CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

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SECTION A. General description of project activity

A.1. Title of the project activity:

Title: Biogas Program for the Animal Husbandry Sector of Vietnam
Version: 3.1
Date: 24 September 2012

A.2. Description of the project activity:

Start date of the VGS project: 19-07-2006
Commissioning of the first digesters: 1-1-2007 (start date phase II)

The starting date is defined as the application for a biogas plant by a \ household. All biogas plants that are commissioned on 1-1-2007 or later are Biogas Program for the Animal Husbandry Sector of Vietnam (BP) phase II biogas plants. The start date of operation of the first phase II biogas plant will be around 10 days after commissioning, however to ensure conservativeness, the emission reductions by these biogas plants are only counted in the next month.

Biogas Program for the Animal Husbandry sector of Vietnam (BP)
Project "Biogas Program for the Animal Husbandry Sector in Vietnam" is implemented by Livestock Production Department the Biogas Project Division (BPD) (under the Ministry of Agriculture and Rural Development (MARD)) in partnership with Netherlands Development Organization (SNV). Overall objectives of project are (i) effectively exploiting biogas technology and developing a commercial viable biogas sector in Vietnam; and (ii) contributing to rural development and environmental protection via provision of clean and affordable energy to rural households, improvement of community's sanitation and rural people's health, creation of jobs for rural labor and reduction of greenhouse gas emissions (GHG).

The purpose of the BP Vietnam Gold Standard Biogas VER Project:
The purpose of the project activity is to (further) develop the commercial and structural deployment of domestic biogas[1] in Vietnam. To that extent, the project will:

- Promote the long-term utilization of renewable energy produced in an environmentally compatible and economically viable way;
- Increase the awareness of prospective livestock smallholder households and extension workers on the full extent of the potential costs and benefits of domestic biogas installations;
- Strengthen the supporting capacity of involved Biogas Construction Teams (BCTs) and (non-) Government officials regarding all aspects of marketing, construction, after sales service and quality management of domestic biogas installations;
- Support the development of a commercially viable, market oriented domestic biogas sector in

[1] *Domestic biogas is defined as any biogas plant with a volume between 4 to 50 m^3, the minimum daily feedstock requirement of the smallest size is manure from 6 pigs or two bovines (20 kg/day) and the largest digester can treat around 300 kg/manure/day (MARD national standard: 10 TCN 97 102 – 2006. Issued by decision N0 4006/QĐ-BNN-KHCN of Ministry of Agriculture and Rural development on 26th December 2006.)*

Vietnam;

- Strengthen the institutional infrastructure for coordination and implementation of sustained dissemination of domestic biogas at national, provincial and district level.

The project will build on the achievements of the "Support Project to the Biogas Programme for the Animal Husbandry Sector in some Provinces of Vietnam" (BP I) and aims to build 107,078 units in the period 2017-2016 in phase II 2007- 2014 and the follow up phase until 2016.

With implementation of this Project, greenhouse gas (GHGs) emissions will be reduced, both from the displacement of non-renewable biomass (NRB) and fossil fuels currently used in stoves with clean and efficient biogas technology, but also by introducing a proper animal waste management system (AWMS).

<u>Contribution to Sustainable Development</u>

The Project will contribute to sustainable development (SD) of Vietnam in several areas:

(1) Contribution to environmental development

- Substitution of conventional household fossil fuels by biogas and efficient biogas stoves, resulting in cleaner indoor air;
- Substitution of biomass fuel that is unsustainably harvested, helping to alleviate deforestation;
- Mitigation of the GHGs emissions by switching a high GHG emissions AWMS practice to a lower GHG emission AWMS practice;
- Substitution of synthetic fertilizer with the organic residue from the digestion process – bio-slurry;
- Improvement of sanitary conditions on the farms through connection of latrines to sewers or biogas digester and regular collection and treatment of animal manure from stables;
- Reduction in environmental load on surface waters as a result of averted discharge of untreated manure; and
- Improvement of indoor (kitchen) air quality by substituting less efficient cooking fuels by biogas.

(2) Contribution to economic development

- Reduction in the expenses for domestic thermal energy;
- Reduction in expenses for synthetic fertilizer by applying bio-slurry;
- Increase in agricultural production yields by applying nutrient rich bio-slurry; and
- Creation of employment opportunities for the construction and maintenance of biogas digester systems in rural areas.

(3) Contribution to social development

- Reduction in domestic workload of women and children by
  - the reduced demand for wood (less time is spent on fuel wood gathering)
  - Provision of a convenient cooking fuel that burns faster and cleaner then solid fuels (time is saved on cooking activities and cleaning the pots)and

- Prevention of respiratory illnesses resulting from indoor air pollution and gastro-enteric diseases attributed to poor sanitary conditions.

(4) Conformation to the governmental policy and strategy of Vietnam

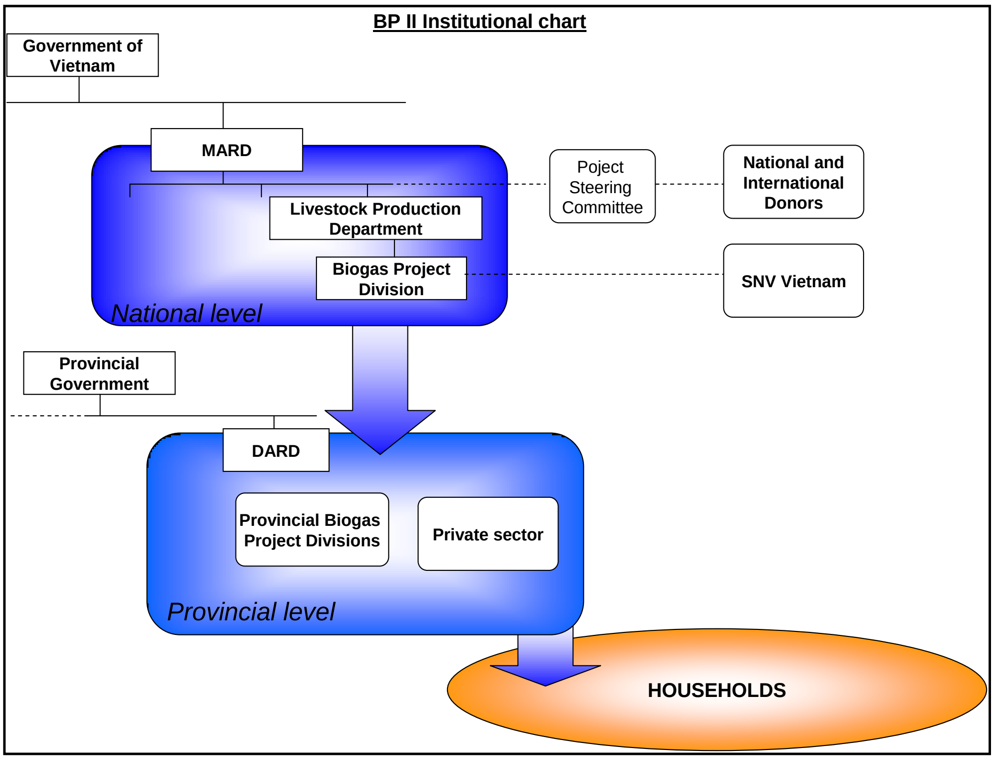
- The Project contributes to the Government's National Strategy for Environmental Protection with the major objectives:-
  - *"To halt pollution acceleration, remedy degraded areas and improve the environment quality and ensure sustainable development of the country is achieved"*;
  - *"To guarantee that all people are entitled to live in an environment with good quality of air, land and water measuring up to standards stipulated by the State"*; and
  - *"To increase the rate of clean energy use to 5% of the total annual energy consumption"*.
- The Project is also consistent with Vietnam's Global Environment Facility Strategy and Renewable Energy Action Plan which promotes the efficient use of energy sources.

BP has received international acclaim by winning the prestigious Energy Globe Award in 2006 and the Ashden Award in 2010. Both awards recognize the tremendous contribution that the programme has achieved in sustainable development, tackling energy poverty and the treat of climate change.

A.3. Project participants:

Name of the Party involved (*) (host) indicates a host party	Private and/or public entity(ies) project participants (*)	Kindly indicate if the Party involved wishes to be considered as project participant
Viet Nam (host)	• Biogas Program for the Animal Husbandry Sector of Vietnam • SNV Vietnam	Yes
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.		

The BP institutional chart of phase II is shown hereunder.



MARD = Ministry of Agriculture and Rural Development
SNV = Dutch Development Organization
DARD = Department of Agriculture and Rural Development (at provincial level)

The programme is coordinated and managed by BDP, a division under the Department of Livestock Production (DLP) of the Ministry of Agriculture and Rural Development (MARD) in partnership with SNV. Hereunder the two projects participants are explained in more detail:

The Netherlands Development Organization (SNV) started in cooperation with national partners the biogas activities in Vietnam in 2003. BP built upon the experiences that SNV gained with the highly successful Biogas Support Programme (BSP) of Nepal, where over 225,000 biogas plants are installed using a market driven approach. SNV supports BP by Technical Assistance (TA) in the field of technology, financing, long term project development, improvements, training and other areas where required. SNV is also the initiator of the VGS development and will decide together with DLP how the revenues originating from VGS will benefit the program development.

The Biogas project Division (BPD) is established by the project Director from DLP (Department of Livestock Production) and is responsible on behalf of MARD and DLP for all program activities and implementation. The responsibilities include the daily management and preparing all the work plans and budget's necessary for execution of the assignment, implement the activities to reach the goals of the program, these are activities related to promotion & marketing, training, construction and biogas plant quality control (QC), extension (bio-slurry application), biogas technology research & development, reinforce access to finance, credit resource, support the development of professional biogas mason team and enterprises, program performance monitoring & evaluation and institutional support. All BPD's major decisions are approved by both the Director from DLP and SNV.

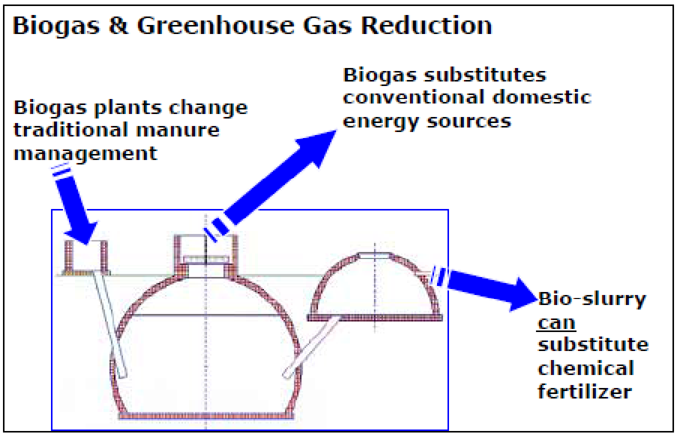
A.4. Technical description of the project activity:

BP is supporting the installment of biogas units of volumes between 4 to 50 m^3 in households with livestock (cattle, buffalos or pigs). The smallest digester has a minimum feedstock requirement of around 20 kg/day, roughly equivalent to 2 bovines or 6 pigs, the largest digester can treat around 300 kilo of manure per day. In this way the manure management type is improved leading to less GHG emissions and improved hygienic and environmental living conditions. The installed biogas units are of fixed dome type. The produced biogas is used to replace conventional fuels like firewood, coal, LPG, kerosene and agricultural residues for cooking. Apart from cooking, biogas lamps are installed that can replace conventional light bulbs (usually in the kitchen), or are used when power cuts occur. Apart from biogas, the slurry produced from the digestion process can replace fertilizers.

The installed biogas units contribute to the reduction of GHG emission in 3 ways:

1. Avoidance of methane emissions from the baseline manure management system by capturing and destroying methane for energy services;
2. Fuel switch from non-sustainable energy sources for cooking and lighting to biogas;
3. The effluent from a biogas system, bio-slurry (digestate), replaces chemical fertilizers.

However, due to the lack of data and for simplification reasons, the emission reductions for the fertilizer substitution will not be accounted for, which increases conservativeness of the calculations. In addition, some household will use biogas for water heating, stable heating and electricity generation. The emission reductions from the displacement of grid electricity by these activities will not be accounted for, which is also conservative.



A.4.1. Location of the project activity:

Socialist Republic of Vietnam, since the inception of the first phase (BP I) the programme has gradually extended its coverage. In 2007 the programme was active in 24 provinces and this has increased to 47 provinces in 2011 and this will increase steadily to all provinces in Vietnam. The coordinates of Vietnam are:

	North	Center	South
Latitude	22º00´ North of the Equator	16º00´ North of the Equator	8º50´ North of the Equator
Longitude	100º00´ East of Greenwich	106º00´ East of Greenwich	109º00´ East of Greenwich

A.4.1.1. Host Party(ies):

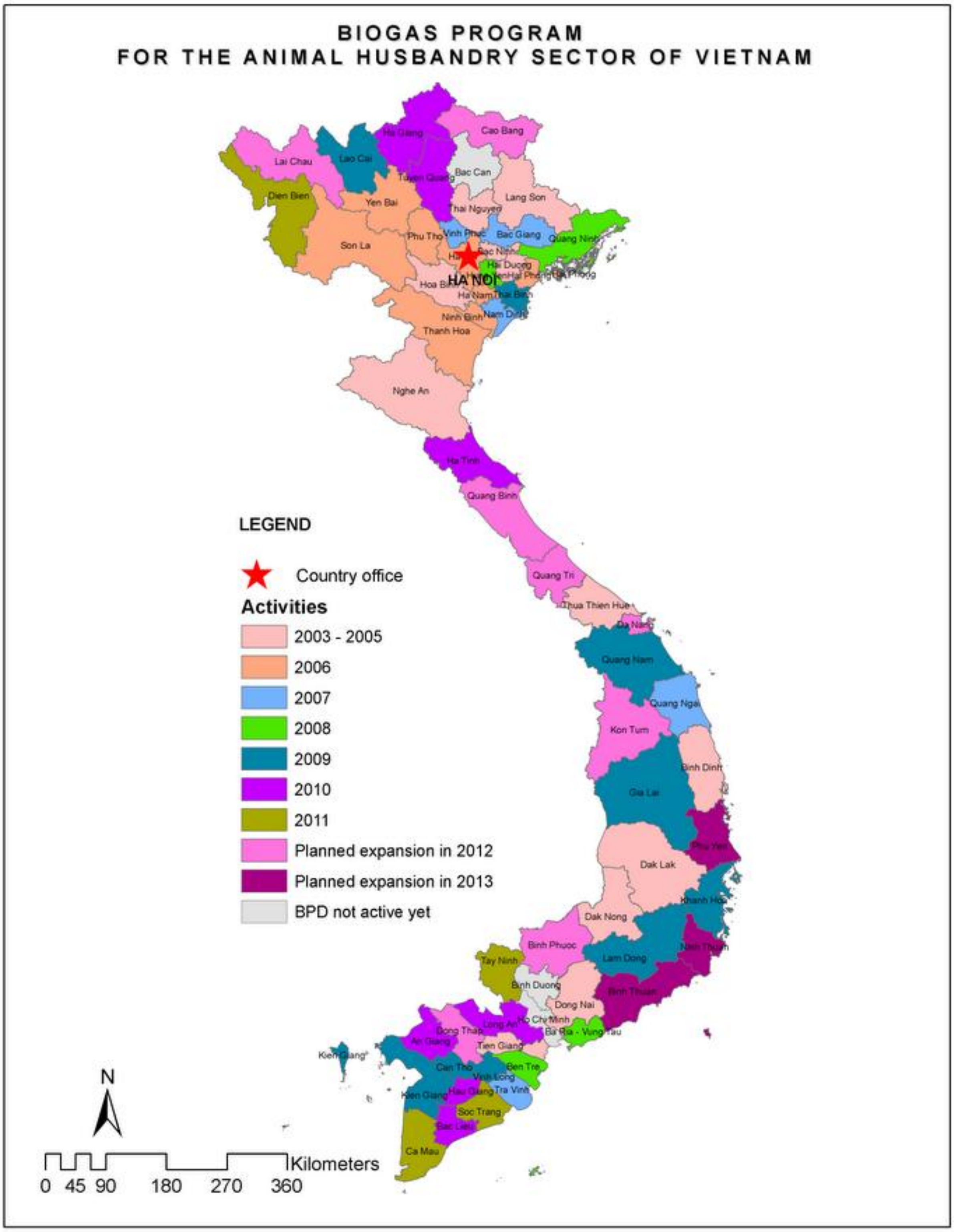
The Socialist Republic of Vietnam.

A.4.1.2. Region/State/Province etc.:

Number	Province	2007	2008	2009	2010	2011	2012	2013
1	An Giang				x	x	x	x
2	Bà Rịa V.Tàu		x	x	x	x	x	x
3	Bắc Giang	x	x	x	x	x	x	x
4	Bắc Kạn						x	x
5	Bạc Liêu				x	x	x	x
6	Bắc Ninh	x	x	x	x	x	x	x
7	Bến Tre		x	x	x	x	x	x
8	Bình Định	x	x	x	x	x	x	x
9	Bình Dương							
10	Bình Phước						x	x
11	Bình Thuận							x
12	Cà Mau						x	x
13	Cao Bằng						x	x
14	Đăc Lăc	x	x	x	x	x	x	x
15	Đăk Nông						x	x
16	Điện Biên					x	x	x
17	Đồng Nai	x	x	x	x	x	x	x
18	Đồng Tháp						x	x
19	Gia Lai			x	x	x	x	x
20	Hà Giang				x	x	x	x
21	Hà Nam	x	x	x	x	x	x	x
22	Hà Tĩnh				x	x	x	x
23	Hải Dương	x	x	x	x	x	x	x
24	Hậu Giang				x	x	x	x

25	Hoà Bình	x	x	x	x	x	x	x
26	Hưng Yên		x	x	x	x	x	x
27	Khánh Hoà			x	x	x	x	x
28	Kiên Giang			x	x	x	x	x
29	Kon Tum						x	x
30	Lai Châu						x	x
31	Lâm Đồng			x	x	x	x	x
32	Lạng Sơn	x	x	x	x	x	x	x
33	Lào Cai			x	x	x	x	x
34	Long An				x	x	x	x
35	Nam Định	x	x	x	x	x	x	x
36	Nghệ An	x	x	x	x	x	x	x
37	Ninh Bình	x	x	x	x	x	x	x
38	Ninh Thuận							x
39	Phú Thọ	x	x	x	x	x	x	x
40	Phú Yên							x
41	Quảng Bình						x	x
42	Quảng Nam			x	x	x	x	x
43	Quảng Ngãi	x	x	x	x	x	x	x
44	Quảng Ninh		x	x	x	x	x	x
45	Quảng Trị						x	x
46	Sóc Trăng					x	x	x
47	Sơn La	x	x	x	x	x	x	x
48	T.Thiên Huế	x	x	x	x	x	x	x
49	Tây Ninh					x	x	x
50	Thái Bình			x	x	x	x	x
51	Thái Nguyên	x	x	x	x	x	x	x
52	Thanh Hoá	x	x	x	x	x	x	x
53	Tiền Giang	x	x	x	x	x	x	x
54	TP Cần Thơ			x	x	x	x	x
55	TP Đà nẵng							
56	TP Hà Nội	x	x	x	x	x	x	x
57	TP Hải Phòng	x	x	x	x	x	x	x
58	TP HCM							
59	Trà Vinh	x	x	x	x	x	x	x
60	Tuyên Quang				x	x	x	x
61	Vĩnh Long			x	x	x	x	x
62	Vĩnh Phúc	x	x	x	x	x	x	x
63	Yên Bái	x	x	x	x	x	x	x
	Total	24	28	37	44	47	57	60

Note: the project intends to scale up to 63 provinces after 2013


BIOGAS PROGRAM
FOR THE ANIMAL HUSBANDRY SECTOR OF VIETNAM
LEGEND
Country office
Activities
2003 - 2005
2006
2007
2008
2009
2010
2011
Planned expansion in 2012
Planned expansion in 2013
BPD not active yet
N
Kilometers
0 45 90 180 270 360
Cao Bang
Lai Chau
Lao Cai
Bac Can
Lang Son
Dien Bien
Yen Bai
Thai Nguyen
Phu Tho
Bac Giang
Son La
HA NOI
Hai Duong
Ninh Binh
Thanh Hoa
Nghe An
Ha Tinh
Quang Binh
Quang Tri
Quang Nam
Kon Tum
Gia Lai
Dak Lak
Dak Nong
Binh Phuoc
Lam Dong
Tay Ninh
Dong Nai
Long An
An Giang
Can Tho
Ben Tre
Tra Vinh
Soc Trang
Ca Mau

A.4.1.3. City/Town/Community etc.:

The objective of the programme is to establish a commercially viable market for domestic biogas. The primary process, biogas construction teams selling high-quality domestic biogas plants to prospective smallholder agricultural households is key in reaching this objective. A consequence of the approach is that biogas dissemination follows market demand, and location details will only be available after households and biogas construction teams have entered into a contractual agreement.

A.4.1.4. Details of physical location, including information allowing the unique identification of this project activity (maximum one page):

Full details of the physical location of the biogas installation will only be available after commissioning and acceptance and are stored in an electronic database. Details include:

- Name of head of household, including personal ID-card number;
- Full address of household (Province / District / Commune/Village);
- Unique plant ID code (PPP/DDD/CCC/xxx); (Province code, District code, Commune code/number);
- Name and ID of Mason that built the plant.

The unique plant ID code will allow for unique identification of each biogas installation.

A.4.2. Category(ies) of project activity:

The project belongs to sectoral scope 1 and 13 and falls into category type I thermal energy to the user and type III methane recovery.

The proposed activity conforms with the type I category as biogas is used to generate thermal energy for cooking and or lighting and also conforms to type III methane recovery as methane being the main constituent of biogas is recovered from animal manure by anaerobic digestion in a bio-digester.

A.4.3. Technology to be employed by the project activity:

The project involves the installation and implementation of model types KT.1 and KT.2 domestic biogas plan or equivalent[2]. In case other domestic biogas technologies are included; a detailed description of the equivalent technology will be included in the monitoring report. Each installation will be installed according to the MARD national standard[3], and in that case the expected lifetime is in the order of 25 years. At the moment of writing around 79% of the digesters installed are of KT.1 type and 21% of KT.2 type. The KT.1, KT.2 and other models of biogas plants have been developed after 1990s in Vietnam. Development is done by the Institute of Energy as well as others based on earlier

[2] Biogas plants that are recognized in the MARD biogas standard for small scale biogas

[3] MARD national standard: 10 TCN 97 ÷102 – 2006. Issued by decision N[0] 4006/QĐ-BNN-KHCN of Ministry of Agriculture and Rural development on 26th December 2006.

Chinese and German design. Design, construction and fitting has been standardized in MARD's "standards for small size biogas plants # 10 TCN 497 – 2005 –- Part 6".

The hemi-spherical fixed dome plants are made on-site, entirely out of brick work. The materials required for construction, including bricks, cement, iron bars, fitting materials etc. are all locally manufactured. Basic appliances, which are also widely available, consist of gas pipe, main valves, stoves and gas lamps. Biogas plants will be installed in the range of 4 m^3 to 50 m^3 with a current average size of $8m^3$ to $15m^3$ (11.35 m^3 on average of units built between 1-1-2007 and 31-08-2011),

Both designs need a fair amount of construction skills, but have otherwise proven to be robust and virtually maintenance-free. With feeding of on-farm produced manure of pigs, cattle or buffalo to the digester, biogas will be produced to meet the energy demand of the household. The residue of the digestion process can be used as organic fertilizer.

The KT.1 model is a further development of the model NL.5 of the Institute of Energy and has been accepted widely in the programme.

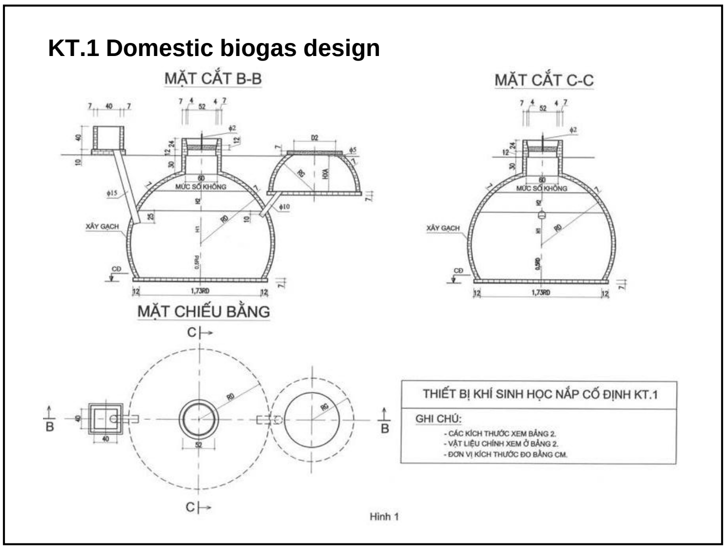


Figure 1: Blueprint of the KT.1 domestic biogas plant

The KT.2 model follows the TG-BP design as applied in the Mekong Delta by the Can Tho University. Similar to KT.1, the revised design for KT.2 accommodates digester volumes of 4 to 50 m^3.

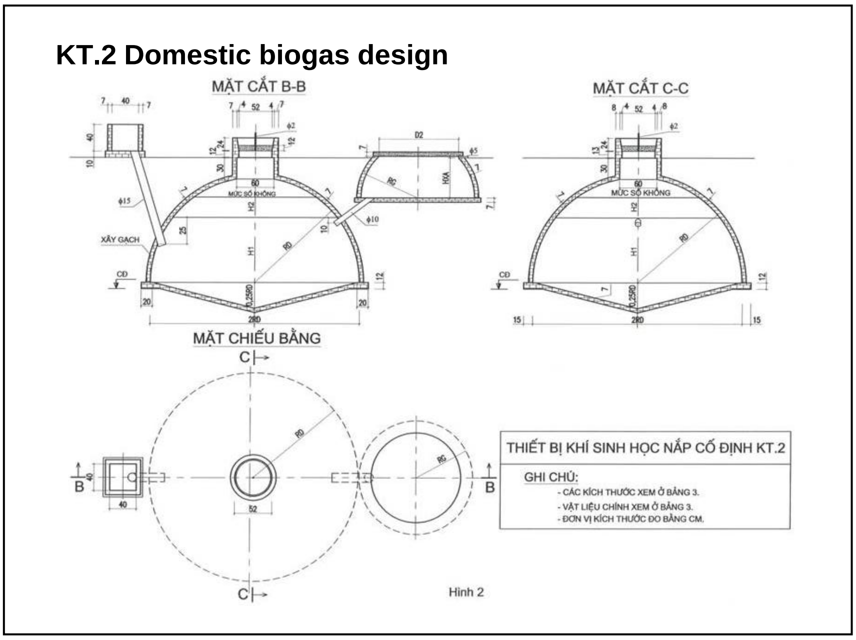


Figure 2: Blueprint of the KT.2 biogas plant design

Although the KT.1 model optimizes material economy best, it needs deeper excavation. For areas with a high water table or rocky ground, the KT.2 is then better suited.

For both models, design variations allow for the type of manure (pig and cattle/buffalo), the dilution ratios of water and manure (1/1, 2/1 and 3/1) and the specific climatic conditions (the North with a cold winter and the South with a warm winter). The programme uses an elaborate design manual, combining over 100 design variations.

A.4.4. Estimated amount of emission reductions over the chosen crediting period:

Credit period: The project applies for a renewable crediting period of 7 years.
Start date of the VGS project: 19-07-2006
Start date of operation of first digesters: 1-1-2007

The retroactive credit period start date is expected to be 1/5/2010 or the VGS registration date minus two years, whatever date is later. The first credit period is expected to run from 1/5/2010 – 30/4/2017.

Expected crediting year		Credit type	Estimated Accumulated units at the end of each year	Estimated annual emission reductions in tCO2e
01/05/2010	31/12/2011	GS-VER	89,176	814,174
01/01/2012	31/12/2012	GS-VER	92,300	573,857
01/01/2013	31/12/2013	GS-VER	95,708	595,323
01/01/2014	31/12/2014	GS-VER	99,116	616,938
01/01/2015	31/12/2015	GS-VER	102,524	638,553
01/01/2016	30/04/2017	GS-VER	107,078	885,028
Total estimated emission reductions(tCO2e)				4,123,873
Total number of credits years				7
Total number of GS credits years				7 years
Average number of credits per year (tCO2e)				589,125
Average emission reduction per biodigester (tCO2e)				6.34

A.4.5. Public funding of the project activity:

The Biogas Programme for the Animal Husbandry Sector has received and will receive public funding from Annex I Parties, i.e. Dutch Funding. Such funds have not been, and will not be, used to purchase VERs, nor will they result in diversion of ODA. The non-ODA diversion declaration is included in the Gold Standard Passport report (GSPR).

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:

Technologies and practices to displace decentralized thermal energy consumption, version 1.0
Sectoral scope 1,3,13. Available online: http://www.cdmgoldstandard.org/wp-content/uploads/2011/10/GS_110411_TPDDTEC_Methodology.pdf

B.2. Justification of the choice of the methodology and why it is applicable to the project activity:

This methodology is applicable to programs or activities introducing technologies and/or practices that reduce or displace greenhouse gas (GHG) emissions from the thermal energy consumption of households and non-domestic premises. Examples of these technologies include the introduction of improved biomass or fossil fuel cook stoves, ovens, dryers, space and water heaters (solar and otherwise), heat retention cookers, solar cookers, bio-digesters.

The IPCC tier 1 approach is adopted for the assessment of the baseline emissions from the animal waste management systems (AWMS). This approach is followed because local data required for an estimation of the methane emission factor per category of livestock is not available. A number of survey on AWMS have been conducted, however, the manure management categories identified were not comparable with the IPCC 2006 Manure management system (MS) categories. In addition, animal waste is partly collected for utilization. Under these conditions, the applied methodology allows for a baseline emission estimate using the IPCC Tier 1 approach. This is conservative. Project emissions from AWMS however, will be estimated with the IPCC tier 2 approach.

There are 2 climate zones in Vietnam, temperate for the provinces with an average annual temperature 25 degrees or lower and warm for those above 25 degrees Celsius. The BFT and PFT will take climate zones into account where relevant for the emissions calculations. The emissions from AWMS are temperature related and therefore the BFT and PFT will target each zone. Emission from fuel use however, are not temperature related and therefore the BFT and PFT for thermal energy use will not target each zone separately.

The BP installs bio-digesters and this activity is covered by the methodology. The methodology lists the following conditions for application:

Table 1: Eligibility assessment

Eligibility criteria	Assessment
1. The project boundary can be clearly identified, and the technologies counted in the project are not included in another voluntary market or CDM project activity (i.e. no double counting takes place). Project proponents must have a survey mechanism in place together with appropriate mitigation measures so as to prevent double-counting in case of another similar activity with some of the target area in common.	The technologies all have a unique identification numbers, based on that numbers double counting can be avoided. A system to avoid double counting is described after this table.
2. The technologies each have continuous useful energy outputs of less than 150kW per unit (defined as total energy delivered usefully from start to end of operation of a unit divided by time of operation).	In 2006 the biogas flow of 100 digesters was measured as part of the Biogas User Survey 2006. The calculated specific thermal output based on the biogas flow and cooking time is around 0.10 kW per cubic meter of digester volume. The largest biogas plant will therefore have a thermal output of 4.99 kW. This is much lower than the 150 kW threshold stipulated by the methodology[4].
3. The use of the baseline technology as a backup or auxiliary technology in parallel with the improved technology introduced by the project activity is permitted as long as a mechanism is put into place to encourage the removal of the old technology (e.g discounted price for the improved technology) and the definitive discontinuity of the use.	BP does not install an improved baseline technology, but a different technology The baseline technology will remain in use in cases there is not enough biogas (i.e. festivities) or for specific activities such a grilling of food which is not possible with a biogas stove.
4. The project proponent must clearly communicate to all project participants the entity that is claiming ownership rights of and selling the emission reductions resulting from the project activity.	This is ensured in the sale contract between the household and the biodigester installer
5. Project activities making use of a new biomass feedstock in the project situation (e.g. shift from non-renewable to green charcoal, plant oil or renewable biomass briquettes) must comply with relevant Gold Standard specific requirements for biomass related project activities, as defined in the latest version of the Gold Standard rules	The project does not make use of new biomass source. The project utilizes manure to produce biogas.

[4] Digesters built in 2006 have the same design as the current digesters and utilize the same feedstock; the calculation values are therefore representative.

The maximum thermal output of the biogas plant is calculated in 2 steps:

STEP 1: Calculation of the specific biogas production (m^3 biogas/ m^3 digester volume)

Table 2: Values for estimation of biogas plant capacity

Item	Value	Unit
Average biogas production of a 9.6 m^3 biogas plant[5]	1,32	m^3/hh/day
Average digester volume[5]	9.6	m^3

The specific biogas production is 1.32/9.6 = 136.8 liter biogas per cubic meter digester volume of the average digester.

STEP 2: Calculation of specific thermal output (kW/ m^3)

Table 3: Values for estimate specific thermal energy capacity

Item	Value	Unit	Source
Methane content in biogas	60	%	AMS-III.D default value
Methane density	0.67	kg/ m^3	
Methane energy density	55.65	MJ/kg	IPCC 2006 volume 4 chapter 10
Biogas stove efficiency	39	%	SNV (2009) Popular Summary of the Test Reports on Biogas Stoves and Lamps prepared by testing institutes in China, India and the Netherlands
Average operating hours of biogas stove	3.3	h/hh/day	BUS 2006

The specific thermal output is calculated with the following equation.

$$\text{Specific thermal capacity} = \text{Specific biogas production} \times \text{Methane density} \times \text{methane content of biogas} \times \text{Energy density of methane} \times \text{Biogas stove efficiency} \, / \, \text{Average operating hours of biogas stove}$$

Specific generation capacity = 0.1368 x 0.67 kg/ m^3 x 60% x 55.65 MJ / m^3 /3.6 (1 MWh/3,600 MJ) x 0.39 / 3.3 = 0.0997 kW/ m^3

The next table shows the thermal output calculated for 7 example digester sizes, including the smallest and the largest digester that is built.

[5] Biogas User Survey (BUS) 2006

Table 4: Calculated thermal output for 7 example digester size

Digester size (m^3)	Thermal output (kW)
4	0.40
10	1.00
11.35	1.13
20	1.99
30	2.99
40	3.99
50	4.99

Double counting

Since in parallel to this BP VGS a CDM PoA the Vietnam Biogas Programme[6] (VBP) is being developed there is a risk of double counting. The PoA is not registered as of date and hence counting has not started. The PoA however, does include a number of units built between 22 June 2007 and 31 December 2009 which are bundled in 2 CPAs. As the PoA only targets households that use fossil fuel, which comprise around 42% of the biogas population, only around 42% of the households in that period are included in the CPAs. The PoA at validation only contains 1 CPA, the second CPA is not yet developed or under review. The next table show which units are included in which project:

Table 5: Overview of units included in the VBP PoA and the BP VGS project

Units in operation by period						
Timeline***	19 July 2006 (in operation from 1/1/2007) to 22 June 2007	22 June 2007-31 December 2009	1/1/2010 (Global stakeholder consultation) – PoA registration date	PoA registration date (around mid-2012)	Credit start date of new CPAs not included in the PoA at time of validation	Credit start data of new CPAs included in the PoA
CDM Programme of Activities, the Vietnam Biogas Programme						
CPA 01 under the PoA		Around 21% of the units are included in CPA 1		CPA 01 credit period start date		
CPA02 (not yet developed)**		Around 21% of the units are included in CPA 2			CPA 02 credit period will start later after DOE desk review and inclusion	
CPA0x (potential)**			*Potential start data of CPA0x*	*Potential start data of CPA0x*	*Potential start data of CPA0x*	*Potential credit period start date of CPA0x*

6 http://cdm.unfccc.int/ProgrammeOfActivities/Validation/DB/FYHTWZ3QLWM91NKR9DB47YIHGQ5KSU/view.html

Biogas Program for Animal Husbandry Sector of Vietnam Voluntary Gold standard Project						
BP VGS	19 July 2006 BP VGS start data. All units are included in the VGS project	All units built are included in BP VGS	1/1/2010 Anticipated VGS retroactive credit period start date. All units built are included	All units excluding the units included in CPA1*	All units excluding the units included in CPA1 and CPA02**	All units excluding the units included in CPA1, CPA02 and CPA 0x**
Double counting risk						
Double counting risk:	No, all units included in VGS	No, counting of CPA01/ 02 only starts after PoA registration date	No, counting of CPA01 and 02 only commences after PoA registration date	Yes, will be mitigated by excluding units included in the CPA included in the PoA from the VGS project* and cross checking of the CPA and PoA databases with the BP VGS database using the unique ID codes of biogas plants		

** all units might remain in the VGS project if this is more attractive to BPD compared to the CDM-PoA.*
*** CPA 02 is not yet developed and until the date of CPA02 inclusion, the units remain in the VGS project. CPA 0x is only included to illustrate how new CPAs can affect the BP project. Both CPA02 and CPA0x will not be developed if the VGS project turns out to be more attractive. The units will remain in the BP VGS project in that case.*
**** Dates represent the moment that a biodigester plant is in operation*

In conclusion

- All units built from 1/1/2007 until the PoA registration data are included in the BP VGS project;
- All units from the VGS credit period start data until the PoA registration data are credited under VGS;
- After the PoA registration data, the units included in CPA 01 will be transferred from VGS to the PoA, *unless* the VGS project is more attractive. The remaining units will remain in the VGS project.
- After the inclusion of CPA02 in the PoA, the units included in CPA 02 will be transferred from the VGS to the PoA, *unless* the VGS project is more attractive. The remaining units will remain in the VGS project.
- Units built under BP after the PoA registration data will be included in the VGS project, unless a new CPA is developed and included. The units includes in any other CPA will be excluded from the VGS project until the date of CPA inclusion.

The CPA database and the VGS database will be provided for verification to the DOE to ensure transparency and to demonstrate single counting.

B.3. Description of the sources and gases included in the project boundary:

The project boundary encompasses the geographical sites all the units commissioned from 1/1/2007 of all biodigester under the project[7]. The project will gradually extend to the whole of Vietnam; the project boundary is therefore Vietnam. The wood fuel collection and production area is also Vietnam (see annex 3).

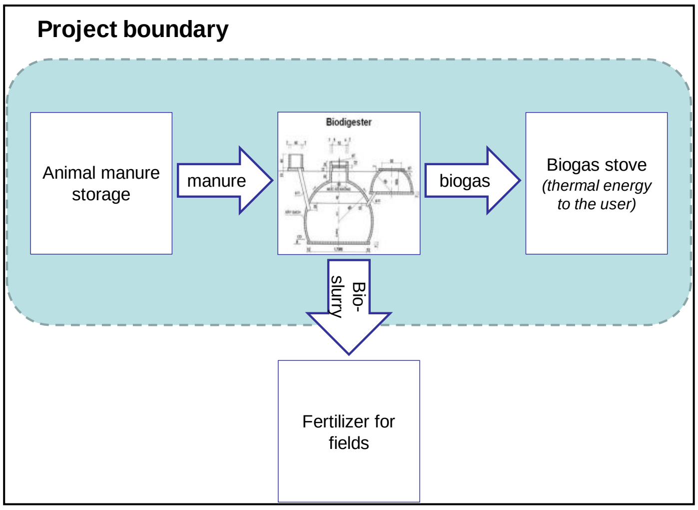


Figure 3: Overview of emission sources included in the project boundary

The next table shows the GHGs included in the project boundary.

[7] Excluding units credited under the CDM PoA, see the previous page

Table 6: GHG Emission sources included in the project boundary

	Source	GHG	Included?	Justification / explanation
Baseline	Thermal energy demand	CO_2	Yes	Major source of GHG emission
		CH_4	Yes	Major source of GHG emission
		N_2O	Yes	Major source of GHG emission
	Animal waste handling and storage	CO_2	No	Excluded as CO_2 emissions from animal waste are CO_2 neutral
		CH_4	Yes	Major source of emissions
		N_2O	No	Excluded for simplification; conservative
Project activity	Bio digester system	CO_2	No	Excluded as CO_2 emissions from bio-slurry are CO_2 neutral
		CH_4	Yes	Emissions from physical leakage
		N_2O	No	Excluded as a biodigester does not produce N_2O gasses
	Thermal energy demand and	CO_2	Yes	Major source of GHG emission
		CH_4	Yes	Major source of GHG emission
		N_2O	Yes	Major source of GHG emission
	Incomplete combustion of biogas	CO_2	No	Excluded as CO_2 emissions biogas are CO_2 neutral
		CH_4	Yes	Major source of emissions
		N_2O	No	Negligible source of emissions

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

A baseline scenario is defined by the typical baseline fuel consumption patterns in a population that is targeted for adoption of the project technology. Hence, this “target population” is a representative baseline for the project activity. The baseline from AWMS are methane emissions from the animal manure management systems resulting from the anaerobic biodegradation of VS.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

The Gold Standard requires that either one of the UNFCCC or Gold Standard approved additionality tools provided in toolkit 2.1, irrespective the scale and type of the project and whatever the stream you are applying for (VER, CDM or JI).

For this project the latest additionality tool available (as of Sep 2009) on the UNFCCC website is used. The tool used is: *Tool for the demonstration and assessment of additionality*" version 6[8]. According to the tool the following step-wise approach should be followed:

Step 1: Identification of alternatives to the project activity;

Step 2: Investment analysis to determine that the proposed project activity is not the most economically or financially attractive;

Step 3: Barriers analysis;

Step 4: Common practice analysis.

An additional step is added to the additionality analysis, and that is the early consideration of carbon revenues.

<u>The prior consideration of carbon finance</u>

The VGS start date is 19 July 2006 and the first unit taken into operation was on 1/1/2007, which is defined as the start date of the BP phase II.. Already at the time of the program planning in 2006 it was clear that the program goals could only be achieved with carbon financing. This is why BPD developed a PIN for a CDM project and received a Letter of Endorsement from the Vietnamese DNA in 2006 and started at the same time with the help of Mitsubishi Securities UFJ the development of a CDM-PDD, as part of a loan proposal of KfW. In 2007/2008 the Vietnamese government decided not to take up the loan from KfW and this cancelled the CDM development. Subsequently, BPD with help of SNV started with the development of a voluntary Gold Standard project in 2008. In parallel to this, in 2009, GFA Envest developed a PoA manual for mini household biogas in Vietnam. GFA Envest recommended developing a VGS project until the moment a CDM PoA is developed and registered. A local stakeholder consultation workshop was conducted by GFA for that purpose in 2009. At the end of 2009 ADB stepped in and it was decided to develop the PoA. No financing was made available for the VGS project. In 2011 BPD contacted Nexus – Carbon for Development to pick up and finalize the VGS project development with the objective supplement the PoA ensuring that all the units can be credited.

Table 7: Timeline of the carbon finance activities

Programme Activity	Year
Carbon feasibility study: Study Domestic Biogas and CDM financing –Proof consideration of carbon for 2006 onwards.[9]	November 2005
Start date of VGS project (first application for a biogas plant, date of completion was on 1/1/2007)	19 July 2006
PIN Reception of Letter of Endorsement (LoE) from Vietnam DNA[10]	28 September 2006
PDD Development by Mitsubishi Securities UFJ as bundle CDM project with credit period start date 1-10-2006	2006- 2007
Baseline development and GS PDD development by SNV (Felix ter Heegde)	January 2008

[8] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v6.0.0.pdf

[9] http://www.natuurenmilieu.nl/pdf/0500_2.1_domestic_biogas_and_cdm_financing_background_paper.pdf

[10] http://www.noccop.org.vn/Data/profile/Airvariable_Projects_75233Tong%20hop%20PIN.pdf

(draft PDD developed: Nov 2008, start date crediting period 1-1-2008	
Approval on the QSEAP-BDP by MARD with consideration of CDM revenue in financing mechanism	20 November 2008
PoA methodology development and project documentation by GFA Envest	March 2009 to September 2009
Local Stakeholder Workshop in Phu Tho and Nghe Anh	April 2009
Submission to UNFCCC EB for public comment	December 30th 2009
GS consultant contract signed between BPD and Nexus – Carbon for Development	September 2011

Step 1: Identification of alternatives to the project activity

Sub-step 1a: Define of alternative scenarios to the proposed project activity.

If the BP would not have been supported with carbon finance, the following scenarios are plausible:

1) Continued use of unsustainable fuel wood and fossil fuel for cooking and kerosene for lighting;
2) The proposed project activity undertaken without being registered as VGS activity;
3) Switch to fossil fuel;
4) Continuation of baseline manure management systems;
5) Development of BP based on donor and/or public funding;

Alternative 1: The business as usual scenario of using unsustainable fuel wood and fossil for cooking and kerosene for lighting. Around 64% of the population uses firewood. In terms of thermal energy output for cooking this scenario would deliver similar thermal output compared to the biogas stove and for most users a lower output for lighting with kerosene compared to biogas lamps.

Alternative 2: Option 2 is not applicable because it is foreseen in the initial plan that revenue from carbon offsets are needed to implement BP II & III. Without carbon finance it is not possible for BP to develop a sustainable market sector by continuing to support mason trainings, quality control and assurance and to support the household[11]. This is currently visible by the fact that BP will not achieve the phase II target of 140,000 households in 2012, but only around 100,000. Also insufficient finance is available to start with the programme activities in four provinces, namely Bắc Kạn, Hà Giang, Quảng Bình, Quảng Trị, Lai Châu and Cà Mau. Provinces which would have been part of BP if more funding was available. Before Nexus stepped in, for both the pre-financing and the development of VGS in September 2011, BP was planning to dismantle its activities in 2012. With the application of VGS BP plans to develop phase III and continue to support the development of the biogas sector. The provisional budget plan of Phase III contains at the moment only carbon finance as Dutch ODA will cease in 2012. In the event that the VGS application is unsuccessful, the program lacks funding for phase III and will likely dismantle.

[11] Currently a subsidy is provided of 1.2 Million VND for KT.1 and KT.2 biogas plants.

Alternative 3: The most credible alternative fossil fuel would be coal or LPG for cooking. LPG however is only used by 23% of the households and coal by 22% (Source VGS database)

Alternative 4: This is the continuation of the baseline manure management scenario. Exact data on the manure management system of the baseline are not available. A journal article from T.K.V Vu et al (2007) indicates that 21% of the manure from pig farms was used for crop fertilization, 22.8% as fish pond feed, 22.8% dried and sold and 33.3% discharged in public sewers[12]. This practice is likely to continue without BP.

Alternative 5: Development of BP based on donor and/or public funding
Alternative 5 is not applicable as the Vietnamese government does not have the funds to finance the subsidy and support component and therefore the same obstacle as described in alternative 2 remains. Donor support for BP will end in 2012 and from that moment on BP will rely on VGS revenues.

Outcome of sub-step 1.A
The most realistic and credible alternative scenario is the continuation of the current situation: the reliance on non-sustainable firewood, fossil fuel and kerosene for lighting. Fuels that cause substantial GHG emission, indoor air pollution and drudgery.

Sub-step 1b: Consistency with mandatory rules and regulations
Alternative 1: Continued use of unsustainable fuel wood, and fossil fuel for cooking and kerosene for lighting.
The procurement of wood for cooking is in full compliance with applicable laws and regulations; unless firewood originates from logging activities in national and protected forests. The procurement of fossil fuels and kerosene for lighting is conform national regulations.

Alternative 2: Continuation of the project activities without carbon finance
The BP activities without carbon finance are consistent with mandatory rules and regulations.

Alternative 3: Switch to fossil fuels
A switch to LPG is in compliance with all mandatory applicable legal and regulatory requirements.

Alternative 4: Continuation of baseline manure management systems
This alternative is in compliance with all applicable legal and regulatory requirements.

Alternative 5: Development of BP based on donor and/or public funding
The implementation of BP is not bound to any legislation that prohibits certain types of funding. The development of BP without carbon finance is compliant will applicable legal and regulatory requirements.

Outcome of Step 1.b:
All the options are consistent with mandatory rules and regulations.

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[12] T.K.V. Vu et al (2007) Livestock Science 112 (288-297). Available online on http://www.prairieswine.com/pdf/34560.pdf

Proceed to Step 2 (Investment analysis) or Step 3 (Barrier analysis). (Project participants may also select to complete both Steps 2 and 3.)

Step 2 is skipped for step 3

Step 3: Barrier analysis

Investment barrier at the level of the BP

Attracting commercial investments. The BP is the national program to support the dissemination of biogas facilities managed by public entities. It is not designed to attract commercial investment for the generation of revenues.

Attracting public funding. The national biogas program is financed by farm holders' contributions and by public funding. To assess the investment barrier of the national biogas program with regard to public funding, the financing history of the overall program is briefly outlined.

The national biogas program started its phase 1 program (2003-2005) with support from the Government of Netherlands. The phase 1 program implemented 18,000 biogas facilities in the years 2003 to 2005. With considerable success of the phase 1 program, the MARD and SNV decided to expand the program.

From 2006, the BPD, with support from the Government of Netherlands, has prepared the phase 2 program, aiming at the installation of 140,000 biogas facilities in 58 provinces of Vietnam. Before the start of the phase 2 program, 1/1/2007, the BPD pursued financing options via the Clean Development Mechanism (CDM) or Voluntary Gold Standard (VGS) in order to close the financial gap. The carbon revenues were considered as an integral and crucial mean for ensuring the project's financial viability. Without the structuring of carbon revenues, the project cannot reach its goals. The MARD and the Government of the Netherlands confirm that a) the funding without carbon revenues is not sufficient to implement the phase 2 program, and b) the CDM is considered to be an integral component of the phase 2 program. Phase III, the period from 2013 to 2018 is facing even higher barriers as the Government of the Netherlands will cease to support the project financially.

(a) Investment barrier for biogas facilities at household level

Small farm holders face an investment barrier due to the high upfront investment of biogas facilities. The implementation of a biogas facility involves significant investment costs at the time of construction. The average costs of a biogas digester per m^3 installed capacity amount to 0.95 million VND. The average size of a biogas facility comprises 11.35 m3[13]. The table hereunder shows the average cost of a digester by for the four most common sizes, the prevalence and the support `cost.

[13] Of digesters built between 1-1-2007 and 31-08-2011(VGS database)

Table 8: Costs of the 4 most prevalent digester sizes[14]

Most common digester size (m^3)	12	9	15	8
Prevalence (%)	39%	28%	19%	14%
Average price (million VND/unit)	9.4	7.4	10.6	6.8
Average Support Costs (million VND/facility)	2.2	2.2	2.2	2.2
Total Average Costs (including support) (million VND/unit)	11.4	9.6	12.8	9.0

Thus, the average price of the most common facility amount to 9.4 million VND (the 12 m^3 digester) comprising material and labor. This is complemented by costs arising from support activities amounting to on average 2.2 million VND. The support comprises:

- Pre-construction and promotion workshops where farm holders are informed on the opportunities of biogas facilities,
- Post-construction user training workshops;
- During construction and post construction quality control on the biogas plant;
- 12 months guarantee on the biogas facility;
- Training in the sound operation of biogas facilities;
- Mason and biogas technician trainings, masons certification, refreshment trainings;
- Subsidy of currently 1.2 million VND[15].

Above services, summarized as support, are crucial to the success of the national biogas program 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 2.2 million VND resulting in an average total costs of 11.3 million VND for the most common digester (the 12 m3 digester, see the above table).

Biogas appliances are bought by the households themselves and come at an additional cost of around 1 million VND[16]. The total investment that a farmer makes is therefore around 10.4 million VND (9.4+1). This is a significant amount for a small farm holder. The Biogas User Survey of 2009 for instance estimated that the income of the average biogas household is around 6.70 to 14.89 million VND/person/year, on average 10.8 million VND (BUS 2009 page 34). Thus biogas investment costs make up make up 87% of the average annual income in case the household would install the most common digester of 12 m^3. Even with the smallest most common digester of 8 m3, the biogas investment is very high (63% on average). This poses a significant barrier to the implementation of biogas facilities.

[14] Construction material prizes and labor rates differ per region; the mentioned prices are sourced from certified masons.

[15] Subsidy figures are annually revised to ensure that the levels are appropriate. In 2006 for instance, the subsidy level was only 600.000, but in 2006 the digester cost was also half.

[16] Biogas stove prices range from approx.. 400,000 to 1.5 million and are sold and manufactured by private enterprises. Biogas lamps cost around 165,000 VND

In another study, the micro credit survey of 2009, hold amongst 407 respondents showed that 64.0% of the respondents claim they cannot afford to pay all the costs incurred by the construction of biogas works. This shows that the investment is a considerably investment for the majority of the households.

This shows that farmers already face an investment barrier even when the support costs are paid for by the programme.

(b) Technological barrier

The biogas technology has been introduced and developed in Viet Nam since 1960. Before the start of BP the most popular digester types were the nylon plastic bag and fixed dome plants. BP which started in 2003, is the first programme that managed to mass disseminate fixed dome technologies. In 2009 there are around 11,068 VACVINA biogas plants (box shaped brick digester with separate plastic gasholder). An unknown number of nylon plastic bag biogas plants are also constructed, however due to the short lifespan of these biogas plants, many are likely out of order. As of date, the dissemination level remains low.

This is due not only to the investment barriers elaborated above, but also due to the suspicion many farmers have towards the biogas digester system. Although the Project's digesters have been proven to work, it has been common in the past for fly-by-night "technology providers" to sell unreliable digesters, particularly the nylon bag digester, at the huge expense of the unsuspecting farmers. The Project thus faces an uphill battle in promoting the biogas technology. The poor quality of biogas digesters is a well-known barrier for the dissemination of biogas digesters worldwide.

In the absence of a proper quality control program, suppliers of biogas plants would compete solely on price. Users cannot determine the quality of biogas units. Thus without the proposed BP activity, biogas constructors would have an incentive to save on costs and provide poor quality systems.

BP provides quality control on all plants constructed under the program. The carbon revenues will support the quality control and the construction standard. Without the carbon revenues the program objective of establishing a viable commercial biogas sector would probably fail and the planned target would not be achieved. It is also evident that in the absence of the project activity the households would continue to use conventional fossil fuels and to dispose the manure in the conventional ways. The Project thus faces an uphill battle in promoting the biogas technology.

There are at the moment 2 competing household biogas technologies in Viet Nam with the KT.1 and KT.2, the nylon bag and the VACVINA biogas plant.

SEDCC[17] (2010) showed in an evaluation study for household Biogas Plant Models in Viet Nam that the technologies promoted by BP have a longer pay back period and a lower initial rate of return compared to the nylon back digester. However, the reliability and the quality of the nylon back are much lower. Users facing the high investment barrier will not choose the KT.1 and KT.2 but will

[17] *Sustainable Energy Development Consultancy Joint Stock Company*

install a Nylon bag digester. Farmers investing in a Nylon bag however will install a digester that is unreliable and after a few years the digester will breaks down. This will not only impact the opinion of that farmer regarding biogas, but he/she will spread the impression to other farmers that biogas does not work. The project hence faces an uphill battle to persuade farmers to invest in a better quality digester which includes proper support arrangements.

Another alternative cheaper than the KT.1 and KT.2 is the Vacvina. In a report of the Consulting Engineers Mekong (2005) the Vacvina was compared with the KT.2. The evaluation study revealed that the VACVINA is a less appropriate model than the KT.2. The digester has several weaknesses compared to the KT.2, such as weaker structural design, higher operation, repair and maintenance costs and the safety of the biogas plant is much lower. The VACVINA biogas plant had the lowest score of safety and the KT.2 the highest. The VACVINA has a low score because gas is not captured in an integrate gasholder but in a plastic bag. The plastic bag is often placed directly under the roof in the stables. The gas pressure is very low in the plastic bag and hence households often have to compress the bag with strings or by putting stones on the bag. Consequently the bag is easily and frequently damaged leading to a situation that gas escapes leading to a potential dangerous situation.

In conclusion, the KT.1 and KT.2 digester offer better quality and lifespan compared to the nylon bag and the VACVINA. Without BP, households will due to the investment barrier choose lower quality alternatives and will not opt for the KT.1 and KT.2.

(c) Barriers due to prevailing practice

Current practice in households in Vietnam is to burn fossil fuels and biomass for cooking. The households with higher living standard also cook on electricity. However, these households are neither the target group nor the programme participants. In order to change the prevailing practice it is necessary to implement the programme to coordinate biogas unit installation on a wide scale and offer subsidy and support to encourage households to participate.

The number of fixed dome biogas units installed in Viet Nam is around 111,000 (Phase I + Phase II units) while the potential is 1,83 million[18], hence less than 10% of the potential is reached. According to the applied methodology the technology can be qualified as "first of its kind" and hence a credible barrier due to prevailing practices is shown according to the applied methodology.

Step 4 Common Practice Analyses

The project has demonstrated to be first of its kind and therefore it is not necessary to execute the common practice analysis[19], see the prevailing barrier analysis.

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[18] *Statistics Office, Household Information for the farming animals (2009)*

[19] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v5.2.1.pdf

Based on the guidance provided in the methodological tool 'tool for the demonstration and assessment of additionality' BP is considered additional

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

Emission reductions are calculated as the difference between the baseline emissions and the project emissions. This project includes two sources of emission reduction:

1. Displacement of non-renewable biomass and fossil fuel;
2. Avoidance of methane emissions from AWMS.

As described under section B.3, the GHG emissions under the baseline condition comprise two sources:

1. CO_2 , CH4 and N2O emission from combustion of non-renewable cooking and lighting fuels;
2. CH_4 emission from the animal waste management system.

The total average baseline emissions per household are calculated as the sum of the total CO_2 emission of the pre-project and baseline emission from the animal waste handling as:

$$BE_h = BE_{th,h} + BE_{aw,h}$$

Equation 1: Estimation of baseline emissions

Where:

BE_h	=	Baseline emissions in the pre-project situation of household h (tCO_2e/year)
$BE_{th,h}$	=	Baseline emissions from fuel consumption for thermal energy needs of households h (tCO_2e/year)
$BE_{aw,h}$	=	Baseline emissions from animal waste handling of households h (tCO_2e/year)

The voluntary Gold Standard biodigester methodology proposes different options for the baseline calculation depending on whether the project activity is implemented under a situation where energy services provided are sufficient or insufficient to meet the needs of stakeholders. According to the methodology, the baseline emissions caused by the consumption of fuel for thermal energy demand can be determined in three separate ways:

1. Pre-project situation
2. Project level energy service demand using a fossil fuel and appliance as in situation with satisfied demand
3. Satisfied demand with fossil fuel mix and technology different from pre-project

Of the three baseline options, option 1 is chosen, this is conservative.

<u>1. Baseline emission (BE) from thermal energy use</u>

Baseline scenario

A baseline scenario is defined by the typical baseline fuel consumption patterns in a population that adopts the project technology. Hence, this "target population" is a representative baseline for the project activity. BPD collects of each household fuel data before a biogas plant is installed in the same household; the data collected is therefore *by definition* representative for the identification of the baseline.

Animal ownership and fuel data collection for the baseline is appropriate as biogas will only be used for cooking and lighting, and hence the baseline fuels used for this purposes is identified as the baseline scenario. Other uses of biogas, such as electricity generation or displacement of electricity by, for example biogas water heaters, is only practiced by a minor part of the biogas population. Emission reductions arising from electricity generation are not accounted for, this is conservative.

The baseline of this project is not fixed as the technologies are adapted progressively through the credit period. Therefore, the baseline will be updated each time when new users are included in the project.

The project scenario is the population of users that have installed a biogas plant, of all these users' baseline fuel data is available. The emission reductions are ascribed by comparing the fuel consumption in the project scenario with the baseline fuel use of the biogas users.

Baseline studies

The baseline scenario is defined by the typical fuel consumption among the target population prior to adopting the project technology. The baseline studies executed are:

A. Baseline non-renewable biomass (NRB assessment);
B. Fuel data collection of each household that installs a biogas plant.

A. Baseline Non-Renewable Biomass Assessment

The fraction of NRB is identified following the guidelines of applied methodology 'Technologies and practices to displace decentralized thermal energy consumption' version 1.0. The NRB assessment may be updated prior to verification if further analysis and or surveys are conducted after the baseline study. The NRB assessment will be reassessed when applying for a renewable of the crediting period based on the most recent information available.

In projects where woody biomass is a component of either the baseline or project scenario, project proponents must specify the extent to which the CO_2 emissions of that biomass are not offset by re-growth in the fuel collection area.

The non-renewable biomass (NRB) assessment is conducted following the CDM EB 23 Annex 18 definition of "renewable biomass" (by inversion) and by collecting evidence through field surveys, literature review and resource/population mapping studies. Depending on the depth and quality of information available on biomass supply and growth in the collection area, project proponents may or may not be able to pursue a quantitative approach. If possible, project proponents should adopt the quantitative approach below; otherwise the qualitative approach should be used. The best method is to combine both approaches and include conservative estimates.

The f_{NRB} is studied by a:

A. Quantitative NRB assessment

B. Qualitative NRB assessment

Both options (a) and (b) assume it is possible to estimate the locations and extent of the areas from which woody biomass fuel used by the project participants is collected. If estimating the collection area is difficult, project proponents can aggregate all reachable woody biomass fuel collection areas within the relevant country and apply a single fraction derived from all collection areas in the country, with respect to the options above.

The project aims to cover whole Vietnam and therefore the geographical boundaries of Vietnam are considered to be the woody biomass fuel collection area. The f_{NRB} is calculated using the following steps:

Step 1

The annual wood fuel increment is which could be harvested sustainable is determined of the identified wood collection area. For this purpose, tools like satellite data, regional statistics, regional or IPCC algometric equations to estimate the above ground biomass increment etc. may be used. This is the mean annual increment (MAI).

Step 2

Determination of annual harvest of woody biomass, including forest clearance, timber extraction, consumption of wood fuels, drawn from fuel collection area A

Step 3

Calculate the shortage of woody biomass in the area:

$$NRB = H - MAI$$

Where:

MAI:	Annual biomass increment (tons/year) on area A
H:	Annual biomass harvest (tons/year) on area A
NRB:	Non-renewing biomass or excess harvest over and above-regrowth, which is the amount of woody biomass removed with attendant CO_{2e} emissions which are not reabsorbed by regrowth.

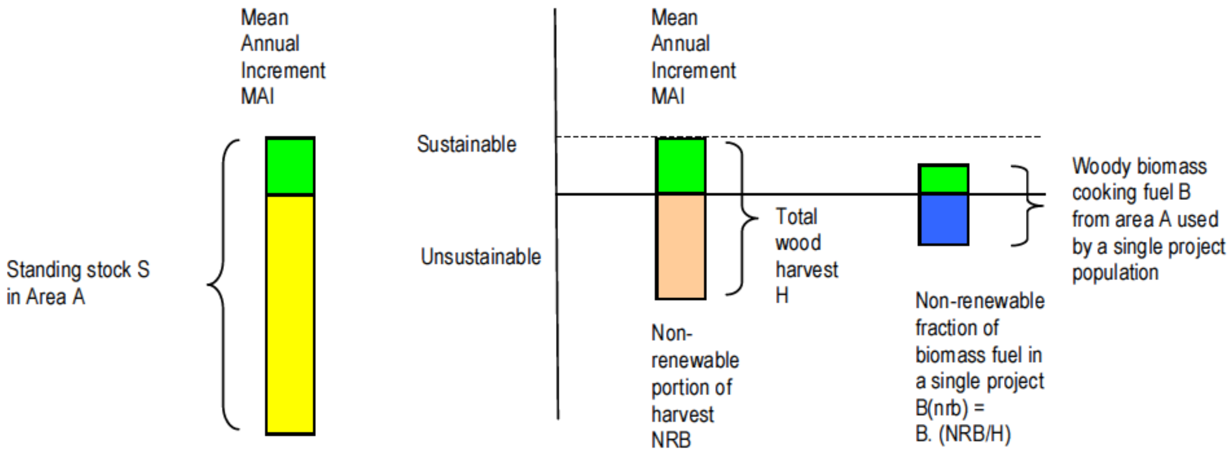

Figure 4: Illustration of the share of wood that can be considered NRB

The diagram illustrates sustainable and unsustainable woody biomass extracted from fuel collection area A. MAI is a percentage of the total standing stock S, and NRB is the harvest taken from area A, net of MAI. The fraction of the harvest which is non-renewable is NRB/H.

Step 4
Ascertain the fraction of extracted woody biomass that is non-renewable, denoted as $f_{NRB.}$ If a quantity of woody biomass supplied from fuel collection area A is used as a fuel for thermal energy production, the fraction $f_{NRB.}$ is assumed to be non-renewable with CO_2 emissions that are not reabsorbed by re-growth.

$$\mathbf{f_{NRB}} = \frac{\mathbf{NRB}}{\mathbf{H}}$$

Equation 2: Calculation of the share of NRB

Where:

f_{NRB}	=	Share of non-renewable biomass
NRB	=	Non-renewable biomass harvest (tons/year) on the project area i.
H	=	Annual biomass harvest (tons/year) on the project area i.

The fraction of NRB is only applied to the biomass fuels charcoal and wood, agricultural residues are considered 0% NRB with the exception of the non-CO2 emissions, which are not renewable.

<u>Qualitative NRB assessment</u>

The quantitative NRB assessment will be supplemented with a qualitative NRB assessment. According to the applied methodology, non-renewable woody biomass (NRB) is the quantity of wood fuel used in the absence of the project activity minus the quantity designated as demonstrable Renewable biomass (DRB), as long as either:

A. Survey results, national or local statistics, studies, maps or other sources of information such as remote sensing data show that carbon stocks are depleting in the project area;

Or at least two of the following supporting indicators are shown to exist (or one of the following combined with above):

- **B.** Trend showing increase in time spent or distance travelled by users (or fuel wood suppliers) for gathering fuel wood or trend showing increase in transportation distances for the fuel wood transported into the project area;
- **C.** Increasing trends in fuel wood price indicating scarcity;
- **D.** Trends in the type of cooking fuel collected by users, suggesting scarcity of woody Biomass;
- **E.** Inadequate access to energy for cooking, or scarcity of wood fuel resources, are significant components of poverty.

Under these conditions, the fraction of woody biomass saved by the project activity in year y that can be established as non-renewable is given by:

$$f_{NRB.} = NRB / (NRB + DRB)$$

Annex 3 details the NRB assessment.

B. Fuel data collection of each household that installs a biogas plant

Fuel data is collected of each household providing maximum achievable reliability and representativeness of the data collected. Renewability and non-renewability indicators are collected separately see A above. The $BE_{th,h}$ for the adopted baseline option 1 for the baseline emission from thermal energy demand is for the pre-project situation calculated as:

$$\boldsymbol{BE_{th,h}} = \sum_{i} (\boldsymbol{f_{NRB,y}}\ \boldsymbol{F_{i,bl,h}} \times \boldsymbol{NCV_i} \times \boldsymbol{EF_{CO2,i}} + \boldsymbol{F_{i,bl,h}} \times \boldsymbol{NCV_i} \times \boldsymbol{EF_{nonCO2,i}})$$

Equation 3: Baseline emissions from thermal energy demand by household

Where

$BE_{th,h}$	=	The total baseline emissions from the thermal energy demand of one household (tCO_{2e}/year)
$f_{NRB,y}$	=	Fraction of biomass during year y that is non-renewable (100% for fossil fuels)
$F_{i,bl,h}$	=	Quantity of fuel *i* consumed in the baseline during year y (kg/household/year) Total amount of fuel type *i* in the baseline scenario (kg/year) of one household
NCV_i	=	Net Calorific Value of fuel type *i* (TJ/ton of fuel)
$EF_{CO2,i}$	=	The CO_2 emission factor per unit of energy of fuel *i* (tCO_{2e}/TJ)
$EF_{nonCO2,i}$	=	The nonCO_2 emission factor per unit of energy of fuel *i* (tCO_{2e}/TJ)

2. Baseline emission from Animal Waste Management Systems ($BE_{AWMS,h}$)

For the calculation of the $BE_{awms,h}$ the IPCC tier 1 approach is adopted. This approach is followed because local data required for an estimation of the methane emission factor per category of livestock is not available. A number of survey on AWMS have been conducted, however, the manure management categories identified were not comparable with the IPCC 2006 Manure management system (MS) categories. In addition, animal waste is partly collected for utilization. Under these conditions, the applied methodology allows for a baseline emission estimate using the IPCC Tier 1 approach. This is conservative.

The following equation is applied to estimate the baseline emissions from animal waste management systems

$$BE_{awms,h} = GWP_{CH4} * \sum_{T} \left(EF_{awms(T)} * N_{(T),h} \right)$$

Equation 4: Equation to estimate baseline emissions from AWMS

Where:

$BE_{awms,h}$	The baseline emissions from handling of animal waste in premise h (tCO_2e/year) of animal category T
GWP_{CH4}	Global warming potential of methane (tCO_2e per tCH4): 21 for the first commitment period. It shall be updated to any future COP/MOP decision
$N_{(T),h}$	The number of animals of livestock species per animal category T
$EF_{awms(T)}$	Emission factor for the defined livestock population category T, (ton CH4 per head per yr). The relevant Default methane emission factor for livestock for default animal waste methane emission factors by temperature and region can be found in tables 10.14, 10.15 & 10.16 in Chapter 10: Emissions from Livestock and Manure Management, Volume 4 - AGRICULTURE, FORESTRY AND OTHER LAND USE, 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

3. Project and leakage emissions

The project proponent should investigate the following potential sources of leakage emissions (LE):

Table 9: Leakage emission assessment

#	Leakage source	Applicability
a	The displaced baseline technologies are reused outside the project boundary in place of lower emitting technology or in a manner suggesting more usage than would have occurred in the absence of the project.	The baseline technologies are not reused outside the project boundary. Furthermore, the baseline technologies outside the project boundary are the same with the same efficiencies
b	The non-renewable biomass or fossil fuels saved under the project activity are used by non-	Most household rely on wood in Vietnam. The small share of household that use a

	project users who previously used lower emitting energy sources.	lower emitting energy source, such as LPG, will not switch back to NRB or coal due to the project activity.
c	The project significantly impacts the NRB fraction within an area where other CDM or VER project activities account for NRB fraction in their baseline scenario.	There are no other CDM or VER activities that account for NRB in their baseline in Vietnam registered.
d	The project population compensates for loss of the space heating effect of inefficient technology by adopting some other form of heating or by retaining some use of inefficient technology	Space heating in an infrequent occurrence in Vietnam and confined to the mountainous areas with limited biogas potential. There is only 1 province out of 49 with an average annual temperature lower than 20oC: Lâm Đồng (18.2), only 206 digesters are built in that provinces
e	By virtue of promotion and marketing of a new technology with high efficiency, the project stimulates substitution within households who commonly used a technology with relatively lower emissions, in cases where such a trend is not eligible as an evolving baseline.	The baseline is not fixed in this project, and the combustion of biogas always leads to lower emissions compared to all baseline fuels as it is 100% renewable.

Space heating may be the only source of leakage emissions, this source however is negligible and not reported. Also, some households install biogas heaters and biogas lamps that warm the house and thereby reducing the need for space heating completely.

Not all fuels will be replaced by biogas. The fuels that people continue to use in the project scenario will be obtained from the monitoring surveys.

The project emissions (PE) involve emissions from the bio-digester, which include physical leakage and incomplete combustion of biogas, as well as emissions from the animal waste not treated in the bio-digester.

The project emission from fuel use are calculated with the following equation

$$\boldsymbol{PE_{p,y,h}} = \sum_{\boldsymbol{i}} (\boldsymbol{f_{NRB,y}}\ \boldsymbol{F_{i,p,h}} \times \boldsymbol{NCV_i} \times \boldsymbol{EF_{CO2,i}} + \boldsymbol{F_{i,p,h}} \times \boldsymbol{NCV_i} \times \boldsymbol{EF_{nonCO2,i}})$$

Where

$PE_{p,yh}$	=	The total project emissions from the thermal energy demand of one household (tCO_{2e}/year)
$f_{NRB,y}$	=	Fraction of biomass during year y that is non-renewable (100% for fossil fuels)
$F_{i,p,h}$	=	Quantity of fuel *i* consumed in the project during year y (kg/household/year)
NCV_i	=	Net Calorific Value of fuel type *i* (TJ/ton of fuel)
$EF_{CO2,i}$	=	The CO_2 emission factor per unit of energy of fuel *i* (tCO_{2e}/TJ)

$EF_{nonCO2,i}$ = The nonCO_2 emission factor per unit of energy of fuel *i* (tCO_{2e}/TJ)

The next equation from the methodology is used to calculate the project emissions from the biodigester system, the emission resulting from physical leakage (PL_y) and resulting from incomplete combustion.

$$PE_{awms,h,y} = GWP_{CH4} \times \sum \left(N_{(T),h,y} \times EFawms_{(T)}\right).PL_y + \sum \left(LC_{(T),h,y} \times EFawms_{(T)}\right) \times \left(1 - \eta_{biogasstove}\right)(1 - PL_y)$$

Where:

$N_{(T),h,y}$ = Number of animals of livestock category T in year y in premise h

$PE_{awms,h,y}$ = Mean emission per household *h* (tCO_2e/year)

$EFawms_T$ = Emission factor for the defined livestock category T, (ton CH_4 per animal per year). Estimated using the IPCC TIER 2 approach.

PL_y = Physical leakage of the biodigester in year *y* (10 %)[20]

EF_T = Annual CO_2 emission factor for livestock category *T*, (tCO_2e animal^{-1} yr^{-1})

GWP_{CH4} = Global Warming Potential (GWP) of methane (tCO_2eq per tCH_4): 21 for the first commitment period. It shall be updated according to any future COP/MOP decisions.

$\eta_{biogasstove}$ = Combustion efficiency of the biogas stove

The EF_{AWMS} will be calculated using the IPCC tier 2 approach:

The following formula is used from the Voluntary Gold Standard Biodigester Methodology to estimate the animal waste management emissions.

$$\boldsymbol{EF_{AWMS(T)}} = \left(\boldsymbol{VS_{(T)}} \times \mathbf{365}\right) \times \left[\boldsymbol{Bo_{(T)}} \times \boldsymbol{D_{CH4}} \times \sum_{\boldsymbol{k}} \frac{\boldsymbol{MCF_{BL,k}}}{\mathbf{100}} \times \boldsymbol{MS_{(T,S,k)}}\right]$$

Where:

$EF_{AWMS(T)}$ = CH_4 emission factor for livestock category T in the project scenario, (tCH_4.animal^{-1})

$VS_{(T)}$ = Daily volatile solid excreted for livestock category T, (kg VS per animal.day $^{-1}$)

365 = Basis for calculating annual VS production, (days yr^{-1})

$Bo_{(T)}$ = Maximum methane producing capacity for manure produced by livestock category T,(m^3 CH_4 kg^{-1} of VS)

D_{CH4} = Conversion factor of m^3 methane to kg methane, (0,067 kg/m^3)

$MCF_{(BL,k)}$ = Methane conversion factors for the animal waste handling system in the baseline situation, bl, by climate zone *k, %*

$MS_{(T,S,k)}$ = Fraction of livestock category T's manure treated in the animal waste management system *S*, in climate region *k*, (dimensionless)

[20] Default value of the applied methodology is adopted (TPDDTEC page 52)

Finally, the emissions from anaerobic disposal of bio-slurry will be estimated. The estimate will be based on the same equation as for the emission from animal waste management (see second equation on the previous page). Applicable VS, B_0, MCF values will be sourced from credible literature sources or the IPCC.

B.6.2. Data and parameters that are available at validation:

(Copy this table for each data and parameter)

Data / Parameter:	**$EF_{b,CO2}$**
Data unit:	$kgCO_2$/TJ fuel
Description:	CO2 emission factor arising from use of fuels in the baseline scenario
Source of data used:	2006 IPCC Guidelines defaults, see chapter 2 Stationary Combustion: http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html
Value applied:	**Fuel *b*** / **$EF_{CO2,}$ (kg/TJ)**: LPG 63100; Charcoal 112000; Coal 94 600; Firewood 112000; Agriculture residues 100000; Kerosene 71900
Any comment:	The CO2 emissions from agricultural residues are considered renewable; hence the CO2 emission will be zero.

Fuel *b*	**$EF_{CO2,}$ (kg/TJ)**
LPG	63100
Charcoal	112000
Coal	94 600
Firewood	112000
Agriculture residues	100000
Kerosene	71900

Data / Parameter:	**$EF_{i,CH4}$**
Data unit:	$kgCH_4$/TJ fuel
Description:	CH_4 emission factor arising from use of fuels in the baseline scenario
Source of data used:	2006 IPCC Guidelines defaults see chapter 2 Stationary Combustion: http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html, table 2.9 Charcoal production from Good Practice Guidance and Uncertainty Management in National GHG inventories: http://www.ipcc-nggip.iges.or.jp/public/gp/bgp/2_2_Non-CO2_Stationary_Combustion.pdf
Value applied:	see table below

Fuel *i*	**$EF_{CH4,}$ (kg/TJ)**
LPG	11.95
Charcoal	330.5
Coal	1458.5
Firewood	1224
Agriculture residues	2210

	<table><tr><td>Kerosene</td><td>12.6</td></tr><tr><td>Charcoal production</td><td>1000</td></tr></table>
Any comment:	Some of the EF values in table 2.9 are ranges; in that case the average value is taken. The wood stove value taken is the value that has reference number 7. This stove is assumed more closely resembling the stoves in Vietnam as it is a value obtained from neighboring countries.

Data / Parameter:	**$EF_{i,N2O}$**
Data unit:	kgN_2O/TJ fuel
Description:	N_2O emission factor arising from use of fuels in the baseline scenario
Source of data used:	2006 IPCC Guidelines defaults, see chapter 2 Stationary Combustion, table 2.9 http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html
Value applied:	<table><tr><th>Fuel i</th><th>EF_{N20,} (kg/TJ)</th></tr><tr><td>LPG</td><td>2.1</td></tr><tr><td>Charcoal</td><td>5.45</td></tr><tr><td>Coal</td><td>NA</td></tr><tr><td>Firewood</td><td>11.25</td></tr><tr><td>Agriculture residues</td><td>9.7</td></tr><tr><td>Kerosene</td><td>1.55</td></tr><tr><td>Charcoal production</td><td>NA</td></tr></table>
Any comment:	Some of the EF values in table 2.9 are ranges; in that case the average value is taken. The wood stove value taken is the value that has reference number 7. This stove is assumed more closely resembling the stoves in Vietnam as it is a value obtained from neighboring countries.

Data / Parameter:	**NCV_i**
Data unit:	TJ/Gg
Description:	Net calorific value of the fuel i used in the baseline
Source of data used:	2006 IPCC Guidelines defaults, see chapter 1 Energy table 1.2 http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html
Value applied:	<table><tr><th>Fuel i</th><th>NCVi (TJ/Gg)</th></tr><tr><td>LPG</td><td>47.3</td></tr><tr><td>Charcoal</td><td>29.5</td></tr><tr><td>Coal</td><td>25.8</td></tr><tr><td>Firewood</td><td>15.6</td></tr><tr><td>Agriculture</td><td>11.6</td></tr></table>

	residues	
	Kerosene	43.8
Any comment:	the category other primary solid biomass is taken for agricultural residues	

Data / Parameter:	**GWP_{CH4}**
Data unit:	tCO_2e per tCH4
Description:	Global Warming Potential (GWP) of methane
Source of data used:	SAR IPCC
Any comment:	21 for the first commitment period. Shall be updated to any future COP/MOP decisions

Data / Parameter:	**GWP_{N2O}**
Data unit:	tCO_2e per tN_2O
Description:	Global Warming Potential (GWP) of nitrous oxide
Source of data used:	SAR IPCC
Any comment:	310 for the first commitment period. Shall be updated to any future COP/MOP decisions

Data and parameters not monitored AWMS

Data / Parameter:	**$VS_{(T)}$**	
Data unit:	kg dry matter per animal per day	
Description:	Daily volatile solid excreted for livestock category T	
Source of data used:	Volume 4 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, chapter 10 (online: http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html)	
Value applied:	Animal T	VS(T) kg/day
	Pig	0.3
	Buffalo	3.9
	Dairy cow	2.8
	Cattle	2.3
Any comment:	Any comment: 365 = basis for calculating annual VS production, days per year	

Data / Parameter:	**$Bo_{(T)}$**
Data unit:	m^3 CH_4 per kg of VS excreted
Description:	Maximum methane production capacity for manure produced by livestock category T
Source of data used:	Volume 4 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, chapter 10 (online: http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html)

<table>
<tr><td>Value applied:</td><td>
<table>
<tr><th>Animal
T</th><th>VS(T)
kg/day</th><th>Bo(T)
m3CH4/kgVS</th></tr>
<tr><td>Pig</td><td>0.3</td><td>0.29</td></tr>
<tr><td>Buffalo</td><td>3.9</td><td>0.1</td></tr>
<tr><td>Dairy cow</td><td>2.8</td><td>0.13</td></tr>
<tr><td>Cattle</td><td>2.3</td><td>0.1</td></tr>
</table>
</td></tr>
<tr><td>Any comment:</td><td></td></tr>
</table>

Data / Parameter:	**$MCF_{(k)}$**
Data unit:	[-]
Description:	Methane conversion factor for each manure management system by climate region k
Source of data used:	Volume 4 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, chapter 10 (online: http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html)
Value applied:	10% for biodigester systems
Any comment:	

<table>
<tr><td>Data / Parameter:</td><td>$EF_{awms,T}$</td></tr>
<tr><td>Data unit:</td><td>$kgCH_4$ per animal per year for livestock type T</td></tr>
<tr><td>Description:</td><td>Animal waste methane emission factor by average temperature</td></tr>
<tr><td>Source of data used:</td><td>IPCC default values for the region Asia from volume 4 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, chapter 10 (online: http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html)</td></tr>
<tr><td>Value applied:</td><td>
<table>
<tr><th>Animal T</th><th>EF (kgCH4/head/year)</th></tr>
<tr><td>Dairy cow</td><td>24.006</td></tr>
<tr><td>Pig</td><td>2.201</td></tr>
<tr><td>Cattle</td><td>1</td></tr>
<tr><td>Buffalo</td><td>2</td></tr>
</table>
</td></tr>
<tr><td>Any comment:</td><td>The IPCC default value depends on the average annual temperature, and for each zone an average is calculated based on the temperature in participating provinces in the respective zone. The EF values for buffalo and cattle were the same in each province for the temperature ranges observed. The values reported is the weighted average based on the emission factors in both zones.</td></tr>
</table>

Data / Parameter:	$\eta_{biogasstove}$
Data unit:	[-]%
Description:	Combustion efficiency of the biogas stove
Source of data used:	98%, the default value from the GS methodology: Indicative Programme, baseline, and monitoring methodology for Small Scale Biodigester
Value applied	98%
Any comments	

B.6.3. Ex-ante calculation of emission reductions:

Details of the Baseline

The baseline for this project is determined in accordance with the following paragraph from the applied methodology:

"the baseline emissions involve emission from use of fossil fuel and non-renewable biomass for cooking and heating, and emissions from the handling of animal waste in the baseline situation"

A. Calculation of the baseline emission from the thermal energy demand (BE_{th})

This estimation of these emissions involves two steps:

1. Determination of annual per household energy consumption
2. Determination of applicable emission factors
3. Determination of the fraction of non-renewable biomass
4. Calculation of the average greenhouse gas emission per household

The data used for the 4 steps originates from the excel workbook which is based on the VGS database.

1. Thermal energy demand

The total amount of the fuel used for thermal energy demand of the households with the technical potential is listed hereunder.

Table 10: Thermal energy demand of the households with the technical potential

Fuel *i*	Average per household (kg/year)	NCV_i (TJ/Gg)	Thermal energy demand (TJ/year)
LPG	17.8	47.3	0.000840292
Charcoal	93.2	29.5	0.002748537
Coal	362.7	25.8	0.009358638
Firewood	1855.4	15.6	0.028943811
Agriculture residues	556.4	11.6	0.006454176
Kerosene	0.7	43.8	0.000029203

2. Applicable emission factors

In absence of national relevant emission factors the default emission factors from the IPCC 2006 Guidelines for National Greenhouse Gas Inventories, volume 2: Energy, Chapter 1 are used, see the next table.

Table 11: CO_2, CH_4 and N_2O emission factors

Fuel *i*	**$EF_{CO2,}$ (kg/TJ)**	**$EF_{CH4,}$ (kg/TJ)**	**$EF_{N20,}$ (kg/TJ)**
LPG	63100	11.95	2.1
Charcoal	112000	330.5	5.45
Coal	94600	1458.5	NA
Firewood	112000	1224	11.25
Agriculture residues	100000	2210	9.7
Kerosene	71900	12.6	1.55
Charcoal production	61805	1000	NA

* Other bituminous coal ** woody waste

3. Fraction of Non-Renewable biomass ($f_{NRB.}$)

The $f_{NRB.}$ is estimated to be 67%. The NRB assessment can be found in Annex 3 of the PDD. The $f_{NRB.}$ value is applicable to CO_2 emissions from firewood, agricultural residues and charcoal consumption and production. Methane and nitrous oxide emission is 100% NRB by definition.

4. Baseline emissions by fuel, GHG and total

The baseline emission is the baseline thermal energy consumption multiplied by emission factors and the global warming potential of each GWP. The GWP applied are taken form the Second Assessment Report of the IPCC, 21 and 310 for CH_4 and N_20 respectively. The GWP will be updated by decision of the COP/MOP.

Table 12: Baseline emission of each fuel and total from thermal energy use

Fuel *i*	**Baseline emissions from CO_2 (tCO_2e/yr)**	**Baseline emission from CH_4 (tCO_2e/yr)**	**Baseline emission from N_20 (tCO_2e/yr)**	**Total (tCO_2e/yr)**
LPG	0.053	0.00	0.001	0.054
Charcoal	0.206	0.02	0.005	0.230
Coal	0.885	0.29	0.000	1.172
Firewood	2.172	0.74	0.101	3.017
Agriculture residues**	0.000	0.30	0.019	0.319
Kerosene	0.002	0.00	0.000	0.002
Charcoal production	0.114	0.06	0.000	0.172
Total	**3.433**	**1.407**	**0.126**	**4.965**

The average annual per household emissions from cooking and lighting is 4.965 tCO_2.

B. Estimation of emissions from AWMS

The following equation is applied to estimate the baseline emissions from animal waste management systems

$$BE_{awms,h} = GWP_{CH4} * \sum_{T} \left(EF_{awms(T)} \; * N_{(T),h} \; \right)$$

Equation 5: Equation to estimate baseline emissions from AWMS

Where:

$BE_{awms,h}$	The baseline emissions from handling of animal waste in premise h (tCO_2e/year)
GWP_{CH4}	Global warming potential of methane (tCO_2e per tCH4): 21 for the first commitment period. It shall be updated to any future COP/MOP decisions
$N_{(T),h}$	The number of animals of livestock species per category T

$EF_{awms(T)}$ Emission factor for the defined livestock population category T, (ton CH4 per head per yr). The relevant Default methane emission factor for livestock for default animal waste methane emission factors by temperature and region can be found in tables 10.14, 10.15 & 10.16 in Chapter 10: Emissions from Livestock and Manure Management, Volume 4 - AGRICULTURE, FORESTRY AND OTHER LAND USE, 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

The IPCC lists for each regions default values for methane emissions from AWMS at various average temperatures in chapter 10 volume 4 of the IPCC 2006 guidelines. As Vietnam has more than 1 climate zones, a determination of the IPCC default value for each climate zone is required. Climate date for each province has been collected and for each province a separate IPCC default factor is obtained. This approach is allows for maximum precision.. The IPCC default emission factor of buffalos and cattle is the same over the range of temperatures observed in Vietnam. The excel file belonging to this PDD details the calculation.

Table 13: Baseline emissions from animal waste management systems

Animal T	**$N_{(T),h*}$** #	**$EF_{(T)}$** $kgCH_4$/head/year	**GWP_{CH4}** tCO_2/tCH4	**$BE_{awms,h}$** tCO_2/head/year
Pig	18.73	5.20	21	2.046
Buffalo	0.21	2.00	21	0.009
Dairy cow	0.03	24.01	21	0.014
Cattle	0.36	1.00	21	0.008
* from VGS database			**Total**	**2.077**

The average annual emissions from AWMS are 2.077 tCO_2 per household.

C. Estimation of project and leakage emissions

The project proponent should investigate the following potential sources of leakage:

Table 14: Leakage emission assessment

#	Leakage source	Applicability
a	The displaced baseline technologies are reused outside the project boundary in place of lower emitting technology or in a manner suggesting more usage than would have occurred in the absence of the project.	The baseline technologies are not reused outside the project boundary. Furthermore, the baseline technologies outside the project boundary are the same with the same efficiencies
b	The non-renewable biomass or fossil fuels saved under the project activity are used by non-project users who previously used lower emitting energy sources.	Most household rely on wood in Vietnam. The small share of household that use a lower emitting energy source, such as LPG, will not switch back to NRB or coal due to the project activity.
c	The project significantly impacts the NRB fraction within an area where other CDM or VER project activities account for NRB fraction in their baseline scenario.	There are no other CDM or VER activities that account for NRB in their baseline in Vietnam registered.
d	The project population compensates for loss of the space heating effect of inefficient technology by adopting some other form of heating or by retaining some use of inefficient technology	Space heating in an infrequent occurrence in Vietnam and confined to the mountainous areas with limited biogas potential. There is only 1 province out of 49 with an average annual temperature lower than 20oC: Lâm Đồng (18.2), only 206 digesters are built in that provinces
e	By virtue of promotion and marketing of a new technology with high efficiency, the project stimulates substitution within households who commonly used a technology with relatively lower emissions, in cases where such a trend is not eligible as an evolving baseline.	The baseline is not fixed in this project, and the combustion of biogas always leads to lower emissions compared to all baseline fuels as it is 100% renewable.

Space heating may be the only source of leakage emissions, this source however is negligible and not reported. Also, some households install biogas heaters and biogas lamps that warm the house and thereby reducing the need for space heating completely.

Not all fuels will be replaced by biogas. The fuels that people continue to use in the project scenario will be obtained from the monitoring surveys. The next table shows the estimated remaining fuel consumptions from BUS 2011.

Table 15: Estimate project emissions from thermal energy use (BUS 2011)

Fuel *i*	**Average per household (kg/year)**	**NCV_i (TJ/Gg)**	**Thermal energy demand (TJ)**
LPG	2.2	47.3	0.000104
Charcoal	0.0	29.5	0.000000
Coal	68.1	25.8	0.001757
Firewood	142.4	15.6	0.002222
Agriculture residues	84.6	11.6	0.000982
Kerosene	0.0	43.8	0.000000

The ex-ante estimated project emissions are shown in the next table by fuel and GHG.

Table 16: Estimate ex-ante project emission from thermal energy use

Fuel	**Baseline emissions from CO_2 (tCO_2e/yr)**	**Baseline emission from CH_4 (tCO_2e/yr)**	**Baseline emission from N_20 (tCO_2e/yr)**	**Total (tCO_2e/yr)**
LPG	0.007	0.00	0.000	0.007
Charcoal	0.000	0.00	0.000	0.000
Coal	0.166	0.05	0.000	0.220
Firewood	0.167	0.06	0.008	0.232
Agriculture residues**	0.098	0.05	0.003	0.147
Kerosene	0.000	0.00	0.000	0.000
Charcoal production	0.000	0.000	0.000	0.000
Total	**0.438**	**0.157**	**0.011**	**0.605**

The total annual ex-ante project emissions are 0.605 tCO_2 per household

The project emissions involve emissions from the bio-digester, which include physical leakage and incomplete combustion of biogas, as well as emissions from the animal waste not treated in the bio-digester.

The ex-ante assumption is that the animal manure management system (AWMS) in the project scenario is that all manure is fed to the digester. The methane conversion factor (MCF) of that AWSM is 10% and the MS (manure management system) is 100% biodigester. The MS.MCF is therefore assumed to be 10%. The remaining emissions are therefore only physical leakage and incomplete combustion. The $EF_{AWMS(p)}$ in the project scenario has been calculated using the IPCC Tier 2 approach using default values for the maximum methane potential (Bo), volatile solids excretion (VS) and methane density and the manure management category biodigester.

Table 17: Emission factor for the defined livestock category T of the project situation

Animal	Volatile Solids (VS) (kg/day)	Maximum Methane potential (Bo_T)	MCF x MS	Density methane (kg/m^3)	$EF_{AWMS\ (P)}$ ($kgCH_4$/year)
Pig	0.3	0.29	10%	0.67	2.128
Buffalo	3.9	0.1	10%	0.67	9.537
Dairy cow	2.8	0.13	10%	0.67	8.902
Cattle	2.3	0.1	10%	0.67	5.625

The project emissions are then the multiplication of the EF_{AWMS} with the physical leakages emissions and the stove efficiency.

Table 18: Physical leakage emission parameters

Item	Value	Source
Physical leakage	**10%**	IPCC default value for biodigesters independent of annual temperatures
Stove combustion efficiency	**98%**	**Old GS Biodigester methodology** http://www.cdmgoldstandard.org/Gold-Standard-Methodologies.347.0.html?&L=0)

In the next table the physical leakage emissions from the biogas plant are shown:

Table 19: Physical leakage emission from biodigester

Animal	PL_{AWMS} ($kgCH_4$/year)	PL_{stove} ($kgCH_4$/year)
Pig	3.985	0.072
Buffalo	0.203	0.004
Dairy cow	0.025	0.000
Cattle	0.203	0.004
Total	**4.417**	**0.080**

The ex-ante assumption is that emissions from bio-slurry is assumed to be 0 as bio-slurry is mostly used as fish feed or as fertilizer. Potential emissions from bio-slurry storage will be studied in detail for each monitoring period and shall be estimated using the IPCC tier 2 approach

The physical leakage emissions, the emissions from incomplete combustion and from bio-slurry storage are 4.417+ 0.080 + 0 = 4.496 $kgCH_4$/household/year equivalent to 0.094 tCO_2/household/year.

D. Ex-ante estimate of the emission reductions

The ex-ante emission reductions are calculated with the following calculation:

$$ER_{y,h} = U_{y,h} \times (BE_{y,h} - PE_{y,h}) \text{ x } N_{p,y}$$

Where:

$ER_{y,h}$	=	Annual average emission reductions in year y
$U_{y,h}$	=	Cumulative usage rate for technologies in project scenario p in year y,based on cumulative adoption rate and drop off rate revealed by usage surveys (fraction)
$BE_{y,h}$	=	Annual average baseline emissions per household in year y
$PE_{y,h}$	=	Annual average project activity emissions per household in year y
$N_{p,y}$	=	Total number of biogas units commissioned as of year y

The next table shows the ex-ante estimate of the emission reductions with an assumed usage rate of 100%.

Table 20: Average annual emission reductions

Emission source	**BE** (tCO_{2e}/h/year)	**PE** (tCO_{2e}/h/year)	**ER** (tCO_{2e}/h/year)
Fuel use	4.965	0.605	4.360
AWMS	2.077	0.094	1.982
Sum	**7.042**	**0.699**	**6.343**

The estimated emission reductions are 6.343 tCO_2 per household per year.

B.6.4 Summary of the ex-ante estimation of emission reductions:

Crediting year		Credit type	Estimated accumulated units in use at end of the year	Estimated annual emission reductions in tCO2e
01/05/2010	31/12/2011	GS-VER	89,176	814,174
01/01/2012	31/12/2012	GS-VER	92,300	573,857
01/01/2013	31/12/2013	GS-VER	95,708	595,323
01/01/2014	31/12/2014	GS-VER	99,116	616,938
01/01/2015	31/12/2015	GS-VER	102,524	638,553
01/01/2016	30/04/2017	GS-VER	107,078	885,028
Total estimated emission reductions(tCO2e)				4,123,873
Total number of credits years				7
Total number of GS credits years				7 years
Average number of credits per year (tCO2e)				589,125
Average emission reduction per biodigester (tCO2e)				6.34

B.7.1 Data and parameters monitored:	
(Copy this table for each data and parameter)	
Data / Parameter:	$\mathbf{f_{NRB,y}}$
Data unit:	Fraction of non-renewability
Description:	Non-renewability status of woody biomass fuel in scenario I during year y
Source of data to be used:	Literature review, surveys
Value of data applied for the purpose of calculating expected emission reductions in section B.5	67%
QA/QC procedures to be applied:	
Any comment:	Fixed by baseline study for each crediting period

Data / Parameter:	$\mathbf{P_{b,y}}$
Data unit:	Quantity of fuel that is consumed in the baseline scenario in year y
Description:	The baseline is continuously updated with new households that install a biogas plant.
Source of data to be used:	BPD database
Monitoring frequency	Once, before the biogas plant is installed at the household that wants to install a biogas plant
QA/QC procedures to be applied:	Fuel data is collected by the district technician before the biogas plant is installed and inspected by the provincial biogas technician before the data is entered into the database
Any comment:	100% representativeness is achieved as fuel data is collected of each household

Data / Parameter:	$\mathbf{P_{h,y}}$
Data unit:	kg/household
Description:	Quantity of fuel that is consumed in the project scenario in year y
Source of data to be used:	Monitoring survey
Monitoring frequency	Updated for every 2 years or more frequently
QA/QC procedures to be applied:	See section B.7.2, data will be collected according to the CMS sampling plan
Any comment:	

Data / Parameter:	$\mathbf{U_{p,y}}$
Data unit:	Percentage
Description:	Percentage of bio-digesters in use in monitoring period y
Source of data to be used:	Usage survey
Monitoring frequency	Updated for every year or more frequently
QA/QC procedures to be applied:	A survey consisting of sample of 30 households for each year credited, with a total minimum sample of at least 100
Any comment:	see page 24 of the applied methodology

AWMS data and parameters monitored over the crediting period

Data / Parameter:	$\mathbf{N_{p,y}}$
Data unit:	units
Description:	Number of biogas plants commissioned
Source of data to be used:	BPD database
Monitoring frequency	Continuously,
QA/QC procedures to be applied:	100% of all plants are checked after completion of the construction by the district technician on compliance with the MARD biogas standard. 5% of the plants will be visited by the provincial technician for the same check (QC on QC on random sampling basis.
Any comment:	The number of units commissioned for each zone will be reported in the monitoring report

Data / Parameter:	$\mathbf{MS_{(T,S,k)}}$
Data unit:	[-]&
Description:	Fraction of livestock category *T*'s manure fed into the biodigester *S*, in climate zone *k*
Source of data to be used:	Monitoring survey
Monitoring frequency	Annual
QA/QC procedures to be applied:	See section B.7.2, data will be collected according to the CMS sampling plan
Any comment:	

Data / Parameter:	**$MS_{(P,S,k)}$**
Data unit:	[-]&
Description:	Fraction of livestock category *T*'s manure not fed into the biodigester *S*, in climate zone *k*
Source of data to be used:	Monitoring survey
Monitoring frequency	Annual
QA/QC procedures to be applied:	See section B.7.2, data will be collected according to the CMS sampling plan
Any comment:	

Data / Parameter:	**$N_{(T)}$**
Data unit:	[-]
Description:	Number of animals of livestock category T
Source of data to be used:	Monitoring survey
Monitoring frequency	Annual
QA/QC procedures to be applied:	See section B.7.2, data will be collected according to the CMS sampling plan
Any comment:	

Data / Parameter:	**PL**
Data unit:	%
Description:	Physical leakage of the biodigester
Source of data to be used:	IPCC default value
Monitoring frequency	Updated with new IPCC guidance, the PP will check annually if there are new IPCC default values applicable
QA/QC procedures to be applied:	.
Any comment:	The physical leakage is not monitored, this is not possible.

Data / Parameter:	**$EF_{awms,T,}$**
Data unit:	$kgCH_4$ per animal per year for livestock type T in the project
Description:	Animal waste methane emission factor by average temperatures
Source of data used:	IPCC default values for the region Asia from volume 4 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, chapter 10 (online: http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html)
Any comment:	

Data / Parameter:	$PE_{bio\text{-}slurry}$
Data unit:	tCO_2e/year
Description:	Emissions from anaerobic disposal of bio-slurry
Source of data used:	The emissions from anaerobic disposal of bio-slurry. The estimate will be based on the same equation as for the emission from animal waste management (see second equation on the previous page). Applicable VS, B_0, MCF values will be sourced from credible literature sources or the IPCC.
Any comment:	

B.7.2. Description of the monitoring plan:

BPD applies three monitoring methods (A) quality control measures and the (B) carbon monitoring survey (C) Usage survey In addition, many trainings and refreshment trainings are executed to ensure that the QC is executed in a proper manner ensuring high quality digesters and data collection/management.

A. Quality control monitoring

The Quality control (QC) on construction is executed by a number of persons: DT (district technician), PT (provincial technician), BPD (Biogas Project division), PBPD (provincial biogas project division) and the masons. The objectives are:

- Guarantee the accomplishment of a unique standard for the unification of all steps of QC at all levels;
- Manage QC in accordance with the project requirements, at all levels;
- Make sure that biogas plants are constructed under the project standard in terms of design and year of construction permitted in the province;
- Ensure subsidy provision for each household.

List of the monitoring elements

No	Activity	Actor	Sample	Modality
1	Plant commissioning and acceptance	District technician Provincial Technician	100% of all plants are checked The provincial technicians will visit on average 5% of the plants on random sampling basis.	Household visits. Plant and household ID. Construction according to standards and training. Proper functioning.
2	*Quality control of "under construction" plant*	District technician	The district technicians will visit each and every plants being constructed.	Household visits. Plant and household ID. Construction according to standards and training. Feedback given to the masons to ensure the quality compliance of quality standards.
3	*Quality control of "construction completed" plant*	Provincial Technician BPD Staff	Based on the received testing & acceptance forms, the provincial technician will, at random, visit 5% of the biogas installations. BPD Staff will randomly check 1 % of the completed plants.	Household visits. Plant and household ID. Construction according to standards and training. Proper functioning. Quality check on the data and information filled in the form by the district technicians.
4	Provisions of after-sale-services and complaints mechanisms	District technician/ Provincial technician will be involved if a problem cannot be solved	100% biogas users will receive post-construction training. The household visit will be implemented upon receiving complaints from biogas users.	Household visit. Plant and household ID, functionality.
5	Biogas User Survey (BUS)	External Consultant	Stratified Random Sample, annual	Household visit. Plant and household ID, functionality and operation. User's satisfaction, applied benefits, s and evaluation of the program's impacts[21].

The next page shows a flow chart of the activities number 1,2 and 3 of the table above. The percentages in the flow charter refer to the percentage of units checked.

[21] The BUS survey is *not* a carbon monitoring survey. Future surveys however, may combine the BUS and the Carbon monitoring survey (CMS)

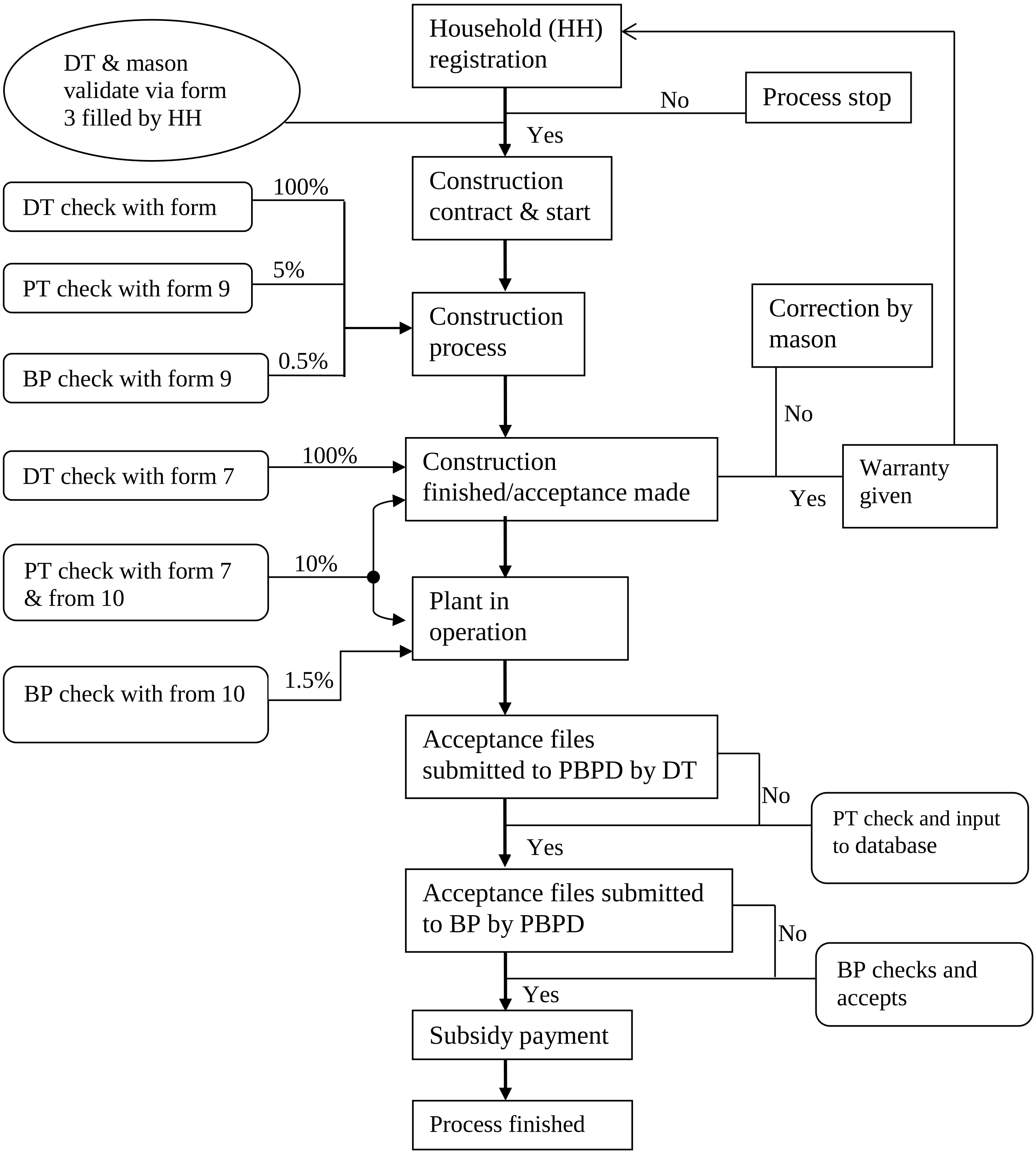

Figure 5: Quality control flow chart enforcement in Biogas Project

Where: DT=District Technician, PT = provincial technician, PBPD= Provincial Biogas Programme Department

B: Carbon monitoring survey (CMS)

In addition, a carbon monitoring survey (CMS) is executed, for the carbon monitoring and the sustainable development monitoring. The CMS includes data collection in two climate zones and in order to adequately collect date each zone is surveyed separately[22]. Data obtained from each zone will be used to calculated the emission reductions and weighted by the proportion of households that are situated in each zone. The CMS will be executed by an independent experienced party that is selected through an open tender. It will combine 6 project studies:

Table 21: Carbon Monitoring Survey (CMS) studies

#	Name of study	Monitoring interval
1	Project non-renewable biomass (NRB) assessment;	Once for the first crediting period
2	Project studies (PS) of target population characteristics;	Annual
3	Baseline Fuel Test and Project Performance Field Test (PFT) of fuel consumption;	Annual
4	Monitoring of the SD parameters.	Annual
5	Leakage emission assessment	Every two year after first verification
6	Maintenance of total sale record and project database	continuous

1. NRB Assessment

Over the course of a project activity the project proponent may at any time choose to re-examine renewability by conducting a new NRB assessment. In case of a renewal of the crediting period and as per Gold Standard rules, the NRB fraction must be reassessed as any other baseline parameters and updated in line with most recent data available. According to Annex 5 of the applied methodology the NRB assessment shall be updated as proposed by the project proponent (PP). The PP proposes to update the $f_{NRB.}$ for each crediting period. As shown in the NRB assessment the FAO (see annex 3) expects that fuel wood deficits will continue in 2020 and therefore the PP assumes that the $f_{NRB.}$ will remain stable throughout the first credit period. The PP choses for that reason a fixed NRB value for the first credit period. The value will be updated for the second credit period.

2. Project survey (PS) of the target population characteristic

Parameters monitored are described in section B7.1.In addition to this, household size, digester size; ID code of the monitored digester will be recorded

3. Baseline Fuel Test (BFT) and the Project Performance Field est (BFT)

The baseline performance field tests (BFT and project performance field test (PFT) measure real, observed technology performance in the field.

[22] The IPCC provides values for 3 climate zones (cool <15°C, temperate ≥15,< 26°C and warm ≥ 26°C), see Chapter 10: Emissions from Livestock and Manure Management, Volume 4 - AGRICULTURE, FORESTRY AND OTHER LAND USE, 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

Baseline data is collected of each household participating in the VGS project before installation of the biogas plant. The BFT is therefore fixed for each household. The aggregate of the baseline emissions of the all participating households however, will be different for each monitoring period because continuously new household will install a biogas plant. The BFT therefore does not have to be updated at household level.

The PFT will measure the performance of the biogas plant, which is defined as degree that biogas displaces baseline fuels. The degree is measured in kg/year of baseline fuel and performance ratio (number of biogas plants in use).

4. Sustainability assessment

The GSPR details the SD monitoring; the output of the SD monitoring will be a separate chapter in the CMS report.

5. Leakage emission assessment

A leakage investigation will be conducted every 2 years as per page 47 of the applied methodology. Physical leakage assessment however is part of the PFT.

6. Maintenance of total sale record and project database

All data collected is stored in a central database and continuously updated. Excerpts of this database will be made available as part of the CMS report.

CMS survey design

The CMS can be part of existing monitoring surveys, the Biogas User Survey. Please note that the BUS itself is not a CMS survey but meant to monitor user satisfaction and other program relevant parameter. The CMS monitoring procedure applied will consist of the following steps:

I. During the selection of new programme participants the data about the fossil fuel consumption in the baseline will be collected of each household;

II. When the biogas plant has been constructed it has to be accepted by the District Biogas Technician. Only after the acceptance by the district technician, provincial technician and BPD the subsidy is sent to the programme participant. At this point the plant is registered with a unique number in the database;

III. The data about the fossil fuel consumption in project case will be collected annually via survey on a sample amongst end-users.

The CMS sampling plan

The CMS sampling plan is developed using guidance of the applied GS methodology and the UNFCCC standard on sampling (EB 65 annex 3: Standard for Sampling and Survey for CDM Project Activities and Programme of Activities)[23]

- **Sampling objective:** The objective of the sampling effort is to obtain reliable data of each climate zone for the CMS survey;

- **Field Measurement Objectives and Data to be collected**: The survey will consist of household visit in random selected end-users to collect data described in section B.7.1. Data will be collected using interview methods, the interviewee will be either the head of the household or the wife of the head of household;

- **Target Population and Sampling Frame:** As Vietnam consists of two climate zones, temperate and warm; the CMS will study each zone separately[24]. The ERs will be calculated based on the information gathered from both zones, and in case one zone contains more households than the other, a proportional weight is applied to the larger zone to adjust for the size difference. The sampling frame for each climate zone will be drawn from the database; all households in the sampling frame represent the target population. Target population membership is recorded in the database and uniquely identifiable based on the ID code of the biogas plant.

    - **Sampling approach:** Clustered random sampling in each climate zone, in each climate zone 10 clusters will be selected randomly for each monitoring interval. One cluster is one district. The two zones are based on IPCC climatic classification: temperate and warm. Data obtained from both zones will be aggregated proportionally (a weight will be applied to the data of each zone based on the total number of biogas households in each zone i.e. if zone A is has only 25% of the households in zone B, the weight of zone B is 4 and zone A 1).
    - **Sample size:** The surveys will be conducted on a sample size estimated by using the "General Guidelines for Sampling and Surveys for Small-scale CDM Project Activities" (CDM EB 65 Annex 2) which prescribes a 90% confidence interval with a 10 % error margin. The VGS methodology applied specifies that if the sample size is large enough to satisfy the 90/10 rule, the overall emission reductions per unit can be calculated per unit or MEAN fuel annual savings per unit. The sample size is calculated using the next equation[25].

$$n = \frac{Nx}{1 + Nx(e)^2}$$

Where:

n = minimal sample size

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[23] http://cdm.unfccc.int/filestorage/T/P/X/TPXDOG9Q5HE7Z18CFBM3VSKIWU4YJ2/eb65_repan02.pdf?t=Qkl8bTBuaXRlfDBBzCTHDwxtF4VIkxoXVrTj

[24] The IPCC distinguishes 3 climate zones: cool <15°C, temperate ≥15,≤ 25°C and warm > 25°C, see Chapter 10: Emissions from Livestock and Manure Management, Volume 4 - AGRICULTURE, FORESTRY AND OTHER LAND USE, 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

[25] http://edis.ifas.ufl.edu/pd006 and Yamane, Taro. 1967. *Statistics, An Introductory Analysis*, 2nd Ed., New York: Harper and Row.

e = level of precision (10%)
Nx = the BP biogas population in $zone_x$
x = Temperature zone (warm or temperature)

For example if zone A contains 60,000 households, the minimum sample size would be 60,000/(1+60,000*(10%^2)) is 100. This ex-ante estimated minimum sample size is used hereunder as an example, the sample size may change based on the number of biogas units built and will be recalculated for each monitoring interval.

- **Survey design and cluster sample size**
  Once overall sample size requirements have been determined, the final step in developing the sample design is to determine how many clusters and how many households per cluster should be chosen. This involves three primary considerations[26]:
  1. The first is the magnitude of the cluster sampling design effect (D). The design effect is caused by the loss of efficiency as there is a risk that the sample is not as varied as it would be with simple random sampling. The loss of effectiveness by the use of cluster sampling, instead of simple random sampling, is the design effect. The design effect is basically the ratio of the actual variance, under the sampling method actually used, to the variance computed under the assumption of simple random sampling. The smaller the number of households per cluster and the lower the intra-class correlation[27] the less pronounced is the design effect[26]. This is because elementary units within clusters generally tend to exhibit some degree of homogeneity with regard to background characteristics and possibly behaviors. As the number of households per clusters increases, sampling precision is lost.
  2. Secondly, the numbers of households in a given cluster or site places a limit on how large the per-cluster sample could potentially be. The census listings or other materials that are to be used as a sampling frame should be carefully reviewed before deciding upon the cluster sample size to be used.
  3. Third, the resources available to undertake the survey fieldwork dictate what is feasible. Transporting and sustaining field staff and supervisors constitute the major costs of carrying out survey field work, and these tend to vary more or less directly with the number of clusters to be covered. Accordingly, field costs are minimized when the number of clusters is kept small.

Because the latter two considerations are likely to vary substantially across applications and settings, only general guidance is offered by Magnani (1997). From a sampling precision point of view smaller clusters are to be preferred over larger clusters. As a general rule, selection no more than 40-50 households per cluster should be relatively safe according to Magnani (1997). Magnani (1997) mentions that there is no general rule on the number of clusters to be selected,

26 Robert Magnani, 1997. Sampling guide. Food and Nutrition Technical Assistance project (FANTA). Academy for Educational Development

[27] The intra-class correlation is a measure of the degree of homogeneity (with respect to the variable of interest) of the units within a cluster. Since units in the same cluster tend to be similar to one another, the intra-class correlation is almost always positive (United Nations (2005) Household sample Surveys in Developing and Transition Countries)

however, the more clusters the more significant it becomes. A total cluster number of 20 considered suitable for this project. This number will be proportionally divided over the zones according to calculated sample size. If the sample size is equal in both zones, in each zone 10 clusters are to be surveyed. This will be determined for each CMS.Each cluster is one district. There are an estimated 480 district in the BP VGS zone. Statistical significant is ensured as the degree of homogeneity within the clusters is low (a district is a big administrative unit, containing many communes and each commune contains many villages) and the number of samples per cluster is low.Cluster sampling will result in a loss of sampling efficiency compared to simple random sampling. In order to correct the potential loss of sampling efficiency, the design effect (D) will be added in the equation to correct the sample size (Magnani, 1997).

Usually the design effect (D) of 1 to 3[28] is used. However, in case there is a low degree of homogeneity within the clusters (a district is a large administrative unit and consists of multiple communes (around 20 in each district), each commune contains many villages and important ER variables such as type of fuel, type and number of animal and biodigester size vary considerably amongst households), the households are known ex-ante (all household data is recoded and stored in the project database) and the number of units taken from each cluster is small, a lowD can be justified. A D of 1.5 is adopted by BP. The total sample size for each zone is therefore (1.5*100) 150 households. If for example a zone contains 10 clusters, 15 (150/10) households will be randomly selected in each cluster.

It is good practice to employ oversampling not only to compensate for any attrition, outliers or non-response associated with the sample but also for the reason that in the event the required reliability is not achieved additional sampling efforts would be required to determine the parameter value (CDM EB 65 Annex 2). Oversampling is employed by increasing the sample size by 10%. If, for example a cluster contains 15 samples, the number of sampled household will therefore be 16.5 and rounded up to 17 (15*110%) households per cluster. The total sample size, will be, with this example 170 per zone, or 340 in total. Which is a significant increase compared to simple random sampling and for that reason BP feels that statistical significance is maintained with the chosen approach.

- **Implementation:** The CMS will be executed at least annual or more frequent. The data collection will be executed by an independent entity which is selected on a number of criteria (experience, legal status of the company, quality of their proposal).
- **Desired Precision/Expected Variance:** The VGS methodology prescribes confidence precision level of 90/10.
- **Procedures for Administering Data Collection and Minimizing Non-Sampling Errors**
  The standard procedure for conducting the data collection is the following steps
  (1) Development of questionnaire;
  (2) Training and selection of surveyors;
  (3) Pilot testing of the questionnaire to ascertain that the questionnaire is appropriate and yields the required information.

[28] http://faculty.smu.edu/slstokes/stat6380/deff%20doc.pdf

- **QA/QC:** The contracted party can only proceed with each step if the step is completed upon satisfaction and when the results are inspected by BPD. The survey team will interview a random selection of biogas households, in case of non-response the surveyor will proceed to the next household in the list of random selected households. The surveyor will document the out-of population cases, refusals and other sources of non-response. Also, the surveyor will only interview informed interviewees, i.e. interviewees with knowledge on cooking and manure practices.
- **QA/QC procedures**: The contracted party will develop an inception report, draft report and final report which are all inspected by BPD before the party can continue with the next stages. The final stage is the workshop, where the results are discussed with BPD and invited independent experts. The final CMS report is subsequently inspected by a contracted DOE.
- **Data storage arrangement:** All data obtained from the CMS will be stored in a database, which will contain the data of the sampled households for each monitoring interval:
    1. Location of each biogas plant surveyed;
    2. Name of the each biogas plant owner;
    3. Unique code of each surveyed biogas plant;
    4. Size of the each surveyed biogas plant;
    5. Type of biogas plant;
    6. Name and ID of mason that built the biogas plant;
    7. Number of animals (Pig, buffalo, cattle and dairy cow);
    8. Fuel consumption (kg/year) of surveyed households;
    9. Date of commissioning for each plant;

C. Usage survey

The usage survey provides a single usage parameter that is weighted based on drop off rates that are representative of the age distribution for project technologies in the database. A usage parameter must be established to account for drop off rates as project technologies age and are replaced. Prior to a verification, a usage parameter is required that is weighted to be representative of the quantity of project technologies of each age being credited in a given project scenario.

For example, if only technologies in the first year of use (age 0-1) are being credited, a usage parameter must be established through a usage survey for technologies age 0-1. If an unequal number of technologies in the first year of use (age 0-1) and second year of use (age 1-2) are credited, a usage parameter is required that is weighted to be equally representative of drop off rates for technologies age 0-1 and age 1-2 . The minimum total sample size is 100, with at least 30 samples for project technologies of each age being credited

The majority of interviews in a usage survey must be conducted in person and include expert observation by the interviewer within the kitchen in question, while the remainder may be conducted via telephone by the same interviewers on condition that in kitchen observational interviews are first concluded and analyzed such that typical circumstances are well understood by the telephone interviewers.

To ensure conservativeness, participants in a usage survey with technologies in the first year of use (age 0-must have technologies that have been in use on average longer than 0.5 years. For technologies in the second year of use (age 1-2), the usage survey must be conducted with technologies that have been in use on average at least 1.5 years, and so on.

The usage survey procedure is as follows:

- Each year BPD will monitor the usage of the biogas units by selecting randomly at least 30 samples (biogas households)[29] from each year credited, the total sample will be over 100 units each time;
- To ensure conservativeness, only technologies will be selected that are in use for at least 0.5 year, for year 1-2 only technologies that are in use for at least 1.5 years etc. for the other years. The next table illustrates this for the period 2007-2011.

Table 22: Usage survey selection (example)

Year	Age group	Units included in the usage survey that are at least in use for (years)	Period of inclucision from	to	Units built in that period	Sample drawn from units built (at random)
2007	0-1	4.5	1-Jan-07	30-Jun-07	3727	≥30
2008	1-2	3.5	1-Jul-07	30-Jun-08	18164	≥30
2009	2-3	2.5	1-Jul-08	30-Jun-09	19342	≥30
2010	3-4	1.5	1-Jul-09	30-Jun-10	24304	≥30
2011	4-5	0.5	1-Jul-10	30-Jun-11	18023	≥30
					Total	**≥150**

After random selection of the households to be surveyed for the usage survey, the obtained drop-off rate of each year will be weighted according to the numbers of units built in that period. The drop-off rate will be applied when calculating the quantity of fuel consumed during year y (Bp,y), where it is assumed that any drop off rate is replaced by fuel consumption of the applicable baseline scenario.

The table above will look the same for the period 2007-2012, except that a new row is added with 2012, for 2013 another row will be added, etc.

Usage survey design (US)
The US can be part of existing monitoring surveys, the Biogas User Survey. Please note that the BUS itself is not a US survey but meant to monitor user satisfaction and other program relevant parameter. The US monitoring procedure applied will consist of the following steps:

I. Details of the biogas households of each household are gathered (see table above for an example)
II. At least 30 households are randomly selected from each age group

[29] See page 24 of the methodology

III. The district technician will survey the households, and the provincial technician will gather the data, inspect the data and enter the data into a database.
IV. The obtained drop-off rate will be used to discount emission reductions

The US sampling plan

- **Sampling objective:** The objective of the sampling effort is to obtain reliable data for the US survey;
- **Field Measurement Objectives and Data to be collected**: The survey will consist of household visit in random selected end-users to collect usage data;
- **Target Population and Sampling Frame:** The sampling frame will be drawn from the database of each age group;
- **Sampling method (approach):** Simple random sampling, each observation is chosen randomly and entirely by chance, such that each observation has the same probability of being chosen.
- **Implementation:** The US will be executed at least annually or more frequent. The data collection will be executed by the district technician and inspected by the provincial technician.
- **Desired Precision/Expected Variance and Sample Size.** The minimum total sample size is 100, with at least 30 samples for project technologies of each age being credited. The applied methodology does not prescribe a desired precision. However, since the sample size is larger than 100, as the sample size is already 150 2012, see table 18, the precision is comparable or higher than the CMS survey.
- **Procedures for Administering Data Collection and Minimizing Non-Sampling Errors:** As per CMS monitoring plan

Trainings

In order to ascertain that the activities are executed with high quality trainings are organized for masons, biogas technicians and each user is trained on the operation and maintenance of their biogas units. The trainings executed currently are:

(i) Province and district technician;
(ii) Biogas mason;
(iii) Potential Biogas user (biogas household and none biogas household).

The main purpose is (1) to promote the biogas program, create awareness of the benefits of biogas and to provide technical supports (2) inform participants about the procedures related to data collection (i.e. for VGS on fuel data collection), subsidy arrangements (3) ensure proper operation and maintenance of the biogas plant by training participants and proper use of the biogas appliances and bio-slurry.

Program brochure, leaflet (technical, safety), promotional CD, Biogas user handbook, safety leaflet and VCDs will be available and given to participants to ensure the improvement and consolidation of the knowledge obtained from the training trainings.

The training schedule is based on approved annual plan, normally divided into ‘Before-construction’ and Post-construction, which are executed as follows:

- **Provincial and district technician training:** carried out by biogas component implementing units in provinces/cities, after the decision to approve annual construction quota is issued and before trainings for biogas mason are conducted. BPD will recommend trainers/ experts and vocational schools that are experienced with biogas technology to biogas component implementing units for their consideration and selection. Trainings will be under supervision of BPD.
- **Biogas mason training:** Mason training can be conducted at the same time or after training for biogas technicians.
- **Biogas user training:** Trainings are conducted at location or in the relevant district at regular interval and include all households that recently have invested in a biogas plant. This includes the "Before-construction" and "post-construction" training.

In addition, refresh training/ exchange workshops are hold to refresh knowledge and to exchange. The training procedure is reviewed annually, updated where necessary and improved where possible.

Storage of records

Each form will be stored for at least 5 years. Decentralized provinces will store the forms at the provincial office. Less experienced provinces (the new provinces) will sent all the forms to the BPD office and there each forms will be stored for at least 5 years.

B.8. Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies):

The baseline is not fixed and will be updated with future participants. The information used in this PDD is based on the units built between 1/1/2007 – 31/08/2011.

Date of completion: 15 October 2011

By Eric Buysman
Ericishier@gmail.com

Eric Buysman who is responsible for the application of the baseline study and monitoring methodology is not a project participant.

Commissioned by Nexus – Carbon for Development
http://www.nexus-c4d.org/

Contact person regarding the project documents

Samuel Bryan (s.bryan@nexus-c4d.org)

SECTION C. Duration of the project activity / crediting period

C.1. Duration of the project activity:

C.1.1. Starting date of the project activity:

19 July 2006

C.1.2. Expected operational lifetime of the project activity:

Around 25 years (expert opinion of SNV biogas advisor)

C.2. Choice of the crediting period and related information:

C.2.1. Renewable crediting period:

C.2.1.1. Starting date of the first crediting period:

1/5/2010 or date of registration minus 2 years, whatever date is later.

C.2.1.2. Length of the first crediting period:

7 years of which 2 years retroactive

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

Not applicable

C.2.2.2. Length:

Not applicable

SECTION D. Environmental impacts

D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

The project does not result in trans boundary impacts, and only has positive impacts on the environment.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

There are no mandatory requirements for the waste management for small-scale household farms. Only for large farms with more than 1000 pig heads and 20000 poultry head requires the EIA and waste management facilities according to decree 149 and circular 02.

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SECTION E. Stakeholders' comments

A separate local stakeholder consultation report (LSCR) is compiled for this project according to GS requirements.

E.1. Brief description how comments by local stakeholders have been invited and compiled:

See the LSCR

E.2. Summary of the comments received:

See the LSCR

E.3. Report on how due account was taken of any comments received:

See the LSCR

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Biogas Program for the Animal Husbandry Sector of Vietnam
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URL:	www.biogas.org.vn
Represented by:	Mr. Hoang Kim Giao
Title:	Director
Salutation:	N/A
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Represented by:	Tom Derksen
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

See the non-ODA diversion declaration in the Gold Standard Passport Report (GSPR The Government of Netherlands affirm that the funding for the project activities for the biogas program have not resulted in the diversion of ODA and that this funding is not counted towards the financial obligation of concerned Parties.

Annex 3

BASELINE INFORMATION

Fuel data
The baseline is developed based on the data collected during the intake interview of each household that will install a biogas plant. The baseline sample includes 100% of the households that participate in the project.

Non-renewability Assessment BP Vietnam

A. BASELINE NON-RENEWABLE BIOMASS ASSESSMENT

The fraction of NRB is identified following the guidelines of applied methodology 'Technologies and practices to displace decentralized thermal energy consumption' version 1.0.

In projects where woody biomass is a component of either the baseline or project scenario, project proponents must specify the extent to which the CO_2 emissions of that biomass are not offset by re-growth in the fuel collection area.

The non-renewable biomass (NRB) assessment is conducted following the CDM EB 23 Annex 18 definition of "renewable biomass" (by inversion) and by collecting evidence through field surveys, literature review and resource/population mapping studies. Depending on the depth and quality of information available on biomass supply and growth in the collection area, project proponents may or may not be able to pursue a quantitative approach. If possible, project proponents should adopt the quantitative approach below; otherwise the qualitative approach should be used. The best method is to combine both approaches and include conservative estimates.

The $f_{NRB.}$ is studied by:

- **A.** Quantitative NRB assessment
- **B.** Qualitative NRB assessment

Both options (a) and (b) assume it is possible to estimate the locations and extent of the areas from which woody biomass fuel used by the project participants is collected. If estimating the collection area is difficult, project proponents can aggregate all reachable woody biomass fuel collection areas within the relevant country and apply a single fraction derived from all collection areas in the country, with respect to the options above.

QUANTATIVE NRB ASSESSMENT

<u>Woody biomass collection areas</u>

In Vietnam forests are categorized by use, these are[30]:

(1) Protection forest

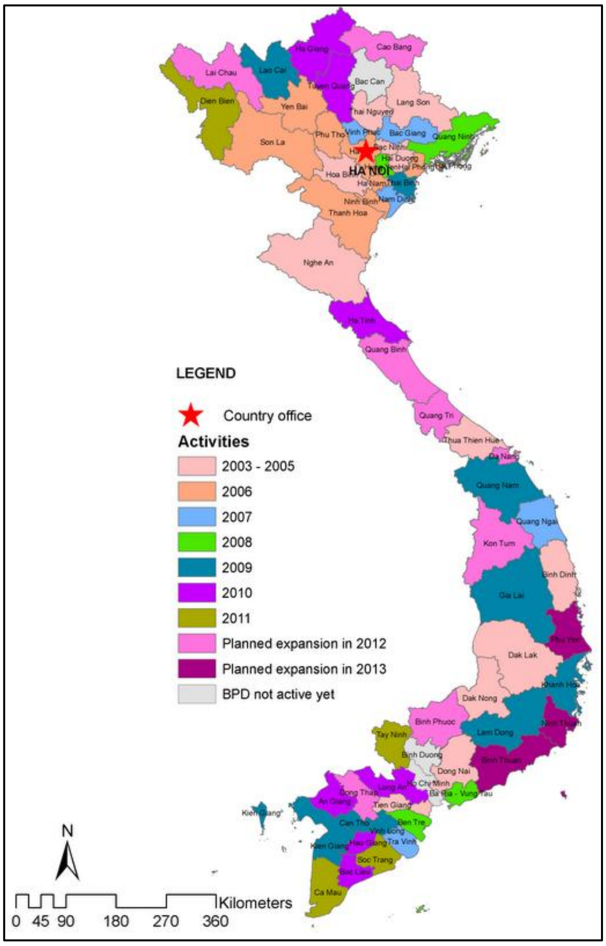
Protection forest is determined primarily to serve the purpose of protecting and enhancing the capabilities on regulation of water sources, soil conservation, and erosion control and desertification prevention, contributing to mitigate natural disasters, climate control, ensuring ecological balance and environmental security.

(2) Special use forest

Special-use forest is the forest type established with the aims at preserving natural resources, forest ecosystem standards of the country, genetic sources of forest fauna species, scientific research, protecting historical sites, beauty spots served as tourisms in combination with ecological environment protection.

(3) Production forest

Production forests are mainly used for manufacturing and trading of timber, NTFPs in combination with some protection and conservation functions.



Wood collection is only allowed from the production forests. The map to the right shows that the project is active in most provinces in the north, central and the south of Vietnam. It is also mentioned that the programme intends to cover the whole of Vietnam. This is in line with the main objective of the programme, the creation of a viable biogas market sector.

The woody collection area is therefore all the production forests in Vietnam. The special use forests and the protection forest are protected by law for exploitation[31].

This is conservative as the provinces where BP is not 'yet' active are the most forested, by including these provinces the fraction NRB will be lower than if the assessment was limited to the project

[30] http://vietnamforestry.org.vn/mediastore/fsspco/2011/07/11/ForestryOfVietNam_2011_EN_Version15.pdf

[31] http://www.theredddesk.org/countries/vietnam/info/law/the_law_on_forest_protection_and_development_vietnam

provinces. Another argument of including the provinces where BP is not yet active is to account for leakage effects (biomass may be sourced from these provinces) and BP may be activity in these provinces in the future. The latter will depend very much on how successful the VGS application turns out to be.

In summary, the geographical boundaries of the production forests of Vietnam are considered to be the woody biomass fuel collection area.

The $f_{NRB.}$ of wood originating from the identified woody biomass collection areas is calculated using the following steps:

Step 1: Calculation of the Mean Annual Increment

The annual wood fuel increment is the quantity of wood which could be harvested sustainable is determined of the identified wood collection area. For this purpose, tools like satellite data, regional statistics, regional or IPCC algometric equations to estimate the above ground biomass increment etc. may be used. This is the mean annual increment (MAI). Extensive data on the mean annual wood increment (MAI) by forest type is not available in Viet Nam. However average values by forest category are available from an FAO report in 2009[32]. Based on the FAO report it was calculated that 52% of the natural forests are protected and 37% of the plantations. These percentages were applied to the latest forest assessment (2009) of MARD. The MAI and the total productive forest area are illustrated in the next table.

Table 23: Annual wood increment by forest category

Forest category	**MAI (m^3/ha/year)** [32]	**Wood collection area (hec)**
Natural forests	0.5-1	4,980,210.40
Plantations	6	1,831,057.08

The calculation of the total mean annual increment is the multiplication of the forest area of each category with the respective mean annual increment. The average MAI is calculated using the MAI of 6 for plantations and for three MAI values, 0.75 (AVG), 0.5 (MIN) and 1 m3/hec/year (MAX). The next table shows the calculated average MAI:

[32] http://www.fao.org/docrep/014/am254e/am254e00.pdf

Table 24: Calculated Mean Annual Increment of the Vietnamese forests (m^3/year)

Forest category	**AVG**	**MIN**	**MAX**
Natural forests	3,735,158	2,490,105	4,980,210
Plantations	10,986,342	10,986,342	10,986,342
Total	14,721,500	13,476,448	15,966,553

Step 2: Determination of annual harvest of woody biomass, including forest clearance, timber extraction, consumption of wood fuels, drawn from fuel collection area A

Three sources of harvest sources are considered:

1. Fuel wood consumption
2. Forest clearance
3. Timber

1. Fuel wood consumption

According to the Vietnamese government the annual biomass harvested for fuel is 0,43 stere per rural capita and 0.3 stere per urban capita[33]. The population of Vietnam is estimated to be 90.55 million inhabitants according to the CIA fact book[34]. The total calculated fuel wood harvested is then 35.62 million m^3.

2. Forest clearance

According to the Ministry of Agriculture and Rural Development[35] in 2010 1057.4 hectare forest area is destroyed and 6723.3 hectare is fired. The total area lost is then 7780.7 hectares. The average biomass growing stock per hectare is according to the FAO32 (2009) 74 m^3/hectare. The total loss is then estimated to be 0.576 million m^3 wood.

The area fired will result next to CO_2 emission is substantial amounts of other GHG emissions[36]. These emissions are not included in the analysis, this is conservative.

[33] Vietnam Forestry Booklet of the Forest Sector Support Partnership (FSSP) (2011), see http://vietnamforestry.org.vn/mediastore/fsspco/2011/07/11/ForestryOfVietNam_2011_EN_Version15.pdf

[34] https://www.cia.gov/library/publications/the-world-factbook/geos/vm.html

[35] http://www.gso.gov.vn/Modules/Doc_Download.aspx?DocID=14413

[36] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_02_Ch2_Generic.pdf

3. Timber extraction

Timber extraction estimates are shown in the next table
:

Table 25: Total timber extraction and imports

Type	Amount (million m^3)[37]
Total timber material in wood processing sector	11
Total timber material in furniture industry	6.2
Imported timber	5

The total amount of timber extracted from the Vietnamese forests are then 11+6.2-6 = 12.2 million m^3. The FAO estimated that timber extraction in 2005 is 10 million m^3/year. Considering the rapid development of the furniture industry, the increase to 12.2 is assumed plausible in 2008. Current values are probably even higher, but unfortunately not available.

4. Total annual harvest

The next table shows the main wood harvest sources

Table 26: Total annual harvest of woody biomass

Source	million m^3/year
Fuel wood	35.62
Forest clearance	0.58
Timber	12.2
Total	**48.40**

Non-timber Forest Products, rattan extraction and Bamboo processing is excluded from the analysis, this is conservative.

Step 3: Calculate the shortage of woody biomass in the area:

$$NRB = H - MAI$$

Where:

- MAI: Annual biomass increment (tons/year) on area A
- H: Annual biomass harvest (tons/year) on area A
- NRB: Non-renewing biomass or excess harvest over and above-regrowth, which is the amount of woody biomass removed with attendant CO_2 emissions which are not reabsorbed by regrowth.

[37] See page 23 of http://www.vietnamforestry.org.vn/NewsFolder/NFP%20Assessment%20Report_EN.pdf

Table 27: NRB by MAI value (million m^3/year)

Scenario 2	Average	max	min
H	48.40	48.40	48.40
MAI	14.72	13.48	15.97
NRB	33.68	34.92	32.43

Step 4: Ascertain the fraction of extracted woody biomass that is non-renewable, denoted as $f_{NRB.}$

If a quantity of woody biomass supplied from fuel collection area A is used as a fuel for thermal energy production, the fraction f_{NRB} is assumed to be non-renewable with CO_2 emissions that are not reabsorbed by re-growth.

$$\mathbf{f_{NRB} = \frac{NRB}{H}}$$

Equation 6: Calculation of the share of NRB

Where:

f_{NRB}	=	Share of non-renewable biomass
NRB	=	Non-renewable biomass harvest (tons/year) on the project area i.
H	=	Annual biomass harvest (tons/year) on the project area i.

Table 28: Calculated $f_{NRB.}$ by MAI value

Scenario 2	Average	max	min
NRB	33.68	34.92	32.43
Harvest	48.40	48.40	48.40
$f_{NRB.}$	70%	72%	67%

The calculated average $f_{NRB.}$ value is on 70%.

Other Quantitative NRB studies

In Can Tho province a CDM domestic biogas project is at the moment at validation[38]. The project is developed by Japan International Research Center for Agricultural Sciences (JIRCAS) and the Can Tho University (CTU). The proposed CDM project implements the VACB farming system for 917 households in 3 districts rural area in Can Tho in the Mekong Delta. The project implements plastic biogas plants (hence no risk for double counting here). The project is, however, located in the project area of BP VGS and hence the same f_{NRB} fraction can be used.

The project is at validation[39] since the end of 2010. A NRB assessment was executed spanning two month. The survey concluded that:

- The situation land remains a forest is not secured;
- The level of carbon stock decreases;
- Trend showing increase in time spent or distance travelled by users (or fuel-wood suppliers) for gathering fuel wood or alternatively trend showing increase in transportation distances for the fuel wood transported into the project area;
- Survey results, national or local statistics, studies, maps or other sources of information such as remote sensing data that show that carbon stocks are depleting in the project area;
- Increasing trends in fuel wood price indicating scarcity;
- Trends in the type of cooking fuel collected by users, suggesting scarcity of woody biomass.

Based on the survey the f_{NRB} was quantified to be 70,92%. The PDD also showed that the situation of NRB consumption already existed prior to 1989, although the f_{NRB} was then only 47.62%. This shows that the unsustainable use of wood is exacerbating as the demand is high while the carbon stocks are gradually diminishing over the last decennia.

QUALITATIVE NRB ASSESSMENT

Quantitative indicators

Increasing prices, difficulties in obtaining wood and increasing time expenditure on wood collection indicate that there is an imbalance between demand and supply of fuel wood. These indicators are assessed for Vietnam based on four studies:

- The Can Tho Study;
- An Improved cooking stove study;
- FAO WISDOM study;

[38] VACB is a nutritional recycling system composed of “Vuon” for orchard –“Ao” for pond –“Chuong” for pigpen and Biogas)

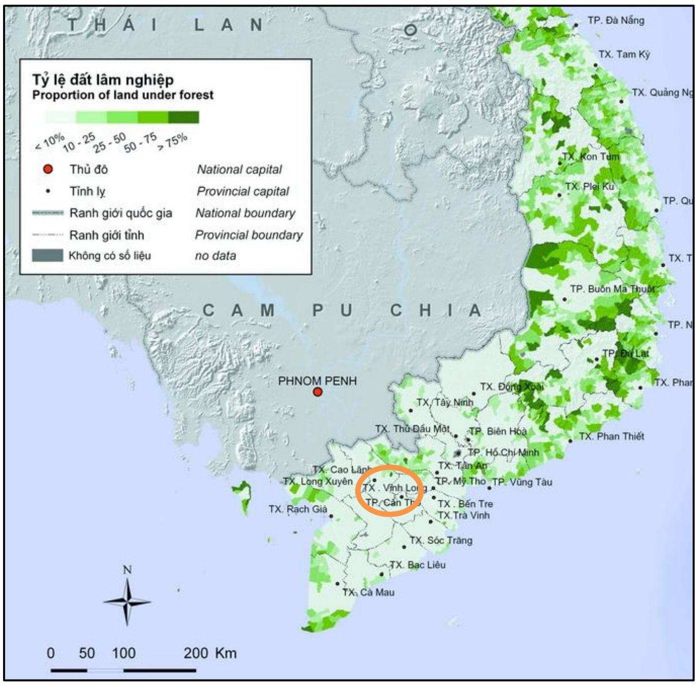
[39] Project documents can be found here: http://cdm.unfccc.int/Projects/Validation/DB/WHN2R5MIZ6DKNFOL3OVA93VHIYQ3TO/view.html

- REDD study.

1. Can Tho Biogas study

As discussed in the quantitative assessment, there are a number of trends showing unsustainable use of firewood:

- The situation land remains a forest is not secured;
- The level of carbon stock decreases;
- Trend showing increase in time spent or distance travelled by users (or fuel-wood suppliers) for gathering fuel wood or alternatively trend showing increase in transportation distances for the fuel wood transported into the project area;
- Survey results, national or local statistics, studies, maps or other sources of information such as remote sensing data that show that carbon stocks are depleting in the project area;
- Increasing trends in fuel wood price indicating scarcity;
- Trends in the type of cooking fuel collected by users, suggesting scarcity of woody biomass.



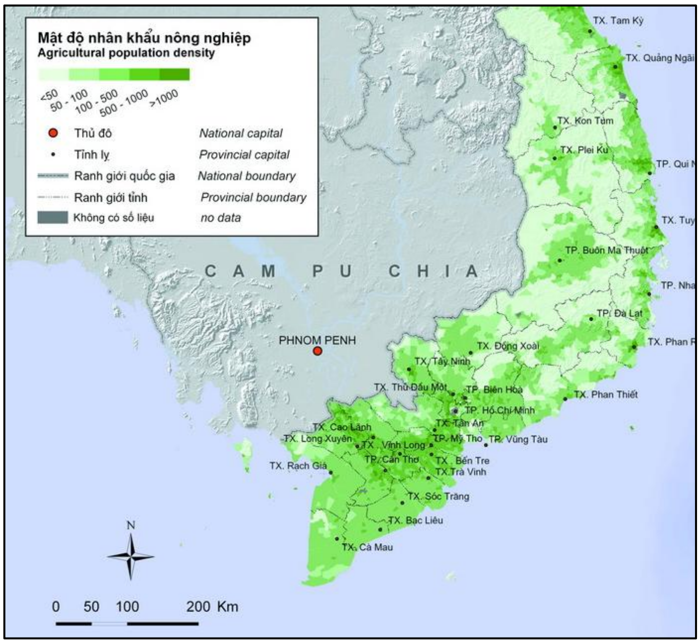


Figure 6: Above: Forest cover in south VN. Beneath: Rural population density in the South

Can Tho can be considered as typical for North-Vietnam, with typical forest cover and typical rural population densities as the two maps on the right show. The study had the following conclusions:

- Remote sensing showed that between 1989 and 2005 the amount of area with woody biomass stock has decreased from 29,000 hectares to 14,600 hectares.
- 44% of the household report price increases of fuel wood, and only 1% claims it decreases.

The study concludes that the demand for fuel wood far exceeds supply.

2. Improved cooking stove study[40]

SNV commissioned in 2010 an Improved Cook Stove Survey in three provinces that are considered typical in North Vietnam. The survey sample size is 754. The study showed that:

- 79.7% of the interviewees respond that firewood is becoming more difficult to collect compared to the past, only 1.2% claims it is becoming easier;
- 61.9% of the respondents claim that the quality of the collected firewood is becoming poorer;
- Firewood is becoming more expensive than in the past; however this is partly attributed to labor costs.

A reduction in the quality of the wood indicates that people cannot collect their preferred species of wood anymore and have switch to inferior quality of wood in order to secure access to energy. This is a clear indication of forest degradation and unsustainable use of wood; typically first the best wood is removed, then the inferior sources. Once most of the wood is collected certain weeds may invade, such as elephant grass or the land is cleared for agricultural purposes.

The vast majority of the interviewees also mentioned that is becoming harder to collect wood, they have to walk further while buying might not be an option as wood prices are increasing. This shows that the amount of wood (biomass growing stock) is not being replenished adequately to support a sufficient supply of wood. The direct effect is that people have to walk further, pay higher prices or are switching to inferior wood for their cooking activities[41]. This is a vicious cycle, which will overtime clear forest areas, promote forest land encroachment and will gradually lead to forest degradation, even in isolated areas.

This study shows that also in the North of Vietnam there is an imbalance between supply and demand of fuel wood and that wood collection practices are not sustainable.

3. FAO Wisdom study

The FAO (2007)[42] commissioned a WISDOM case study in Southeast Asia for the years 2000 and 2015 on wood-energy supply/demand scenarios in the context of poverty mapping. The study revealed that there is a great imbalance between wood supply and demand in Vietnam. A whopping 40.3% of the population lives in areas with a high deficit condition in wood supply to meet their demand. In total almost 65% of the population lives in deficit area, see the next figure:

[40] Survey on Cookstove Usage in Nothern Vietnam (2011) SNV and Mekong Development Services

[41] Which burn less good and cause more smoke, and thereby degrading the indoor air quality

[42] Drigo R. 2007. Wood-energy supply/demand scenarios in the context of poverty mapping. A WISDOM case study in Southeast Asia for the years 2000 and 2015

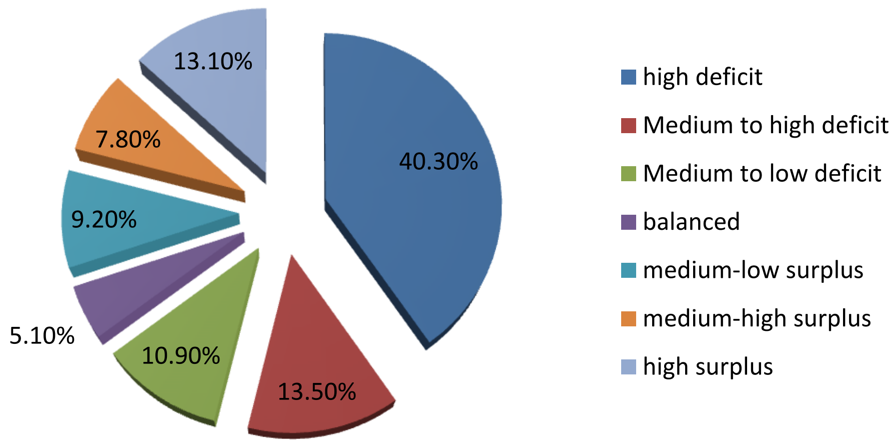


Figure 7: Distribution of wood supply/demand balance categories in Vietnam (FAO,2007)

Only 64.8% of the population lives in areas with a low to high deficit. Most the population in Vietnam has therefore problems with allocating and securing sufficient fuel wood for their cooking activities. Around 40% of the people facing with malnutrition lived in areas with wood fuel deficits, of which half faced critical conditions (concomitance of high to critical wood fuel deficits).

The FAO forecasts that this situation would increase in the business as usual scenario and only marginally decreases in the GFPOS scenario (the most likely scenario according to the FAO), see the next figure

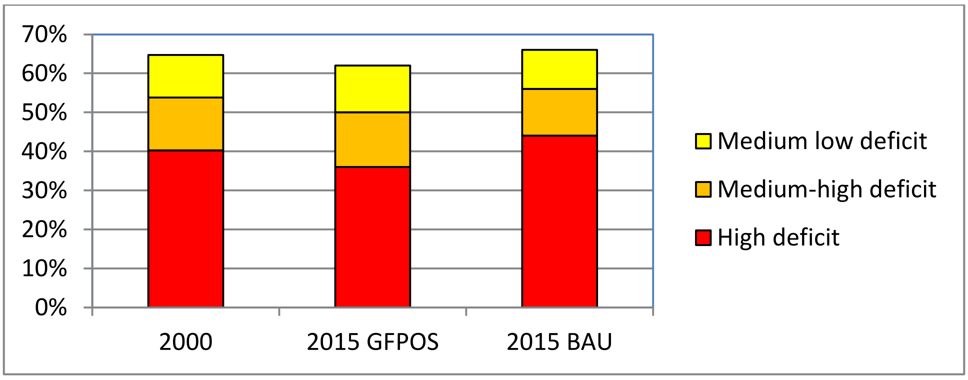


Figure 8: Distribution of rural population by deficit wood fuel supply and demand balance categories in 2000 and in 2015 according to the GFPOS and BAU scenarios (adapted from the FAO report)

The imbalance therefore is forecast to continue well into 2015. The two maps hereunder show the wood fuel balance and the population density. The relationship between wood fuel deficit and population density is very clear – there where the population is higher is where the deficit is higher. The figure also shows that most of the rural population suffers from a deficit wood fuel supply.

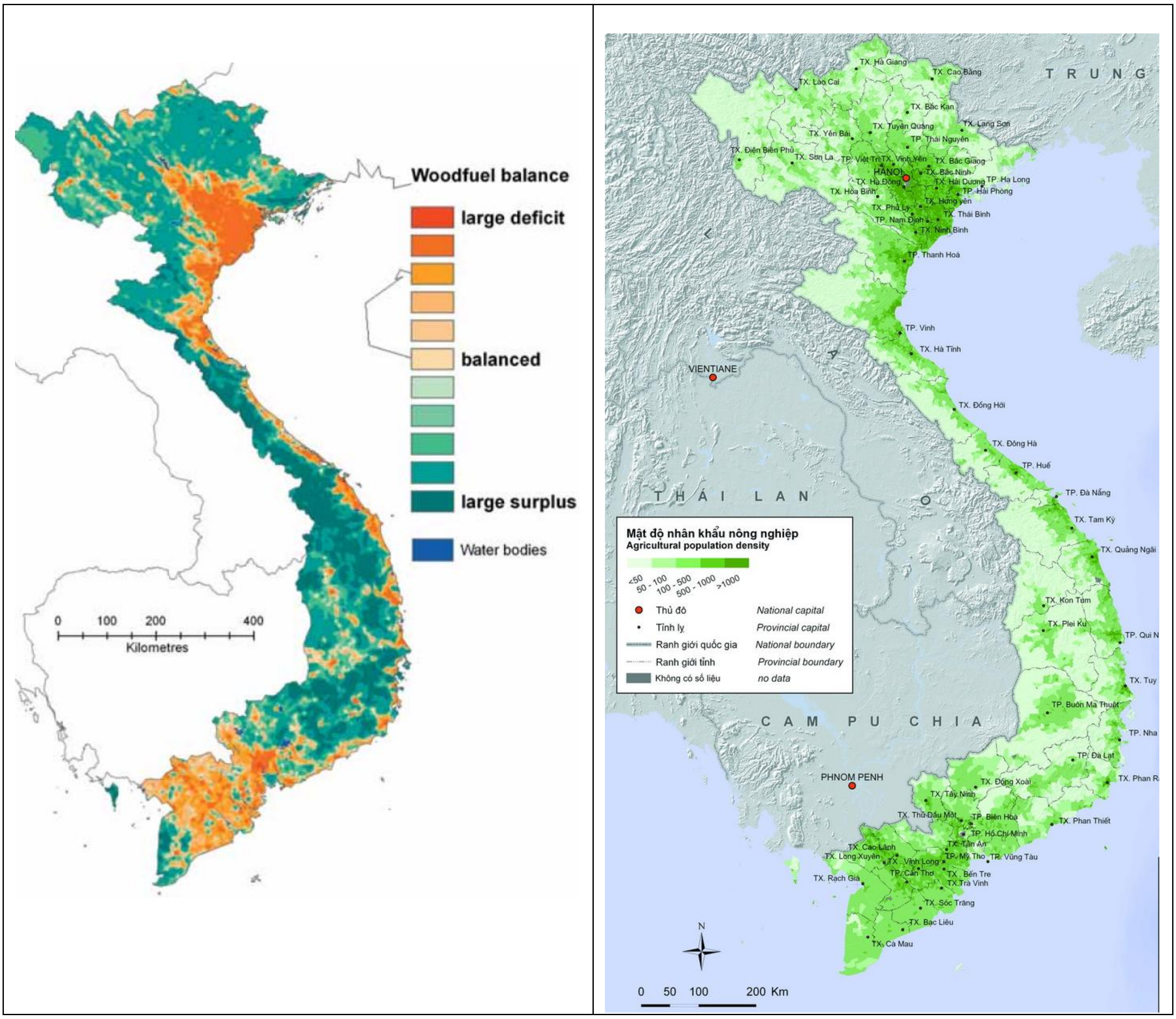


Figure 9: Left: Wood fuel deficit map and (right) rural population density map

The FAO WISDOM report concludes that wood fuel deficit is rampant in Vietnam. The FAO predicts that people in that case switch to lower grade fuels (agricultural residues) and or cook less meals. This link was also shown in the report; around 40% of the people facing malnutrition live in areas with fuel wood deficits. The situation will only marginally reduce according to the FAO in 2015 or even exacerbate in the BAU scenario.

Vietnam has a relatively large forest cover of 39.1% and this area is slowly expanding. Carbon stocks however are declining at the same moment with around 0.11% per year (FAO, 2009). This means that the quality of the Vietnamese forest is being reduced, i.e. the biomass (and carbon) growing stock is decreasing. This is one of the reasons why people experience a fuel wood deficit. Another explanation can be found in the observation that Vietnam has a low per capita forest area and wood volume in comparison with other countries in combination with a high fertility. On average, Vietnam has only 0.15 hectare of forest per capita and 9.16 m^3 of standing stock per capita while the world average figures are 0.97 hectare and 75 m^3 standing stock (MARD 2007)[43]. A low standing stock per capita translates to low annual increment availability per capita. In a country as Vietnam, with a large rural population relying on fuel wood, this leads to the observed imbalance by FAO between fuel wood supply and demand and the consequent reliance on NRB. This Ministry of Agriculture and Rural Development supports this assessment by stating: '*The forest resources are over exploited, the new forest plantations cannot catch up with the intensive illegal logging and destruction*'[44], or in other words, the demand is higher than the supply of wood products causing overexploitation of the forest resources.

4. REDD study Vietnam

A national REDD[45] study was conducted in 2009 by SNV and IndoChina Carbon. As part of the REDD study, the state of the forest was studied. The report concludes that:

According to government statistics the total forest area in Vietnam has increased to 12.6 million ha in 2006 (37% of land area) from 9.2 million ha in 1992. This is viewed partly as a result of Government policies on reforestation which have a target of 43% of land area covered in forests by 2015. Looking further into this data the picture is less rosy. For one, the definition of what has been included under forests has changed to include previously omitted limestone forests. Also much of the increase has been down to plantations, which account for 2.5 million ha and natural regeneration which contained large areas of bamboo [which has a low carbon stock]. Even accounting for these factors the data tends to show a very slight level of deforestation of natural forests. Information collected by World Bank and others in particular project sites would tend to indicate the situation may not be so promising.

The study continues with:

It is generally acknowledged that the quality of natural forests continues to be more fragmented and degraded. Forest degradation is a big issue in Vietnam. Over two-thirds of Vietnam's natural forests are considered poor or regenerating, while rich and closed canopy forest constitutes only 4.6 percent (in 2004) of the total. Lowland forests supporting their full natural biodiversity have been almost entirely lost. The chances of full generation are rapidly decreasing with the isolation of the rich natural forest patches. Reports by the National Forest Inventory, Monitoring and Assessment Program (NFIMAP) show that the quality and biodiversity of forest are continually deteriorating. Between 1999 and 2005 the area of natural forest classified as rich decreased by 10.2% and medium forest reduced by 13.4%.

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[43] Quoted from http://www.fao.org/docrep/014/am254e/am254e00.pdf

[44] https://docs.google.com/viewer?url=http%3A%2F%2Fwww.illegal-logging.info%2Fpresentations%2F17-180108%2Flong.pdf

[45] Understanding REDD – Implications for Lao PDR, Nepal and Vietnam by SNV Asia and IndoChina Carbon (ICC) (2009)

In other words, while the forest cover may increase, be it by changes in forest cover definition or plantations, the average biomass growing stock and therefore the carbon stock is decreasing. A lower biomass growing stock means that the exploitable biomass volume is decreasing likewise. This is an unsustainable situation where the biomass exploitable volume is dwindling while the demand for wood remains very high in Vietnam. The main drivers for continuing degradation are generally recognized as (quoted from the REDD report):

- Vietnam is a world leader in the export of coffee, cashew, pepper and an important global player in other export crops. This drive to export agricultural commodities is putting greater pressure on the scarce land and leading to the conversion of forest lands particularly in the central highlands;
- The rapid economic development is fuelling the need for greater energy demands and improved infrastructure. Vietnam has ambitious plans for hydropower and road development carving up parts of the countryside;
- Vietnam has become an important hub for wood processing and the sale of garden furniture in particular. The current demands for timber far outweigh the current supply in Vietnam. This is placing pressure on the forests in Vietnam and the neighboring countries in the region;
- The poorest communities, particularly in the mountainous areas, many of whom are from ethnic communities, continue to practice shifting cultivation and depend heavily on the forests for their needs. This continues to put pressure on the forests in these areas;
- There is also the continuing problem of illegal logging. There are an estimated 30-50,000 forest violations per annum, very few of which result in criminal prosecution. Lack of capacity to enforce rules, lack of coordination between enforcement agencies, unclear tenure as well as corruption continues to drive this problem.

DECISION OF THE FRACTION OF NRB

The decision of the f_{NRB} is based on three factors:

- f_{NRB} outlook (how will the situation develop in the near future);
- Sensitivity analysis;
- Adoption of f_{NRB} with supporting arguments from the qualitative assessment.

<u>Factor 1: Outlook</u>

The FAO developed for 2000, 2010 and 2020 with leap the following fuel wood demand, supply and shortfall under a number of scenarios; the baseline scenario and scenario 1 (baseline replacing fuel wood with other alternative fuel at different levels, conditional on sectors using fuel wood as energy).[46]

[46] FAO also developed 2 other scenario, but not included as the baseline scenario is assumed to be the most correct

Table 29: Fuel wood demand, supply and shortfall under the baseline scenario (million m^3)

Fuel wood	**1995**	**2000**	**2010**	**2020**
demand (H)	33.96	35.00	36.11	34.19
supply (MAI)	33.96	24.31	18.79	17.84
shortfall (NRB)	0.00	10.67	17.33	16.34
Calculated f_{NRB}	**0%**	**30%**	**48%**	**48%**

The FAO report excluded demand for timber. The inclusion of timber will increase the fraction of NRB, see the next table

Table 30: FAO forecast with inclusion of timber

Fuel wood	**1995**	**2000**	**2010**	**2020**
demand (H)	33.96	35.00	36.11	34.19
supply (MAI)	33.96	24.31	18.79	17.84
shortfall (NRB)	0.00	10.67	17.33	16.34
Calculated f_{NRB}	0%	50%	65%	65%

** Timber values of 2003 used for 2000 and values of 2008 for 2010 and 2020 by lack of other data*[30]

In all cases, there is shortfall of wood, even in 2020 with increased utilization of wood replacement technologies. Wood shortfall and therefore wood deficit is forecast to continue in the near and far future. This will mean that the unsustainable harvesting practices will continue and that the pressure on the forest will not decrease before 2020.

The calculated f_{NRB} with timber based on the FAO study is 65%, comparable to the estimate in the quantitative assessment.

Factor 2: Sensitivity analysis

The sensitivity analysis is based on the f_{NRB} values calculated using other sources. The sources are described in detail on the previous page, these are:

1. FAO with values of 2010 + timber
2. Can Tho Biogas project
3. MIN Scenario
4. AVG scenario
5. MAX scenario
6. Average of all f_{NRB} estimates

The following figure shows the calculated values:

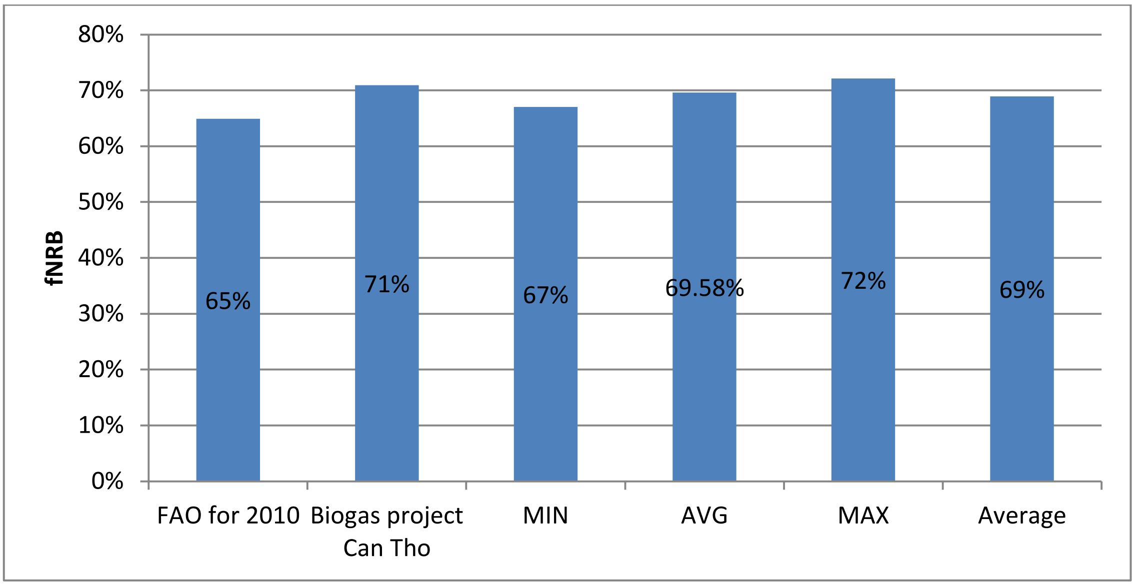

Figure 10: Calculated f_{NRB}

The values obtained are very close to each other. The average of all the estimates is practically the same estimate as the AVG estimate (the average estimate in the quantitative analysis)

3. Decision on f_{NRB}

The qualitative assessment showed that it is becoming harder for households to obtain fuel wood. This strongly supports the outcome of the quantitative assessment that a substantial part of the wood is not replaced by regrowth. All the f_{NRB} estimates are comparable and with a range of ±4% of the average. The most conservative scenario is adopted for the f_{NRB} of the quantitative assessment (MIN), a f_{NRB} of 67%. This value is well in in with other estimates and the qualitative assessment.

Annex 4

MONITORING INFORMATION

see section B.7.2