



IMPLEMENTATION PLAN
for a
 BIOGAS PILOT PROGRAM
 (BPP)
 in Lao PDR



(FINAL DRAFT)
Vientiane – Lao PDR
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Executive Summary

Lao PDR is largely a rural and mountainous, landlocked country bordered by China, Vietnam, Myanmar, Thailand and Cambodia. It covers an area of 236,800 square kilometres and stretches more than 1,700 km from north to south and about 100 to 400 km from east to west. It has a population of about 5.8 million people (census 2004). A large part of the population depends for their income on farming activities with integrated farming systems - crop production combined with livestock rearing being common. The Gross Domestic Product (GDP) per capita in 2004 amounted to about US\$ 390 making Lao PDR one of the poorest countries in South East Asia.

Livestock consist mainly of cattle, pigs and buffalos. Cattle is being kept for beef while buffalos are used for draft power and pigs mainly for meat. In almost all cases the livestock is also a source of "safekeeping" of financial resources. Cattle and buffalo are grazed extensively in fallow upland fields, grazing areas and forests. Management inputs are minimal as animals are left to graze in remote areas where ample feed is available and farmers check animals every few days. At other times and in particular during the paddy growing season, some (but not all) animals are brought back to an enclosure or pen every night or sometimes even during day and night.

Lao PDR has abundant hydropower electric sources but most of the electricity generated is exported to neighbouring countries like Thailand and Vietnam and in fact only 47% of households have access to electricity. The population itself depends mainly on traditional sources of energy like fuel wood and charcoal with over 95% of the population depending on these traditional sources of energy for household energy use. Fuel wood is generally abundantly available almost all over the country possibly with the exception of Xiengkhuang and is generally cheap in those cases where it is monetized (most fuel wood is collected for free) and in almost all cases there is no problem with its supply nor is harvesting of the wood at present a direct threat to the environment.

Biogas, produced from livestock manure can be a substitute for these traditional sources of energy both for cooking as well as lighting but not for space heating. However, even though biogas has a long history in Lao PDR and has many benefits, almost all of the digesters, with the exception on 30 units installed early 2005, are no longer operational due to various reasons among which incorrect sizing and a lack of understanding how to manage/maintain the unit might be the most important.

Biogas can substitute for other sources of energy and saves time in cooking and in cleaning cooking utensils. It also reduces the financial burden of buying fuel wood and/or reduces the time spent on collecting fuel wood. Cooking with biogas instead of fuel wood significantly reduces the amount of smoke and PIC's (particles of incomplete combustion) which both affect the health of people close to the cooking fire and the use of biogas has a beneficial effect on the health status, in particular the women and children.

The resulting an-aerobically digested sludge or effluent from the biogas digester is a potent organic fertilizer and can reduce the use of chemical fertilizers while at the same time preventing that the raw dung is discarded into surface water or seeps into ground water sources. This results in improved living conditions because of better manure management (less smell, etc.). Besides, the installation of biogas digesters provides employment and income and may also result in the setting up of SMEs like biogas digester construction companies.

Technically Lao PDR has considerable potential for biogas as the temperature is right, quality building materials are available at most places, skilled and unskilled labor is available, livestock holdings are sufficiently large, etc. However, there are also negative factors of which the low price of wood fuels is a major hurdle as well as the fact that livestock is often free-roaming or with other words, dung to feed the digester may not be available where it is needed (close to

the digester) while government policies are ambiguous whether cattle should be kept at home or outside the village.

Likewise, the financial and economic potential of biogas digesters is clouded by the low price of the other sources of energy with which biogas needs to compete. As a result of the low price and the high interest rates (albeit influencing the resulting IRR to a lower extent) the Internal Rate of Return (IRR) for the installation of biogas digesters by farmer households is in almost all cases negative where fuel wood is being substituted by biogas. In the case of charcoal as cooking fuel, the picture is somewhat less bleak. Consequently, the non-monetary benefits of biogas need to be stressed to convince farmer households to install biogas digesters.

The Government of the Netherlands decided, based upon the positive experiences obtained in Nepal and Vietnam with biogas, to support biogas by making funds available for expansion in these two countries as well as providing funds for new programs in Bangladesh, Cambodia and Lao PDR. Feasibility studies were carried out in Lao PDR which showed a technical potential for biogas and as a result a proposal for a Biogas Pilot Program (BPP) was developed. The goals and objectives for the BPP can be stated to be:

The Goal:

To improve the livelihoods and quality of life of rural families, men and women, and reduce the impact of biomass resource depletion in Lao PDR through exploiting the market and non-market benefits of domestic biogas digesters.

The Purpose:

To establish a series of biogas pilot activities to form the basis of a future larger scale biogas program that will establish a commercially viable domestic biogas sector

The BPP, which is planned to be started in some selected districts of Vientiane Municipality, where biogas is expected to have potential – sufficient livestock which are mainly stabled, sufficient number of farmer households with adequate earnings and sufficient interest by farmer households in the technology - has several components all deemed necessary to establish a sustainable program or with other words a program which will continue on its own once support is withdrawn. Each component has its own objective which can be described as follows:

Component 1: Promotion

To stimulate and inform stakeholders on the benefits and costs of domestic biogas and to publicise the program

As the project is new and stakeholders' knowledge on biogas technology and benefits is low to non-existent, the Promotion Component (PR) will be at the forefront of the program. It will work on 2 levels: to promote biogas as a technology and to promote the program itself.

An important element of the project will be to investigate whether all potential beneficiaries are being effectively reached through current PR activities and to devise ways in which to ensure that this happens. Whilst this will not be as directly relevant to the first year of the project, this will be particularly important as base information for the up-scaling of following phases in which it is expected that the geographical scope of the program will expand and there will be greater opportunities to involve the poor.

Regular monitoring of the PR strategy will be important to make sure that it is effectively reaching beneficiaries and other stakeholders.

Component 2: Financing

To lower the financial threshold and improve access to credit and repayment assistance, to facilitate easier access to domestic biogas for all potential implementing agencies, with particular emphasis on the poor, women and other disadvantaged groups

Although the two are obviously linked, the Financing Component deals with investment finance not project finance. The Financing Component has three distinct aspects namely Farmer Contributions, Credit and Subsidy.

In order to encourage a sustainable market driven biogas sector, the funding for biogas installations and the associated stable and kitchen renovation should come from the farmer household. Subsidy will be provided from Year 1 of the project, although the amounts (initially a flat rate of 100 Euro) and procedures will be reviewed throughout the project.

Even though farmer households will be mainly funding the biogas digester construction themselves, most farmer households will not have the cash means with which to do so. During the preparatory work for this program, it was found that access to appropriate credit is likely to be crucial to its success as there are few farmer households who can afford to pay cash for a digester. Formal credit systems, familiar with biogas technology, do not exist in Lao PDR. In addition, interest rates charged are high to very high and as a result further investigation needs to be done to identify and develop potential credit providers. The development of credit products may take time to develop and may not be able to be implemented until the latter part of the project and should be developed with a long term view to up-scaling.

A subsidy amounting to 100 Euro (about 1/3rd of the investment cost) will be used as a tool to improve people's access to biogas technology by reducing the cost, as a promotional tool, and as a quality control incentive as it is not paid until after the digester has received final approval.

Component 3: Construction and After Sales Service

To facilitate the construction and continued operation of 6600 biogas digesters

Whilst the project will not actually construct or install any biogas digesters itself, a key measure of success of the project is the number of digesters constructed. The project facilitates construction through helping to develop and support Biogas SMEs and through providing the information and quality assurance framework, technical training and eventually, credit and subsidy support.

Component 4: Quality Management

To maximise the effectiveness of the investment made by the biogas owners and to maintain consumer confidence in domestic biogas technology

Quality Management will be particularly important in ensuring that the technology works reliably from the very beginning to provide the best examples to encourage the uptake of the technology. It will also be important to get the Quality Management as good as possible as early as possible to ensure the sustainability of the project by keeping people's faith in the technology.

During the project, but particularly during Year 1, the quality guidelines will be evolving as more is learned about biogas in the Lao PDR context. These guidelines will include checklists and technical specifications and will be outlined in the Project Handbook.

Component 5: Training

To provide the skills for business people to run biogas SMEs and for biogas users to be able to operate their digesters effectively

As the project is new there will be a need for widespread introductory and technical training with implementing agencies, staff and other stakeholders. The exact training needs and the best ways in with to deliver this training will be identified in a Training Needs Analysis to be conducted early in the first year of the project.

Of particular importance to the project is the biogas user training with emphasis on women. Lessons learned from other projects in Lao PDR show that when delivering household level training, it can be difficult to involve women in training unless they are specifically targeted.

Component 6: Extension

To provide the information to allow biogas users to effectively exploit all the benefits of biogas

The Extension component will disseminate the results of research to biogas users and Biogas SMEs and will facilitate the development of demonstration plots and activities. It will pay special attention to maximising the benefits of biogas beyond the base benefit of using gas for cooking. Particular attention will be paid to ways in which biogas can benefit enterprises and income generation activities. As this project is only a pilot, most attention will be paid to the proper use of slurry as a non chemical fertiliser.

One of the key aspects of this project is establishing some biogas demonstration sites. Ideally, these sites would showcase more than just a working biogas digester, but would also demonstrate the use of multiple household appliances (e.g. stove, lighting, water heating), good slurry use, latrine connection. It is expected that 40 or 50 sites will be developed, with at least 2 or 3 in every village to reach the maximum number of potential owners.

Component 7: Institutional Support

To maximise the ability of key biogas related institutions to be able to provide the services and support required by the biogas sector to facilitate access to domestic biogas and the development of quality biogas products

In addition to supporting Biogas SMEs, an important function of the project is to support biogas related institutions such as the Implementing agency and the Biogas Advisory Board. The advisory board will both provide and receive support. The advisory board will be an important part of the project management and will require project support and expertise to function. At national level the advisory board will consist of Ministerial and Departmental stakeholders, donors and technical experts.

Component 8: Monitoring and Evaluation

To identify project progress and impact on stakeholders/other aspects in order to facilitate knowledge transfer

Monitoring will focus on three main areas: Monitoring and Evaluation of project implementation, Quality Control of digester construction and maintenance and Impact on Users and Research. This will include establishing a project baseline, data collection activities such as annual Biogas User Surveys, construction and maintenance records, collation of results and recording of activities in semi-annual reports, Impact Assessments and other external monitoring or assessment activities.

Component 9: Research and Development

To increase knowledge about domestic biogas issues to maximise effectiveness, quality and service delivery of the biogas program

The Research and Development component is closely allied with the Extension and the Training components. It has two distinct research areas: research into the most appropriate technology for the Lao PDR context and research that assists the exploitation of biogas benefits.

Component 10: Project Management

To support and coordinate the activities driving the development of a commercially viable biogas sector

The Department of Livestock and Fisheries (DLF) of the Ministry of Agriculture and Forestry will be the executing partner. The procedures for the operation of the project office will be outlined in the Project Handbook. All operations will take place using in accordance with Lao PDR laws and SNV Lao PDR rules and regulations in accordance with the requirements of SNV and of donors.

The financial resources required for a successful implementation of the proposed biogas pilot program amount to € 3,046,214 considering an average digester size of 6m³. Of this amount some € 1,410,968 has to be financed by the farmer households from their own means and/or through bank loans. DGIS is requested to fund the required expenses for program management (€ 449,345) and subsidy (€ 660,000) cost under the Asia Biogas Program. SNV is requested to provide technical assistance to a total cost of € 485,901 while MAF/DLF will contribute € 40,000 (mainly in kind) in the form of program office accommodation, water, electricity, and means of communication, etc.

Acronyms and Abbreviations

ABP	Asia Biogas Program
APB	Agriculture Promotion Bank
a.o.	Amongst others
ARI	Acute Respiratory Diseases
BAB	Biogas Advisory Board
BOD	Biological Oxygen Demand
BOQ	Bill of Quantities
BPP	Biogas Pilot Program
BPPO	Biogas Pilot Program Office
COD	Chemical Oxygen Demand
COLD	Chronic Obstructive Lung Disease
CTTE	Canadian Thai Trilateral Environment
DGIS	Directorate General International Cooperation, the Netherlands
DLF	Department of Livestock and Fisheries
EdL	Electricite du Laos
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
Lao PDR	People's Democratic Republic of Laos
LDC	Least Developed Country
Log-frame	Logical framework
LPRP	Lao People's Revolutionary Party
LWU	Lao Women's Union
MAF	Ministry of Agriculture and Forestry
MDG	Millennium Development Goals
MI&H	Ministry of Industry and Handicraft
MoU	Memorandum of Understanding
NAFES	National Agricultural and Forestry Extension Service
NAFRI	National Agricultural and Forestry Research Institute
NEM	New Economic Mechanism
NGPES	National Growth and Poverty Eradication Strategy
NUOL	National University of Laos
PAFO	Provincial Agricultural and Forestry Office
p.t.	Part Time
R&D	Research and Development
RETs	Renewable Energy Technologies
SME	Small and Medium Enterprise
SNV	SNV Netherlands Development Organisation
STEA	Science Technology and Environmental Agency
TRI	Technology Research Institute
TSS	Total Suspended Solids
UNDP	United Nations Development Program
UXO	Unexploded Ordinance

Exchange rates 15 May 2006

1 US Dollar equals 10,100 Kip

1 Euro equals 12,900 Kip

1 Introduction and Background

1.1 Lao PDR: The Country

Lao People Democratic Republic (Lao PDR) is largely a rural and mountainous, landlocked country bordered by China, Vietnam, Myanmar, Thailand and Cambodia. Lao PDR covers an area of 236,800 square kilometres. It stretches more than 1,700 km from north to south and about 100 to 400 km from east to west. The Mekong River which forms most of the border with Thailand and Myanmar flows through the country for about 1,500 km. The topography is predominantly mountainous with cultivated floodplains along some reaches of the Mekong River and its larger tributaries. The climate is typically tropical monsoon and the rainy season starts from April/May to September/October, with an average annual rainfall of 1,600 mm. Temperatures are coolest during December and January and highest in April and May.

Lao PDR has a population of around 5.8 million (census 2004), with an estimated annual growth rate of 2.7%, one of the highest in East Asia. The population density is 23 people per square kilometre which is one of the lowest in East Asia. The population comprises of three main ethnic groups: the Lao Loum (lowland) which account for 68%, the Lao Theung (low mountains) accounting for 22% and the Lao Sung (high mountains) for the remaining 10%. However, the population is diverse, consisting of approximately 131 ethnic groups. Around one in ten Lao people – much of the country's elite – left the country in the 1970s following the change in regime. The administrative system of the country includes some 11,000 villages in 142 districts in 16 provinces, 1 city region (Vientiane Capital) and 1 special region (Xaisomboun) – see figure 1¹.

The official language is Lao, a tonal language structurally similar to Thai. Before 1975, French was the predominant foreign language spoken. Between 1975 and 1989, many Lao studied Russian or other Soviet bloc languages. Among younger Lao, English is now the most widely-spoken second language.

Theravada Buddhism, the dominant religion of Laos, is followed by approximately 60 per cent of the population, especially amongst so-called Lao-Loum or the lowland Lao. Animism is still widely practiced among a number of minority groups, especially in the more remote rural areas.

1.2 Lao PDR: Economic Overview

Since 1986, Laos, in line with its larger socialist neighbors, has promoted gradual economic liberalization through the so-called New Economic Mechanism (NEM). In doing so, the government has moved cautiously from a hard-line regime with a centrally planned economy to a more market-oriented system.

In August 1991, the National Assembly adopted a new constitution which formalized the establishment of a market-oriented economy, guaranteed the right of every Lao citizen to own property, and provided protection for foreign and domestic investment. Indicators of the more open society that has emerged over the past decade include greater freedom to travel, choice of employment, and the development of a fledgling private sector.

¹ Xaisomboun Special Zone has been abolished in January 2006 and this area has been split up into two parts with the southern part added to Vientiane Province and the Northern part to Xiengkhuang Province. However, maps, statistics, etc. have not yet been altered so the "old" division of 16 Provinces, 1 City Region and 1 Special Zone is in this report still adhered to.

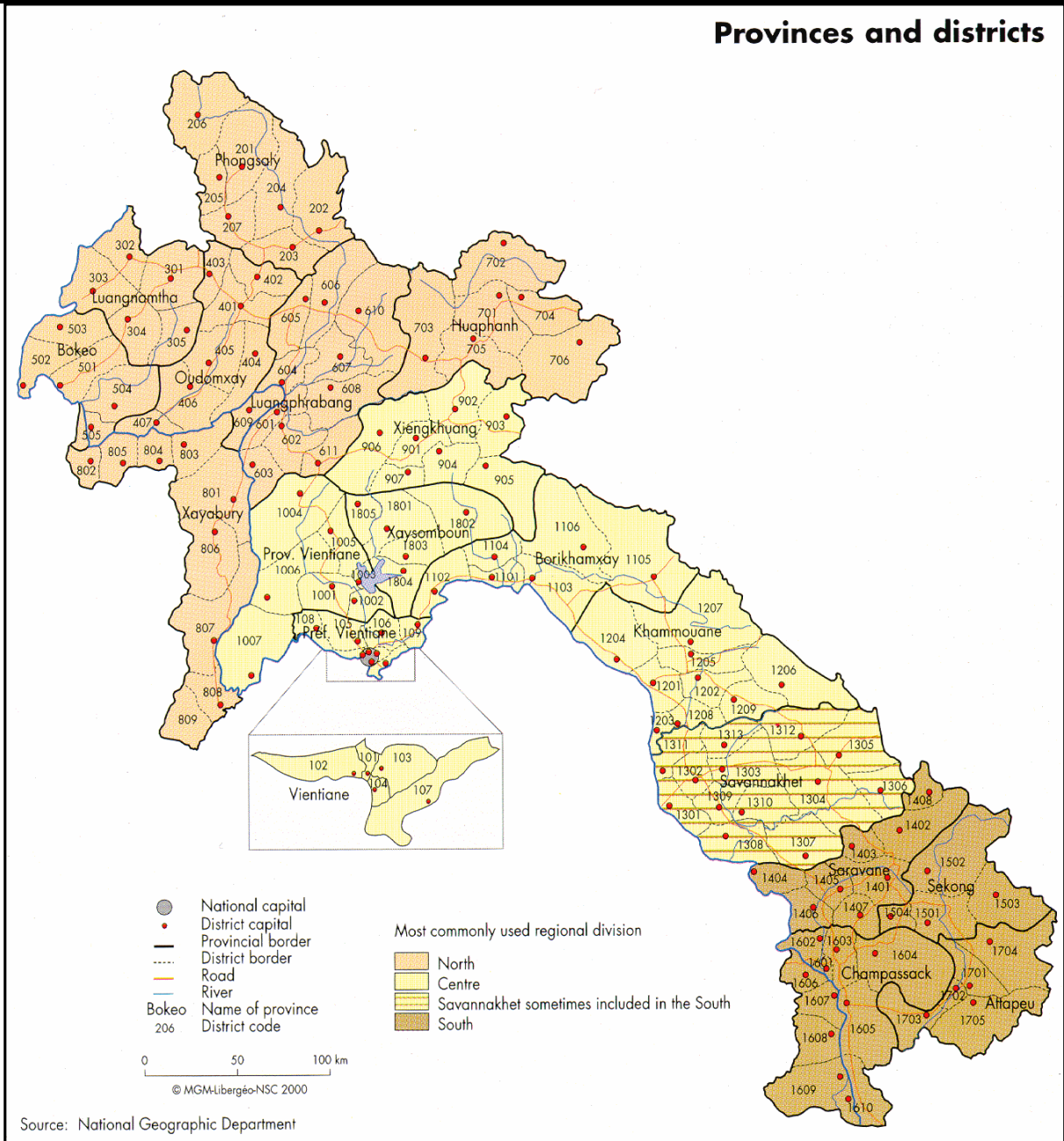


Figure 1: Provinces and Districts of Lao PDR – See Annex 5 for names of the districts

1.3 Lao PDR: Social and Economic Overview

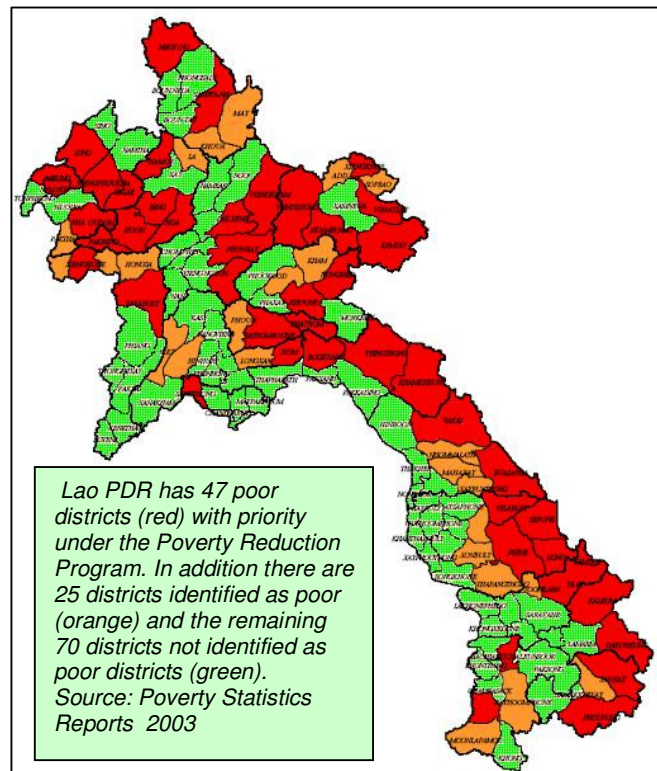


Figure 2: Poor Districts Lao PDR

With an estimated per capita income of US\$390 (GDP at current price) in 2004, the Lao People's Democratic Republic (Lao PDR) is one of the poorest countries in South East Asia. It is classified by the UN as a Least Developed Country (LDC). In 2004, 71 percent of its population lived on less than US\$2 a day, and 23 percent on less than US\$1 a day. A significant decline in poverty has been achieved however during the last decade: using Lao PDR national poverty line (of approximately \$1.5 a day) the incidence of poverty has fallen from 46 percent in 1992/93 to around 33 percent in 2002/03 (see figure 2 for an geographic overview of poverty in Lao PDR).

It has significant natural resources like forestry, minerals and hydro-electric power. Agriculture is the major sector contributing 52 percent of GDP and employing 80 percent of the labour force; the industry accounts for 23% and services for 26%.

Donors provide considerable financial and technical support; in 2003/04, donor-funded programs accounted for 5 percent of GDP, 29 percent of total public expenditure, and 63 percent of the capital budget.

Table 1: Overview of some Socio-Economic Indicators in Lao PDR

Indicator	Value	
Life Expectancy at Birth	59 Years	(2000)
Net enrolment ratio in primary education	83%	(2002)
Human Development Index	0.48	(1999)

Source: Millennium Development Goals: Progress Report Lao PDR January 2004

Economic performance of Lao PDR has continued to improve during 2004 and 2005 and it is projected to grow at 7.3 percent in 2005 and to continue growing steadily at 7 percent in 2006. However, a large part of this growth comes from increased foreign investment flows in

hydropower and mining: without increased investment and exports through large projects, real growth would have been about 4.2 percent in 2003, 6 percent in 2004 and projected at 4.8 percent in 2005 and 2006. Therefore, promoting growth in sectors other than mining and hydropower is increasingly important for ensuring stable and rapid growth in the long-run.

Real growth in Lao PDR reached 6.4 percent in 2004, up from 5.8 in 2003. Agriculture recovered from 2003, growing at above 3 percent in 2004 and 2005 (projected), in comparison to 1.8 in 2003; this increase came mainly from recovery in crops after the drought. Manufacturing picked up on the back of strong domestic demand. Private investment and exports in other sections performed better too. Rapid growth in the neighbouring countries and increasing foreign investment and trade provide a base for keeping this performance in the future.

1.4 Agriculture in Lao PDR

Agriculture is economically an important sector in Lao PDR as in the year 2000 it accounted for 52% of GDP with crops contributing 29%, livestock and fisheries 18% and forestry 5% (ADB Country Economic Review, 2001). Livestock are found on most farms in the Lao PDR with 89% of all farm households raising one or more livestock types (Agricultural Census, 2000).

Livestock are the most important single source of cash income for farmers (LECS 2, 1999). Nationally, about 30% of cash income from agriculture was derived from livestock in 1997/98. This figure was more than 50% in the northern provinces of Phongsali and Huaphanh. Apart from being a major source of cash income, farmers keep livestock for accumulation of capital and wealth; draft power to cultivate land and transport agricultural produce; and manure for vegetable, fruit and crop production. Farmers also cite other advantages such as the relative stability of prices for livestock and livestock products, particularly when compared to price fluctuations of cash crops, the ease of selling livestock to generate cash at any time; the ability of ruminants (cattle, buffalo and goats) to utilize common property resources such as grasslands and fallow cropping areas;

Cattle and buffalo are grazed extensively in fallow upland fields, grazing areas and forests while pigs are normally kept either in a pen at home or roam freely around the house. Management inputs in the case of cattle and buffalos are minimal as these animals are left to graze in remote areas where ample feed is available and farmers check animals every few days. At other times, animals are brought back to an enclosure or pen every night.

The gender division of labor in livestock management is such that women and men jointly care for cows and buffaloes. In the rainy season these animals often graze in the forests and in the dry season in the fallow rice fields. Women pound most of the animal feed and feed the pigs and poultry. Sometimes men also feed the pigs. (Schenk-Sandbergen et al, 95).

1.5 Energy situation in Lao PDR

Lao PDR has some exploitable energy sources available like abundant hydropower and biomass as well as some coal deposits with all the coal being exported at the moment. The energy consumption for 2005 in Lao PDR can be characterized as being heavy biomass based as is shown in table 2 as well as table 3:

Table 2: Energy Consumption by Type 2005

	Energy Consumption in 2005					
	Electricity	Oil	Gas	Charcoal	Fuel Wood	Sawdust
Tera Joules	4,633	11,430	88	7,283	40,176	318
% of Total	7.25	17.88	0.14	11.39	62.85	0.50

Source: EdL Annual report 2005 and DoE statistics.

Table 3: Shares of Different Fuels in the Household Energy Mix 1995

Type of Fuel	Urban	Rural	National
Fuel wood	68.3	97.7	92.7
Charcoal	17.0	1.6	4.3
Electricity	10.4	0.1	1.9
Sawdust	2.7	0.3	0.7
Others	1.6	0.3	0.5

Source: Results from the Population Census 1995, SPC, National Statistical Centre, April 1997

As is evident from the table 2, biomass (fuel wood, sawdust and charcoal) accounted in 2005 for over 74% of all energy used in the country. However, this dependence on biomass energy sources in fact is higher if the conversion factor from wood to charcoal is taken into account (1 kg of charcoal requires 3-4 kg of wood). Most of the biomass is used for cooking and space heating as well as for small scale industrial applications (brick making, salt making, etc).

One of the reasons of the heavy dependence on biomass is the easy availability of wood and charcoal and consequently low price in almost all rural areas as well as some of the more urban areas. Fuel wood collection generally is no threat to the environment although in some cases it may lead to over-cutting of resources like in areas of Xiengkhuang province. In fact in most areas fuel wood and to a lesser extent charcoal are not monetized as a lot of people collect their own fuel wood and make their own charcoal. While no generally valid price of fuel wood and charcoal can be given, table 4 provides some prices in different areas:

Table 4: Typical Fuel Wood and Charcoal Prices

Location	Fuel wood	Charcoal
Vientiane Municipality/Province	70 Kip/kg	1,200 Kip/kg
Pakxe semi-urban area	45 Kip/kg	1,000 Kip/kg
Attapeu semi-urban area	20 Kip/kg	350 Kip/kg
Saravan semi-urban area	65 Kip/kg	600 Kip/kg
Houaphan Urban area	140 Kip/kg	1,000 Kip/kg
Xiengkhuang Urban area	570 Kip/kg	2,000 Kip/kg

Unfortunately very little information is available on household fuel consumption other than what was collected during field visits. Based on these very limited number of consumption data, the average fuel wood consumption for a family would be about 10 kg. per day while, if charcoal is used, about 1.5 kg per family per day is used. Due to unavailability of data, no accurate estimate on timesaving (fuel wood collection and preparation) resulting from the introduction of biogas can be provided.

2 Status of Biogas in Lao PDR

2.1 History and Current Projects

Biogas is a relatively new technology for Lao PDR with the first digesters having been installed during the period 1995-1999. One of the first digesters was installed near Vientiane in Ban Xiengda, Xaisettha District using Chinese technology. This was later followed by a program funded by the Canadian Thai Trilateral Environment (CTTE) program using Thai-German technology. Some 18 digesters were installed all over Laos ranging in size from 8 to 16 cubic meters. Most² of these digesters are no longer in operation due to various reasons among which incorrect sizing and a lack of understanding how to manage/maintain the unit might be the most important.

In addition a few digesters have been constructed apparently on a "one-off" basis. One of these digesters is located in PakBo (Savannakhet) at the Pakbo Livestock and Fisheries Centre, (PAFO/DLF) using a Vietnamese design while another digester was constructed at Champassak Agriculture and Forestry College (MAF) in Pakxe using the Thai-German design. Both appeared to be working well during the visit although the latter digester experienced problems during the rainy season with reduced gas output most probably caused by an in-balance of the water-dung ratio due to partial flooding³. In 2005 another program funded by the Yunnan (China) Government was undertaken by the National Agricultural and Forestry Extension Service (NAFES) of the Ministry of Agriculture and Forestry (MAF). 30 digesters were built in Ban Nongphouviang, Pak Ngum District using a Chinese design. Farmer households appear to be happy with the units although it is too early to draw meaningful conclusions at this point in time.

Considering that SNV has extensive experience with Biogas and on the request of the Dutch Ministry of Development Cooperation, SNV explored ways to extend biogas technology in Asian countries. With regard to Lao PDR, several feasibility studies were commissioned by SNV with regard to biogas development in Lao PDR (First fact finding mission in February 2003 and Second fact finding mission in July 2003 as well as the Biogas In Lao PDR - Appraisal report of June 2004).

This first study, which was quite critical about the prospects for biogas in Lao PDR, recommended that a follow-up study be carried out which should concentrate on the niche areas identified (Champassak and Savannakhet) with emphasis on an integrated approach. The second fact finding study was more optimistic but at the same time identified several issues which needed to be addressed in order to ensure success.

- Before the first biogas digester is constructed, a conducive environment for the dissemination of biogas should be created.
- At present insufficient data are available to estimate more precisely the economic and social potential of biogas in Lao PDR.
- The technical quality of the biogas digesters produced under the framework of STEA/TRI was found to be largely satisfactory but the cost of the existing Lao model is very high (beyond the capacity of rural population to afford).
- STEA/TRI should coordinate with MIH, MAF, CPC, APB and LWU to implement the biogas program. However, intra-department cooperation leaves much to be desired so there may be a need for a preparatory phase to develop a "Cooperation Strategy"
- STEA/TRI should focus on strengthening of and involvement of the private sector.

² Out of the 10 digesters funded by CTTE, studied by the SNV staff, 9 are no longer operational while the single plant (12 m³ at the Technology Research Centre of TRI/STEA) which still operates is seriously underfed (probably only 5% of the prescribed feeding).

³ There may be other reasons as well why in the rainy season gas output is reduced.

Considering that the 1st and 2nd studies were to some extent contradictory and the issues which needed to be addressed, SNV decided to commission an external appraisal. While the appraisal basically concluded that a national biogas program was not feasible, it nevertheless recommended to start with a modest pilot program as the basic technology is available, government policies in the areas of private sector development, credit supply and sustainable energy development are promising and national and international institutions are supportive to investigate and invest in further development of the RETs including biogas.

Based on those findings, Lao PDR was included in the "Asia Biogas Program: Access to sustainable energy for 1,300,000 people" (Project funded by the Netherlands Ministry of Development Cooperation - DGIS/DMW). This Asian Biogas Program or ABP, aims to provide access to biogas for 1.3 million people in Asia over the period 2005 up to 2011. The Dutch Minister for Development Cooperation signed a Memorandum of Understanding on the financing of the proposal with SNV on 14 December 2004.

A MoU on the technical assistance for a Biogas Pilot Program is expected to be signed in the near future with the Ministry of Agriculture and Forestry (MAF) Lao PDR and SNV Lao PDR. At present two SNV advisors on Renewable Energy Technologies (1 international and 1 national advisor) are stationed in Vientiane to develop a.o. the Biogas Pilot Program (BPP) with the aim not only to construct a number of quality biogas digesters but also to develop a viable biogas sector in Lao PDR. As part of the preparation for the implementation of a Biogas Pilot Program the following activities have been undertaken:

- In September 2005, the survey on potential biogas users and data collection of potential Household use of biogas was conducted in Vientiane Capital;
- Consultation rounds with potential partners in the Biogas Pilot Program were conducted;
- Existing biogas digesters were surveyed and their appropriateness studied for use in the Biogas Pilot Program;
- Activities are ongoing to select the most suitable digester design for Lao PDR.

2.2 Biogas and the Millennium Development Goals (MDGs), the National Growth and Poverty Eradication Strategy (NGPES) and the Sixth National Socio-Economic Development Plan (2006-2010)

The Asia Biogas Program and the Biogas pilot program have their roots in various international and national policies, the core of these being the Millennium Development Goals (MDG). At a national level, the National Growth and Poverty Eradication Strategy and the Sixth National Socio-Economic Development Plan which also relate to the MDG are important references for the project. Below is an outline of how the BPP contributes to achieving the goals of each.

2.2.1 United Nations Millennium Development Goals

MDG 1 Eradicate extreme poverty and hunger

Target 1: To halve extreme poverty

In general, households who install biogas digesters are not amongst the poorest of the poor due to the fact that for a biogas digester to function, a household must have a minimum number of animals that is often more than a very poor family has. However, the biogas dissemination process and the resulting reduced claim on common ecosystem services do affect the livelihood conditions of (very) poor non-biogas households as well. For example:

- Construction and installation of biogas creates employment for landless rural people
- Biogas saving on the use of traditional cooking fuels increases the availability of these fuels for (very) poor members of the community
- Pollution control and waste management benefit all members of the community

MDG 3 Promote gender equality and empower women

Target 4: Eliminate gender disparity in education

It is predominantly women and girls who spend the most time and effort providing traditional energy services and using a domestic energy supply. Biogas directly benefits this group in the following ways:

- Biogas can provide light that helps women and girls to extend the amount of time in the day that they can study and gain access to education and information or engage in economic activities
- Domestic biogas reduces the workload of women by reducing the need to collect firewood, tend fires and clean the soot from cooking utensils. This can save on average 2-3 hours per household per day
- The reduced smoke from replacing traditional fire wood stoves with biogas can improve the health of women (and children) who are most exposed to the dangers of wood smoke
- The provision of biogas can provide an additional or more cost effective home based energy source that can enable women to participate in home based enterprises to generate additional income or at least generate income in a way that suits their life and obligations

MDG 4 Reduce child mortality

Target 5: Reduce by two-thirds the under-five mortality rate

Half of the world's population cooks with traditional (mostly biomass based) energy fuels. Indoor air pollution from burning of these fuels worldwide kills over 1.6 million people each year, out of which indoor smoke claims nearly one million children's (<5) lives per year. Diseases that result from a lack of basic sanitation, and the consequential water contamination, cause an even greater death toll, particularly under small children (<5 mortality caused by diarrhoea is approximately 1.5 million persons per year).

- Biogas stoves substitute conventional cook stoves and energy sources, virtually eliminating indoor smoke pollution and, hence, the related health risks that particularly affect children who are often heavily exposed to indoor smoke
- Biogas significantly improves the sanitary condition of the farm yard and its immediate surrounding, lowering the exposure of household members to harmful infections especially children who spend extended periods in the farm yard. This benefit can be further enhanced by connecting a toilet to the digester
- Proper application of bio-slurry will improve agricultural production (e.g. vegetable gardening), thus contributing to food security for the community

MDG 6 Combat HIV/AIDS, malaria and other diseases.

Target 8: Halt / reverse the incidence of malaria and other major diseases

Indoor air pollution and poor sanitary conditions annually cause millions of premature deaths.

- Biogas virtually eliminates health risks (e.g. respiratory diseases, eye ailments, burning accidents) associated with indoor air pollution.
- Biogas improves on-yard manure and night-soil management, thus improving sanitary conditions and protecting freshwater sources, lowering the exposure to harmful infections generally related with polluted water and poor sanitation.

MDG 7 Ensure environmental sustainability

Domestic biogas can help to achieve sustainable use of natural resources, as well as reducing (GHG) emissions, which protects the local and global environment. Application of bio-slurry increases soil structure and fertility, and reduces the need for application of chemical fertilizer.

Target 10 Halve the proportion of people without sustainable access to safe drinking water and basic sanitation.

- Biogas reduces fresh water pollution as a result of improved management of dung.
- Connection of the household toilet to the biogas digester significantly improves the sanitary conditions in the farmyard therefore reducing the risk of water contamination.

2.2.2 National Growth and Poverty Eradication Strategy (NGPES) and the Sixth National Socio-Economic Development Plan

The NGPES of Lao PDR is split into four main sectors (agriculture/forestry, education, health, infrastructure) with five supporting sectors (energy and rural electrification, agro-forestry, tourism, mining and construction materials). The cross sector priorities are environment, gender, information and culture, population, social security, capacity building. The BPP supports and contributes directly and indirectly to a number of these sectors as outlined below.

Sector and Relevant Aspects	How BPP Can Contribute
Agriculture/Forestry	
<ul style="list-style-type: none"> Ensure food security for all Lao People Promote commodity production Diversify and modernise the agricultural and forestry sector 	<ul style="list-style-type: none"> Use of slurry reduces need for expensive synthetic fertiliser and improves soil quality and yield Improved stables and better manure management improves livestock health especially enterprises with high animal population density
<ul style="list-style-type: none"> Conserve the natural environment and protect threatened species and habitats 	<ul style="list-style-type: none"> Reduces reliance on fuel wood that is usually gathered from natural forest areas Reduces groundwater pollution
<ul style="list-style-type: none"> Improve rural livelihoods 	<ul style="list-style-type: none"> Cost savings through not having to purchase firewood or fertiliser Labour savings through not having to collect fuel wood, reduced cooking time, reduced cleaning time Alternative or improved enterprise opportunities through the use of biogas (eg kilns, incubators, boilers)
Education	
<ul style="list-style-type: none"> Expansion of vocational, technical and higher education to meet the demands of the new labour market and to improve economic rates of return on human capital investments 	<ul style="list-style-type: none"> Supporting technical education providers to provide specific biogas training
<ul style="list-style-type: none"> Training of skilled workers, technicians, professionals and intellectuals to have capacity to apply modern science and technology to serve development needs 	<ul style="list-style-type: none"> Training and upgrading the skills of skilled workers
Health	
Substantial improvement in people's health status, especially of the poor (including through the provision of safe drinking water, improved sanitation and environmental health).	<ul style="list-style-type: none"> Improved health through reduced indoor air pollution Improved health through better sanitation including the connection of latrines to biogas digesters Improved health through reducing pollution in groundwater
Energy and Rural Electrification	
<ul style="list-style-type: none"> Continue mini-developments (micro-hydropower, solar and wind energy projects for off grid power supply in remote areas). 	<ul style="list-style-type: none"> Provides off grid lighting Provides off grid heating
Agro-forestry	
<ul style="list-style-type: none"> Promote food processing, cotton and silk production, traditional medicine manufacturing, handicrafts and other agro-forestry industries. 	<ul style="list-style-type: none"> Provides lighting and heat source for kilns and boilers
Industrial Development (SMEs)	
<ul style="list-style-type: none"> Promote and strengthen SMEs that are adapted to potential and ability of people 	<ul style="list-style-type: none"> Provides support to SMEs that provide biogas installation/construction and support services
Gender	
<ul style="list-style-type: none"> Access for women to basic services 	<ul style="list-style-type: none"> Provides a household level heat and light source; improved sanitation
<ul style="list-style-type: none"> Collection of gender disaggregated data Gender related data and needs assessments 	<ul style="list-style-type: none"> Project information collection and analysis conducted in a gender sensitive manner
<ul style="list-style-type: none"> Assistance to women in accessing rural savings and credit schemes 	<ul style="list-style-type: none"> Financing elements of the project pay special attention to including women
<ul style="list-style-type: none"> Application of gender equity in extension and training services 	<ul style="list-style-type: none"> Women specifically targeted for training and extension services, particularly in regards to digester operation and slurry use
Environment	
<ul style="list-style-type: none"> Deforestation and forest quality degradation 	<ul style="list-style-type: none"> Project reduces reliance on fire wood that is usually collected from natural forest resources, sometimes in

<ul style="list-style-type: none"> • Land Degradation 	<p style="text-align: center;">an ad hoc manner</p> <ul style="list-style-type: none"> • Provides a non-synthetic fertiliser that improves soil nutrients and structure
<ul style="list-style-type: none"> • Decline in Urban Environment • Water Resources and Environmental Health (including indoor air pollution) 	<ul style="list-style-type: none"> • Provided improved sanitation (both human and animal). Particularly important in the urban and semi-urban areas where livestock rearing takes place • Reduces indoor and outdoor air pollution through reduced wood smoke
Capacity Building	
<ul style="list-style-type: none"> • General capacity building for sound public management and administration 	<ul style="list-style-type: none"> • Provides capacity building of the implementing agency in regards to biogas technology and capacity building in regards to technology dissemination and its related social aspects

It will be important for all the activities in BPP to be undertaken with the long term view that the program will need to take a greater poverty reduction focus if it is to be up-scaled after 2009 in order to truly be in line with the NGPES. This will include paying special attention to identifying barriers to access for the poor so that they can be taken into consideration in future designs.

It should also be noted that the BPP is in direct support of the Sixth National Socio-Economic Development Plan in particular with regard to the part on Natural Resources and the Environment as BPP supports:

- building capacity for more effective environmental management (wood fuel and forest issues);
- the use of environmental friendly technologies (biogas digesters);
- the use of renewable energy based on local and regional conditions (biogas);
- reduces the portion of the population using solid fuels (biogas instead of wood fuels);
- reduces carbon dioxide emissions (better manure management, etc.) and;
- helps maintain the proportion of forest cover at 55% of the total land area.

2.3 Technical Potential of Domestic Biogas

Biogas is generally considered to be feasible in those places where:

- the temperature is warm (tropical and sub-tropical conditions);
- collecting and transporting of quality construction materials is easy;
- skilled and unskilled labour for digester construction is locally available;
- feeding materials such as water and livestock dung are easily available;
- other household energy sources are either scarce, not available or are expensive; and
- bio-slurry is appreciated as an organic fertiliser and/or fish feed.

Looking into the above conditions, Lao PDR does meet some but not all of the conditions indicated.

In most areas, temperature is not a problem but could pose some problem in the northern mountains and other high lying areas where during wintertime the temperature can drop to 10 degrees centigrade or lower

With regard to construction materials, Lao PDR generally has good quality bricks available although in remote(r) areas bricks may not be available or are expensive due to transport costs. Cement and iron bars are no problem but sand and stones (aggregate/chips) sometimes are expensive again due to high transport costs. Availability of skilled labour (masons) as well as unskilled labour is generally not a problem. Water is commonly available from local sources like wells, streams and rivers.

In regards to the availability of dung/manure, a study carried out in 2002 showed that in 1999 the total cattle, buffalo and pig population amounted to 944,000 (cattle), 992,000 (buffaloes) and 1,036,000 (pigs). To properly operate a biogas digester, three to nine head of cattle that spend at least a large part of the day or night in a stable would be required. Less than three head would provide insufficient gas to justify the investment, more than nine head would, in

most cases, provide more gas than can be used for domestic cooking purposes. Similar to cattle, a biogas digester would require approximately 3 to 9 buffalo to meet the gas requirements of the owner while, in the case of pigs, a farmer household should keep between 7 and 30 mature pigs. These figures are indicative only, as for the selection of the proper size of the digester, the daily available amount of dung has to be considered. Considering the number of livestock required, the potential for biogas appears to be considerable as there are some 70,000 farmer households with a sufficient number of cattle, some 60,000 farmer households with a sufficient number of buffalo and roughly 20,000 farmer households with enough pigs as shown in table 5. Annex 6 shows a more detailed overview of livestock holdings by province and size. In practice the number will be higher as many farmer households will not only have cattle but buffalo and/or pigs as well so that farmer households with smaller holdings may well have a sufficient number of livestock (cattle and/or buffaloes and/or pigs). While it is difficult to estimate the technical potential due to many uncertainties, one may assume that, based on livestock holdings, the potential for biogas digesters could be well over 100,000 units.

However, in practice the potential number will be far lower due to prevailing livestock practices, policies by the Lao PDR government as well as the availability of competing sources of energy like fuel wood and charcoal which in almost all rural areas are available in abundance and at low or no cost⁴.

Table 5: Livestock Holdings in Lao PDR

Livestock Type	Agro-based HH	HH with Livestock	Number of HH with number of Livestock					Average per HH
			1	2	3-4	5-9	10+	
Cattle	668,001	208,140	33,923	48,489	55,114	50,459	20,155	4.5
Buffaloes	668,001	322,142	83,490	82,500	96,373	51,592	8,187	3.1
Pigs	668,001	327,500	125,383	76,148	59,244	48,782	17,943	3.2

Cattle/Buffalo are normally kept for beef, for draft power and as safekeeping of financial resources. There are practically 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. However, there are also places where the cattle are not kept at home but outside the village and the latest recommendations by the Ministry of Agriculture, indicate that livestock (cattle and buffalo) should not be kept at home but outside the village for reasons of disease prevention. In contrast, there is no similar ruling for pigs even though manure management for pig manure is often non-existent resulting in un-hygienic conditions within the village.

While it is not clear in how far this recommendation by the Ministry of Agriculture is adhered to by farmer households, it does influence the potential of biogas production as dung may not be at the place where it is needed (near the cooking place) and would need to be transported. In addition, in areas with more intensive agricultural practices like around Vientiane, there is a market for dung (sold as fertilizer for about 0.5 USD (5-6,000 Kip per bag). Dung from cattle/buffaloes produced at the farmyard is collected and is used as fertilizer.

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 and it is usually disposed of in surface water. Pigs are kept for fattening and are sold when they are large/heavy enough.

Other Energy Sources which biogas can substitute like fuel wood and charcoal are generally easily available although there are places, notably around Vientiane and areas in Xiengkhuang Province, where wood for fuel becomes a bit more scarce and, as a result, more expensive.

⁴ Labour cost for collection and preparing the fuel wood (splitting, sizing, drying, etc.) has not been taken into account as these functions are difficult to value in monetary terms.

However, in the majority of places in Lao PDR wood fuels are abundant and available at low or no cost and biogas purely as a source of energy has stiff competition.

2.4 Benefits of Biogas

The benefits of biogas are many and tangible. They have been well documented in the areas of energy supply, agriculture, health, sanitation, enterprise improvement, gender and environment. Biogas can have direct financial benefits, but by far the greatest benefits are non-financial. The following aspects of biogas have the following benefits:

Animal dung and night soil is collected regularly and fed into the biogas digester. This does the following:

- Reduces pollution that leads to a cleaner farm environment and greater water catchment area
- Reduces human and animal disease by improving sanitary conditions related to bad sanitation and polluted surface water
- Reduces greenhouse gas emissions through the improved manure management system

The generated gas substitutes traditional fuels. In doing so it:

- Reduces indoor air pollution that is caused by the incomplete combustion of conventional fuels therefore reduces eye and respiratory illnesses, particularly for those most heavily exposed to indoor smoke, namely women and children
- Reduces workload, especially in regards to collecting firewood, maintaining cook fires and cleaning cooking pots. Fuel wood collection in Lao PDR takes in average about 1 hour per day (Syhanath, 2006) and the total workload can be reduced by an estimated 1.5 hours per day and primarily benefits women and children.
- Increases opportunities to use appliances such as gas lanterns and water heaters
- Reduces greenhouse gas emissions from conventional energy sources mainly used for lighting.
- Can provide income generation opportunities by providing an energy source for technologies and activities such as incubators, kilns, lanterns, boilers and cooking flames that is a new resource or more cost effective than previous sources

The an-aerobically digested residue, otherwise known as 'bio-slurry' is a potent organic fertilizer that when applied can:

- Provide a fertilizer that is superior to synthetic fertilizer in terms of available nutrients and soil texture, and that increases agricultural yields between 20% and 40%
- Provide a catalyser for composting other agricultural waste. When used this way, it increases the amount and quality of organic fertilizer from the composting process.
- Improve handling safety of residue due to the fact that the process of digestion followed by composting makes the manure more hygienic therefore safer
- Reduce fertiliser costs of farmer households by reducing the amount of synthetic fertiliser used
- Reduce greenhouse gas emissions through avoiding the application and production of synthetic fertiliser
- Enable farmer households to participate in animal husbandry in areas in which discharge regulations would otherwise have been prohibitive: because anaerobic digestion reduces the TSS and BOD/COD levels in the farm waste significantly.

The strengthening of biogas service enterprises and the support for market development can:

- Provide expanded employment opportunities, particularly for labourers, many of whom are likely to be from poorer families
- Improve income generation opportunities for SME operators
- Improve SME business practices

These benefits, although not all equally tangible, not only profit the investor, but have an impact on the community in meso- and macro- levels as well.

2.5 Impact of Biogas: Who Benefits?

Although BPP is a pilot project that is being conducted primarily to trial technology and dissemination models and to collect information for potential up-scaling, there will also be end beneficiaries who will experience a range of the benefits that are outlined above.

In the Biogas Pilot Program, the end beneficiaries will be Lao households living in rural and semi-urban areas who raise livestock (at least 7 adult pigs or 3 adult cattle/buffalos kept at home). These people will have access to sufficient capital to afford the entire cost of a new household scale biogas digester and will have a use for the gas and need for the waste disposal and use for the slurry. BPP will not work with these people directly, but will work through the target group which is biogas SMEs who will disseminate and support the technology.

2.5.1 Access and Equity Issues (The Poor, Ethnic Minorities and Gender Issues)

One of the significant limitations of choosing these target and beneficiary groups is that although the majority of these people may be poor or at least be considered to have low incomes, they are not the poorest of the poor. Even with financing support, the project will not alone be sufficient to reach the poorest of the poor with the current technology. The base requirement of 7 adult pigs or 3 head of cattle, necessarily exclude the poorest (particularly in Lao PDR where the NGPES defines poverty in terms of rice and wealth in terms of livestock). Similarly, due to the geographical location of the project, the beneficiaries are unlikely to include many members of ethnic minority or other disadvantaged groups. Despite these limitations, BPP will investigate barriers to access for these groups and formulate recommendations as to how to better include them in future phases.

Even though BPP will not have good access to the very poor and ethnic minorities, it will actively involve both men and women. Internationally, biogas has been repeatedly shown to benefit both women and men. Even though men and women have different roles in regards to digester construction and use, the benefit can be clearly seen for everyone. International research has been done investigating these roles, but it will be an important part of BPP to supplement this research with specific information about the Lao PDR context in order to develop an appropriate program. An important tool for doing this will be the annual Biogas User Survey which will collect gender disaggregated data and will contain specific questions on the ways both men and women use biogas. The Biogas User Survey is detailed in the activity plan below.

Within the Biogas Pilot Program special attention will be given to enhancing access to the project for women. Attention will be paid to ensuring that women are owners or co-owners of biogas digesters with men, that they are involved in training- particularly in the areas that are more relevant to them than others, that they receive promotional information, they are involved in planning activities and that the information that is collected about the ways in which they use biogas is acted upon.

2.6 Financial and Economic Potential

The financial and economic potential of biogas is well documented in other countries. It is not yet clear what this potential is in Lao PDR, particularly as it is still unclear what the direct economic benefit of fuel substitution will be as it seems that many people access firewood at no or very low monetary cost. A major focus of this pilot project will be to gather information to make a reliable estimation of the financial and economic potential.

However, even though no final decision has been made with regard to the digester size, some rough calculations have been made with regard to the financial returns of a typical digester with a size of 6 cubic meters. This size was chosen assuming that this size would be the

preferred and/or most common size for most farmer households considering availability of livestock at the farm, financial situation of the majority of the farmer households, etc,

While few reliable data on fuel wood use are available, some surveys show that some 10 kg fuel wood per family per day is used for cooking. However, large variations exist between lowland and upland based farmer households which for a larger part can be explained by the need for space heating in upland areas as well as family size.

It has therefore been assumed that the use of biogas produced by a 6 m³ biogas installation would result in replacing on average 10 kg. fuel wood in the lowland areas per family per day or about 3600 kg of wood per year (about 10 cubic meter per year which may be on the high side considering the outcome of study carried out in 1988 – see the box below).

Project Lao 82-006 Luangprabang Watershed Management of UNDP/FAO undertook a fuel wood consumption survey in the eighties for three different ethnic groups in the project area. The survey resulted in the following average fuel wood consumption rate in m³./hh/year

<i>(1) Upland Lao</i>	<i>30 cubic meter per year per household</i>
<i>(2) Midland Lao</i>	<i>15 cubic meter per year per household</i>
<i>(3) Lowland Lao</i>	<i>7 cubic meter per year per household</i>

The basic data (Base Case) for the financial analysis for the use of a biogas digester are presented in the following table.

Digester size	6 m ³
Investment cost biogas digester	350 USD / 274 Euro
Exchange rate Kip per 1 USD / 1 Euro	10,100 / 12,900
Fuel wood cost (Vientiane area)	70 Kip/kg
Charcoal cost (Vientiane area)	1,200 Kip/kg
Interest rate	36%
Farmer household down-payment	15% down-payment (mainly in kind)
Subsidy	120 USD / 100 Euro
Loan repayment in years	2
Maintenance cost in % of investment/year	2
Fuel wood use per day per family	10
Charcoal use per day per family	1.5

In this case it has been assumed that the benefits associated with the use of biogas digesters are derived solely from the savings in expenditures from biomass fuels. In practice there are other savings like time saved in collecting wood fuels or making charcoal, improved health conditions while cooking (less indoor air pollution, etc.) etc. In this case these benefits have not been taken into account as these do not result in cash savings. With regard to the use of the digested slurry as fertilizer, this also has not been taken into account as in many cases farmer households do use the raw dung as fertilizer and in fact in some places there is a trade in dung for use as fertilizer by other farmer households.

Figure 3 presents the results of a sensitivity analysis on the price of fuel wood. The IRR becomes negative when the price of fuel wood is below 110 Kip (about 0.01 US\$/kg). Taking the price of fuel wood in (semi)urban areas like Vientiane Municipality as the "benchmark or base-case" with fuel wood prices being about 70 Kip/kg⁵, it appears that biogas will not be financially attractive for most fuel wood users (Table 4 on page 4 shows fuel wood prices ranging from 20-570 Kip/kg.). Only in urban areas in the north, where the fuel wood price is above this level, the IRR becomes positive but in most cases remains quite low.

⁵ Fuel wood prices in Phonsavan (Xiengkhuang) are many times higher than in Vientiane. However, these prices are not representative for the country and for that reason fuel wood prices for Vientiane have been taken for the Base Case calculations.

Influence of Fuel wood price on IRR

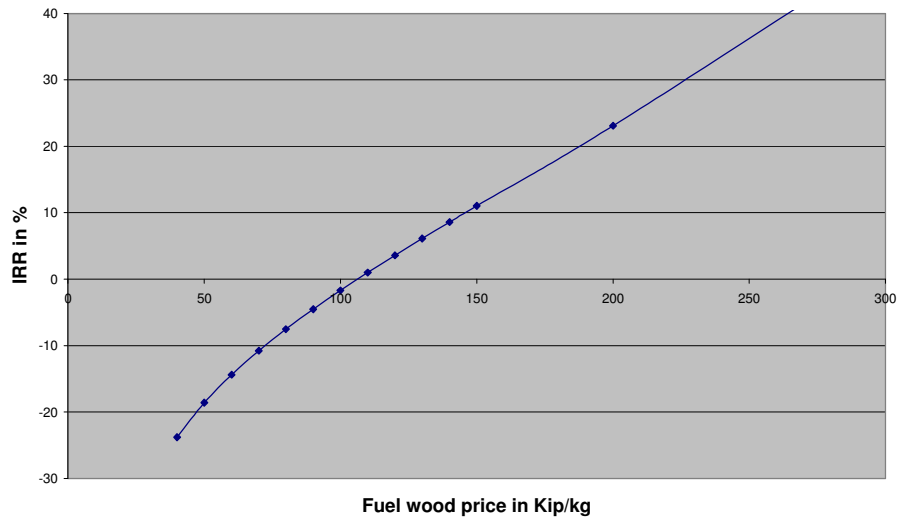


Figure 3: Influence of fuel wood price on IRR

In the case of charcoal, which is the preferred fuel in urban areas like around Vientiane and the larger cities along the Mekong river, the base-case picture is a bit more positive as shown in figure 4 as the “break-even” point lies around 700 Kip/kg equal to about 0.07 USD/kg. (Table 4 on page 4 shows charcoal prices ranging from 350-2,000 Kip/kg.). However, charcoal is not a common fuel in rural areas as is shown in table 3 with only 1.6% of rural households using charcoal in as their main energy source (10% in urban areas).

Influence of Charcoal price on IRR

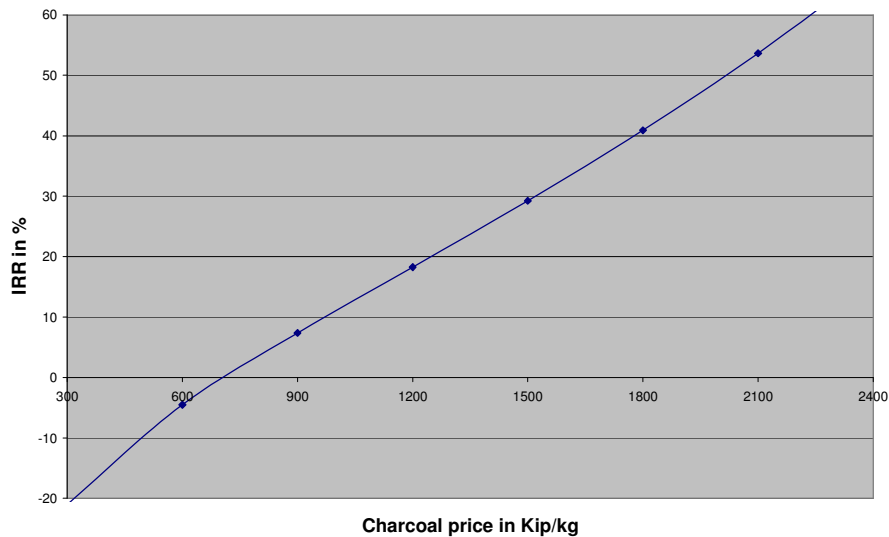


Figure 4: Influence of charcoal price on IRR

A sensitivity analysis on the interest rate was carried out, shown in figure 5. The figure indicates that the IRR is not as sensitive to the interest rate change as it is to the price of fuel wood and/or charcoal.

Influence of Interest Rate on IRR

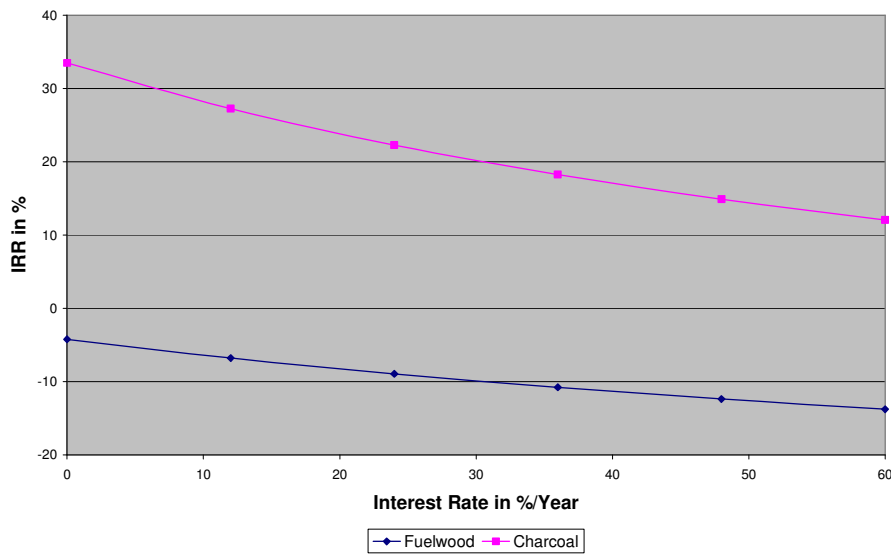


Figure 5: Influence of Interest rate on IRR

The “base case” analysis assumes that a loan taken by the farmer household to invest in a biogas digester will be repaid in two years. In case the repayment period is lengthened to 5 years, the Internal Rate of Return (IRR) worsens as is shown in figure 6.

Influence of Loan Repayment in Years

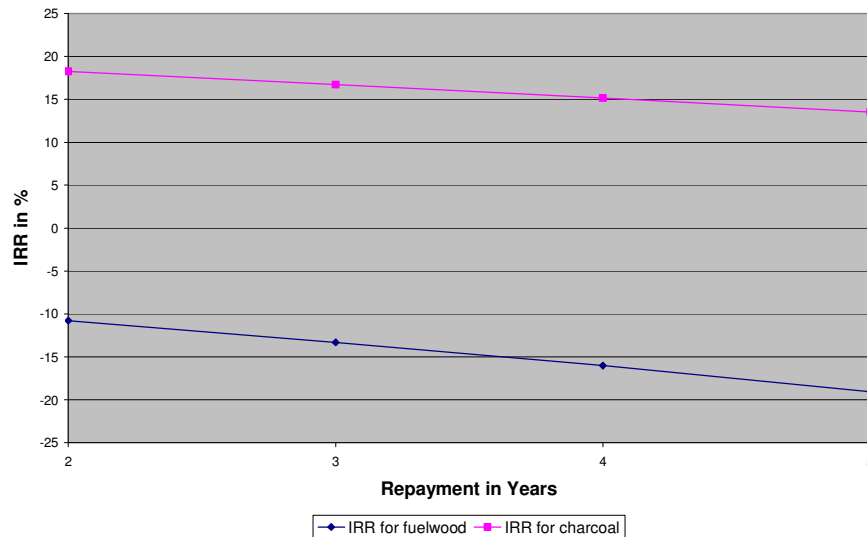


Figure 6: Influence of Repayment period on IRR

It is therefore clear that a biogas digester, while being beneficial for the users in terms of non-monetary benefits (improved hygiene, time saving, environmental benefits, etc.), can generally not be promoted/sold using monetary benefits as “promotion/sales” argument. For that reason the non-monetary benefits will have to be the main “selling-point” to convince farmer households to invest in a biogas digester.

2.7 Proposed Digester Design

A number of different digester designs have been investigated to select the one that is most suited to the Lao PDR context. The models/types range from the design used in Nepal known as GGC 2047, the Deenbandhu model used in India as well as Cambodia where it is known as the "Farmers Friend", the Thai/Lao-German model of which 16 units have been installed in Lao PDR, the Chinese dome design (30 unit installed in Lao PDR) and the design used in Vietnam locally known as KT2A. The following parameters have been considered to select the most appropriate design for Lao PDR:

- Total digester construction cost;
- Construction materials and whether they are easily available in rural areas in Lao PDR;
- Technical skills required and whether those skills already exist in rural areas and if not whether they can be developed;
- Suitability for Lao climate, livestock operations and infrastructure limitations (transport, etc.);
- Ease of use and maintenance;
- Reliability and quality;
- Income generation potential (e.g. can local people benefit from construction employment opportunities); and
- Appeal to SME's to construct biogas digesters as a commercial venture

The process of comparing the different models and rating their suitability for use in Lao PDR indicated that there are no large differences in between the 5 models compared (Prakash Ghimire, 2006). However, considering that preferably only one digester type will be selected to be disseminated by the BPP in Lao PDR, the model used widely in Nepal is considered the be most suitable for Lao PDR as it can be constructed out of bricks as well as stone masonry – something which is useful in upland areas with a lack of clay for brick making. This model has a proven track record (over 100,000 units built with most of them in operation), are easy to build and maintain and have a high level of user satisfaction. The drawback of this model is that it is less suited for areas with a high water table (flat bottom which increases uplift) and the labour intensive construction method of the dome⁶.

The model, tentatively called the "Lao-Net" will be made available in 4 different sizes 4, 6, 8 and 10 cubic meter digester volume and will be available with 2 different type of inlet structures – an inlet structure below ground level for pig farms with the dung flushed in with water when cleaning the pig sty and another system with a dung mixer above ground level for cattle/buffalo dung as the dung has to be mixed with water. Table 6 gives the different volumes, daily dung feeding rates, average gas production as well as the expected cost.

Table 6: Digester volumes and daily feeding rates for the 4 "standard" size digesters

Digester volume in m3	4	6	8	10
Daily dung requirement* kg.	20-40	40-60	60-80	> 80 kg
Daily gas production in m3	0.8 – 1.6	1.6 – 2.4	2.4 – 3.2	> 3.2
Cost in USD/Euro**	309/242	350/274	415/325	464/363

* Based on a hydraulic retention time of 40 days, type of manure, etc.

** Including 15% Guarantee and After Sales Service Charge

The Bill of Quantities (BoQ) for the 4 different size of digesters is attached as Annex 4

⁶ This model requires that the soil removed to construct the digester needs to be filled in again to act as the shape of the dome and, once the dome has been cast out of concrete, the soil has to be removed again through the manhole in the side of the digester.

3 Program Description

3.1 The Asia Biogas Program

The Asia Biogas Program is currently being coordinated by SNV and is primarily being funded by DGIS. BPP will fall under this program and will have access to the resource and knowledge network that is well established in the region.

The Asia Biogas Program involves the two established programs in Nepal and Vietnam, and the relatively new programs in Bangladesh, Cambodia and Lao PDR. SNV will also facilitate the setting up of strategic biogas partnerships and a regional biogas network. It is estimated that an additional 1.3 million people will be reached through this Program in the period from 2005 up to 2011. In addition, viable biogas markets will be established with good prospects for continued deployment of biogas digesters after the Program period.

The overall objective of the Asia Biogas Program (ABP) is to further develop the market for biogas as an indigenous, sustainable energy source in selected countries in Asia.

The specific objectives of the Asia Biogas Program are:

- To provide adequate Technical Assistance (TA) for the consolidation of phase IV of the Biogas Support Program (BSP) in Nepal up to June 2009;
- To expand the Biogas Program (BP) in Vietnam through implementation of phase II from January 2006 up to June 2011;
- To launch and implement biogas programs in Cambodia, Bangladesh and Lao PDR from January 2005 up to December 2009.
- To establish strategic partnerships with relevant institutes in China and India and to create a regional network of partners in biogas from January 2005 up to December 2008.

SNV believes that the incorporation of the different country programs into one regional program will enhance learning, effectively develop knowledge and make deployment of TA more efficient. The regional approach will also have a positive impact on the willingness of crucial partners like governments and credit institutions to participate in the respective country programs.

3.2 Objective of the proposed Biogas Pilot Program (BPP)

The Goal:

To improve the livelihoods and quality of life of rural families, men and women, and reduce the impact of biomass resource depletion in Lao PDR through exploiting the market and non-market benefits of domestic biogas digesters.

The Purpose:

To establish a series of pilot activities to form the basis of a future larger scale program that will establish a commercially viable domestic biogas sector

The Objectives of Each Component:

Component 1: Promotion

Objective

To stimulate and inform stakeholders on the benefits and costs of domestic biogas and to publicise the program

Component 2: Financing

Objective

To lower the financial threshold and improve access to credit and repayment assistance, to facilitate easier access to domestic biogas for all potential implementing agencies, with particular emphasis on the poor, women and other disadvantaged groups

Component 3: Construction and After Sales Service

Objective

To facilitate the construction and continued operation of 6600 biogas digesters

Component 4: Quality Management

Objective

To maximise the effectiveness of the investment made by the biogas owners and to maintain consumer confidence in domestic biogas technology

Component 5: Training

Objective

To provide the skills for business people to run biogas SMEs and for biogas users to be able to operate their digesters effectively

Component 6: Extension

Objective:

To provide the information to allow biogas users to effectively exploit all the benefits of biogas

Component 7: Institutional Support

Objective

To maximise the ability of key biogas related institutions to be able to provide the services and support required by the biogas sector to facilitate access to domestic biogas and the development of quality biogas products

Component 8: Monitoring and Evaluation

Objective

To identify project progress and impact on stakeholders/other aspects in order to facilitate knowledge transfer

Component 9: Research and Development

Objective

To increase knowledge about domestic biogas issues to maximise effectiveness, quality and service delivery of the biogas program

Component 10: Project Management

Objective

To support and coordinate the activities driving the development of a commercially viable biogas sector

3.3 Justification of Target Area

The BPP is planned to start in four Districts in Vientiane Province. This area was chosen to run the pilot because there are enough farmer households having an adequate number of livestock and these animals are in most cases stabled. There are enough farmer households with adequate earnings or access to credit to be able to afford to construct a biogas digester and there is in principle interest from farmer households. At least one small scale renewable energy SME has been identified to assist with the implementation and the sites are close enough to Vientiane for them to be efficiently monitored by SNV Advisors and the implementing agency⁷.

The target area does not allow for research into the suitability of digesters in mountainous areas or in ethnic minority communities, but it is felt that it is more important to identify and clarify the basic technology and project conditions before complicating things by investigating these issues, although they will be an important consideration in any future phases.

⁷ Further explanation of who the implementing agency (implementing partner) will be is contained in the Organisational Set-Up section.

3.4 Output Targets

As it is a pilot program, BPP has modest targets. The project has been developed to explore the market in a specific area of the country and to test the most suitable overall approach for wide-scale biogas dissemination. The actual implementation of the pilot project will begin in 2007 with the remainder of 2006 being used as a preparatory phase. There will be a 'stop/go' decision made at the end of 2007 based on the information gathered throughout the year as to whether the program should continue or not. If the decision to continue is taken, then the project scope, activities and targets will all be revised in light of the lessons learned. The tentative cumulative production targets and number of beneficiaries up to 2010 are planned as follows:

Table 7: Cumulative Digesters and Beneficiaries 2006 – 2010

Lao PDR	2006	2007	2008	2009	2010
Cumulative number of biogas digesters	-	100	1,200	3,400	6,600
Cumulative number of beneficiaries	-	600	7,200	20,400	39,600

The Asia Biogas Program Project Document indicates that in the first year the target of the ABP Laos program would be to install 900 biogas digester units in Lao PDR. However, considering that very little experience exist in Lao PDR with setting up a "national/pilot" biogas program as well as the need for preparatory activities like developing promotional materials, developing training materials, conducting training programs, etc. it is clear that the number of biogas digesters installed will be much lower than planned in the ABP project document.

While no final decision has been made with regard to the actual number of digesters to be installed in 2007, as this will depend upon the preparatory activities as well as finalizing the agreement with MAF/DLF, the number is expected to be no more than 100 digester units in the area around Vientiane City with emphasis on Naxaithong, Xaithani, Pak Ngum and Hatxaifong districts. The provisional production planning for 2007 is presented in table 8 below.

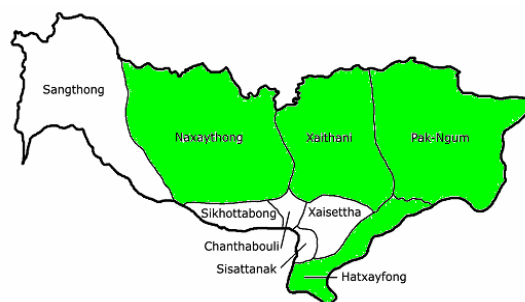


Table 8: Provisional Production Planning for 2007

2007 Production Planning														
Province	District	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
Vientiane	Hatxaifong			2	2	2				2	3	3	6	20
Vientiane	Pak-Ngum				1	1				1	2	3	6	14
Vientiane	Xaithani				2	2				2	4	4	8	22
Vientiane	Naxaithong		2	2	2	2					6	10	20	44
Total			2	4	7	7				5	15	20	40	100

3.5 Conditions for Continuing to Years 2 – 4

The conditions for continuing BPP through years 2 – 4 are based on the indicators as contained in the log-frame. It will not be necessary for every condition to be met in order to take the decision to continue. The results of year 1 will need to be weighed up and lessons learned and current circumstances will all play an important part in the discretionary decision to continue. The decision will be made by group consensus between the implementing agency and SNV/Lao PDR.

4 Activities

For the purposes of organisation, budgeting, reporting and management, the project has been broken into 10 components. These components form the core of the logical framework (log-frame) on which the whole project is based. The log-frame is in Annex 1 and provides detail of these components and will form the basis of the monitoring and evaluation strategy. Each project component has a set of activities. These activities have been broken into Year 1 Activities and Years 2 -4 Activities, as Year 1 is considered to be the preparatory year of BPP It will be important to review the activities should the project continue to Years 2 – 4 in light of lessons learned in Year 1.

The following is a detailed list and explanation of the activities. The activities have been presented in relation to their corresponding results and objectives within the log-frame. A more detailed indication of the timing of these activities will be drawn up in a work plan once agreement has been reached between MAF/DLF and SNV Lao PDR. The list of activities is not intended to be exhaustive but rather the minimum activities to be conducted. New activities and priorities will be developed as each sector strategy is formed at the start of the project.

4.1 Component 1: Promotion and Marketing:

No	Component and Objectives	Activities Year 1	Activities Years 2-4
1	Component 1: Promotion Objective To stimulate and inform stakeholders on the benefits and costs of domestic biogas and to publicise the program Outputs	Develop Promotions Strategy for promotion of biogas Develop Promotions Strategy for promotion of the program	Revise and update Promotions Strategy for promotion of biogas Revise and update Promotions Strategy for promotion of the program
1.1	Promotional material developed, reproduced and distributed to target districts	<ul style="list-style-type: none"> Develop biogas promotional leaflet Develop biogas poster Distribute promotional material 	<ul style="list-style-type: none"> Revise and reprint biogas promotional leaflet Revise and reprint biogas poster Develop biogas promotional video Reproduce biogas promotional video Distribute promotional material
1.2	Print, radio and (where appropriate) television media coverage regularly initiated and supported	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Broadcast Biogas TV programs Broadcast Biogas Radio programs Write or arrange for articles in local and national press
1.3	Other promotional activities initiated and supported as appropriate, including encouraging word-of-mouth promotion and trade fair displays	<ul style="list-style-type: none"> Opening Ceremony 100 Digester Ceremony Conduct Promotional Meetings Other promotional activities 	<ul style="list-style-type: none"> 2000 Digester Ceremony 4000 Digester Ceremony Closing Ceremony Development and Maintenance of website Production of Newsletter Conduct Promotional Meetings Other promotional activities like developing biogas related curricula for use in schools, etc.
1.4	Special promotional activities developed to target women who may not be reached by other PR activities	<ul style="list-style-type: none"> Conduct an analysis to identify relevant groups not being reached by current PR activities 	<ul style="list-style-type: none"> Develop multi lingual promotional resources (if appropriate) Develop alternatives to text based promotional resources Develop alternative dissemination programs to access groups that are not reached by standard PR

The Promotion and Marketing Component has the following target audiences:

Target Audience	Message	Media	Purpose
Prospective Biogas Users	Background information, technical specifications and information on the benefits of biogas	Leaflets, posters, local television, local radio, role play, comedies, etc.	Encourage Participation
Prospective Disadvantaged Biogas Users	Background information and technical specifications and information on the benefits of biogas	Leaflets, posters, local television, local radio, multi-lingual media and text based alternatives	Encourage Participation
Existing Biogas Users	Technical information and information on maximising benefits of biogas	Leaflets, posters, booklets, local television, local radio	Enable Proper Use of Digesters
Prospective Construction Teams	Technical information and technical specifications	Leaflets, posters, booklets	Enable Proper construction of digesters and business skills
Local Authorities	Background information; program information	Leaflets, posters, videos, newspaper articles, television and radio broadcasts	To influence local policy to encourage the uptake of biogas
Donors	Background information, program information	Leaflets, posters, videos	Resource Mobilisation
Partners	Background information, program information, technical information	Leaflets, posters, videos, television and radio broadcasts	Technology and training development
Internal Stakeholders	Progress and program information, technical information	Newsletters	To keep all stakeholders up to date on developments and to maintain understanding that everyone is part of a national program

As the project is new and stakeholders' knowledge on biogas technology and benefits is low to non-existent, the Promotion Component (PR) will be at the forefront of the program. It will work on 2 levels: to promote biogas as a technology and to promote the program itself.

There will be some cross-over between the PR Component and the Training Component particularly in relation to the materials developed (including posters and leaflets) and the word of mouth promotion that trainees will be encouraged to conduct.

An important element of the project will be to investigate whether all potential beneficiaries are being effectively reached through current PR activities and to devise ways in which to ensure that this happens. Whilst this will not be as directly relevant to the first year of the project, this will be particularly important as base information for the up-scaling of following phases in which it is expected that the geographical scope of the program will expand and there will be greater opportunities to involve the poor.

Regular monitoring of the PR strategy will be important to make sure that it is effectively reaching beneficiaries and other stakeholders.

4.2 Component 2: Financing

No	Component	Activities Year 1	Activities Year 2 - 4
2	Component 2: Financing Objective To lower the financial threshold and improve access to credit and repayment assistance, to facilitate easier access to domestic biogas for all potential customers, with particular emphasis on the poor, women and other disadvantaged groups	<ul style="list-style-type: none"> Develop financing strategy including Credit and Subsidy analysis 	<ul style="list-style-type: none"> Revise and update financing strategy including Credit and Subsidy analysis
	Outputs		
2.1	Research conducted to identify financial requirements of prospective biogas users and to identify potential providers	<ul style="list-style-type: none"> Market analysis of the availability and need for credit facilities 	<ul style="list-style-type: none"> N/A
2.2	Eligibility criteria for subsidy and credit products are established with special attention paid to providing access to the poor and other disadvantaged groups	<ul style="list-style-type: none"> Develop eligibility criteria for subsidy products Develop eligibility criteria for credit products Develop credit products Implement subsidy and credit products 	<ul style="list-style-type: none"> Develop eligibility criteria for subsidy products Develop eligibility criteria for credit products Develop credit products Implement subsidy and credit products
2.3	All prospective biogas users who are eligible for subsidy arrangements are registered before they commence construction activities	<ul style="list-style-type: none"> Identify prospective biogas users Register prospective biogas users 	<ul style="list-style-type: none"> Identify prospective biogas users Register prospective biogas users
2.4	Subsidies are made available to all eligible prospective biogas users	<ul style="list-style-type: none"> Distribute subsidies Monitor distribution 	<ul style="list-style-type: none"> Distribute subsidies Monitor distribution
2.5	Targeted biogas credit arrangements identified and facilitated for all eligible prospective biogas users with a special emphasis on products for poor and disadvantaged groups	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Develop strategy for targeting disadvantaged groups including revising the credit strategy for these groups
2.6	Subsidies and other financing mechanisms fairly and effectively managed	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Guidelines for subsidy allocation and distribution are reviewed and updated Regular audits of subsidies and financing mechanisms undertaken

Although the two are obviously linked, the Financing Component deals with investment finance not project finance. An explanation of project finance can be found in Chapter 5. The Financing Component has three distinct aspects namely Farmer Contributions, Credit and Subsidy.

4.2.1 Farmer Contributions

In order to encourage a sustainable market driven biogas sector, the majority, if not all of the funding for biogas installations and the associated stable and kitchen renovation should come from the farmer household. Subsidy will be provided from Year 1 of the project, although the amounts (initially a flat rate of 100 Euro) and procedures will be reviewed throughout the project. The majority of construction costs will come from the farmer household either from their savings or from a loan to be taken for the purpose of investing in a biogas digester (see 4.2.2) and for a small part as "in kind" contribution (labour for digging, etc.).

4.2.2 Credit

Even though farmer households will be mainly funding the biogas digester construction themselves, most farmer households will not have the cash means with which to do so. During the preparatory work for this program, it was found that access to appropriate credit is likely to be crucial for the success of the biogas pilot program as there are few farmer households who can afford to pay cash for a digester. Formal credit systems are not yet well developed in Laos and those that do exist are not familiar with biogas technology. As a result further investigation needs to be done to identify and develop potential credit providers. An external consultant will be contracted to identify these providers and to create a plan to help them develop credit products for biogas.

A key aspect of developing useful and sustainable credit products will be identifying the actual needs of biogas users. In many cases, support in accessing existing commercial credit products may be all that is required. In other cases, it may be necessary to develop specialist credit products specifically for the biogas program to assist with construction costs and the costs of setting up or improving enterprises and household infrastructure as a result of installing biogas. It may be necessary to provide direct advisory support to credit provider implementing agencies.

This should all be done with a long term view to adapting credit products further to disadvantaged groups when this becomes necessary. Women are often the most eligible family members for credit (especially through LWU Credit programs) and this must be taken into consideration not only when developing credit products but when linking them to the development of biogas installations (e.g. ensuring that women are officially co-owners or owners of the digesters that they receive credit for). The development of credit products may take time to develop and may not be able to be implemented until the latter part of the project and should be developed with a long term view to up-scaling.

4.2.3 Subsidy

The subsidy aspect of the project will be a tool to improve people's access to biogas technology by reducing the cost, as a promotional tool, and as a quality control incentive as it is not paid until after the digester has received final approval. During this Pilot phase, the subsidy will be funded by the Asia Biogas Program and will be reviewed at the end of the project to determine whether other (preferably more sustainable) forms of funding are available for any up-scaling that may occur in subsequent phases.

The subsidy will be set at a flat rate of 100 Euros (to be paid in Kip). At this stage, it is envisaged that there is no need to have a tiered subsidy scheme, means tested to encourage poorer participants as this would just be a complicating factor. This should be seriously considered for subsequent phases as a tool for increasing access.

To be eligible for participation in the subsidy scheme, households need to express their interest in operating a biogas digester, and meet basic technical and financial criteria. These criteria and a set of regulations are to be developed during the first six months of the program. At an average investment of 3.5 million Kip for the complete installation (6 m³ digester volume), the subsidy consists of 36% of the investment. It should be noted, however, that experience from other countries has shown that farmer households often take the opportunity to modernize or improve their stables, kitchen and latrine at the same time, and invest in biogas appliances which can increase the total costs to 5 million Kip. However, it is not sure if this will happen in Lao PDR as this may increase the amount of credit required.

The methodology for subsidy channelling, distribution and monitoring will be developed in Year 1 of the project.

4.3 Component 3: Construction and After Sales Service

No	Component	Activities Year 1	Activities Years 2-4
3	Component 3: Construction and After Sales Service Objective To facilitate the construction and continued operation of 6600 biogas digesters	<ul style="list-style-type: none"> Develop a strategy to involve SMEs in the biogas sector 	<ul style="list-style-type: none"> Revise and update strategy to involve SMEs in the biogas sector
	Outputs		
3.1	At least 2-3 companies providing biogas installation, after sales service and other technical services is established in pilot target area	<ul style="list-style-type: none"> Market assessment conducted 	<ul style="list-style-type: none"> Ongoing technical support given to biogas SMEs as required
3.2	At least 6600 new digesters are constructed by the end of the project	<ul style="list-style-type: none"> Develop technical guidelines for construction and after sales service Distribute technical guidelines 	<ul style="list-style-type: none"> Choose preferred digester design Warranty system for the work of Biogas SMEs developed
3.3	90% of all digesters receive an annual check-up in their first two years	<ul style="list-style-type: none"> Proper after sales-service conducted by Biogas SMEs 	<ul style="list-style-type: none"> Annual checkups conducted by Biogas SMEs
3.4	After sales service is provided to biogas owners to a level to which they are satisfied	<ul style="list-style-type: none"> Ongoing after sales service is provided to biogas owners by those who installed the digesters 	<ul style="list-style-type: none"> Ongoing after sales service is provided to biogas owners by those who installed the digesters

Whilst the project will not actually construct or install any biogas digesters itself, a key measure of success of the project is the number of digesters constructed. The project facilitates construction through helping to develop and support Biogas SMEs and through providing the information and quality assurance framework, technical training and eventually, credit and subsidy support.

For the purposes of the project, Biogas SMEs will be businesses that can supply and install biogas technology in various forms, whether they are mason teams or installers of prefabricated digesters. One SME has been identified for the commencement of the project in Year 1 and others will be sought and given support to develop as the project progresses.

In order to eventually develop a self sustaining biogas industry the market demand must be stimulated as must the businesses that service that demand. Although only a Pilot Project, the long term aim of the project will be to achieve this. The Project will do this through a combination of all its components, in particular Promotions and Marketing, Quality Management and Training. The provision of technical and business skills to existing Biogas SMEs will allow them to specialise or diversify into biogas and to strengthen their businesses in general.

Through the technical guidelines, refresher training and quality control mechanisms of the program, the quality of the services provided by these businesses will remain high adding to the ongoing sustainability of the sector.

4.4 Component 4: Quality Management

No	Component	Activities Year 1	Activities Years 2 - 4
4	Component 4: Quality Management Objective To maximise the effectiveness of the investment made by the biogas owners and to maintain consumer confidence in domestic biogas technology	<ul style="list-style-type: none"> Develop Quality Management Strategy/System 	<ul style="list-style-type: none"> Revise and update Quality Management Strategy
	Outputs		
4.1	Construction (including materials) and maintenance of domestic biogas digesters quality guidelines are developed and accepted	<ul style="list-style-type: none"> Develop guidelines for Quality Management 	<ul style="list-style-type: none"> Revise and update guidelines for Quality Management
4.2	6600 new biogas digesters are commissioned tested and accepted	<ul style="list-style-type: none"> Project technicians to Quality check and supervise construction of new biogas digesters Project technicians to test and accept digesters 	<ul style="list-style-type: none"> Project technicians to Quality check and supervise construction of new biogas digesters Project technicians to test and accept digesters
4.3	Random quality checks control conducted on commissioned biogas digesters	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Project technicians to give 10% of all new domestic biogas digesters random quality control checks
4.4	90% of quality checked biogas digesters pass	<ul style="list-style-type: none"> Quality Management reports by project technicians submitted and accepted 	<ul style="list-style-type: none"> Quality Management reports by project technicians submitted and accepted
4.5	Random quality checks are conducted on after sales service	<ul style="list-style-type: none"> Random checks conducted by project technicians 	<ul style="list-style-type: none"> Random checks conducted by project technicians
4.6	90% of after sales service quality checks pass	<ul style="list-style-type: none"> Quality Management reports by project technicians submitted and accepted 	<ul style="list-style-type: none"> Quality Management reports by project technicians submitted and accepted

The Quality Management of the Project will be particularly important in ensuring that the technology works reliably from the very beginning to provide the best examples to encourage the uptake of the technology. It will also be important to get the Quality Management as good as possible as early as possible to ensure the sustainability of the project by keeping people's faith in the technology.

The bulk of quality control checks will be done by biogas technicians. Each biogas digester will be physically checked and commissioned by a biogas technician using standard criteria. Random checks will be conducted by project technicians and overall quality management will also be done at this level. Frontline QC will be done by Project Biogas Technicians who sign off on newly constructed biogas digesters. During the up-scaling of the project, this system will need to be reviewed as there will be considerable human resource pressures in doing this. In addition, random on-site spot checks will be conducted by project technicians during construction and in the months after construction. At least 10% of digesters will be checked in this way.

During the project, but particularly during Year 1, the quality guidelines will be evolving as more is learned about biogas in the Lao PDR context. These guidelines will include checklists and technical specifications and will be outlined in the Project Handbook that is mentioned later in this document. Quality Control is a time consuming activity and requires considerable personnel time. As a result it is important that quality standards are clear and that technicians are proficient at recognising and monitoring them. To ensure that this happens, Project Biogas Technicians will receive regular refresher training and procedures and standards will be regularly reviewed.

4.5 Component 5: Training

No	Component	Activity Year 1	Activity Year 2 - 4
5	Component 5: Training Objective To provide the skills for business people to run biogas SMEs and for biogas users to be able to operate their digesters effectively	<ul style="list-style-type: none"> Develop training strategy, guidelines and program 	<ul style="list-style-type: none"> Revise and update develop training strategy, guidelines and program
	Outputs		
5.1	Training Needs Analysis conducted for all stakeholders including partners, current and potential masons, supervisors, biogas companies and biogas users (both men and women) including disadvantaged groups	<ul style="list-style-type: none"> Conduct Training Needs Analysis 	<ul style="list-style-type: none"> Revise and update Training Needs Analysis
5.2	Implementing agency/partner training developed and conducted	<ul style="list-style-type: none"> Develop implementing agency/partner training Develop materials for implementing agency/partner training Conduct implementing agency/partner training 	<ul style="list-style-type: none"> Develop and conduct additional and refresher implementing agency/partner training
5.3	Technical training for project staff developed and conducted for all technical staff	<ul style="list-style-type: none"> Develop technical training Develop materials for technical training Conduct technical training 	<ul style="list-style-type: none"> Develop and conduct additional and refresher training
5.4	Skills upgrade for new Biogas Masons/supervisors/installers developed and implemented	<ul style="list-style-type: none"> Develop skills upgrade training for masons/supervisors and installers Develop materials for skills upgrade training for masons/supervisors/installers Conduct skills upgrade training for masons/supervisors and installers 	<ul style="list-style-type: none"> Develop and conduct additional and refresher training
5.5	Biogas User training for men and women developed and implemented for all new biogas users	<ul style="list-style-type: none"> Develop pre construction Biogas User Training Develop post construction Biogas User Training Develop materials for Biogas User Training TOT Biogas User Training Arrange Biogas User Training 	<ul style="list-style-type: none"> Develop pre construction Biogas User Training Develop post construction Biogas User Training Develop materials for Biogas User Training TOT Biogas User Training Arrange Biogas User Training
5.6	Other appropriate training developed and implemented where needed	<ul style="list-style-type: none"> Conduct study tour for Advisory Board Develop Other training Implement other training 	<ul style="list-style-type: none"> Develop subsidy distribution training Conduct subsidy distribution training Develop Other training Implement other training
5.7	Establish relationships with technical and higher education institutions to provide training and to include biogas in their curriculum and research portfolios	<ul style="list-style-type: none"> Identify at least one partnership with a higher education institution 	<ul style="list-style-type: none"> Establish at least one partnership with a higher education institution Develop biogas curriculum and include in regular post graduate and undergraduate programs

The Training component is closely linked with the Research and Development component, particularly in regards to establishing relationships with research and higher education institutions. The Training component is also closely linked with the Extension component in which hands on dissemination of research knowledge will be conducted in the field.

As the project is new there will be a need for widespread introductory and technical training activities with implementing agencies, staff and other stakeholders. The exact training needs and the best ways in with to deliver this training will be identified in a Training Needs Analysis to be conducted early in the first year of the project.

Of particular importance to the project is the biogas user training. Lessons learned from other projects in Lao PDR show that when delivering household level training, it can be difficult to involve women in training unless they are specifically targeted. In the case of biogas, it is important to involve both men and women in training as much of the decision making as to whether to invest in technology is made by men, but most of the use of the technology is done by women. To address this, the biogas user training will be split into two sections and will be tailored more specifically to the different biogas users within the household. The pre-construction training that deals mainly with the promotion of biogas and the logistics of construction will be developed with both the men and women of the household in mind with particular emphasis on the men who often make the decisions on infrastructure. It is expected that a quota of 40% women and 60% men will be set for this training. The post construction training that deals mainly with the use and maintenance of the digester will have greater emphasis on the women in the household who are usually the ones who operate the biogas digester both in regards to using the gas and feeding the digester. It is expected that a quota of 80% women and 20% men will be set for this training.

Vocational schools have already been informally investigated, and it is clear that training in many of the basic skills required for installing biogas such as masonry already exist and can be supported.

The project will look at eventually developing higher levels of formal training. This will be done in conjunction with the Research and Development component with special emphasis on establishing at least one formal partnership will be developed with a higher education or technical institute to conduct research and higher level training. This higher level training could deal with numerous aspects of biogas including technology development, renewable energy, social impact and agricultural extension.

4.6 Component 6: Extension

No	Component	Activities Year 1	Activities Years 2 - 4
6	Component 6: Extension Objective: To provide the information to allow biogas users to effectively exploit all the benefits of biogas	<ul style="list-style-type: none"> Develop extension strategy, guidelines and program 	<ul style="list-style-type: none"> Revise and update extension strategy, guidelines and program
	Output		
6.1	Extension requirements identified and at least one partnership for extension delivery formed	<ul style="list-style-type: none"> Conduct analysis of extension requirements Identify at least one partner to conduct extension 	<ul style="list-style-type: none"> Update and revise analysis of extension requirements
6.2	Proper extension material is available to farmer households and other interested persons as well as biogas users	<ul style="list-style-type: none"> Develop materials for slurry extension Distribute extension material 	<ul style="list-style-type: none"> Develop materials for slurry extension Distribute extension material
6.3	Farmer households receive direct support from extension workers	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Extension workers conduct extension visits to farmer households and biogas users
6.4	Visits to demonstration sites supported	<ul style="list-style-type: none"> Identify biogas users who use slurry well and establish as demonstration sites Disseminate information about these sites 	<ul style="list-style-type: none"> Identify biogas users who use slurry well and establish as demonstration sites Disseminate information about these sites

With close links to the Research and Development and, Promotion and Marketing and Training Components, the Extension component will disseminate the results of research to biogas users and Biogas SMEs and will facilitate the development of demonstration plots and activities.

The most important first step will be to identify a partnership to help develop and conduct Extension. Extension is another time consuming activity and existing relationships and networks are important in conducting effective extension. It will be important to identify a partner who has these networks and relationships already. Staff from the Project will work with the extension partners to develop extension strategies and materials, and will provide as much support as possible in conducting extension.

The Extension component will pay special attention to maximising the benefits of biogas beyond the base benefit of using gas for cooking. Particular attention will be paid to ways in which biogas can benefit enterprises and income generation activities. As this project is only a pilot, most attention will be paid to the proper use of slurry as a non chemical fertiliser. To a lesser degree, there will be some emphasis on using slurry as fish food, improved animal husbandry techniques such as optimal stable design, and using biogas to fire drying kilns or incubators. At this stage, extension will only be provided in these areas if there is market demand, and any market demand or potential will be noted for future reference. Emphasis will be placed on integrated enterprises that use biogas for a multiple of purposes.

One of the key aspects of this project is establishing some biogas demonstration sites. Ideally, these sites would showcase more than just a working biogas digester, but would also demonstrate the use of multiple household appliances (e.g. stove, lighting, water heating), good slurry use, latrine connection, and ideally examples of using biogas in an income generation capacity (e.g. cooking food for pigs, chicken incubation). These sites could also eventually be candidates for slurry use trials and other research. Realistically, however, the comprehensiveness of these sites will be limited. It is expected that 40 or 50 sites will be developed, with at least 2 or 3 in every village to reach the maximum number of potential owners.

Site visits to these sites will be organised for prospective users, technicians and interested institutions. Owners will be given technical support where necessary to develop and maintain their sites as well as to enable them to effectively demonstrate and discuss them.

4.7 Component 7: Institutional Support

No	Component and Outputs	Activities Year 1	Activities Years 2 - 4
7	<p>Component 7: Institutional Support Objective</p> <p>To maximise the ability of key biogas related institutions to be able to provide the services and support required by the biogas sector to facilitate access to domestic biogas and the development of quality biogas products</p>	<ul style="list-style-type: none"> Develop Institutional Support Plan 	<ul style="list-style-type: none"> Revise and update Institutional Support Plan
	Outputs		
7.1	A biogas advisory board established	<ul style="list-style-type: none"> Provisionally establish Biogas Advisory Board 	<ul style="list-style-type: none"> Establish Biogas Advisory Board
7.2	Provision of technical support to private enterprise involved in biogas	<ul style="list-style-type: none"> Provide technical support to potential and existing biogas suppliers when they request it 	<ul style="list-style-type: none"> Provide technical support to potential and existing biogas suppliers when they request it
7.3	Provision of ad hoc support to external institutions and individuals who require it for the purposes of implementing biogas	<ul style="list-style-type: none"> Ad hoc support of external institutions including providing information and hosting site visits and study tours 	<ul style="list-style-type: none"> Ad hoc support of external institutions including providing information and hosting site visits and study tours

In addition to supporting Biogas SMEs an important function of the project is to support biogas related institutions. In the case of this project, this primarily means internal organisations such as the Implementing agency and the Biogas Advisory Board. Support is not limited to these groups, however as it has been shown in biogas programs in other countries that there is considerable interest in Biogas from external organisations and demand for ad hoc support, particularly in experience sharing. In other country programs, this support has included sharing promotional materials and advisory services, but more importantly it has involved hosting site visits and showcasing technology. The types of external organisations that may ask for support include donors who are looking to start their own biogas programs, members of SNV's Regional Biogas Program and private energy enterprises.

The Biogas Advisory Board will both provide and receive support. The advisory board will be an important part of the project management and will require project support and expertise to function. At national level the advisory board will consist of Ministerial and Departmental stakeholders, donors and technical experts.

4.8 Component 8: Monitoring and Evaluation

No	Component and Outputs	Activities Year 1	Activities Years 2 - 4
8	Component 8: Monitoring and Evaluation Objective To identify project progress and impact on stakeholders/other aspects in order to facilitate knowledge transfer	<ul style="list-style-type: none"> Design Monitoring and Evaluation System for the research elements, impact assessments and the project itself 	<ul style="list-style-type: none"> Revise and update Monitoring and Evaluation System for the research elements, impact assessments and the project itself
	Outputs		
8.1	Annual project monitoring reports completed and accepted	<ul style="list-style-type: none"> Establish project baseline Produce semi-annual reports Develop and print survey forms for biogas users, supervisors, masons and technicians Conduct monitoring surveys 	<ul style="list-style-type: none"> Develop Project Database Produce semi-annual reports Develop and print survey forms for biogas users, masons and technicians Conduct monitoring surveys
8.2	Periodic assessment (including biogas user surveys) on all beneficiaries including the poor, women and other disadvantaged groups is completed and reports are accepted	<ul style="list-style-type: none"> Conduct one assessment Conduct Biogas User Survey 	<ul style="list-style-type: none"> Conduct annual Biogas User Survey Conduct Project Impact Assessment – including Environmental and Social Impact Assessment Conduct biogas and social inclusion/gender studies Conduct mid-term and final review
8.3	External surveys, studies and evaluations commissioned and completed	<ul style="list-style-type: none"> Conduct other external surveys as required 	<ul style="list-style-type: none"> Conduct other external surveys as required
8.4	Program improvement is carried out based on the information from the monitoring reports and impact assessments progressively	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Semi Annual program reviews undertaken during semi annual reviews based on monitoring information and impact assessments

As this is a pilot project and the lessons learned through it will form the basis of any future programs, the observation, monitoring and reporting of activities is of core importance.

Monitoring will focus on three main areas: Project implementation, Quality Control of digester construction and maintenance and Impact on Biogas Users and Research. Although numerically the project will be small, it will still be important to conduct thorough monitoring to ensure financial and statistical transparency and accountability and to make sure that the inputs and efforts are the most efficient possible. It will also be important to make sure that project activities are monitored closely to identify as many lessons as possible in order to decide whether to continue to Year 2 -4 and the way in which any up-scaling should be conducted.

A Monitoring and Evaluation system will be devised at the beginning of the project. This will be based on the log-frame. This will include establishing a project baseline, data collection activities such as annual Biogas User Surveys, construction and maintenance records, collation of results and recording of activities in semi-annual reports, Impact Assessments and other external monitoring or assessment activities. This information will be used in iterative evaluation that will include a formal project review semi-annually.

An important part of the monitoring process will be comprehensive and accurate record keeping. If the project continues to Years 2 – 4, a Project Database will be developed that contains records of every biogas digester constructed under the auspices of the project and approved. This will be particularly important if subsidies are introduced and increased accountability is required.

In regards to biogas digester monitoring, the standards to which monitoring will occur are explained in detail in the Quality Management component. Specific technical standards will be developed as the project progresses.

4.9 Component 9: Research and Development

No	Component and Objectives	Activities Year 1	Activities Years 2 - 4
9	Component 9: Research and Development Objective To increase knowledge about domestic biogas issues to maximise effectiveness, quality and service delivery of the biogas program	<ul style="list-style-type: none"> Develop a Research and Development Strategy with a strong emphasis on technology selection 	<ul style="list-style-type: none"> Review and update Research and Development Strategy with a greater emphasis on how the technology and slurry are used
	Outputs		
9.1	At least one new biogas digester in each Village chosen as designated demonstration site	<ul style="list-style-type: none"> Identify at least 1 demonstration site in each district by the end of yr 1 	<ul style="list-style-type: none"> Continue demonstration sites
9.2	Partnerships established with research and higher education institutions to conduct biogas research	<ul style="list-style-type: none"> Identify at least 1 research partnership by the end of yr 1 	<ul style="list-style-type: none"> Establish and activate at least 1 research partnership
9.3	Technical research and design conducted	<ul style="list-style-type: none"> Conduct trials/research to identify biogas technology most appropriate for the Laos context Conduct research into project potential 	<ul style="list-style-type: none"> Continue biogas technology trials Conduct trials/research into contextually appropriate household level biogas accessories Conduct trials/research into contextually appropriate income generation biogas accessories
9.4	Research conducted into social aspects of biogas use and the results disseminated	<ul style="list-style-type: none"> Conduct formal research into the social aspects of biogas use including close analysis of the perceived benefits and impacts on people's lives and the barriers to access to disadvantaged groups 	<ul style="list-style-type: none"> Continue to conduct formal research into the social aspects of biogas use including close analysis of the perceived benefits and impacts on people's lives and the barriers to access to disadvantaged groups

The Research and Development component is closely allied with the Extension and the Training components. This is especially as both these components will play key roles on implementing the findings of the research conducted in the Research and Development component. A key feature of the Research and Development component is that partnerships will be established with Research and Development institutions in some cases these partnerships will be related to those established for Training purposes.

The Research and Development component has two distinct research areas: research into the most appropriate technology for the Lao PDR context and research that assists the exploitation of biogas benefits. The results of the R&D into the improvement of biogas benefits will be disseminated through the extension program and the results of the technology research will be disseminated through the QA Guidelines and Biogas SME training.

4.10 Component 10: Project Management

No	Component and Objectives	Activities Year 1	Activities Years 2 - 4
10	Component 10: Project Management Objective To support the activities driving the development of a commercially viable biogas sector	<ul style="list-style-type: none"> Develop a project management strategy 	<ul style="list-style-type: none"> Revise and update project management strategy
	Outputs		
10.1	Project operational documents updated and developed	<ul style="list-style-type: none"> Produce Project Handbook during first 6 months of project Produce Project Guidelines during first 6 months of project 	<ul style="list-style-type: none"> Review Project operational documents annually
10.2	Biogas Project Office Established and maintained	<ul style="list-style-type: none"> Physically establish and staff Biogas Project Office within the first 6 months 	<ul style="list-style-type: none"> Conduct Procedural and organisational reviews biannually
10.3	Annual Plans submitted and accepted	<ul style="list-style-type: none"> Prepare and submit annual plan 	<ul style="list-style-type: none"> Prepare and submit annual plan
10.4	Regular Reports submitted and accepted	<ul style="list-style-type: none"> Prepare and submit all regular reports 	<ul style="list-style-type: none"> Prepare and submit all regular reports
10.5	Workshops conducted	<ul style="list-style-type: none"> Hold annual staff meeting 	<ul style="list-style-type: none"> Hold annual staff meeting Conduct other workshops as required
10.6	Periodic Audit Reports submitted and accepted	<ul style="list-style-type: none"> Annual financial audit reports submitted 	<ul style="list-style-type: none"> Annual financial audit reports submitted Biannual procedural audit reports submitted
10.7	The implementation plan for rollout of project activities developed and implemented	<ul style="list-style-type: none"> Implementation plan finalised and approved in first 3 months of project 	<ul style="list-style-type: none"> Implementation plan revised and updated Implementation plan milestones met as per schedule

The Department of Livestock and Fisheries (DLF) of the Ministry of Agriculture and Forestry will be the executing partner. The project office will be separate from DLF although it comes under their umbrella. This set-up is in line with the directive of DLF which stipulates that project offices should be separate from the department. The project office will be based in Vientiane and its roles and responsibilities will be properly defined once agreement between SNV and MAF/DLF has been reached. Tentatively it is proposed to use SNV Lao PDR rules and regulations in order to create sufficient flexibility in managing the office and its operations.

The procedures for the operation of the project office will be outlined in the Project Handbook to be developed in the first 6 months of Year 1. If the project progresses to Year 2 – 4, this Handbook will be updated and revised to accommodate the increased scale and lessons learned in Year 1. All operations will take place in accordance with Lao PDR laws and SNV Lao PDR rules and regulations in accordance with the requirements of SNV and of donors.

The BPO will be responsible for oversight and overall administration of the Project. In addition it will have a technical team responsible for the oversight of technical and quality assurance activities. In general the activities of the BPO will follow the log-frame and activities list as outlined in this document and supported by the Project Handbook.

5 Financing of the Project

The project will be co-financed by DGIS of the Dutch government through the Asia Biogas Program. The Government of Lao PDR will provide in-kind project support (office space, facilities like water, electricity and means of communication, etc.), and the majority of funding for biogas digester construction will come from farmer households themselves.

The total funding required for 6,600 digesters to be constructed over a 5 year period (2006-2010) amounts to 3,046,214 Euro. Out of this total amount the Asian Biogas Program will provide 1,109,345 Euro and the Government of Lao PDR will provide 40,000 Euro (in kind contribution). In addition the farmer households, who install a biogas digester, are expected to finance the construction cost of the digester (minus the subsidy) and the total amount (credit and self financed) is estimated at about 1,410,968 Euro. Finally, the contribution by SNV, who will provide the technical assistance for the biogas program, is estimated at 485,901 Euro over a 4 year period. The financing provided through the Asia Biogas Program for the BPP will be used for project management as well as for providing a subsidy to farmer households either directly or through the financial system. The BPP is expected to implement a total of 6,600 digesters over a 5 year period. Assuming that each household which installs a biogas digester has a family size of 6, the total number of beneficiaries will be 39,600 people.

Lao PDR	2006	2007	2008	2009	2010	Total
Construction target biogas digesters	-	100	1,100	2,200	3,200	6,600
Number of beneficiaries 6 people/HH		600	6,600	13,200	19,200	39,600

5.1 Subsidy Requirement

The total amount of subsidy required for the 6,600 biogas digesters amounts to 660,000 Euro at a flat rate of 100 Euro per digester.

Lao PDR	2006	2007	2008	2009	2010	Total
Construction target biogas digesters	-	100	1,100	2,200	3,200	6,600
Subsidy requirement in Euro		10,000	110,000	220,000	320,000	660,000
Subsidy from Promotion budget		8,495				

The subsidy requirement in 2007 will be higher as it is proposed that 50 digesters will be built as demonstration units with 85% subsidy (15% of the cost to be provided by the farmer household) from the BPP, another 50 digesters will be built with 50% subsidy while after that the farmers who install a biogas digester under the Biogas Pilot Program will receive the agreed upon subsidy of 100 Euro per unit. However, it is proposed, considering that biogas is an unknown entity in Lao PDR, that the "extra subsidy" will be drawn from the Promotion budget for year 1 (2007).

5.2 Credit Requirement

It has been assumed that the majority of the farmer households who decide to install a biogas digester will require credit to do so. However, there will also be farmer households who are able and willing to pay in cash and while their exact number is not known, it has been conservatively estimated that some 10% of the farmer households will not require credit. Most of these farmer households will be the "early deciders" and for that reason credit requirements in the initial phase of the BPP will be less than in the later phases. Considering that the subsidy rate is fixed over the project period and that there will be price rises over time for building materials, wages, etc. it has been assumed that the price of a digester will increase with 5% per year. In addition to the credit, the farmer households will provide 170,017 Euro during year 1 (8,905 Euro) and 2 (161,112 Euro) as their own contribution for the construction of

10% of the digesters (self-financed). Using these assumptions, the credit required over the 4 year period has been estimated as follows:

Lao PDR	2006	2007	2008	2009	2010	Total
Construction target biogas digesters	-	100	1,100	2,200	3,200	6,600
Cost of Digester in Euro		274	288	302	317	
Average credit per unit (1)		0	0/188	202	217	
Credit requirement in Euro			101,358	444,587	695,006	1,240,951
Self-financed by farmers		8,905	161,112			170,017
Total Farmer Contribution		8,905	262,470	444,587	695,006	1,410,968

(1) It has been assumed that in the first year no credit is required (100 farmer households provide their own funding) and in the second year 560 farmer households will finance the biogas digester themselves and for that reason do not require credit

5.3 BPP and BPPO Budget

The total budget required, to be funded through the Asia Biogas program, to implement the Biogas Pilot Program amounts to Euro 1,109,345 out of which 449,345.—is earmarked to manage the program and another Euro 660,000 is allocated for subsidy payments, all for a 4 year period. This amount does not include capital input by the farmer households either in cash or in credit nor does it include the amount (in kind) to be provided by the Government of Lao PDR. The following table shows the amounts allocated to the various activities to be undertaken by the BPPO.

Lao PDR - YEAR	2006	2007	2008	2009	2010	Total
Target no. of digesters	-	100	1,100	2,200	3,200	6,600
Promotion and Marketing	5,000	13,495	12,000	12,000	10,000	52,495
Quality Control		1,000	3,000	4,800	4,800	13,600
R&D and Standardization		2,000	4,000	4,000	4,000	14,000
Training	2,000	8,000	12,000	13,000	15,000	50,000
M&E		1,250	5,500	6,000	6,000	18,750
Central Management	5,000	40,000	51,000	56,000	56,000	208,000
Regional Management		0	16,500	18,000	18,000	52,500
External Evaluation		0	10,000	0	10,000	20,000
Unforeseen Expenses		5,000	5,000	5,000	5,000	20,000
SUB-TOTAL	12,000	70,745	119,000	118,800	128,800	449,345
Investment Subsidy		10,000	110,000	220,000	320,000	660,000
TOTAL	12,000	80,745	129,000	338,800	448,800	1,109,345

Besides the funding for activities to be carried out by the BPPO, SNV will provide technical assistance to the BPP through its advisors as shown below:

Lao PDR - YEAR	2006	2007	2008	2009	2010	Total
Technical Assistance						
Technical Assistance SNV	49,548	100,582	104,603	108,792	113,140	476,665
Audits, etc.		2,000	2,200	2,400	2,600	9,200
TOTAL	49,548	102,582	106,803	111,192	115,740	485,901

In addition to funding from the Asia Biogas program and Technical Assistance from SNV-Lao PDR, the Government of Lao PDR is expected to provide assistance (mainly in kind) with regard to office accommodations, running costs of the office (electricity, water, communication, etc. as shown below:

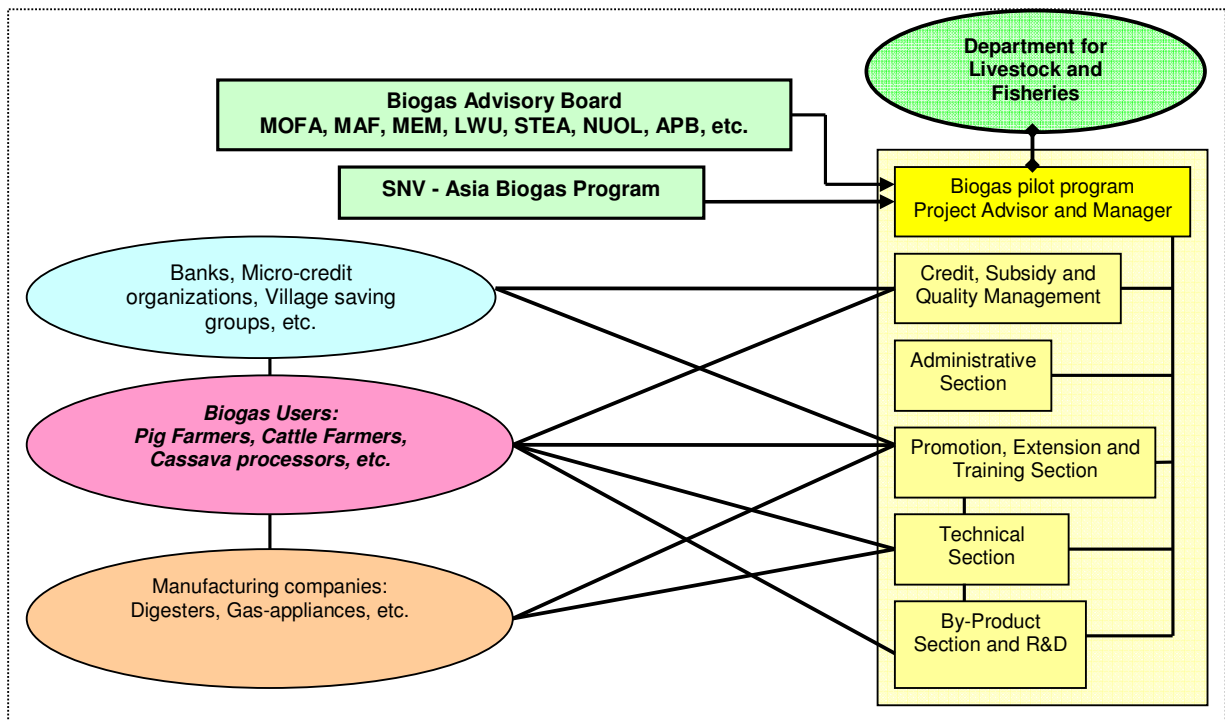
Lao PDR	2006	2007	2008	2009	2010	Total
Construction target biogas digesters	-	100	1,100	2,200	3,200	6,600
Lao PDR Government Contribution		10,000	10,000	10,000	10,000	40,000

6 Institutional Aspects/Implementing Partners

The main implementing partner will be the Department for Livestock and Fisheries (DLF) of the Ministry for Agriculture and Forestry (MAF) with support from SNV - Lao PDR. The working relation between the two partners will be formalised in a MoU tentatively to be signed in October 2006.

The Department for Livestock and Fisheries is initially expected to provide office space and facilities to the Biogas Pilot Program (BPP) at its premises. The BPP leads the whole program and has responsibility for the development and the proper direction of the program in Lao PDR. The main activities to be carried out and guided consist of promotion, preparation and coordination of training activities, subsidy channelling and administration, overall program management, etc. as described in Chapter 4 of this document. The organizational chart for the BPP is shown in Figure 7. It should be noted, as negotiations with DLF/MAF have not yet been concluded, that the exact institutional aspects may change from that shown and are to be finalized once negotiations have been completed.

Figure 7: Organizational chart of the Biogas Pilot Program



The **Biogas Pilot Program Office** or BPPO will be managed and partially staffed by staff from DLF/MAF. The BPPO will be supported financially and technically through the ABP, the Lao PDR Government and other potential donor agencies. The BPPO will be free to decide its organizational structure and management team and will be guided by the Biogas Advisory Board on an **"as and when needed"** basis.

The Project Advisor from DLF/MAF (part time position) will advise the Project Manager (full time position). The latter will be assisted by one or more professionals to be recruited from the private sector (in close cooperation between DLF/MAF and SNV-Lao PDR using rules and regulations from SNV-Lao PDR), is responsible for day to day project management, reporting and documenting, liaison with sector agencies and government bodies, coordinating with banks

and private sectors, approaching, and coordinating with other donors and INGOs active in the alternative energy sector.

Critical tasks like quality control, credit and subsidy management etc. will be kept separate from the more direct implementing activities. This is necessary in order to distinguish roles of promotion and dissemination from quality management and credit and subsidy administration.

The BPPO will be supported by a full time SNV advisor. However, pending final approval of this position by SNV, the support will be temporarily provided by the two SNV advisors on Renewable Energy with support from the SNV Senior Flexible Advisor on Biogas based in Phnom Penh, Cambodia and the SNV Senior Flexible Advisor on Finance based in Vientiane.

Position	Part time	Full time	TA (SNV)
Project Advisor	To be appointed by MAF/DLF		
Project Manager		To be recruited	
Biogas Technician		To be recruited	
Training and Promotion Officer		To be recruited	
Project Administrator		To be recruited	
Assistant Administrator		To be recruited	
Advisor SNV Lao PDR			Senior Level

The Biogas Pilot Project is planned to be guided by a **Biogas Advisory Board** (BAB). The BAB will be helpful in order to coordinate the activities of the BPP in the context of an overall renewable energy framework as at present there are various ministries and departments dealing with RE issues. Besides, having a coordinating role in the renewable energy sector, the BAB is also expected to do advocacy work within their own organizations and related institutions and partners, provide advice on policy matters and approve annual work plans and monitor progress made over time. In addition the BAB will play an active role in evaluating the BPP. It is expected that the BAB will meet at least twice a year or more often if the need arises.

The composition of the BAB should reflect the society as a whole (no bias toward a particular sector) and for that reason members should come not only from the Livestock/Agriculture and/or the Energy/Environment sector but also the biogas user side represented by farmer organizations, the Lao Women’s Union, the Lao Front for National Construction, etc. Members of the BAB should have sufficient seniority to enable them to function properly as an advisory and project management guiding function.

7 Risk Matrix

Risk	Result	Likelihood	Preventative or Mitigating Action	Responsibility
Farmer households are not interested in biogas because the direct financial benefits of biogas are not apparent enough (e.g. because fire wood is cheap/free)	Market is reduced or may even be non-existent	High	BPO actively promotes non-monetary benefits. BPO should seek active cooperation with the LWU, the Ministry of Health and other organizations to stress in particular the health benefits of using biogas (reduction of ARI, COLD, etc. which are a major cause of under-5 mortality)	BPO
Volume of interest is not enough for it to be commercially viable for SMEs	Not enough SMEs to develop a commercially viable sector	High	Mixed enterprises are promoted by BPO Promotion of biogas supported	BPO
No suitable micro-credit systems available to finance biogas digesters at the farm household level	Farmers households can not afford a biogas digester	High	Actively promote micro-credit systems and promote biogas digesters as a viable technology at existing credit providers	BPO
Local sanitation or other urban planning regulations and requirements change in a way that prohibits biogas digesters (e.g. animals cannot be stabled in urban areas)	Biogas digesters cannot be legally built in the form that they are currently promoted in Biogas digesters become irrelevant	Medium	Sanitation and other urban planning regulations are regularly monitored and designs and approaches are modified to meet these changes	BPO
The biogas sector is fragmented due to non-coordinated projects and designs	Market is reduced or project implementation is conducted inefficiently	Medium	BPO actively interacts with other projects and stays informed on developments, coordinating with other projects where possible, and is confined to a selective area	BPO
National laws and regulations do not allow for a suitable project management unit to be developed	An alternative model for project management must be found	Medium	BPO investigates a number of management models	BPO
Livestock production does not increase as projected	Less demand for biogas than estimated	Low	Focus on existing producers not just future producers	BPO
Livestock production significantly exceeds projections and more large scale producers emerge than expected	Less demand for small scale household biogas than expected	Low	Investigate and strategise for large scale biogas	BPO
Large scale outbreak of disease affecting the livestock sector	Number of small scale livestock producers decrease therefore existing biogas digesters become inoperable and potential for new biogas digesters reduces	Low	Situation is observed and project activities adjusted to fit specific context of outbreak	BPO

8 Annexes

Annex 1: Logical Framework (Log-frame)

Annex 2: List of References

Annex 3: Biogas Digester Design and Specifications

Annex 4: List of Construction Materials for Biogas Digesters

Annex 5: Province and District Names from Figure 2

Annex 6: Livestock holdings by Province, Type and Size

Annex 1: Logical Framework

	Project Description	Key Indicators: Year 1 Pilot	Key Indicators: Year 2-4 Pilot	Means of Verification	Assumptions/Risks
	<p>Goal To improve the livelihoods and quality of life of rural farmer households, and reduce the impact of biomass resource depletion in Lao PDR through exploiting the market and non-market benefits of domestic biogas</p>	<ul style="list-style-type: none"> 100 new biogas digesters built in Vientiane Province by end of year 1 90% of new biogas digesters connected to indoor cooking facilities by end of yr 1 20% of new biogas digesters have domestic toilets attached by end of project 40% of new biogas household have a slurry pit by end of yr 1 40% of households with biogas use biogas slurry by end of yr 2 	<ul style="list-style-type: none"> 6600 new biogas digesters built by end of year 4 90% of new biogas digesters connected to indoor cooking facilities by end of project 40% of new biogas digesters have domestic toilets attached by end of project 40% of new biogas household have a slurry pit by end of project 60% of households with biogas use biogas slurry by end of project 	<ul style="list-style-type: none"> Project Reports Monitoring Reports Construction Records 	<ul style="list-style-type: none"> Lao PDR Government continues to support biogas at the policy level The results of Year 1 indicate that the project is feasible and that it should continue
	<p>Project Purpose To establish a series of pilot activities to form the basis of a future large scale program that will establish a commercially viable domestic biogas sector</p>	<ul style="list-style-type: none"> At least 2-3 private sector biogas construction companies are established or identified by the end of yr 1 At least 1 Village in each District has new biogas digesters by end of yr 1 At least 8 Villages in 4 Districts have access to biogas construction companies and/or skilled teams of masons by end of yr 1 At least 1 potential credit provider that can finance biogas is identified in each District 	<ul style="list-style-type: none"> At least 2-3 private sector biogas construction companies are established by the end of project At least 8 Villages in 4 Districts have new biogas digesters by end of project At least 12 Villages in 4 Districts have access to biogas construction companies and/or skilled teams of masons by end of project At least 50% of all digester owners have access to credit that can be used to finance biogas 	<ul style="list-style-type: none"> Project Reports Monitoring Reports Construction Records 	<ul style="list-style-type: none"> Farmer households do not begin to show a wholesale preference for other technologies or a wholesale mistrust for biogas Labour and material costs do not rise dramatically Masons and Renewable Energy Technology enterprises are interested in diversifying their businesses
1	<p>Component 1: Promotion and Marketing Objective To stimulate and inform stakeholders on the benefits and costs of domestic biogas and to publicise the program</p>	<ul style="list-style-type: none"> Promotional material distributed to all biogas target areas by end of yr 1 70% of biogas users accurately report the (financial and non financial) costs and benefits of domestic biogas in the User Survey at the end of yr 1 	<ul style="list-style-type: none"> Promotional material distributed to all biogas target areas annually 90% of biogas users accurately report the (financial and non financial) costs and benefits of domestic biogas in the User Survey annually 	<ul style="list-style-type: none"> Project Reports Biogas User Surveys Monitoring Reports 	<ul style="list-style-type: none"> Promotional material is officially approved
	Outputs				
1.1	Promotional material developed, reproduced and distributed to target districts	<ul style="list-style-type: none"> Promotional material distributed to all target districts by the end of yr 1 	<ul style="list-style-type: none"> Promotional material distributed to all biogas target districts annually 	<ul style="list-style-type: none"> Project Reports 	
1.2	Print, radio and (where appropriate) television media coverage regularly initiated and supported	<ul style="list-style-type: none"> Print, radio and (where appropriate) television coverage reported for all target districts by the end of yr 1 	<ul style="list-style-type: none"> Print, radio and (where appropriate) television coverage reported for all target districts annually 	<ul style="list-style-type: none"> Project Reports Publication Lists 	<ul style="list-style-type: none"> Research indicates that print, radio and television are effective and cost effective media

	Project Description	Key Indicators: Year 1 Pilot	Key Indicators: Year 2-4 Pilot	Means of Verification	Assumptions/Risks
1.3	Other promotional activities initiated and supported as appropriate, including encouraging word-of-mouth promotion and trade fair displays	<ul style="list-style-type: none"> Other promotional activities reported for all target districts by the end of yr 1 	<ul style="list-style-type: none"> Other promotional activities reported for all target districts annually 	<ul style="list-style-type: none"> Project Reports 'Traffic' reports at trade fair stalls Customer feedback surveys at trade fair stalls User Survey 	<ul style="list-style-type: none"> Opportunities for other types of promotion arise within short project time frame
1.4	Special promotional activities developed to target women who may not be reached by other PR activities	<ul style="list-style-type: none"> All women respondents to Biogas User Survey report having been exposed to PR products at the end of yr 1 	<ul style="list-style-type: none"> All women respondents to Biogas User Survey report having been exposed to PR products annually 	<ul style="list-style-type: none"> Project Reports PR materials Biogas User Survey 	
2	<p>Component 2: Financing Objective</p> <p>To lower the financial threshold and improve access to credit and repayment assistance, to facilitate easier access to domestic biogas for all potential clients, with particular emphasis on the poor, women and other disadvantaged groups</p>	<ul style="list-style-type: none"> At least 1 potential popularly accessible credit facility that provides sufficient funds for biogas construction is identified in every target village by the end of yr 1 Information is collected about the financial and poverty situation for 100% of digester owners by the end of yr 1 	<ul style="list-style-type: none"> At least 1 popularly accessible credit facility that provides sufficient funds for biogas construction is available in every target village by the end of the project The majority of new biogas digester owners who apply for credit are approved 	<ul style="list-style-type: none"> Project Reports Credit records Construction records User Surveys 	<ul style="list-style-type: none"> Financial institutions are willing to negotiate flexible credit products Special effort is made to officially include the poor, women and other disadvantaged groups
	Outputs				
2.1	Research conducted to identify financial requirements of prospective biogas users and to identify potential providers	<ul style="list-style-type: none"> At least 1 potential popularly accessible credit facility that provides sufficient funds for biogas construction is identified in every target village by the end of yr 1 Information is collected about financial and poverty situation for 100% of digester owners by the end of yr 1 	<ul style="list-style-type: none"> Information is collected about the financial and poverty situation for 100% of digester owners on commissioning of digesters At least 1 survey is conducted that investigates people who could not access sufficient credit in years 2 - 4 	<ul style="list-style-type: none"> Research Reports Project Reports 	
2.2	Eligibility criteria for subsidy and credit products are established with special attention paid to providing access to the poor and other disadvantaged groups	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> 100% of poor or disadvantaged (including women) applicants are eligible for some form of financial assistance during the establishment of their biogas digesters 100% of total approved applicants are eligible for some form of financial assistance during the establishment of digesters 	<ul style="list-style-type: none"> Project Reports Credit records Construction records User Surveys 	
2.3	All prospective biogas users who are eligible for subsidy arrangements are registered before they commence construction activities	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> 100% of prospective biogas users who are eligible for subsidy arrangements are registered before they commence construction 	<ul style="list-style-type: none"> Project Reports Credit records Construction records User Surveys 	<ul style="list-style-type: none"> Information dissemination activities achieve maximum penetration
2.4	Subsidies are made available to all eligible prospective biogas users	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> 100% of all eligible prospective biogas users are given access to subsidies 	<ul style="list-style-type: none"> Project Reports Credit records Construction records User Surveys 	

	Project Description	Key Indicators: Year 1 Pilot	Key Indicators: Year 2-4 Pilot	Means of Verification	Assumptions/Risks
2.5	Targeted biogas credit arrangements identified and facilitated for all eligible prospective biogas users with a special emphasis on products for poor and disadvantaged groups	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> 100% of poor or disadvantaged (including women) applicants are eligible for credit during the establishment of their digesters 70% of total applicants are eligible for project credit products during the establishment of their digesters 	<ul style="list-style-type: none"> Project Reports Credit records Construction records User Surveys 	
2.6	Subsidies and other financing mechanisms fairly and effectively managed	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Guidelines for subsidy allocation and distribution are reviewed and updated annually Less than 5% of subsidy recipients lodge formal complaints Audit reports state that subsidies and other financing mechanisms are fairly and effectively managed 	<ul style="list-style-type: none"> Project Reports User Surveys Audit Reports 	<ul style="list-style-type: none"> Subsidy recipients lodge formal complaints when there is an issue Issues are properly recorded by Pilot Project
3	<p>Component 3: Construction and After Sales Service Objective</p> <p>To facilitate the construction and continued operation of 6600 biogas digesters</p>	<ul style="list-style-type: none"> At least 100 new digesters are constructed in the target districts by end of yr 1 After sales service is available to 100% of new biogas owners 	<ul style="list-style-type: none"> At least 6600 new digesters are constructed in the target districts by the end of project After sales service is available to 100% of new biogas owners 	<ul style="list-style-type: none"> Project Reports Construction Records User Surveys 	
	Outputs				
3.1	At least 1 company providing biogas installation, after sales service and other technical services is established in pilot target area	<ul style="list-style-type: none"> At least 1 company is regularly providing biogas services in the pilot target area by the end of yr 1 	<ul style="list-style-type: none"> At least 1 company is regularly providing biogas services in the pilot target area by the end of the project 	<ul style="list-style-type: none"> Project Reports 	
3.2	At least 6600 new digesters are constructed by the end of the project	<ul style="list-style-type: none"> At least 100 new digesters are constructed in the target districts by end of yr 1 	<ul style="list-style-type: none"> At least 6500 new digesters are constructed nationwide during the project life 	<ul style="list-style-type: none"> Project Reports Construction Records 	
3.3	90% of all digesters receive an annual check-up in their first two years	<ul style="list-style-type: none"> 90% of all digesters receive an annual check-up in their first two years 100% of all digesters receive at least one follow-up check-up 100% of biogas households have access to after sales service 	<ul style="list-style-type: none"> 90% of all digesters receive an annual check-up in their first two years 100% of all digesters receive at least one follow-up check-up 100% of biogas households have access to after sales service 	<ul style="list-style-type: none"> Project Reports Construction Records User Surveys 	
3.4	After sales service is provided to biogas owners to a level to which they are satisfied	<ul style="list-style-type: none"> 90% of service requests are responded to within 7 days 90% of biogas owners express satisfaction with after sales service during biogas user survey 	<ul style="list-style-type: none"> 90% of biogas owners express satisfaction with after sales service when responding to biogas user survey 	<ul style="list-style-type: none"> Project Reports Biogas User Surveys 	
4	<p>Component 4: Quality Management Objective</p> <p>To maximise the effectiveness of the investment made by the biogas owners and to maintain consumer confidence in domestic biogas technology</p>	<ul style="list-style-type: none"> Quality Management guidelines are established by the end of yr 1 90% of all tested biogas digesters pass QA testing at time of testing 90% of all tested after sales service providers pass QA testing at time of testing 	<ul style="list-style-type: none"> 90% of all tested biogas digesters pass quality assurance testing at time of testing 90% of all tested after sales service providers pass quality assurance testing at time of testing 	<ul style="list-style-type: none"> Monitoring records User Surveys 	

	Project Description	Key Indicators: Year 1 Pilot	Key Indicators: Year 2-4 Pilot	Means of Verification	Assumptions/Risks
	Outputs				
4.1	Construction (including materials) and maintenance of domestic biogas digesters quality guidelines ⁸ are developed and accepted	<ul style="list-style-type: none"> Construction and maintenance of domestic biogas digesters quality guidelines are developed and accepted by end of yr 1 	<ul style="list-style-type: none"> Construction and maintenance of domestic biogas digesters quality guidelines are reviewed annually 	<ul style="list-style-type: none"> Monitoring records User Surveys Construction records 	
4.2	100 new biogas digesters are commissioned tested and accepted	<ul style="list-style-type: none"> 100 new biogas digesters are commissioned, accepted by the end of the project 	<ul style="list-style-type: none"> 6600 new biogas digesters are commissioned, accepted by the end of the project 	<ul style="list-style-type: none"> Monitoring records User Surveys Construction records 	
4.3	Random quality checks control conducted on commissioned biogas digesters	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> 5% of all new domestic biogas digesters are given random quality control checks by the end of the project by Pilot Project technicians 	<ul style="list-style-type: none"> Monitoring records User Surveys Construction records 	
4.4	90% of quality checked biogas digesters pass	<ul style="list-style-type: none"> 90% of all new domestic biogas digesters that are given quality control checks pass 	<ul style="list-style-type: none"> 90% of all new domestic biogas digesters that are given random quality control checks pass 	<ul style="list-style-type: none"> Monitoring records User Surveys Construction records 	
4.5	Random quality checks are conducted on after sales service		<ul style="list-style-type: none"> All after sales service providers are given random quality control checks after their certification by the end of the project 	<ul style="list-style-type: none"> Monitoring records User Surveys Construction records 	
4.6	90% of quality checked after sales service pass	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> All after sales service providers that are given random quality control checks pass 	<ul style="list-style-type: none"> Monitoring records User Surveys Construction records 	
5	Component 5: Training Objective To provide the skills for business people to run biogas SMEs and for biogas users to be able to operate their digesters effectively	<ul style="list-style-type: none"> 100% of new biogas users receive pre and post construction training by the end of yr 1 	<ul style="list-style-type: none"> 100% of new biogas users receive pre and post construction training within 1 month of their digesters being commissioned 	<ul style="list-style-type: none"> Training reports Project reports User Surveys 	
	Outputs				
5.1	Training Needs Analysis conducted for all stakeholders including partners, current and potential masons, biogas companies and users	<ul style="list-style-type: none"> Training Needs Analysis conducted and report approved during the first 6 months of the project 	<ul style="list-style-type: none"> Ad-hoc Training Needs Analyses⁷ conducted and approved as commissioned 	<ul style="list-style-type: none"> Training Needs Assessment document Training reports Project reports User Surveys 	
5.2	Client/partner training developed and conducted	<ul style="list-style-type: none"> All training plans approved and implemented Representatives from all clients and partners attend training in year 1 of the project 	<ul style="list-style-type: none"> All training plans approved and implemented Representatives from all clients and partners attend additional training as required 	<ul style="list-style-type: none"> Training reports Project reports User Surveys 	
5.3	Technical training for project staff developed and conducted for all technical staff	<ul style="list-style-type: none"> All training plans approved and implemented All technical staff trained in QA processes at time of recruitment 	<ul style="list-style-type: none"> All training plans approved and implemented All technical staff trained in QA processes at time of recruitment 	<ul style="list-style-type: none"> Training reports Project reports User Surveys 	

⁸ These guidelines to act as 'Quality Standard' for the purposes of the pilot. With the possible up-scaling of the next phase, official national standards can be investigated and developed if appropriate. These standards are likely to change as new technologies are identified and adopted

	Project Description	Key Indicators: Year 1 Pilot	Key Indicators: Year 2-4 Pilot	Means of Verification	Assumptions/Risks
5.4	Skills upgrade for new Biogas Masons/installers developed and implemented	<ul style="list-style-type: none"> All training plans approved and implemented 100% of masons/installers requiring refresher training as identified in the Training Needs Analysis receive training by the end of yr 1 	<ul style="list-style-type: none"> All training plans approved and implemented 100% of new masons/installers requiring refresher training receive training by the end of the project 	<ul style="list-style-type: none"> Training reports Project reports User Surveys 	
5.5	Biogas User training for men and women developed and implemented for all new biogas users	<ul style="list-style-type: none"> All training plans approved and implemented 100% of new biogas users (including women) receive training during construction and immediately afterwards 	<ul style="list-style-type: none"> All training plans approved and implemented 100% of new biogas users (including women) receive training during construction and immediately afterwards 	<ul style="list-style-type: none"> Training reports Project reports User Surveys 	
5.6	Other appropriate training developed and implemented where needed	<ul style="list-style-type: none"> All ad-hoc training conducted as per requirements in the Training Needs Analysis in a timely fashion, by the end of yr 1 	<ul style="list-style-type: none"> All ad-hoc training conducted as per requirements in the TNA in a timely fashion, by the end of the project 	<ul style="list-style-type: none"> Training reports Project reports User Surveys 	
5.7	Establish relationships with technical and higher education institutions to provide training and to include biogas in their curriculum and research portfolios	<ul style="list-style-type: none"> At least 1 partner is identified by end of yr 1 	<ul style="list-style-type: none"> At least one partnership is established and active 	<ul style="list-style-type: none"> Project reports 	
6	Component 6: Extension Objective: To provide the information to allow biogas users to effectively exploit all the benefits of biogas	<ul style="list-style-type: none"> Extension partners identified by end of yr 1 	<ul style="list-style-type: none"> Extension provided to all biogas users on effective use of biogas slurry by the end of project 		
	Output				
	Extension requirements identified and at least one partnership for extension delivery formed	<ul style="list-style-type: none"> Extension partners identified by end of yr 1 	<ul style="list-style-type: none"> Extension partners active by the end of yr 2 	<ul style="list-style-type: none"> 	
6.1	Proper extension material is available to farmer households and biogas users	<ul style="list-style-type: none"> Extension material developed and approved by the end of year 1 	<ul style="list-style-type: none"> Extension material reviewed and updated annually 	<ul style="list-style-type: none"> Training reports Project reports User Surveys 	
6.2	Farmer households receive direct support from extension workers	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> 100% of new biogas users receive at least one visit from extension workers within 6 months of the commissioning of their new biogas digesters 70% of new biogas users receive multiple visits from extension workers over the duration of the project Proper use of slurry covered in training programs 	<ul style="list-style-type: none"> Project reports Training reports 	
6.3	Visits to demonstration sites supported	<ul style="list-style-type: none"> At least 1 biogas user in each village reports in each Biogas User Survey being visited by people interested in establishing biogas 	<ul style="list-style-type: none"> At least 1 biogas user in each village reports in each Biogas User Survey being visited by people interested in establishing biogas 	<ul style="list-style-type: none"> Project reports Biogas User Surveys 	<ul style="list-style-type: none"> The value of digesters as demonstration sites is recognised and people request to view them

	Project Description	Key Indicators: Year 1 Pilot	Key Indicators: Year 2-4 Pilot	Means of Verification	Assumptions/Risks
7	<p>Component 7: Institutional Support Objective</p> <p>To maximise the ability of key biogas related institutions to be able to provide the services and support required by the biogas sector to facilitate access to domestic biogas and the development of quality biogas products</p>	<ul style="list-style-type: none"> Key external biogas stakeholders report receiving support when requested 	<ul style="list-style-type: none"> A National Advisory Board is established by the end of yr 2 Key external biogas stakeholders report receiving support when requested 	<ul style="list-style-type: none"> Project reports 	
	Outputs				
7.1	A national biogas advisory board established	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> One national advisory board is established by end of yr 2 	<ul style="list-style-type: none"> Project Reports 	
7.2	Provision of technical support to private enterprise involved in biogas	<ul style="list-style-type: none"> All potential biogas suppliers receive technical support when they request it 	<ul style="list-style-type: none"> All potential biogas suppliers receive technical support when they request it 	<ul style="list-style-type: none"> Project Reports 	
7.3	Provision of ad hoc support to external institutions and individuals who require it for the purposes of implementing biogas	<ul style="list-style-type: none"> All external parties who approach the project receive a response Site visits and other support is provided to external institutions who may benefit from it 	<ul style="list-style-type: none"> All external parties who approach the project receive a response Site visits and other support is provided to external institutions who may benefit from it 	<ul style="list-style-type: none"> Project Reports 	<ul style="list-style-type: none"> The project isn't overwhelmed with requests that take time away from core functions There is mutual benefit in information sharing and possible future partnering
8	<p>Component 8: Monitoring and Evaluation Objective</p> <p>To identify project progress and impact on stakeholders/other aspects in order to facilitate knowledge transfer</p>	<ul style="list-style-type: none"> Yr 1 Annual project monitoring report submitted and approved Monitoring and impact data is included in annual reports and ad hoc publications 	<ul style="list-style-type: none"> Annual project monitoring reports are submitted and approved Periodic impact assessments are submitted and approved Monitoring and impact data is included in annual reports and ad hoc publications 	<ul style="list-style-type: none"> Project Reports Monitoring Reports Impact Assessment reports 	<ul style="list-style-type: none"> Good records are kept throughout the project Good quality baseline data is collected Gender and poverty disaggregated data is collected and kept
	Outputs				
8.1	Annual project monitoring reports completed and accepted	<ul style="list-style-type: none"> Project monitoring report approved 	<ul style="list-style-type: none"> 100% of annual reports are approved 	<ul style="list-style-type: none"> Annual reports 	
8.2	Periodic assessment (including biogas user surveys) on all beneficiaries including the poor, women and other disadvantaged groups is completed and reports are accepted	<ul style="list-style-type: none"> At least one assessment is conducted at the end of the first year Biogas User Surveys contain a social analysis 	<ul style="list-style-type: none"> At least one assessment is conducted during the second phase of the project All impact assessment reports are approved Biogas User Surveys contain a social analysis 	<ul style="list-style-type: none"> Impact assessment reports User surveys Gender surveys 	
8.3	External surveys, studies and evaluations commissioned and completed	<ul style="list-style-type: none"> Ad hoc surveys, studies and evaluations are approved 	<ul style="list-style-type: none"> Ad hoc surveys, studies and evaluations are approved 	<ul style="list-style-type: none"> Project reports Study and evaluation reports 	
8.4	Program improvement is carried out based on the information from the monitoring reports and impact assessments progressively	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Program improvement plans are developed after all major monitoring reports and impact assessments are submitted Implementation of improvement plans is included in Annual Plans and Reports 	<ul style="list-style-type: none"> Project reports Program improvement plans Annual plans 	

	Project Description	Key Indicators: Year 1 Pilot	Key Indicators: Year 2-4 Pilot	Means of Verification	Assumptions/Risks
9	Component 9: Research and Development Objective To increase knowledge about domestic biogas issues to maximise effectiveness, quality and service delivery of the biogas program	<ul style="list-style-type: none"> • Reports and/or publications are produced to inform the decision about whether to continue on to phase 2 by the end of yr 1 	<ul style="list-style-type: none"> • Reports and/or publications are produced at the completion of all research • Examples of how research results are implemented in the program are contained in Annual Plans and Reports 	<ul style="list-style-type: none"> • Project reports • Publications/publication s lists • Annual Plans 	
	Outputs				
9.1	At least one new biogas digester in each village chosen as designated demonstration site	<ul style="list-style-type: none"> • At least 1 demonstration site is identified in each district by the end of yr 1 	<ul style="list-style-type: none"> • Reports and/or publications are produced at the completion of research 	<ul style="list-style-type: none"> • Project reports • User Surveys • Publications/publication s lists 	
9.2	Partnerships established with research and higher education institutions to conduct biogas research	<ul style="list-style-type: none"> • At least 1 partnership is identified by the end of yr 1 	<ul style="list-style-type: none"> • At least 1 partnership is established and active 	<ul style="list-style-type: none"> • Project Reports 	
9.3	Technical research and design conducted	<ul style="list-style-type: none"> • Research is conducted into technology and project potential to inform the second phase by end of yr 1 	<ul style="list-style-type: none"> • Comparative research conducted on the digester model being trialled by the end of the project • At least one appropriate improved household scale biogas digester designed or identified by the end of the project • Improved appropriate household level biogas accessories identified and/or designed by end of project • Improved appropriate income generation biogas accessories identified and/or designed by end of project 	<ul style="list-style-type: none"> • Project Reports • Research Documents 	<ul style="list-style-type: none"> • There is commercial demand for improved household and income generating technology
9.4	Research conducted into social aspects of biogas use and the results disseminated	<ul style="list-style-type: none"> • Research is conducted into user needs, user profile, credit products and project potential to inform the second phase by end of yr 1 	<ul style="list-style-type: none"> • Reports and/or publications are produced at the completion of research • Research conducted into the poverty alleviation aspects of Biogas and ways to improve access to those for whom access is currently difficult by end of project 	<ul style="list-style-type: none"> • Publications • Project Reports • Publication Lists • Biogas User Survey 	
10	Component 10: Project Management Objective To support the activities driving the development of a commercially viable biogas sector	<ul style="list-style-type: none"> • All Annual Plans submitted and approved • All regular reports submitted and approved 	<ul style="list-style-type: none"> • All Annual Plans submitted and approved • All regular reports submitted and approved • All periodic audit reports yield positive feedback 	<ul style="list-style-type: none"> • Annual Plans • Project reports • Audit reports 	
	Outputs				
10.1	Project operational documents updated and developed	<ul style="list-style-type: none"> • Project Handbook produced during first 6 months of project • Project Guidelines produced during first 6 months of project 	<ul style="list-style-type: none"> • Project operational documents reviewed annually 	<ul style="list-style-type: none"> • Handbooks • Project Reports 	

	Project Description	Key Indicators: Year 1 Pilot	Key Indicators: Year 2-4 Pilot	Means of Verification	Assumptions/Risks
10.2	Biogas Project Office Established and maintained	<ul style="list-style-type: none"> • Biogas Project Office physically established and staffed within the first 6 months 	<ul style="list-style-type: none"> • Procedural and organisational reviews conducted and implemented Annually 	<ul style="list-style-type: none"> • Project Reports • Audit Reports 	
10.3	Annual Plans submitted and accepted	<ul style="list-style-type: none"> • All Annual Plans submitted and approved 	<ul style="list-style-type: none"> • All Annual Plans submitted and approved 	<ul style="list-style-type: none"> • Annual Plans 	
10.4	Regular Reports submitted and accepted	<ul style="list-style-type: none"> • All regular reports submitted and approved 	<ul style="list-style-type: none"> • All regular reports submitted and approved 	<ul style="list-style-type: none"> • Project Reports 	
10.5	Workshops conducted	<ul style="list-style-type: none"> • All regular reports contain information about workshops held • Participant feedback forms yield positive feedback after each workshop 	<ul style="list-style-type: none"> • All regular reports contain information about workshops held • Participant feedback forms yield positive feedback after each workshop 	<ul style="list-style-type: none"> • Project Reports • Workshop reports • Participant surveys 	
10.6	Periodic Audit Reports submitted and accepted	<ul style="list-style-type: none"> • Results of audit contained in final report 	<ul style="list-style-type: none"> • Results of all periodic audits contained in periodic reporting 	<ul style="list-style-type: none"> • Project reports • Audit reports 	
10.7	The implementation plan for rollout of project activities developed and implemented	<ul style="list-style-type: none"> • Implementation plan finalised and approved in first 3 months of project 	<ul style="list-style-type: none"> • Implementation plan milestones met as per schedule 	<ul style="list-style-type: none"> • Project Reports • Audit Reports 	

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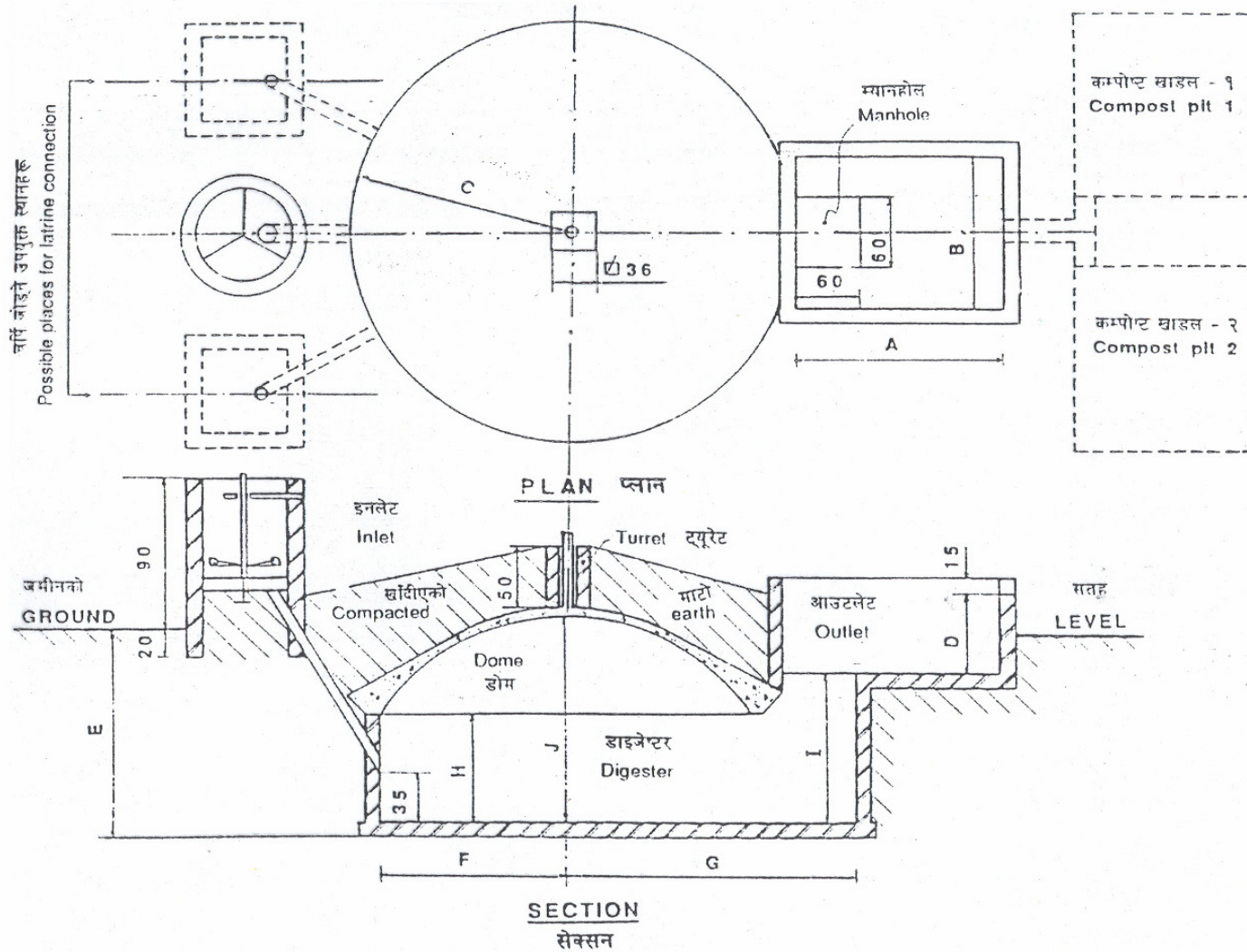
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Annex 3: Digester Design and Specifications



Annex 4: Bill of Quantities for Biogas Digester

Bill of Quantities and Cost for Bio Digester Capacity 4, 6, 8 and 10 m³

SN	Item	Unit	Unit Cost USD	4m ³		6m ³		8m ³		10m ³	
				Quantity	Total Cost USD	Quantity	Total Cost USD	Quantity	Total Cost USD	Quantity	Total Cost USD
I	Construction Materials										
1	Bricks	piece	0.02	2500.0	50.0	3000.0	60.0	3500.0	70.0	4000.0	80.0
2	Cement	bag	4.00	13.0	52.0	16.0	64.0	19.0	76.0	23.0	92.0
3	Gravel 1x2	m ³	12.00	1.0	12.0	1.1	13.2	1.2	14.4	1.3	15.6
4	Coarse sand	m ³	10.00	0.8	8.0	0.9	9.0	1.0	10.0	1.1	11.0
5	Fine sand	m ³	10.00	1.1	11.0	1.2	12.0	1.3	13.0	1.4	14.0
6	Inlet PVC pipe 10cm dia, length 2m	piece	3.50	2.0	7.0	2.0	7.0	2.0	7.0	2.0	7.0
7	Iron bars ø 6	kg	0.70	10.0	7.0	12.0	8.4	14.0	9.8	17.0	11.9
8	Binding wire	kg	0.90	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
9	Acrylic emulsion paint	Liter	3.00	1.0	3.0	1.0	3.0	1.0	3.0	1.3	3.8
				Subtotal 1			150.5		177.1		203.7
II	Accessories										
10	G.I, Gas outlet pipe Ø 0.5", 0.6m length	piece	3.00	1.0	3.0	1.0	3.0	1.0	3.0	1.0	3.0
11	Cast iron nipple, Ø 0.5" for connection from 90° cast iron elbow to main gas valve	piece	0.35	1.0	0.4	1.0	0.4	1.0	0.4	1.0	0.4
12	Main gas valve (Ball valve Ø 0.5")	piece	1.70	1.0	1.7	1.0	1.7	1.0	1.7	1.0	1.7

13	Male-female socket Ø0.5", for connection from main gas valve to PVC. (PVC with aluminum thread).	piece	0.45	1.0	0.5	1.0	0.5	1.0	0.5	1.0	0.5
14	PVC 90° elbow	piece	0.12	4.0	0.5	4.0	0.5	4.0	0.5	4.0	0.5
15	T-socket Ø0.5" for water trap (aluminum thread inside)	piece	0.40	1.0	0.4	1.0	0.4	1.0	0.4	1.0	0.4
16	Glue for PVC connection	bottle	0.70	1.0	0.7	1.0	0.7	1.0	0.7	1.0	0.7
17	Water drain	piece	3.00	1.0	3.0	1.0	3.0	1.0	3.0	1.0	3.0
18	Gas tap	piece	5.50	1.0	5.5	1.0	5.5	2.0	11.0	2.0	11.0
19	Teflon tape	piece	0.25	1.0	0.3	1.0	0.3	1.0	0.3	1.0	0.3
20	Liquid gasket rubber	bottle	1.40	0.5	0.7	0.5	0.7	0.5	0.7	0.5	0.7
21	PVC pipe Ø 0.5",	m	1.30	10.0	13.0	10.0	13.0	10.0	13.0	10.0	13.0
22	Gas rubber hose pipe Ø 0.5"	m	0.40	1.0	0.4	1.0	0.4	2.0	0.8	2.0	0.8
23	Stoves - single burner	piece	12.50	1.0	12.5	1.0	12.5	2.0	25.0	2.0	25.0
24	Lamp	piece	5.00	1.0	5.0	1.0	5.0	1.0	5.0	1.0	5.0
					Subtotal-II	47.4		47.4		65.8	65.8
III	Labor										
25	Skilled Labor	No.	4.50	9.0	40.5	10.0	45.0	11.0	49.0	12.0	54.0
26	Unskilled Labor	No.	1.50	20.0	30.0	24.0	36.0	28.0	42.0	32.0	48.0
					Subtotal III	70.50		81.00		91.00	102.00
					Total	268		305		360	404
					Guarantee and After-sales Service (15%)	40		45		55	60
					Total Cost of Installation in USD	309		350		415	464
					Total Cost of Installation in Euro	242		274		325	363

Annex 5: Province and District Names and Codes from Figure 2

Province/District Code	Province/District Name	1995 Pop. No.	1995 HH No.	1995 Area Sq. Km.	1995 No. of Villages
LAO PDR		4,581,258	752,405	236,800	11,640
100	Vientiane Mun.	528,109	88,863	3,920	486
101	Chanthabuly	59,621	10,179		
102	Sikhottabong	75,227	12,087		
103	Xaysetha	73,810	12,206		
104	Sisettanak	58,302	9,735		
105	Naxaithong	44,460	7,581		
106	Xaythany	99,473	16,310		
107	Hadxaiphong	65,450	11,885		
108	Sangthong	17,261	2,933		
109	Parkngeum	34,505	5,947		
200	Phongsaly	152,820	24,833	16,270	662
201	Phongsaly	25,657	4,599		
202	Maykhetpakngeum	22,975	3,663		
203	Khoua	28,231	4,891		
204	Samphanh	25,151	3,890		
205	Boenneua	14,057	2,393		
206	Nhot Ou	24,253	3,269		
207	Bountay	12,496	2,128		
300	Luangnamtha	114,519	20,580	9,325	485
301	Namtha	35,179	5,648		
302	Sing	22,559	4,393		
303	Long	21,291	4,004		
304	Viengpoukha	14,873	2,786		
305	Nalae	20,617	3,749		
400	Oudomxay	210,820	33,300	15,370	803
401	Xay	48,191	7,620		
402	La	14,835	2,449		
403	Mnamor	25,468	3,902		
404	Nga	24,352	3,771		
405	Beng	26,974	4,257		
406	Hoon	48,261	7,813		
407	Pakbeng	22,739	3,488		
500	Bokeo	113,493	19,664	6,196	397
501	Huaixay	43,979	7,656		
502	Tonpheung	19,573	3,623		
503	Meang	7,907	1,427		
504	Pha Oudom	26,410	4,500		
505	Paktha	15,624	2,458		
600	Luangprabang	365,333	59,813	16,875	1222
601	Luangprabang	63,333	10,558		
602	Xieng Ngeum	34,330	5,667		
603	Nan	28,334	4,693		
604	Park Ou	21,277	3,926		
605	Nambak	47,523	7,556		
606	Ngoi	39,859	6,372		
607	Pak Xeng	26,009	4,254		
608	Phonxay	24,586	3,799		
609	Chomphet	24,893	4,336		
610	Viengkham	38,948	6,207		
611	Phoukoune	16,241	2,445		
700	Huaphan	246,414	36,094	16,500	904

701	Xamneua	46,728	6,748		
702	Xiengkhor	75,271	11,061		
703	Viengthong	20,494	3,146		
704	Vienxai	32,823	4,821		
705	Huameaung	23,462	3,459		
706	Xamtay	47,636	6,859		
800	Xayabury	291,705	49,337	16,389	571
801	Xayaburi	60,471	9,646		
802	Khorp	16,174	2,709		
803	Hongsa	24,713	3,973		
804	Ngeun	12,805	2,028		
805	Xienghone	24,847	4,281		
806	Phiang	40,331	6,531		
807	Paklai	61,633	10,249		
808	Kenethao	32,987	6,454		
809	Botene	17,744	3,466		
900	Xiengkhuang	200,075	29,834	15,880	506
901	Paek	56,985	8,969		
902	Kham	39,397	5,836		
903	Nonghed	33,333	4,629		
904	Khoune	28,984	4,189		
905	Morkmay	7,810	1,087		
906	Phookood	20,190	3,117		
907	Phaxay	13,376	2,007		
1000	Vientiane Prov.	286,089	47,167	15,927	496
1001	Phonhong	65,652	11,098		
1002	Thoulakhom	57,063	9,543		
1003	Keo Oudom	19,450	3,206		
1004	Kasy	29,699	4,565		
1005	Vangvieng	44,209	7,127		
1006	Feuang	37,739	5,921		
1007	Xanakham	32,277	5,707		
1100	Borikhamxay	163,847	26,642	14,863	455
1101	Pakxanh	35,328	5,829		
1102	Thaphabath	20,022	3,460		
1103	Pakkading	29,332	4,984		
1104	Bolikanh	15,035	2,413		
1105	Khamkeuth	47,805	7,423		
1106	Viengthong	16,325	2,533		
1200	Khammuane	273,779	49,837	16,315	874
1201	Thakhek	68,301	12,288		
1202	Mahaxay	22,878	4,335		
1203	Nongbok	39,184	6,765		
1204	Hinboon	50,867	9,319		
1205	Nhommlath	21,773	4,333		
1206	Bualapha	20,080	3,621		
1207	Nakai	15,668	2,890		
1208	Xebangfay	19,879	3,571		
1209	Xaygouathong	15,149	2,715		
1300	Savannakhet	671,581	106,858	21,774	1560
1301	Khantabouly	124,427	20,168		
1302	Outhoomphone	69,076	10,786		
1303	Atsaphangthong	48,574	7,680		
1304	Phine	41,071	5,975		
1305	Sepone	35,683	6,397		
1306	Nong	16,770	2,768		

1307	Thapangthong	24,060	3,356		
1308	Songkhone	81,929	13,256		
1309	Champone	86,612	13,808		
1310	Xonbuly	34,661	5,046		
1311	Xaybuly	42,928	7,114		
1312	Vilabuly	24,624	3,956		
1313	Atsaphone	41,166	6,548		
1400	Saravane	256,550	42,381	10,691	720
1401	Saravane	65,512	10,167		
1402	Ta Oi	19,901	3,039		
1403	Toomlarn	16,301	1,985		
1404	Lakhonepeng	30,650	5,502		
1405	Vapy	26,805	4,538		
1406	Khongxedone	46,288	8,033		
1407	Lao Ngarm	43,510	7,789		
1408	Samuoi	7,583	1,328		
1500	Sekong	63,836	9,520	7,665	278
1501	Lamarn	18,028	2,652		
1502	Kaleum	13,562	1,995		
1503	Dakcheung	16,971	2,425		
1504	Thateng	15,275	2,448		
1600	Champasak	500,994	84,230	15,415	896
1601	Pakse	64,343	10,367		
1602	Sanasomboon	55,347	9,623		
1603	Bachiangsaleumsook	34,249	5,915		
1604	Paksong	44,648	7,509		
1605	Pathoomphone	42,989	7,370		
1606	Phonthong	74,487	12,137		
1607	Champasack	49,455	8,205		
1608	Sukhuma	38,202	6,367		
1609	Moonlapamok	32,322	5,366		
1610	Khongxedone	64,952	11,371		
1700	Attapeu	87,182	15,167	10,320	188
1701	Xaysetha	25,512	4,347		
1702	Samakkhixay	19,327	3,246		
1703	Sanamxay	19,696	3,524		
1704	Sanxay	12,329	2,273		
1705	Phouvong	10,318	1,777		
1800	Xaysomboon SR	54,112	8,285	7,105	137
1801	Xaysomboon	11,612	1,772		
1802	Thathom	7,468	1,239		
1803	Hom	6,619	1,137		
1804	Longsan	18,596	2,785		
1805	Phun	9,817	1,352		

Annex 6: Livestock holdings by Province, Type and Size**NUMBER OF AGRICULTURAL HOLDINGS WITH CATTLE BY NUMBER OF ANIMALS AND PROVINCE, 1999**

No	Provinces	No. of holdings	No. of holdings with cattle	Number of cattle					Average holding
				1 head	2 head	3-4 head	5-9 head	> 10 head	
	Northern	238,443	56,125	14,141	14,539	15,101	9,463	2,880	3.5
1	Phongsaly	24,393	5,520	2,163	1,620	1,119	461	157	2.5
2	Luangnamtha	19,777	5,015	1,429	1,693	1,215	615	63	2.8
3	Oudomxay	33,365	8,685	2,339	2,086	2,197	1,552	511	3.5
4	Bokeo	18,844	4,060	703	899	1,404	805	250	4
5	Luangprabang	55,720	10,864	3,224	2,740	2,677	1,752	470	3.4
6	Huaphanh	36,942	10,680	2,531	2,635	3,089	1,861	564	3.7
7	Xayabury	49,402	11,301	1,752	2,866	3,400	2,417	865	4.3
	Central	293,527	111,208	14,545	23,041	30,317	30,327	12,980	4.9
8	Vientiane Municipality	48,580	9,244	1,041	1,919	2,333	2,583	1,368	5.1
9	Xiengkhuang	28,081	16,509	1,864	2,591	4,089	5,061	2,904	5.8
10	Vientiane Province	43,672	15,062	1,376	2,858	3,632	4,389	2,808	6.1
11	Borikhamxay	26,513	7,070	938	1,644	1,996	1,807	686	4.8
12	Khammuane	43,618	12,667	2,537	2,624	3,942	2,997	567	3.8
13	Savannakhet	95,444	46,542	6,240	10,805	13,267	12,298	3,932	4.4
14	Xaysomboon Special Region	7,619	4,114	549	600	1,058	1,192	715	5.9
	Southern	136,031	40,808	5,237	10,909	9,696	10,669	4,295	4.9
15	Saravane	41,320	16,128	2,730	4,082	4,001	4,171	1,142	4.1
16	Sekong	9,720	2,022	382	455	575	498	112	4
17	Champasack	70,233	21,230	2,018	6,079	4,777	5,530	2,826	5.5
18	Attapeu	14,758	1,428	107	293	343	470	215	5.8
	Lao PDR	668,000	208,140	33,925	48,488	55,111	50,459	20,157	4.5

NUMBER OF AGRICULTURAL HOLDINGS WITH BUFFALOES BY NUMBER OF ANIMALS AND PROVINCE, 1999

No	Provinces	No. of holdings	No. of holdings with buffaloes	Number of buffaloes					Average holding
				1 head	2 head	3-4 head	5-9 head	> 10 head	
	Northern	238,443	100,748	28,456	25,312	29,543	15,317	2,123	2.9
1	Phongsaly	24,393	11,620	3,910	3,527	2,936	1,127	121	2.5
2	Luangnamtha	19,777	8,437	3,275	2,271	1,954	841	96	2.4
3	Oudomxay	33,365	14,697	4,284	3,439	4,434	2,317	222	2.9
4	Bokeo	18,844	7,159	1,834	1,734	2,428	960	205	3.0
5	Luangprabang	55,720	19,052	5,560	4,816	5,689	2,691	296	2.9
6	Huaphanh	36,942	19,918	5,266	4,618	6,138	3,428	468	3.1
7	Xayabury	49,402	19,865	4,327	4,907	5,964	3,953	715	3.3
	Central	293,527	141,654	32,583	36,096	43,898	25,158	3,920	3.2
8	Vientiane Municipality	48,580	8,919	1,080	2,386	3,084	2,173	197	3.6
9	Xiengkhuang	28,081	15,361	4,596	3,254	4,494	2,708	308	3.0
10	Vientiane Province	43,672	14,522	1,848	3,042	5,063	3,820	749	4.0
11	Borikhamxay	26,513	8,861	1,690	1,900	2,649	2,126	497	3.9
12	Khammuane	43,618	24,437	4,629	7,090	7,643	4,063	1,012	3.4
13	Savannakhet	95,444	64,738	17,773	17,611	19,416	9,064	875	2.8
14	Xaysomboon Special Region	7,619	4,816	967	813	1,549	1,204	282	4.1
	Southern	136,031	79,738	22,451	21,092	22,932	11,117	2,144	3.0
15	Saravane	41,320	24,813	8,441	6,357	6,370	3,082	563	2.7
16	Sekong	9,720	4,462	1,017	1,059	1,242	916	227	3.7
17	Champasack	70,233	42,285	12,500	11,415	12,767	5,055	547	2.7
18	Attapeu	14,758	8,178	493	2,261	2,553	2,064	807	4.8
	Lao PDR	668,000	322,139	83,492	82,499	96,372	51,592	8,185	3.1

NUMBER OF AGRICULTURAL HOLDINGS WITH PIGS BY NUMBER OF ANIMALS AND PROVINCE, 1999

No	Provinces	No. of holdings	No. of holdings with pigs	Number of pigs					Average holding
				1 head	2 head	3-4 head	5-9 head	> 10 head	
	Northern	238,443	151,404	46,428	34,335	31,439	28,905	10,294	3.7
1	Phongsaly	24,393	15,624	4,491	4,135	3,396	3,090	512	3.1
2	Luangnamtha	19,777	12,688	3,815	2,625	3,432	2,409	406	3.1
3	Oudomxay	33,365	22,482	7,074	5,241	4,644	3,940	1,582	3.7
4	Bokeo	18,844	11,843	3,748	3,265	2,813	1,635	382	2.9
5	Luangprabang	55,720	29,841	9,895	5,917	5,480	5,398	3,151	4
6	Huaphanh	36,942	30,393	5,577	5,797	7,069	9,143	2,807	4.5
7	Xayabury	49,402	28,533	11,828	7,355	4,605	3,290	1,454	3.1
	Central	293,527	112,071	45,864	26,335	18,754	15,125	5,993	3.0
8	Vientiane Municipality	48,580	4,781	1,775	1,451	771	476	308	3.1
9	Xiengkhuang	28,081	21,768	5,838	5,556	5,007	4,216	1,151	3.4
10	Vientiane Province	43,672	17,716	6,684	3,785	2,640	2,899	1,708	3.7
11	Borikhamxay	26,513	11,565	4,504	2,672	2,001	1,756	632	3.1
12	Khammuane	43,618	10,239	3,793	2,077	2,008	1,707	654	3.5
13	Savannakhet	95,444	40,684	21,620	9,747	5,280	2,907	1,130	2.3
14	Xaysomboon Special Region	7,619	5,318	1,650	1,047	1,047	1,164	410	3.8
	Southern	136,031	64,030	33,091	15,478	9,051	4,752	1,656	2.2
15	Saravane	41,320	22,448	11,644	5,099	3,143	1,893	668	2.3
16	Sekong	9,720	6,144	1,882	997	1,529	1,254	481	3.7
17	Champasack	70,233	31,301	18,178	8,326	3,666	950	181	1.8
18	Attapeu	14,758	4,137	1,387	1,056	713	655	326	3.5
	Lao PDR	668,000	327,503	125,383	76,149	59,244	48,783	17,944	3.2