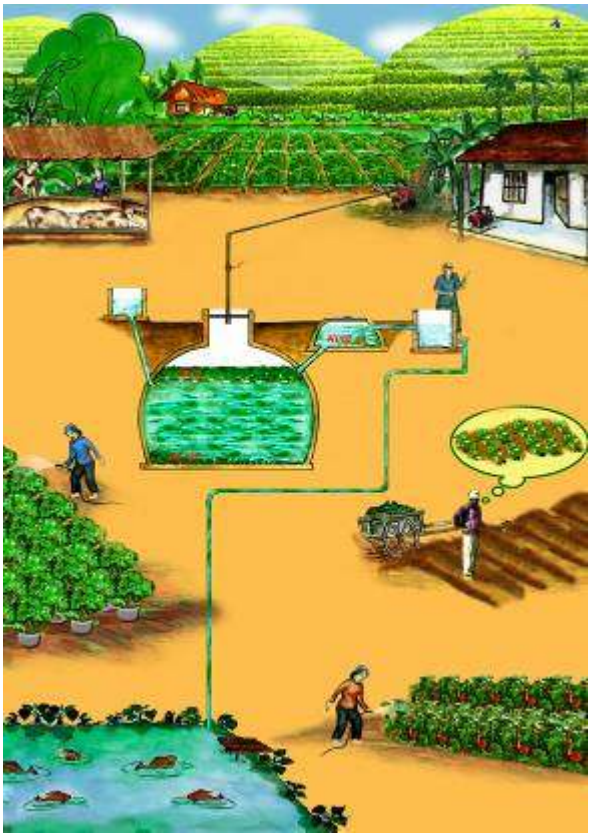

FEASIBILITY STUDY OF A NATIONAL BIOGAS PROGRAMME ON DOMESTIC BIOGAS IN THE PHILIPPINES

By SNV Netherlands Development Organisation

and

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Acknowledgement

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

Executive summary

This report presents the findings of an ADB commissioned study by a consultancy team of four from SNV, WI and PEI to assess the feasibility for a domestic biogas market in the Philippines. Meetings with different stakeholders were held and field visits were conducted in 5 provinces around the country during two weeks in November 2009. The results of the study are the following:

The feasibility of a domestic biodigester programme in the Philippines will vary much per geographical area. The consultants conclude that in specific provinces a modest biodigester programme for a few thousand biodigesters may be possible. Therefore a market survey to assess the demand more precisely would be recommended for the provinces of Batangas and Kalinga and the INREM Project areas Bukidnon, Benguet, Cagayan and Northern Mindanao.

The Consultants defined factors limiting the demand and supply side of a potential commercial biodigester market:

- The common backyard farmer in rural Philippines has too little livestock numbers to operate a biodigester.

- Rural areas in the Philippines are poor, creating a threshold when it comes to the ability to invest in a biodigester.

- Fuel wood is widely available and this will reduce incentives for households to invest in alternative energy sources.

To assess the supply side of biodigesters, consultants noticed the following:

- Bricks are not available and thus concrete is used as construction material. This makes the costs very high (PHP 70,000), triple compared to similar (brick made) biodigesters in other Asian countries.

- Fuel substitution values of an estimated PHP 600/month will not justify such a high investment.

It is therefore concluded that the market for domestic biodigesters is deemed to be a **niche market**. Consultants visited areas with better-off households, practicing intensive hog raising that resulted in severe environmental pressure (like in Batangas and Kalinga). For this type of households (medium scale) biogas technology could be a commercially viable good.

For the provinces mentioned above, consultants advise to further investigate the scope of the market through a **market survey** to assess a) the demand and price elasticity and b) potential of different biodigester models in terms

of maximum costs, technical requirements (medium/small scale) and alternative construction materials.

The table below presents a short description of key findings in specific areas

Table 1 Key findings per visited area

Area	Key findings and sources	Expected feasibility
Bohol INREMP	Data at Provincial Veterinarian Office of Bohol showed less than 100 households with > 6 hogs; Biogas constructor produced small numbers only; Biogas user could not recall anyone else investing in biogas.	Low
Cebu	Experienced biogas consultant constructed over 10 years only 70 digesters; Limited demand due to low number livestock per farming unit. Earlier up scaling attempts failed.	Low
Bukidnon INREMP	According to the Provincial Veterinary office, Lantapan Municipality and Regional Agricultural Department most backyard farmers raise <5 hogs; However, farmers' representatives saw a potential demand of some 1,500 biodigesters. Statistics suggest average hog holders with ~5 hogs.	The findings are somewhat contradictive; Another market survey should validate the (sort of) biodigester demand.
Batangas	According to farmers cooperative, 5,000 households raise between 20 and 50 hogs; Consultants witnessed severe environmental pollution due to poor waste management and badly operating biodigesters.	A survey is recommended to verify the scope and (sort of) demand.
Kalinga INREMP	Respondents indicated the majority of farms have 10 to 20 hogs.	A survey is recommended to verify the scope and (sort of) demand.

2002 Census of Agriculture data of INREMP areas suggest conducting a survey in Bengue and Cagayan as well.

Different biodigesters have been visited for which an overview is presented below. Average costs of biodigesters in other Asian SNV biogas projects are much lower:

Table 2 Overview of biodigesters in the Philippines

Model	Costs (PHP)	Material	Comments
Average SNV fixed dome model in Asia	*25,000*	*Brick made*	*Proven technologies*
Chinese fixed dome	70,000	Concrete	Proven technology
Box shaped digester	80,000	Concrete	Robust, but low in efficiency
DOST floating drum	100,000	Concrete and steel	Iron drum difficult to transport, costly.
DOST portable digester	15-20,000	Plastic container	Unproven technology
Tubular Digesters	25,000	Poly-ethylene	Requires constant maintenance, high rate of failure
Tubular Digesters	85,000	High density poly-ethylene	Price comparable to concrete digesters
Chinese composite (not observed)	70,000	Fiber glass	Proven technology, price depends much on transport costs.

Considering the relative high costs of digesters in the Philippines it is recommended to keep a close eye on the current R&D activities by SNV and the ADB Energy for All initiative to lower the costs of biodigesters. As a first step however, a more solid figure on the demand and customer needs is required before making a proper selection between biodigester models.

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Abbreviations

ADB – Asian Development Bank

ASEAN – Association of Southeast Asian Nations

BAI – Bureau of Animal Industry

BAS – Bureau of Agricultural Statistics

CALABARZON – Calamba, Laguna, Batangas, Rizal and Quezon Provinces

CAR – Cordillera Administrative Region

CARP – Comprehensive Agrarian Reform Programme

CvSU – Cavite State University

DAR – Department of Agrarian Reform

DENR – Department of Environment and Natural Resources

DOST – Department of Science and Technology

EIRR – Economic Internal Rate of Return

FIRR – Financial Internal Rate of Return

GDP – Gross Domestic Product

GNP – Gross National Product

HECS – Household Energy Consumption Survey

IAP – Indoor air pollution

IEE – Initial Environmental Examination

INREMP – Integrated Natural Resources and Environmental Management Project

IRR – Internal Rate of Return

ITDI – Industrial Technology Development Institute

LDPE – Low Density Polyethylene

LPG – Liquefied Petroleum Gas

MDG – Millennium Development Goal

NGO – Non-government Organization

SIDC – Sorosoro Ibaba Development Cooperative

SNV- Netherlands Development Organisation

TPED – Tubular Polyethylene Digester

WHO – World Health Organization

WI – Winrock International

Exchange rate 1 USD = 46.4 Philippines Peso (December 2009)

Chapter 1 Country background

The Philippines is an archipelagic country of 7,100 islands located in Southeast Asia. The Philippine islands are clustered into 3 main island groups: Luzon, Visayas and Mindanao. It has a total land area of about 300,000 Km2 and a coastline of 36,289 km. The capital city is Manila, which is one of the 17 cities and municipalities that make up the Metropolitan Manila Area. Socio economic development in rural Philippines lags behind compared to cities and semi urban areas.

The table below show important factors indicating the potential of domestic biogas: rural population (market), wealth (ability to invest), livestock (input materials) and household energy sources.

Table 3 Philippines and neighboring countries

	Total Pop, Million[1]	**Rural Pop,** Million	**Surface** 1,000 Km2[2]	**HDI**[3]	**GDP/ Capita** in ppp USD	**GDP growth 2008** %	**Hogs** Heads Million 2009[4]	**Cattle** Heads Mln 2009	**Access to modern energy** % rural pop[5]
Philippines	93	31	300	0.745	3,153	3.8	13.5	2.6	29.5
Vietnam	89	65	331	0.718	2,363	6.2	26.6	6.7	20.4
Thailand	68	43	513	0.886	7,613	2.6	8.3	6.5	52.7
Indonesia	205	110	1,860	0.726	3,455	6.2	6.7	11.5	22.5
Malaysia	26	8	330	0,823	12,536	4.6	2.0	0.8	95.3

Sources: As footnoted

When comparing these figures with Vietnam, a country with a huge demand of some 2 million digesters, one would expect a demand in the Philippines half as large; and still considerable. The findings of the report alas point to a more sobering figure.

For administrative purposes, the government has grouped the country's three main islands into 17 regions. The regions are generally organized to group provinces that have the same cultural and ethnological characteristics. Most government agencies operate regional offices instead of individual provincial offices. These regional offices are usually situated in the city designated as the regional center. The regions themselves do not possess a separate local government, with the exception the Autonomous Region in Muslim Mindanao (ARMM), which has an elected regional assembly and governor. An important aspect to this is that after elections not only strategic direction may change,

[1] UN department social and economic affairs, http://esa.un.org/unpp/index.asp, Dec. 09.
[2] UN UN Statistics Divison http://unstats.un.org/unsd/default.htm Dec. 09.
[3] Human Development Indices 2008, http://hdr.undp.org/en/statistics/
[4] BAS Philippines 2009
[5] WHO-UNDP The Energy Access Situation in Developing Countries http://content.undp.org/

but also management, staff, and even the very existence of services like agricultural extension centers may disappear. This should be recognized as far as a programme would be coordinated by any public entity. During the field visits it was observed that the election period is prone to brutal political violence that may hamper project implementation.

The Philippines has a tropical climate with two seasons: the rainy season which runs from June to November and the dry season between December and May. Temperatures around the year are ranging from 22° to 32°C in June to October and during the coolest period in November to February from 22° to 28°C. This means the whole year round the temperatures are high and favorable for the fermentation process in the biodigester. Water from rivers and catchments areas is widely available.

The country is positioned along the typhoon belt and Pacific Ring of Fire. Consequently, it is affected by some 15 typhoons and 5 to 6 cyclonic storms per year. It is also vulnerable to landslides, volcanic eruptions, earthquakes and tsunamis. Among the environmental issues plaguing the country are uncontrolled deforestation especially in watershed areas, soil erosion, air- and water pollution in major urban centers, coral reef degradation, and increasing pollution of coastal mangrove swamps that are important fish breeding grounds.

Chapter 2 Purpose, Objective, Methodology and Limitations

This study is being conducted through the "Energy for All Partnership". The Energy for All Partnership was launched in June 2009 at the Asia Clean Energy Forum in Manila as a regional response to the challenge of regional energy poverty. The Partnership aims to provide access to modern energy to an additional 100 million people in the Asia-Pacific region by 2015. The Energy for All Partnership is supported by a secretariat, which is hosted by the Asian Development Bank (ADB) and facilitated by The Foundation for Development Cooperation (FDC).

One of the working groups being supported by The Energy for All Partnership is the working group that focuses on domestic biogas led by SNV, Netherlands Development Organisation. SNV's proposal for this working group targets the installation of one million digesters by 2015/2016, providing additional access to energy for about 5 million people. Based on an initial assessment on its technical potential, the Philippines is considered as one of the new countries to be included into the Partnership.

At the same time ADB is developing the Integrated Natural Resources & Environmental Management (INREM) Project, focusing on the rapid degradation of the uplands areas through forest destruction, unsustainable

farming practices and poverty reduction in the lowlands. Considering its benefits, the introduction of biodigesters can help to tackle these challenges. Therefore the study took into account areas covered by the INREM Project.

The goal of this study is to assess the feasibility of setting-up and implementing a national program on domestic biogas in the Republic of the Philippines. The priority given to this study is to assess the scope of the market for domestic biogas systems, rather than implementation modalities, subsidy levels, micro finance, etc.

Consultants kept in mind the commercial sector/market-based approach as adopted many other biogas programmes in Asia and Africa, aiming to establish a commercial viable market which is visualized in the conceptual framework below. In the heart of this model is the market, where suppliers

Figure 1 Functions for biogas programmes

and customers interact.

To establish the feasibility of such a market in the Philippines the study involved the following steps:

1. Collection of secondary information concerning biogas development and implementation in the Philippines and internationally,
2. Consultation with key informants in the Philippines and abroad,
3. Conduct of field visits and interviews with practitioners on their actual experiences,
4. The study mission included a workshop to share the preliminary results of the mission with the relevant stakeholders,
5. Formulation of a study report.

In a period of two weeks in November 2009 a group of 4 consultants with (inter)national biogas expertise from Winrock International, SNV Netherlands Development Organisation and Preferred Energy Inc. conducted field visits to 5 different regions in the Philippines to assess the demand and opportunities for supply in light of the feasibility of a national biogas programme.

Interviews and group sessions were conducted with stakeholders from the civil, public and private sector such as governmental-, and NGO staff, farmers cooperatives, farmer representatives, non-biogas using households and biogas using households. Observations were made regarding the household situation and its surroundings. On the national institutional level, the Department of Energy, Department Science and Technology, Department of Agriculture, several Provincial Veterinarian Offices, Universities, Planet Finance and Cooperatives were consulted about their current and past activities, aspirations and visions on domestic biogas in the Philippines. See list of consultations in annex 2.

To analyze the potential for biogas, the study used the results of the 2004 Household Energy Consumption Survey (HECS) conducted jointly by the Department of Energy (DOE) and the National Statistics Office (NSO).

Consultants primarily took into account conventional domestic biogas technology fed by a minimum of 20 Kg dung a day, equivalent to 6 pigs or 2 cows. Apart from that, consultants touched upon the opportunities and limitation for biogas for small farmers with fewer livestock. Industrial scale digesters fall beyond the scope of this study. The selected provinces were based on INREM Project coverage and where consultants expected to have high biogas potential.

As explained further in the next chapter, it became clear the focus was to be on hog rearing rather than cattle or poultry. Cattle are normally free roaming and poultry is practiced on an industrial scale, requiring large scale biogas systems. Hogs to certain extent are raised in pens enabling manure collection and in quantities suitable for domestic biogas. The feedstock in the ARRM Muslim region would obviously differ.

Domestic biodigester technologies come in many designs, shapes and at different costs. In this report, the most popular technologies are assessed.

The consultants acknowledge that the study was made in a short period of time, however, considering the experience within the consultancy team and the large variety of information sources, they are confident their findings are valid.

Chapter 3 The Agricultural Sector

In terms of the feasibility of a domestic biogas market, the number of farmers having sufficient livestock and collectable manure is a determining factor to the market. Therefore in this chapter the scope of the agricultural sector and the aggregation level per farming unit is analyzed.

In 2008, the country's Gross National Product (GNP) grew by 6.17 % while its Gross Domestic Product (GDP) expanded by 3.84%, against a demographic growth of 2%. Even while the general macroeconomic outlook improved in recent years, the Philippine economy still faces several challenges. The country needs to maintain its reform momentum in order to catch up with regional competitors, improve employment opportunities, and alleviate poverty. Moreover, given its unequal distribution of income, the Philippines still needs increased levels of sustained growth to make progress in alleviating poverty.

Its rural population comprises 30-35% of its total population, and relies on agriculture for its main livelihood. Agriculture contributed 18% to the GDP and posted an expansion of 3.23 % growth in 2008. Over 12 million persons were employed in the agricultural sector, representing 35% of the country's employment.

People empowerment is being implemented in this sector through the Comprehensive Agrarian Reform Program (CARP) which gives farmers ownership of the land they till. Aside from tilling land, Filipino farmers are also engaged in livestock production. In fact, almost all backyard farmers would normally raise livestock to supplement family income and diet.

3.1 Livestock and poultry

Livestock and poultry are classified as a sub-sector in the Filipino agriculture sector. Among the livestock raised by farmers are hogs, cattle, chicken, carabao, goats and ducks. The table below shows a gradually increasing inventory of animals in the last 10 years of about 1 to 5% a year.

Table 4 Livestock and poultry inventory
Livestock and Poultry Inventory by Year and Animal Type

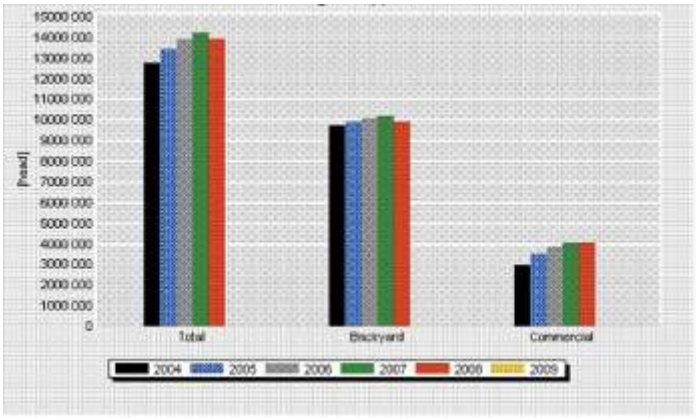
	Carabao	Cattle	Goat	Hog	Chicken	Duck
1999	3,005.99	2,425.93	3,050.96	10,397.00	113,789.04	8,613.65
2000	3,024.40	2,478.85	3,151.47	10,710.69	115,186.98	9,264.66
2001	3,065.81	2,495.58	3,214.76	11,063.14	115,606.52	9,986.80
2002	3,122.03	2,547.82	3,293.90	11,652.70	126,831.13	9,911.27
2003	3,179.54	2,557.04	3,270.44	12,364.30	128,515.45	9,807.09
2004	3,269.98	2,593.29	3,357.62	12,561.69	122,010.18	10,211.31
2005	3,326.83	2,547.96	3,535.20	12,139.69	136,003.40	10,438.74
2006	3,360.68	2,519.74	3,735.82	13,046.68	134,332.86	11,146.74
2007	3,383.62	2,565.85	4,048.55	13,459.33	135,640.20	10,161.58
2008	3,338.57	2,566.49	4,174.25	13,701.02	154,259.31	10,508.20
2009	3,320.97	2,586.39	4,222.23	13,596.40	158,663.06	10,577.40

Source: Bureau of Agricultural Statistics (BAS)
Contact: info@bas.gov.ph
Unit: in thousand heads

3.2 Swine Industry

Hog raising is the second largest commercial agri-food industry in the Philippines, after the banana industry. It generated about 16% of the Agriculture and Forestry Industry sales in 2006 (Census of the Philippine Business and Industry). As of January 2008, total hog inventory was estimated at 13.7 million heads, of which 71% were raised in "backyard farms", a category of 50 pigs and below, while 29% were in commercial farms. The swine industry, which accounted for 80% of total livestock production, registered a 2.72% growth during the year. The top three producing regions are Regions III, IV-A and VI with region VI having the most backyard inventory and region III topping the population in commercial farms (BAS, 2008).

Table 5 Hog Raising in the Philippines



Hog raising: 71% backyard, 29% commercial

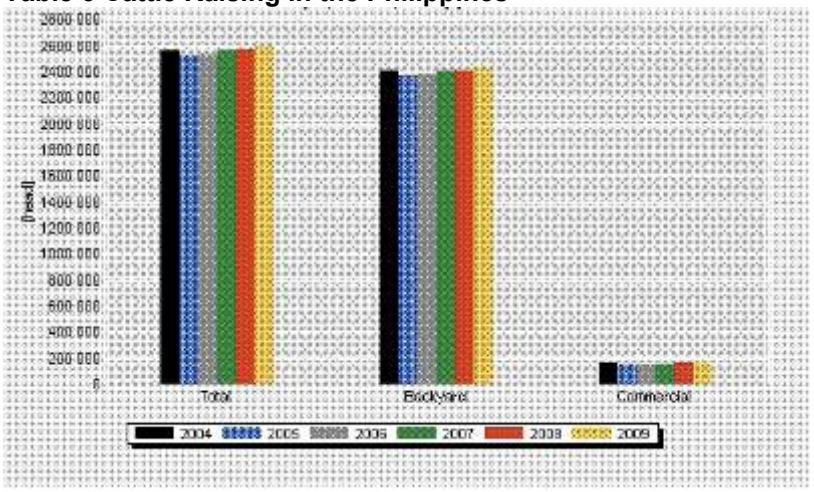
Among all sorts of livestock, hog raising appears to have the most potential for a domestic biogas market. Hog raisers with > 6 hogs usually have pens that allow collection of manure, and apart from that, hog manure is a strong polluter and produces a large volume of gas per kg. A map of the geographical dispersion of backyard farmers in the Philippines is presented in Annex 4. For those backyard farmers with only 1-3 hogs, it is common to tie hogs under a tree or let them roam freely around the yard. During 'fiestas' those hogs are slaughtered and consumed, leaving no hogs left until the next fattening cycle starts with little piglets that are raised until the next 'fiesta'.

3.3 Cattle Industry

The total cattle population as of January 1, 2009 was projected at over 2.5 million heads. Around 94% of the total cattle population was raised in backyard farms. Of the total cattle population, cows accounted for 40%. Yearlings contributed 19%, heifers 17%, bulls and other classification added 12% to the total cattle population. The top cattle raising regions were: Region I (Ilocos region), Region X (Northern Mindanao), Region VII (Central Visayas), Region IV-A (CALABARZON) and Region VI (Western Visayas). Together, they accounted for about 53% of the total cattle inventory in the

country. Region I has the highest number of backyard cattle inventory while Region 10 produced the most number of cattle from commercial farms.

Table 6 Cattle Raising in the Philippines



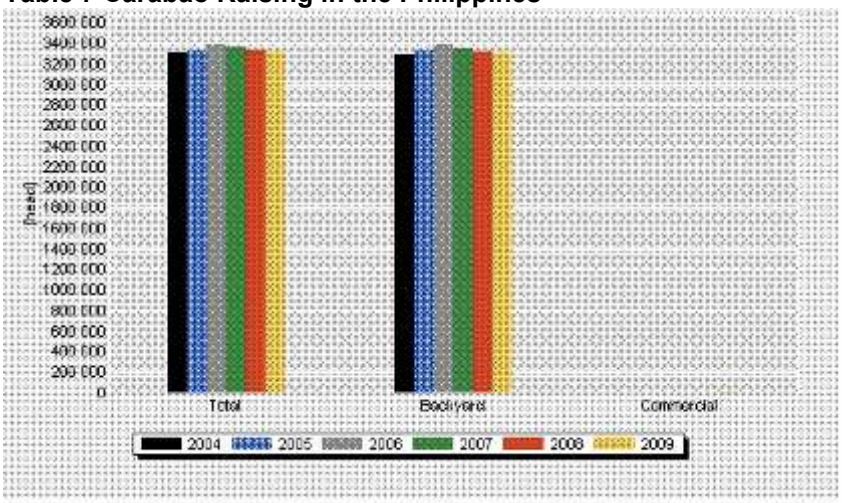
Cattle raising: 93.6% backyard, 6.4% commercial

Although 93% is classified as backyard cattle farming, the important question for a biogas market is whether it is stabled or not, and allowing to collect manure into the digester. It was observed that most farmers let their cattle roam freely, leaving little manure left to be fed into a biodigester.

3.4 Carabao Industry

Carabao (water buffalo) is a farm animal that is raised both for tilling the land and for meat. As of January 1, 2009, total carabao population was estimated at 3.32 million heads. Backyard farms account for 98% of total carabao population. Region III, II and VI have the most inventory share, each accounting for 10% of total population.

Table 7 Carabao Raising in the Philippines



Carabao raising: 98% backyard, 2% commercial

It is common the carabao works on the field and is not stabled or kept in a designated location. For this practice manure collection is not possible. Changing in behavior of the farmer to stable livestock, at least by night, might enlarge the potential for biogas.

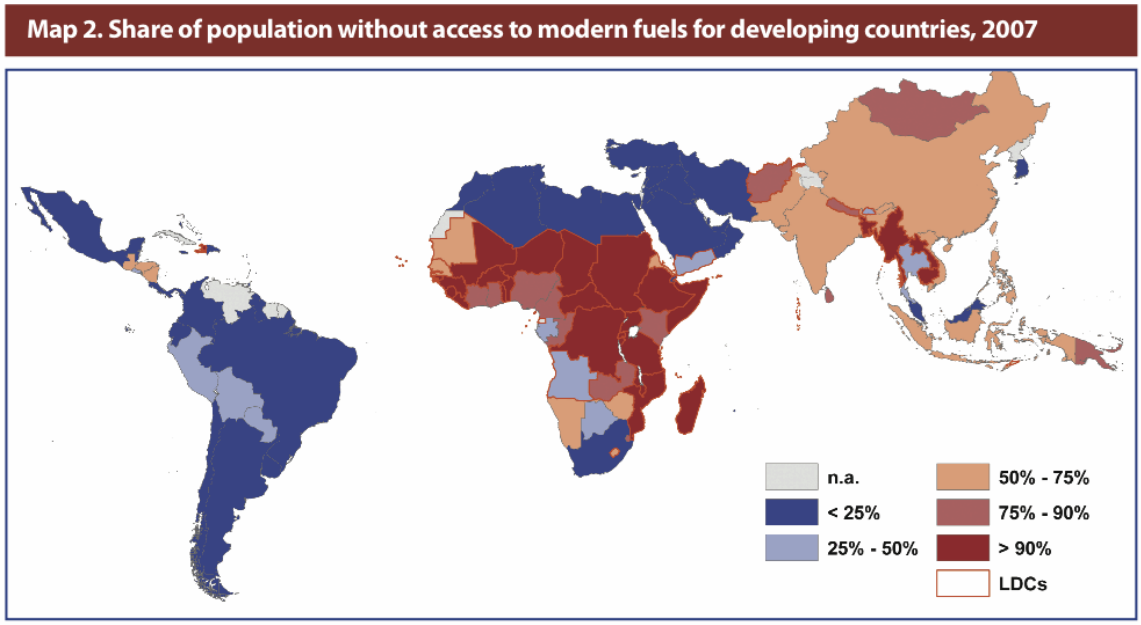
Due to the low aggregation level and livestock raising practices the potential for a biogas market is lower than the statistical data on livestock production would indicate. Therefore field surveys are needed to arrive at a valid indication of biogas demand.

Chapter 4 The Household Energy Sector

One of the challenges developing nations face is the rural population's access to modern energy sources. This is important to livelihood improvement and employment opportunities that can improve household incomes and quality of life in general. The use of biodigesters can bring about these results, as proven in many biogas programmes around the world.

A WHO-UNDP study on global access to modern fuels, “The Energy Access Situation in Developing Countries,”, reported that the majority of the population in most African and Asian countries does not have access to modern fuels (see map below). “Modern fuels” refer to electricity, liquid fuels and gaseous fuels such as LPG, natural gas, and kerosene when used as cooking fuels.

Figure 2 Percentage of population without access to modern fuels, 2007[6]



Notes: Based on UNDP's classification of developing countries and the UN's classification of LDCs. Some of the small countries and island states are not visible in the map. For a complete list of countries, see Appendix 2. Modern fuels refer to electricity, liquid fuels, and gaseous fuels such as LPG, natural gas, and kerosene. The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations or UNDP concerning the legal status of any country, territory, city or area or its authorities, or concerning the delimitation of its frontiers or boundaries.

Despite its high development, the Philippines falls in the category of which 50 to 75 % of its population does have access to modern energy services. On the other hand, in rural areas only 29.5 % of the population has access to modern energy services. (For Vietnam this percentage is 20.4, Thailand 52.7, Malaysia 95.3 and Indonesia 22.5). Over the past few decades many urban and richer households have been able to step up the energy ladder, and move away from firewood to kerosene or LPG stoves leaving behind millions of poor households in rural and peri-urban areas to use traditional open fires and/or inefficient fuels.

Table 8 Fuels used for cooking in % of the population

	Philippines, National	Philippines, Rural
Electricity	1.3	0.2
Gas	43.4	27
Kerosene	4.7	2.4
Charcoal	6.8	8.3
Wood and Agricultural residues	41.8	60.8
Coal		1.4
Other	2.0	
Access to modern fuels	49.4	29.5

[6] WHO-UNDP The Energy Access Situation in Developing Countries 2009 http://content.undp.org/go/newsroom/publications/environment-energy/www-ee-library/sustainable-energy/undp-who-report-on-energy-access-in-developing-countries-review-of-ldcs---ssas.en

Smoke from inefficient stoves and poorly ventilated homes kills 1.6 million people each year, 85% of them women and children under 5. The number of deaths attributed to traditional fuels in the Philippines is estimated at 7,200 a year.[7] Modern energy sources like biogas do not exhibit these health dangers.

Chapter 5 Household Income

In the next table we see the relation between income data and the type of fuel which is used in the Philippines.

The following table shows the relation between energy sources of households and income classification.

Table 9 Household Energy Use per Income Class

	All Income Classes,	Percentage of Households In Income Class Per Region					
Fuel Type	Thousands	**<P5,000**	**P5,000–P9,999**	**P10,000–P14,999**	**P15,000–P24,999**	**P25,000 and over**	**Not reported**
Any Fuel	*16,973*	*5,705*	*5,372*	*2,336*	*1,997*	*1,555*	*7*
Electricity	14,872	74.13%	90.52%	97.22%	98.60%	98.59%	100.00%
LPG	8,842	20.14%	51.01%	76.93%	86.98%	90.87%	71.43%
Gasoline	1,986	3.72%	9.49%	14.68%	21.78%	31.19%	14.29%
Diesel	567	0.96%	1.55%	3.34%	6.31%	14.47%	0.00%
Kerosene	9,525	79.40%	57.91%	39.94%	30.35%	22.06%	28.57%
Fuelwood	9,357	79.88%	56.22%	37.80%	27.24%	22.57%	28.57%
Charcoal	5,811	26.47%	34.77%	38.31%	42.91%	43.60%	42.86%
Biomass Residue	3,177	31.74%	17.01%	10.10%	6.11%	6.05%	0.00%
Percentage per Income Class		*33.61%*	*31.65%*	*13.76%*	*11.77%*	*9.16%*	*0.04%*
Cumulative Percentage		*33.61%*	*65.26%*	*79.03%*	*90.79%*	*99.95%*	*99.99%*

Source: HECS 2004

The table above demonstrates the relation between household income and fuel use:

- Electricity and especially LPG use increases as household income increases;
- Kerosene and fuelwood consumption decrease consistently showing their displacement as lighting and cooking fuels;
- Gasoline and diesel consumption also increase dramatically as transport becomes an option for higher income households;
- Low income households rely on kerosene for lighting and fuelwood for cooking. Those households with access to biomass residues probably use the same as substitute for fuelwood.
- The high rate of electricity use has no bearing to rural areas.

Income levels per region

[7] GVEP 2009, Cookstoves and Markets: Experiences, Successes and Opportunities http://www.gvepinternational.org/news/139/

The following table shows household income per region. It is noted that about one-third of households are in the lowest income category (earning below PHP 5,000 per month). Nearly one-third falls within the next income category (PHP 5,000 to PHP 9,999).

Table 10 Household Income per Region

Region	Total Households, Thousands	Percentage of Households In Income Class Per Region					
		<P5,000	P5,000–P9,999	P10,000–P14,999	P15,000–P24,999	P25,000 and over	Not reported
National Capital Region	2,360	7.9%	29.5%	20.9%	22.3%	19.3%	
Cordillera Administrative Region	285	40.1%	24.7%	13.1%	11.4%	10.8%	
Region I - Ilocos	894	34.8%	29.2%	13.0%	10.2%	12.6%	0.2%
Region II - Cagayan Valley	600	40.3%	36.0%	9.4%	7.8%	6.4%	
Region III - Central Luzon	1,870	19.1%	36.7%	18.8%	15.0%	10.3%	
Region IVA - CALABARZON	2,298	19.6%	32.8%	19.1%	16.3%	12.2%	
Region IVB - MIMAROPA	516	57.9%	21.8%	6.6%	6.7%	7.1%	
Region V - Bicol	966	48.8%	32.1%	9.4%	6.0%	3.6%	
Region VI - Western Visayas	1,288	47.4%	31.1%	8.8%	8.3%	4.4%	
Region VII - Central Visayas	1,248	40.8%	28.1%	12.4%	9.8%	8.7%	0.1%
Region VIII - Eastern Visayas	769	50.9%	28.0%	8.1%	7.7%	5.3%	
Region IX - Zamboanga	602	54.6%	27.7%	8.6%	5.0%	4.2%	
Region X - Northern Mindanao	759	43.4%	30.2%	11.7%	9.4%	5.3%	
Region XI - Davao	834	36.4%	38.7%	12.1%	7.6%	4.8%	0.4%
Region XII - SOCCSKSARGEN	735	55.0%	26.9%	8.2%	6.5%	3.5%	
CARAGA	424	44.7%	33.1%	11.3%	7.9%	2.9%	
Autonomous Region Muslim Mindanao	522	39.8%	46.0%	6.7%	3.0%	4.6%	
Total Philippines	16,973	5,703	5,380	2,342	2,003	1,562	
Percentage of Total		33.6%	31.7%	13.8%	11.8%	9.2%	0.0%
Cumulative Percentage		34%	65%	79%	91%	100%	100%

Source: HECS 2004

Thus, about two-thirds of the population falls within subsistence-level income with practically no capacity for additional cost burden. Although this category is likely to rely on solid fuels for which biogas would be a cleaner alternative, income levels will pose a constraint to biodigester dissemination. INREMP areas even fall below the national average.

Chapter 6 Stakeholders

There are at least 6 government agencies, 13 state universities and colleges, a number of Local Government Units (LGU) and various private sector companies and innovators involved in the promotion of biogas technology. These organizations implement their respective programs and projects independent of each other.

1. ***The Department of Energy (DOE)*** – promotes the development of biogas systems through its Affiliated Renewable Energy Centers (AREC) based in 13 State Universities and Colleges in various regions of the country.

2. ***The Department of Science & Technology (DOST)*** - is involved in biogas promotion through its various attached agencies and councils like the Philippine Council for Industry and Energy Research and Development (PCIERD) and the Industrial Technology Development Institute (ITDI) whose role directly relate to research, development, demonstration and pilot scale implementation of biogas projects. Regional offices also implement their own biogas projects.
3. ***Department of Agriculture–Bureau of Animal Industry (BAI)*** – formulates and implements programs to develop and expand the livestock, poultry and dairy industries. As part of their program for waste management and by way of increasing farm income, BAI has developed a tubular polyethylene digester (TPED) which it promotes among livestock farmers. Some 100 are disseminated.
4. ***Department of Agriculture–Bureau of Soils (BoS) –*** developed a household biogas system called the Portagas.
5. ***Department of Agrarian Reform (DAR)*** – currently piloting a biogas project with an NGO, the Philippine Center for Water & Sanitation (PCWS) using domestic household wastes.
6. ***Local Government Units (LGUs)*** - prepare and implement waste management programs in their respective jurisdiction in coordination with other government agencies responsible for solid waste management.
7. ***Cavite State University*** – designated as the National Biogas Center, this state-run university has conducted a number of seminars and hands-on trainings on biogas technology and constructed already some 1,000 digesters.
8. ***Department of Environment and Natural Resources (DENR)*** – responsible for the conservation, management, development and proper use of the country's environment and natural resources; DENR is the country's Designated National Authority (DNA) for the Clean Development Mechanism (CDM) and promotes biogas technology as among the projects that can help the mitigation of climate change.
9. ***Private Sector companies/agents –*** private individuals that are either investing or providing services for the installation and operation of either domestic or commercial biogas digesters.
10. ***Farmers Cooperatives -*** for instance, SIDC Sorosoro Ibaba Development Cooperative, is a cooperative active in promoting sustainable farming practices. Cooperatives can be instrumental for having good understanding and close relationship to farmers.

Consultants witnessed enthusiasm from almost all officials from the different departmental, regional and provincial governmental offices. Next to that, there seemed to be considerable knowledge and understanding about biogas

technology through current and former biogas initiatives. Nevertheless it was acknowledged the results of biogas initiatives were limited[8] in terms of scope and impact. The reasons given to this were ambiguous, like for instance lack of coordination, poor technical know-how, low awareness of farmers, etc. However, the scope of market itself may have been the root factor that constrained success.

Chapter 7 Policies

The most promising policies for biogas dissemination seem the ordinances issues by national or local authorities to mitigate environmental pollution and livestock, mainly hog raising, in suburban areas. For instance, farmers that have a certain number of hogs are required to request for a Certificate of Non-coverage from the Department of Energy and Natural Resources (DENR). In such cases, as reported in the municipality of Lantapan, hog raising was forbidden in semi urban areas to mitigate smell, ground and water pollution and to control diseases. Biogas technology can be a solution to this problem as it reduces the smell, diminishing pathogens which may allow hog raising again in areas that would have otherwise been excluded.

Another example is that of Barangay Sorosoro Ibaba in Batangas City where backyard swine farms proliferate. The local authorities together with the Sorosoro Ibaba Development Cooperative (SIDC), agreed to implement a "no waste management, no pigs policy" in order to solve the deteriorating waste disposal problem in the area. Farmer-members of the cooperative therefore were "obliged" to install either a biodigester or a septic tank to manage their waste stream before they could participate in the hog dispersal/fattening program of the cooperative.

In support of its energy and environmental goals, the Philippine Government has enacted various legislations, which effectively support the promotion of biogas technology. Among these laws are:

- Philippine Energy Plan (PEP) is one of Energy Independence and focuses on attaining a sustainable 60.0 percent energy self-sufficiency beyond 2010 through alternative fuels.

- Republic Act (RA) 8749 Philippine Clean Air Act of 1999 - sets goals for the reduction of GHG emissions in the country using permissible standards and control strategies.

- RA 9275 known as "Clean Water Act of 2004" - aims to protect the country's water bodies from pollution from land-based sources (industries and commercial establishments, agriculture and community/household activities).

[8] Strategic Agricultural Action Plan of the Philippines

- The Renewable Energy Act of 2008 - aims to further increase renewable energy utilization in the country, including biogas. The law provides for income tax holidays, duty free importation of equipment, 0% VAT, among other things.

- Presidential Decree (PD) 984 known as Pollution Control Decree of 1976 to prevent, abate and control pollution of water, air and land for the more effective utilization of the resources of this country.

- PD 1586 known as Establishing Environmental Impact Statement System including other Environmental Management Related Measures and for Other Purposes to attain and maintain a rational and orderly balance between socio-economic growth and environmental protection.

- PD 1151 known as Philippine Environmental Policy to formulate an intensive integrated program of environmental protection through a requirement of environmental impact assessment and statements.

- PD 1152 known as Philippine Environment Code that establishes specific environment management policies and prescribe environment quality standards.

- DENR Administrative Order (AO) 34 series of 1990 - Revised water usage and classification/water quality criteria Section Nos. 68 and 69 and Chapter III of the 1978 NPCC Rules and Regulations.

- DENR AO 35 series of 1990 Revised Effluent Regulations of 1990, Revising and Amending the Effluent Regulations of 1982.

- RA 7160 Local Government Code of 1991 - transfer and implementation of certain DENR functions devolved to the local government units (LGUs); the LGUs provide assistance for proper waste management.

- RA 9003 Ecological Solid Waste Management Act of 2000 ensures the protection of public health and environment through the adoption of a systematic, comprehensive and ecological waste management program.

Additionally, the following Presidential Decrees (PD) provide incentives for biogas projects as solutions to some major problems of pollution control, energy production and food production:

- PD 1068 promotes and gives fiscal support to the production of non-conventional sources of energy, among which is biogas.

- PD 1159, the Agricultural Investments Incentives Law supports biogas works as a forward and backward integration scheme for piggeries and livestock farms because of its energy output, its feed and fertilizer potentials.

Both decrees are implemented with the original Investment Incentive Laws (RA 5186) and the export incentive law (RA 6135), now integrated by PD 1789 as the Omnibus Investment Incentives Act.

The Strategic Agricultural Action Plan of the Philippines likewise recognizes that biogas technology shows great promise in two aspects:

1. First, it promotes the exploitation of methane gas from wastes, hence contributing towards the energy needs and saving on non-renewable resources.

2. Second, the technology promotes better environment through better waste management.

The Action Plan specifies that to promote the technology, the policy should be placed in context with waste management, environmental protection and renewable energy sources.

Consultants concluded that there is a large number of policies that are in line with biogas development. In the next section the findings from the field visits will shed more light on the potential of this technology.

Chapter 8 Field visits

Consultants of this study conducted field visits to the provinces of Bohol, Cebu, Bukidnon, Batangas, and Kalinga, and interviewed key persons from governmental bodies at regions, provinces and municipalities, and with farmer-cooperatives and NGOs. In addition constructors, (non) biogas using households were approached. Finally consultants organized a group meeting with farmers' representatives. Next to that observations were made regarding the social and physical environment to define the technical demand for domestic biogas digesters. The findings of these field visits are presented per province; technical details are provided in the successive chapter.

8.1 Bohol

According to the Provincial Veterinarian Office of Bohol, there are 76,000 backyard and 218 commercial farms on the island. However, in their records it is stated that only about one hundred farmers were raising sufficient livestock for a domestic biodigester.

The office staff mentioned a certain Mr. Mario, who was recognized as a constructor of box shaped biodigesters (technical details shown later in this report). One of his digesters was visited and the user was very pleased with the benefits in terms of manure treatment, fertilizer and energy supply for commercial ends and fuel savings.

Nevertheless, after 2.5 years of operation, she could not recall anyone that had also invested in a digester. The high costs (PHP 80,000) and the limited livestock rearing made such a digester unfeasible for most families in the area. Her digester was actually a gift from one of her family members.

A visit to the family of the constructor indicated that Mr. Mario had only produced a very limited number of digesters in the past years.

The consultant coincidently met with Mr. Silvio and Mr, Paul, former staff of a former UNDP funded biogas project, executed in the early nineties in Bohol. This project was about the introduction and the development of the same box-shaped biodigester. They claimed to have constructed a couple of dozens of these box shaped digesters since 1996 and pointed to the high costs and limited awareness as constrains to wider dissemination.

The consultants concluded that for this province the market potential is marginal due to livestock practices and low income levels. On top of that it was observed this island is endowed with an abundance of biomass that can be used as energy source.

8.2 Cebu

On Cebu island the consultants also met with Mr. Bajenting, a biogas constructor and -consultant from Cebu who is working for the NGO Carats on ecological friendly agriculture. He constructed about 70 Chinese fixed dome model digesters in the last 10 years. In the past, he trained a group of masons in biogas construction hoping this would enlarge the supply side of the value chain. However it did not seem to take off, according to Mr. Bajenting this was due to the low technical skills, lack of commitment from the recruits and the high price of the digester. Also he mentioned the aggregation level of the hog raising units was generally too small. According to Mr. Bajenting

communal pens hosting livestock of different farmers should be introduced to make biogas feasible for more families in Cebu.

The consultants concluded that the market in Cebu is limited due to the high costs and the small number of livestock that a regular farmer raises. The feasibility of bringing livestock from different farmers together under one stable is doubtful, certainly when aiming at a market for a substantial number of biodigesters.

8.3 Bukidnon

The Provincial Veterinary Office of Bukidnon was visited and the head of the office Ms. Diaz was interviewed. According to her, most farmers in Bukidnon are backyard raisers with less than 5 pigs. At the same time she recognized a growing concern of households about fuel collection, because of the increase of land area allocated to pineapple plantations.

In Lantapan municipality of Bukidnon, the agricultural office and one NGO representative were interviewed. The information from this interview indicated that out of 28,000 households of this municipality the lion share raised less than 3 pigs and that vermiculture[9] is widely practiced, eliminating the advantage of manure management as selling point to biodigesters.

Figure 3 Group meeting farmers

In the same province a group meeting was held with 10 commune leaders representing a total of 5,000 farmers. These representatives were considered middle class farmers. They attended the presentation about the benefits and limitations of biogas technology and showed particular interest in the fuel substitution value of biogas. After the discussion that followed, a rough estimate of some 1,500 technical eligible farming households were identified. Cooking on gas derived from manure or even night soil was not believed to pose any problems in terms of social acceptability.

[9] Composting utilizing various species of worms.

However the interview with a reasonably well off, non-biogas using farmer with 3 pigs, proved that there was interest in the benefits but that an investment of PHP 20,000 would already be too costly for the family.

A meeting was held with department of agriculture Lanao del Norte, Region X director Mr. Mahanoy. He was experienced in domestic biogas. Since the 1970s, a number of projects have been executed but no significant quantities of digesters were constructed ever since. He reckoned for the average farmer the number of livestock is too small and the financial means are too limited. He expected the market for biogas to be small, an opinion that was later on shared by his colleague Ms. Ramos.

The consultants concluded that in Bukidnon there might be a niche market for higher income farmers. A follow up survey is needed to be conducted to verify the willingness and ability to invest against the price of a selected biodigester model.

8.4 Batangas

In Batangas a visit was paid to SIDC, a professional and ambitious farmer cooperative with 13,500 members. Mr. Rico Geron, General Manager of this 'social enterprise' explained the need for biogas in terms of environmental protection and told about the former biogas initiatives entailing some 100 digesters. (One industrial sized lagoon digester provided electricity to run the SIDC office.) In the field the consultants witnessed many medium scale hog farms, which manure disposal resulted in a tremendous strain on the environment. According to Mr Geron the number of households rearing between 20 and 50 pigs may add up to some 5,000.

Some of the farmers already attempted to build biodigesters, at the high costs of PHP 60,000 to PHP 120,000, but were largely dissatisfied with the system. Some were poorly built and too small for the daily manure input, resulting in low retention time and an inefficient operation with visible gas production in the effluent. Farmers invested in a biodigester to comply with the policy of "no waste management, no pigs".

Figure 4 Environmental degradation in Batangas

A visit to the area therefore reveals the basic failure of policy as evidenced by (a) the air quality and odor prevailing in the area; (b) the poor condition of the bio-digesters; and (c) the polluted state of the creek that passes through the barangay. The result is dissatisfaction among users even while environmental degradation is not deterred.

Figure 5 Undersized digester; picture of unsatisfied user

In this province the consultants witnessed the unfolding of an environmental hazard caused by intensive hog raising. The bad reputation of biogas technology is associated with the lack of knowledge of technicians and constructors resulting in poor quality digesters. This however can be overcome by introducing a capacity building programme and re-train constructors. The designs needed in this area are of medium scale, allowing influent from 20 to some 300 pigs.

8.5 Kalinga

In the province of Kalinga, consultants witnessed the operation of a number of plastic tube digesters, or Tubular Polyethylene Digester (TPED). The appreciation and operation of this digester was mixed. Like so often, this

Figure 6 Tubular biodigesters

model requires constant maintenance and will only operate well if the user is committed to carry out constant repairs. The quality of the digesters and therefore its reputation are bottlenecks which can be tackled by a robust biogas programme. Stronger materials such as high density poly ethylene may improve the quality, however raise costs as well.

Further it was told by the solid waste management coordinator of Tabuk, Mr Val Pay-Ong, that in this area most of the farmers have around 20 hogs, indicating a potential market for domestic biogas digesters.

8.6 Conclusion of the field visits

Based on the field visits it can be concluded in Bohol and Cebu the potential is very low. Reasons are:

1. Low number of livestock per farming unit
2. Low income level
3. High costs of the digester
4. Low awareness
5. Lack of incentives
6. Availability of fuel wood

Areas recommended for having a closer inspection, namely Batangas, Kalinga and to lesser extend Bukidnon:

1. High number of livestock among farmers
2. Richer farmers
3. Serious environmental problems
4. Recognitions of fuel substitution value and slurry use

For these areas surveys are needed among a larger number of farmers and –representatives to arrive at a solid indication of the potential market and to consider technical and financial requirements for a digester.

Figure 7 Backyard farmers rural Philippines

8.7 Communal biodigesters

A solution to the limited number of livestock per farmer is to bring together livestock from different farmers in one communal shed. In this respect the consultants witnessed spacious set up of villages with large distances between houses, like in figure 6. Under such circumstances households commonly rear only small numbers of livestock which

are free roaming. The concept of communal pig pens will pose difficulties as distances between raising units are far. In practice communal biodigesters encounter considerable challenges in managing equally sharing of benefits and taking care of operation and maintenance.

In the following section the different technologies that are popular in the Philippines are assessed against variables like efficiency, durability and price.

Chapter 9 Biodigester models

In this section the supply side is assessed in terms of efficiency, price, and viability for a larger customers market.

9.1 Technical factors

Consultants found detailed description of national technical standards for different types of domestic biogas digesters, referred to as "Philippine Engineering Standard Agricultural Structures - Biogas Plant"[10]. The formulation of this national standard was initiated by the Agricultural Machinery Testing and Evaluation Center (AMTEC) under the project entitled "Enhancing the Implementation of the AFMA, Through Improved Agricultural Engineering Standards" which was funded by the Bureau of Agricultural Research (BAR) of the Department of Agriculture (DA). Interviewees of different departments however did not seem to be aware of these standards, indicating low awareness and lack of enforcement.

9.2 Construction costs

When taking into account different models of biodigesters in the Philippines, one very important aspect has to be taken into account, which is the absence of bricks in rural areas. Bricks are not available and are only used for the esthetical upgrading of private dwellings, mainly in cities. The consequence of this is that digesters are constructed by concrete, which pushes the price to some 70,000 PHP for a digester. Not so much the price of concrete but the amount needed is responsible for the high costs.[11] All in all this is almost 3 times higher than in other Asian countries, see table below.

[10] With gratitude to Wim van Nes.

[11] Price of a 40 Kg bag of cement in rural Philippines is PHP 220, in Vietnam PHP 138, Indonesia PHP 276 and Nepal PHP 368. See Annex 4 for more details on construction material costs.

Table 11 Costs of biodigesters

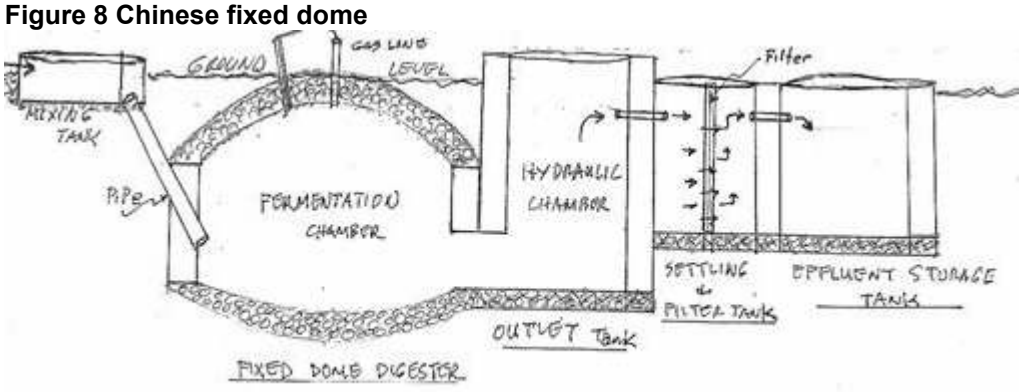
	Investment	Local currency	PHP
Philippines HDPE		[PHP]	70,000
Philippines cement		[PHP]	70,000
Nepal	42,673	[NPR]	28,589
Vietnam	8,000,000	[VND]	24,046
Cambodia	2,052,650	[KHR]	25,915
Bangladesh	26,000	[BDT]	21,138
Laos	4,232,000	[LAK]	26,076
Pakistan	43,351	[PKR]	28,487

A detailed bill of quantities of construction materials and labour is needed to point out exactly what makes this price difference so big. However in Annex 3 the price indications of regular construction materials in rural Philippines are provided. Alternative construction materials and especially synthetics should be considered to lower costs.

Based on the consultants research and field visit observations, there are at least 6 different most popular models in use which are presented below.

9.3 Chinese fixed dome model

Figure 8 Chinese fixed dome

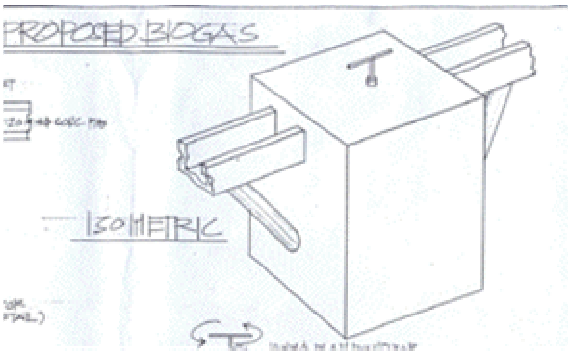


This model is patented after the Chinese fixed dome. Consultants met with Mr. Bajenting, the constructor who built 70 digesters over the last 15 years on the island of Cebu.

The Cavite State University is currently disseminating some 1,000 of these digesters and estimates that local construction cost of this fixed dome biogas system arrives at PHP 10,000 per cubic meter capacity. Thus, an average 6 cubic meter system will cost about PHP 60,000.

Figure 9 Box shape biodigester

9.4 Box-Shaped Digester



The consultants observed several units of box-shaped digester in Batangas and Mindanao. This design was introduced by a UNDP programme in the early nineties and is unique to the Philippines as other countries have adopted circular and dome shape designs.

This model requires relatively more construction materials than dome shaped digesters and has unused spaces in the corners or the box. The flow pattern of the substrate will bypass those corners resulting in low efficiency of the digester compared to its total volume. In Bohol this 6 m^3 model costs 80,000 PHP.

In Batangas the consultants observed similar boxed shape models that were not in a good operational state. The digesters were overfed because the digester volume was too small for the influent. Owners constructed a digester to comply with local regulations rather than investing in a suitable waste treatment/energy solution.

Figure 10 DOST floating drum

9.5 DOST Floating Digester Designs

Consultants observed in Batangas, the floating drum from the Industrial Technology Development Institute of the Department of Science and Technology (DOST-ITDI). Floating drum digesters have the benefit of constant gas pressure and the iron drum is air tight. On the other hand the price is high and transportation of the iron drum is cumbersome. Another concern is that iron is prone to corrosion.

Figure 11 DOST portable biodigester

9.6 The DOST portable system

The DOST-ITDI with floating gasholder is made out of plastic containers that are commonly found in Metro Manila. This is designed to be fed by kitchen waste.

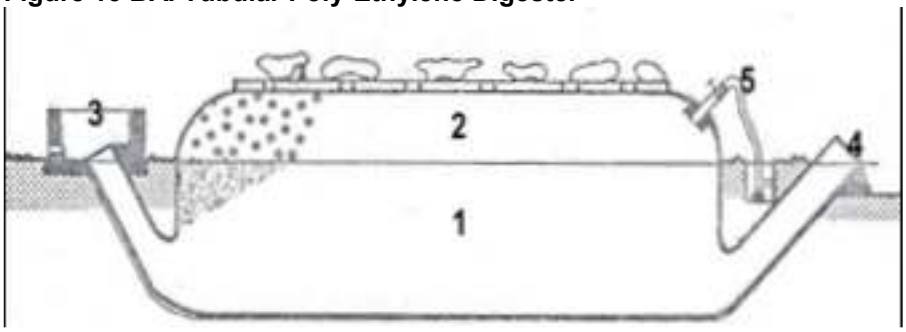
The DOST-ITDI engages with local manufacturers for the fabrication of their systems. The Consultants had the opportunity to visit one user who explained the system was not functioning

any longer; the owner did not attempt to look for problems and solutions. Production price varies from PHP 15,000 to PHP 20,000.

9.7 Tubular Poly-Ethylene Digesters

Tubular Poly-Ethylene Digesters (TPED) have been demonstrated by the Bureau of Animal Industry (BAI) for over 10 years.

Figure 13 BAI Tubular Poly-Ethylene Digester



This locally produced TPED uses low density poly-ethylene (LDPE) sheets formed into tubular shape.

This design has been proven to work in Filipino farms only under constant maintenance and repair as the material is easily torn and is not able to withstand exposure to the sun's radiation. See photograph from consultants in Tabuk, Kalinga. BAI has reported that other areas also have the same malfunctioning problems. Therefore mixed appreciation of this biogas model is felt by the farmers. The price of this model is about PHP 25,000.

Figure 14 Quality problems tubular digester

9.8 High Density Poly-Ethylene

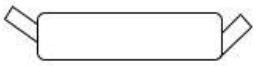
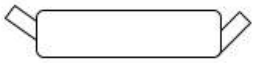
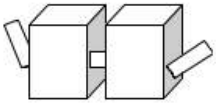
Recent TPED digesters use High Density Poly-Ethylene (HDPE); a more robust material that has been proven in local conditions. This is the same material used by commercial biogas development companies for medium- and large-scale biogas projects.

TPED designs can be implemented very quickly as the biogas digester may be fabricated in an ideal location and transported to the site.

The BAI has now developed several designs that cater to the various market segments for biogas in the country. These designs and their estimated costs (December 2008 cost levels) are shown below.

Table 12 Cost of TPED

Annex E
Biogas Models

Models		Material	effective volume (m^3)	Capacity			Cost ('000)		
				swine (hd)	Catlle (hd)	Poultry (hd)	Material and labor	Plastic	Total
1		PE .06mm 1.2Øm x 10 m	9.0	20	4	1600	20	5	25
2		HDPE 1.0mm 1.5mm 1.5Øm x 10 m	13.2	30	6	2,400	30	45	75
3		HDPE 1.0mm 1.5mm 2.1Øm x 10 m	23.5	52	10	4,160	35	55	85
4.		HDPE $1.0m^3$ drum	1.5	3	-	240	10	8	18

File name Project proposal /Biogas

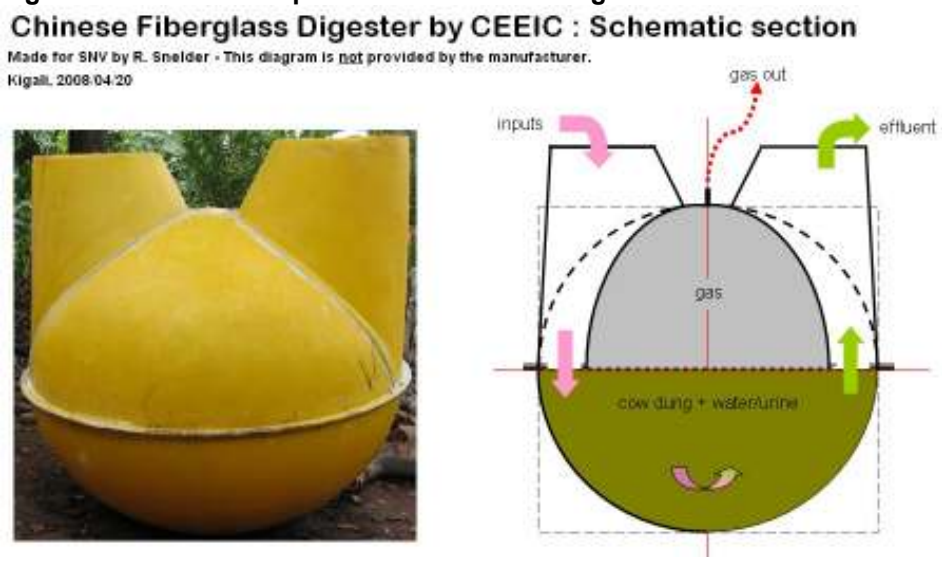
The following observations are made on these designs. TPED model 1 is made of LDPE material at relative lower costs, TPED models 2 to 3 are made of HDPE and although larger in volume, the price does approach concrete fixed dome digesters.

A total of 99 TPED LDPE biogas digesters were reportedly installed nationwide, mostly in smallholder farms. With government support, those were promoted through demonstration projects, conduct of seminars and study tours. Overall, the impact of the TPED to backyard swine raisers has not been very significant.

Figure 15 Tubular biodigesters in Kalinga

The Chinese composite digester has not been observed by the consultants, but considering the lack of bricks this model seems to be a potential alternative to the concrete ones. Composite fixed domes are made of fibre glass and epoxy and are produced in China and Vietnam. These models have also been introduced in the SNV biogas programme in Rwanda were bricks are expensive and/or scarce, like in the Philippines. The digester in Rwanda is imported from China and cost about 70,000 PHP.

Figure 16 Chinese composite fixed dome biodigester



Chapter 10 Integrated Natural Resources and Environmental Management (INREM) Project

The INREM project aspires to implement a biogas development subcomponent within its coverage areas. Therefore consultants analyzed data in those areas in further detail.

The INREM Project Areas include:[12]

1. Chico River Basin (CAR and Cagayan Valley),
2. Bukidnon River Basins (Bukidnon and Misamis Oriental) ,
3. Wahig-Inabanga River Basin (Bohol) and
4. Lake Lanao Watersheds (Lanao del Sur).

Approximately 210,000 household beneficiaries are targeted under the Project. Domestic biogas may be implemented among these beneficiaries with sufficient animal waste from livestock they raise.

Hogs are usually raised in pens that allow for collection of manure, thus making hog farming the best source of feedstock to biogas digesters. The 2002 data on the inventory of hogs and number of farms raising hogs gathered from NSO is presented below.

The following table shows the comparative statistics of these areas. This data may be conservative considering that these are based on 2002 NSO surveys and livestock holders expanded their cattle over the last 8 years.

Table 13 INREM project areas and livestock raising

Region	Population 2000	% Rural Pop	Hog Pop 2002	# of farms	Average Pop/farm	HDI
CAR	**1,365,412**	**64.0%**	**202,631**	**61,861**	**3**	
Abra	209,481	83.0%	33,086	13,297	2	0.636
Benguet	330,129	62.7%	25,205	6,298	4	0.646
Ifugao	161,623	70.4%	29,130	10,155	3	0.461
Mountain Province	140,631	90.9%	22,391	7,472	3	0.570
Kalinga	174,023	74.9%	70,375	14,574	5	0.553
Apayao	97129	87.5%	22,444	10,065	2	0.545
CAGAYAN VALLEY	**2,813,159**	**77.8%**	**538,826**	**151,708**	**4**	
Cagayan	993,580	82.3%	244,768	63,568	4	0.856
Isabela	1,287,575	75.1%	197,810	56,706	3	0.649
Nueva Viscaya	366,962	70.0%	64,669	19,878	3	0.621
Quirino	148,575	78.0%	27,936	10,001	3	0.580

[12] INREMP Project Document

Central Visayas	**5,706,953**	**54.0%**	**579,930**	**222,742**	**3**	
Bohol	1,139,130	76.0%	151,655	69,395	2	0.574
N.Mindanao	**2747585**	**59.5%**	**575,073**	**151,274**	**4**	
Bukidnon	1,060,415	72.2%	258,633	53,383	5	0.569
Misamis Or.	1126215	46.6%	146,101	46,889	3	0.575
ARMM	**2,412,159**	**78.8%**	**37,364**	**13,208**	**2**	
Lanao del Sur	669,072	82.5%	6,830	2,685	3	0.464

Source: NSO, Data/Quickstat & NSO 2002 Census of Agriculture

Based on the data above, the provinces with the highest average of hogs (5) are Bukidnon and Kalinga followed by an average of 4 in Benguet, Cagayan and Northern Mindanao. Considering a minimum requirement of 6 hogs, the distribution around the average will show how many farmers would have enough livestock to operate a digester. This particular figure is commonly difficult to find in agricultural data bases and will solicit for a field survey to assess the situation in reality. Therefore a larger survey is needed to come to a better understanding of the demand.

Chapter 11 Financial analysis

In this section calculations are made to assess investment costs of a biodigester against its financial benefits. The purpose is to arrive at a reasonable price indication at which an investment can be justified. Calculations are making use of the simple payback returns and the Financial Internal Rate of Return (FIRR) and aim at small backyard farmers with 3 hogs and backyard farmers with 6 hogs. This is done to explain from a financial point of view why a biodigester requires a minimum of feedstock and to arrive at an indication of a maximum of investment costs.

The Economic Internal Rate of Return (EIRR), includes the benefits from slurry, time savings and GHG emission reduction. These are not considered as this short study is lacks those data. A future survey should include these aspects as well.

11.1 Backyard farmers raising 3 hogs

Small backyard farmers with little livestock are assumed to belong to a low income class earning < PHP 10,000, and relaying on solid fuels for cooking energy needs as (explained in Chapter 4). Based on consultants' estimates, such a household consumes 4 Kg wood per day, at a price of PHP 5 per Kg.

This results in fuel expenses of PHP 20 per day, or PHP 600 per month and PHP 7,200 per year (This is comparable to fuel substitution values in Cambodia and Vietnam, with 506 and 460 PHP/month respectively[13].)

4 Kg of fuel wood produces energy for cooking with an equivalent of 8 MJ net. The manure production for 3 average pigs generates biogas equivalent to 5 MJ net, substituting just above half the households' daily energy needs. Because hogs are raised for consumption during 'fiestas', the post-fiesta periods will provide little to no gas. Assuming that half of the year the input of manure is close to zero, annual fuel substitution would only arrive at 25% only, and substitutes annually 25% of PHP 7,200, which is PHP 1,800.

It is further assumed a farmer gets interested to invest against a simple payback time of roughly 3 years. For a small farmer this would justify an investment of 3*PHP 1,800= **PHP 5,400**, (far below the price of any biodigester). The internal rate of return is calculated based on an investment of PHP 80,000, a yearly fuel substitution 1,800 and a lifespan of 15 years. Thus for small holders the **IRR is -11%**.

11.2 Backyard farmers raising 6 hogs

For farmers with 6 hogs, the manure will produce biogas with a net energy value of 10 MJ net per day; enough for all energy needs for cooking. Biogas production can fluctuate due to selling and buying of hogs, but can be assumed to be enough the whole year around. The energy substitution for these farmers is assumed to be 100% and the value is the same as for the value for small farmers, namely PHP 7,200.

Taking into account a simple payback time of 3 years, based on fuel savings alone an investment of **PHP 21,600** would be justified. This still comes short to the current price of biodigesters in the Philippines, but comes close to the costs of brick made digesters in other countries.

The internal rate of return is calculated based on an investment of PHP 80,000, a yearly fuel substitution PHP 7,200 and a lifespan of 15 years. For small holders with 6 hogs the **IRR is 3%.**

In the case of holders with larger number of livestock, the remaining gas can be used for cooking pig food, as well as for lighting. Next to that a substantial flow of slurry can be used as fertilizer which in turn will increases crop yields and income. The manure production of semi industrial pens (~150-500 hogs) will, as witnessed in Batangas, may have severe consequences for the air-, ground- and water quality. Biogas technology is in such a context will have additional selling arguments.

[13] SNV Biogas User Survey Vietnam 2009, SNV Biogas User Survey Cambodia 2007.

For a more precise calculation of benefits a biogas user survey is needed so that the benefits of slurry use, time savings, and GHG emission reduction can be quantified.

In conclusion, the high cost of the biodigester is a prohibiting factor to the development of a biogas market. Studies on reducing cost prices of digesters are important to follow. The Biogas Workgroup under the Energy for All initiative is currently assessing such a research; the results should be taken into consideration when a costumer market is defined in a next survey.

Chapter 12 Conclusions and recommendations

The consultants collected data from various sources and analyzed all relevant information leading to the following conclusions and recommendations:

12.1 Livestock and potential demand

Despite the promising statistical data on livestock and the large proportion of backyard scale farmers in the national agricultural sector, the consultants noticed constraints to the feasibility of a biogas programme in the Philippines due to the dominance of holders with small numbers of livestock. Cattle are usually free roaming and poultry is mostly kept in industrial scale units. Hog raisers seems the most promising for biogas, however the mayor share has less than 6 hogs. However there are strong differences among regions.

Recommendation: Based on the field visits of the consultants the following provinces that have merit for further investigation, namely Mindanao, Batangas and Kalinga. The statistical data from the INREMP suggest to also to include the areas of Benguet, Cagayan and to certain extend Northern Mindanao.

12.2 Households and potential demand

Based on this study, the consultants observed that rural Philippines is poor and many farming households will not have the financial ability to pay for a biodigester. This type of farmer is also very likely to have small numbers of livestock. Therefore the target group will be defined in the category of middle class farmers with > 20 hogs.

In many areas throughout the country there is an abundance of biomass for which the argument of fuel substitution is weak. However, middle class and semi-industrial farmers may substitute LPG, which would normally be bought.

Lastly the consultants did not foresee problems in social acceptance for cooking on gas from manure and nightsoil.

Recommendation: Domestic biogas in the Philippines seems to be a niche market for middle class farmers who raise a substantial number of livestock and have the financial means to make the investment. They should be

considered the initial target group and later more challenging market segments could be approached.

12.3 Supply of biodigester in the Philippines

When it comes to an assessment of the supply side consultants met with a number of committed biogas constructors. Despite their efforts, the turnover, let alone profitability, seemed not substantial. The same can be concluded for NGO and governmental initiatives. The main reason is the high price of biodigesters leaving little room to add profit margins to the costs.

Recommendation: Initiatives in biogas technologies should be preceded by a market survey to define viable business opportunities. The costs of biodigesters need to include a fair profit margin for the constructor.

12.4 Biodigester models

An overview of different models is presented in this study report and one important observation was the exceptional high costs of the digesters, namely up to triple of those in surrounding countries. This is primarily explained by the absence of bricks and reliance on costly cement. HDPE tube models came in close range to the price of concrete fixed dome digesters.

Recommendation: Clearly the high costs of the models will prevent the market to develop fast. A market survey should define the maximum costs prospective customers are willing to pay. Based on the current financial analysis this figure would suggest a digester to costs around PHP 25,000. The viability of different –synthetic- digesters need to be investigated further. The Energy for All initiative is at the time of writing starting such a research. Synthetic domestic biodigesters will probably have the advantage above the concrete ones.

12.5 Finance

Based on the calculations made based on estimated fuel substitution values and the costs of a digester in the Philippines it seems the current investment costs hardy justifies an investment in biogas technology. In case a customers demand is identified, the high costs will still likely to prohibit a market to be developed by its own. Therefore innovations on cost reduction should be actively pursued and next to that a subsidy level is deemed necessary to convince prospective customers.

12.6 Institutional set up

At this moment consultants have focused on the market potential rather than on the design of a possible biogas program. However it was noted that from the government side (Department of Agriculture, Energy and Science and Technology and from Universities), the interest to partake in a program was high. It is expected to need to make distinction between "pockets of biogas potential", making a regional set up is more appropriate than a nation wide programmatic approach.

12.7 Next steps to take

The advice of the consultants is to further investigate the market potential of the domestic biogas market in the Philippines.

1) Biogas is considered as a niche market for those farmers engaging in intensive hog raising, that are relatively well off, who purchase fuel and face an eminent waste management problem. A **market survey** is needed to find out the scope of the demand. Such a survey should result in the quantification of households that are willing and able to make an investment in a certain biogas technology. FIRR and EIRR could be used as tools to calculate costs and benefits and its commercial viability and need for subsidies and micro finance.

2) Secondly, and of equal importance, is to assess the price elasticity[14] for such a technology and to consider viable models and different construction materials against the maximum cost price.

3) Thirdly the technical design parameters should be assessed and adapted to the social and physical conditions of the Philippines. It can be expected the biogas market study would indicate a demand of medium scale biodigesters and the need for electricity generators and grid systems.

4) From this point onwards the scope and required key functions like suppliers/constructors, credit providers and support functions like training, quality control, promotion and extension (see figure 1) can be defined. Based on these definitions, suitable stakeholders can be identified in the next stage of project design formulation.

5) Would the scope of such a market justify a biogas programme, it is likely that a firm subsidy component is needed to attract and convince customers as well as micro finance scheme to widen up the market. Possibilities of carbon finance through the compliance and/or voluntary market should be taken into account to (partly) cover these costs.

[14] Price elasticity of demand (PED) is to show the responsiveness of the quantity demanded of a good or service to a change in its price.

Annex 1 Terms of Reference
Study on the Feasibility of a National Programme on Domestic Biogas in the Philippines

1. Brief introduction

In June 2009, the Asian Development Bank (ADB) formally launched the "Energy for All Partnership" that aims to provide access to modern energy to an additional 100 million people in the Asia-Pacific region by 2015. More than 800 million people in the region have no access to energy, and nearly 1.8 billion people still rely on traditional biomass fuels to meet their cooking and heating needs. It is estimated that more than 1.5 million people, mostly women and children, die every year because of the indoor air pollution from the use of biomass fuel.

The Energy for All Partnership will support a number of working groups including one focusing on domestic biogas to be led by SNV Netherlands Development Organisation.

The SNV proposal developed for this working group targets the installation of one million units by 2015/2016 through a market-based approach, providing additional access to energy for about 5 million people. These biogas plants are expected to have significant environmental benefits through reduction of pressure on forests and on the global level by reduction of greenhouse gas emissions. Based on an initial assessment on the technical potential, the Philippines is considered as one of the new countries to be included into the Partnership.

In order to develop a possible programme, a feasibility study on domestic biogas in the Philippines is recommended. This document presents the Terms of Reference (ToR) for such study.

2. Objective of the study

The objective of the study is to assess the feasibility to set-up and implement a national programme on domestic biogas in the Republic of the Philippines.

More specifically, the study will address the following areas:

- Country background including agricultural & livestock sector, energy demand and supply, energy policy and plans;
- History of domestic biogas and experiences with existing, similar projects;
- Potential demand for domestic biogas;
- Financial (FIRR) and tentative economic feasibility (EIRR) at household level;

- Opportunities of using domestic biogas to achieve environmental benefits, in particular through reduction of pressure on forests and the use of bio-slurry to improve soil productivity;
- Possible supply of services for domestic biogas, and if feasible;
- Rough outline for a national programme on domestic biogas, including potential partners and proposed organization structure, in case a national programme appears to be feasible.

3. Activities and methodologies

The following activities and methodologies are proposed:

A. Preparation of a mission to the Philippines by collecting secondary information, contacting key respondents and informants in the Philippines and abroad, and drafting checklists for field visits and interviews;

B. Mission to the Philippines (16 days), to meet key respondents and informants for interview and discussion and to pay field visits to potential areas including biogas plants installed in the past, see Annex 1 for a provisional list. The field visits will be limited to maximum three potential areas. The selection of these areas will be based on statistical data on the density of relevant livestock and preferably include the following areas: Island of Mindanao, Chico River Basin in the Cordillera Administrative Region in Luzon, Wahig-Inabanga in Bohol in the Visayas, and Rio Grande de Mindanao basin and its major tributaries in Mindanao (including Pulangi River that covers upper and lower Bukidnon, Lanao del Sur, Allah Valley and Bualan river, and Cotabato), Upper Bukidnon River Basin in Bukidnon, and Lake Lanao River Basin in Lanao del Sur and in some parts of Lanao del Norte. The mission shall include a workshop to share the preliminary results of the mission with the relevant stakeholders (to be decided in consultation with the ADB) to discuss the possible roles of the different stakeholders as well as the rough outline of a possible national biogas programme;

C. Formulation of the draft study report and submission for comment to Winrock International, SNV, ADB and other relevant stakeholders in and outside of the Philippines;

D. Submission of the final study report by incorporating the comment from the various stakeholders.

4. Expected output

The output on the feasibility study shall be:

- A clear presentation of the preliminary results of the mission with tentative conclusions and recommendations, to be delivered through a

PowerPoint presentation during the stakeholders meeting at the end of the mission in the Philippines, and;

- A well-structured and clearly written report not exceeding 50 pages excluding annexes providing informed recommendations on the possibilities to set-up a national biogas programme in the Philippines. Annex II presents a tentative table of contents for the report.

5. Time schedule

The mission to the Philippines shall be completed within a period of 16 days in October and November 2009. Winrock International, SNV, ADB and other stakeholders will provide within 10 working days comment on the draft report. After that, the final study report will be presented within five working days.

6. Composition of the team

The mission team shall consist of three members: an international team leader, a biogas expert and one independent national expert. Winrock International will contract at their own costs the team leader (to be engaged for 10 days) and two national experts (to be engaged for 30 days) having a profound institutional background on renewable energy in the Philippines. ADB will contract the biogas expert (to be engaged for 25 days) to be proposed by SNV.

7. Required budget and proposed financing

The costs of this study will consist of the fees of the three team members and their costs for travelling and DSA. The estimated expenditures amount to a total maximum of USD 56,600. Financing is proposed through Winrock International (50%) and ADB - Energy for All Partnership (50%).

8. Further arrangements

In the Philippines, the mission will work under the supervision of the team leader of Winrock International. The Biogas Expert will be accountable to the Project Officer under the overall guidance of the Director, Sustainable Infrastructure Division (RSID) of the ADB. The team is free to discuss any matter concerning the assignment with any institution or individual, but is not authorized to make any official commitments on behalf of Winrock International, SNV or ADB.

Annex 2 Schedule of the mission

	Activity	**Persons**
Thursday 19 November		
5.00-16.00	Hanoi-Manila	Bastiaan Teune, team member
17.00-18.00	Welcome meeting	Jim Orprecio, team leader Bastiaan Teune, team member
Friday 20 November		
9.00-12.00	Team meeting hotel room	Jim Orprecio, team leader Grace Yeneza, team member Bert Dalasung, team member Bastiaan Teune, team member
13.10-15.00	Team meets ADB	Ahsan Tayyab, Jiwan Acharya, Sustainable Infrastructure Division Shaanti Kapila, Regional coordinator Energy for All Initiative Cindy Tiangco, Energy for All Initiative
15.15-17.00	Team meets department of Energy; Biomass Energy Management Division	Ms. Ruby de Guzman, OIC Chief of Biomass Division Mr. Josep Calip, Science and Research Specialist Biomass Div.
Saturday 21 November		
7.00-9.30	Travel Manila-Bohol	Jim Orprecio, team leader Bastiaan Teune, team member
10.00-11.00	Visit Provincial Veterinarian Centre Bohol	Ms. Stella Lapiz, Provincial Veterinarian Ms. Lionida Dagoro chief Agricultural Health Division Mr. Daisy Busco planning officer Mr. Dindo Bongalos, agricultural pasture development Mr. Romy Garcia chief

		Administration office
14.00-15.30	Visit biogas household	Ms. Anriza Domagot, digester owner
16.00-17.00	Biogas constructor of box shape model	Ms. Eliza Ochoco (wife of Mr. Mario Ochoco, biogas constructor in Bohol)
18.00-19.30	Biogas project Bohol UNDP 1996 and biogas enthusiasts	Mr. Salvio Makinano Mr Paul Sambas
Sunday 22 November		
8.00-15.00	Travel Bohol-Cebu-Mindanao	Jim Orprecio, team leader Bastiaan Teune, team member
10.00-11.00	Biogas consultant NGO CARATS in Cebu	Mr. Bobby Bajenting, biogas consultant for NGO CARATS on natural farming
Monday 23 November		
7.30-10.00	Travel Cagayan de Oro-Bukidnon province	Jim Orprecio, team leader Bastiaan Teune, team member
10.00-11.00	Provincial Veterinary office Bukidnon	Dr. Nancy Diez, Head of Office
13.00-14.15	Lantapan municipality, Agricultural Department	Mr. Bayani Santos, head of Agricultural Department Mr. Norberto Contreras, president ALSA Kalikupan - NGO on environment
14.30-16.00	Group meeting farmer representatives	12 participants representing 4 "barangas" and 2 NGOs, total 5,000 households
16.15-16.45	Interview non-biogas farmer	Ms. Soledad Opos
17.00-20.30	Travel Lantapan-Cagayan de Oro	Jim Orprecio, team leader Bastiaan Teune, team member
Tuesday 24 November		
10.00-11.15	Department of Agriculture Lanao province, Region X	Mr. Constantino Maghanoy, Asst. Regional Director, DA Region 10
12.00-18.00	Travel Mindanoa-Manila	Jim Orprecio, team leader Bastiaan Teune, team member

13.00-14.00	Airport meeting Regional Department of Agriculture and Central Mindanao University	Ms. L. Ramos, Director Dept. of Agriculture Region X Mr. Rodrigo Malunhao, Sr. President, Central University Mindanao
Wednesday 25 November		
9.00-12.00	Team meeting	Jim Orprecio, team leader Grace Yeneza, team member Bert Dalasung, team member Bastiaan Teune, team member
13.00-17.00	Biogas research Ministry of Science and Technology	Grace Yeneza, team member Bert Dalusung, team member
13.00-17.00	Work plan	Jim Orprecio, team leader Bastiaan Teune, team member
17.00-19.00	Team meeting	Jim Orprecio, team leader Grace Yeneza, team member Bert Dalusung, team member Bastiaan Teune, team member
Thursday 26 November		
6.30-9.30	Travel Manila-Batangas	Grace Yeneza, team member Bastiaan Teune, team member Mr. Ferdi
9.30-11.15	Cooperative on SIDC 13,500 farming members 100 digesters and one lagoon	Mr. Rico Geron, General Manager Ms. Marie Fe, CEO assistant
11.30-12.00	Visit biogas user 10 m3	Ms. Edna Olgado
12.15-12.30	Short visit biogas user 15m3	Name unsatisfied user due to too small digester
13.00-13.30	CIGAR lagoon type digester 75 Kw	Technician
14.00-17.00	Travel Batangas-Manila	Grace Yeneza, team member Bastiaan Teune, team member Mr. Ferdi
Friday 27 November		
Time	Travel Manila-Kalinga	Bert Dalasung, team

		member
8.30-10.00	Planet Finance on micro finance for biogas costumers	Grace Yeneza, team member Bastiaan Teune, team member Mr. Philippe Geang, Microfinance Constultant
10.00-12.00	Preparing ppt ADB	Grace Yeneza, team member Bastiaan Teune, team member
13.00-14.30	Meeting and presentation ADB	Grace Yeneza, team member Bastiaan Teune, team member
15.00-16.30	Department of Agriculture	Cindy Tiangco, Energy for All Initiative Grace Yeneza, team member Bastiaan Teune, team member Mr. Carlos Magnaye, OIC, Planning and Programming Division Mr. Fernando Flores, Project Dev't Officer Ms. Maria Kris Monzales
Saturday 28 November		
9.00-17.00	Work out data and reporting	Bastiaan Teune, team member
Sunday 29 November		
	Free day	Bastiaan Teune, team member
Monday 30 November		
10.00-18.00	Travel Manila-Hanoi	Bastiaan Teune, team member

Annex 3 Bill of materials in rural Philippines

PARTICULARS	UNIT	UNIT COST (PhP)
Portland Cement, 40 kgs	bag	220.00
Sand	cubic meter	600.00
Gravel (1-2 cm diameter)	cubic meter	700.00
Clay Brick (2"x8")	piece	12.00
13mm diameter GI Pipe Sch. 40	piece	315.00
9mm x 6m Reinforced Steel Bar	piece	100.00
150mm diameter PVC pipe		
10' length	piece	750.00
20' length	piece	1,500.00

Price indications 2010

Annex 4 Map of the Philippines Backyard Hog Raisers
With kind support of Ubo Pakes, www.gis-tm.com