periodically monitored and advised upon by a Provincial Biogas Steering Committee. This committee will also consider and endorse the Annual Plan of Activities for the biogas sector in the Province. The committee's members represent the main actors in the biodigester sector in the province. The chair of the committee will be with the Provincial Development Committee (PPC) or otherwise delegated by the DDC.



### 13.2.3 Key Organizations at Provincial Level

Whereas at the national level policymaking, R&D and administration are the main activities; the 'real work', extension and promotion; credit provision, construction, quality control and after-sales service take place in the selected provinces. The list below shows which organizations could perform these tasks.

Extension Promotion	Extension services in regular contact with the farming communities. Activities include awareness raising, technical advice on digester size and capacity, advice on affluent use. Suitable extension services can be: Department of Agriculture and Live stock, Department of Women Affairs, NGOs active in the province, loan officers from credit institutes.
Credit Provision	Local branches of regulated financial institutions, i.e. ACLEDA bank and AMRET. Besides provision of credit these institutions can also be used to channel subsidies to the new biodigester owners
Construction, Repair & maintenance	Local construction entrepreneurs skilled in the biodigester construction technique by the programme
Quality control	Quality control needs to be performed on the construction, including the pipe work as well as on the after-sales services provided by the private entrepreneurs. This task needs to be done by biodigester technicians assigned to the PBPO.
Administration	Registering new clients and subsidy application to the BPO needs to be done by the PBPO

## 14.0 Estimate of Programme Cost

The yearly estimated costs (in Euro) consisting of activity costs, investment costs and costs of TA provided by SNV are summarised as follows:

<b>Cambodia</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>Total</b>
(Plants)	(-)	(1,000)	(3,000)	(5,500)	(8,000)	(17,500)
Activity costs (including subsidy)	137,900	425,940	580,620	848,600	1,099,260	3,092,320
Plant investment costs (excluding subsidy)	-	200,000	600,000	1,100,000	1,600,000	3,500,000
SNV TA	125,000	250,000	250,000	200,000	150,000	975,000
<b>Total</b>	<b>262,900</b>	<b>875,940</b>	<b>1,430,620</b>	<b>2,148,600</b>	<b>2,849,260</b>	<b>7,567,320</b>

Biogas farmers (likely through existing credit providers like ACLEDA and AMRET), the Government of Cambodia and donors (ODA) are proposed to contribute to the financing of the Programme, see the table for the amounts (in Euro):

<b>Cambodia</b>	<b>Farmers</b>	<b>Government</b>	<b>ODA</b>	<b>Total</b>
Activity costs	-	160,320	2,932,000	3,092,320
Investment costs	3,500,000	-	-	3,500,000
SNV TA	-	-	975,000	975,000
<b>Total</b>	<b>3,500,000</b>	<b>160,320</b>	<b>3,907,000</b>	<b>7,567,320</b>

## **15.0 Conclusion and Recommendations**

During the debriefing workshop on 4 November 2004, representatives of sector related organizations endorsed the proposed set-up of a national biodigester programme.

It is recommended that SNV will select Cambodia to establish a national biodigester programme.

SNV, with its experience with this type of institutional coordination, should ensure the provision of technical assistance to the programme and to the various institutes, aiming at capacity building of the respective organizations.

Additional it is recommended that SNV will commit itself to assist the national Biogas Programme Office with the mobilization of the necessary resources to ensure programme implementation.

To that effect SNV shall recruit a Senior Biogas Advisor, stationed in Phnom Penh, who will in 2005 be responsible for the necessary preparatory work the preparation phase to establish a national biodigester programme. These include:

- Presentation and agreement of the final mission report with Cambodian stakeholders on the final design and implementation modalities of a national biodigester programme.
- The Ministry of Agriculture Forestry Fisheries and SNV will come to an agreement (MoU) on the modalities to establish a national Biodigester Office under the Special Project for Food Security.
- ACLEDA Bank Plc. or other financial institutions and SNV will come to an agreement (MoU) on the modalities to establish appropriate credit facilities for a national biodigester programme
- SNV will take the necessary steps to make legal and institutional arrangements with the Government of Cambodia for the realization of a national biodigester programme with SNV technical assistance.

From 2006 to 2009 the SNV Senior Biogas Advisor will advise the national Biodigester Office on the execution of the programme.

- Additional research to be initiated in 2005 to compare the performance of various biodigester technologies under Cambodian circumstances and environment.

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## **ANNEXES**

## ANNEX I Cost calculation of different biodigesters in the Cambodian context

Quotation	GGC 2047				VACVINA				KT 1				KT 2				Plastic Tube CRDT							
	Unit	Qnt	US\$	US\$	Unit	Qnt	US\$	US\$	Unit	Qnt	US\$	US\$	Unit	Qnt	US\$	US\$	Unit	Qnt	US\$	US\$				
<b>A Construction Materials</b>																								
Bricks/Stone	Piece	1400	0.03	42	Pcs	2000	0.03	60	Pcs	1240	0.03	37	Pcs	1250	0.03	38	Pcs	85	0.03	3				
Sand	cum	2.1	3.75	8	cum	1.4	3.75	5	cum	1.2	3.75	5	cum	1.3	3.75	5	cum	0.3	3.75	1				
Gravel 1x2	cum	1.1	12.00	13	cum	0.6	12.00	8	cum	0.1	12.00	1	cum	0.1	12.00	1	cum		12.00					
Gravel 4x6	cum		5.00		cum	1.1	5.00	6																
Reinforcement rod (8mm)	Kg	10.5	0.88	9	Kg	28.0	0.88	25	Kg	7.0	0.88	6	Kg	7.0	0.88	6	Kg		0.88					
Cement @ 50kg p/bag	Bag	10	3.75	38	Bag	16	3.75	60	Bag	10	3.75	36	Bag	10	3.75	38	Bag	2	3.75	8				
<i>Sub Total Construction mat</i>				<b>109</b>	<i>Sub Total Construction mat</i>				<b>163</b>	<i>Sub Total Construction mat</i>				<b>85</b>	<i>Sub Total Construction mat</i>				<b>88</b>	<i>Sub Total Construction mat</i>				<b>11</b>
<b>B Unskilled Labour Cost</b>																								
Labours	Days	15	1.50	23	Days	15	1.50	23	Days		1.50		Days				Days	3	1.50	5				
<i>Sub Total Un Skilled</i>				<b>23</b>	<i>Sub Total Un Skilled</i>				<b>23</b>	<i>Sub Total Un Skilled</i>				<b>5</b>	<i>Sub Total Un Skilled</i>				<b>5</b>					
<b>C Pipes and Fittings</b>																								
Metal pipe (21mm dia.)	meter	1	1.25	1	meter	1	1.25	1	meter	1	1.25	1	meter	1	1.25	1	meter	1	1.25	1				
PVC Tube (21mm dia.)	meter	2	0.88	2	meter	2	0.88	2	meter	2	0.88	2	meter	2	0.88	2	meter	10	0.88	9				
Soft plastic tube(21mm dia.)	meter	25	0.40	10	meter	25	0.40	10	meter	25	0.40	10	meter	25	0.40	10	meter	25	0.40	10				
L-shape PVC (100mm dia.)-inlet	meter	4	1.25	5	meter	4	1.25	5	meter	4	1.25	5	meter	4	1.25	5	meter	4	1.25	5				
T-shape PVC (21mm dia.)	pcs	4	0.13	1	pcs	4	0.13	1	pcs	4	0.13	1	pcs	4	0.13	1	pcs	4	0.13	1				
L-shape PVC (21mm dia.)	pcs	4	0.13	1	pcs	4	0.13	1	pcs	4	0.13	1	pcs	4	0.13	1	pcs	4	0.13	1				
PVC valve (21mm dia.)	pcs	3	0.50	2	pcs	3	0.50	2	pcs	3	0.50	2	pcs	3	0.50	2	pcs	3	0.50	2				
PVC pipe (100mm dia.)-outlet	meter	1	2.25	2	meter	1	2.25	2	meter	1	2.25	2	meter	1	2.25	2	meter	1	2.25	2				
Metal valve (21mm dia.)	pcs	2	1.25	3	pcs	2	1.25	3	pcs	2	1.25	3	pcs	2	1.25	3	pcs	2	1.25	3				
Metal pipe(21mm dia.)- Length 10cm	pcs	2	0.38	1	pcs	2	0.38	1	pcs	2	0.38	1	pcs	2	0.38	1	pcs	2	0.38	1				
L-shape metal pipe	pcs	4	0.38	2	pcs	4	0.38	2	pcs	4	0.38	2	pcs	4	0.38	2	pcs	4	0.38	2				
Plastic for gas reservoir	meter		0.68		meter	7.5	0.68	5	meter	7.5	0.68	5	meter	7.5	0.68	5	meter	32	0.68	22				
Glue for PVC connecting	kg	0.5	0.75	0	kg	0.5	0.75	0	kg	0.5	0.75	0	kg	0.5	0.75	0	kg	0.5	0.75	0.4				
<i>Sub total Pipes</i>				<b>28</b>	<i>Sub total Pipes</i>				<b>33</b>	<i>Sub total Pipes</i>				<b>33</b>	<i>Sub total Pipes</i>				<b>33</b>	<i>Sub total Pipes</i>				<b>56</b>
<b>D Appliances Cost</b>																								
Stove-angle	Set	1	7.00	7	Set	1	7.00	7	Set	1	7.00	7	Set	1	7.00	7	Set	1	7.00	7				
Mixture	Set	1	10.00	10	Set		10.00		Set		10.00		Set		10.00		Set		10.00					
Paint	Litre	1	2.40	2	Litre		2.40		Litre		2.40		Litre		2.40		Litre		2.40					
Bentonite/Redoxide									bag	1	1.00	1	bag	1	1.00	1								
Inlet Pipe	Meter	4	1.40	6	Meter		1.40		Meter	4	1.40	6	Meter	4	1.40	6	Meter	4	1.40	6				
Dome gas pipe	Pcs	1	5.30	5	Pcs		5.30		Pcs		5.30		Pcs		5.30		Pcs		5.30					
Main Valve: SANWA	Pcs		3.70		Pcs		3.70		Pcs		3.70		Pcs		3.70		Pcs		3.70					
W/Drain	Pcs	1	2.20	2	Pcs		2.20		Pcs		2.20		Pcs		2.20		Pcs		2.20					
Gas Tap	Pcs	1	3.30	3	Pcs	1	3.30	3	Pcs	1	3.30	3	Pcs	1	3.30	3	Pcs	1	3.30	3				
Rubber hose pipe	Meter	1	0.40	0	Meter	1	0.40	0	Meter	1	0.40	0	Meter	1	0.40	0	Meter	1	0.40	0				
Fencing	set		22.00				22.00				22.00				22.00				22.00	22				
DC Adapter	set		2.00				2.00				2.00				2.00				2.00					
Gas suck Fan	set		1.00				1.00				1.00				1.00				1.00					
<i>Sub total Appliances</i>				<b>36</b>	<i>Sub total Appliances</i>				<b>11</b>	<i>Sub total Appliances</i>				<b>17</b>	<i>Sub total Appliances</i>				<b>17</b>	<i>Sub total Appliances</i>				<b>38</b>
<i>Sub total A B C D</i>				<b>196</b>	<i>Sub total A B C D</i>				<b>229</b>	<i>Sub total A B C D</i>				<b>135</b>	<i>Sub total A B C D</i>				<b>138</b>	<i>Sub total A B C D</i>				<b>110</b>
<b>E Construction Charge</b>																								
Construction			8.00			7	8.00	56	m/days		8.00		m/days		8.00				8.00					
Pipe Installation			5.00			3	5.00	15	m/days	15	5.00	75	m/days	15	5.00	75			5.00	5				
Fixed				64																5				
<i>Sub Total Construction Charge</i>				<b>64</b>	<i>Sub Total Construction Charge</i>				<b>71</b>	<i>Sub Total Construction Charge</i>				<b>75</b>	<i>Sub Total Construction Charge</i>				<b>75</b>	<i>Sub Total Construction Charge</i>				<b>5</b>
<b>Grand Total</b>				<b>260</b>	<b>Grand Total</b>				<b>300</b>	<b>Grand Total</b>				<b>210</b>	<b>Grand Total</b>				<b>213</b>	<b>Grand Total</b>				<b>115</b>



## ANNEX II Programme Budget

<b>Financial Requirement National Biogas Programme Cambodia</b>						
<b>Programme Management</b>	2005	2006	2007	2008	2009	
	Preparation phase		Implementation phase			
(start mid 2005/18 months)						
Year	0	I	II	III	IV	Total
Estimated Production		1000	3000	5500	8000	17500
No. of provinces involved	0	2	4	6	6	
Promotion & Marketing	12,500	10,000	20,000	25,000	25,000	92,500
Quality Control		3,000	7,500	12,000	12,000	34,500
R&D and Standardization	30,000	25,000	15,000	15,000	15,000	85,000
Effluent programme (R&D, extension, trai	5,000	15,000	20,000	30,000	30,000	100,000
Training	16,900	26,440	32,120	46,100	54,260	175,820
Monitoring and evaluation	0	15,000	20,000	25,000	25,000	85,000
Institutional Support	9,000	9,000	9,000	9,000	9,000	45,000
Programme Management National BO	64,500	187,500	162,000	159,000	159,000	732,000
Programme Management Provincial BO		20,000	40,000	60,000	60,000	180,000
External Evaluation		30,000			30,000	60,000
<b>Sub - Total in Euro</b>	<b>137,900</b>	<b>340,940</b>	<b>325,620</b>	<b>381,100</b>	<b>419,260</b>	<b>1,604,820</b>
<b>Technical Assistance</b>						
	2005	2006	2007	2008	2009	
	Preparation phase		Implementation phase			
(start mid 2005/18 months)						
Year	0	I	II	III	IV	Total
International TA SNV	50,000	100,000	100,000	100,000	100,000	450,000
International TA SNV	50,000	100,000	100,000	50,000		300,000
Flex SNV Advisors	25,000	50,000	50,000	50,000	50,000	225,000
<b>Sub - Total Cost in Euro</b>	<b>125,000</b>	<b>250,000</b>	<b>250,000</b>	<b>200,000</b>	<b>150,000</b>	<b>975,000</b>
<b>Total Financial requirement</b>						
	2005	2006	2007	2008	2009	
	Preparation phase		Implementation phase			
(start mid 2005/18 months)						
Year	0	I	II	III	IV	Total
Production	0	1,000	3,000	5,500	8,000	17,500
Subsidy Component (E 85/-p/p) KT1/2 model		85,000	255,000	467,500	680,000	1,487,500
Credit Requirement (E 200/- p/p)	0	200,000	600,000	1,100,000	1,600,000	3,500,000
Programme Cost	137,900	340,940	325,620	381,100	419,260	1,604,820
Technical Assistance	125,000	250,000	250,000	200,000	150,000	975,000

### **ANNEX III Programme for Feasibility Study**

<b>Date</b>	<b>Activities, meetings</b>
October 6	– Travel via Bangkok
October 7	– Arrival Phnom Penh, Lunch and field trip to biodigesters in Hoketh. – Mr. Iwan Baskoro, Coordinator, Cambodia Fuel Saving Project – Mr. Mish Cuong La Quan, Programme Officer CFSP – Mr. Rogier van Mansvelt, Project Coordinator, University of Amsterdam – Ms. Bridget McIntosh, CDM and Sustainable Energy Advisor, Climate Change Office – Mr. Rotha Nao, Project Manager CFSP
October 8	– Mr. Kean Sophea, Team leader, Food Security and Poverty Reduction, Ministry of Agriculture, Forestry and Fishery (MAFF) – Mr. Brendah Boucher, Project Coordinator, CRDT – Mr. Rainer Ernst Israel, Director, ILI-Consulting Engineers – Mr. Pen Rotha, Director, Farmer Livelihood Development Organization
October 9	– Breakfast meeting with CFSP, CCO – Planning meeting with Iwan Baskoro, Bridget McIntosh and Rotha Nao
October 10	– Travel to Hanoi
October 11	– Ms. Andy Wehkamp, Director SNV/Vietnam – Mr. Harm Duiker, SNV/Vietnam – Meeting with Biogas Project Office staff
October 12	– Mr. Nguyen Quang Khai, chief Biogas Engineer, BPO
October 13	– Field Visit, Biogas digesters
October 14	– Dr. Klaus Muller, Director, KfW/Vietnam – Ms. Isabelle Steimer, Environmental Expert, KfW/Vietnam – Planning
October 15	– Mr. Pham Van Thanh, Director, Centre for Rural Communities (VACVINA)
October 16	– Travel Hanoi – Phnom Penh
October 17	– Preparation and planning
October 18	– Planning, recruitment of team member Mr. Sok Bunheng, data study preparation
October 19	– Dr. Sat Samy, Under Secretary of State, Ministry of Industry, Mines and Energy (MIME) – Mr. Toch Sovanne, Head of Renewable Energy Office, MIME – Mr. Chan Socheat, Deputy Director of Department of Energy Technique, MIME – Mr. Tun Luan, Deputy General Director, General Department of Energy, MIME
October 20	– Field visit MAFF
October 21	– Mr. Seyna Rin, Senior Manager, Small and Medium Enterprise Cambodia – Mr. Po Samang, Senior Manager SME – Mr. Chandrasekar Govindarajalu, Senior Environmental Specialist, Climate Change Team, Environmental Department, The World Bank – Mr. Loeng Sopheap, Deputy Marketing Manager, ACLEDA Bank Plc. – Mr. Antony J. Jude, Deputy Head/Senior Portfolio Management Specialist, Cambodia Resident Mission, Asian Development Bank

October 22	<ul style="list-style-type: none"> <li>- Mrs. Chou Bun Eng, Executive Director, Cambodian Women for Peace and Development</li> <li>- H.E. Prach Sun, Secretary of State, Ministry of Environment</li> <li>- Mr. Sum Thy, Chief of Climate Change Office, Department of Planning and Legal Affairs, Ministry of Environment</li> <li>- Bridget McIntosh CDM and Sustainable Energy Advisor, Department of Planning and Legal Affairs, Ministry of Environment</li> <li>- Mr. Try Meng, Under Secretary of State, Ministry of Rural Development</li> </ul>
October 23	<ul style="list-style-type: none"> <li>- Discussion on Draft Report on Provincial Data with Rogier van Mansvelt</li> </ul>
October 24	<ul style="list-style-type: none"> <li>- Report writing/planning</li> </ul>
October 25	<ul style="list-style-type: none"> <li>- Mr. San Ty, Training Officer and Researcher, Centre for Livestock Development and Agricultural Development, University of Tropical Agriculture Foundation</li> <li>- Mr. Kamina Ntenda Musangu, Agricultural Development and Food Security Officer, FAO</li> <li>- Mr. Kean Sophea, Team leader, Food Security and Poverty Reduction, Ministry of Agriculture and Fishery</li> </ul>
October 26	<ul style="list-style-type: none"> <li>- Mr. Doekle Wielinga, Chief Technical Advisor, Technical Support Office, Ministry of Rural Development/ILO</li> <li>- Mr. Hun Savuth, Office Coordinator Technical Support Office, Ministry of Rural Development/ILO</li> <li>- Mr. Seng Naron, Director Department of Training and Research, Ministry of Rural Development</li> <li>- Meeting with CFSP staff on institutional arrangements</li> <li>- Preparations for CFSP workshop on National Biogas Programme in Cambodia</li> </ul>
October 27	<ul style="list-style-type: none"> <li>- CFSP Biodigester workshop on National Biogas Programme in Cambodia</li> <li>- Mr. Julien Calas, Charge de Mission, Groupe Agence Francais du Development (AFD)</li> </ul>
October 28	<ul style="list-style-type: none"> <li>- Ms. Neang Kcrum Noeur, Director of Women Affairs, Takeo Province</li> <li>- Mr. Ith Sarun, Director of Provincial Departments of Agriculture, Forestry and Fisheries, Takeo Province</li> <li>- Mr. Tim Son, Deputy Director of Provincial Department of Rural Development, Takeo Province</li> <li>- Project staff, Food Security and Poverty Office, Ministry of Agriculture, Forestry and Fisheries, FAO</li> </ul>
October 29	<ul style="list-style-type: none"> <li>- Discussion on Final Report on Provincial Data with Rogier van Mansvelt</li> <li>- Meeting with CFSP on institutional arrangement</li> </ul>
October 30	<ul style="list-style-type: none"> <li>- Report Writing</li> </ul>
October 31	<ul style="list-style-type: none"> <li>- Report writing</li> </ul>
November 1	<ul style="list-style-type: none"> <li>- Report Writing/Preparations debriefing</li> </ul>
November 2	<ul style="list-style-type: none"> <li>- Preparations debriefing</li> </ul>
November 3	<ul style="list-style-type: none"> <li>- Ms. Ma Vanny, Director of Family Economic Development Department/Village Fund Coordinator, Ministry of Women's and Veteran's Affairs (MWVA)</li> <li>- Preparations debriefing</li> </ul>
November 4	<ul style="list-style-type: none"> <li>- Debriefing</li> <li>- Mr. San Vanny, Deputy Director General, Ministry of Agriculture, Forestry and Fisheries</li> </ul>
November 5	<ul style="list-style-type: none"> <li>- Internal SNV Reporting</li> <li>- Dr. Sat Samy, Under Secretary of State, Ministry of Industry, Mines and Energy (MIME)</li> <li>- Farewell Dinner CFSP, SPFS, CCCO</li> </ul>
November 6	<ul style="list-style-type: none"> <li>- Travel to Bangladesh</li> </ul>

## ANNEX IV Attendance List Debriefing 4 November 2004

Full Name	Company	E-mail	Business Phone	Mailing Address
B Mcintosh	MoE	camclimate@online.com	12452795	
Chan Danith	FAO	danithchan@fao.org	12966157	# 5, St. 370
Dama Lenk	SME Cambodi	damalengk@yahoo.com	12836229	#288, Phnom Pench, Laos
Dav Sokunthea	RUPP	sokuntheadav@yahoo.cin	12454902	
Erik Middelink	SME Cambodi	erik@sme.forum.org.kh	012-304334	#288, Phom Penh
Hamon Emelone	VSF	vsf_cambodia@online.com	12607442	# 13, St 400
Hang Seiha	MIME	hanseiha@yahoo.com	12888517	# 47, Norodom Bld
Heng Chinda	RUPP			Phnom Penh
Hing Pheavanich	RUPP			#2318, Russey Keo
Iwan Baskoro	CERES, CFSP	iwan@efsp.org.kh	12306264	#45, Str 606
Jack Cortenraad	SNV	jcortenraad@snv.org.la	+856 (-20) -55117	P.O. Box 9871, Vientiane
Kayeswar Sulpya	GERES/CFSP	Kayesulpya@cfsp.org.kh	016-7-7-43	# 45, St. 606
Kean Sophea	MAFF/FAO	sfps@cimnet.com.kh	12782799	MAFF
Keo Chanda	E&D	LO@online.co.kh	12306264	#74, St 360
Khim Mirya	RUPP	wirya_k@yahoo.com	12359293	# 149, Russey Keo District
Le Sivan Minh	GERES	mclequan@cfsp.org.kh	12259942	
Mao Rotha	CFSP	mao-rotha@org.kh		#45, St. 606, PNP
Nou Sovannara	MIME	sovann_dara@yahoo.com	12921214	# 47m Biridin Bld
Oun Syvibola	LWF	syvibola@lwfcam.org.kh	12571365	P.O. Box 37 pp
Pen Ratana	RUPP		11779963	
Pich Sokdang	RUPP	friends478@yahoo.com	12398900	
Rogier Van Mansvelt	CFSP	mansvelt@zonnet.nl	012-304332	#26m street 67
Runa Corsel		rundcorse@online.com.kh	12809941	# 36, St 426
Sam Inn	LWF	saminn@lwfcam.org.kh	12551886	P.O. Box 37 PP
San Thy	MoE	cceap@online.com.kh	16907764	#48, Phnom Penh
San Yau		san_yao@online.com.kh		17851161
Sum Thy	MOE	cceap@online.com.kh	16907764	# 48, Phnom Penh
Toch Sovanna	MIME	tsovanna@hotmail.com	11959699	#45
Tong Chantheang		chantheang@ovenetcan.ne	12976082	#39, St. 528, Benneg Kok 1
P. Pent		CEDAC	Cambodia Biogas	
Tou Bunna	MRD			
Tun Leakhena	CFSP	CFSP2@online.com.kh	012 756555	# 45, St. 606, PNP
UN Roeun		roeun21@hotmail.com	12928533	#288, Phom Penh
Vong Narith	CFSP	Narith_vong@yahoo.com		# 45, Str 606
Wayne M'callun	AFSC	maswayne9@hotmail.com		9., Sreanbel

## **ANNEX V            Terms of Reference**

### **1            Introduction**

Feasibility Study for a Cambodian Biodigester Support Programme.

#### **1.1    Brief history Initial communication**

The initial communication was established during the first SNV identification mission to Cambodia from 4-7 July 2004 by Jack Cortenraad (SNV Cambodia) and Luuk Boon (SNV Vietnam). Their recommendation to explore further the options to introduce Biogas Practice in Cambodia was adopted by the Biogas Practise Team (BPT). During the Biogas Practice Team (BPT) Workshop conducted on 28 and 29 September in Wassenaar The Netherlands, the following methodology to introduce the Biogas Practice in new countries was agreed upon:

- a. Initial communication (trigger);
- b. Pre-feasibility study (desk study, scope, market, area, main stakeholders, need assessment. Renewable Energy (RE) survey report, energy demand reports);
- c. Feasibility study (in-depth assessment RE & biodigester opportunities, Technical Assistance (TA) formulation);
- d. Project Identification Note (outline proposed programme/activities, in country presentation, identification stakeholders, donors, partners);
- e. Programme Design Document (desk/in country, implementation modality, action plan and budget, organization and institutional arrangement, CDM preparations, approach actors/donors);
- f. Agreement.

The steps taken so far and yet to be made for Cambodia are outlined below.

### **2            Pre-feasibility study**

The information required for a pre-feasibility study consists of the following elements:

- Need assessment;
- History of biodigester technology applied so far;
- Technological feasibility;
- Social context;
- Financial and economical feasibility;
- Institutional setting.

One of the organisations contacted to obtain this information is the Cambodian Research Centre for Development (CRCD). In September 2004 they published a study called 'Review and Recommendations for Households Biodigesters in Cambodia'. This study contains most if not all the information required at this stage. In addition the study continues in giving considerations and aspects of a Cambodia Biodigester Support Programme.

Both the SNV summary report on the first identification mission as well as the CRDC report indicate that there is a open atmosphere in the discussions with Government officials and that the various parties are interested in a large(r) scale biodigester programme.

### **3. Objective**

#### **3.1 Overall objective of study / job**

The overall objective of the study is to assess the possibilities to design a programme to stimulate the emergence of a national biodigester sector programme in Cambodia. The study is divided into two main parts:

- 1) Fact finding on the key elements concerning a national biodigester programme.
- 2) Formulate an outline for a national biodigester support programme in Cambodia.

#### **3.2 Specific objectives**

##### **3.2.1 Fact-finding**

The specific objectives concerning the fact-finding can be divided into four categories:

###### Demand side:

- 1) Evaluate the experiences gained with biodigester installation in Cambodia as perceived by the users.
- 2) Energy services and fuel requirements of livestock holding households and other potential users (also as baseline data and information if the Clean Development Mechanism (CDM) is pursued in the future).
- 3) Assessment of the potential market for a (pilot) biodigester programme in terms of potential number of beneficiaries, number and size of biodigesters to be constructed.
- 4) Analysis of the gender aspects of biodigesters in the specific context of ethnic diversity in Cambodia, specifically on ownership conditions and workload of women and children. Analysis of the potential risks a biodigester programme faces in Cambodia, specifically in terms of resistance against credit, resistance against cooking on animal and human faeces.

###### Technical factors:

- 5) The potential and actual resource availability. Information is to be collected on cattle (and other animals where relevant) per households as well as the trends and feeding practices and current practices on dung handling with regard to composting and the use of organic fertilisers.
- 6) The availability of water the year round.
- 7) The availability, quality and prices of common construction materials.
- 8) Analysis of the private sector capacity in the context of the production of biodigesters, quality of mason craftsmanship in rural areas as well as the availability and quality of technical training centres.
- 9) Evaluate the experiences gained with biodigester installation with respect to technical problems, repair and after-sales service. Assessment of the current designs constructed and the need for quality standards and enforcement.
- 10) The need, quality and production of appliances related to biodigester operation and biodigester use.
- 11) Assessment of the perspectives of the use of digester effluents as fertilizer.
- 12) Identification of appropriate technologies suitable for mass dissemination and for CDM requirements.



Financial and economical factors:

- 13) Potential financial set-up. The existing credit mechanisms and the capacity of the financial sector, particularly for micro-finance. Assessment of potential financing schemes and the need for capacity building in this sector related to biodigesters.
- 14) The costs and benefits. Analysis of the potential impact of biodigesters on fuelwood savings, on crop production and fisheries and on the health situation in the rural areas, specifically of women and children. The possible employment opportunities created by a national programme.
- 15) Assessment of the need for a subsidy scheme to make biodigesters more in reach for small farmers, as a quality enforcement tool and as a promotional tool.

Institutional factors:

- 16) The policies. Provision of an overview of all relevant policies of the Government of Cambodia in the context of a Biodigester Programme. Assessment of the willingness of the Government to develop a National Biodigester Programme and additional Renewable Energy Technologies (RETs) for rural application.
- 17) The institutional set-up. Provision of an overview of all relevant stakeholders:
  - a. Ministries and departments within ministries
  - b. Other government levels and agencies
  - c. Private sector
  - d. R&D and training facilities
  - e. (I)NGOs

Describe each agency's mandate, specific policy and activities undertaken and ongoing in the context of biogas. Analyse the human resource situation of each agency in the context of biogas. Give a number of scenarios of an organizational structure to develop and implement a biodigester programme. Highlight the key elements in an appropriate organizational structure.

### **3.2.2 Formulate an outline for a National Biodigester Support Programme**

Based on the data collected, discussions with potential partners and the experiences gained in the Nepal and Vietnam programmes, an outline for a (pilot) Biodigester Support Programme will be formulated. This outline will be presented to the potential partners for their comments and suggestions before the end of the mission to Cambodia. Part of the outline will be the required SNV-Technical Assistance (TA) component and Function Task Description of the person(s) involved. The outcome of this study will be input for a detailed PIN.

#### **4 Tasks**

The main tasks of the study will consist of discussions and interviews with key actors in the present biodigester activities and those who could play a role in a future set-up, with biodigester farmers and non-biodigester farmers, and with representatives of the Government and rural credit agencies.

The institutions currently involved in biodigesters are:

1. UTA - University of Tropical Agriculture
2. FAO/MAFF/SPFS - Special Programme for Food Security
3. CRDT - Cambodian Rural Development Team
4. CSFP - Cambodian Fuel wood Saving Project (GEREs)
5. FLD - Farmer Livelihood Development
6. RCSA - Rural Children Saving Association

The main Credit Institutions are:

7. Association of Cambodian Local Economic Development Agencies (ACLEDA)
8. Catholic Relief Services

The Government agencies involved are:

9. MAFF - Ministry of Agriculture Forestry and Fisheries
10. DET - Department of Energy Technique of the Ministry of Industry Mines and Energy
11. MoE - Ministry of Environment and particularly the Climate Change Office, housed in this Ministry.

Most of these tasks have already been conducted by the Cambodian Research Centre for Development and are documented in 'Review and Recommendations for Household Biodigesters in Cambodia' (Bridget McIntosh). To a large extent her findings will have to be verified. CFSP will assist in the identification of local RE/Biogas experts who will join the study team.

For the collection of data on existing (baseline) studies related to energy use and farm management local experts shall be hired if required. In the first instance this information is used to identify a pilot area. The identified pilot area will be the focal point of the second part of the mission.

#### **5 Timing**

The working schedule is given in Appendix III.

#### **6 Reporting**

Based on existing documentation, interviews with stakeholders, CFSP workshop and field visit, and the study team will formulate an outline of a Biodigester Support Programme in Cambodia. The proposed programme outline will be presented towards the end of the mission in Cambodia. Stakeholders are expected to provide feedback on the programme outline and agree with further initiatives. Tentative dates: 4-5 November 2004. The outcome of the debriefing with Cambodian stakeholders will be presented to the SNV-Asian cluster and simultaneously to the Biogas Practice Team. Tentative dates: second week December. The final study report will be submitted to the Cambodia stakeholders, SNV-Asia cluster and Biogas Practice Team.

## ANNEX VI Function Task Description SNV Advisor

<b>Job Description - Additional part: Senior Advisor Biogas Cambodia</b>		<b>Salary scale: 11</b>
		<b>Date of preparation: 30 November 2004</b>
<b>Theme: Context</b> <ul style="list-style-type: none"> <li>- Organizational unit: NRM Portfolio Asia region and Biogas practice area</li> <li>- Accountability: Portfolio Coordinator Vietnam</li> <li>- Framework: Vietnam management agreement</li> </ul>	<b>Areas of results:</b> Until end of 2005: Further detailed formulation and contracting of the programme Development and execution of institutional and organizational arrangements Until end of 2009 Construction progress, quality and coverage	
<b>Responsibilities:</b> <b>A. Advisory services</b> <ol style="list-style-type: none"> <li>1. Assures quality of services provided by SNV advisors within his/her field of expertise.</li> <li>2. Initiates and contributes to regional activities within his/her field of expertise.</li> <li>3. Stimulates market and product innovation by the team.</li> <li>4. Monitors impact of services provided by the team.</li> <li>5. Evaluates client satisfaction vis-à-vis the provided services.</li> </ol> <b>B. Learning &amp; Teamwork</b> <ol style="list-style-type: none"> <li>1. Actively participate in the SNV Biogas Practice Team.</li> <li>2. Coaching of clients and colleagues.</li> <li>3. Assist MAFF and other sector stakeholders to participate in national networks on Renewable Energy/Biogas</li> <li>4. Assist MAFF and other sector stakeholders to participate in regional and global networks on Renewable Energy/Biogas.</li> </ol> <b>C. Positioning</b> <ol style="list-style-type: none"> <li>1. Provides input for decision making in biogas / RE practice area development in the Asia region regarding positioning.</li> <li>2. Actively explores new markets – product - client combinations</li> <li>3. Acts as an expert in the biogas / RE practice area and exposes this to our clients and networks</li> </ol> <b>D. Knowledge management / development</b> <ol style="list-style-type: none"> <li>1. Ensures proper documentation of activities and</li> </ol>	<b>Contacts:</b> <ul style="list-style-type: none"> <li>- SNV portfolio coordinator</li> <li>- SNV country Director</li> <li>- Biogas Practise Team Coordinator and members</li> <li>- Government Agencies</li> <li>- Private Sector Enterprises</li> <li>- International and National Development Agencies</li> <li>- Donor Agencies</li> </ul>	<b>Decisions:</b> Decision making powers will be based on a Management Agreement with the Portfolio Coordinator of the country of posting, in co-ordination with the Biogas Practice Team.
	<b>Knowledge and skills:</b> <ol style="list-style-type: none"> <li>a) Experience with capacity building in advisory role in Developing Countries.</li> <li>b) Experience with project formulation and design</li> <li>c) Experience with institutional development (regulations, decrees, operating standards, etc.)</li> <li>d) Sound understanding and mastering of various advisory techniques</li> <li>e) Adaptation to cultural setting</li> </ol>	<b>Job requirements:</b> <ol style="list-style-type: none"> <li>a) Academic level of working and thinking with specialization on RE/Biogas</li> <li>b) Active knowledge of English (verbally and written)</li> <li>c) Minimum of 7 – 8 years of relevant working experience in a related field</li> <li>d) At least 6 years working experience in Asian/African setting</li> <li>e) Experience advising towards national/local</li> </ol>