Gold Standard®

Gold Standard for the Global Goals
Key Project Information & Project Design Document (PDD)

Version 1.1 – August 2017

National Biodigester Programme, Cambodia
GS751

Gold Standard

KEY PROJECT INFORMATION

Title of Project:	National Biodigester Programme, Cambodia
Brief description of Project:	Development of a market-oriented biodigester sector in Cambodia with the aim to exploit the potential of biogas in Cambodia enabling rural households to switch to clean cooking from relying on wood, reduce deforestation and improve agricultural yields through the use of bio-slurry
Expected Implementation Date: Expected duration of Project:	Since 13 March 2006 31/12/2025
Project Developer:	National Biodigester Programme (NBP)
Project Representative:	Saoleng Lam
Project Participants and any communities involved:	NBP
Version of PDD: Date of Version:	2.~~0~~1 ~~28/01/19~~22/02/19
Host Country / Location:	Cambodia
Certification Pathway (Project Certificating/Impact Statements & Products	Impact Statements & Products - SDG 13: Gold Standard Emissions Reductions (carbon credits)
Activity Requirements applied: (mark GS4GG if none relevant)	GS4GG
Methodologies applied:	TPDDTEC 3.1
Product Requirements applied:	N/A
Regular/Retroactive:	Retroactive
SDG Impacts:	1 – SDG 13: Climate Action (Cumulative VERs) 2 – SDG 2: Zero Hunger: Area on which bio-slurry is applied 3 – SDG 7: Affordable and Clean Energy: Number of people benefitting from biogas
Estimated amount of SDG Impact Certified (CPIII annual average)	SDG 13: 78,699 SDG 2: 48,315 SDG 7: 117,838

SECTION A. Description of project

A.1. Purpose and general description of project

>> *(Provide a brief description of the project including the description of scenario existing prior to the implementation of the project.)*

The National Biodigester Programme

In January 2006, the Ministry of Agriculture, Forestry and Fisheries (MAFF) and SNV[1] agreed on the joint development of a National Biodigester Programme (NBP) as a way to create an indigenous, sustainable energy source in Cambodia and to utilize the potential of biogas in the country.

The scenario existing prior to the project activity

Before the onset of the project activities, most households with the technical potential for a biodigester rely primarily on wood for cooking both causing substantial exposure to hazardous household air pollution (with related health hazards) and contribution to deforestation.

A substantial part of the fuel wood is collected, which is both drudgery and significant time expenditure for especially women. Purchased wood on the other hand is a burden on the limited household's revenues. In addition, unhygienic animal waste management practices and the lack of access to basic sanitation result in pollution, foul odour, methane emissions and a relatively high prevalence of hygiene related diseases, such as diarrhoea.

The purpose of the National Biodigester Programme

The overall objective of the National Biodigester Programme is the dissemination of domestic biodigesters as an indigenous, sustainable energy source through the development of a commercial, market oriented, biodigester sector in eight selected provinces of Cambodia. The project activities aim to resolve the issues sketched of the baseline scenario above, by hygienically treating animal and human waste in a biodigester to produce a clean renewable cooking fuel, biogas, whereas the treated waste is to be used as a potent and safe organic fertilizer. The specific objectives of the National Biodigester Programme contributing to its overall objective are:

1. To increase the number of family sized, quality biodigesters with the total 8,600 biodigesters in the period 2019-2025 in selected provinces
2. To ensure the continued operation of all biodigesters installed under the biodigester programme;
3. To maximise the benefits of the operated biodigesters, in particular the optimum use of digester effluent;
4. Technical and promotional capacity development of the stakeholders within the NBP for further wide scale deployment of biodigester technology in Cambodia. This objective will particularly focus on the development of a capable and viable private sector responsible for marketing, construction and after-sales service of biodigesters;

[1] *Please note, SNV is no longer involved in the project*

A.2. Eligibility of the project under Gold Standard

>> *(Describe how the project meets the eligibility criteria as per section 3.1.1 of GS4GG Principles & Requirements document and the relevant activity requirements document)*

The project is eligible as per section 3.1.1 of the GS4GG Principles and Requirements as there is a Methodology associated with the activity: Technologies and Practices to Displace Decentralized Thermal Energy Consumption v3.1. In section 1.0 of the methodology is described that bio-digesters are eligible.

A.3. Legal ownership of products generated by the project and legal rights to alter use of resources required to service the project

>> *(Justify that project owner has full and uncontested legal ownership of the products that are generated under Gold Standard Certification and has legal rights concerning changes in use of resources required to service the Project for e.g. water rights, where applicable.)*

Households that invest in a biodigester sign a sales contract, called form 03. In that form, a clause is included on the VER rights transfer from the households to NBP. This clause, No 19 states:

"*Transfers all rights, credits, entitlements, benefits or allowances arising from or in connection with any greenhouse gas emissions reductions arising from the operation of the biodigester (Emission Reductions), and agrees to take all necessary action required to ensure the transfer of those Emission Reductions to the National Biodigester Programme*"

Moreover, a clause is included in the biodigester franchise contract between the BCA (Biodigester Construction Agency), PBPO (Provincial Biodigester Programme Office) and the NBPO (NBP office)

NBP itself is entitled to utilize carbon credits to advance the programme development. This is stipulated in a MoU between NBP and MAFF (Ministry of Agriculture, Fisheries and Forestry).

A.4. Location of project

A.4.1. Host Country

Cambodia

A.4.2. Region/State/Province etc.

NBP is currently active in the following provinces:

#	Province	Active since
1	Kampong Cham	Mar-06
2	Kandal	Mar-06
3	Svay Reang	Mar-06
4	Takeo	Oct-06
5	Kampong Speu	Oct-06
6	Kampong Chhnang	Dec-07
7	Kampot	Dec-07
8	Kampong Som (Preah Sihanouk)	Nov-09
9	Kep	Dec-09
10	Prey Veng	Oct-08
11	Siem Reap	Dec-09

12	Pursat	Jan-10
13	Battambang	Jan-10
14	Kampong Thom	Sep-10
15	Tbong khmum	Sep-14
16	Phnom Penh	May-06[2]

NBP has the long term aim to meet the biogas potential in the whole country depending on the budget available to enlarge the geographical scope of the Program.

A.4.3. City/Town/Community etc.

>>

All the households with the technical potential (>15kg of manure at their disposal on a daily basis) within the project area are targeted, irrespective of district, commune or village. However, since the objective of the programme is to establish a commercially viable market for domestic biogas, the biodigester dissemination will follow market demand. Consequently, location details will only be available *after* households and biogas construction enterprises have entered into a contractual agreement with the BCA.

A.4.4. Physical/Geographical location

>> (*Include information allowing the unique identification of this project.)*

Table 1: GPS coordinates of the provincial capital in the current NBP provinces

#	Province	Latitude (xx° xx' xx" N)	Longitude (xx° xx' xx" W)
1	Kampong Cham	11° 59' 00" N	105° 27' 00" E
2	Kandal	11° 78' 30" N	104° 81' 70" E
3	Svay Reang	11° 05' 00" N	105° 48' 00" E
4	Takeo	10° 59' 00" N	104° 47' 00" E
5	Kampong Speu	11° 27' 00" N	104° 30' 00" E
6	Kampong Chhnang	12° 00' 00" N	104° 30' 00" E
7	Kampot	10° 36' 00" N	104° 10' 00" E
8	Kampong Som	10°38′00" N	103°30′00" E
9	Kep	10°29′00" N	104°18′00" E
10	Prey Veng	11°29' 00" N	105°19' 00" E
11	Siem Reap	13°21′44″ N	103°51′35″E
12	Pursat	12°32′00" N	103°55′00" E
13	Battambang	13°06′00" N	103°12′00" E
14	Kampong Thom	12°42′00" N	104°53′00" E
15	Tbong khmum	11°54′34″N	105°38′49″E
16	Phnom Penh	11°33′43" N	104°53′18" E

In case NBP extends to other provinces, location details will be included in the monitoring report.

[2] *Orginally NBP was not active in Phnom Penh. However, several districts were transferred from Kandal to Phnom Penh and as a result of this administrative change NBP is now also activity within the Phnom Penh administrative zone*

A.5. Technologies and/or measures

>> *(Describe the technologies and measures to be employed and/or implemented by the project, including a list of the facilities, systems and equipment that will be installed and/or modified by the project. Include information essential to understand the purpose of the project and how it will contribute positively to three SDGs.)*

NBP installs, through franchised Biodigester Company Agencies (BCA), biodigesters. The main type of digester that NBP installs is the Farmer's Friend digester and a scaled down version of this model, the S1 in the size of 2 to 15 m^3 with possibility to construct up to 50 m^3 Both technologies have an expected lifespan of over 25 years. The programme is otherwise biodigester technology agnostic, provided that technologies meet the following requirements:

1. Durability: Biodigesters are expected to last for over 10 years
2. Gas storage: The digester should be able to store at least 50% of daily gas production
3. Warrantye: A minimum warranty of 1 year shall be offered

The list of facilities, system and equipment that will be installed include:

- Inlet (for mixing the manure with water)
- Biodigester and integrated gasholder
- Compensation tank
- Slurry pit (to store overflown slurry temporarily before it is scooped to the compost hut)
- Compost hut (optional but strongly encouraged)
- Toilet (optional)
- Gas piping and water trap (water trap is necessarily to remove condense water from the biogas)
- A biogas stove (stoves dissiminated via NBP are recommended but not mandatory)
- Pressure gauge (gas pressure in the plant is a proxy for gas availability)
- Biogas lamp / biogas rice cooker (both optional)

NBP is a market-based programme and the actual number of digester installed depends on the market conditions. NBP however forecasts the following uptake of digesters in this CP:

Description/year	2019	2020	2021	2022	2023	2024	2025	2026	Total	Avearge
Number of digesters	1,000	1,100	1,200	1,250	1,300	1,350	1,400	1,400	**10,000**	**1,250**

NBP contributes directly to three SDGs:

1 – SDG 13: Climate Action: The installation of biodigester reduces GHG emissions by displacing NRB and LPG by the provision of a clean and renewable fuel: biogas and by reducing methane emissions from animal waste management systems by capturing methane gas in a biodigester and using it for cooking

2 – SDG 2: Zero Hunger: A biodigester produces next to biogas bioslurry (the effluent). Bio-slurry is an organic and high quality fertilizer which helps farmers to increase crop yields while maintaining soil health[3]. The combination of improved soil quality, yield and reduced fertilization cost (i.e farmers don't have to buy chemical fertilizers anymore) will improve farmer's income and their food security.

[3] https://www.hivos.org/sites/default/files/publications/bioslurry_a_supreme_fertiliser_a_study_on_bioslurry_results_and_uses.pdf

3 – SDG 7: Affordable and Clean Energy: Biogas generated from biodigesters enables households to have access to an affordable **and** clean source of energy. Biodigesters have an estimated lifespan of 25 years and the pay-back period is only around 2-3 years. Given that manure is produced at the households and available for free, the short pay-back period, households will have access to a free and clean source of energy for the majority of the technology lifespan.

A.6. Scale of the project

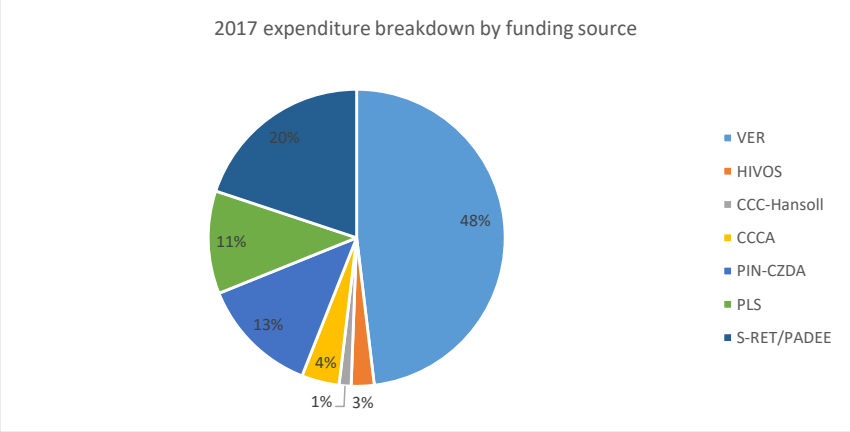
>> (Define whether project is micro scale, small scale or others. Justify the scale referring to relevant activity requirement.)

As per Gold Standard for the Global Goals Renewable Energy Requirement paragraph 1.23, the NBP project activity is defined as non-microscale[4]. The emission reductions are over 10,000 tCO_{2eq} annually.

A.7. Funding sources of project

>> (Provide the public and private funding sources for the project. Confidential information need not be provided.)

NBP received a mix of funding sources, including VER income, HIVOS, CCC-Hansoll, CCCA, PIN-ZCDA, PLS, S-RET/PADEE. The funding breakdown is shown here below[5]:



The figure shows clearly that carbon finance plays a very important role in financing the project.

A.8. Assessment that project complies with 'gender sensitive' requirements

>> (Answer the four mandatory questions included under Step 1 to 3 in "Gold Standard Gender Equality Guidelines and Requirements" available here.)

Step 1 to 3 of the Gold Standard Gender Equality Guidelines and Requirements are assessed below:

Step 1: Basic context

[4] *https://globalgoals.goldstandard.org/wp-content/uploads/2017/06/200-GS4GG-Renewable-Energy-Activity-Requirements-v1.0.pdf*

[5] NBP 2017 Annual report

1: Does the project reflect the key issues and requirements of gender-sensitive design and implementation as outlined in the gender policy?

NBP is meeting the foundational gender sensitive minimum standards[6]. For example, NBP has a gender sensitive design and ensures that both women and men are involved during trainings and village group meetings. For example, trainings are generally organized at a moment that is convenient for women and not interfering with their other (domestic) chores.

2: Does the project align with existing country policies, strategies and best practices?

Key national policies are:

- Neary Rattanak IV – five year strategic plan for Gender Equality and Women's empowerment 2014-2018 of the Ministry of Women's affairs (MOWA)[7]
- MAFF Gender Mainstreaming Policy and Strategic Framework in Agriculture 2016-2020[8]

The latter document is the most relevant, and addresses issues like time / labour to collect firewood limits women's capacity for higher value tasks which limits nutrition, health, education and life opportunities, limited access to energy that makes women's lives even more difficult.

NBP aligns with existing countries policies and best strategies, see below

Table 2: Key examples of alignment with national policy

Document	Chapter	How
Neary Rattanak IV	3.2 Gender and Climate Change, Green Growth and Disaster Management	Green growth and resilience against climate change, i.e. through the use of bio-slurry which improves soil health and elimiting the need to collect wood
MAFF Gender policy	Chapter 5. Outcome 1: Women have improved acces to agricultural inputs. Page 42 Outcome 1 indicator 1: Percentage of women and men who use improve agricultral inputs and Indicator 2: Access to mico-credit Chapter 5: Outcome 2 Great access to information and knowledge; page 42 Indicator 1: men and women that have adopted best practices and 4: Women and men that participated in technical skill training	Outcome 1:Indicator 1: Biodigester enable women to have access to key agricultural inputs such as bio-slurry as fertilizer. Indicator 2: NBP has set-up a micro finance program for those willing to borrow money for biodigester investment Outcome 2: Indicator 1: NBP enables women to benefit from biodigester technology for cooking and improvement of farm economics. Indicator 4: Biodgester usage training are skewed towards particpation of women as they are the key users of the technology. This enables them to have greater access to information and knowledge

[6] See page 10 paragaph 15 of https://www.goldstandard.org/sites/default/files/documents/gs_gender_policy-2.pdf

[7] *Available online: http://www.mowa.gov.kh/inc/uploads/2018/01/MoWA-Neary-Rattanak-IV-2014-2018-EN.pdf*

[8] *MAFF: Gender mainstreaming policy and strategic framework in agriculture 2016-2020*

Step 2: Apply GS safeguarding principles

3. Does the project address the questions raised in the Gold Standard Safeguarding Principles & Requirements document?

Yes, please refer to Section D.1 of the LSCR. In that report all questions raised in the Gold Standard Safeguarding Principles & Requirements document are addressed.

Step 3: Conduction stakeholder consultation

4. Does the project apply the Gold Standard Consultation & Engagement Procedure Requirements? Explain how.

Yes, the LSCR describes this in detail, see section B.1.iii, and includes consideration of all stakeholder categories, ethnicities, gender and races.

SECTION B. Application of selected approved Gold Standard methodology

B.1. Reference of approved methodology

>>

The methodology applied is Technologies and Practices to Displace Decentralized Thermal Energy Consumption version 3.1.

B.2. Applicability of methodology

>> *(Justify the choice of the selected methodology(ies) by demonstrating that the project meets each applicability condition of the applied methodology(ies))*

Table 3: Eligibility assessment

Eligibility criteria	Assessment
1. The project boundary needs to be clearly identified, and the technologies counted in the project are not included in any other voluntary market or CDM project activity (i.e. no double counting takes place). In some cases, there maybe another similar activity within the same target area. Project proponents must therefore, have a survey mechanism in place together with appropriate mitigation measures so as to prevent any possibility of double counting.	All biodigesters installed under NBP have a unique registration number. That number indicates when and where the digester was built, based on that numbers double counting can be avoided. There are no similar activities in the project area that claim carbon finance.
2. The technologies each have continuous useful energy outputs of less than 150 kW per unit (defined as total energy delivered usefully from start to end of operation of a unit divided by time of operation).	The largest biogas plant that NBP currently installs is 15 m^3. In theory it is possible to construct a 50 m^3 plant, that plant would produce 37.43 kW/day at maximum (see ER spreadsheet tab thermal output) This is much lower than the 150 kW threshold.
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	NBP 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. Fuel use by

improved technology) and the definitive discontinuity of the use.	the baseline technology in the project scenario will be accounted for as project emissions. Encouraging households to give up their baseline technology would create an adverse situation because they would revert back to three stone stoves in case there is not enough biogas instead of a better baseline technology. Corresponding emissions are accounted for as part of the project emissions
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 set out in the sale contract between the household and the biodigester installer, see section A.3
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	This applicability criterion is not applicable as no new biomass feedstock is used in the project scenario.
5 A. Adequate evidence is supplied to demonstrate that indoor air pollution (IAP) levels are not worsened compared to the baseline, and greenhouse gases emitted by the project fuel/stove combination are estimated with adequate precision	The area with the cleanest air in rural areas are biogas kitchens according to a household air pollution study executed by E.buysman in 2015[9]. The study showed that biogas reduces PM2.5 levels, with a reduction of around 36% reduction in exposure and 88% reduction in kitchen concentrations. CO levels are also much lower, but in most cases, including the baseline households lower than the 24-hour WHO guidelines.
5B. Records of renewable fuel sales may not be used as sole parameters for emission reduction calculation, but may be used as data informing the equations in section 2.0 of this methodology.	Not applicable, household use manure from their own animal herd.
6. Regarding application of the methodology to bio-digesters, including animal waste management. If more than one climate zone is included in the project activity, a distinction per climate zone must be considered. The distinct geographical boundary of each project area must be clearly documented in the project documentation, using representative GPS data.	The climatic conditions in the NBP project area are practically uniform with an average temperate of 27◦C with little variation in the provinces, see http://www.cambodia.climatemps.com/. The climate type in Cambodia is Rainforest, see http://www.naturalhistoryonthenet.com/Continents/asia.htm

B.3. Project boundary

The project boundary encompasses the geographical sites all the units commissioned from 13/03/2006 of all biodigester under the project, The project will, depending on external financing and the VER price, extend to the whole of Cambodia the project boundary is therefore Cambodia. The wood fuel collection and production area are also Cambodia.

[9] http://www.ccacoalition.org/en/news/report-biogas-and-household-air-quality-rural-cambodia

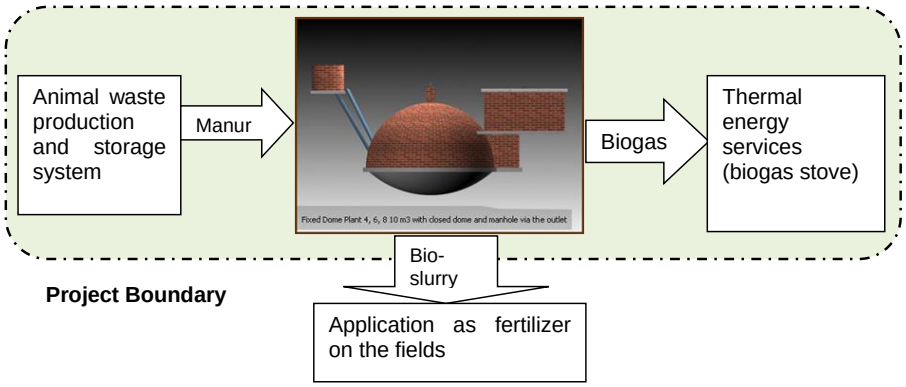


Table 4: GHG Emission sources included in the project boundary

	Source	GHG	Included?	Justification / explanation
Baseline	Thermal energy demand for human food preparation and water boiling	CO_2	Yes	Major source of GHG emission
		CH_4	Yes	Major source of GHG emission
		N_2O	Yes	Major source of GHG emission
		BC	No	Major source of GHG emission but excluded for simplification
	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	Biodigester 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 for human food preparation and water boiling	CO_2	Yes	Major source of GHG emission
		CH_4	Yes	Major source of GHG emission
		N_2O	Yes	Major source of GHG emission

B.4. Establishment and description of baseline scenario

>> (Explain how the baseline scenario is established in accordance with guidelines provided in GS4GG Principles & Requirements and the selected methodology(ies). In case suppressed demand baseline is used then same should be explained and justified.)

The baseline scenario is defined by the typical baseline fuel consumption patterns in a population that is targeted for adoption of the project technology, this includes households that rely mainly on wood, mainly on charcoal, mainly on LPG or other fuels. Section B.6.2 details these baseline scenarios.

The baseline from AWMS is the emissions from animal manure management systems resulting from the anaerobic biodegradation of organic matter

B.5. Demonstration of additionality

>> (If the proposed project is not a type of project that is deemed additional, as stated below, then follow guidelines in section 3.5.1 of GS4GG Principles & Requirements to demonstrate additionality.)

Additionality was demonstrated during the initial project design validation/registration for CPI and further demonstration of additionality is not required during project design renewal

In section A.7 the qualitative narrative is provided on the **Ongoing Financial Need** by providing the relative proportion of carbon finance in overall financing and therefore meeting the 3.5.2.3 Gold Standard Principle and Requirement.

B.6. Sustainable Development Goals (SDG) outcomes

B.6.1. Relevant target for each of the three SDGs

>> (Specify the relevant SDG target for each of three SDGs addressed by the project. Refer most recent version of targets here .)

Goal	Target	Output indicator
Sustainable Development Goal 7 Affordable and Clean Energy	7.1 By 2030, ensure universal access to affordable, reliable and modern energy services	7.1.2: Proportion of population with primary reliance on clean fuels and technology
Sustainable Development Goal 2 Zero hunger	2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality	2.4.1: Proportion of agricultural area under productive and sustainable agriculture
Goal 13: Climate Action	13.2 integrate climate change measures into national policies, strategies, and planning	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production

-The monitoring of the contribution to the chosen SDG indicatorss will replace the SD monitoring system of CPII. As per GS requirements this is allowed as long as at least 2 SD indictors can be linked to the SDGs other than SDG 13.

B.6.2. Explanation of methodological choices/approaches for estimating the SDG outcome

>> (Explain how the methodological steps in the selected methodology(ies) or proposed approach for calculating baseline and project outcomes are applied. Clearly state which equations will be used in calculating net benefit.)

Goal 7 contribution:

SDG 7.2.1: Proportion of population with primary reliance on clean fuels and technology

Target: Number of people benefitting from biogas

This will be calculated with the following equation

Equation 1: Calculation of contribution to SDG7

$$P_{clean,y} = N_{b,y} \times U_y \times B_{daily} \times H_{s,y}$$

Where:

$P_{clean,y}$	=	Total number of households using primarily biogas in year y
$N_{b,y}$	=	Total number of biodigesters in year y
U_y	=	Usage rate in year y
$B_{daily,y}$	=	Share of biogas households that uses biogas at least once per day for cooking in year y
$H_{s,y}$	=	Number of family members permanent residing in the household in year y

Baseline situation: In the baseline no construction of biodigesters occurred. Therefore, baseline outcome benefit is zero

Project situation: The contribution to this SDG are all the digesters in operation since the on-set of NBP.

SDG 7.2.1 will replace the CPII SD indicator 6: livelihhood of the poor. In CPII the parameter chosen was: 'Cumulative number of users that use biogas for cooking' which is identical to the contribution to SDG 7.2.1

Goal 2 contribution

SDG 2.4.1: Proportion of agricultural area under productive and sustainable agriculture

Target: Total area on which bio-slurry is applied

This will be calculated with the following equation

Equation 2: Calculation of contribution to SDG2

$$A_{bs,y} = N_{b,y} \times U_y \times \%BS_y \times A_{bs,h,y}$$

Where:

$A_{bs,y}$	=	Total area on which bio-slurry is applied in year y in hectare
$N_{b,y}$	=	Total number of biodigesters in year y
U_y	=	Usage rate in year y

$\%BS_y$ = Share of households that use bio-slurry for crop production in year y
$A_{bs,h,y}$ = Average area per household on which bio-slurry is applied in year y

Baseline situation: In the baseline no construction of biodigesters occurred. Therefore, baseline outcome benefit is zero

Project situation: The contribution to this SDG is the usage of bio-slurry as a organic and climate friendly input to sustainable agriculture.

SDG 2.4.1 will replace the CPII SD indicator 2: 'Soil condition'. In CPII the parameter chosen was: 'Cumulative number of users that use bio-slurry' which is similar to the contribution to SDG 2.4.1 with the exception that the resuls are multiplied with the area on which bio-slurry is applied

SDG 13 contribution

13.2.1 "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
This is achieved through the roll-out of a national programme that promotes the generation of GHG emission reductions due to the displacement of fossil fuels and non-renewable biomass and improved manure management practices.

GHG 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 fuels
2. Avoidance of methane emissions from AWMS.

1. Displacement of non-renewable biomass and fossil fuels

Baseline fuel scenario
The baseline scenario is defined by the typical fuel consumption for household cooking among the target population prior to adopting the project technology. 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 however, this is conservative.

Baseline fuel test
The BFT will be executed during CPIII MPI as per applied methodology for the different identified baseline scenarios. The following baseline scenarios and ratio's were identified in the baseline study that was carried out mid-2018 by Patrick Kooijman (See Appendix III for baseline survey design). The following Table illustrates the different baseline scenarios and their corresponding ratios, as per the survey results. This will be updated annually as part of the monitoring survey.

Table 5 *Type of baseline scenarios and distribution per identified baseline scenario*[10]

Baseline scenario	Parameter	Results
Households with main fuel wood	$B_{b1,wood}$	76%
Households with main fuel charcoal	$B_{b2,charcoal}$	5%
Household with main fuel LPG	$B_{b3,LPG}$	18%
Housholds using other fuels	n/a	0.4%

The BFT that will be carried out for CPIII MPI will quantify the fuel consumption in each scenario. The PP may simplify this by proposing one scenario for wood and apply these results to charcoal, which is conservative. LPG consumption was determined in the baseline survey. Households using other fuels are not included in the ER calculations, which is conservative.

Project fuel test

Households may continue to use NRB and LPG next to using biogas. Wood and charcoal fuel consumption will be measured with a representative sample of end users in order to measure real, observed technology performance in the field; the so-called Project Fuel Test. The emission reductions from fuel displacement will be calculated as per option 2 of the methodology for each verification[11]. LPG consumption will not be monitoring using the PFT but instead determined using survey methods, see section B.7.1 for the monitoring procedure of LPG

Emission reductions are credited by comparing fuel consumption in a project scenario to the three baseline scenarios. As the baseline fuel and the project fuel and the corresponding emission factors are different, the overall GHG reductions achieved in year *y* are calculated as follows (equation 2 TPDDTEC V3.1):

$$\mathbf{ER_y} = \sum_{b,p1} N_{p1,y} * U_{p,y} * \left(f_{NRB} * ER_{b,p,y,CO2} + ER_{b,p,y,non-CO2}\right) - \sum LE_{p1,y} \quad \textbf{(3)}$$

Where:

$\sum_{b,p}$	Sum over all relevant (Baseline b/project p) couples
$N_{p,y}$	Cumulative number of biodigesters months[12] included in the project database for project scenario p in against baseline scenario b in year y. $N_{p,y}$ applied is the value of last month to allow for a 1 month period for digester starting up. This is conservative because in most cases within 2 weeks biogas is being produced
$U_{p,y}$	Cumulative usage rate for technologies in project scenario p1 in year y, based on cumulative adoption rate and drop off rate (fraction)
$ER_{b,p,y,CO2}$	Specific CO_2 emission savings for an individual technology of project p1 against an individual technology of baseline b1, b2, b3 in year y, in tCO_2/year, and as derived from the statistical analysis of the data collected from the field tests

[10] See survey results from in the ER database 'PDD sections'

[11] *The PP decided not to adopt the per capita default of 0.5 ton wood per annum, this was deemed not representative for Cambodia and the region.*

[12] Contrary to the methodology NBP measures this in months and not days as it takes 2 weeks before biogas is produced. In each case, the next month after installation is taken as the technology starting date of operation which is conservative.

$ER_{b,p,y,non\text{-}CO2}$ Specific non-CO_2 emission savings for an individual technology of project p1 against an individual technology of baseline b1, b2, b3 in year y, converted in tCO_2/year, and as derived from the statistical analysis of the data collected from the field tests

f_{NRB} Fraction of biomass used that can be established as non-renewable biomass

$LE_{p1,y}$ Leakage for project scenario p1 in year y (tCO_2e/yr)

Charcoal emissions will be calculated by expressing the total amount of charcoal consumed in wood equivalants and multiplying this with the wood emission factors. The applied charcoal to wood ratio is 1 to 6 as per IPCC 1996 revised guidelines chapter 1 page 45[13].

As specific non-CO_2 emission savings are treated in a separate equation: see

$$\sum \mathrm{ER}_{\mathrm{CO2},y} = (\sum \mathrm{BE}_{\mathrm{b},\mathrm{CO2},y} - \sum \mathrm{PE}_{\mathrm{p1},\mathrm{CO2},y} - \sum \mathrm{LE}_{\mathrm{p1},\mathrm{CO2},y}) * \mathrm{U}_{\mathrm{p1},y} \quad \textbf{(4)}$$

Where:

$\sum ER_{CO2,y}$ Cumulative CO_2 emission reductions from the substitution of non-renewable biomass and fossil fuels

$\sum BE_{b,CO2,y}$ Cumulative baseline emissions as calculated below under formula (**5**)

$\sum PE_{p1,CO2,y}$ Cumulative project emissions as calculated below under formula (**6**)

$\sum LE_{p1,CO2,y}$ Cumulative leakage as per methodology guidance[14]

$U_{p1,y}$ Cumulative usage rate for technologies in project scenario p1 in year y, based on cumulative adoption rate and drop off rate (fraction)

The following formula calculates the baseline emissions per household (equation 3 of TPDDTEC v3.1):

$$BE_{b,y} = B_{b,y} * ((f_{NRB,y} * EF_{b,fuel,CO2}) + EF_{b,fuel,nonCO2}) * NCV_{b,fuel} \quad \textbf{(5)}$$

Where:

$BE_{b,y}$ Emissions for baseline scenario b during the year y in tCO_2e

[13] http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref3.pdf

[14] Technologies and practices to displace decentralized thermal energy – v3.1 p.20

$B_{b,y}$	Quantity of fuel consumed in baseline scenario b during year y, in tons, as per by-default factors (cases with project performance field test only)
$f_{NRB,,\ y}$	Fraction of biomass used during year y for the considered scenario that can be established as non-renewable biomass (drop this term from the equation when using a fossil fuel baseline scenario)
$NCV_{b,fuel}$	Net calorific value of the fuel that is substituted or reduced (IPCC default for wood fuel, 0.015 TJ/ton)
$EF_{b,fuel,CO2}$	CO_2 emission factor of the fuel that is substituted or reduced. 112 tCO_2/TJ for Wood/Wood Waste, or the IPCC default value of other relevant fuel
$EF_{b,fuel,nonCO2}$	Non-CO_2 emission factor of the fuel that is substituted or reduced

Project emissions:

The project scenario is defined by the fuel consumption of end users within the targeted population that adopts the biodigester technology. This formula calculates the project emissions per household (as per equation 5 of TPDDTEC v3.1)

$$PE_{p,y} = B_{p,y} * ((f\ NRB,\ y * EF_{p,fuel,\ CO2}) + EF_{p,fuel,\ nonCO2}) * NCVp,\ _{fuel} \quad \textbf{(6)}$$

Where:

$PE_{p,y}$	Emissions for project scenario p during year y in tCO2e
$B_{p,y}$	Quantity of fuel consumed in project scenario p during year y, in tons, and as derived from the statistical analysis conducted on the data collected during the project performance field tests (cases when no baseline performance field test are performed, e.g. by-default baseline factors)
$f_{NRB,\ y}$	Fraction of biomass used during year y that can be established as nonrenewable biomass (drop this term from the equation when using a fossil fuel baseline scenario)
$NCV_{p,fuel}$	Net calorific value of the project fuel (IPCC default for wood fuel, 0.015 TJ/ton). This is equal to the baseline fuel NCV in projects which use the same fuel.
$EF_{p,fuel,CO2}$	CO_2 emission factor of the project fuel. This is equal to the baseline

fuel EF in projects which use the same fuel, 112 tCO2/TJ for Wood/Wood Waste, or the IPCC default value of other relevant fuel

$EF_{p,fuel,nonCO2}$ Non-CO_2 emission factor of the project fuel. This is equal to the baseline fuel EF in projects which use the same fuel.

Fuel usage data for the three baseline scenarios and project scenario was collected by the KPT survey, as explained above.

The f_{NRB} adopted is the DNA approved default of 77%[15] . The f_{NRB} value is applicable to CO_2 emissions from firewood and charcoal consumption and production.

2. Baseline and project emissions from AWMS:

The emissions from the animal waste management system of the baseline are determined using the IPCC 2006 Tier 2 approach. This approach is applicable for households with distinctive animal waste management system, where the majority of the waste is collected and where the animals are kept near the houses. The following formulas are used to estimate the animal waste management emissions.

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

Equation 7: Calculation of baseline emissions

Where,

$BE_{awms,h}$ = The baseline emission from handling of animal waste in for premise h (tCO_{2e} per year)

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

$EF_{awms,T}$ = Emission factor for the defined livestock category T, (tonCH4 per animal per year)

GWP_{CH4} = Global warming potential of methane (tCO_2e per tCH4): 25 for the second commitment period. It shall be updated to any future COP/MOP decision

The emission factor ($EF_{awms(T))}$ for tier 2 approach is calculated as follows (equation 16 of the applied methodology),

$$EF_{awms(T)} = (VS_{\mathrm{T}} \times 365) \times \left[Bo_{\mathrm{T}} \times \frac{0.67kg}{m^3} \times \sum_{k}^{1} \frac{MCF_{T,k}}{100} \times MS_{(\mathrm{T,k})} \right]$$

Equation 8: Baseline emissions from animal waste management by animal category T

Where:

[15] *https://cdm.unfccc.int/sunsetcms/storage/contents/stored-file-20140210181830099/SSCWG43_Annex%204_Info%20note_fNRB%20Cambodia_ver%2001.0.pdf*

$EF_{awms(T)}$	=	CH_4 emission factor for livestock category T, (tCH_4 per animal per year)
$VS_{(T)}$	=	Daily volatile solid excreted for livestock category T, kg VS.animal $^{-1}$
365	=	Basis for calculating annual VS production, days yr^{-1}
Bo_T	=	Maximum methane producing capacity for manure produced by animal T m^3 CH_4 kg^{-1} of VS
0.67	=	Conversion factor of m^3 methane to kg methane
$MCF_{T,K}$	=	Methane conversion factors for the animal waste handling system from livestock category T of MS system k
$MS_{T,k}$	=	Fraction of livestock category T's manure in the animal waste management system k

Country specific default data is not available for VS, Bo, MCF and MS. IPCC 2006 default values will be used for Bo and MCF. MS will be obtained using survey methods (see section B.7.1). IPCC 2006 default values will be used except for pigs which will be determined ex-post with the following equation[16]:

Equation 9: Weight adjusted VS excretion

$$VS_{LT,y} = \left(\frac{W_{site}}{W_{default}}\right) \times VS_{default} \times nd_y$$

Where:

W_{site}	=	Average animal weight of a defined livestock population at the project site (kg)
$W_{default}$	=	Default average animal weight of a defined population, this data is sourced from IPCC 2006 guidelines (kg)
$VS_{default}$	=	Default value for the volatile solid excretion rate per day on a dry-matter basis for a defined livestock population (kg dm/animal/day)
nd_y	=	Number of days in year *y* where the animal manure management system is operational
$VS_{LT,y}$	=	Adjusted VS value for year y

The average weight (Wsite) is the average of entry weight at the farm and weight when the pig leaves the farm. Farmers are often able to estimate the weight of fattening pigs reliably as the weight of birth is known and the value of selling the pigs is based on their weight. However, in the case of boars and sows this is not known as those animals are not sold and reside on the farm. In order to ascertain the weight of sows and boars, the method described on the Pig Site[17] was adopted, which is a common practice in the livestock industry and this was done during the last 4 verifications. This is possible with the following equation:

[16] As per equation 3 of AMS-III.D v21

[17] *As per the method described on this website http://www.thepigsite.com/articles/541/weighing-a-pig-without-a-scale/*

Equation 10: Weight a pig without scale[Error! Bookmark not defined.]

$$Pig\ weight = Hg^2 \times L \times 69.3$$

Where:
Hg = Hearth girth in meter and L = length in meter

The Hg and the L are explained in the figure below:

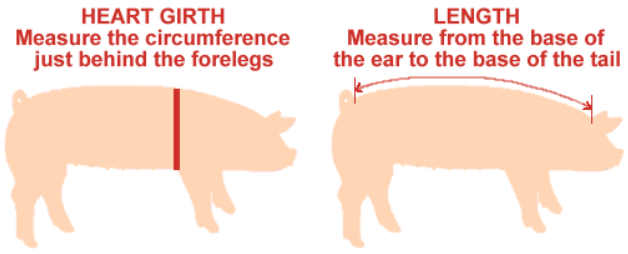


Figure 1: Hearth girth and length measurement

It is however challenging to measure sows and boars, as these are large animals weighing over 120 kg and sometimes over 180 kg and do not stand still and may behave aggresively. Previous experiences have shown that it is possible to divert attention of sows by giving them something to eat, but nevertheless, it remains a challenge. It is expected however that at least 25% of sows in the survey population can be measured.

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.

Equation 11: PE from AWMS, see equation 17 of the applied methodology

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

Where:

$N_{T,h,y}$	=	Number of animals of livestock category T in year y in premise h
EF_{awmsT}	=	Emission factor for the defined livestock category T, (ton CH_4 per animal per year).
PL_y	=	Physical leakage of the biodigester in year *y* (10 %)[18]
GWP_{CH4}	=	Global Warming Potential (GWP) of methane (tCO_2eq per tCH_4): 25 for the second commitment period. It shall be updated according to any future COP/MOP decisions.

[18] Default value of the applied methodology is adopted (TPDDTEC page 68)

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

Leakage emissions

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

Table 6: Leakage emission sources to be assessed

#	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 Cambodia. The small share of household that use a lower emitting energy source, such as LPG, are not likely to use NRB instead of LPG 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.	The project is not large enough to significantly impact the NRB component of another CDM or VER project; NBP is active in many provinces and spread out over a large area. The impact on the NRB is therefore negligible
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 does not occur in Cambodia
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.
F	Physical leakage emissions	This source is included in the project emissions
G	Emissions due to continued use of baseline fuels	Included in the project emissions

B.6.3. Data and parameters fixed ex ante for monitoring contribution to each of the three SDGs

(Include a compilation of information on the data and parameters that are not monitored during the crediting period but are determined before the design certification and remain fixed throughout the crediting period like IPCC defaults and other methodology defaults. Copy this table for each piece of data and parameter.)

Relevant SDG indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Data / Parameter:	**$EF_{,CO2}$**
Unit	$kgCO_2/TJ$ fuel
Description:	CO_2 emission factor arising from use of fuels in the baseline scenario and continued use of baseline fuels in the project scenario
Source of data	2006 IPCC Guidelines defaults, see chapter 2 Stationary Combustion: http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html
Value(s) applied	**Fuel *b*** / **$EF_{CO2,}$ (kg/TJ)**: LPG 63100; Charcoal in wood eq 112000; Firewood 112000
Choice of data or Measurement methodsand procedures	**N/A**
Purpose of data	Calculation of baseline and project emissions
Additional comment	CO2 and non-CO_2 emissions factors for charcoal may be estimated as above or alternatively by researching a conservative wood to charcoal production ratio (from IPCC, credible published literature, project-relevant measurement reports, or project-specific monitoring) and multiplying this value by the pertinent EF for wood.

Relevant SDG indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Data / Parameter:	**EF_{CH4}**
Unit	$kgCH_4/TJ$ fuel
Description:	CH_4 emission factor arising from use of fuels in the baseline scenario and continued use of baseline fuels in the project scenario
Source of data	2006 IPCC Guidelines defaults see chapter 2 Stationary Combustion: http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html, table 2.9
Value(s) applied	**Fuel *i*** / **$EF_{CH4,}$ (kg/TJ)**: LPG 11.95; Charcoal in wood equivalent 1224; Firewood 1224

Choice of data or Measurement methods and procedures	**N/A**
Purpose of data	Calculation of baseline and project emissions
Additional comment	CO2 and non-CO_2 emissions factors for charcoal may be estimated as above or alternatively by researching a conservative wood to charcoal production ratio (from IPCC, credible published literature, project-relevant measurement reports, or project-specific monitoring) and multiplying this value by the pertinent EF for wood. 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 Cambodia as it is a value obtained from neighbouring countries.

Relevant SDG indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Data / Parameter:	**$EF_{i,N2O}$**
Unit	kgN_2O/TJ fuel
Description:	N_2O emission factor arising from use of fuels in the baseline scenario
Source of data	2006 IPCC Guidelines defaults, see chapter 2 Stationary Combustion, table 2.9 http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html
Value(s) applied	

Fuel *i*	**$EF_{N20,}$ (kg/TJ)**
LPG	2.1
Charcoal in wood equivalent	11.25
Firewood	11.25

Choice of data or Measurement methods and procedures	N/A
Purpose of data	Calculation of baseline and project emissions
Additional comment	CO2 and non-CO2 emissions factors for charcoal may be estimated as above or alternatively by researching a conservative wood to charcoal production ratio (from IPCC, credible published literature, project-relevant measurement reports, or project-specific monitoring) and multiplying this value by the pertinent EF for wood. 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 Cambodia as it is a value obtained from neighbouring countries.

Relevant SDG indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their

	ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Data / Parameter:	**NCV_i**
Unit	TJ/Gg
Description:	Net calorific value of the fuel i used in the baseline
Source of data	2006 IPCC Guidelines defaults, see chapter 1 Energy table 1.2 http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html
Value(s) applied	Fuel *i* / **NCV_i (TJ/Gg)**: LPG 47.3; Charcoal in wood equivalent 15.6; Firewood 15.6
Choice of data or measurement methods and procedures	N/A
Purpose of data	Calculation of baseline and project emissions
Additional comment	In case charcoal is expressed in wood equivalents, the NCV of firewood will be applied

Relevant SDG indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Data/Parameter	**$B_{b1,wood}$**
Unit	Tonnes/year
Description	Amount of woody biomass used in the baseline scenario b1
Source of data	N/A will be established once during MPI CPIII
Value(s) applied	1435.10 (ex-ante value taken from CPII PDD v2.3)
Choice of data or measurement methods and procedures	Baseline fuel consumption will be determined with a Kitchen Performance Test as per the requirements of the TPDDTEC methodology.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Relevant SDG indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Data/Parameter	**$B_{b2,charcoal}$**
Unit	Tonnes/year
Description	Amount of charcoal (in fuel-wood equivalents) used in the baseline scenario b2
Source of data	N/A will be established once during MPI CPIII
Value(s) applied	215.50 (ex-ante value taken from CPII PDD V2.3)
Choice of data or measurement methods and procedures	Households have been asked how much charcoal they use for cooking and undergo a Kitchen Performance Test as per the requirements of the TPDDTEC methodology.

Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Relevant SDG indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Data/Parameter	**$B_{b3,LPG}$**
Unit	Tonnes/year
Description	Amount of LPG used in the baseline scenario b3
Source of data	CPIII baseline survey carried out in mid 2018,see Appendix III for more details)
Value(s) applied	27.197
Choice of data or measurement methods and procedures	It is not practical to establish LPG consumption using the KPT for reasons of safety. Instead, households were be asked how often they buy a bottle and the bottle size will be recorded. Annual consumption was be calculated as: $$Annual\ LPG\ consumption\ (\frac{kg}{year}) = \frac{Bottle\ size\ (kg)}{Usage\ period\ (days)} \times 365$$
Purpose of data	Calculation of baseline emissions
Additional comment	Fixed for CPIII

Relevant SDG indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Data / Parameter:	**Charcoal to wood ratio**
Unit	[_]
Description:	Charcoal to wood conversion ratio
Source of data used:	SAR IPCC
Value (s) Applied	1:6
Choice of data or Measurement methods and procedures	N/A
Purpose of data	Calculation of baseline and project emissions
Any comment:	From IPCC 1996 revised guidelines, Chapter 1, page 45: http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref3.pdf

Relevant SDG indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Data / Parameter:	**GWP_{CH4}**
Data unit:	tCO_2e per tCH4
Description:	Global Warming Potential (GWP) of methane
Source of data used:	AR IPCC
Value (s) applied	25

Choice of data or Measurement methods and procedures	N/A
Purpose of data	Calculation of baseline and project emissions
Any comment:	25 for the second commitment period. Shall be updated to any future COP/MOP decisions

Goal	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Data / Parameter:	**GWP_{N2O}**
Data unit:	tCO_2e per tN_2O
Description:	Global Warming Potential (GWP) of nitrous oxide
Source of data used:	AR IPCC
Value (s) applied	298
Choice of data or Measurement methods and procedures	N/A
Purpose of data	Calculation of baseline and project emissions
Any comment:	298 for the second commitment period. Shall be updated to any future COP/MOP decisions

Relevant SDG indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
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 (s) applied	Animal / kgVS/day: Pig 0.3; Buffalo 3.9; Cow 2.3
Choice of data or Measurement methods and procedures	N/A
Purpose of data	Calculation of baseline and project emissions
Any comment:	Any comment: 365 = basis for calculating annual VS production, days per year, region Asia and for animal weights of 319 kg for cow, 380 for buffalo and 28 kilo for market and breeding swine. The VS value will be proportionally adjusted when credible animal weight data is available as per equation 3 of AMS-III.D v21 and see section B.6.2

Relevant SDG indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
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)
Value (s) applied	Animal T: Pig — $Bo_{(T)}$ $m^3CH_4/kgVS$: 0.29; Buffalo: 0.10; Cattle: 0.10
Choice of data or Measurement methods and procedures	N/A
Purpose of data	Calculation of baseline and project emissions
Any comment:	N/A

Relevant SDG indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Data / Parameter	**MCF(k)**
Unit	%
Description	Methane conversion factors for each manure management system by climate region k (Cambodia 27.7 C)
Source of data	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)
Value(s) applied	***Anaerobic lagoon*** **80%** ; ***Slurry*** **78%** ; ***Dry lot*** **2%** ; ***Daily spread*** **1.0%** ; ***Solid storage*** **5%** ; ***Other*** **1%** ; ***Pasture*** **2%**
Choice of data or measurement methods and procedures	As per requirement of the methodology and sourced from Tables 10.A-4 through A-9., Chapter 10, Volume 4 of the 2006 IPCC Guidelines The IPCC is a standard, credible source of emissions factors.
Purpose of data	Calculation of baseline and project emissions
Additional comment	IPCC (2006); May be updated according to any future changes by the IPCC Categry other includes manure that is sold, or not collected and the lowest MCF is adopted (of daily spread) which is conservative

Relevant SDG Indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Data/Parameter	**$LE_{p,y}$**
Data unit	tCO_2e/year
Description	Leakage in project scenario during year y
Source of data	N/A
Value applied	0
Choice of data or measurement methods and procedures	N/A
Purpose of data	Calculation of leakage emissions
Additional comment	According to the methodology applied "leakage risks deemed very low can be ignored as long as the case for their insignificance is substantiated" (p.16). Section *B.6.2 table 6* of the PDD provides an overview of potential sources of leakage, including their applicability and justification for excluding the sources of leakage. The assessment deemed the leakage source neglible and are therefore not montored. As also stated, leakage due to continuation of baseline fuels and AWMS emission from manure not fed in the biodigester and physical leakage are included in the project emission and monitored on an annual interval.

Relevant SDG indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Data / Parameter	**$EF_{awms,T}$**
Unit	$kgCH_4$ per animal per year for livestock type T in the project
Description	Animal waste methane emission factor by average temperature
Source of data	Baseline survey and data from 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)
Values applied	**Animal T** / **Value**: Cow 5.952; Pig 14.928; Buffalo 14.266. See ER database sheet ER_AWMS for more details
Choice of data or measurement methods and procedures	Calculated as per requirement of the methodology and sourced from Tables 10.A-4 through A-9., Chapter 10, Volume 4 of the 2006 IPCC Guidelines The IPCC is a standard, credible source of emissions factors.
Purpose of data	Calculation of baseline emissions
Additional comment	IPCC (2006); May be updated according to any future changes by the IPCC

Relevant SDG indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Data / Parameter:	$\eta_{biogasstove}$
Data unit:	[-]%
Description:	Combustion efficiency of the biogas stove
Source of data	Centre for Energy Studies, Institute of Engineering for the Nepal Biogas Support Programme[19].
Value applied	99.4%
Choice of data or measurement methods and procedures	N/A
Purpose of data	Calculation of project emissions
Any comments	BSP is the mother programme of NBP. The combustion efficiency is according to the study 99.4%. That figure is assumed reasonable and conservative

B.6.4. Ex ante estimation of outcomes linked to each of the three SDGs

See the ER_database spreadsheet SDG2 and SDG7 2017 estimate for more details on SDG2 and SDG7.

SDG 2	**Proportion of agricultural area under productive and sustainable agriculture**			
	Target: Households that reply on bio-slury as sustainable organic fertilizer			
	$A_{bs,y} = N_{b,y} \times U_y \times \%BS_y \times A_{bs,h,y}$			
	Where:	Description	Value	Comment
	Abs,y	**= Total number of household using bio-slurry year y**	38447	
	y	= Year	2017	
	$N_{b,y}$	= Total number of biodigesters in year y month 11	26514	Value of month 11 taken to account for digester start up time
	U_y	= Usage rate in year y	79%	Values from MPVI CPII (latest available data)
	$\%BS_y$	= Share of households that uses bio-slurry for crop production in year y	96%	
	$A_{bs,h,y}$	= Average area per household on which bio-slurry is applied in year y	1.90	Biogas User Survey 2015

[19] https://www.researchgate.net/profile/Asheesh_Kumar4/post/what_are_all_the_methods_that_we_can_employ_to_increase_the_combustion_efficiency_when_LPG_is_used_as_the_fuel/attachment/59d6207e79197b807797ef48/AS%3A273821083340822%401442295441788/download/efficiency_measurement_of_biogas_kerosene_and_lpg_stoves_nepal_2001.pdf

Gold Standard

SDG 7	Proportion of population with primary reliance on clean fuels and technology **Target:** households that reply on on clean fuels and technology: biogas $P_{clean,y} = N_{b,y} \times U_y \times B_{daily} \times H_{s,y}$			
Where:				
	Description		**Value**	**Comment**
$P_{clean,y}$	=	**Total number of household using primarily biogas in year y**	97515	
y	=	Year	2017	
$N_{b,y}$	=	Total number of biodigesters constructed at the end of year y	26514	Value of month 11 taken to account for digester start up time
U_y	=	Usage rate in year y	79%	Values from MPVI CPII (latest available data)
$B_{daily,y}$	=	Share of biogas households that uses biogas at least once per day for cooking in year y	99%	
$H_{s,y}$	=	Number of family members permenent residing in the household in year y	4.69	

SDG 13: Emission reductions

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

1. BFT- Thermal energy demand

The total amount of the fuel used for thermal energy demand of the households with the technical potential is listed hereunder (for more see ER database sheet 'ER_FUEL)

Table 7: Baseline scenario's, ex-ante fuel estimate

Baseline scenario	Kg/year	% of users[20]
LPG (ex-post)	27.197	18.5%
Charcoal in wood eq	215.500	5.2%
Firewood	1435.100	75.9%
Other	0[21]	0.4%

Most households use wood and some LPG or charcoal. The category other includes rice husk or other renewable fuels and is excluded from the baseline which is conservative. The fuel baseline emissions are shown in the next table (see ER database sheet ER_FUEL for more details)

Table 8: 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_2O (tCO_2e/yr)	Total (tCO_2e/yr)
LPG	0.015	0.00	0.000	0.015
Charcoal in wood eq	0.015	0.01	0.001	0.021
Firewood	1.465	0.52	0.057	2.042
Total	**1.4949**	**0.5252**	**0.0577**	**2.0778**

Determination Baseline Emission from AWMS

1. Determination of the management system (MS)

The baseline survey, see appendix 3, included a survey on the MS according to the IPCC tier 2 approach. Results from the survey showed that not all animals are stabled during the whole day and there are differences during the dry and the wet season. Assumed is that the animal waste excreted is proportional to the time spent either stabled or in the field, thus, if an animal is in the field for 25% of the time, assumed is that 25% of the animal waste is excreted in the field and the other 75% when stabled. All the excreted waste in the field belongs to the animal waste management system (AWMS) 'pasture'. The manure management systems and the respective MCF by type of animal are found in the baseline study are depicted in the next table (please refer to ER worksheet tab MS AWMS and ER_AWMS for detailed calculation).

[20] Figures may not add up due to rouding

[21] Other fuels are not considered in the baseline, this is conservative

Table 9: Animal Manure management systemsin the baseline

Animal	Slurry	Anaerobic lagoon	Dry lot	Daily spread	Solid storage	Other	Pasture
Cow	5.27%	0.25%	3.63%	7.72%	54.57%	0.25%	28.32%
Pig	31.54%	11.12%	10.07%	5.83%	35.95%	1.92%	3.57%
Buffalo	12.70%	3.03%	3.98%	7.33%	33.74%	0.00%	39.21%

To calculate the EF per animal *T* the default IPCC values are used for MCF, VS and Bo since no country specific data is available and based on that the EF_T was calculated. The emission per household of all the animals from the animal waste management systems are subsequently calculated and depicted in the next table. The number of animals originates from the baseline survey and used as an ex-ante estimate on animal ownership of potential biodigester users.

Table 10: Ex-ante Baseline emission from animal waste management

Animal T/hh	Average population N_T/hh	EF_T ($kgCH_4$/year)	GWP_{CH4}	$BE_{aw,T,h}$ (tCO_2e/year)
Cow	3.550	5.952	25	0.528
Pig	1.879	14.928	25	0.701
Buffalo	0.389	14.266	25	0.139
		Total		**1.368**

Total Baseline emissions

The total BE emissions resulting from both manure management practices and thermal energy needs, are depicted in the next table.

Table 11: Total baseline emission of the targeted households

Emission source	Acronym	BE (tCO_2/year/h)
Thermal energy demand	BE_{th}	2.078
AWMS	BE_{AW}	1.368
Total	**BE**	3.446

Estimation of project and leakage emissions

As per section B.6.2, table 6 only the following project and leakage emissions will be calculated:

1. Continued use of baselines fuels in the project scenario
2. Emissions attributed to AWMS in the project scenario, incomplete combustion and physical leakage

1. Continued use of baselines fuels in the project scenario

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 ex-ante estimated remaining fuel consumptions, values are taken from CPII MRVI:

Table 12: Estimated project emissions from thermal energy use

Fuel *i*	Average per household	NCV_i	Thermal energy demand
	(kg/year)	(TJ/Gg)	(TJ)
LPG	3.880	47.300	0.000184
Charcoal in wood eq	10.350	15.600	0.000161
Firewood	72.490	15.600	0.001131

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

Table 13: Estimated 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_2O (tCO_2e/yr)	Total (tCO_2e/yr)
LPG	0.012	0.000	0.000	0.012
Charcoal	0.014	0.004	0.001	0.019
Firewood	0.098	0.035	0.004	0.136
			sum	**0.166**

2. Emissions attributed to AWMS in the project scenario, incomplete combustion and physical leakage

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.

Ex-ante AWMS data applied is taken from MRVI of CPII. The remaining emissions are therefore only physical leakage and incomplete combustion. The EF_{AWMS} 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 14: 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} ($kgCH_4$/head/year)

Cow	2.300	0.100	10.746%	0.670	**6.044**
Pig	0.591	0.29	33.453%	0.670	**14.011**
Buffalo	3.900	0.100	10.001%	0.670	**9.539**

The project emissions are then the multiplication of the EF_{AWMS} with the physical leakages emissions and the stove efficiency, see section B.6.3 for the default values.

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

Table 15: Physical leakage emission from biodigester

Animal	**$PL_{\_AWMS}$ ($kgCH_4$/year)**	**PL_{stove} ($kgCH_4$/year)**
Cow	2.146	0.012
pig	2.633	0.014
Buffalo	0.371	0.002
Total	**5.149**	**0.028**

The physical leakage emissions and the emissions from incomplete combustion are 5.149+ 0.028= 5.177 $kgCH_4$/household/year equivalent to 0.129 tCO_2/household/year.

D. Ex-ante estimate of the emission reductions

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

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

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
$BE_{y,h}$	=	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 calculated using the usage rate of MRVI of CPII (79.3%)

Table 16: Average annual emission reductions

Emission source	**BE** (tCO_{2e}/h/year)	**PE** (tCO_{2e}/h/year)	**ER** (tCO_{2e}/h/year)
Fuel use	2.078	0.166	1.912
AWMS	1.368	0.129	1.239
Sum	**3.446**	**0.296**	**3.150**

The estimated emission reductions are 3.150 tCO_2 per household per year

B.6.5. Summary of ex ante estimates of each SDG outcome

SDG 2 contribution: Indicator 2.4.1 "Proportion of agricultural area under productive and sustainable agriculture

Monitoring paramenter: Total area on wich bio-slurry is applied as feritlizer (hectare)

Year	Baseline estimate	Project estimate	Net benefit
2019	0	42,829	42,829
2020	0	44,475	44,475
2021	0	46,272	46,272
2022	0	48,150	48,150
2023	0	50,105	50,105
2024	0	52,134	52,134
2025	0	54,239	54,239
Total number of crediting years	7		
Annual average over the crediting period	48,315		

SDG 7 contribution: SDG 7.2.1: Proportion of population with primary reliance on clean fuels and technology Monitoring paramenter: number of people that rely on biogas for cooking

Year	Baseline estimate	Project estimate	Net benefit
2019	0	104,458	104,458
2020	0	108,473	108,473
2021	0	112,856	112,856
2022	0	117,438	117,438
2023	0	122,204	122,204
2024	0	127,154	127,154
2025	0	132,287	132,287
Total number of crediting years	7		
Annual average over the crediting period	117,838		

13.2.1: Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production Monitoring parameter: tCO2 reduced

Year	Baseline estimate	Project estimate	Net benefit
2019	76423	6558	69865
2020	79284	6804	72480
2021	82417	7073	75345
2022	85762	7360	78402
2023	89243	7658	81585
2024	92861	7969	84893
2025	96616	8291	88325
Total	602607	51712	550895
Total number of crediting years	7		
Annual average over the crediting period	78,699		

See sheet SDG_performance in the ER database for more details

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

(Include specific information on how the data and parameters that need to be monitored in the selected methodology(ies) or proposed approaches or as per mitigation measures from safeguarding principles assessment or as per feedback from stakeholder consultations would actually be collected during monitoring. Copy this table for each piece of data and parameter.)

Relevant SDG Indicator	SDG 7.2.1: Proportion of population with primary reliance on clean fuels and technology
Relevant SD indicator	SD 6: livelihood of the poor~~x...~~
Data / Parameter	$B_{daily,y}$
Unit	percentage
Description	Share of biogas users that uses biogas at least once per day for cooking in year y
Source of data	Carbon monitoring survey
Value(s) applied	Ex-ante: 99% (MPVI CPII)
Measurement methods and procedures	Determined using survey methods
Monitoring frequency	Annual
QA/QC procedures	Transparent data analysis and reporting

Purpose of data	Calculation of SDG contribution
Additional comment	

Relevant SDG Indicator	SDG 7.2.1: Proportion of population with primary reliance on clean fuels and technology
Relevant SD indicator	SD 6: livelihood of the poor
Data / Parameter	$Hs_{,y}$
Unit	Household size
Description	Number of family members permanent residing in the household in year y
Source of data	Carbon monitoring survey
Value(s) applied	4.69 (MPVI CPII)
Measurement methods and procedures	Determined using survey methods
Monitoring frequency	Annual
QA/QC procedures	Transparent data analysis and reporting
Purpose of data	Calculation of SDG contribution
Additional comment	

Relevant SDG Indicator	Indicator 2.4.1 “Proportion of agricultural area under productive and sustainable agriculture
Relevant SD indicator	SD 3: Soil Condition
Data / Parameter	$\%BS_y$
Unit	percentage
Description	Share of households that uses bio-slurry for crop production in year y
Source of data	Carbon monitoring survey
Value(s) applied	Ex-ante: 96% (MPVI CPII)
Measurement methods and procedures	Determined using survey methods
Monitoring frequency	Annual
QA/QC procedures	Transparent data analysis and reporting
Purpose of data	Calculation of SDG contribution
Additional comment	This questions cannot be answered by farmers that have recently installed their digester outside the cropping season. They are often storing bio-slurry in their compost hut awaiting the cropping season. If these farmers are committed to apply bio-slurry during that season, they will be counted towards contributing this SDG.

Relevant SDG Indicator	Indicator 2.4.1 “Proportion of agricultural area under productive and sustainable agriculture
Relevant SD indicator	SD 3: Soil Condition
Data / Parameter	$A_{bs,h}$

Unit	hectare
Description	Total area on which bio-slurry is applied
Source of data	Biogas user survey 2015
Value(s) applied	N/Aex-ante value: 1.9
Measurement methods and procedures	Determined using survey methods
Monitoring frequency	Annual
QA/QC procedures	Transparent data analysis and reporting
Purpose of data	Calculation of SDG contribution
Additional comment	

Relevant SDG Indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Data / Parameter	$B_{p,y}$
Unit	kg/ project household-year
Description	Quantity of biomass fuel that is consumed in the project scenario in year y
Source of data	Project performance test
Value(s) applied	Ex-ante value applied (wood and charcoal from CPII MRVI)
Measurement methods and procedures	Updated for every 2 years or more frequently after the first verification
Monitoring frequency	Biennial, starting from MPI
QA/QC procedures	Transparent data analysis and reporting

Fuel	Average per household (kg/year)
Charcoal in wood eq	10.350
Firewood	72.490

Relevant SDG indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Data/Parameter	$B_{p,LPG}$
Data unit	kg/ project household-year
Description	Amount of LPG used in the project scenario
Source of data	Annual monitoring reports, ex-ante applied from baseline study
Value(s) applied	3.880 ex-ante (MPVI CPII value)

Choice of data or measurement methods and procedures	It is not practical to establish LPG consumption using the KPT for reasons of safety. Instead, households were be asked how often they buy a bottle and the bottle size will be recorded. Annual consumption was be calculated as: $$Annual\ LPG\ consumption\ (\frac{kg}{year}) = \frac{Bottle\ size\ (kg)}{Usage\ period\ (days)} \times 365$$
Purpose of data	Calculation of project emissions
Additional comment	

Relevant SDG Indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Data/Parameter	**$B_{b,ratio}$**
Data unit	%
Description	Baseline scenario ratios
Source of data	Annual monitoring reports, ex-ante applied from CPIII baseline study data (see NBP CPIII PDD ER spreadsheet)
Value(s) applied	**Baseline scenario** / **% of users** **Households with main fuel wood** — $B_{b1,ratio}$ — 76% **Households with main fuel charcoal** — $B_{b2,ratio}$ — 5% **Household with main fuel LPG** — $B_{b3,ratio}$ — 18% **Housholds using other fuels** — n/a — 0.4%
Measurement methods and procedures	Households will be asked which baseline scenario they fell into before receiving a biogas digester. The four baseline scenarios are defined by asking the households *"what is your primary fuel source for cooking purposes?"*. The purpose of this question is to allocate a household to a baseline scenario, whereby 'primary' fuel consumption is defined as that fuel meeting more than 50% of their fuel needs for cooking purposes. The households that respond *"firewood"*, for example, are subsequently allocated to the baseline scenario b1. This means that households in, for example, baseline scenario b1 may also use small amounts of fossil fuels (i.e. secondary and tertiary fuels) for cooking, which will be included in the baseline emissions.
Monitoring frequency	Annually
QA/QC procedures	
Purpose of data	Calculation of baseline emissions

Relevant SDG Indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Data / Parameter	**$fNRB_{i,y}$**

Unit	Fraction of Non-Renewable Biomass
Description	Non-renewability status of woody biomass fuel in scenario i during year y
Source of data	The fNRB is calculated from FAO and IPCC, and this is also indicated in UNFCCC SSC WG 35 Annex 20 with same approach of fNRB estimation, see http://cdm.unfccc.int/Panels/ssc_wg/meetings/035/ssc_035_an20.pdf
Value(s) applied	77%
Measurement methods and procedures	the latest approved fNRB figure by the Cambodia DNA will be used for each monitoring period
Monitoring frequency	Fixed by baseline study for a given crediting period, updated if necessary as specified in section 3.1 of the applied methodology
QA/QC procedures	Transparent data analysis and reporting
Purpose of data	Calculation of GHG emissions from NRB
Additional comment	As applicable, NRB assessment may be used for multiple scenarios

Relevant SDG Indicator	**Indicator 2.4.1** "Proportion of agricultural area under productive and sustainable agriculture **SDG 7.2.1:** Proportion of population with primary reliance on clean fuels and technology **13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Relevant SD indicator	SD 3: Soil Condition SD 6: Livelihood of the poor
Data / Parameter	**$U_{p,y}$**
Unit	Percentage
Description	Percentage of bio-digesters in use in monitoring period y
Source of data	Usage survey
Value(s) applied	79.36% ex-ante (CPII MPVI)
Measurement methods and procedures	An assessment of the drop-off rate of usage requires that digesters of different age groups are assessed. Monitoring shall be carried out on a random sample of digesters of different ages. The minimum total sample size is 100, with at least 30 samples for biogas digesters of each age bracket (measured in annual increments) being surveyed. The usage rate of thermal applications will be monitored annually using survey methods to satisfy the requirements put forth by the methodology 'Technologies and practices to displace decentralized thermal energy consumption' V3 1 U_p will be calculated as follows: $$U_p = U_{us} \times UP_{us} \times C_y$$ Where

U_p	=	Percentage of biodigesters in use
U_{us}	=	Percentage of biodigesters in use during the usage survey
UP_{us}	=	Fraction of the year that digesters were temporarily out of use due to repairs or sale of animals on average in the MP

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	Cy	=	Correction factor of the number of days out of operation biodigesters were in operation during monitoring year y. Calculated as $C_y = 1 - \frac{OUT_y}{TOT_y}$ Where, OUT_y = cumulative plant years in operation of plants that went out of operation during in year y ((Total number of plants out of operation in the respective monitoring period* days in operation) / 365) TOTy= Plant-year of all plants in operation in year y (plants in operation x years in monitoirng period, e.g. times 1 year during annual monitoring)
Monitoring frequency	Annual		
QA/QC procedures	To account for void responses and lack of availability of some households on the day of the survey, additional households within each age group should be questioned. To ensure conservativeness, participants in a usage survey with technologies in the first year of use (age 0-1) 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.		
Purpose of data	Calculation of share of units in use		
Additional comment	The usage survey will be implemented by NBP or a third party. A single usage parameter is weighted to be representative of the quantity of project technologies of each age being credited in a given project scenario		

Relevant SDG Indicator	**Indicator 2.4.1** "Proportion of agricultural area under productive and sustainable agriculture **SDG 7.2.1:** Proportion of population with primary reliance on clean fuels and technology **13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Relevant SD indicator	SD 3: Soil Condition SD 6: Livelihood of the poor
Data / Parameter	$N_{b,y}$
Unit	units
Description	Number of biogas plants commissioned
Source of data	NBP database
Value(s) applied	26,585 (31/12/2017)
Measurement methods and procedures	100% of all plants are checked after completion of the construction by the PBPO technician or by the BCAs. . The main goal of NBP is to developa market based biogas programme and will gradually allow experienced BCAs to take over the commission check. The results of the commissioning check are recorded in Form

	9, this is currently a physical document but in the coming years this may transit to using tablets. Only when Form 9 is approved by NBP, data is entered into the central database. All Form 3, the hard copies, are stored at NBP.
Monitoring frequency	Continuously
QA/QC procedures	Transparent data analysis and reporting. Hard copies of all construction contracts will be available and kepy at NBP
Purpose of data	Calculation of emission reductions
Additional comment	$N_{p,y}$ will be determined on a monthly basis. The applied value in the calculations however, will be the value of the previous month to allow for a 1 month period for starting up the biodigester. This is conservative because in most cases within 2 weeks biogas is being produced

Relevant SDG Indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Data / Parameter	$MS_{(T,S,k)}$
Unit	[-] %
Description	Fraction of livestock category T's manure fed into the bio-digester, S in climate region k
Source of data	Monitoring survey CPII MRVI (12Jul18 ER Database v1.6)
Values applied	
Measurement methods and procedures	See section B.6.2, data will be collected according to the CMS sampling plan
Monitoring frequency	Annual
QA/QC procedures	Transparent data analysis and reporting
Purpose of data	Calculation of contribution to SDG13
Additional comment	There is only one climate region k in Cambodia

	Biodigester
cow	56.26%
Pig	35.07%
Buffalo	53.95%

Relevant SDG Indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Data / Parameter	**$MS_{(P,S,K)}$**
Unit	[-]
Description	Fraction of livestock category *T*'s manure not fed in the biodigester ,S in climate region k
Source of data	Monitoring survey CPII MRVI (12Jul18 ER Database v1.6)
Values applied	

Animal T	Slurry/Liquid	Anaerobic lagoon	Dry lot	Daily spread	Solid storag	Other	Pasture	Sum = MS_{notfed}
cow	4.85%	0.27%	1.63%	2.36%	13.35%	2.51%	18.77%	**43.74%**
Pig	20.85%	15.92%	2.10%	5.88%	16.18%	4.00%	0.00%	**64.93%**
Buffalo	4.29%	0.38%	0.79%	2.92%	6.65%	4.79%	26.23%	**46.05%**

Measurement methods and procedures	See section B.6.2, data will be collected according to the CMS sampling plan
Monitoring frequency	Annual
QA/QC procedures	Transparent data analysis and reporting
Purpose of data	Calculation of contribution to SDG13
Additional comment	The sum of the MS in the table in values applied is MSnotfed. The PP applies IPCC Tier 2 approach and will monitor the AWMS of the MS not fed into the digester. There is only one climate region k in Cambodia

Relevant SDG Indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Data / Parameter	$N_{(T)}$
Unit	[-]
Description	Number of animals of livestock category T
Source of data	CMS survey
Value(s) applied	Ex-ante value applied from CPIII baseline survey:
Measurement methods and procedures	See section B.6.2, data will be collected according to the CMS sampling plan
Monitoring frequency	Annual
QA/QC procedures	Transparent data analysis and reporting
Purpose of data	Calculation of contribution to SDG13
Additional comment	

Animal T	**N(T),h** [#]
cow	3.550
pig	1.879
Buffalo	0.389

Relevant SDG Indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Data / Parameter	**PL**
Unit	%
Description	Physical leakage of the biodigester

Source of data	IPCC default value for plants that leak
Value(s) applied	10% or calculated value
Measurement methods and procedures	The PP may opt to calculate the percentage of leakage as per section A6.3 of the applied metholodgy. On page 68 of section A.6.3 it is stated: *Where project participants use lower values or percentage of physical leakage, they should provide measurements proving that this lower value is appropriate for the project activity.* The measurement is as follows: In case households report that their digester leak, in case there is an obvious biogas smell, or when there is visible leakage, i.e. bubbling, it is assumed that the biodigester leaks. PL is therefore calculated as: $PL = 10\% * \%BD_{leak}$ where $\%BD_{leak}$ = the share of households with a leaking biodigester and 10% is the IPCC default value for physical leakage. In case the PP does not measure the leakage, $\%BD_{leak}$is 100% meaning that all plants are assumed to leak as per IPCC estimate.
Monitoring frequency	Annual
QA/QC procedures	Phyiscal leakage will be assessed during the carbon montoring survey using observation methods (is there a biogas smell) and by asking the households if there are leakages or the default is applied
Purpose of data	Calculation of project emissions
Additional comment	Physical leakage of the bio-digester

Relevant SDG Indicator	**13.2.1** "Number of countries that have communicated the establishment or operationalisation of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production
Data / Parameter	W(site)
Unit	(kg)
Description	Average pig weight at the project site of sows and boars (kg)
Source of data	Carbon monitoring survey
Value(s) applied	N/A – data will become available during annual monitoring and the IPCC VS default values are adjusted for site specific animal weight as per equation 3 of AMS-III.D v21
Measurement methods and procedures	The weight of fattening pigs and piglets is the average between the weight entering the farm and leaving the farms. Pigs that stay for a long time at the farm, which are sows and boars, will be determined using credible methods from the literature as described in section B.6.2. In section B.6.2 it is described how based on the girth and the length of the pig the weight can be determined reliably[22].
Monitoring frequency	Annual
QA/QC procedures	See section B6.2 for more details

[22] *As per the method described on this website http://www.thepigsite.com/articles/541/weighing-a-pig-without-a-scale/*

Purpose of data	Calculation of VS excretion
Additional comment	At least 25% of all sows shall be measured. Boars are relatively rare and in case less than 5 boars can be measured the average sow weight will be adopted as boar weight. This is conservative as male pigs attain higher weights than female pigs.

B.7.2. Sampling plan

>> (If data and parameters monitored in section B.7.1 above are to be determined by a sampling approach, provide a description of the sampling plan.)

A. Quality control monitoring

Quality control on plants in operation and under construction

Quality control on plants in operation and under construction is a key aspect of quality enforcement and the long-term success of the programme. The controls are conducted by supervisors of the PBPOs or in the future by experienced BCAs with regular assistance from the National Programme Office technicians. The latter also conduct quality control on the quality control performed by the PBPOs on a random sample basis.

A PBPO supervisor visits upon completion each biodigesters. The PBPO supervisors monitor if the plant is completed according to standardized specifications. If the final quality of the plant is considered acceptable, the plant is officially handed over to the farmer and a plant completion report is filled and signed by both parties. With a copy of the report the farmer can claim the subsidy on the investment. All plant completion reports are entered into the programme database located at the department of agriculture in Phnom Penh.

Quality control on masons and BCAs

BCAs and mason teams who corporate with the PBPO and benefit from the subsidy scheme, are required to seek recognition from NBP and the PBPO office. Such recognition is subject to a series of strict conditions such as:

- approval of standard design and sizes of biodigesters;
- trained, certified and registered masons for the construction of biodigesters;
- construction of biodigesters on the basis of detailed quality standards;
- provision of PBPO approved quality biodigester appliances (pipes, valve, stove, water trap, lamp);
- provision of proper user training and provision of a user instruction manual;
- provision of one year guarantee on appliances and two years guarantee on the civil structure of the biodigester, including an annual maintenance visit during the guarantee period;
- timely visit of a technician to the biodigester in case of a complaint from the user;
- Proper administration.

These conditions are put down in an agreement between the PBPOs and the biodigester construction companies.

Newly trained masons are required to have practical training with skilled masons for at least two plants before they can build plants independently. These new masons will receive the payment equally to 65% of the skilled mason's labour wage. For masons who are new to the art of digester construction, 100% of the first 4 plants built independently are inspected. This percentage gradually declines as more experience is gained and the overall quality level is considered to be satisfactory. An experienced mason will have about 25% of his plants inspected during the construction. Masons and/or companies with less than satisfactory performance will be facilitated in upgrading their skills. If the poor performance is persisting they are eliminated from the programme.

After sale services

After sales service is an integral part of the product delivered by individual masons and/or BCA. The after sales service include proper instruction of the user on the operation of the plant and maintenance as well as a 1 year guarantee on appliances and 2 years on the civil structure of the plant. The guarantee provision includes at least 2 visits with a 1 year interval, starting 3 months after the completion of the plant and a final visit one week before the end of warranty period. These visits have to be recorded on the backside of the guarantee certificate which is issued to the owner.

User trainings

The instruction of the user will include the following aspects of plant operation and maintenance:

- proper feeding of the plant;
- proper use of biodigester;
- regular simple maintenance like cleaning of the burner, changing the mantle of the lamp and the use of the water trap;
- proper use of the plant effluent;
- Cooking habits and cooking environment.

Avoidance of double counting

Every plant is upon completion but before commissioning inspected by a PBPO supervisor or BCA director. This is a structured inspection with the use of a Plant Completion Report Form (form no.9). This is also the moment when the plant is handed over from the company or mason to the owner. The PBPO supervisor or BCA director, the concerned mason and the plant owner will go through this inspection together and if they agree the plant, including the piping and the appliances installation, is completed, each one of them will sign the form while the PBPO director will also stamp it.

Of this form the first page goes to the owner, the second to the NBP national office and a third one remains with the PBPO. The owner will receive his subsidy if he presents himself together with his identity card at an ACLEDA Bank branch office if it concerns a cash plant. The bank will photocopy the form, the ID card and a receipt for the payment will be signed by the farmer. For loan plants the same procedure is followed be it that the plant owner has to present himself at the branch office of the MFI where the loan was obtained.

The banks will make a monthly statement of the subsidy payments made by them which will include the plant owner's name and address, the plant code, date of payment. The PBPOs will send the Completion Reports (form no.9) to the NBP office where they will be entered in the data base. The bank reports will be tallied with the completion reports received by NBP.

Of the completed plants entered in the Dbase, the technical unit of the NBP will take a random sample of about 10% and check at the farm site the data, including the measurements of the plant, on the completion report submitted by the PBPO. In the case that irregularities are observed, the sample size for a specific province, supervisor or mason can be increased. Further controls are done through the Biogas User Survey, with a random sample of plants, and through the follow-up of the bio slurry extension staff.

The next table includes the complete list of QC monitoring items:

Form no:	Activity	By whom:
Form 01	Registration of Farmer's interest after village meeting	PBPO Supervisor or BCA
Form 02	Feasibility control at farmer's house. If positive and a credit is required, a copy of this form is submitted to the MFI. The form is stored at the PBPO office.	The form is filled-out by PBPO supervisor or registered mason.
Form 03	Construction contract between client, technician and PBPO or between client and company with copy to the PBPO.	Technician or company, client and PBPO.
Form 04	Enrolment form of newly certified masons. These masons are entered into the Dbase to check if the plants are build and maintained by certified masons.	Data entry by NBP data typist. Control by NBP Information System Manager and Technical Manager.
Form 06	Quality control report. Quality control during the construction of a random sample of about 40% of all plants which are checked during the construction on quality standards. The forms are entered in the NBP Dbase and feedback is given to the PBPOs and companies. Copies of the quality forms are kept at the PBPO and the NBP office.	PBPO quality supervisor. Data entry by NBP data typist, checked by NBP Information System Manager.
Form 09	Completion report. All plants, after completion but before commissioning, are checked by a PBPO supervisor and client. If found that the plant is completed and up to quality standards, the plant is handed over to the owner for use. The owner can claim subsidy at a bank with his copy of the report. The data are entered at the NBP Dbase and copies are kept at the PBPO and NBP office. Data are used for progress reports and subsidy transfer control.	PBPO quality supervisor or BCA. Data entry by NBP data typist, checked by NBP Information System Manager.
Form 10	End warranty report: All plants at the end of two-year warranty, the survey will be conducted by mason for checking the final situation of the plant. All the reparation work will be done at this stage if needed. The summary report are kept and NBP office and entered into NBP Database while the full original copies are kept at the PBPO.	Mason Data entry by NBP data typist, checked by NBP Information System Manager.
Form 11	Quality control on quality control and after-sales service. About 5% of the plants in use are randomly checked by the NBP technicians on the accuracy of form no 9 and on the quality of the after-sales service. The forms are entered into the Dbase by the technician who has done the check for comparison with the data of the plant submitted via form no. 9.	Check and data entry by NBP technician. Control by NBP technical manager.

The CMS sampling plan is developed using guidance of the applied GS methodology and the UNFCCC standard on sampling (EB 69 annex 5: Standard for Sampling and Survey for CDM Project Activities and Programme of Activities)[23]

1. Sample design of CMS

#	Item	Description
1	Objectives and Reliability Requirements	The objective is to obtain unbiased and reliable estimates of the monitoring parameters at a confidence / precision level of 90/10.
2	Target population	Households that have installed an NBP certified biodigester
3	Sampling method and sampling frame	Probability-Proportional-to-size (PPS) random cluster sampling using a two-stage cluster design: (1) Clusters are selected with probability-proportional-to-size (PPS) at the first stage of sample selection and (2) households are randomly from each cluster at the second stage[24]. The primary sampling units are districts and the second sampling units are randomly selected households belonging to the target group in the clusters. PPS sampling is statistically the most significant sampling method as ensures that each household has the same probability to be selected[24][25].
3.1	Number of clusters	The selection of clusters involves three primary considerations[25]: **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[26] the less pronounced is the design effect. This is because elementary units within clusters generally tend to exhibit some degree of homogeneity with regard to background characteristics and possibly behaviours. 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. **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

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[23] http://cdm.unfccc.int/UserManagement/FileStorage/S9J6CIEN84WGU1KQBA2MRFH0ZO5LX3

[24] Magnani (1997) Sampling guide. Food and Nutrition Technical Assistance Project

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

[26] 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)

		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. Magnani (1997) mentions that there is no general rule on the number of clusters to be selected, however, the more clusters the more significant it becomes. According to Purnami et al (2011) a reliable way of cluster selection is with the following equation: $$k \approx \left(\frac{n}{2}\right)^{1/2}$$ *Where k is the minimum sample of clusters and n the total population of clusters.* The number of cluster chosen will be > k and preferably around 15 which was custom during CPII
3.2	Design effect and Sampling Design Effect	Usually the design effect (D) of 1 to 3[27] 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 10 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 low D can be justified. A D of 1.5 is adopted by NBP as the households to be surveyed are known. 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%.
3.3	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[28]. $$n = \frac{N}{1 + N(e)^2} \times D \times 110\%$$ Where:

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

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

		n = minimal sample size e = level of precision (10%) N = the biogas population D = design effect 110% = Oversampling of 10% For example, if N is 20,000, the calculated n is (20,000/(1+20,000*10%^2)*1.5*110% = 164 ~ 165. The sample size per cluster is then calculated as: $$n_{cl} = \frac{n}{\#CL}$$ Where: n = minimum sample size #CL = Number of clusters n_{cl} = Cluster sample size With the example sample size of 165 households, the cluster sample size is consequently 165/15 = 11. In case a district is selected as cluster containing less than 11 biogas households, the neighbouring district will be added to the cluster to ensure that the cluster contains 11 or more households. This may happen if NBP recently started in the particular district.
4	Sampling frame	The sampling frame is a random selection of households that belong to the target population in the selected cluster

2. Data

#	Item	Description
i	Field measurements	The survey will consist of household visit in random selected end-users with the objective to collect reliable and unbiased data. The 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.
ii	Quality Assurance/Quality Control	Several mechanisms will be put into place to avoid non-sampling errors (bias) and to obtain reliable date for each parameters: • **Good Questionnaire Design and piloting** The survey questionnaire will be developed and tested under real life conditions (pilot testing: taken to the field and tested with farmers as interviewees). The outcome of that testing will result in an improved questionnaire and will only be used after approval of NBP • **Cross checking** A random selection of 10% of the surveyed households will be crosschecked by telephone or by physical visits. All important ER relating data collected during the survey will be cross checked with the respondent during the telephone call or household visit. • **Data entry and cross checking** Data will be entered by trained personal.
iii	Procedures for Administering Data Collection and	The survey team will interview a random selected household and answers will be recorded in a questionnaire, in case of non-response the surveyor will proceed to the next household. The surveyor will document the out of population cases, refusals and other sources of non-response. Also, the

	Minimizing Non-Sampling Errors	surveyor will only interview informed interviewees, i.e. interviewees with knowledge on cooking and the biogas plant. The original questionnaire used will be made available for inspection by DOE.

3. Implementation

#	Item	Description
i	**Implementation**	The CMS will be executed annually. 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). Persons involved will have the following qualifications and experience: • Surveyors: Person that is trained by the survey team leader • Survey team leader: Experience person and has been involved in at least 2 other surveys • Reporting and PDD updating: Person that is involved in at least one verification or in large related surveys
ii	**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 each biogas plant owner; 3. Unique code of each surveyed biogas plant; 4. Size of 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.

The majority of interviews in a usage survey will 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 analysed such that typical circumstances are well understood by the telephone interviewers.

The usage survey procedure is as follows:

- Each year NBP 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 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 visits 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 PBPO or NBP staff or a third party.
- **Desired Precision/Expected Variance and Sample Size**. The minimum sample size is 100, it will be ensure that this requirement is met during each usage survey.
- **Procedures for Administering Data Collection and Minimizing Non-Sampling Errors:** As per CMS monitoring plan

D. Baseline and Project Fuel test

The baseline performance field test (BFT) and the project performance field test (PFT) measure real, observed technology performance in the field. Consumption is measured with a representative sample of end users under each defined baseline scenario (in the absence of the project technology) and project scenario.

The BFT/PFT is executed according to this protocol:

- The minimum recommended test period is 3 days as per methodology. During CPII NBP however, NBP was given approval to reduce this period to 1 day as most households do not use fuels anymore other than biogas. Therefore, the test period shall be 1 days[30]
- Cooking practices includes will be fuels used for human food cooking and boiling water
- Cooking practices shall be during 'normal days'. Normal days are defined as periods without extra eaters. Depending on the family, this excludes days like festivals or holidays or weekend days. The MC can take place in the weekend if it can be proven that fuel use is not higher during these days (i.e. the same number of people eat meals as during the week).
- Households are instructed that they cook normally during the test. The aim is to capture their usual behaviour in the kitchen, as if no tests were happening
- To conduct the tests, ensured is that the cook uses fuel only from a designated stock which is pre-weighed.

[29] See page 24 of the methodology

[30] *A MC of 1 days (24 hour) is allowed by the GS during CPII*

- The number of person-meals will also be recorded in the following categories: Child 0-14 years, Female over 14 years, male 15-59 and male over 59 years old.
- Fuel will not be provided to the households, but they will be assisted with gathering enough wood if necessary. The reason being is that the main fuel, wood, is not purchased but collected.

The PFT design is depicted in the table below

Table 17: PFT and BFT survey design

Item	Conversion in PFT	Conversion in BFT
Sampling objective:	The objective of the sampling effort is to obtain reliable fuel use data of project households	Idem but of baseline households
Field Measurement Objectives and Data to be collected:	The survey will consist of a 24 hour measurement campaign	idem
Target Population and Sampling Frame:	The sampling frame will be drawn from the project database	Households are those with the technical potential for biogas and with the same socio-economic and cultural practices as the PFT households and similar stove and fuel usage as collected by the baseline survey
Sampling method (approach):	Cluster random sampling using the CMS sampling frame with a minimum sample of 30 households	Neighbouring households to the PFT households
Implementation:	Biennial	Once in CPIII and to be executed for MPI
Desired Precision/Expected Variance and Sample Size.	90/10 rule of the applied methodology or the lower bound of the one-sided 90% confidence interval in case 90/10 is not achieved	
Procedures for Administering Data Collection and Minimizing Non-Sampling Errors:	The test will be executed by a third party and 10% of the households will be double checked either by visits or telephone calls	

B.7.3. Other elements of monitoring plan

>>
N/A

SECTION C. Duration and crediting period

C.1. Duration of project

C.1.1. Start date of project

>> *(Specify start date of the project, in the format of DD/MM/YYYY. Describe how this date has been determined as per the definition of start date provided in section 3.4.3 of GS4GG Principles & Requirements document and provide evidence to support this date.)*

The starting date is 13/03/2006
The starting date for retroactive Gold Standard application 24/05/2009

C.1.2. Expected operational lifetime of project

>> (Specify in years)

21 years.

C.2. Crediting period of project

C.2.1. Start date of crediting period

>> (Specify in dd/mm/yyyy. This can be start of project operation or two years prior to the date of Project Design Certification, whichever is later.)

Start date of third crediting period is 01/01/2019

C.2.2. Total length of crediting period

>> (Specify the total length of crediting period sought in line with GS4GG Principles & Requirements or relevant activity requirements.)

7 years

SECTION D. Safeguarding principles assessment

D.1. Analysis of social, economic and environmental impacts

>> (Refer the GS4GG Safeguarding Principles and Requirements document for detailed guidance on carrying out this assessment.)

Safeguarding principles	Assessment questions	Assessment of relevance to the project (Yes/potentially /no)	Justification	Mitigation measure (if required)
3.0 SOCIAL & ECONOMIC SAFEGUARDING PRINCIPLES				
3.1 Principle 1 - Human Rights	1. Does the project respect internationally proclaimed human rights and is not be complicit in violence or human rights abuses of any kind as defined in the Universal Declaration of Human Rights? 2. Does the project discriminate with regarding to participation and inclusion?	No	1. Cambodia has signed and ratified the "International Convention Economic, Social and Cultural Rights" and the "International Covenant on Civil and Political Rights[31]". The project respects human rights, including dignity, cultural property and uniqueness of indigenous people. The installation of biodigesters relies on individual households voluntarily investing. The voluntary nature of this purchase will ensure that the individual dignity, cultural property and uniqueness of indigenous peoples are respected. Thus, the project is not complicit in Human Rights abuses 2. Cambodia ratified the ILO Convention C087 (Freedom of Association and Protection of the	N/A

[31] *https://tbinternet.ohchr.org/_layouts/TreatyBodyExternal/Treaty.aspx?CountryID=29&Lang=EN*

			Right to Organise Convention, 1948) and C098 (Right to Organise and Collective Bargaining Convention, 1949)[32] All staffs are voluntary working under NBP and are free to form association and provide feedback. Employment at NBP, PBPO or franchised enterprises, BCAs, do not discriminate against individuals and employment of staff is not based on gender, race, religion, sexual orientation or on any other basis.	
3.2 Principle 2 - Gender Equality and Women's Rights	**Gender assessment question** 1. Is there a possibility that the Project might reduce or put at risk women's access to or control of resources, entitlements and benefits? 2. Is there a possibility that the Project can adversely affect men and women in marginalised or vulnerable communities (e.g., potential increased burden on women or social isolation of men)? 3. Is there a possibility that the Project might not take into account gender roles and the abilities of women or men to participate in the decisions/designs of the project's activities (such as lack of time, child care duties, low literacy or educational levels, or societal discrimination)? 4. Does the Project take into account gender roles and the abilities of women	No	1. No, the project does not affect control of resources, entitlements and benefits as, on the contrary, it brings benefits on time and resources savings which are mainly accrued to women 2. Project does not adversely affect men and women in marginalised or vulnerable communities 3. No, on the contrary as per item 2 above. It frees up time. NBP is open to all but there are certain societal barriers that prevent women to attend certain meetings due to household chores. Therefore, users' trainings and small group meetings are organized at a time convenient for women, around 8:30-9:30. In fact, in 2017, 1342 out of 2338 participants on compos training were female and 5868 out of 9117 participants of the small group meetings were female and 55% of the user trainings were female[33]	N/A

[32] http://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:11200:0::NO::P11200_COUNTRY_ID:103055

[33] NBP 2017 annual report

	or men to benefit from the Project's activities 5. Does the Project design contribute to an increase in women's workload that adds to their care responsibilities or that prevents them from engaging in other activities? 6. Would the Project potentially reproduce or further deepen discrimination against women based on gender, for instance, regarding their full participation in design and implementation or access to opportunities and benefits? 7. Would the Project potentially limit women's ability to use, develop and protect natural resources, taking into account different roles and priorities of women and men in accessing and managing environmental goods and services? 8. Is there a likelihood that the proposed Project would expose women and girls to further risks or hazards?		4. The Project has taken into account gender roles and the abilities of women or men to benefit from the Project's activities. The Project is demand driven and any minority, if they have the ability to pay and enough manure, can invest. 5. On the contrary, it saves women a lot of time by no having to collect wood, faster and more convenient cooking and less cleaning of pots and pans as not soot is produced. 6. No, most of the benefits are accrued to women, see item 5 and the project does therefore not deepen discrimination 7. The Project does not limit women's ability to use, develop and protect natural resources as it would help women eliminate the need to collect firewood and therefore it protects natural resources. 8. Biodigesters are a safe and established technology in Cambodia, so no risks are anticipated regardless of gender, women, girls or boys.	
	The Project shall not directly or indirectly lead to/contribute to adverse impacts on gender equality and/or the situation of women. Specifically, this shall include (not exhaustive):	No	**1. T**he project is not complicit in Sexual harassment and/or any forms of violence against women - address the multiple risks of gender-based violence, including sexual exploitation or human trafficking. Slavery, imprisonment, physical and mental drudgery, punishment or coercion of women and girls. There are no restriction of women's rights or access to resources (natural or economic).	N/A

	Projects shall apply the principles of non-discrimination, equal treatment, and equal pay for equal work, specifically: • Where appropriate for the implementation of a Project, paid, volunteer work or community contributions will be organised to provide the conditions for equitable participation of men and women in the identified tasks/activities. • Introduce conditions that ensure the participation of women or men in Project activities and benefits based on pregnancy, maternity/paternity leave, or marital status. • Ensure that these conditions do not limit the access of women or men, as the case may be, to Project participation and benefits.	No	- Contributions are equal and equitable. Pay is fixed for masons and independent of gender. - both men and women are free to participate in any of the activities. - There are no restrictions. The program is demand driven and has therefore no influence on who wants to invest	
3.3 Principle 3 - Community Health, Safety and Working Conditions	1. Are adverse impacts on the health and safety of affected communities during the Project's life cycle from both routine and non-routine circumstances happening? 2. Are workers provided with safe and healthy working conditions and to prevent accidents, injuries, and disease?	1. no 2.?	The Cambodian Constitution provides Cambodians with a range of rights and obligations such as Articles 228-232 of the Labour Law[34] 1. Biodigesters hygienically treat waste and eliminate household air pollution. Health consequently will be improved	N/A

[34] http://www.cambodiainvestment.gov.kh/the-labor-law-of-cambodia_970313.html

			2. All masons are trained and certified on safe working conditions. NBP obliges mason to buy an accident insurance which is the most dangerous activity.	
3.4 Principle 4 - Cultural Heritage, Indigenous Peoples, Displacement and Resettlement	**3.4.1 Sites of Cultural and Historical Heritage** 1. Does the Project Area include sites, structures, or objects with historical, cultural, artistic, traditional or religious values or intangible forms of culture (e.g., knowledge, innovations, or practices)? **3.4.2 Forced Eviction and Displacement** 2. Does the Project require or cause the physical or economic relocation of peoples (temporary or permanent, full or partial)? **3.4.3 Land Tenure and Other Rights** 3. Does the Project require any change to land tenure arrangements and/or other rights? **3.4.4 Indigenous Peoples** 4. Are indigenous peoples present in or within the area of influence of the Project and/or is the Project located on land/territory claimed by indigenous peoples?	1. No	Cambodia has signed and ratified the "Convention for the Safeguarding of the Intangible Cultural Heritage, 2003"[35] 1. The project area are most provinces in Cambodia, but the site of the digesters is located at backyard of farms without any objects with historical, cultural, artistic, traditional or religious values or intangible forms of culture on a voluntary basis and does not involve and is not complicit in the alteration, damage or removal of any cultural heritage., 2. No, biodigesters are only built at the premise of a household farm 3. No, as above, the project does not result in a change in land tenure rights. 4. No, no land claims by indigenous people occur nor do indigenous people live in the project area.	N/A
3.5 Principle 5 - Corruption	The Project shall not involve, be complicit in or inadvertently contribute to or reinforce corruption or corrupt Projects.	1. no	Cambodia ratified the United Nations Convention against Corruption in September 2007[36]	N/A

[35] http://portal.unesco.org/en/ev.php-URL_ID=33391&URL_DO=DO_TOPIC&URL_SECTION=201.html

[36] http://www.unodc.org/unodc/en/corruption/ratification-status.html

			The NBP, PPBO, BCA masons etc. do not engage in any type of corruption activities	
3.6 Principle 6 - Economic Impacts	**Does the project:** 1. Promote equitable, sustainable economic growth and stability and Projects that are appropriate and considerate of the economic situation in which they are developed? 2. Respect and promote worker's rights, to promote the right to decent work, fair treatment, non-discrimination, and equal opportunity for workers, and to avoid the use of forced labour and child labour? 3. Prioritise appropriate and properly considered local employment and procurement wherever possible? **3.6.1 Labour rights** 1. Are working conditions in compliance with national labour and occupational health and safety laws? 2. Are workers allowed to establish and join labour organisations? 3. Are working agreements with all individual workers documented and implemented? Are working hours not more than 48 hours per week? Is there a provision for overtime? Modalities on health insurance? Modalities on termination of contract with provision of	1. no 2. No	1. Yes, most farmers rely on wood for cooking and biogas is a solution to their problems related to wood collection and air pollution. Also, the bio-slurry helps them to improve farm economics. All farmers have access to the biodigester, provided they have the ability to pay and enough livestock. Those without it, could become masons and earn an income by constructing biodigesters 2. Yes, because masons can only get certified when 18 years old, likewise unskilled masons are at least 18 years old because as per Cambodian labour law. The selection of masons is not based on gender, race, or religion, but based on ability, willingness to work, basic education etc. 3. All employment is local, and masons live in the same district as where they work **3.6.1 labour rights** 1. Yes, working conditions of masons are in compliance with national labour law and occupational health and safety laws. 2. Yes, they are allowed to join any organisations, union or labour. Cambodia ratified the ILO Convention C087 (Freedom of Association and Protection of the Right to Organise Convention, 1948) and C098 (Right to Organise and Collective Bargaining Convention, 1949)[37]	N/A

[37] http://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:11200:0::NO::P11200_COUNTRY_ID:103055

	voluntary resignation. Is there provision for annual leave of 10 days or more? 4. Is the employment model applied local and culturally appropriate? 5. Is there child labour? What age verification mechanisms does the project employ to prevent this? **3.6.2 Negative economic consequences** 1. Can NBP demonstrate that the Project implemented (Biodigesters) are financially sustainable beyond the project crediting period? 2. Does the project consider potential risk to the local economy and have these been taken into account in the project design, implementation, operation and after the project? Including ensuring that the benefits are socially inclusive and sustainable also to vulnerable and marginalized social groups?	3. no 3.6.1 labour rights no **3.6.2 negative social** consequences no	3.BCAs and masons are independent from NBP, however the franchise contract with NBP stipulates that they have to follow the labour law. There is no provision for overtime – as workers are all freelance. An accident insurance is provided to the masons by the BCA. No, but masons work on a freelance basis, and work is often one digester or a few at the time 4. Yes, all is the employment model is culturally appropriate 5. Certification of masons is only possible aged 18 and above. The certification is the ID card. NBP verifies this with the ID card or birth certificate **3.6.2 Negative economic consequences** 1. Yes, warrantyis still offered after the crediting period by locking a after warranty fee for BCAs that will only be released after the warranty period. Furthermore, once a biodigester is constructed, they last for around 20 years. 2. No risks are attributed or associated with this project. On the contrary skilled and non-skilled employment is created benefitting the rural economics reducing the need to migrate for good quality jobs.	

4.0 ENVIRONMENTAL & ECOLOGICAL SAFEGUARDING PRINCIPLES

Principle 1 - Climate and Energy	**1.** Will the Project increase greenhouse gas emissions over the Baseline Scenario? 2. Will the Project use energy from a local grid or power supply (i.e., not connected to a national or regional grid) or fuel resource (such as wood, biomass) that provides for other local users?	No	1. No, as can be observed from the results from CPII and CPI 2. No, the project relies on manure which is currently not used a fuel	N/A
Principle 2 – Water	Will the Project affect the natural or pre-existing pattern of watercourses, ground-water and/or the watershed(s) such as high seasonal flow variability, flooding potential, lack of aquatic connectivity or water scarcity?	No	1. No the construction of biodigesters does not affect natural or pre-existing pattern of watercourses, ground-water and/or the watershed	N/A
4.2.2 Erosion and/or Water Body Instability	1. Could the Project directly or indirectly cause additional erosion and/or water body instability or disrupt the natural pattern of erosion? If 'Yes' or 'Potentially' proceed to question 2 2. Is the Project's area of influence susceptible to excessive erosion and/or water body instability?	No	1. No, the construction occurs in backyards and does not cause erosion 2. Not applicable.	N/A
Principle 3 – Environment, ecology and land use				
4.3.1 Landscape Modification and Soil	1. Does the Project involve the use of land and soil for production of crops or other products?	no	1. No, the construction of biodigesters does not use soil or crops.	N/A
4.3.2 Vulnerability to Natural Disaster	Will the Project be susceptible to or lead to increased vulnerability to wind, earthquakes, subsidence, landslides, erosion, flooding, drought or other extreme climatic conditions?	no	1. No, the construction of biodigesters is not related to these risks.	N/A

4.3.3 Genetic Resources	Could the Project be negatively impacted by the use of genetically modified organisms or GMOs (e.g., contamination, collection and/or harvesting, commercial development)?	No	1. This is not applicable to the project as it does not produce crops	N/A
4.3.4 Release of pollutants	Could the Project potentially result in the release of pollutants to the environment?	No, or not larger than the baseline	1. Digester effluent can cause local eutrhopifcaiton if not use similar to the baseline situation. However, most farmers use bio-slurry which is a superior fertilizer compared to farm yard manure and the impact is therefore less on the environment compared to the baseline.	N/A
4.3.5 Hazardous and Non-hazardous Waste	Will the Project involve the manufacture, trade, release, and/ or use of hazardous and non-hazardous chemicals and/or materials?	No	1. No hazardous and non-hazardous chemical are involved in biodigester use and construction	N/A
4.3.6 Pesticides & Fertilisers	Will the Project involve the application of pesticides and/or fertilisers?	Yes	1 Farmers are trained to use bio-slurry as effective organic fertilizer which can improve yields and soil quality. However, the project does not encourage using chemical fertilizers	N/A
4.3.7 Harvesting of Forests	Will the Project involve the harvesting of forests?	No	On the contrary, the project will result in a lower demand for firewood	N/A
4.3.8 Food	Does the Project modify the quantity or nutritional quality of food available such as through crop regime alteration or export or economic incentives?	No	On the contrary, bio-slurry is a very good fertilizer which improves crop quality	N/A
4.3.9 Animal husbandry	Will the Project involve animal husbandry?	No	The project involves the construction of biodigesters through the development of a private sector. Households that invest however, raise animals, but the project only focusses on the manure excreted and managed	N/A
4.3.10 High Conservation Value Areas and Critical Habitats	Does the Project physically affect or alter largely intact or High Conservation Value (HCV) ecosystems, critical habitats,	No	Not applicable, the project only built digesters in backyards of farmers	N/A

	landscapes, key biodiversity areas or sites[12] identified?			
4.3.11 Endangered Species	1. Are there any endangered species identified as potentially being present within the Project boundary (including those that may route through the area)? 2. Does the Project potentially impact other areas where endangered species may be present through transboundary affects	No	1. No, the project only focusses on rural areas with technical potential for biogas. These exclude area where endangered species may live 2. No, as above	N/A

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from stakeholders

>> (Describe how stakeholder consultation was conducted in accordance with GS4GG Stakeholder Procedure Requirements and Guidelines.)

The LSCR was conducted in accordance to the GS4GG Stakeholder Procedure Requirements and guidelines by taking into account:

- Step 1: Proper preparation
  - Stakeholder mapping in line with the 6 category codes of the GS
  - Instruction to the Provincial offices to ensure sufficient participation of women
  - Large scale media campaign via Facebook which reached almost 200,000 Cambodians, announcement posters and banners at frequented places
- Step 2: Meeting held as per Step 2 in the Guidelines
  - The agenda was based on the Step 2 requirements, for more see the LSCR
- Step 3: Document → see LSCR for the documentation that was prepared in accordance with the Guidelines
- Step 4: Incorporate Feedback: See E.2.
- Step 5: Stakeholder feedback round
  - The stakeholder feedback round was organized as per GS4GG Stakeholder procedure requirements and guidelines. A 2-month feedback period was initiated on the 10th of August until the 10th of October. Stakeholders were pro-actively contacted by email and through Facebook. It is anticipated that through Facebook over 100,000 Cambodians will be reached. Both the email and the Facebook advertisement include a link to the NBP website were all documents, including the PDD, can be found. Evidences of the reach-out to stakeholders can be found in the LSCR.

E.2. Summary of comments received

>> (Provide a summary of key comments received during the consultation process.)

All key comments are copied here below from the LSCR.

Stakeholder comment	Was comment taken into account (Yes/ No)?	Explanation (Why? How?)
How did you calculate and measure of CO2 emission?	No	Question is an information request and it was answered in detail.
Farmers with biodigester, they need to collect animal manure and keep manure in front their house. How does it effect to human health and environment?	No	It was explained that biogas has a positive effect on human health and the environment
Biogas farmers practice the cultivation of integrated farming systems by using bio-slurry. Can it affect the yields and quality of vegetables production?	No	It was explained that bioslurry improves yields, reduces weed propagation and is superior compared to farm yard manure
Farmers need to afford $250-$400 build the biodigester. If farmers don't have enough money to build the biodigester, can be called social discrimination? Could NBP make it more discount on biogas construction?	No	NBP is a market-based program and the farmer's contribution is important when setting up a market based project with a long term vision. Giving away digesters does not lead to ownership and long term use. NBP however has a system in place with affordable credit to those

		that cannot afford and various subsidies such as $150 subsidy, T-shirt, pots and 500 bricks free. NBP also designed a smaller digester for poorer farmers that is more affordable
Farmers have difficulty collecting 20 kg of manure a day, would it negatively affect the biodigester if they reduce 10kg of animal manure?	No	It was explained that there is no relationship between feeding and lifespan of the technology
Some women want to use biodigester, but they cannot afford to build the biodigester. Could NBP reduces the lower rate than 1.2% of loan in building biodigester for vulnerable women?	No	The subsidy is already at sub-market rates and beyond the control of NBP as well
Could MFIs provide additional loan to debt farmers for biodigester construction?	No	Only if these farmers are still credit worthy, i.e. are not too indebted
Does the NBP think of a long time in use of current model of biodigester? Do the biogas households is still functioned while other countries mobilize the medium scale of biodigester?	No	Digesters last for over 20 years, in other countries they also use biogas and NBP will follow the market and come with different models such as medium scale with changing market conditions
Through mechanism from Provincial Department of Forestry and Fisheries (PDAFF) and under support from GIZ, how does PDAFF link with NBP to exchange experiences from each other?	No	Yes, NBP is part of these networks and this was explained in detail

No other comments were received through the SFR.

E.3. Report on consideration of comments received

>> (Describe how the comments have been addressed by providing a clarification to the stakeholder or by altering the design of the project or by proposing to monitor any anticipated negative impacts etc.)

No negative impacts were identified by the stakeholders and for that reason a design change was not required. NBP will however, through the mechanism implemented for continuous stakeholder feedback/grievance mechanism, record, track and monitor issues and where necessary adapt the project design accordingly.

Appendix 1. Contact information of project participants

Registration number with relevant authority	National Biodigester Programme
Street/P.O. Box	PO Box 2590
Building	N/A
City	Phnom Penh
State/Region	N/A
Postcode	N/A
Country	Cambodia
Telephone	+85523992609
Fax	+85523992604
E-mail	admin@nbp.org.kh
Website	www.nbp.org.kh
Contact person	Mrs. Lam Saoleng
Title	Programme Coordinator
Salutation	Mrs.
Last name	Lam
Middle name	N/A
First name	Saoleng
Department	N/A
Mobile	+85517961056
Direct fax	N/A
Direct tel.	N/A
Personal e-mail	saoleng@nbp.org.kh

Appendix 2. Summary of post registration design changes

The project has transitioned to GS4GG and as a result the SD monitoring was updated and modified to reflect the new GS guidelines. Three SDGs were adopted which replaced the SD indicators identified and monitoring during CPII.

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Appendix 3. Baseline study

Study content

According to the applied Gold Standard methodology, the project proponent must conduct the following baseline studies:

1. **Baseline non-renewable biomass (NRB) assessment, if biomass is one of the baseline fuels;**

   In projects where woody biomass is a component of either the baseline or project scenario, project proponents must specify the extent to which the CO2 emissions of that biomass are not offset by re-growth in the fuel collection area.

   As per TAC decision taken on June 2012, tit is allowed to adopt NRB fractions approved by the CDM EB[38]. This projects adopt the value approved of 77%[39] as the fNRB and fixes it for this crediting period unless new information becomes available.

2. **Baseline survey (BS) of target population characteristics**

   Parameters collected include those mentioned on page 13 of the applied methodology

3. **Baseline performance field test (BFT) of fuel consumption**

   The BS covered target population characteristics but as discussed earlier, the BFT will be executed during MPI.

Baseline Survey Sample Sizing

The baseline survey should be carried out using representative and random sampling, following these guidelines for minimum sample size:

- Group size <300: Minimum sample size 30 or population size, whichever is smaller
- Group size 300 to 1000: Minimum sample size 10% of group size
- Group size > 1000 Minimum sample size 100

The estimated biogas potential in Cambodia is over 500,000 households[40], the sample size chosen therefore is larger than 100 and increased to 200 and even later to 230.

Survey design

The baseline survey will cover the whole Cambodia and to maximize fieldwork efficiency and keeping the cost reasonable low, a clustered randomize sampling method is proposed.

Based on the census of agriculture in Cambodia 2013, about 3.2 million cattle were raised and keep at household and in average there was 3 animals per household raising cattle. The number of cattle in the country were counted and geographically classified into four main regions the Plains Zone, Tonle Sap Lake Zone, the Plateau and Mountainous Zone, and the coastal Zone.

[38] https://www.goldstandard.org/articles/tac-rule-updates

[39] https://cdm.unfccc.int/sunsetcms/storage/contents/stored-file-20140210181830099/SSCWG43_Annex%204_Info%20note_fNRB%20Cambodia_ver%2001.0.pdf

[40] NBP estimates

Table 18: Number of cattle by province[41]

Region	Name of provinces	Number Cattle	Percentage	Total interviews to be completed (proportional)
Plains Zone	Kampong Cham Kandal, Phnom Penh Prey Veng, Svay Rieng, Takeo Tboung Khmum	1,300,000	41%	80
Tonle Sap Lake Zone	Banteay Meanchey, Battambang, Kampong Chhnang, Kampong Thom, Pursat, Siem Reap, Oddar Meanchey, Pailin	900,000	28%	60
Plateau / Mountains	Kampong Speu, Kratie, Mondulkiri, Preah Vihear, Ratanakiri, Stung Treng	700,000	22%	40
Coastal	Kampot, Koh Kong, Preah Sihanouk, Kep	300,000	9%	20
Total	**25 provinces/municipalities**	**3,200,000**	**100.0%**	**200**

In the next step the number of households with animals was determined by province, see below:

Table 19: Number of households with cattle by province

			Cattle (A)	Buffalo (B)	Pig (C)	A+B+C
#	**Zone**	**Zone/Province**	**Number of Households Reporting**	**Number of Households Reporting**	**Number of Households Reporting**	**Total hh with animals**

[41] Latest Census of agriculture in Cambodia 2013 , see http://www.fao.org/fileadmin/templates/ess/ess_test_folder/World_Census_Agriculture/Country_info_2010/Reports/Reports_5/KHM_ENG_REP_2013.pdf

1	Plain Zone	Kampong Cham	65,608	6,807	21,347	93,762
2	Plain Zone	Kandal	52,828	1,563	11,967	66,358
3	Plain Zone	Phnom Penh	10,103	56	4,061	14,220
4	Plain Zone	Prey Veng	105,430	16,917	62,664	185,011
5	Plain Zone	Svay Rieng	56,794	33,846	44,651	135,291
6	Plain Zone	Takeo	113,218	1,856	60,293	175,367
7	Plain Zone	Tboung Khmum	35,909	10,512	16,420	62,841
1	Tonle Sap Lake Zone	Banteay Meanchey	10,702	668	8,154	19,524
2	Tonle Sap Lake Zone	Battambang	46,274	1,013	10,203	57,490
3	Tonle Sap Lake Zone	Kampong Chhnang	45,170	11,184	20,340	76,694
4	Tonle Sap Lake Zone	Kampong Thom	62,215	14,983	23,484	100,682
5	Tonle Sap Lake Zone	Pursat	26,415	18,625	13,274	58,314
6	Tonle Sap Lake Zone	Siemreap	60,772	4,441	29,919	95,132
7	Tonle Sap Lake Zone	Oddar Meanchey	6,922	347	6,423	13,692
8	Tonle Sap Lake Zone	Pailin	1,558	-	515	2,073
1	Coastal Zone	Kampot	79,448	3,980	37,397	120,825
2	Coastal Zone	Koh Kong	2,016	2,942	4,752	9,710
3	Coastal Zone	Preah Sihanouk	2,474	1,800	3,337	7,611
4	Coastal Zone	Kep	4,405	377	2,510	7,292
1	Plateau and Mountainous Zone	Kampong Speu	104,081	751	25,248	130,080
2	Plateau and Mountainous Zone	Kratie	23,395	6,809	7,184	37,388
3	Plateau and Mountainous Zone	Mondul Kiri	3,210	1,232	3,698	8,140
4	Plateau and Mountainous Zone	Preah Vihear	19,644	2,499	18,284	40,427
5	Plateau and Mountainous Zone	Ratanak Kiri	5,282	2,216	6,603	14,101
6	Plateau and Mountainous Zone	Stung Treng	5,404	8,448	5,896	19,748

Using a probability proportional to size random selection method[42] first a representative province was selected in each zone based on the number of households with animals.

Then two districts were randomly selected in the selected province and in that district a number of villages was randomly selected for every 10 households in the zone sample size, see the table below:

Table 20: Selected villages for the BS

Selected villages						
Zone	**District**	**Village**	**Province**	**District**	**Village**	**Households**
Plains	1	1	Takeo	Kiri Vong	Andoung Chrung	10
		2			Ponley	10

[42] *The PPS method gives clusters with a higher animal density a proportional higher change to be selected in order to ensure that each households in the zone has the same chance to be selected*

		3			Boeng Tumnob	10
		4			Daeum Rumdael	10
	2	1		Tram Kak	Angk Ta Chan	10
		2			Trapeang Trakiet	10
		3			Paen Meas	10
		4			Mrum	10
Tonle Sap Lake	1	1	Kampong Chhnang	Rolea B'ier	Trapeang Popel	10
		2			Thnal Thmei	10
		3			Sat Lang	10
	2	1		Sameakki Mean Chey	Chrak Tnaot	10
		2			Chanva riel	10
		3			Kngaok pong	10
Plateau / Mountains	1	1	Kampong Speu	Kong Pisei	Angk Sangkream	10
		2			Ta Yang	10
	2	1		Samraong Tong	Tuek L'ak	10
		2			Sla	10
Coastal	1	1	Kampot	Banteay Meas	Srae Kan Chen	10
	2	1		Chhuk	Khnach Romeas	10
			4 provinces	**8 districts**	**20 villages**	**200**

During the survey execution it appeared that most households did not own buffaloes, while as per CPII MVI survey, around 19% of the biodigester users feed their plant with buffalo manure. Therefore, it was decided to survey an additional 30 households in provinces of which it is known that many households own buffalos: Prey Veng and Svay Rieng[43]. In those provinces only households that own buffalos were selected in order to obtain a sufficiently large sample that reflects the current distribution of animals amongst the biodigester household population.

The sampling procedure was as follows, randomly selection of 2 districts in Prey Veng and Svay Rieng and randomly selection of 2 communes in Svay Rieng and 1 in Prey Veng. In each commune 10 households were subsequently interviewed.

The total sample size was therefore 200+30 = 230 households.

Screenshots of the sampling procedure are available at request.

Implementation

- **Human resources**

Eric Buysman: The key responsible person for the baseline survey data analysis is Eric Buysman. Eric was selected based on a tendering process. He has been involved in NBP since 2006 and was leading all the pervious registration and verification activities. Eric oversees all the activities, from ensuring proper data collection by the contracted parties to reporting and DOE assistance in the field.

Patrick Kooijman: Patrick Kooijman is an independent consultant and has worked before on NBP monitoring surveys and KPT monitoring. Patrick was selected for this task by Eric and NBP.

[43] Expert interview with NBP coordinator

- **Survey team and implementation**

Patrick Kooijman, the senior survey coordinator, recruited 6 surveyors and 1 field supervisor. Preference was given to surveyors that had previous experience with biogas surveys or other relevant surveys. The Patrick Research Team consisted of Savuth Yet, survey supervisor and 6 trained and experience surveyors. In total 3 survey teams consisting of 2 surveyors were set up. Most of the surveyors, including the field supervisor, worked on similar assignments before. In the case that a surveyor did not have previous experience with biogas surveys, they were coupled with someone that did have relevant experience. To ascertain that all surveyors have the same understanding and to update their knowledge on the subject a training was organized on 13 -14 August 2018 and this included a test in the field. The survery itself was executed in the period 16 to 31 August.

Data collection tools

Questionnaire: The questionnaire was developed by the carbon consultant together with Patrick and is based on previous questionnaires that were used for CPII baseline survey. The questionnaire was administered digitally using the application KoBoCollect. The aim of using this method was to improve data collection, data consistency and to reduce costs. The questionnaire was pilot tested during the surveyor training using tablets of Huawei (Mediapad T1 7.0) on which the application was installed. Feedback from the field was used to finalize and improve the questionnaire. Subsequently, the questionnaire was translated into Khmer.

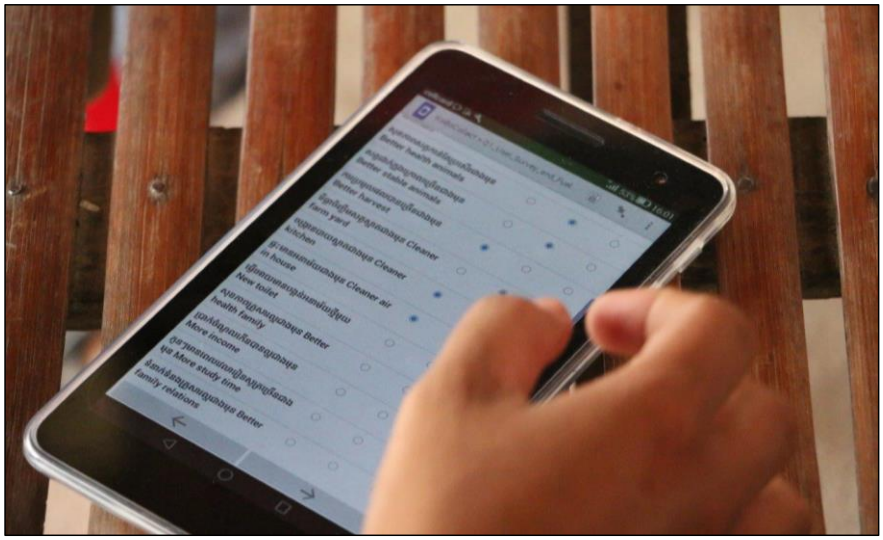

Figure 25: Tablet with questionnaire in KoboCollect

Newton scales were sometimes used to assist the surveyor with determining the fraction of manure that flows in to the different manure management systems. In most cases however, all manure was fed into the biodigester (=100%) and the newton scale were not sued. In other cases, it was easy to determine the share fed, i.e. 2 out of 3 buckets etc. In case this was not clear, surveyors measured the amount of manure fed to the biodigester and the amount not fed into the biodigester. Five calibrated weights were made for NBP and these are used every year to check if the scales are working correctly, see the picture hereunder:

Figure 36: Weight check on Electronic Balance and the electronic Newton scale

Results
Relevant results are described in section B.6.2

No baseline study report was prepared. The raw survey data was directly copied into the ER spreadsheet used for the PDD (see tab baseline data) and used for the analysis.

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Revision History

Version	Date	Remarks
1.1	24 August 2017	Updated to include section A.8 on 'gender sensitive' requirements
1	10 July 2017	Initial adoption