



Monitoring report form for CDM programme of activities
(Version 04.0)

Complete this form in accordance with the instructions attached at the end of this form.

MONITORING REPORT

Title of the PoA	Nepal Biogas Support Program-PoA		
UNFCCC reference number of the PoA	9572		
Version numbers of the PoA-DD applicable to this monitoring report	17.0		
Version number of this monitoring report	02		
Completion date of this monitoring report	01/06/2021		
Monitoring period number	First monitoring period under renewed PoA period 31 Jan 2020 – 30 Jan 2027		
Duration of this monitoring period	31/01/2020 to 31/12/2020		
Monitoring report number for this monitoring period	02 of 02		
Coordinating/managing entity	Alternative Energy Promotion Centre (AEPC)		
Host Parties	Host Party of the PoA	Is this the host Party of a CPA covered in this monitoring report? (yes/no)	
	Nepal	Yes	
Applied methodologies and standardized baselines	AMS.I.E. Switch from Non-Renewable Biomass for Thermal Applications by the User (version 09)		
Sectoral scopes	Type I: 1 : Energy industries (renewable - / non-renewable sources)		
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by all CPAs covered in this monitoring report in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013 until 31 December 2020	Amount achieved from 1 January 2021
	0	79,769 tCO ₂ e	0
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the CPA-DDs for the CPAs covered in this monitoring report	84,124 tCO ₂ e		

PART I Monitoring of programme of activities (PoA)

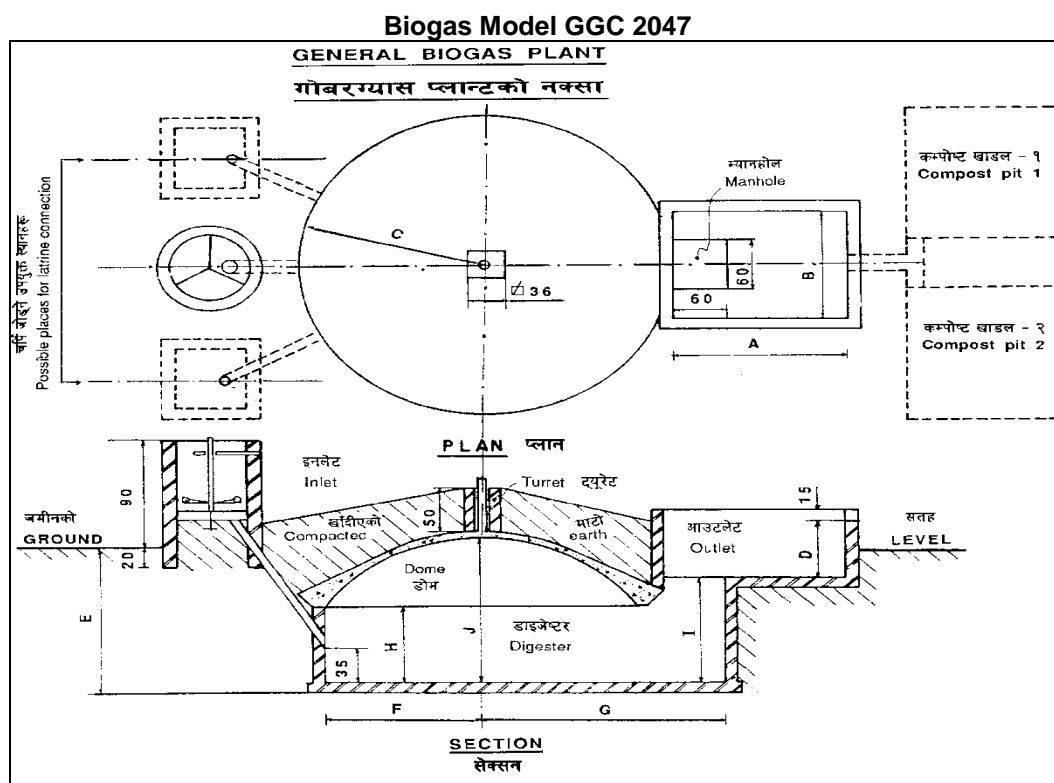
SECTION A. Description of PoA

A.1. General description of PoA

The Biogas Support Program (BSP) aims at implementing household biogas applications. These applications displace firewood and fossil fuels with biogas from animal waste and human excreta. The biogas is used as a fuel for cooking, therefore the displacement of non renewable biomass (NRB) is counted as emission reduction under the Clean Development Mechanism (CDM) and Gold Standard (GS). Target group under the BSP are households with at least one head of cattle (generally cows or buffalos) who currently use non-renewable biomass (firewood) for cooking purpose. The baseline of the PoA considers only non-renewable biomass replaced through household biogas applications. Only households previously using non-renewable biomass are eligible to the PoA.

The technologies used in this CPA are household biogas digesters with a sludge and gas holding capacity range of up to 10 m³. The different sizes of the digesters that would be included in the programme would be of 2, 4, 6, 8 and 10 m³. The programme uses only one design i.e. GGC 2047 model. The biogas digesters are based on a uniform technical design and are manufactured and installed following established technical standards in Nepal. The digester itself is a closed underground container made of concrete or other materials.

Nepal Biogas Support Program-PoA was registered on 31st January 2013. The reference number of the PoA is 9572. The first renewable period of the PoA is 31st January 2013 to 30th January 2020. The duration of PoA is from 22nd June 2007 to 21st June 2035. The PoA is renewed for 2nd renewal period.



Biogas plants constructed under this PoA comprise of three major components; the inlet, the digester and the outlet, aligned in a straight line. All these structures are prepared of masonry walls of bricks or stones, depending upon the material availability. Digester unit is a underground chamber where the mixture of animal dung and water is fed into where the microbial activity takes place. The microbes act upon the dung (the substrate) under anaerobic conditions to release methane and carbon dioxide. The methane released from the digester is collected at the dome which is connected to gas hose pipe fitted at turret at the center of the dome. Biogas collected at the dome dispensed to biogas stove through this gas hose pipe via turret. Once the gas pressure is sufficient in dome, it exerts pressure to the slurry in the digester and slurry is released from the outlet.

A.1.1. Corresponding generic component project activities (CPAs)

Title and reference number of the corresponding generic CPA	Version of the PoA-DD	Sectoral scopes	Applied methodologies and standardized baselines
Nepal Biogas Support Program- CPA XXXX (9572-XXXX)	17.0	Type I: Renewable Energy Projects Category	AMS.I.E. Switch from Non-Renewable Biomass for Thermal Applications by the User (version 09)

A.1.2. CPAs included in the PoA

Title and UNFCCC reference number of the CPA	Version of the PoA-DD	Title and reference number of the corresponding generic CPA	Crediting period type and duration	Covered in this monitoring report? (yes/no)
Nepal Biogas Support Program- CPA 1: 20,000 digesters (9572-P2-0001-CP2)	17.0	Nepal Biogas Support Program- CPA XXXX (9572-XXXX)	31/01/2020 to 30/01/2027 (Renewable)	Yes
Nepal Biogas Support Program - CPA 10: 10,589 digesters (9572-P2-0011-CP1)	17.0	Nepal Biogas Support Program- CPA XXXX (9572-XXXX)	18/05/2020-17/05/2027 (Renewable)	Yes

A.2. Coordinating/managing entity

Alternative Energy Promotion Centre

SECTION B. Implementation of PoA**B.1. Description of implemented PoA**

The PoA has the start date of 22 June 2007 and 10 CPAs implemented under the PoA are proposed for the verification during this monitoring period. However, only 2 CPAs (CPA-1 and CPA-10) are included in this report and the remaining 8 CPAs are covered in another report. The detail of each CPA is given in table 1 below.

Table 1: Detail of CPAs implemented under Nepal Biogas Support Program PoA

Ref	CPA title	Number of Digesters	Construction Start Date	Construction End Date
9572-P2-0001-CP2	Nepal Biogas Support Program- CPA 1: 20,000 digesters ¹	19,999	22/06/2007	18/03/2009
9572-P2-0011-CP1	Nepal Biogas Support Program - CPA 10: 10,589 digesters ²	10,589	13/07/2018	19/10/2019
Total		173,343		

AEPC is the coordinating/managing entity of the Nepal Biogas Support Program - PoA. The PoA is being supported by the GoN and several international Development Partners (DP). The support mainly covers technical assistance and financial inputs to cover subsidy amount. AEPC is responsible for coordinating national level financial institutions and other relevant government agencies promoting the biogas technology. Besides subsidy administration, AEPC had established a biogas credit fund with the objective of providing wholesale lending for biogas installation through micro finance institutions especially for low-income people in the remote areas. More recently, AEPC has established a Central Renewable Energy Fund (CREF) with one handling Bank and few partner banks to channel the subsidy and credit through a revolving fund.

¹ This CPA has been renewed for next crediting period and the applicable methodology is AMS I.E Version 09. So, this CPA is included in 2nd monitoring report for this monitoring period.

² The applicable methodology for this CPA is AMS I.E Version 09. So, this CPA is included in 2nd monitoring report for this monitoring period to make the report consistent.

AEPC is responsible for carrying out performance reports to ensure the monitoring requirements of the CDM PoA are met. On the behalf of AEPC, Biogas Sector Partnership Nepal (BSP-Nepal), a national level non-governmental organization is an implementing agency for the PoA. BSP-Nepal facilitates and provides technical assistance to biogas companies (BCs), processes the subsidy applications and recommend AEPC for subsidy reimbursement to the users through BCs. It also assists in conducting quality control and regular monitoring of the installed biogas digesters and developing skill enhancement among BCs.

Nepal Biogas Promotion Association (NBPA) as an umbrella organization of biogas companies advocates and promotes biogas programme at micro and meso levels; promotes interests of the BCs and selfregulates them through the code of conduct and other appropriate mechanism and arranges for a supply of biogas system materials, especially to BCs that have low business volume and coordinate with BSP-Nepal and BCs to develop partners at micro and meso level.

Biogas Companies are pre-qualified by AEPC and are responsible for demand collection, construction and providing after sales services. Additionally BCs are responsible for training users on operations and maintenance of the digesters; proper composting and use of slurry. BC's compulsorily deliver after sales service and other services during guarantee period, and if needed, after guarantee period as well.

The technologies used in this CPA are household biogas digesters with a sludge and gas holding capacity range of up to 10 m³. The different sizes of the digesters that would be included in the programme would be of 2, 4, 6, 8 and 10 m³. The programme uses only one design i.e. GGC 2047 model. The detail of the technology is described in section A.1 of this MR.

Monitoring of each CPAs under the PoA was done as stipulated in the registered CPA-DDs. User survey was conducted to the sampled biogas user household for each CPAs individually. The detail of the sampling and user survey for each CPAs are described in section E.3 of this MR. The total emissions reductions achieved during this monitoring period from the CPAs included in this monitoring report is 79,769 tCO₂ e.

B.2. Post-registration changes to PoA

B.2.1. Corrections

N/A

B.2.2. Inclusion of monitoring plan

N/A

B.2.3. 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.2.4. Changes to programme design

N/A

B.2.5. Changes specific to afforestation or reforestation activities

N/A

PART II Monitoring of CPAs

Two CPAs for this monitoring period are covered in this monitoring report. CPA wise monitoring was done as per the PoA-DD. Each CPAs are monitored at least bi-ennially following the sampling and surveys provisioned in the registered PoA-DD and corresponding CPA-DDs. As the CPAs are similar in terms of technologies, same approach for all the CPAs has been followed. The percentage of the digester operational is the main monitoring parameter to calculate the emission reduction for this PoA. The detail of the sampling and survey done is presented in section E.3 of this MR. Based on the survey employed, following results on operational status and consumption of woody biomass was found during monitoring period:

Particulars	Symbol	CPA-1	CPA-10
Stratified proportion (%)	Py	86.81	83.53
Average annual consumption of woody biomass per household	BCPJ,HH,y	0.5	0.41

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 (ton/HH/Year)			
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SECTION C. Implementation of CPAs

C.1. Description of implemented CPAs

This monitoring report presents the details of two CPAs (CPA#1 and CPA#10) proposed for verification in this monitoring period. All the digesters included in these two CPAs are the household biogas digesters based on the anaerobic digestion technologies. The CPAs have the digesters installed with capacity ranging from 2 m³ to 10 m³.

AEPC maintains the record of installed biogas digesters. Each biogas installed under different CPAs is identified with its unique dome gas pipe number and hence the uniqueness of the identity is maintained for each digester. Since all the digesters implemented under all CPAs of the PoA are centrally maintained, possibility of the double counting of the digesters between and within CPAs is avoided.

CPA-1:

This CDM Program Activity (CPA) is part of the Nepal Biogas Support Program-Programme of Activity (PoA). This CPA includes 19,999 digesters which were implemented between 22/06/2007 and 18/03/2009. The table below provides the overview of digesters implemented under CPA-1.

Size \ Region	Terai	Hill	Mountain Remote Hill or	Total
4 m3	416	2,690	5	3,111
6 m3	9,393	6,128	96	15,617
8 m3	1,141	118	4	1,263
10 m3	5	3	0	8
Total	10,955	8,939	105	19,999

CPA-10:

This CDM Program Activity (CPA) is part of the Nepal Biogas Support Program-Programme of Activity (PoA). This CPA includes 10,589 digesters which were implemented between 13/07/2018 and 19/10/2019. The table below provides the overview of digesters implemented under CPA-10.

Size \ Region	Terai	Hill	Mountain or Remote Hill	Total
2 m3	2	4	0	6
4 m3	2215	1956	107	4278
6 m3	2111	4081	37	6229
8 m3	50	19	0	69
10 m3	2	5	0	7
Total	4380	6065	144	10589

C.2. Location of CPAs

All the specific case CPAs are implemented across Nepal in different districts. The geographical coordinates of Nepal are:

Latitude – North 26.20 degree to North 30.45 degree

Longitude – East 80.07 degree to East 88.20 degree

The table below provides the overview of the biogas digesters implemented under different CPAs incorporated in this monitoring report in different districts of Nepal.

SN	Districts	CPA-1	CPA-10
1	Achham	2	15
2	Arghakhanchi	78	4
3	Baglung	38	52
4	Baitadi	8	0
5	Bajhang	12	22
6	Bajura	2	26
7	Banke	374	269
8	Bara	416	244
9	Bardiya	498	379
10	Bhaktapur	64	9
11	Bhojpur	0	0
12	Chitwan	1114	184
13	Dadeldhura	18	9
14	Dailekh	15	102
15	Dang	345	272
16	Darchula	45	33
17	Dhading	581	487
18	Dhankuta	7	25
19	Dhanusa	51	77
20	Dolakha	126	52
21	Dolpa	0	0
22	Doti	0	0
23	Gorkha	451	670
24	Gulmi	55	13
25	Humla	0	0
26	Ilam	460	215
27	Jajarkot	1	46
28	Jhapa	2770	582
29	Jumla	2	0
30	Kailali	730	507
31	Kalikot	24	19
32	Kanchanpur	757	323
33	Kapilbastu	333	47
34	Kaski	1051	221
35	Kathmandu	87	24
36	Kavre	506	334
37	Khotang	5	0
38	Lalitpur	192	21
39	Lamjung	673	366
40	Mahottari	82	79
41	Makwanpur	788	690
42	Morang	1078	384
43	Mugu	0	0
44	Mustang	7	0
45	Myagdi	41	0
46	Nawalparasi	746	224
47	Nuwakot	188	254
48	Okhaldhunga	8	132
49	Palpa	457	135
50	Panchthar	108	3
51	Parbat	24	27
52	Parsa	106	92
53	Pyuthan	47	58
54	Ramechhap	116	313
55	Rasuwa	0	0
56	Rautahat	169	164
57	Rolpa	0	12
58	Rukum	0	78
59	Rupandehi	587	72

SN	Districts	CPA-1	CPA-10
60	Salyan	15	21
61	Sankhuwasabha	4	1
62	Saptari	9	91
63	Sarlahi	295	191
64	Sindhuli	581	624
65	Sindhupalchowk	100	135
66	Siraha	37	115
67	Solukhumbu	3	0
68	Sunsari	458	84
69	Surkhet	139	213
70	Syangja	580	244
71	Tanahu	1125	387
72	Taplejung	4	14
73	Terhathum	15	1
74	Udayapur	191	105
Total		19999	10,589

C.3. Post-registration changes to CPAs

C.3.1. Temporary deviations from the monitoring plans in the included CPA-DDs, applied methodologies, standardized baselines or other methodological regulatory documents

N/A

C.3.2. Corrections

N/A

C.3.3. Changes to the start date of the crediting period

N/A

C.3.4. Inclusion of monitoring plan

N/A

C.3.5. Permanent changes to the included monitoring plans, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other methodological regulatory documents

N/A

C.3.6. Changes to project design

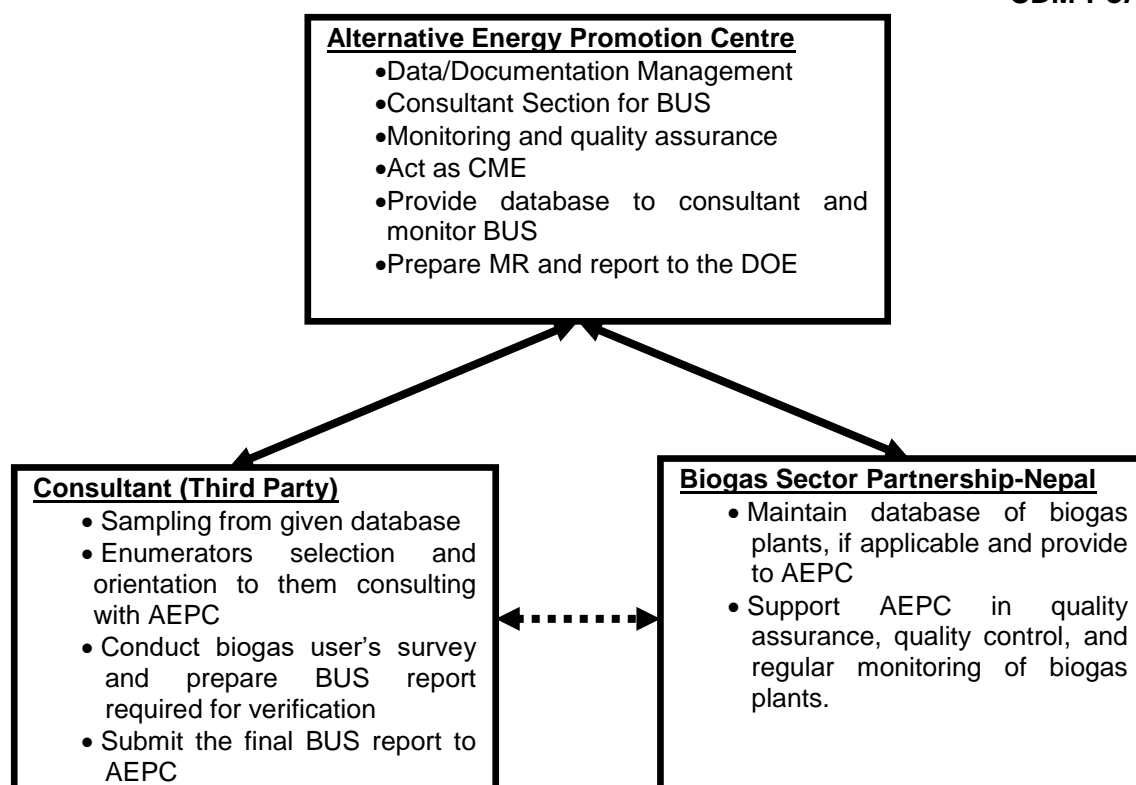
N/A

C.3.7. Changes specific to afforestation or reforestation CPA

N/A

SECTION D. Description of monitoring system of CPAs

As a CME as well as CPA implementer, AEPC maintains the database of the biogas plants installed by the pre-qualified companies. On the behalf of AEPC, Biogas Sector Partnership Nepal (BSP-Nepal), a national level non-governmental organization keeps the database for the PoA. BSP-Nepal facilitates and provides technical assistance to biogas companies, processes the subsidy applications and recommend AEPC for subsidy reimbursement to the users through BCs. It also assists in conducting quality control and regular monitoring of the installed biogas digesters and developing skill enhancement among BCs. The Biogas User's Survey is conducted every year as a basis for emission reduction calculation. The third party (consultant) conducts the Biogas User Survey. Based on the survey, AEPC prepares monitoring report and maintain all required documents for verification. The roles and responsibilities of each entity for GHG monitoring are shown below:



SECTION E. Data and parameters

E.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	CPA-1: 19,999 CPA-10: 10,589
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.
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 similar project activities. The woody biomass substituted or displaced is conservatively taken as 4.5 tons/HH/years for ex-ante calculation of emission reduction for which the annual average consumption of woody biomass before the start of the project activities is 5.04 tons/HH/year and the average annual woody biomass consumption by pre-project device during the project activities is 0.54 tons/HH/Year.
Value(s) applied	5.04 tonne/household/year
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.

E.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	CPA-1: Constructed between June 22, 2007 to March 18, 2009 CPA-10: Constructed between July 13, 2018 to October 19, 2019
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

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	N/A
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	CPA-1: 0.50 CPA-10: 0.41
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	CPA-1: 72,557.16 tonnes CPA-10: 25,581.17 tonnes

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> $By = N_{HH} * (BC_{BL,HH,y} - BC_{PJ,HH,y})$ $N_{HH} = N * P_y$ <p>where N is the number of bio digesters installed in the project and P_y is Proportion of Bio digesters operational estimated based on the sample survey</p>
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 for each CPA
Purpose of data/parameter	Calculation of baseline emission
Additional comments	Once the biogas included in the component project activity completes its operational lifetime, those biogas will not be considered for the next consecutive monitoring.

Confirmation of replacing non-renewable biomass

In addition to the monitoring of the, confirmation of non-renewable biomass was also monitored as per the PoA-DD. Basically this was confirmed by monitoring the following during user survey:

Trend in time to reach the forest

Trends in distance travelled for firewood gathering or trends in time needed for firewood gathering indicating depletion of resources available was monitored through perception survey and found following results:

Type	% response	
	CPA-1	CPA-10
Increased	91.86	93.06
Same as Previous	4.65	4.17
Decreased	3.49	2.78

Source: Biogas User Survey, 2020 (for all CPAs)

Trends in price of firewood

The households were interviewed on the perceived price of firewood in 1989, 2000 and 2020. The results are summarized below:

Year	Average price of fuelwood (NPR)	
	CPA-1	CPA-10
1989	52	45
2000	123	121
2020	343	306

Source: Biogas User Survey, 2020 (for all CPAs)

Increased use of low grade biomass

The households were asked on changes in trends in the quality of biomass fuel that suggest the scarcity of woody biomass for cooking. the result is presented below:

Response	% of respondent responding to the use of low grade biomass	
	CPA-1	CPA-10
Yes	93.02	95.83
No	6.98	4.17

Source: Biogas User Survey, 2020 (for all CPAs)

From results above, majority of the respondents felt that the time to reach the forest has been increased whereas the cost of firewood is also in increasing trends. The majority of people also perceived that the use of low grade biomass has been increased. The results suggest the scarcity of woody biomass for cooking hence confirming the displacement or substitution of the non-renewable woody biomass by each CPAs.

E.3. Implementation of sampling plan

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 PoA-DD, sampling design considered 90% confidence interval with 10% margin of error for the biogas users' survey.

(a) 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 (i.e. CPA-1: 19999, CPA-2: 10,589)

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

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

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	CPA-1	CPA-10	Remarks
		Value		

Total Number of Population	N	19999	10589	Number of Biogas in CPA
Number of Biogas in Terai	g_t	10955	4380	Database
Expected operational Proportion of Biogas in Terai	p_t	0.79	0.98	Biogas User Survey (2018/19) for CPA-1 and reference for CPA-10 is taken from the Biogas User Survey 2018/19 from CPA-9
Number of Biogas in Hill	g_h	8939	6065	Database
Expected operational Proportion of Biogas in Hill	p_h	0.71	0.93	Biogas User Survey (2018/19) for CPA-1 and reference for CPA-10 is taken from the Biogas User Survey 2018/19 from CPA-9
Number of Biogas in Remote Hill	g_{rh}	105	144	Database
Expected operational Proportion of Biogas in Remote Hill	p_{rh}	1	1	Biogas User Survey (2018/19) for CPA-1 and reference for CPA-10 is taken from the Biogas User Survey 2018/19 from CPA-9
Overall variance	SD^2	0.18	0.05	
Overall Proportion		0.76	0.95	
V- Value	SD^2/P^2	0.32	0.05	
Sample Size	n	85.57	13.62	
Round up	n	86.00	14.00	
Minimum sample for Terai	n_t	48.0	6.0	
Minimum sample for Hill	n_h	39.0	9.0	
Minimum Sample for Remote Hill	n_{rh}	1.0	1.0	
Final Minimum Sample	n	88.0	16.0	

(1)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	CPA-1	CPA-10	Remarks
		Value		
Total Number of Population	N	19999	10589	Number of Biogas in CPA
Number of Biogas in Remote Hill	g_{rh}	105	144	Database

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Actual mean for Remote Hill	m_{rh}	1.4	1.4	As this is the first monitoring for mean value parameter, the reference is taken from PoA-DD
Actual Standard Deviation for Remote Hill	SD_{rh}	0.24	0.24	As this is the first monitoring for mean value parameter, the reference is taken from PoA-DD
Number of Biogas in Hill	g_{hi}	8939	6065	Database
Actual Mean for Hill	m_{hi}	0.51	0.51	As this is the first monitoring for mean value parameter, the reference is taken from PoA-DD
Actual standard deviation for Hill	SD_{hi}	0.25	0.25	As this is the first monitoring for mean value parameter, the reference is taken from PoA-DD
Number of Biogas in Terai	g_{te}	10955	4380	Database
Actual Mean for Terai	m_{te}	0.54	0.54	As this is the first monitoring for mean value parameter, the reference is taken from PoA-DD
Actual standard deviation for Terai	SD_{te}	0.28	0.28	As this is the first monitoring for mean value parameter, the reference is taken from PoA-DD
Overall variance	SD^2	0.07	0.07	
Overall mean	Mean	0.53	0.53	
V- Value	SD^2/P^2	0.25	0.24	
Sample Size	n	68.06	64.97	
Round up	n	69.00	65.00	
Minimum Sample for Remote Hill	n_{rh}	1.0	1.0	
Minimum sample for Hill	n_h	31.0	38.0	
Minimum Sample for Terai	n_{te}	38.0	27.0	
Final Minimum Sample	n	70.0	66.0	

Considering the minimum sample stipulated in PoA-DD and the sample calculated, the sample were chosen conservatively as followed:

Particulars	CPA-1	CPA-10
Sample Calculated (Mean value Parameters)	70	66
Sample Calculated (Proportional Parameters)	88	16
Conservative sample No	88	66
<i>Minimum sample for Terai</i>	48	27
<i>Minimum sample for Hill</i>	39	38
<i>Minimum Sample for Remote Hill</i>	1	1
Minimum sample stipulated in PoA-DD	75	75
Sample Taken for the Survey	99	86
<i>Sample in Terai</i>	54	35
<i>Sample in Hill</i>	44	49
<i>Sample in Remote Hill</i>	1	2

(b) Allocation of samples

As stratified sampling has been used, minimum sample required for the Terai, Hill and Remote hill have been met. The tables below depict the sample allocation against the installed digesters in respective CPAs.

CPA-1

Ecological Belts	Installed Biogas Plants		Sample Required	Sample Biogas Plants
	Number	Proportion		Number
Remote Hill	105	0.52	1	1
Hill	8939	44.70	39	44
Terai	10955	54.78	48	54
Total	19999	100	88	99

CPA-10

Ecological Belts	Installed Biogas Plants		Sample Required	Sample Biogas Plants
	Number	Proportion		Number
Remote Hill	144	1.36	1	2
Hill	6065	57.28	38	49
Terai	4380	41.36	27	35
Total	10589	100	66	86

(c) Survey

Sample households were selected accordingly using “Rand” function in Excel. Survey of those households were conducted in October/November 2020 due to COVID impact. The enumerators were trained on structured questionnaire. Having accumulated the data collected during the survey, the consultant analyzed the data using appropriate tools and prepared the “Biogas User Survey” report for individual CPAs.

The results from the monitoring for the operational status and consumption of woody biomass of the CPAs are given below:

Particulars	Symbol	CPA-1	CPA-10
Stratified proportion (%)	Py	86.81	83.53
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 (ton/HH/Year)	BCPJ,HH,y	0.50	0.41

(d) 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. The data was collected by deploying the enumerators to the field. The enumerators were provided with the printed copy of the questionnaires to fill it on-site. The collected information was recorded in a systematic database format. The data was presented and interpreted by using different statistical tools. The data collected from the field survey was encoded in Excel and analyzed by a qualified statistician. To minimize the risk of data discrepancies and for assurance of the quality of data collected, the enumerators were trained and the questionnaires were pre-tested prior to their introduction in the field under the supervision and guidance of the statistician. While transferring the data from questionnaires into Excel, qualified statistician prepared the encoded database format. The data from questionnaires were transferred to that database format based on the codes provided for each response in questionnaires under the supervision of qualified statistician.

SECTION F. Calculation of emission reductions or net anthropogenic removals**F.1. Calculation of baseline emissions or baseline net removals**

As per the approved PoA-DD and CPA-DD, 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 = **19,999 for CPA-1**
 P_y : Percentage of digesters implemented that is operational in year y = **86.81 %**
 $BC_{BL,HH,y}$: Average annual consumption of woody biomass per household before the start of the project activity, **5.04 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)**

$$B_y = 19,999 \times 0.8681 \times (5.04 - 0.50) \times 336/365 = 72,557.16 \text{ tonne}$$

Considering the corresponding values for CPA-10 with 228 days monitoring period,
 $B_y = 25,581.17 \text{ tonnes}$

Calculation of Baseline Emission

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

For CPA-1:

$$BE_y = 72,557.16 \times 0.861 \times 0.0156 \times 63.7 = 62,079 \text{ tCO}_2\text{eq (Round-down value)}$$

For CPA-10:

$$BE_y = 25,581.17 \times 0.861 \times 0.0156 \times 63.7 = 21,887 \text{ tCO}_2\text{eq (Round-down value)}$$

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

N/A

F.3. Calculation of leakage emissions

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

For CPA-1:

$$LE_y = 0.05 \times BE_y = 0.05 \times 62,079 = 3,103 \text{ tCO}_2\text{eq (round-down value)}$$

For CPA-10:

$$LE_y = 0.05 \times BE_y = 0.05 \times 21,887 = 1,094 \text{ tCO}_2\text{eq (round-down value)}$$

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

CPA UNFCCC reference number	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 until 31/12/2020	From 01/01/2021	Total amount
9572-P2-0001-CP2	62,079.00	0	3,103.00	0	58,976	0	58,976

9572-P2-0011-CP1	21,887.00	0	1,094.00	0	20,793	0	20,793
Total	83,966	0	4,197	0	79,769	0	79,769

F.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the included CPA-DDs

CPA UNFCCC reference number	Amount achieved during this monitoring period (t CO ₂ e)	Amount estimated ex ante for this monitoring period in the CPA-DD (t CO ₂ e)
9572-P2-0001-CP2	58,976	59930
9572-P2-0011-CP1	20,793	24194
Total	79,769	84,124

F.5.1. Explanation of calculation of “amount estimated ex ante for this monitoring period in the CPA-DD”

For the ex-ante calculation in PoA DD, the equations given in section F 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:

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
 P_y : Percentage of digesters implemented that is operational in year y
 $BC_{BL,HH,y}$: Average annual consumption of woody biomass per household before the start of the project activity, **5.04 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,

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

$$LE_y = 0.05 \times BE_y = 1874 \text{ tCO}_2\text{eq.}$$

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

$$ER_y = BE_y - PE_y - LE_y$$

Based on the number of days in the monitoring period, ex-ante emission reduction is proportionately calculated for the monitoring period.

Parameters	CPA-1	CPA-10
N_{HH}	19,999	10589
P_y	89%	89%
$BC_{BL,HH,y}$	5.04	5.04
$BC_{PJ,HH,y}$	0.54	0.54

$f_{NRB,y}$	86.1%	86.1%
$NCV_{biomass}$	0.0156	0.0156
$EF_{projected\ fossilfuel}$	63.7	63.7
Ex-ante emission reduction (tCO₂eq)/Year	65,103	38731
Monitoring period (days)	336	228
Ex-ante emission reduction (tCO₂eq) for the monitoring period	59930	24194

F.6. Remarks on increase in achieved emission reductions

N/A

F.7. Remarks on scale of small-scale CPAs

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

Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
04.0	6 April 2021	Revision to: <ul style="list-style-type: none"> • Reflect the “Clarification: Regulatory requirements under temporary measures for post-2020 cases” (CDM-EB109-A01-CLAR).
03.0	31 May 2019	Revision to: <ul style="list-style-type: none"> • Ensure consistency with version 02.0 of the “CDM project standard for programmes of activities” (CDM-EB93-A07-STAN); • Add a section on remarks on the observance of the scale limit of small-scale CPAs during the crediting periods; • Add "changes specific to afforestation or reforestation activities/CPA" as a possible post-registration changes; • Clarify the reporting of net anthropogenic GHG removals for A/R PoAs between two commitment periods; • Make structural and editorial improvements.
02.0	7 June 2017	Revision to: <ul style="list-style-type: none"> • Ensure consistency with version 01.0 of the “CDM project standard for programmes of activities” (CDM-EB93-A07-STAN); • Make editorial improvements.
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