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PoA CDM Manual

Mini Biogas Plants for Households

GFA Envest, Germany

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PoA CDM Manual

“MINI BIOGAS PLANTS FOR HOUSEHOLDS”

**DESIGNED WITHIN THE FRAMEWORK OF THE STUDY
“POA CONCEPT DEVELOPMENT FOR THE USE OF BIOGAS INSTALLATIONS IN SMALL AND MEDIUM SIZED PIG FARMS FOR A DECENTRALISED ENERGY SUPPLY IN VIETNAM”**

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The basis for the development of the Manual has been the PoA Blueprint Book published by KfW (2009) whereby the topic of biogas for households is further elaborated.
A unique contribution came from the Netherland´s Development Organization (SNV), bringing in their experience from operating some of the largest biogas programmes in the world.

Authors

Blank Daniel

Brockmann Ksenia

Burian Martin

Foerster Elke

Kapor Zoran

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LIST OF ABBREVIATIONS

ADB	Asian Development Bank
BP	Biogas Program
BPD	Biogas Program Division of the SNV Biogas Programme in Vietnam
BUS	Biogas User Surveys
CDM	Clean Development Mechanism
CDM EB	CDM Executive Board
CNECB	CDM National Executive and Consultative Board
CERs	Certified Emission Reductions
CO_2	Carbon Dioxide
COP	Conference of the Parties to the UNFCCC
CPA-DD	CDM Programme Activity Design Document
DGIS	Directorate General for International Cooperation
DNA	Designated National Authority
DOE	Designated Operational Entity
ERPA	Emission Reduction Purchase Agreement
EUR	Euro
GEF	Grid Emission Factor
GS	Gold Standard
ICD	International Cooperation Department
IRR	Internal Rate of Return
LoA	Letter of Approval
LoE	Letter of Endorsement
ODA	Official Development Assistance
NRB	Non Renewable Biomass
OECD	Organization of Economic Cooperation and Development
PDD	Project Design Document
PIN	Project Identification Note
PoA	CDM Programme of Activities
PoA-DD	PoA Design Document
SCUK	Steering Committee for Implementing the UNFCCC and Kyoto Protocol
SSC	CDM Small Scale (Methodology/Project/PoA)
tCO_2e	Tons Carbon Dioxide Equivalents
UNFCCC	United Nations Convention on Climate Change
USD	US Dollar
VERs	Verified Emission Reductions
VND	Vietnamese Dong

1 INTRODUCTION

1.1 Objective of the manual

The PoA CDM Manual "Mini biogas plants for households" has been developed as part of the Study "*PoA concept development for the use of biogas installations in small and medium sized pig farms for a decentralized energy supply in Vietnam*", supported by the International Climate Protection Initiative of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). The manual was designed based on the lessons learned during the study development, as well as on the experience of one of the two largest biogas programmes of SNV, namely progammes in Nepal and in Vietnam. It further elaborates on the summarized discussion of the PoA approach provided in the PoA Blueprint Book (KfW, 2009).

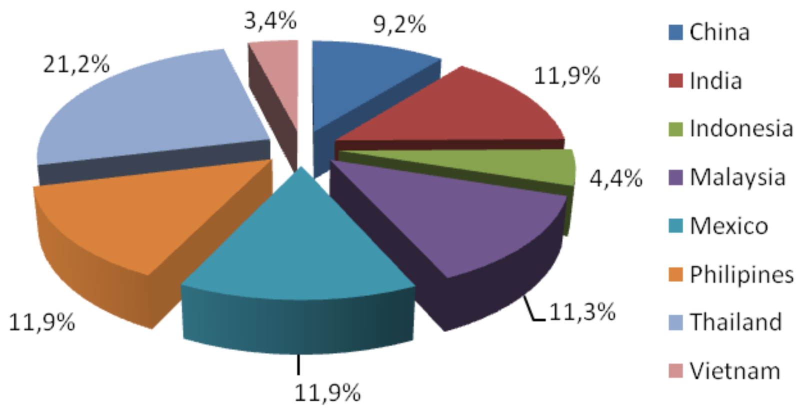
The objective of the manual is to support the development of biogas programmes as CDM PoA and to assist in determining the most suitable set-up for the biogas programme. Although hopes are high towards the Programme of Activities approach bringing in micro size projects under the CDM mechanism, developers are still facing numerous obstacles. In order to reach the critical number of participants, the biogas programmes for households often depend on a monetary incentive for the participants. The high programme costs can only be partly reimbursed via the PoA carbon finance. However, the high risk involved with the lack of experience with PoA approach and EB rules and procedures, presents a significant obstacle for its application. We hope that the lessons learned described in this manual will facilitate the broader application of PoA.

1.2 CDM Biogas projects

1.2.1 Overview of the existing biogas projects

The number of biogas projects that are under validation, requesting registration or registered is 516, or 11.6% of the CDM projects (UNEP Risoe, March 2009). However, the highest number of biogas projects is concentrated in 5 countries, namely: Thailand, India, China, Malaysia and the Philippines.

Figure 1: Biogas projects in 8 countries that host together 85% of the all biogas projects



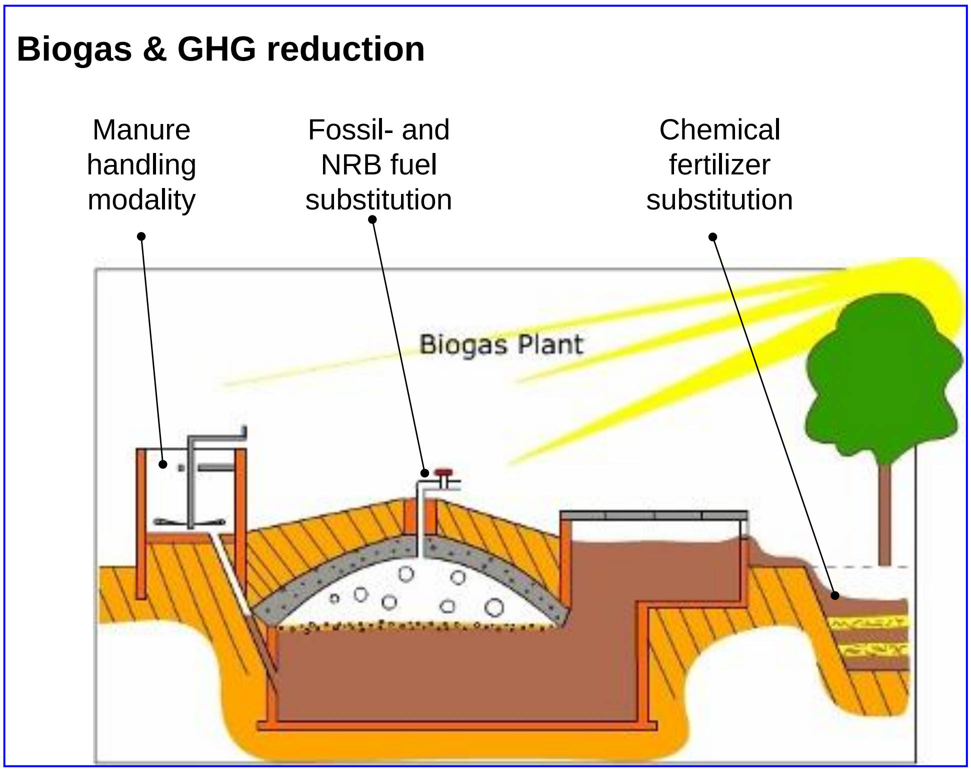
Source: UNEP, Risoe, 2009

Most of the registered projects are situated on the commercial livestock farms and the main emission reduction takes place due to the change of the manure management as well as from fuel switch in those cases where biogas is used for energy generation. By installing the biogas unit the animal manure that was previously deposited in an open lagoon in the baseline scenario is fermented in the biogas digester and the methane emission is avoided. The generated biogas can be either flared or used for energy generation. The average methane content of the biogas is 60-65% and the energy value 6-6.5 kWh/m^3. Biogas can be used to replace fossil fuels for heating purposes, or for producing heat and electricity by introducing a CHP unit. Apart from the benefits of replacing fossil fuels and improving the manure management system, the by-product after the fermentation of the manure is a digestate (bio-slurry) which could be used as high nutrient organic fertilizer.

1.2.2 Emission reduction from mini biogas installations in a household

Domestic biogas installations reduce greenhouse gas (GHG) emissions in three ways: i) by changing the manure management modality; ii) by substituting fossil fuels and non-renewable biomass for cooking (and to a smaller extent for lighting) with biogas, and; iii) by substituting chemical fertilizer with bio-slurry.

Figure 2: Schema of the GHG reduction by biogas plant installation



Source: SNV, 2005

i) **Emission reduction by change of manure management method** depends on the method used before the biogas installation. Each manure management system is characterised by the Methane Conversion Factor. The MCF defines the portion of methane production potential. In general, in anaerobic conditions the MCF is higher than in aerobic systems with all its intermediary levels.

ii) **The substitution of fossil fuels (so called "Fuel-switch")** for cooking with biogas reduces the GHG emissions from fossil fuel consumption or electricity (partially) produced from fossil fuels. The amount of emission reduction depends on the amount of fossil fuels replaced, and the type of fossil fuel replaced (decisive is the carbon intensity of the fuel type). In case biogas replaces grid electricity, e.g. by biogas lamps, the emission reduction depends on the grid emission factor (calculated according to CDM regulations). A part from the fossil fuels, biogas can also replace the non-renewable biomass and claim emission reductions.

iii) **Substitution of chemical fertilizer with bio-slurry.** Bio-slurry is the by-product of biogas production and is a solid and fluid product of substrate decomposition in the fermenter. It can be applied as organic fertilizer and thus replace mineral fertilizers. The substitution of mineral fertilizers entails an emission reduction, but due to complicated monitoring this component is usually not taken into account in household biogas projects.

1.3 PoA vs. standard CDM approach

The Programmatic Approach was officially established in 2007 by the adoption of Guidelines and Procedures for PoA by the CDM EB. Due to high transaction costs small single CDM projects had previously hardly been represented in the CDM portfolio. The PoA approach was designed in order to bring in the possibility for small projects. With the PoA approach the project approval process for many individual activities that are distributed over space and time are brought together. The transaction costs for small-scale CDM projects include: PDD development costs, validation costs, registration costs, monitoring, verification and CERs issuance costs. Only the registration and CERs issuance (administration fee) costs are dependent on the project size (amount of generated CERs). Due to this fact, projects on micro level, like household and small industry level are burdened with nearly the same transaction costs as other small scale projects. One of the alternatives designed to lower the transaction costs in the standard CDM approach was bundling of projects. The differences between bundling and PoA approach will be elaborated later in the text.

A CDM PoA occurs at two levels: at the program level and at the activity level. At the program level, the PoA is the organizational and financial framework that provides structure to the activities, and is managed by a coordinating entity for a period of no longer than 28 years. At the program activity level, a single measure or a set of measures to reduce GHGs is applied to many plants/installations of the same type over the time life of the Program. A CDM PoA is considered: "*a voluntary coordinated action by a private or public entity which coordinates and implements any policy/measure or stated goal (i.e., incentive schemes and voluntary programs), which leads to GHG emission reductions or net GHG removals by sinks that are additional to any that would occur in the absence of the PoA, via an unlimited number of CDM program activities (CPAs)*" (Annex 38, EB32). On the other side, a CPA is more similar to a standard CDM project in the sense that both must comply with procedures and modalities of the CDM and each must include an activity that has a direct, real and measurable impact on emission reductions. By definition (Annex 38, EB32), a CPA is: "*a single, or a set of interrelated measure(s), to reduce GHG emissions or result in net anthropogenic greenhouse gas removals by sinks, applied within a designated area defined in the baseline methodology*".

Table 1: Advantages and disadvantages of the pCDM compared to standard CDM

Characteristic	Description
Advantages	
Multiplicity of activities to reduce GHG distributed in time and space	Numerous activities are participating in the program and resulting in GHG emission reduction in multiple sites over lifetime of the program. The sites could be located in one or more countries.
One managing / coordinating entity, many implementers	The program is coordinated or managed by one entity, which can be private or public, and does not necessarily achieve the reductions but promotes others to do so. The coordinating entity is responsible for the CERs distribution and communication with the EB.
Duration (PoA and CPA)	The length of the PoA is up to 28 years (60 for A/R projects). The crediting period of a CPA is either a maximum of seven years (twenty for A/R) project activities) which may be renewed at most two times, or a maximum of ten years (thirty for A/R) with no option for renewal. [1]
Size	For SSC pCDM only the individual CPAs have to be under the SSC threshold, while the overall Program size can go beyond.
Monitoring and verification	The total volume of emission reductions to be achieved by a program may not be known at the time of the registration. Each CPA has to be monitored according to the methodology and sampling procedures could be applied for monitoring and verification purposes.
No registration for CPAs	After the registration of the PoA individual CPAs are not required to request registration. Instead the DOE includes the CPA after a check that the CPA follow the rules for inclusion in the PoA.
Can run in more than one country	A PoA can run in more than one country providing that the Letter of Approval from each of the countries is obtained.

[1] EB 32, Annex 38

Disadvantages	
Starting date of an CPA	In contrast to the standard CDM approach where the starting date of a project activity can be before the project registration[2], the earliest starting date of a CPA can be the commencement of validation of the programme of activities, i.e. the date on which the CDM-POA-DD is first published for global stakeholder consultation of a PoA[3].
Revalidation of the PoA due to methodology revision	The PoA procedures require that in the case the methodology is revised after registration of the PoA, the PoA has to be adjusted accordingly. All changes made to the PoA require reassessment and validation by the DOE and approval from the EB.[4]
Combination of methodologies needs an approval from the UNFCCC Secretariat	In case a combination of approved methodologies is used for the PoA development, the DOE needs to submit a request for approval of the application of multiple methodologies to the UNFCCC Secretariat. Based on the request the Panel or Working Group evaluate if the combination is sufficient to address all project emissions and leakages that may occur as a result of the implementation of the CPA.[5]

As it can be seen from the table, the programmatic approach has significant advantages for small sized projects compared to the single CDM approach. Transaction costs are reduced under the pCDM and from this perspective the approach achieves similar objectives like bundling of small-scale projects. However, there are significant differences between the PoA approach and bundling of SSC projects[6]:

[2] In case the project start is before the validation the prior consideration of the CDM has to be proved following the "Guidelines on the demonstration and assessment of prior consideration of the CDM" EB 49, Annex 22

[3] EB 47, Annex 29
Exemption to the rule: PoAs that undergo the validation until 31st December 2009 may include CPAs with the starting date between 22nd June 2007 and the date of the validation; EB 47

[4] Procedures for registration of programme of activities as a single CDM project activity and issuance of CERs for a programme of activities, Version 02, CDM EB

[5] EB 47, Annex 29 and 31 ("Procedures for Approval of the Application of Multiple Methodologies to a Programme of Activities"")

[6] CDM4CDM Working Paper No. 3, 2007

Table 2: Differences between bundling and PoA approach

	Bundle	Program
Sites	Ex–ante identification of exact sites	GHG reductions must be estimated ex-ante. Exact sites may not be known, but type and maximum potential volume is known.
Project participants	Each single activity is represented by a CDM project participant.	Only the entity implementing the program represents the project activity as a CDM project participant.
	Project participants are identical to entities achieving reductions.	The project participant does not necessarily achieve the GHG-reducing activities, but rather promotes others to do so.
Project activities	Each activity in the bundle is an individual CDM project activity	The sum of all individual activities under the program is the CDM project activity.
	Composition does not change over time	No pre-fixed composition (uptake of an incentive could be unknown)
	All projects in a bundle must be submitted and start at the same time	Program is validated and registered based on identification of targeted activities. Actual reductions are not confirmed until verification, and that can be done by sampling.
Size	The size of the bundled small-scale activities has to be under the standard small-scale threshold	The size of the single CPAs have to be below the small-scale threshold, allowing the overall PoA size to be unlimited

Although until today there is only one PoA project registered with corrections, a significant break-through at least on level of the rules and procedures has come on the 47th EB meeting in May 2009. The major introduced modifications are:

- The combination of two and more methodologies for the baseline was allowed;
- The DOE liability for the erroneous inclusion of a CPA has been limited to one year after the inclusion of a CPA into a registered CPA, or six months after the issuance of the CERs for that CPA, whichever is later.
- Debundling: in case each of the subsystems/measures within a CPA has an installed capacity of less than 1% of the prescribed SSC threshold for the given methodology, than that CPA of a PoA does not have to perform the debundling check.

At the time of writing this manual eleven PoA projects were under validation and one has been registered with corrections [7]:

Table 3: PoA CDM project under validation and requesting registration

Project name	Country
Under validation	
Installation of Solar Home Systems in Bangladesh	Bangladesh
Methane capture and combustion from Animal Waste Management System (AWMS) of the 3S Program farms of the Sadia Institute	Brazil
New Energies Commercial Solar Water Heating Programme in South Africa	South Africa
Uganda Municipal Waste Compost Programme	Uganda
Promotion of Energy-Efficient lighting using Compact Fluorescent Light Bulbs in rural areas in Senegal	Senegal
Masca Small Hydro Programme	Honduras
Solar Water Heater Programme in Tunisia	Tunisia
Energy Saving Renovation Programme at Instant Coffee Production Factories of Dongsuh Foods Corporation in Korea	South Korea
Installing Solar Water Heating Systems in the South of Viet Nam	Vietnam
Hydraulic rams for irrigation and domestic water supply in Zhejiang, China	China
CFL lighting scheme – "Bachat Lamp Yojana"	India
Registered with corrections	
CUIDEMOS Mexico (Campana De Uso Intelegente De Energia Mexico) – Smart Use of Energy Mexico	Mexico

[7] UNEP Risoe, August 2009

2 BIOGAS PROGRAMME FOR HOUSEHOLDS

2.1 Key components of a biogas programme for households

In order to set-up a sustainable biogas programme for households the maximum of institutional capacities available in the programme's geographical activity area (e.g. country) has to be mobilized. The goal of the programme is to promote the dissemination of biodigesters that utilize manure at household level and/or to reduce the utilization of fossil fuels, finally establishing a developed, sustainable and commercial biogas sector.

The first step is the participatory assessment of the potential demand for interventions of third parties and of possible constraints faced by service suppliers. Based on the results a national programme can be outlined, together with objectives, targets, institutional arrangements, costs and financing (SNV, 2009).

The programme has to be designed accordingly in order to overcome the barriers that prevent dissemination of biodigesters in households[8]:

- **Initial costs barrier** – provision of subsidy to lower the initial investment costs (could be in combination with a microcredit).
- **Technological barrier** – the design of the biodigester has to be adjusted to the needs of the participants. Also the quality standard has to be implemented and training for the users about the biogas operation provided.
- **Information/behavior barrier** – information about the benefits of the biogas, awareness raising and promotion is required.

The technology has to be selected together with the biodigester (component) producer(s) in order to ensure quality standards. High and constant quality is quite a decisive factor since the living time of a programme is typically long. These quality standards should also be defined for adjacent equipment like stoves or biogas lamps.

[8] PoA Blueprint book, KfW 2009

The main components of a biogas programme are outlined in the table below:

Table 4: Objectives of the main components of a biogas programme

Component name	Component objective
Promotion	To stimulate demand, informing beneficiaries and stakeholders on the benefits and costs of domestic biogas.
Financing	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.
Construction and After Sales Service	To facilitate the construction of biogas plants with appropriate technology and ensure their continued operation.
Quality Management	To maximize the effectiveness of the investment made by the biogas owners and to maintain consumer confidence in domestic biogas technology.
Training	To provide the skills for business people to run biogas SMEs, for biogas users to be able to operate their plants effectively.
Institutional Support	To maximize the ability of key biogas related institutions to provide the services and support and integrate domestic biogas in policies and laws required by the biogas sector to facilitate access to domestic biogas and the development of quality biogas products.
Monitoring and Evaluation	To identify programme progress and impact on stakeholders/other aspects in order to facilitate knowledge transfer.
Research and Development	To increase knowledge about domestic biogas issues to maximize effectiveness, quality and service delivery of the biogas programme.

Source: SNV, 2006

Figure 3: Short description of the SNV Biogas programme in Vietnam

The Vietnamese and Netherlands Governments signed an MoU for the implementation of a household biogas dissemination programme in 10 provinces of Vietnam in January 2003. The ***"Support Project to the Biogas Programme for the Agricultural Sector in some Provinces in Vietnam" known as "BP I"***- uniquely joined Vietnam's technical knowledge on fixed dome digester design and construction with Netherlands' experience with large-scale dissemination of household biogas particularly in Nepal. The total number of biogas digesters of 18,000 was completed as programmed during the first phase up to January 2006. The remainder of 2006 was used as an "interim phase" while waiting for the conclusion of the negotiations to start Phase II. This interim phase started late (May 2006) with the construction target of 9,550 biogas digesters, of which 8,777 were completed. In July 2006 the Ministry of Agriculture and Rural Development in Vietnam (MARD), DGIS and SNV signed an MoU to support the second phase of the biogas programme (BPII). This phase II (2007-2010) aims to expand programme operations in almost the entire country (58 provinces) to build a total of 140,000 biogas digesters. Till the end of October 2008, the project has supported construction of 50,000 biogas plants, provided training for 364 provincial and district technicians, 687 biogas mason teams, and organized numerous of promotion workshops and trainings for biogas users. 99% of the installed plants are reported to be fully operational. The project was awarded with Energy Globe Award 2006, which is the most reputable and honored award to project having significant contribution to reduce "global warming.

Source: Various SNV publications

The design of a biogas programm has to ensure that all actors have a strong inherent interest in participating. The incentive for the actors can either be financial (grant, loan subsidy for the households) or non-monetary (health of family members, expansion of client base for financial institution, cost-recovery for maintenance, quality improvements of suppliers or technical assistance etc.). These incentives are success factors for the programme (KfW PoA Blueprint Book, 2009).

Figure 4: Key success factors of SNV biogas programme in Nepal

Mendis and van Nes (2001) summarise the key success factors of the BSP Nepal as follows:

- Identifying the most appropriate and cost-effective design for the product before launching a wide-scale dissemination programme;
- Establishing and enforcing solid design, quality and service criteria that will ensure the reliable and cost-effective operation of installed plants;
- Identifying the key institutional players and assisting in strengthening the capacity of these players to effectively carry out their respective roles;
- Securing the commitment and support of financial institutions to work in close partnership for the dissemination and financing of the product;
- Designing and applying financial incentives needed to stimulate the market and attract buyers in a manner that is uniform, transparent, and easy to administer.
- Ensuring that financial incentives reach the target groups to bring down prices of the biogas plants.
- Providing technical and management support to all key players;
- Instituting coordinating committees to ensure the cooperation and partnership of stakeholders, and
- Sufficient resources for product support and market development.

2.2 Technology of the mini biogas plants

Biogas is generated from digesting human excreta, animal excreta or other organic substances (agricultural product). Biogas consists of Methane - CH_4, accounting for 60-70%, Carbon dioxide – CO_2, accounting for 30-40%, and Nitrogen- N_2 and Hydro Sulphate – H_2S, accounting for the rest. The calorific value of biogas is 4,500-6,000 cal/m^3, which is roughly equivalent to energy obtained by burning 1 liter of ethanol, 0.8 liter of gasoline, 0.6 liter of crude oil or 1.4kg of char coal.

Today there are many biogas production technologies used for households: plastic digester, pipe digester, solid dome type, etc. However most of the biogas programmes apply the **solid dome type** due to the high-safety level, relatively easy construction, high production capacity and long lifetime. The main parts of the solid dome biogas plant are the digester and the compensation tank. In the digester the appropriate conditions for anaerobic digestion are maintained and biogas is produced. The compensation tank has the task to create gas pressure by retaining effluent coming out from digester when gas is produced. In this way the produced biogas is under pressure and distributed via the pipes to the end-use point. The hemi-spherical fixed dome plants are made on-site, entirely out of brick work.

Upon the requirement of the households, biogas plants range in digester size from 4m^3 to 20m^3. The additional appliances, also usually locally available, consist of gas pipe, main valves, stoves and gas lamps. The produced biogas is mainly used for cooking using single stove and double stove cookers. Also the biogas can be used for water heating and lighting, using biogas lamps which can replace a light bulb of 25 W (SNV; 2009).

Apart from biogas, a side product is **bio-slurry**, a mixture of solids and liquids produced by the decomposition of the organic substrate. Bio-slurry is a highly nutrient organic fertilizer and can replace many types of mineral fertilizer in agricultural production.

The amount of produced biogas depends on the origin and amount of manure discharged into the unit, as well as the ratio manure/water. The gas yield per unit of feedstock, however, is widely constant and is presented in the table below.

Table 5: Gas yield per feedstock

Fermentation material	Amount of waste per day (kg/animal head)	Dry matter content (%)	Carbon/ nitrogen (C/N) ratio	Gas yield of the feedstock (liter/kg/ day)
Manure				
Cow	15 - 20	18 - 20	24 - 25	15 – 32
Buffalo	18 - 25	16 - 18	24 - 25	15 – 32
Pig	1.2 – 4.0	24 - 33	12 - 13	40 – 60
Poultry	0.02 – 0.05	25 - 50	5 - 15	50 - 60
Human	0.18 – 0.34	20 - 34	2.9 - 10	60 - 70
Plant				
Fresh water hyacinth		4 - 6	12 - 25	0.3 – 0.5
Dry paddy straw		80 - 85	48 - 117	1.5 – 2.0

Source: SNV Biogas programme in Vietnam

2.3 Benefits of the biogas plant installation for households

A high quality biogas plant needs minimum maintenance costs and can produce gas for at least 15-20 years without major problems and re-investments. On **household level**, biogas plants provide clean cooking energy, contribute to health improvement through a better hygienic situation and reduce the time needed for biomass collection, especially for women. On **programme level**, the benefits are in the first place creation of new employment/work and environmental situation improvement.

Figure 6: Benefits of an average biogas plant in Nepal

An average biogas plant in Nepal serving a household of 6 or 7 people generates the following, main benefits:

- Saving of traditional cooking fuel such as firewood: 2,000 to 3,000 kg/year
- Reduction of workload: 1.5 to 3 hours/day
- Reduction of greenhouse gasses: up to 5.0 ton of CO2 equivalent/year
- Reduction of indoor air pollution: 3 persons/household are less exposed
- Toilet attachment: up to 65% of all biogas households have latrines connected to the biogas plants
- Potential increase of agricultural production or saving on the use of chemical fertilizer (biogas plants produce very high quality organic fertilizer – the bio-slurry): up to 40%
- Improved sanitation, less pollution to underground water

Source: SNV Nepal

The benefits of the biogas plants in households can be divided into economic, social and environmental. It is important that these benefits are specified and verified in a participatory manner with the target group. The methodology for ‘Stakeholder Consultation Workshops’ as provided by the Gold Standard (GS: http://www.cdmgoldstandard.org/) is a suitable approach.

Economic benefits

On the household level energy expenses are significantly reduced. Also labour required for the collection of firewood and transport of fossil fuels is reduced and can be used for productive works instead. By the replacement of mineral fertilizers with bio slurry, expenses are reduced.

On the programme level the biogas sector development opens new employment possibilities, especially in rural areas.

Figure 7: Economic benefits of the biogas plants within SNV BP in Vietnam

The economic benefits in the SNV BP in Vietnam come from the reduced costs for fuels, namely coal and firewood. The estimated amount of cost savings for energy is 1.5 – 2 million VND/year. Taking account that the investment costs are around 9.8 million VND, the repayment period is 5 years.

Source: BUS 2005, SNV Vietnam

<u>Social benefits</u>

The social benefits of the biogas plants are significant. The reduction of workload, particularly for women and children, increases opportunities for education and other social activities. Also the sanitary conditions improve resulting in less gastro enteric diseases.

On the programme level, the awareness of sustainable farming and animal husbandry practices are increased.

<u>Environmental benefits</u>

By substituting conventional fuels and synthetic fertilizer, and changing traditional manure management systems, biogas installations reduce the emission of greenhouse gases. Improved manure management practices reduce ground and surface water pollution and odour. The bio-slurry application improves soil texture thus reducing degradation. The reduction of firewood use contributes to checking deforestation and reduces forest encroachment.

Domestic biogas installations also **contribute to reaching the UN Millennium Development Goals.** In the table below the MDG addressed by domestic biogas installations are listed.

Table 6: Domestic biogas installations and the Millennium Development Goals

Millennium Development Goal	Benefits from the domestic biogas installations
MDG 1 Eradicate extreme poverty and hunger	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
MDG 3 Promote gender equality and empower women	Biogas can provide light that helps women and girls to extend the amount of time that they can study. 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
MDG 4 Reduce child mortality	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 surroundings, lowering the exposure of household members to harmful infections especially children who spend extended periods in the farm yard. 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.	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 to polluted water and poor sanitation
MDG 7 Ensure environmental sustainability	Large scale domestic biogas programmes positively influence national policies on sustainable development (e.g. agriculture, forestation, poverty reduction) Biogas programmes usually comply with and support government policies and programmes that have positive environmental impacts including pollution control, green house gas emission reduction and forestation - Biogas reduces fresh water pollution as a result of improved management of manure. - Connection of the household toilet to the biogas plant significantly improves the sanitary conditions in the farmyard therefore reducing the risk of water contamination.

Source: SNV Vietnam

2.4 Financial requirements

The costs of a biogas programme depend on the costs of the biogas plant installation, support activities and programme implementation[9]. The investment costs for a biogas plant are usually covered by the households, while the programme provides an incentive to install the biogas unit (e.g. a subsidy covering part of the investment costs) and supporting activities, such as trainings for biogas users and biogas constructors, after sale services etc.. The costs for the progamme coordinator can be covered from various sources. The sale of CERs can be one of the financing mechanisms.

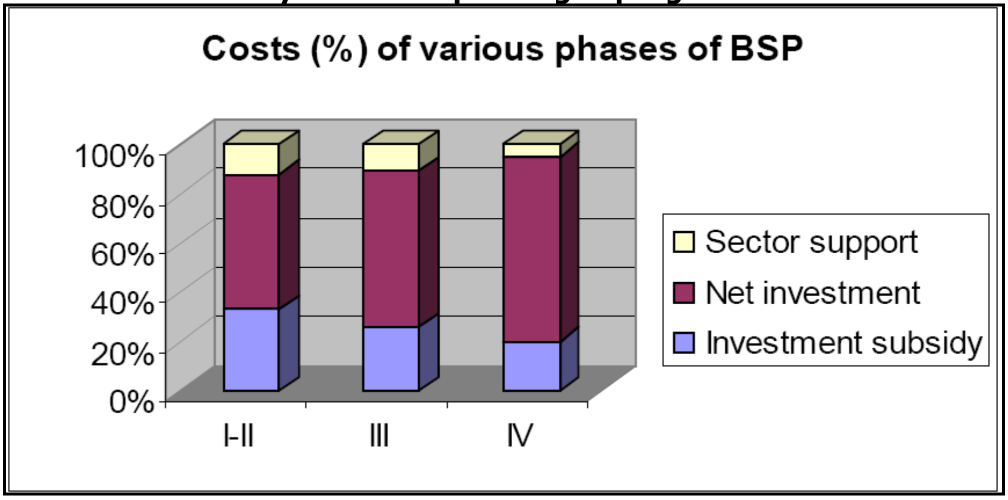
One of the oldest biogas programmes is the SNV biogas programme in Nepal, running since 1992. The business model was the combination of an investment subsidy coupled to strict enforcement of quality control. This programme was aimed at private biogas sector development and requires long term engagement and mobilization of external financial support. Depending on the sector development, the external financing has to be phased out. As shown in the table and graph below during the programme development, the shares of the sector support and the investment subsidy have been decreasing.

Table 7: Costs of various phases of the SNV biogas progamme in Nepal

Phase	I-II	III	IV
Period	1992-1997	1997-2003	2003-2009
Plants (number)	20,119	91,196	200,000
Costs (in million EUR)	7.8	41.7	97.4

Source: Van Nes, SNV Nepal

Figure 8: Shares of costs for sector support, net investment and investment subsidy in SNV Nepal biogas programme



Source: Van Nes, SNV Nepal

[9] For biogas dissemination barriers see chapter 2.1.

The costs of a biogas plant installation are the initial barrier for disseminating biogas plants to households. Depending on the region and the size the costs of a biogas plant range from 200-400 EUR in Asia, to 500-1,000 EUR in Africa. The cost difference between the regions results from different costs of production factors (raw materials, design, technology, human resources etc.), the way the installation is organized and the interaction between supply and demand (KfW PoA Blueprint Book, 2009).

Figure 9: Average costs of a biogas unit installation in Vietnam

The average costs of a biogas digester per m3 installed capacity amount to 38.2 EUR. The average size of a biogas facility comprises 10.4 m3. Thus, the total costs of an average facility amount to 397 EUR comprising material, labor and biogas appliances (i.e. cooking devices and biogas lamps). This is complemented by costs arising from support activities. The support comprises

- Workshops where farm holders are informed on the opportunities of biogas facilities,
- Facilitation of the construction of biogas facilities ensuring the application of resilient materials and biogas techniques,
- 12 months guarantee on the biogas facility,
- Training in the sound operation of biogas facilities;

Above services, summarized as support, are crucial to the success of the biogas programme and inherently connected to the implementation of biogas techniques. The costs of support amount to approx. 20% of a facility's investment cost. The average support costs amount to 80 EUR resulting in average total costs of 476 EUR per facility.

Average costs in EUR/m^3	38.2
Average size of the biogas plant in m^3	10.4
Total average costs in EUR/m^3	397
Average support costs in EUR/unit	80
Total average costs (including support) in EUR/unit	476

This is a significant amount for a small farm holder. Vietnam's average GDP per capita is 593 EUR. Thus biogas investment costs make up 80.3% of the average annual income. This poses a significant barrier to the implementation of biogas facilities without the SNV biogas programme. The programme overcomes this barrier by providing a subsidy of 48.2 EUR (vintage 2008) and by providing all services summarized under support free of charge.

Source: SNV Vietnam

3 CDM POA BIOGAS PROGRAMME FOR HOUSEHOLDS

3.1 Timing

Experience has shown that in standard CDM projects it can take up to two years from the first project idea to project registration (KfW PoA Blueprint Book, 2009). At the moment there is only one PoA registered , CUIDEMOS in Mexico, and it is expected that this period will be even longer for PoA projects due to unclear procedures and the lack of experience among project developers, DOEs and EB.
In case the programme is designed as a CDM PoA, the project cycle should be started as soon as possible. Once the programme set up is agreed the programme documentation should be developed and the registration procedure initiated. The current rule regarding the CPA design document preparation states that the starting date of any CPA "*is and will not be prior to the commencement of validation of the programme of activities, i.e. the date on which the CDM PoA-DD is first published for global stakeholder consultation*" (Annex 29, EB 47). This rule is a difference to regular CDM projects where projects that have already started can be registered in case they prove the *prior consideration of CDM* (significant due to the time consuming registration process).
Analogue to CDM, in case the programme has started before the PoA -DD has been published for global stakeholder consultation, the programme has to prove *prior consideration of the CDM*. This means that the programme coordinator has to provide evidence that the CDM was considered as an integral part of the programme at the time of its planning. At its 41st meeting the EB introduced the "*Guidelines on the demonstration and assessment of prior consideration of the CDM*"[10] which oblige the project participants to notify the Host Party DNA and the UNFCCC Secretariat about their intention to seek CDM status within 6 months after the project start[11].

[10] EB 41 Annex 46, revision EB 48, Annex 61

[11] Starting date of a CDM project activity – the earliest date at which either the implementation or construction or real action of a project activity begins. (CDM Glossary, ver. 05)

3.2 Key elements for PoA project structure

The structure of a PoA project depends on the actors involved and the programme goal. In case of biogas programmes for households as well as for other PoAs, the starting point is usually to determine the required type and level of incentive a programme needs in order to attract the critical amount of participants for achieving its goal.

In designing the PoA, the **programme coordinator** plays the decisive role. The coordinator is responsible for the structure and business model of the PoA, as well as for organization of contracts and agreements with programme partners or CPAs and CERs management. Also the programme coordinator is responsible for designing an incentive system to attract programme participants. Possible types of incentives include price discounts, grants and loans at favorable rates or simply payments on delivery for achieved emission reductions (KfW PoA Blueprint Book, 2009).

The PoA coordinators can be **banks** which are engaging more and more in the carbon market. In this context banks can also design attractive financial products. Also **energy supply companies** can be PoA coordinators, especially in case of energy savings activities under the programme. **NGOs and private companies** with well established local network can be PoA coordinators, as well as **development organization** with a good network and reputation among local population. However, in case of ODA financed projects, ODA diversion should be taken into account (see chapter 3.6).

Carbon rights

Before the development of the PoA is initiated, the **carbon rights** have to be clearly assigned. The host country´s legislation relating this issue has to be taken into consideration, especially in case of ODA financed projects. Since the actual emission reduction takes place on household level, the owners of the CERs should be the biogas plant owners. However, depending on the programme design, the participants can either receive carbon revenues from the coordinator after the project is implemented or registered, or can cede their CERs to the coordinator in exchange for the initial investment subsidy and support provided.

Size of a CPA

A single CDM project activity (**CPA**) within a PoA can be determined by various factors. Due to the simplified rules and procedures for small-scale methodologies, programme coordinators usually select the SSC thresholds as one of the criteria for the CPA definition. In case of biogas programme replacing fossil fuels for thermal energy (cooking or heating), the CPA threshold is 45 MW thermal energy installed.

Figure 10: Determination of a CPA size for the SNV biogas programme in Vietnam

Size of the CPA In order to profit from applying the simplified small-scale methodologies and procedures, each CPA within a PoA has to be under the SSC threshold. The estimated installed capacity of one biogas facility based on the average digester size and the average operation time of the biogas stove is 5.9 kW. The calculation of the installed capacity per digester is presented below.

Item	Value	Unit
Quantity of biogas production	1,012	m^3/hh/year
Energy content of biogas	23.1	MJ/m^3
Biogas stove efficiency	55	%
Average operating hours of stove	5.5	h/hh/day

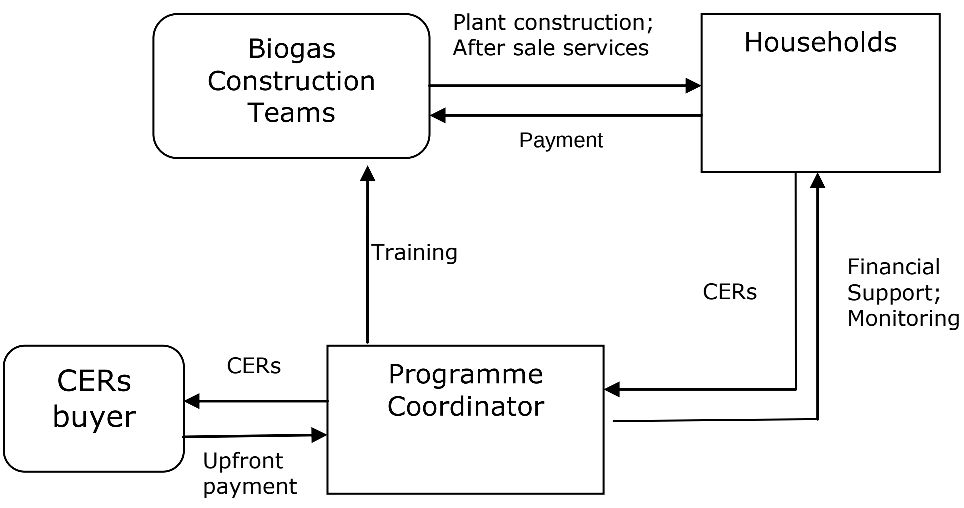
Generation capacity of each household:
1012 m^3/yr × 23.1 MJ/m^3 / (5.5×365) hr/yr × (1MWh/3600 MJ) / 55% = 5.88 kW

The number of biogas facilities that can be installed under the limit is 7,627 facilities and thus **the size of the CPA could be conservatively limited to 7,600 biogas facilities**.

Source: GFA ENVEST study team

The PoA business model depends on the programme design and on the ownership of CERs. One of the possible business concepts is the one proposed for the SNV biogas programme in Vietnam below.

Figure 11: Possible PoA concept for the SNV biogas programme in Vietnam



Source: GFA ENVEST study team

3.3 PoA project cycle and transaction costs

The PoA project cycle is very similar to the standard CDM cycle. It is divided into the implementation phase and the operational phase. The objective of the ***implementation phase*** is to have the project registered at the UNFCCC. Once the project is registered and starts running, than the operational phase begins with the objective to have CERs issued. In the implementation phase the project design documents have to be developed, namely PoA-DD and the CPA-DD. Based on the project design documents the host country is asked to issue the Letter of Approval. The independent validation of the PoA-DD and CPA-DD is done by the Designated Operational Entity. After the successful validation and the issuance of the LoA, a PoA can apply for the registration by the UNFCCC. The documents needed to apply for the registration are the project design documents (PoA-DD, CPA-DD generic, and one specific CPA-DD), validation report from the DOE, and the LoA.

During the ***operational phase***, the monitoring has to be done by the project coordinator and the monitoring reports have to be verified by the DOE. Based on the verified monitoring report, a PoA can ask for the CERs to be issued by the UNFCCC. The difference between single CDM projects and the PoA CDM is that additional CPAs can be added after the PoA registration. Each new CPA requires a CPA-DD. In the table below the steps in the PoA cycle are presented, as well as the estimated costs.

Table 8: PoA development steps and related transaction costs

Activity	Entity	Estimated costs[12]	Comments
Implementation phase			
Development of a PoA idea and a PIN	Project management entity and CDM consultant	8,000 – 15,000 EUR	Without feasibility studies / field visits / baseline surveys etc. Upfront
Letter of Endorsement	DNA	N.A.	
Development of PoA-DD and CPA-DD	CDM Consultant	50,000 – 150,000 EUR	Using a small-scale methodology which is likely in the case of PoAs Upfront
Letter of Approval	DNA	N.A. (translation costs)	
Validation of the CDP-POA-DD/CDM-CPA-DD	DOE	Up to 50,000 EUR (once)	Upfront and yearly verification
Implementation concept	Project management entity	Up to 100,000 EUR	Includes record keeping system for each CPA, adaptation of internal procedures and documentation etc.
Registration	UNFCCC	Registration fee[13] is calculated depending on the amount of CERs[14]	Registration costs of a POA are determined by the size of the first CPA.
Operational phase			
Monitoring.	Project management entity	30,000 – 100,000 EUR	Upfront and yearly expenses
Ongoing verification and validation of new CPAs	DOE	10,000 – 30,000 EUR	
Issuance of the CERs	UNFCCC	Issuance fee is calculated based on the amount of CERs[15]	

Source: KfW PoA Blueprint Book, 2009

[12] It is considered that the international consulting knowledge is needed.

[13] No registration fee and share of proceeds at issuance have to be paid for CDM projects activities hosted in least developed countries

[14] 0.10 USD for the first 15.000 t CO_2e, 0.20 USD for any amount in excess of 15.000 t CO_2e in a given calendar year.
No registration fee has to be paid for CDM project activities with expected average annual emission reduction over the crediting period below 15,000 t CO2-equivalent (EB 23, Annex 35).

[15] See footnote 10. The issuance fee for the first CERs issuance is deducted from the registration fee. (EB 6 Annex 5)
Apart from the administration fee the Adaptation Share of Proceeds is a deduction of 2% of the certified emission reductions (CERs) generated by the project each year used to fund measures in developing country Parties to the Protocol that will assist them in adapting to the adverse effects of climate change. In case the CDM project takes place in a Least Developed Country the adaptation share of proceeds is exempted. COP in 17/CP.7

3.4 Selection of methodologies

The emission reduction from a biogas digester is based on avoiding the combustion of fossil fuels respective non-renewable biomass, and on reducing methane emissions from the agricultural waste management systems, and eventually from wastewater streams of the associated household.
In the following it will be evaluated if the available and approved CDM methodologies cover the relevant emission reduction components and if the same are applicable under the PoA. The methodologies must cover the following emission reduction components:

a) Methane avoidance from animal manure management system
b) Fuel switch from fossil fuel to renewable energy
c) Switch from non-renewable biomass to renewable energy.

Since the EB 47th meeting it is allowed to combine one or more methodologies for PoAs.
The question on the applicability of the approved CDM methodologies to the PoA is addressed by the Executive Board (EB). During its 35th meeting the EB clarified "that methodologies are approved for application both to CDM project activity and to CDM programme activities (CPA) under a Programme of Activities (PoA)" (EB 35 Meeting Report, paragraph 15). During a previous meeting, the 32nd meeting, the EB had restricted the application of approved SSC CDM-Methodologies in case of CPAs which individually do not exceed the SSC threshold to SSC CDM-methodologies once they have first been reviewed, and as needed, revised to account for leakage in the context of SSC-CPA (EB 32, Annex 38, Version 2.1). The SSC-methodologies existing at that time have been reviewed meanwhile. However, it is concluded that the newer EB decision from the 35th meeting outdates the older EB decision from the 32nd meeting and thus allows all approved CDM methodologies to be applied to CPAs under the PoA.
The applicability of large scale methodologies is not discussed here since their monitoring and/or leakage requirements seem too expensive or simply unachievable to be complied within a household/ small farm level biogas programme like presented in this study. This discussion is thus superfluous.
So, the open question is on the approved CDM-Methodologies that cover the above emission reduction components. Since methodologies are subject to continuous revision and adoption herein, only those versions of the methodologies are considered which were available at the time of production of this manual.

a) Methane Avoidance from Animal Manure Management System

The emission reduction component of methane avoidance falls into Type III of SSC methodologies, denominated "Other projects". Under this type there offers AMS-III.R: "Methane

Recovery in Agricultural Activities at Household/ Small Farm Level" and AMS-III.D: "Methane Recovery in Animal Manure Management Systems". Generally speaking, AMS-III.R addresses project activities at individual households/ small farms while AMS-III.D addresses larger (livestock) farms.
Although this study explicitly addresses households/ small farms both methodologies are eligible and the applicability is not restricted to the household methodology. Going for AMS-III.D the households/ small farms, however, might be unnecessarily over-loaded with monitoring obligations or face narrower applicability criteria. In contrast, larger farms may only go for AMS-III.D since the applicability criteria of AMS-III.R exclude units with an emission reduction from methane avoidance above 5 t CO_2e per unit (compare Table 9). CPAs can be aggregated under the two Type III-Methodologies up to the maximal emission reduction of 60.000 t CO_2e.

Table 9: General Comparison of AMS-III.R to AMS-III.D

	AMS-III.R (Version 1)	AMS-III.D (Version 14)
Max ER for PoA	None	None
Max ER for CPA	60.000 t CO_2e	60.000 t CO_2e
Max ER single unit	5 t CO_2e	60.000 t CO_2e
Calculation ER		ER limited to *ex-post* BE minus *ex-post* PE
Animal keeping		confined
Applicability	Anaerobic systems as to IPCC Guidelines	Anaerobic lagoons with depth > 1 m and retention time > 1 month
Calculation	IPCC Tier 2 or regional values	IPCC Tier 2 or regional values
Project emissions	Physical leakage: CH_4 System operation: CO_2	Physical leakage: CH_4 System operation: CO_2 Flaring: CO_2 Final storage of slurry
Digestate		Not discharged into natural water resources
Combination	I-C. (mandatory)	Any Type I-Methodology (optional)
Biogas Utilisation	Like stipulated under AMS-I.C	Multiple usages

Unlike under AMS-III.D, under AMS-III.R the applicability criteria for the baseline treatment system are more flexible since any system with anaerobic decay of manure or agricultural waste is eligible. Further, AMS-III.R does not exclude certain treatment

systems for the treated waste stream from the biogas digester while AMS-III.D excludes the discharge to natural water resources.
A hurdle in the application of AMS-III.R to a biogas programme for households/ small farms might be the mandatory combination with AMS-I.C "Thermal Energy Production with or without Electricity". The major use of accruing biogas is thus limited to thermal energy production. Electricity production is not excluded, but must only occur in second place (e.g. in a cogeneration unit). Also, the displaced energy source must be fossil fuel instead of non-renewable biomass. The displacement of non-renewable biomass can be accounted for under AMS-I.E. If this hurdle is dominant to the project activity, AMS-III.D might represent the first choice.

b) Renewable Energy and Switch from Non-Renewable Biomass

For the emission reduction component "renewable energy" within the biogas programme for households/ small farms, potential methodologies are of the Type I ("Renewable Energy"). Most appropriate to the programme seem to be AMS-I.C "Thermal Energy Production with or without Electricity" and AMS-I.E "Switch from Non-Renewable Biomass for Thermal Applications by the User". The other Type I-Methodologies address electricity only or mechanical energy production.
As can be seen in Table 10 the applicability criteria for all SSC-Methodologies under Type I are restricted to such activities with capacities below 45 MW (thermal). For electric energy generation the limit is 15 MW and for cogeneration systems the cumulated generation limit is 45 MW (thermal) with the conversion electric to thermal energy 1:3. In the framework of the PoA these limits are relevant to the single CPAs.

Table 10: General Comparison of AMS-I.C to AMS-I.E

	AMS-I.C (Version 14)	AMS-I.E (Version 1)
Max ER for PoA	None	None
Max ER for CPA	45 MW(thermal) or 45 MW(thermal and electric) 15 MW(electric)	45 MW(thermal)
Displacement	fossil fuel or electricity by renewable energy end-users	non-renewable biomass (equivalent to a projected fossil fuel) by renewable energy end-users
Combination	AMS-I.E (optional), AMS-I.D (optional)	AMS-I.C (optional)
Project Emissions	Provision of biomass residues: CO2 Fossil fuel/ electricity consumption: CO2 Any other significant source	

In case of electricity production replacing grid electricity AMS-I.D is to be applied in order to calculate the grid emission factor. AMS-I.E can be combined with AMS-I.C in order to account for a share of fossil fuel, if needed, replaced by the thermal energy gained from the project activity.

Selecting the most appropriate methodology or the most appropriate combination of methodologies for a household/ small farm biogas programme should take into account various aspects. The methane avoidance component achieves highest emission reductions in warm climates and in case of anaerobic lagoons or other anaerobic liquid storage. The applicability of AMS-III.R is not restricted to anaerobic lagoons. However, the estimation of the potential emissions reduction should take into account the portion of livestock categories' manure handled using manure management systems that do not feature the same anaerobic conditions as anaerobic lagoons. Manure management systems with weaker anaerobic conditions are often not interesting to be included into a methane avoidance component because of relatively high project emissions that in the worst case might even exceed baseline emissions. If it turns out that the inclusion of the methane avoidance component makes sense, then the criterion of maximum 5 t CO_2e per unit of emission reduction should be checked.
If the production of electricity or mechanical energy makes sense in a household/ small farm biogas programme is questionable and will depend on the available technology. The production of

thermal energy is normally directly via the use of biogas in cookers or water heaters.

3.5 Data collection and monitoring

The data need of the methodologies is defined by the data need for the establishment of the baseline and the calculation of project emissions and monitoring requirements. The data collection itself is not always strictly predefined, but can be modified by the project proponent within a certain range as long as good argumentation is provided.

Determining the emission reduction from **methane avoidance** with the Type III SSC-Methodologies both presented methodologies refer to the Tier 2 approach of the IPCC Guidelines for Agriculture. The Tier 2 approach sets the cornerstones of data need for the baseline establishment. This includes data on the manure management system, regional data on animal mass, volatile solids excretion rates and methane production capacity (B0) (compare Table 11).

Table 11: Data Comparison of AMS-III.R to AMS-III.D

	AMS-III.R (Version 1)	AMS-III.D (Version 14)
Baseline data	Survey (95% cnf.): Amount of waste in VS (incl. average livestock population, VS per head, management system)	Amount of waste in VS (incl. average livestock population, VS per head, management system),
Peculiarities		B0, VS adoptable[16]
Monitoring	Surveys (annually): - number of operating systems - running hours of operation per system - average livestock population, manure/ waste generated and fed into digesters - proper soil application of final sludge Conventional: - fossil fuel or electricity for the operation of the system	Conventional: - livestock number, manure system, manure amount - biogas amount, methane content, flow meters, sampling devices, running hours - proper soil application of final sludge - fossil fuel or electricity for the operation of the system

The data about the manure management system includes a) climate (temperature), b) retention time of manure in management system, c) fraction of livestock per management system (acc. to IPCC Guidelines 2006, Agriculture, Table 10.18).

[16] To developed countries values only if same genetics, established FFR, similar weights.

In contrast to the other data, data on the manure management system cannot be displaced by IPCC default values. It is crucial information in establishing the baseline. The same data must either be fitted to IPCC categories of animal waste management systems or good scientifically justified argumentation acceptable to the DOE is needed that relates the identified systems to the IPCC categories of systems.

The definition of animal waste management systems in the IPCC Guidelines for agriculture is meant to represent the whole range of manure management systems worldwide and as such should allow the fitting of an identified system. Within biogas programmes for households/ small farms, however, the variety of management is huge often even within a single household/ farm. Further, retention times vary across the cultivation season depending on the type of available crops and alternative utilizations of manure like sale or feeding into fish ponds. These circumstances should be considered by the project proponent collecting the data on the manure management system.

For the calculation of the emission reduction achieved by utilising recovered biogas for a **fuel switch project component** the Type I methodologies offer. Thereof, only AMS-I.C and AMS-I.E are considered in the following. This is due to the fact that AMS-III.R can only be used in combination with AMS-I.C and that AMS-I.E can be interesting to biogas programmes since it accounts for emission reductions due to the displacement of non-renewable biomass. Both methodologies are applicable for thermal appliances, the most relevant technology in small biogas programmes.

In AMS-I.E "Switch from non-renewable biomass for thermal applications by the user" the quantity of biomass substituted can be determined by two different ways. The first is the collection of historical data or surveyed data on the number of appliances multiplied by an average substitution per appliance. The second is the calculation from the thermal energy produced by the project activity divided by the calorific value and the efficiency of the old appliance. The measurement of the thermal energy produced for small scale biogas digesters might confront the project coordinator with problems of quantification/ metering. Equipping household biogas digesters with gas flow meters usually is not cost effective.

Table 12: Data Comparison AMS-I.C (without electricity) to AMS-I.E

	AMS-I.C (Version 14)	AMS-I.E (Version 1)
Baseline	- thermal energy supplied - efficiency of old appliances (measured or acc. to manufacturers)	- proof non-renewability of biomass since 1989 (surveys or government or historic data) - quantity of biomass substitution either a) or b): a) number of appliances times average substitution per appliance (historical data or surveys) b) thermal energy produced per newky installed system and efficiency of replaced system (from sampling or literature).
Monitoring	**If ER < 5 t CO_2e:** - annually check representative sample of appliances in operation **ELSE a),b), or c):** a) energy produced b) energy produced for sample of systems c) quantity of renewable biomass displacing fossil fuels with efficiencies of old and new appliances - amounts of biomass and fossil fuel consumed	- annually check all appliances for operation OR representative sample - quantity of renewable biomass
Leakage		-Survey of non-project households to monitor leakage due to increased non-renewable biomass consumption after project implementation -other CDM project increasing the share of non-renewable biomass due to the project

Statistical Procedures for Data Collection and Monitoring

Instead of measuring sampling techniques can be used. The advantage of sampling is obvious and lies in the reduced number of systems for which data has to be collected. The relation between the number of systems to the achieved emission reduction is extremely disadvantageous in household projects and often becomes worse in PoAs on household level, which are often dispersed projects across wide geographical areas.

Sampling, however, is not restricted to such variables that are explicitly allowed for sampling within the respective methodology like shown in the above section on data need. "[...] Project implementers may propose to obtain estimates of [...] variables using sampling techniques if that is the only practical or cost effective means to obtain them." (Annex 27, EB47, paragraph 9).

The purpose of sampling is to obtain unbiased and reliable estimates of the mean or total values of key variables. The survey design should assure that inquired households/ farms reflect the population of households/ farms without a significant deviation between both groups. Certain error levels and confidence levels are therefore to be defined. The "*Draft General Guidelines on Sampling and Surveys*" (Annex 27, EB 47) define acceptable error and confidence levels. In the draft "point estimates for engineering calculation", "baseline penetration or equipment characteristic", and "change in technology penetration or performance" are distinguished against each other. For the first two a minimum confidence level of 90% with a maximum error level (ε) of ±10% is recommended, for the third a minimum confidence level of 80% with a maximum error level of 20% is prescribed. In the described methodologies AMS-I.C and AMS-III.R for the variables for which sampling is described ask for a confidence level of 95%.

The integral of the standard normal distribution depends on two variables: the standard deviation of a population and the mean of the population. With larger sample sizes the standard deviation of the sample decreases and the standard normal distribution takes a steeper form. This means that with larger samples sizes the confidence level is increased. However, it is not only the confidence level that increases with the sample size, but also the sampling effort. It is the goal to balance this trade-off at an optimal level. In our case CDM-methodologies or the "Draft Guidelines" predefine the level of accuracy with the confidence and error level. Thus the question remains which is the minimum sample size to assure the required accuracy. Thereby the relation of the sample size to the population size is less dominant than the absolute size of the sample.

In general, the minimum sample size for infinite populations (the formula for finite populations delivers smaller values) can be estimated according to Formula 1. Other sources like the "Draft Guidelines on Sampling and Surveys" (CDM EB 47, 2009, Annex 27) suggest to use additionally the coefficient of variation (CV). The coefficient of variation calculates as $(\sigma/\mu)^2$, i.e. the standard deviation of the sample divided by the mean of the sample.

Formula 1: Minimum Sample Size for Infinite Populations (Rinne, 1995)

$$n \geq z^2 \times \frac{s^2}{\varepsilon^2 \times y}$$

with:
n: minimal sample size
ε: tolerated error (100% - confidence level)
z: probability deduced from the central probability of the standard normal distribution
s: standard deviation of the sample
y: mean of the sample

The minimum sample size is large enough so that the standard deviation of the sample is small enough to assure that the required confidence level (reflected in the value of z) is kept at the tolerated error. However, this is only true for random samples. Other sampling approaches usually require larger samples, which might be overcompensated by reduced costs through easier executable sampling schemes than random sampling.

3.6 Additionality

Additionality is an integral part of any emission reduction project. The so-called "additionality proof" needs to demonstrate that the project would not be implemented without carbon revenues. This proof can be given following the "*Tool for the demonstration and assessment of additionality*" (CDM EB 39, 2008, Annex 10). Usually projects need to demonstrate that the project achieves a negative or unattractive internal rate of return (IRR) without carbon revenues.
In case of ODA (co-)funded projects it is recommended to check if the project can prove additionality on the programme level (e.g. that the ODA funds do not suffice for the achievement of programme goals) and on the household level (i.e. that the installation of the biogas plants is not feasible without the support provided by the programme).

3.7 Optimizing benefits from carbon finance

The benefit of carbon finance depends on the amount of CERs per digester, which is again, dependent on the size of digester and the emission baseline. The existing CDM projects which have characteristics of biogas programmes include such with methane emission reduction from the change of manure management and the fuel-switch through biogas, while others only include the fuel-switch component. In these projects the CER quantities per household vary from 1.76 tCO_2/year up to 7.0 tCO_2/year. These amounts can only be reached in case the baseline emission originates from fossil fuels, or from non-renewable biomass. In order to prove that the biomass is non-renewable, there is a need for substantial amounts of data (statistical and survey data). The manure management component can bring in significant share of CERs only in case the applied manure management systems have high MCF, which often is not the case in household systems.

Table 13: CER estimates for CDM biogas programmes

Programme name	Nr. of house-holds	Size of bio-digester (m3)	Cost of bio-digester	Emissions from manure /hh (tCO2)	Emissions from fossil fuels /hh (tCO2)	Emissions from fuel-wood /hh (tCo2)	Annual amount of CERs	Ave-rage amount of CERs per bio-dige-ster
Bagepalli CDM Biogas Programme (India) (AMS-I.C)	5,500	2	n.a.	n.a.	0.08 (kerosene)	3.56	19,553	3.56
Biogas Support Program – Nepal (BSP – Nepal) Activity 1&2 (AMS-I.C)	Project 1: 9,708 Project 2: 9,688	4-10	183-287	n.a.	0.07 (kerosene)	7.52	Project 1: 46,990 Project 2: 46,893	7.00
Hubei Eco-Farming Biogas Project Phase (China) (AMS-I.C + AMS-III.R)	33,000	8-15	296-420	0.5-0.8	2.5-3.1 (coal)	n.a.	58,219	1.76
Kolar Biogas Project and Hassan Biogas Project (India) (AMS-I.C + AMS-III.R)	10,000	2-3	250-290	3.47	0.09 (kerosene)	3.26	61,883	6.2

Source KfW PoA blueprint Book, 2009

In case the level of fossil fuel consumption on household level is low in the baseline, it could be suspected that the demand is suppressed. Under the Gold Standard (GS) "Biodigester" methodology, this effect is addressed with the possibility to survey only selected households with a higher living standard for which it is assumed the fuel demand was satisfied ("satisfied demand" approach). Also, apart from GS, other VER standards may be more suitable for providing carbon finance to a biogas programme and the coordinator should investigate all the options before selecting the standard.

<u>Impact of carbon finance</u>

In order to estimate the carbon finance the two SNV programmes with different incentive scheme were compared following the approach applied in the KfW PoA Blueprint Book.

In cases where the programme incentive includes a monetary subsidy to the participant for the investment, the programme fixed costs are high. The SNV biogas programme in Vietnam is providing the subsidy of 48 EUR as well as financing the supporting activities. Thus the estimated programme support costs per unit reach up to 120 EUR.

Table 14: Overview of the programme costs for a biogas programme

Cost components	Upfront (EUR)	Annual (EUR)
Project design and CDM documentation	250,000	30,000
Monitoring		10,000
Programme support (subsidy, training etc.)	120 per unit	
Programme running costs		12 per unit

Taking into account 50,000 biogas units, the programme costs per unit reach 125 EUR upfront and 12.8 EUR annually.

In order to calculate the critical size of the programme for the break-even and the IRR of 15%, the CERs generation is taken into account in three scenarios: (i) 1.0 tCO_2/a resulting from small to medium digester, applying one methodology; (ii) 2.5 tCO_2/a resulting from larger scale digester or combination of two methodologies; and (iii) 5 tCO_2/a resulting from large scale digester and applying the combination of two methodologies. For the calculation of the critical size of the project, a CER price of 10 EUR has been taken.

Table 15: Critical size of a domestic biogas programme with higher support costs for the break-even and IRR of 15%[17]

Annual CERs per digester	Critical size (number of biodigesters)	
	Break- even	IRR of 15%
1.0	n.a.	n.a.
2.5	13,500	80,000
5.0	2,660	3,530

As it can be seen in case of lower CER amounts per biodigester, the programme cannot rely on carbon revenues since the break-even point is not achieved due to the high fixed costs for the

[17] The discount rate of 10% for the calculation.

project development. Only in case of higher CER amounts, carbon finance can provide significant income. In most cases the programme has to rely on other financing sources, such as ODA.
For a programme providing only soft loan instruments, the programme costs are significantly lower. From the adapted budget of an SNV programme in Africa for 15,000 units, the nominal costs per biodigester reach 380.50 EUR upfront and 18.90 EUR in annual costs. The project provides soft loans to households with a low interest rate and a payback period of five years.

Table 16: Critical size of a domestic biogas programme with smaller programme costs for the break-even and IRR of 15%

Annual CERs per digester	Critical size (number of biodigesters)	
	Break- even	IRR of 15%
1.0	19,100	n.a.
2.5	9,000	29,200
5.0	4,780	7,100

In this case the critical size of the project is significantly lower. However, in both cases the biogas programme is only attractive at a level of several thousands of participants.

Due to the additional costs for the PoA development and implementation, the programme coordinator has to decide if the number of households and the amount of CERs per household is high enough for the PoA to be feasible. Although by applying the PoA, the transaction costs are lowered, the costs of monitoring (e.g. installation of metering devices in case of AMS-I.C or conducting surveys for the non-biogas users in case of AMS-IE), can easily exceed the benefit from carbon finance in the PoA. All of these aspects have to be taken into account at the time of the PoA planning.

3.8 Main obstacles in developing the PoA

The development of PoAs for biogas programme for households faces the obstacles related to the general PoA, as well as the obstacles specific to the biogas programme for households.

Lack of data

In order to apply the CDM methodologies for the PoA CDM project and to develop the baseline extensive data is required. In case of biogas plants the data about the fossil fuel consumption for cooking is needed, the data for the assessment of the non-renewable firewood and the data about the applied manure management systems. Agricultural statistics usually do not collect and show data about small and medium farms (households), and a programme coordinator has to obtain this data through surveys. Although the CDM EB allows project developers to use surveys for the data collection, the first draft procedures for sampling and surveys for data collection have only be issued in May 2009. The collection of data via surveys has also proven to be difficult since (local) staff usually require training and trial and error processes are often necessary and time consuming. Questionnaires are usually poorly understood by farmers since the data need for a CDM project is something new to them. In order to improve understanding and thus data quality, the questionnaires should apply locally recognized units for amounts of fuel consumed and the locally applied manure managements systems. An example of the manure management questionnaire and fuel consumption questionnaire is provided in Annex.

High monitoring costs

From the applicable methodologies for the household biogas units, only AMS-III.R is completely adapted to the micro-household level. The Type I methodologies, namely AMS-I.C has some provisions related to households (e.g. simplified monitoring in case the emission reduction per system is less than 5 t CO_2 eq.), but it was rarely applied so far. The simplified monitoring for the AMS-I.C includes the measurements of the biogas consumed. The costs of the measuring equipment, even only applied to the sample, would entail increased investment costs and training costs. This would significantly burden the biogas programme.

Unclear carbon rights

Before the PoA implementation the carbon rights have to be resolved. The standard approach is that the farmers participating in the programme have to cede their carbon rights against the programme subsidy for the biogas installation. In this case the carbon revenues can support the programme financing. However, the farmer has little or no incentive to participate in the project monitoring. The other option is that the subsidy to the farmer is financed by the carbon revenues. This option has limited application for national biogas programmes since the subsidy for the initial investment is one of the main incentives for the farmers´ participation in the programme. Farmers will not trust in carbon revenues, an asset they are not familiar with.

ODA diversion

Biogas programmes are often dependent on public funding. In case the programme is (co)financed using ODA, then the issue of ODA diversion has to be cleared out. ODA diversion refers to the problem that ODA funding may be used to finance industrial countries efforts for meeting emission targets. The Development Assistance Committee of the Organization of Economic Cooperation and Development (OECD-DAC) developed a note on good practice for ODA diversion. OECD (2004) concludes that ODA funds may finance emission reduction projects, but the generated emission certificates shall not be transferred to the donor without financial compensation.

At its 7th Meeting in Marrakesh, in 2001 the Conference of the Parties (CP) to the UNFCCC agreed on modalities and procedures for a Clean Development Mechanism. In particular, it was agreed (CP7, decision 17) *"that public funding for clean development mechanism projects from parties in Annex 1 is not to result in the diversion of official development assistance and is to be separate from and not counted towards the financial obligations of Parties included in Annex I".*

In case the programme uses ODA financing it is necessary to prove that no ODA diversion will occur. In order to be on the safe side, the ODA provider and the carbon buyer should come from the different Annex I parties.

Regulatory barriers

The regulatory barriers have been partially lifted and modified by EB in May 2009 (EB 47). However, several barriers are still valid:

- **Liability of DOEs** - CPAs can be reviewed within one year after the inclusion of CPA or renewal of the crediting period of the CPA, or six months "after the issuance of CERs for that CPA". In case the CPA is excluded, the DOE is liable for CERs issued from rejected CPAs.
- **Starting date of a CPA** – the decision on PoA states that the staring date of a CPA can only be after the validation of the PoA-DD.
- **Constant adaptation to methodologies** – in case the approved methodology is put on hold or withdrawn, no new CPAs will be included in the PoA. If the methodology is revised, the PoA has to be revised accordingly[18].
- **Combination of methodologies requires approval from the EB** - Since the EB 47th meeting it is allowed to combine one or more methodologies for PoAs. However, while the combination of methodologies is widely used in standard CDM, it requires special approval from the EB following the "*Procedures for approval of the application of multiple methodologies to a programme of activities*" (EB 47). This is probably going to hamper the use of combined methodologies, and PoA itself, since the procedure for obtaining the approval might require too much time.

[18] However, such revisions are not required in cases where a methodology is revised without being placed on hold or withdrawn (Annex 29, EB 47).

4 CONCLUSIONS AND CHALLENGES

The conclusions and challenges given here are based on the experiences from the existing programmes in Nepal, Africa and Vietnam as well as on the findings of the Study "PoA concept development for the use of biogas installations in small and medium sized pig farms for a decentralized energy supply in Vietnam".

Figure 12 Lessons learned on CDM from the SNV Nepal Biogas Programme

The Biogas Support Programme (BSP) has been operating in Nepal since 1992. Currently, the Programme is in its fourth phase (July 2003-June 2009) and is targeting to install 200,000 biogas plants during this phase.

Two small scale biogas CDM projects got registered in December 2005 with the CDM Executive Board. These 2 CDM projects comprise 19,396 plants build through the Programme in the period November 2003 to April 2005.

One of the major problems during the conception of these projects was the use of the methodology. The two registered projects are using AMS I.C (version 6). However this methodology did not have any provisions for the replacement of non-renewable biomass in the baseline. Although the projects got registered, it started a process with the CDM Executive Board and its small scale methodology working group to develop a methodology applicable in this situation.

A new methodology was not available until early 2008, blocking the development and registration of any new projects for two years. The new methodology finally approved, takes a more conservative approach therefore reducing the expected credits per biogas plant. The most important lesson learned from this was the time and effort it takes to go through these processes with the CDM Executive Board while the outcome can be uncertain.

Another important lesson was the improvements necessary in the Programme approaches and systems to meet the CDM requirements. Particularly, improvements around the areas of quality control and monitoring systems, database management system, and environmental impact monitoring have been made. These improvements were necessary to be able to both provide more detailed data and also to keep collecting data over a longer period than would have been required under normal Programme requirements.

The first verification of the projects took place in December 2006, however up to the second quarter of 2009, no CERs have been issued. Problems arose around the monitoring plan for the projects and how monitoring was performed in practice. The lesson learned here is on the importance of a clear, specific and realistic monitoring plan and the need for specific (and sometimes separate) monitoring of the plants in the CDM project, even if they are part of a bigger programme.

Looking forward, new challenges are coming up regarding the debundling rules for small scale CDM projects and the possibilities and difficulties in using a PoA approach. New lessons will need to be learned in these processes. Therefore the biggest lesson learned might be on the high demands the CDM puts on programme implementers through its relative complexity and constantly changing methodological and procedural framework.

Source: SNV Nepal

Conclusions:

- The primary incentive for installing biodigesters for farmers is saving fuel costs. The second incentive is dealing with waste management problems like odour. Odour problems from manure occur often in densely populated areas with high livestock farming density.
- By avoiding the use of fossil fuels and recovery of methane, farmers contribute to the mitigation of greenhouse gases. Also the use of bio-slurry as organic fertilizer improves the soil quality and reduces mineral fertilizers costs.
- Biodigester programmes furthermore have positive sustainable development effects such as alleviating the workload for women and children and easing health problems due to indoor pollution.
- Biodigesters cost between EUR 200 and EUR 1,000 and high initial investment costs are the main barrier for households installing biodigesters (KfW PoA Blueprint Book, 2009). In some countries, this can be successfully alleviated by developing suitable micro-finance support systems or by introduction of financial incentives
- The PoA approach can support biogas programmes by providing additional revenues. However, the transaction costs and monitoring costs have to be taken in consideration because carbon revenues can only give small contribution to the programme implementation costs and prefinancing of grants and loans.
- A high-quality and cost-effective design of biodigesters and annual and solid aftersales service is important to ensure the lifetime of the installation and its use in the households (KfW PoA Blueprint Book, 2009)
- Depending on size and region biodigesters reduce GHG by between 0.5 and 7 t CO_2e/year.

Challenges:

- This type of project will unlikely be of sufficient profitability for a commercial approach and needs public support. Seed funding for grants and subsidies to credit lines are needed and the potential CER buyer or private investor has to undertake the risk of the PoA, or the programme has to seek the support of the public institution or international donors (KfW PoA Blueprint Book, 2009). In this case ODA diversion and additionality can be questioned
- The carbon finance has to be optimized so that the approach (PoA, standard CDM or VER) and methodologies are selected which bring the highest profit (considering revenues and transaction and monitoring costs).
- The PoA is more suitable for well-established programmes as application period is long, in addition to the high critical mass of digesters required to secure the financial attractiveness of the programme, requiring a high number of programme participants. In this case "*prior consideration of CDM*" proof is needed (see chapter 3.1).
- The technical support (installation and management) is of greatest importance and the incentives for all actors have to be designed in a proper way.
- The PoA set-up has to be flexible enough to adapt to the market conditions due to the long period of adaptation and dynamic changes in the population habits in developing countries.

5 ANNEX

5.1 Annex I - Manure management questionnaire - Example

Instructions for filling in the questionnaire

This questionnaire is used for the identification of the livestock population and manure quantities and management on the farm. The first part of the questionnaire is for the description of the livestock population present at the farm at the time the questionnaire is filled-out.

The second part is designed to provide data about the manure application and manure management systems. Where the provided answer is only Yes/No please answer by marking one of the two. In case the answer to the question is positive, please answer the sub question. In case the answer in negative, please continue to the next question. In case the answers provided are not clear please ask the local BPD staff for explanations. The descriptions of the manure management systems are provided below the question 5. After completing the questionnaire please perform the check as described at the bottom of the page (the sum of the % given in the sub questions 1 to 5 for each animal category should be 100%). Thank you for your cooperation!

Part 1

Data about livestock on the farm

Animal type	Swine (sows, > 90kg)	Piglets (<25 kg)	Porkers (25-90 kg)	Cow	Buffalo	Poultry	Other
Number of animal							
Average weight of the animal							
Are they grazing? If yes how many hours per day?							

Part 2

Data about manure application and manure management

1. **Do you have an installed bio-digester?** Yes/No

   a. If yes how many % of the manure are you feeding in?

      i. pig______(%)

      ii. Cattle ______(%)

      iii. Chicken ________(%)

2. **Do you sell part of your manure?** Yes/No

   a. If yes which manure? Pig manure/ Cattle manure/chicken/All

b. If yes how many % of the manure?

i. pig______(%)

ii. Cattle ______(%)

iii. Chicken ________(%)

3. **Do you burn manure as fuel?** Yes/No

a.If yes how many % of the manure? ______ (%)

4. **Do you discharge the manure into the fish pond?** Yes/No

a.If yes, how many % of the manure? _____(%)

i. pig______(%)

ii. Cattle ______(%)

iii. Chicken ________(%)

5. **Do you use the manure as fertilizer?** Yes/No

a.If yes, how many % of the manure? ....______(%)

i. pig______(%)

ii. Cattle ______(%)

iii. Chicken ________(%)

b. If yes, for the manure used as fertilizer put in the share of the manure management method applied for **pig manure**:

Daily spread	**Lagoon**	**Sewage**	**Pile (solid storage)**	**Earth pond or cement tank with cover**	**Earth pond or cement tank without cover**	**Pit < 1month**	**Pit >1 month**
(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)

c) If yes, for the manure used as fertilizer put in the share of the manure management method applied for **cattle manure**:

Daily sprea d	**Lagoo n**	**Sewag e**	**Pile (solid storage**	**Earth pond or**	**Earth pond or**	**Pit < 1mont**	**Pit >1 mont**

			)	**cement tank with cover**	**cement tank without cover**	**h**	**h**
(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)

Daily spread	*Manure is routinely removed from a confinement facility and is applied to cropland or pasture within 24 hours of excretion.*
Lagoon (Uncovered anaerobic lagoon)	*A type of liquid storage system designed and operated to combine waste stabilization and storage. Lagoon supernatant is usually used to remove manure from the associated confinement facilities to the lagoon. Anaerobic lagoons are designed with varying lengths of storage (up to a year or greater), depending on the climate region, the volatile solids loading rate, and other operational factors. The water from the lagoon may be recycled as flush water or used to irrigate and fertilize fields.*
Pile (solid storage)	*The storage of manure, typically for a period of several months, in unconfined piles or stacks. Manure is able to be stacked due to the presence of a sufficient amount of bedding material or loss of moisture by evaporation.*
Earth pond or cement tank (liquid/slurry)	*Manure is stored as excreted or with some animal addition of water in either tanks or earthen ponds outside the animal housing, usually for periods less than one year.*
Pit (pit storage below animal confinements)	*Collection and storage of manure usually with little or no added water, typically below a slatted floor in an enclosed animal confinement facility, usually for periods less than one year.*

Check for the properly completed questionnaire

The questionnaire has been properly completed in case the sum of the % for the sum questions of the questions 1 to 5 for each animal type is 100%. Also the sum of the % given in the question 5 sub question b) and c) should be 100%.

Thank you for your cooperation!

5.2 Annex II – Baseline fuel consumption questionnaire – example

1. General data:

Name:	
Village:	
Date:	
Number of people in the household	
Income	___________ per day per week per month per year

2. Fossil fuel consumption:

	Coal		
Use	Cooking	Lighting	Other use
Amount (kg)	___________ per day per week per month per year		
Price	___________		
	LPG		
Use	Cooking	Lighting	Other use
Amount (kg)	___________ per day per week per month per year		
Price	______________		
	Kerosene		
Use	Cooking	Lighting	Other use
Amount (kg)	____________ per day per week per month per year		
Price	___________		

3. Biomass consumption:

	Firewood		
Use and source	Amount (kg)		
Used for cooking	____________ per day per week per month per year		
Used for other purposes	____________ per day per week per month per year		
Purchased	____________ per day per week per month per year		
Collected from forests	____________ per day per week per month per year		
Collected from private land	____________ per day per week per month per year		
Other source (specifiy)_______	____________ per day per week per month per year		
Purchased Wood:	Price	_______________	
	Price trend in recent years	Increasing Decreasing	Stable Don´t know
Collected wood:	Time spent collecting (hours)	________	per day per week per month per year
	Trend in time taken to collect wood in recent years:	Increasing Decreasing	Stable Don´t know
	Distance to collection	__________	
	Distance trend in past years	Increasing Decreasing	Stable Don´t know
	Type of firewood collected (if possible provide approximate share)	Chopped trees:	_________
		Chopped branches:	_________
		Dead wood on ground:	_________
		Other:	_________
	Other biomass		
Type (specify)	Amount (kg)		
	____________ per day per week per month per year		
	____________ per day per week per month per year		

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