



**Monitoring report form for CDM project activity
(Version 07.0)**

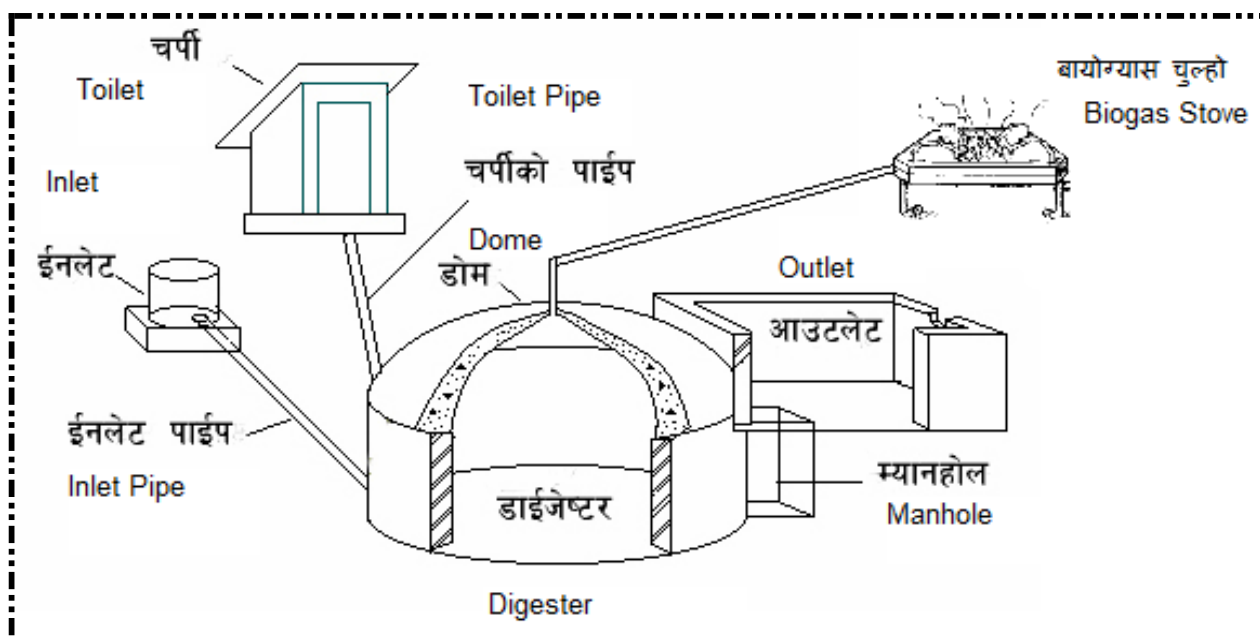
MONITORING REPORT		
Title of the project activity	Biogas Support Program - Nepal Activity-4	
UNFCCC reference number of the project activity	5416	
Version number of the PDD applicable to this monitoring report	11.1	
Version number of this monitoring report	01	
Completion date of this monitoring report	16/02/2021	
Monitoring period number	09	
Duration of this monitoring period	01/08/2019 to 31/12/2020	
Monitoring report number for this monitoring period	01	
Project participants	Alternative Energy Promotion Centre (AEPC)	
Host Party	Nepal	
Applied methodologies and standardized baselines	Applied Methodology: AMS.I.E. (ver. 09) Switch from Non-Renewable Biomass for Thermal Applications by the User Standardized baseline: Not applicable	
Sectoral scopes	Type I: Energy Industries (renewable/ non renewable sources)	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	0	91,391 tCO ₂ e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	107,080 tCO ₂ e	

SECTION A. Description of project activity

A.1. General description of project activity

The purpose of the Biogas Support Program (BSP) is to promote household biogas digesters and biogas stoves to households with at least one head of cattle located in Nepal through the capacity enhancement of the private sector to be able to carry out feasibility, installation and after sales services of the biogas plants. The digesters enable households to displace firewood and fossil fuels with biogas from animal waste and human excreta. The generated biogas will feed biogas cook stoves, and replace the firewood used for cooking in wood stoves in the baseline scenario. The replacement of firewood that is non-renewable biomass (NRB) is counted as emission reduction under the Clean Development Mechanism (CDM). Emission reductions are determined by defining the percentage of NRB in the firewood replaced, since firewood is the only biomass source replaced by the project of which a part is NRB.

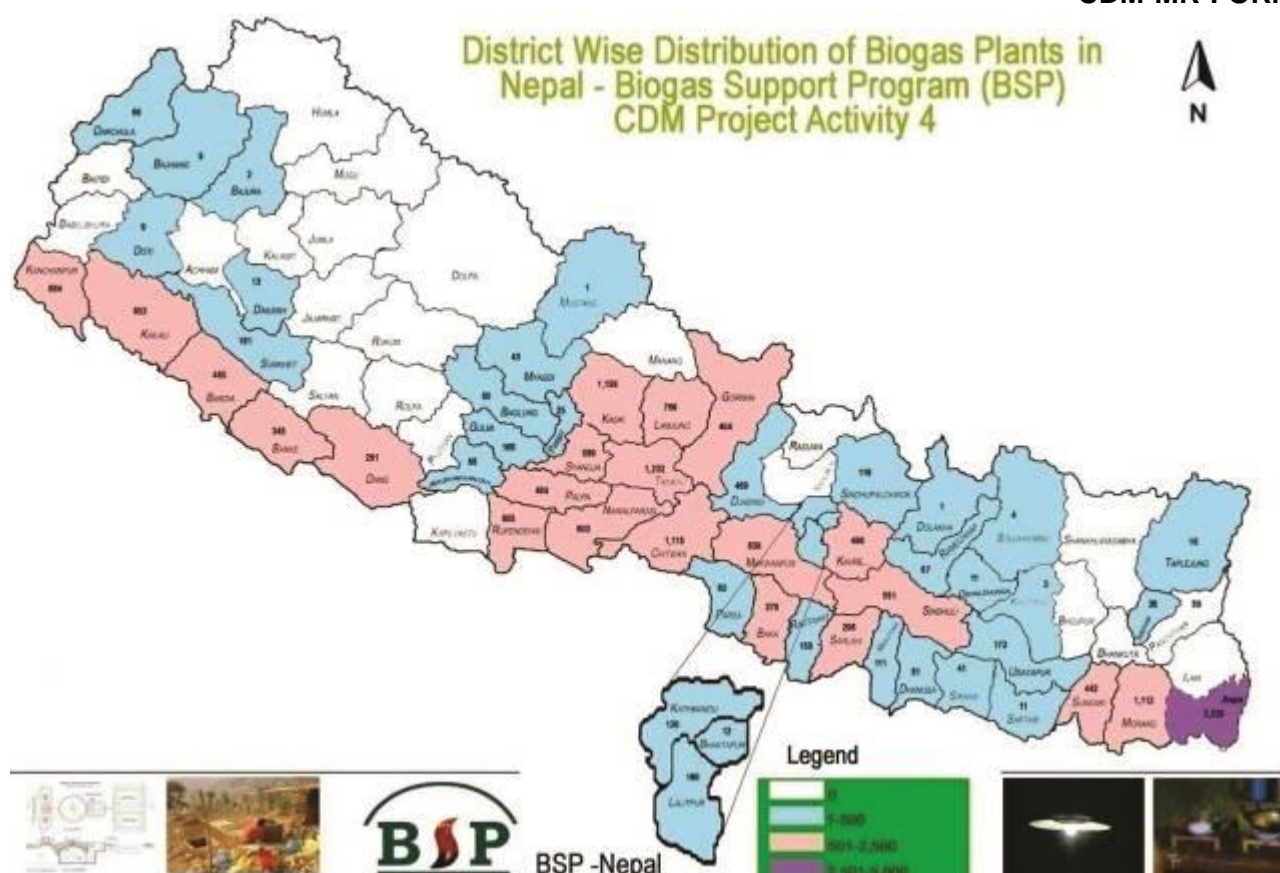
The BSP is centrally managed by the Alternative Energy Promotion Centre (AEPC) with the support of Biogas Sector Partnership Nepal (BSP-NEPAL), the implementing agency of AEPC is a government entity that executes renewable/alternative energy programs in Nepal, including BSP. The project activity includes 20,318 digesters which were implemented between 09/05/2006 and 21/06/2007. The technologies used in the proposed project are biogas stoves that are fed by household biogas digesters. The digesters have a sludge and gas holding capacity range of up to 10 m³. The biogas plants are based on a uniform technical design and are manufactured and installed following established technical standards in Nepal. These digesters include a compartment for the preparation of the digester feedstock at the inlet, the main digester and an overflow for the digestion product. The digester itself is a closed underground container made of concrete or other materials. The feedstock consists mainly of cattle manure and human excreta to which water is added. The biogas is extracted from the digester and transported to a stove. The digester has an overpressure which creates a stable flow of gas for use in the cooking stoves. The gas has a methane content of 52%. The biogas produced from the digester will be fed into the stove. The biogas consumption of each stove is 400 litre/hour.



A total of 91,391 tCO₂e of emission reductions had been achieved in this monitoring period.

A.2. Location of project activity

The digesters are located in various regions and provinces in Nepal. Each digester is uniquely identified through a plant code in the BSP database. Since the project sites are scattered across the country, the range of geographical coordinates of the country, i.e. 26° N – 30° N, 80° E – 88° E is provided as the reference for this project activity. Locations of the biogas plants are also shown in the map below.



A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Nepal (host Party)	Alternative Energy Promotion Centre (AEPIC)	No

A.4. References to applied methodologies and standardized baselines

Methodology used: AMS-I.E. ver. 9 - Switch from non-renewable biomass for thermal applications by the user

Reference: <https://cdm.unfccc.int/methodologies/DB/WHTQUFLWCVNB9CIUZC198A712WGQR4>

A.5. Crediting period type and duration

13/12/2018 – 12/12/2025 (Renewable).

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

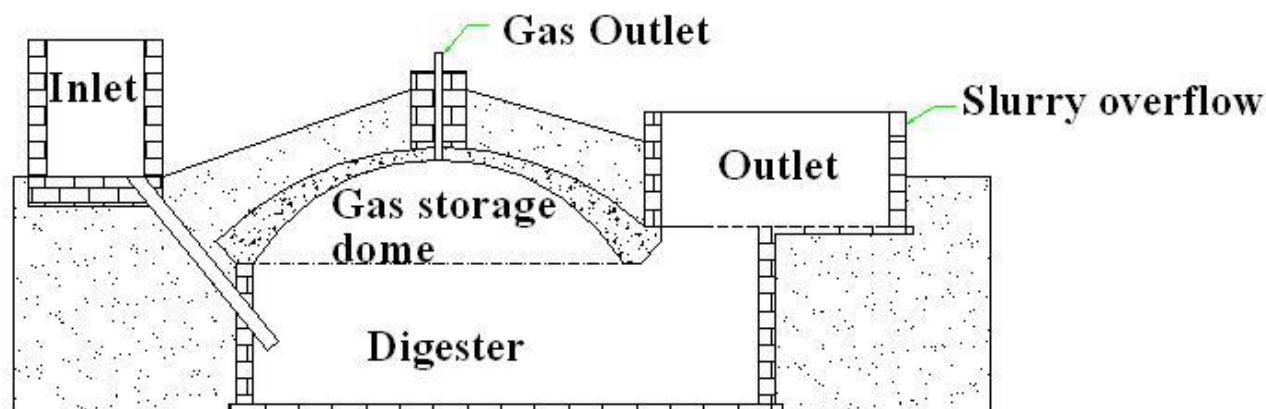
The project activity includes 20,318 digesters which were implemented between 9 May 2006 and 21 June 2007. Table 1 provides an overview of the digesters, categorised according to their size and location.

Table 1: Digesters listed in the Biogas Support Program - Nepal Activity-4

Region Size (m3)	Terai	Hill	Mountain or Remote Hill	Total
4	408	2,408	16	2,832
6	9,604	5,944	117	15,665
8	1,503	177	4	1,684
10	109	28	0	137
Total	11,624	8,557	137	20,318

The technologies used in the proposed project are biogas stoves that are fed by household biogas digesters. The digesters have a sludge and gas holding capacity range of up to 10 m³. The biogas plants are based on a uniform technical design and are manufactured and installed following established technical standards in Nepal. These digesters include a compartment for the preparation of the digester feedstock at the inlet, the main digester and an overflow for the digestion product. The digester itself is a closed underground container made of concrete or other materials.

The feedstock consists mainly of cattle manure and human excreta to which water is added. The biogas is extracted from the digester and transported to a stove. The digester has an overpressure which creates a stable flow of gas for use in the cooking stoves.



Biogas User Survey was conducted during February/March 2019. No other major events affecting biogas digester equipment that impact the applicability of the methodology for any of the biogas digester that are included in the project activity were not reported during the monitoring period.

B.2. Post-registration changes

B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies, standardized baselines or other methodological regulatory documents

N/A

B.2.2. Corrections

N/A

B.2.3. Changes to the start date of the crediting period

N/A

B.2.4. Inclusion of monitoring plan

N/A

B.2.5. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other methodological regulatory documents

N/A

B.2.6. Changes to project design

N/A

B.2.7. Changes specific to afforestation or reforestation project activity

N/A

SECTION C. Description of monitoring system

The project monitoring system implemented includes assessment of the performance of biogas units, consumption of woody biomass after project activity by pre-project devices and collection of data to confirm the displacement of NRB.

The registered PDD requires monitoring of the following parameters:

1. Average annual consumption of woody biomass per household in the pre-project devices during the project activity, if it is found that pre-project devices were not completely displaced but continue to be used to some extent.
2. Digester performance (Operational %) of the biogas digester in particular monitoring period to calculate the Quantity of woody biomass that is substituted or displaced.
3. Monitoring should confirm the displacement or substitution of the non-renewable biomass at each location (using the indicators on the use of NRB as detailed earlier).

1. Average Annual Consumption of Woody Biomass:

The average consumption of woody biomass after project activity was assessed based on the annual Biogas User Survey (BUS). The Annual Biogas User Survey was conducted following the Guidelines for Sampling and Surveys for CDM Project activities and Programme of Activities, Version 4.0. As part of the survey, statistically representative sample of biogas users was surveyed and in order to achieve 90% confidence interval and a 10% margin of error requirement for the sampled parameters. The sample was taken from different geographical regions (Terai, Hill and Mountain), proportionate to the bundled plants in the project. In order to have an unbiased and independent assessment, the survey was carried out through an independent agency

2. Digester performance.

The performance of the bio-digesters and continued displacement of NRB was assessed based on the annual Biogas User Survey (BUS). The Annual Biogas User Survey was conducted following the Guidelines for Sampling and Surveys for CDM Project activities and Programme of Activities, Version 4.0. As part of the survey, statistically representative sample of biogas users was surveyed and in order to achieve 90% confidence interval and a 10% margin of error requirement for the sampled parameters. The sample was taken from different geographical regions (Terai, Hill and Mountain), proportionate to the bundled plants in the project. In order to have an unbiased and independent assessment, the survey was carried out through an independent agency to check the operation/functioning of the biogas units installed as part of the project activity. To monitor performance of the digester, the following parameter was monitored through the BUS:

- (i) Digester operation at the time the survey is conducted.

3. Displacement of NRB. The fraction of the Non Renewable Biomass displaced by the project activity has been determined ex-ante in the PDD and has been fixed for the third crediting period. The fraction of non-renewable biomass has been fixed ex ante as 86.1%. The following indicators were monitored through annual survey to confirm the displacement of NRB use by households, Perceptions of the biogas users on these indicators were captured through survey and analysed. The indicators included:

- a. Trends in distance travelled for firewood gathering or trends in time needed for firewood gathering indicating depletion of resources available
- b. Trends in price of firewood indicating demand and scarcity
- c. Trends in type of cooking fuel collected that could indicate scarcity of fire wood.

At least two of the above indicators should confirm the displacement of non-renewable biomass. The survey collected the data pertaining to the indicators. All the monitored data required for verification and issuance will be kept for two years after the end of the crediting period.

Roles and Responsibilities

BSP was supported by the Nepalese government and international donors including the German Development Bank (KfW) and the Netherlands Development Organisation (SNV funded by DGIS). An overview of the responsibilities of all organisations involved in the programme were as follows:

Alternative Energy Promotion Centre- Operation and Management Plan

- The AEPC is responsible for overall coordination and the execution of the BSP.
- The AEPC is responsible for overall monitoring and evaluation together with SNV/N and other development partners).

- The AEPC is responsible for carrying out Annual Biogas Users' Survey that is also in line with the requirements of the CDM. The Biogas Users' Survey reports the performance of the digesters as well as perceptions of biogas users on the various indicators that confirm the displacement of NRB.

Netherlands Development Organization in Nepal

- The SNV/N provided advisory services to organizations of the biogas sector. The advisory services were provided on a demand-driven basis in technical, promotion, marketing, poverty linkage, gender and social inclusion, capacity strengthening aspects.
- The SNV/N was responsible for overall monitoring and evaluation together with the AEPC and other development partners).

BSP-Nepal

- The AEPC from the support of BSP-NEPAL as an implementing agency supported in facilitation, backstopping, promotion as well as regulating to develop the sector.
- The BSP-NEPAL was responsible for quality control and regular monitoring of the subsidised biogas plants, including qualification of companies, performance evaluation, grading, penalty, bonus, disqualification as well as for provision of after-sales services and warrantee.

Biogas Companies (BCs)

- BCs were responsible to disseminate information on the programme, its benefits, the subsidy, credit, etc. from BSP-NEPAL and other partners.
- BCs were responsible to promote market and construct quality biogas plants.
- BCs were responsible to handover the Users' Manual and other information materials from BSP-NEPAL and train the users on operation and maintenance of the plants.
- BCs were responsible for training users on proper use of slurry, composting and use of it.
- BCs were responsible to complete documentation required for processing of subsidy, and for release of the after-sales service guarantee money and submit them to BSP-NEPAL in a timely manner.
- BCs were responsible to cooperate and accompany BSP-NEPAL personnel in the field for quality control and other verification purposes.
- BCs are responsible to facilitate AEPC, its staffs and any other entity entrusted by AEPC to monitor and verify project activity.

BCs regularly visit households and deliver the promised after-sales service and other services fully respecting the promised guarantee. They continue providing these services perpetually even after expiry of the guarantee period but on demand basis charging the households for the cost incurred.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

Data/Parameter	f_{NRBy}
Unit	%
Description	Fraction of woody biomass saved by the project activity during year y that can be established as non-renewable biomass
Source of data	Calculated as per "TOOL30: Calculation of the fraction of non-renewable biomass"
Value(s) applied	86.1 %
Choice of data or measurement methods and procedures	The value is calculated as 86.1% using the national statistics and also validated by the Ministry of Forest and Environment, Government of Nepal.
Purpose of data/parameter	Calculation of baseline emission
Additional comments	This parameter is fixed for the crediting period.

Data/Parameter	$EF_{\text{projected fossil fuel}}$
Unit	tCO ₂ /TJ
Description	Emission factor for the projected fossil fuel consumption in the baseline.
Source of data	IPCC
Value(s) applied	63.7

Choice of data or measurement methods and procedures	Default value (AMS-I.E. Version 09 requires using this value).
Purpose of data/parameter	Calculation of emission reduction
Additional comments	The value is fixed for the crediting period

Data/Parameter	N_{HH}
Unit	Number
Description	Number of households in the project activity in year y
Source of data	BSP database.
Value(s) applied	20,318
Choice of data or measurement methods and procedures	The registration procedure of the BSP database avoids double counting of digesters and the registration of digesters that have not been commissioned. The BSP database is the basis for subsidy disbursement.
Purpose of data/parameter	Calculation of baseline emission
Additional comments	During calculation of Emission Reduction, the actual number of households having the biogas operational are considered.

Data/Parameter	BC_{BLHH,y}
Unit	tonne/household/year
Description	Average annual consumption of woody biomass per household before the start of the project activity
Source of data	Based on survey (Biogas User Survey (BUS)) for the project activity.
Value(s) applied	5.09
Choice of data or measurement methods and procedures	Calculated using option (b) Historical data or a sample survey conducted as per the latest version of the "Standard: Sampling and surveys for CDM project activities and programme of activities;" Biogas User Survey follows the standard sampling and surveys indicated in the PDD registered for second crediting period.
Purpose of data/parameter	Calculation of baseline emission
Additional comments	This value is used in the calculations and is fixed for the crediting period.

D.2. Data and parameters monitored

Data/Parameter	Date of commissioning of project device of type i
Unit	Date
Description	Actual date of commissioning of the project device.
Measured/calculated/default	Default
Source of data	Internal database/records
Value(s) of monitored parameter	Constructed between May 9, 2006 to June 21, 2007
Monitoring equipment	Data base
Measuring/reading/recording frequency	Fixed and recorded at the time of commissioning
Calculation method (if applicable)	The registration procedure of the BSP database avoids double counting of digesters and the registration of digesters that have not been commissioned. The commissioning date is the basis for subsidy disbursement
QA/QC procedures	This can be checked from the commissioning report and subsidy application form.
Purpose of data/parameter	Calculation of baseline emission

Additional comments	N/A
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Data/Parameter	NCV_{biomass}
Unit	TJ/tonne
Description	Net calorific value of the non-renewable woody biomass, briquettes or charcoal used in project devices
Measured/calculated/default	Default
Source of data	Methodology AMS I.E. Version 09
Value(s) of monitored parameter	0.0156
Monitoring equipment	N/A
Measuring/reading/recording frequency	Yearly
Calculation method (if applicable)	De-fault value will be applied from the methodology AMS I.E version 09
QA/QC procedures	N/A
Purpose of data/parameter	Calculation of baseline emission
Additional comments	N/A

Data/Parameter	BC_{PJ,HH,y}
Unit	tonnes/household/year
Description	Average annual consumption of woody biomass per household in the pre-project devices during the project activity, if it is found that pre-project devices were not completely displaced but continue to be used to some extent.
Measured/calculated/default	Calculated
Source of data	Biogas User Survey
Value(s) of monitored parameter	0.50
Monitoring equipment	Survey
Measuring/reading/recording frequency	At least once every two years (biennial)
Calculation method (if applicable)	Biogas User Survey is conducted on a sample of households. The sample size is determined to achieve 90% confidence interval and a 10% margin of error. During the survey, the estimates of the biogas users on the average annual consumption of woody biomass during the monitoring period is captured.
QA/QC procedures	Though the methodology requires sample survey biannually, PP conducts the user survey annually to ensure the number of biogas digesters operational for that particular year.
Purpose of data/parameter	Calculation of baseline emission
Additional comments	ERs will be accounted only for functional biogas in the particular monitoring period

Data/Parameter	B_y
Unit	tonnes/household/year
Description	Quantity of woody biomass that is substituted or displaced
Measured/calculated/default	Calculated
Source of data	Biogas User Survey

Value(s) of monitored parameter	5.09 – 0.5 = 4.59
Monitoring equipment	Survey
Measuring/reading/recording frequency	Once in a year
Calculation method (if applicable)	<p>The calculation of the By depends on the operational status of the biogas units for the particular monitoring period and the operational status will be checked annually during the Biogas User Survey. From the total population of biogas units included in the project activity, statistically representative samples will be drawn for the purpose of carrying out the survey. The sample size is determined to achieve 90% confidence interval and a 10% margin of error. The percentage of biogas units found to be operational during the sample survey shall be used to calculate the weighted average operational status of the biogas which then will be used to calculate By as follows:</p> <p>$By = N_{HH} * (BC_{BL,HH,y} - BC_{PJ,HH,y})$ or By per household will be $(BC_{BL,HH,y} - BC_{PJ,HH,y})$</p>
QA/QC procedures	Every year, the Internal Quality Control System samples 5% of the digesters that are newly implemented in that year, 2.5% of the digesters that implemented a year before and another 2.5% of the digesters implemented two years before that particular year. However, since the digesters included in this project activity were implemented in 2006/2007 and the second crediting period is started only in 2018, results from the internal quality system will not apply to the project activity for future monitoring. This parameter will therefore be monitored as part of the annual biogas users' survey.
Purpose of data/parameter	Calculation of baseline emission
Additional comments	Once the biogas included in the project activity completes its operational lifetime of 20 years, those biogas will not be considered for the next consecutive monitoring.

Data/Parameter	Trends in distance travelled for firewood gathering or trends in time needed for firewood gathering indicating depletion of resources available
Unit	-
Description	This parameter was used to confirm the displacement or substitution of the non-renewable woody biomass at each location.
Measured/calculated/default	Calculated.
Source of data	Biogas User Survey 2019/20.
Value(s) of monitored parameter	Majority of users (60.20%) said increased or during the survey period.
Monitoring equipment	Survey.
Measuring/reading/recording frequency	Annually
Calculation method (if applicable)	Annual Biogas User Survey was conducted on sample households. The sample size was determined to achieve 90% confidence interval and 10% margin of error. During the survey, the perceptions of the biogas users on the distance travelled and the time spent for firewood harnessing was captured and analyzed to show the depletion of resources.
QA/QC procedures	The registered PDD required the survey to be carried out on 75 households in anticipation of non-responses. A sample size of 115 households was considered for the 2019/20 survey, which is more than the sample size specified in the monitoring plan of the registered PDD. The number of households in the sample was increased to remedy the possibility of incomplete questionnaires. The surveyors were trained and supervised to minimize any bias.

Purpose of data/parameter	To confirm the displacement and substitution of the non-renewable woody biomass
Additional comments	NA

Data/Parameter	Trends in price of firewood indicating demand and scarcity
Unit	-
Description	This parameter was used to confirm the displacement or substitution of the non-renewable woody biomass at each location.
Measured/calculated/default	Calculated.
Source of data	Biogas User Survey 2019/20.
Value(s) of monitored parameter	The cost of fuel-wood per kg was NRs. 1.4 in 1989 which is increased to NRs. 19.2 per kg during the survey period. The increasing trend in fuel wood price reflects the fuel-wood scarcity.
Monitoring equipment	Survey.
Measuring/reading/recording frequency	Annually.
Calculation method (if applicable)	Annual Biogas User Survey was conducted on sample households. The sample size was determined to achieve 90% confidence interval and 10% margin of error. During the survey, the perceptions of the biogas users on the price of firewood was captured and analyzed to show the increase demand and scarcity of firewood.
QA/QC procedures	The registered PDD required the survey to be carried out on 75 households in anticipation of non-responses. A sample size of 115 households was considered for the 2019/20 survey, which is more than the sample size specified in the monitoring plan of the registered PDD. The number of households in the sample was increased to remedy the possibility of incomplete questionnaires. The surveyors were trained and supervised to minimize any bias.
Purpose of data/parameter	To confirm the displacement and substitution of the non-renewable woody biomass
Additional comments	NA

Data/Parameter	Trends in type of cooking fuel collected that would indicate a scarcity of firewood.
Unit	-
Description	This parameter was use to confirm the displacement or substitution of non-renewable woody biomass at each location.
Measured/calculated/default	Calculated.
Source of data	Biogas User Survey 2019/20.
Value(s) of monitored parameter	Majority (69.40%) of respondents in all ecological regions responded that they replaced woody biomass with lower quality fuels such as twigs, branches and agricultural residues. This change in trends in the quality of biomass fuel suggest the scarcity of woody biomass for cooking
Monitoring equipment	Survey.
Measuring/reading/recording frequency	Annually.
Calculation method (if applicable)	Annual Biogas User Survey was conducted on sample households. The sample size was determined to achieve 90% confidence interval and 10% margin of error. During the survey, the type of cooking fuel used by households was assessed to demonstrate the scarcity of firewood.

QA/QC procedures	The registered PDD required the survey to be carried out on 75 households in anticipation of non-responses. A sample size of 115 households was considered for the 2019/20 survey, which is more than the sample size specified in the monitoring plan of the registered PDD. The number of households in the sample was increased to remedy the possibility of incomplete questionnaires. The surveyors were trained and supervised to minimize any bias.
Purpose of data/parameter	To confirm the displacement and substitution of the non-renewable woody biomass
Additional comments	NA

D.3. Implementation of sampling plan

Parameters monitored

The project monitoring system implemented in the project includes assessment of the performance of biogas units and collection of data to confirm the displacement of NRB. Following parameters are monitored:

1. Average annual consumption of woody biomass per household in the pre-project devices during the project activity, if it is found that pre-project devices were not completely displaced but continue to be used to some extent.
2. Digester performance (Operational %) of the biogas digester in particular monitoring period to calculate the Quantity of woody biomass that is substituted or displaced.
3. Monitoring should confirm the displacement or substitution of the non-renewable biomass at each location (using the indicators on the use of NRB as detailed earlier).

As stipulated in annex 5 of the PDD, sampling design considered 90% confidence interval with 10% margin of error for the biogas users' survey.

Target Population

The target population for the survey was the 20,318 households using biogas digesters for cooking purpose in remote hill, hill and terai ecological zones and spread across Nepal.

Sampling Method and Sample Size Determination

Sample size was determined using stratified random sampling taking into account different ecological zones (Terai, Hills and Remote Hills) as strata. The sampling was performed within the level of precision of 10% and a confidence level of 90%.

The sample size was calculated based on two parameters of interests (mean value parameters and proportion parameters):

(1) Proportion parameters (Biogas Performance)

The sample size was determined using following formula

$$n \geq \frac{1.645^2 NV}{(N-1) \times 0.1^2 + 1.645^2 V}$$

$$\text{Where: } V = \frac{SD^2}{\bar{p}^2} = \frac{\text{overall variance}}{\bar{p}^2} \text{ and } \bar{p} \text{ is the overall proportion.}$$

n= sample size

N=Total number of households using biogas digesters in all ecological zones

$$SD^2 = \frac{(g_a \times p_a(1 - p_a)) + p_b(g_b \times (1 - p_b)) + (g_c \times p_c(1 - p_c)) + \dots + (g_k \times p_k(1 - p_k))}{N}$$

$$\bar{p} = \frac{(g_a \times p_a) + (g_b \times p_b) + (g_c \times p_c) + \dots + (g_k \times p_k)}{N}$$

Where,

g_i is the size of the i_{th} group and p_i is the expected proportion of i_{th} group

The samples were calculated with following assumption:

Particulars	Symbol	Value	Remarks
Total Number of Population	N	20,318	Database
Number of Biogas in Terai	g_t	11624	Database
Expected operational Proportion of Biogas in Terai	p_t	0.96	As per Biogas User Survey 2018/19 for the project activity
Number of Biogas in Hill	g_h	8557	Database
Expected operational Proportion of Biogas in Hill	p_h	0.0.97	As per Biogas User Survey 2018/19 for the project activity
Number of Biogas in Remote Hill	g_{rh}	137	Database
Expected operational Proportion of Biogas in Remote Hill	p_{rh}	0.33	As per Biogas User Survey 2018/19 for the project activity

From the above formula, the sample size is calculated as 11. So, the sample in Terai, Hill and Remote Hill are calculated as 7, 5 and 1 proportionately with total of 13 samples.

(2) Mean Value Parameter (Average annual consumption of woody biomass)

The sample size was determined using following formula

$$n \geq \frac{1.645^2 NV}{(N-1) \times 0.1^2 + 1.645^2 V}$$

Where,

$V = (SD/Mean)^2$

n = Sample Size

N = Total number of Population

SD = Overall standard deviation

Mean = Overall mean for the average annual woody biomass consumption by pre-project device during project activity

1.645 = Represent 90% confidence required

0.1 = Represent the 10% relative precision

The samples were calculated with following assumption:

Particulars	Symbol	Values	Remarks
Total Number of Population	N	20318	Database
Number of Biogas in Remote Hill	g_{rh}	137	Database
Actual mean for Remote Hill	m_{rh}	0.4	As per Biogas User Survey 2018/19 for the project activity
Actual Standard Deviation for Remote Hill	SD_{rh}	0	As per Biogas User Survey 2018/19 for the project activity
Number of Biogas in Hill	g_{hi}	8557	Database
Actual Mean for Hill	m_{hi}	0.76	As per Biogas User Survey 2018/19 for the project activity
Actual standard deviation for Hill	SD_{hi}	0.4	As per Biogas User Survey 2018/19 for the project activity
Number of Biogas in Terai	g_{te}	11624	Database
Actual Mean for Terai	m_{te}	0.78	As per Biogas User Survey 2018/19 for the project activity
Actual standard deviation for Terai	SD_{te}	0.41	As per Biogas User Survey 2018/19 for the project activity

Particulars	Symbol	Values	Remarks
			activity
Overall variance	SD ²	0.16	
Overall mean	Mean	0.77	
V- Value	SD ² /P ²	0.28	

The sample size calculated for mean value is 75. Proportionately, the sample can be distributed in Remote Hill, Hill and Terai with 1, 32 and 43 respectively with total of 76 samples.

So, sample size is conservatively taken as 76. To make sure the minimum samples size as mentioned in the PDD and anticipating non-response, total of 115 samples were drawn.

Sampling Frame

The 20,318 biogas plants spread over the three ecological zones of Nepal comprised the sampling frame for PA-4. Out of total biogas digesters included in PA-4, the sample was drawn as per the PDD from the different strata for the survey

Allocation of samples

The total biogas installed in ecological belts was identified and the installed proportion was calculated. In the next step, a random number was generated in MS Excel by using the “randbetween” function; the sample were selected randomly. The sample allocation and selection are given in table 3 and table 4 below:

Table 3: Number of biogas plants installed and sample selected by ecological belts

Strata	Installed Biogas Plants		Sample Biogas Plants	
	Number	Proportion	Sample required	Sample taken
Remote Hill	137	0.67	1	4
Hill	8557	42.12	32	47
Terai	11624	57.21	43	64
Total	20318	100	76	115

Table 4: Sample districts and Primary Sampling Units

Cluster	District	Number of Samples
Eastern Remote Hill	Sankhuwasabha	2
Eastern Hill	Ilam	3
Eastern Terai	Morang	25
Central Hill	Makwanpur	18
Central Terai	Chitwan	14
Western Hill	Tanahun	24
Western Terai	Nawalparasi	10
Mid-Western Hill	Surkhet	2
Mid-Western Terai	Bardiya	9
Far-Western Remote Hill	Darchula	2
Far-Western Terai	Kailali	8

Quality Assurance/Quality Control

Efforts were made to ensure the quality of the data collected from the field. QA/QC measures were implemented to attain the desired 90/10 confidence/precision for the parameters under consideration. In order to assure the quality of data collected, the questionnaires were pre-tested prior to their introduction in the field.

SECTION E. Calculation of emission reductions or net anthropogenic removals

E.1. Calculation of baseline emissions or baseline net removals

As per the approved PDD, the formula for calculations of emission reduction is:

$$BE_y = B_y \times f_{NRB,y} \times NCV_{biomass} \times EF_{projected_fossilfuel} \quad (1)$$

Where:

BE_y Baseline Emissions during the year y (tCO₂e)
 B_y Quantity of woody biomass that is substituted or displaced in tonnes (tonnes/year)
 $f_{NRB,y}$ Fraction of woody biomass used in the absence of the project activity in year y that can be established as non renewable biomass using survey methods (Fixed Ex-ante = 86.1%)
 $NCV_{biomass}$ Net calorific value of the non-renewable woody biomass that is substituted (IPCC default for wood fuel: 0.0156 TJ/tonne)
 $EF_{projected_fossilfuel}$ Emission factor for substitution of non renewable woody biomass by similar consumers. Use a value of 63.7 tCO₂/TJ

Calculation of Quantity of woody biomass that is substituted or displaced

The quantity of woody biomass that is substituted or displaced (B_y) is determined using:

$$B_y = N_{HH} \times P_y \times (BC_{BL,HH,y} - BC_{PJ,HH,y}) \quad (2)$$

where,

N_{HH} : Number of digesters installed in the Project = **20,318**

P_y : Percentage of digesters implemented that is operational in year y = **84.79 % (Calculated from the user survey report)**

$BC_{BL,HH,y}$: Average annual consumption of woody biomass per household before the start of the project activity, **5.09 tonne/household/year (fixed ex-ante)**

$BC_{PJ,HH,y}$: Average annual consumption of woody biomass per household in the pre-project devices during the project activity, **0.50 tonne/household/year (Monitored)**

$$B_y = 20,318 \times 0.8479 \times (5.09 - 0.50) \times 519/365 = 112,437.91 \text{ tonnes (Considering 519 days monitoring period)}$$

Calculation of Baseline Emission

Considering the other parameters as given above, the baseline emission is calculated as below:

$$BE_y = 112,437.91 \times 0.861 \times 0.0156 \times 63.7 = 96,201 \text{ tCO}_2\text{eq}$$

E.2. Calculation of project emissions or actual net removals

Project emission (PE_y) is considered as zero as this is not applicable for this project activity.

E.3. Calculation of leakage emissions

Considering the leakage of 5% (as per the methodology AMS I.E. version 9), leakage emission is calculated as:

$$LE_y = 0.05 \times BE_y = 0.05 \times 96,201 = 4,810 \text{ tCO}_2\text{eq}$$

E.4. Calculation of emission reductions or net anthropogenic removals

	Baseline GHG emissions or baseline net GHG removals (t CO ₂ e)	Project GHG emissions or actual net GHG removals (t CO ₂ e)	Leakage GHG emissions (t CO ₂ e)	GHG emission reductions or net anthropogenic GHG removals (t CO ₂ e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	96,201	0	4,810	0	91,391	91,391

E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PDD

Amount achieved during this monitoring period (t CO ₂ e)	Amount estimated ex ante for this monitoring period in the PDD (t CO ₂ e)
91,391	107,080

E.5.1. Explanation of calculation of “amount estimated ex ante for this monitoring period in the PDD”

For the ex-ante calculation in PDD, the equations given in section E.1 above were used where following assumption were made:

$$BE_y = B_y \times f_{NRB,y} \times NCV_{biomass} \times EF_{projected_fossilfuel} \quad (1)$$

Where:

Where:

BE_y Baseline Emissions during the year y (tCO₂e)

B_y Quantity of woody biomass that is substituted or displaced in tonnes
(tonnes/year)

$f_{NRB,y}$ Fraction of woody biomass used in the absence of the project activity in year y that can be established as non renewable biomass using survey methods
(Fixed Ex-ante = 86.1%)

$NCV_{biomass}$ Net calorific value of the non-renewable woody biomass that is substituted
(IPCC default for wood fuel: 0.0156 TJ/tonne)

$EF_{projected_fossilfuel}$ Emission factor for substitution of non renewable woody biomass by similar consumers. Use a value of 63.7 tCO₂/TJ

The quantity of woody biomass that is substituted or displaced (B_y) is determined using:

$$B_y = N_{HH} \times P_y \times (BC_{BL,HH,y} - BC_{PJ,HH,y}) \quad (2)$$

where,

N_{HH} : Number of digesters installed in the Project = **20,318**

P_y : Percentage of digesters implemented that is operational in year y = **100 %**

$BC_{BL,HH,y}$: Average annual consumption of woody biomass per household before the start of the project activity, **5.09 tonne/household/year (fixed ex-ante)**

$BC_{PJ,HH,y}$: Average annual consumption of woody biomass per household in the pre-project devices during the project activity, **0.53 tonne/household/year**

$$B_y = 20,318 \times 100\% \times (5.09 - 0.53) = 92,650.08 \text{ tonne}$$

$$\text{So, } BE_y = 79,270 \text{ tCO}_2\text{eq}$$

Considering the leakage of 5%, leakage emission is calculated as:

$$LE_y = 0.05 \times BE_y = 3,963 \text{ tCO}_2\text{eq.}$$

Project Emission is considered as zero as this is not applicable. So, ex-ante emission reduction for this monitoring period is calculated as:

$$ER_y = BE_y - PE_y - LE_y = 79,270 - 0 - 3,963 = 75,307 \text{ tCO}_2\text{eq}$$

Monitoring period (Days): 519

Annual estimated ER: 75,307 tCO_{2eq}/Year

$$\text{So, total ex-ante emission reduction for this monitoring period} = 75,307 \times 519 / 365 = 107,080 \text{ tCO}_2\text{eq}$$

E.6. Remarks on increase in achieved emission reductions

N/A

E.7. Remarks on scale of small-scale project activity

The small scale project activity is not a de-bundled component of a large CDM project. Each of the independent subsystems (bio digesters) included in the project activity is not greater than 1% of the threshold defined for a small scale project.¹ 1% of the 15 MWel (45MWth) threshold for type I projects is 150 kWel (450kWth). The capacity of a digester is 1.86 kWth and hence remains well below the 1% of 15 MW thresholds.

¹ Guidelines on Assessment of Debundling for SSC Project Activities – Version 03, (EB 54, Annex 13)

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Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
07.0	31 May 2019	Revision to: <ul style="list-style-type: none"> • Ensure consistency with version 02.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Add a section on remarks on the observance of the scale limit of small-scale project activity during the crediting period; • Add "changes specific to afforestation or reforestation project activity" as a possible post-registration changes; • Clarify the reporting of net anthropogenic GHG removals for A/R project activities between two commitment periods; • Make editorial improvements.
06.0	7 June 2017	Revision to: <ul style="list-style-type: none"> • Ensure consistency with version 01.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Make editorial improvements.
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: <ul style="list-style-type: none"> • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.
04.0	25 June 2014	Revisions to: <ul style="list-style-type: none"> • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from <i>F-CDM-MR</i> to <i>CDM-MR-FORM</i>; • Editorial improvement.
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB 70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).

<i>Version</i>	<i>Date</i>	<i>Description</i>
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.
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