Monitoring report form for CDM project activity
(Version 07.0)

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

MONITORING REPORT		
Title of the project activity	Micro Scale Biogas CDM Project of CROSS	
UNFCCC reference number of the project activity	8784	
Version number of the PDD applicable to this monitoring report	03 dated 12/07/2017	
Version number of this monitoring report	01	
Completion date of this monitoring report	08/03/2021	
Monitoring period number	03	
Duration of this monitoring period	01/08/2019 to 31/12/2020 (Inclusive of both the days)	
Monitoring report number for this monitoring period	01	
Project participants	M/s Community Reconstruction of Social Service (CROSS)	
Host Party	India	
Applied methodologies and standardized baselines	AMS I.E. Switch from Non-Renewable Biomass for Thermal Applications by the User, Version 04, EB 60.	
Sectoral scopes	1. Sectoral Scope 1; TYPE I - RENEWABLE ENERGY PROJECTS 2. Conditional Sectoral Scope 13; Waste Handling and Disposal	
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 tCO_2	12,461 tCO_2
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	31,140 tCO_2	

SECTION A. Description of project activity

A.1. General description of project activity

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The purpose of the project activity is to set up 5,000 biogas plants (digesters) of $2m^3$ capacity each for single households in Chittoor district where the NGO, CROSS is working, and in this way replace Non-Renewable Biomass with biogas for cooking and heating water. In the baseline, traditional inefficient wood stoves were being used, leading to release of Greenhouse Gas emissions. By replacing the traditional inefficient wood stoves by biogas, there is reduction of GHGs thereby contributing to addressing climate change and sustainable development goals of the country.

A.2. Location of project activity

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Host Party; INDIA
Region/state/province, etc.; Andhra Pradesh
City/town/community, etc.; All Mandals of Chittoor
Physical/geographical location:

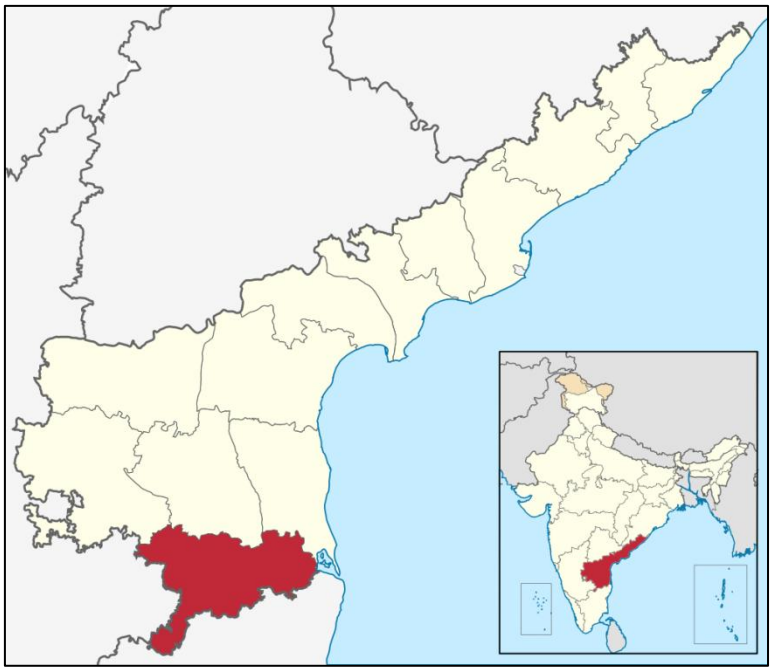

Fig 1: Map of Andhra Pradesh and Chittoor District in which the project is implemented

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
INDIA (host)	Private entity: M/s Community Reconstruction of Social Service (CROSS)	No

A.4. References to applied methodologies and standardized baselines

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Sectoral Scope 01, TYPE I - RENEWABLE ENERGY PROJECTS, I.E. Switch from Non-Renewable Biomass for Thermal Applications by the User, Version 04, EB 60.

A.5. Crediting period type and duration

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Type: Renewable
State date: 01-01-2014
Length of the crediting Period corresponding to this monitoring period: 7 years - 01 Jan 2014 - 31 Dec 20

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

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a) Provide information on the implementation status of the project activity during this monitoring period in accordance with the applicable provision for description of implemented registered CDM project activity in the Project standard.

Community Reconstruction of Social Service (CROSS) is a Non-Governmental Organization (NGO) working in Chittoor district of Andhra Pradesh, India. CROSS works for the betterment of economically backward section of the district. The project activity is construction of 5,000 biogas plants in the project area. Of these, 3059 units were built till the end of this monitoring period. The project involves construction and commissioning of household level biogas units, their maintenance and monitoring the emission reductions generated. The construction of biogas plants was done in a phased manner. The details of the units commissioned are as follows:

Taluk	2013	2014	2015	2016	2017	2018	2019	Total
G.D.Nellore	31	157	329	73	163	52	7	812
Karvetinagaram	30	61	136	11	46	6	2	292
Nagalapuram				118	25	26	8	177
Nagari				38	99	12	5	154
Narayanavanam				29	127	12		168
Nindra				27	181	29	2	239
Pichatur				96	78	24	6	204
Puttur				62	98	32		192
Ramachandrapuram				22	49	7		78
S.R.Puram	1	48	141	59	95	33	1	378
Vadamalapeta				6	41	3	9	59
Vedurukuppam		29	171	40	78	16	8	342
Grand Total	**62**	**295**	**777**	**581**	**1080**	**252**	**48**	**3095**

The list of beneficiaries, their unique user ID, village, and other details are provided in the ER calculations excel file. The dates of commission of all the biogas plants is listed in the excel sheet. The project activity of 3095 biogas units was implemented in 264 villages of 12 Mandals, Chittoor district, the details of which are as follows.

Mandal	Number of Villages	Number of Households
G.D.Nellore	78	812
Karvetinagaram	26	292
Nagalapuram	10	177
Nagari	12	154
Narayanavanam	12	168
Nindra	12	239
Pichatur	14	204

Puttur	10	192
Ramachandrapuram	16	78
S.R.Puram	27	378
Vadamalapeta	10	59
Vedurukuppam	37	342
Total	264	3095

Alongside, construction of biogas units, repair and maintenance of constructed units were also done during this monitoring period. Of the constructed units, 85.30% (2640) units were operational at the end of this monitoring period. The remaining 14.70% units became non-operational at various times of the monitoring period.

The operational domestic biogas units are in continuous use after installation. In between, due to repair and maintenance, some of the biogas units were not be in operation for different durations of time. For each of the unit, the days not operational, is recorded. This information is included in the excel ER calculations sheet. The date on which the problem occurred and the problem was fixed is recorded in the village level monitoring sheets and then entered into the online monitoring solution, which is the basis for emission reduction calculations for only the operational units and operational days of installed units. The various reasons and days lost due to repairs and maintenance are as follows:

Problems	Number of biogas units with issues	Non-operational biogas days1 for the monitoring period (1st August 2019 – 31st Dec 2020)
Biogas Dried	380	175,922
Empty and Re-plaster Dome	223	107,408
Not Feeding the Biogas	203	99,041
Unit Demolished	164	84,038
Cattle Sold	88	34,687
Kitchen not Used	72	32,990
Repair Outlet Tank	20	7,936
Repair Gas Pipe	45	7,161
Gate Valve Broken	50	5,087
Burners Repair	18	4,924
Replace Stove	8	1,850
Replace Gate Valve	21	1659
Biogas Slurry Too Watery	11	1486
Replace Gas Pipe	9	895
Needs Minor Repair	5	791
Nozzle Jet	21	632
Drain Water in Gas Pipe	4	621
Change Nozzle	23	404
CIM Tube	3	348
Stove Repair	5	6
Total	**1,373**	**567,886**

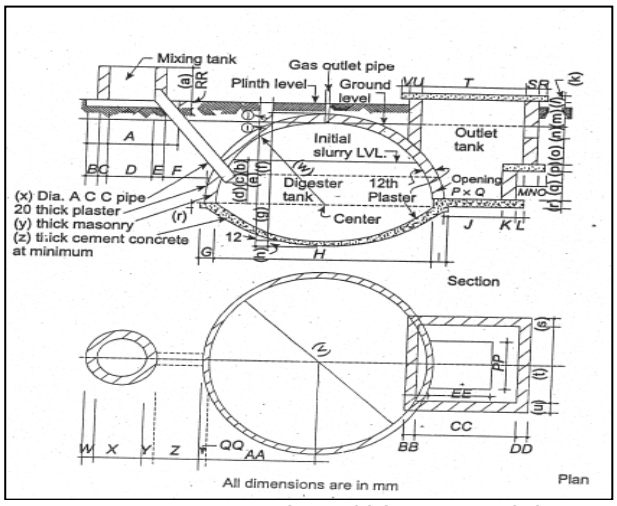
[1] This is the total number of days in the monitoring period for all the biogas units which were under repair and not operational. Thus for a month of 30 days, the total biogas days for 3095 units are 3095 x 30 days = 92,850 days

The beneficiaries inform the village volunteers or the biogas case workers of any repairs required. Minor repairs are done by them, while the major repairs such as repair of cracked domes and re-plastering of domes are done by trained masons.

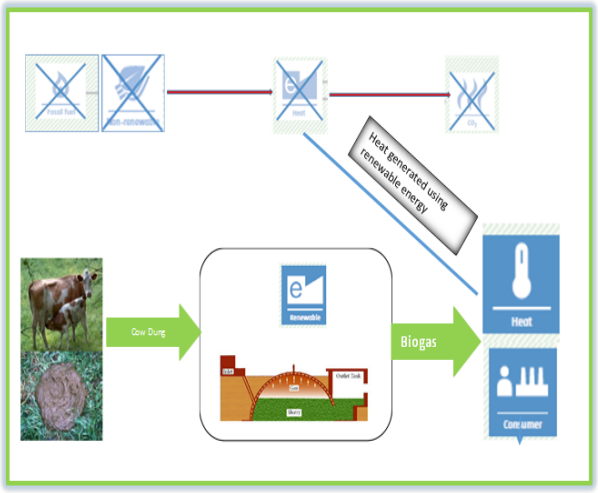
b) For the description of the installed technology(ies), technical process and equipment, include diagrams, where appropriate.

The biogas plant of Deenbandhu model (Fig 2) consists of a digester with a fixed, non-movable gas space. Users prepare batches of dung slurry in the mixing tank, before allowing the final mixture to flow into the digester for methane formation phase. By utilizing dung substrate in an anaerobic digestion and combustion system, biogas is made available. Biogas is generated by fermentation of cellulose rich organic matter under anaerobic conditions. In anaerobic conditions, the methane-producing bacteria become more active. The anaerobic digestion consists of three stages: I Hydrolysis; II Acid formation and III Methane fermentation. The processes are carried out by two sets of bacteria namely acid forming bacteria and methane formers. The acidogenic phase I is the combined hydrolysis and acid formation stages in which the organic wastes are converted mainly into acetate, and phase II is the methanogenic phase in which methane and carbon dioxide are formed. The recovered gas is combusted and used for cooking and water heating. The chosen methane recovery and combustion system is the time tested Deenabandhu model biogas technology which is well-known in India.

The individual plant consists of a mixing chamber where waste water and cow dung are mixed, an inlet pipe to feed the slurry into the reactor, the main biogas reactor/digester where methane formation/recovery takes place, a slurry outlet pipe, an outlet chamber, and a slurry platform. The outlet pipe and tank are provided to remove the digested/treated sludge or fermentation residue and the slurry platform is provided to maintain the treated slurry in clean condition. A pipe leading from the top of the dome to the stove is provided to supply biogas to a 2-ring stove inside the house. The cross-section of a biogas unit is as shown in Fig 2.



Cross-section of biogas model



Technical process and equipment of biogas unit

Deenabandhu Model Biodigester

Biogas Stove in the kitchen used for cooking

Fig 2: Deenabandhu 2 cum Biogas Unit installed in the project activity

B.2. Post-registration changes

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

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There are no temporary deviations from registered monitoring plan and applied methodology

B.2.2. Corrections

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There are no corrections to project information or parameters fixed at validation.

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

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There is no change in the start date of crediting period.

B.2.4. Inclusion of monitoring plan

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There is no inclusion of a monitoring plan to the registered PDD as it was included during the registration of the project activity.

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

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There is no inclusion of a monitoring plan to the registered PDD as it was included during the registration of the project activity.

B.2.6. Changes to project design

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There was a change in project design to include all Mandals of Chittoor District during the previous monitoring period. The change to the project design was approved by the UNFCCC on 26/10/2017[2]

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

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Not Applicable

SECTION C. Description of monitoring system

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Implementation Plan: The project activity was implemented only after it was registered as a CDM project activity. Emission Reductions yet to be generated was sold, in advance, to a Carbon Investor under an ERPA drawn up for the purpose. Carbon Revenue is being used in a completely open and transparent manner to construct the 5,000 biogas units. Orders to various local entrepreneurs for construction of biogas units i.e. bricks, cement, sand, stoves, pipes, nozzle was placed after procuring the advance ER revenues as the project is funded only from carbon revenue.

A CDM Team was appointed to facilitate construction and maintenance of the biogas units as described below.

Project Management and Monitoring: This Biogas CDM project is being implemented and monitored by CROSS to construct 5,000 domestic biogas units of $2m^3$ capacity, for as many farmer families in the Mandals of Chittoor district, Andhra Pradesh, India.

Biogas Project Management Unit within CROSS: A dedicated team has been set up within CROSS for management and monitoring of the Biogas CDM Project. This Project Management & Monitoring Unit consists of the following staff:

Biogas CDM Project Manager: The biogas CDM project manager is in overall in-charge of the project activity. He is responsible for overall project implementation and meeting the requirements of monitoring protocol. His main functions are to coordinate between Biogas CDM Staff and village functionaries, ensure quality from material supply, through construction, to commissioning of units and to set up a repair and maintenance system to attend to issues that cannot be locally addressed through the Village level systems.

IT Professional: The IT professional is responsible for maintenance of digitized monitoring solution and monitoring sheets for CDM Verification

- Ensure that authentic data is entered into the solution and make spot checks to verify
- Deal with the IT Company, TRISTLE that prepared the solution.
- Peruse the analytical reports in the digitized monitoring solution and recognise patterns to predict problem areas and under-performance

Accountant: He is responsible for ensuring a strict and diligent spending of carbon revenues and the recording thereof in a computerised accounting package. He reports to the Director, CROSS. He administers the following tasks:

- Arrange for the bulk purchase of cement and hardware and transfer them to the Mandal
- Arrange timely payments for material suppliers and masons
- Inspect quality of material (bricks and sand) before making payments
- Negotiate for the timely supply of high quality cement and hardware
- Prepare statutory reports for end of year audit

[2] https://cdm.unfccc.int/PRCContainer/DB/prcp333290370/view

Biogas Field Workers: Biogas field workers have been appointed for overseeing the construction of biogas units. The field worker is in-charge of construction of the biogas units and report to the Project Manager and their tasks are:

- Inspect the number of cattle, distance from kitchen in each household, mark and arrange for excavation of pits
- Identify local suppliers of material (bricks and sand) for each village, get the price and quality approved by the Project Manager, and arrange for transportation to the villages
- Transport cement and hardware to the Village
- Assign Masons to particular villages and oversee the quality of their work and ensure that End User family labour is actively used
- Record the progress of processes in specially designed formats and enter the data into the digitized monitoring solution on a fixed day every week

Post construction of the biogas units, the biogas field workers continue to be responsible to:

- Form and support village level institutions; assist in selection of Volunteers, train and support them
- Record the monthly totals from the Daily Monitoring Books maintained by Volunteers and, once a month, enter the data into the digitized monitoring solution
- Contract Masons and attend to major repairs that cannot be handled by the village level institution.

Masons: Trained masons by NEDCAP are involved in construction of the biogas units in the region. Each of their personal and contact details is stored in the digitized monitoring solution to fix responsibility.

Similarly, the personal and contact details of each Material Supplier are also recorded, along with their bank account numbers. Payments are made only by crossed cheque to unable audit of the accounts for the project activity.

Management system at village level:

End User Groups: About 20-25 End User families are organized into SHGs for local management of construction and post construction, ensuring proper functioning of all biogas units in their respective villages. These SHGs are a support system for End User.

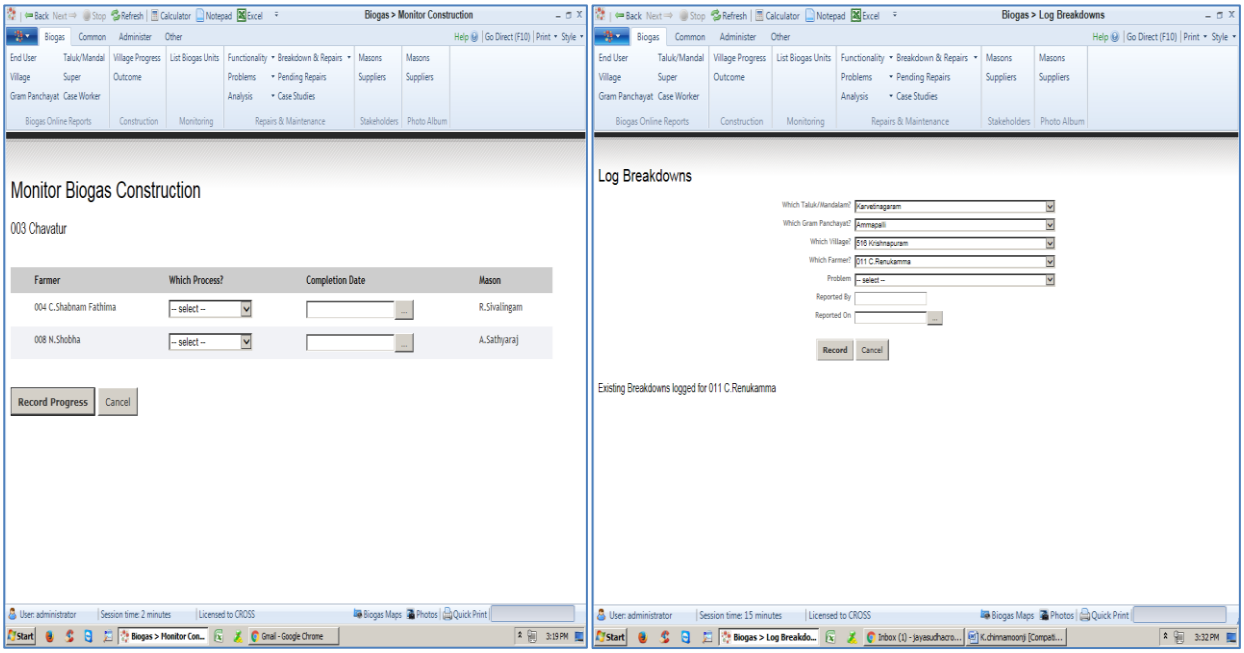
Volunteers: Every participating village has Volunteer, preferably women staff with either minimum SSLC or PUC qualification, to monitor usage of biogas units. She is a young woman, selected by the End User Group of her Village. She is responsible for post construction monitoring of usage and be the first to identify dysfunctional units. The Volunteer either prompt the End User Group to set right a problem or bring it to the notice of the Biogas Field Worker.

Digitized Monitoring system: A customised Biogas CDM Monitoring database Solution developed and tested by Tristle Technologies Pvt. Ltd. for CROSS, is used to maintain demographic data, construction processes, and the regular monitoring of the project activity. Tristle Technologies Pvt. Ltd. has developed a database which is permission driven, intuitive and easy to use by Project Staff and Volunteers. All activity processes, including financial transactions, are digitally entered and monitored at the CROSS head office. Open and transparent online reports are used by all the Project Staff and secondary stakeholders to know the Progress and Results. Reports can be generated at all levels – Project, Mandal, Gram Panchayat, Village and Participating Family. The database is updated on an everyday basis, as and when Project Staff return from their respective villages.

Real-time reports are available to everyone in an open and transparent manner for the following:

- Implementation Progress (overall project to village reports) on
    - Construction progress, time line & efficiency
    - Gender disaggregated analysis & dwelling details of participating families
    - Daily usage resume, Audit & Maintenance & CER generation to date
    - Total expenditure & average cost per unit

- Participating Families
    - Demographic details
    - Mason, Commissioned Date & Usage Days
    - Construction Details with Date, Process, & Who Monitored
- Construction Overview
    - Village-wise Progress
    - Output, Outcome & Results
- Monitoring of operating units
- Masons & Suppliers
    - Masons
    - Suppliers
    - Photo Albums of Masons and Suppliers
- Reports that meet CER Verification requirements
    - Monitoring operating units
    - Full List of all the Commissioned Units
        - Non-usage days



Snapshot of the TRISTLE Monitoring Database Solution for construction

The solution is used to:

- Record the Mandals, Gram Panchayats and Villages where the CDM project is implemented
- Enter demographic details on participating Families
- Select Villages & Families
- Assign Staff and Volunteer responsibilities during the actual construction and monitoring phases, respectively

Monitoring during Construction Phase: Construction of Biogas Units is being carried out in a phased manner. The various processes involved in the implementation of the technology are as follows:

- Selection of Participating Families
- Defining Masons & Material Suppliers
- Monitoring Construction Progress
    - Marking
    - Excavation
    - Supplying crushed stone jelly, sand, bricks and cement
    - Supplying Hardware
    - Concreting, Brick Work & Plastering

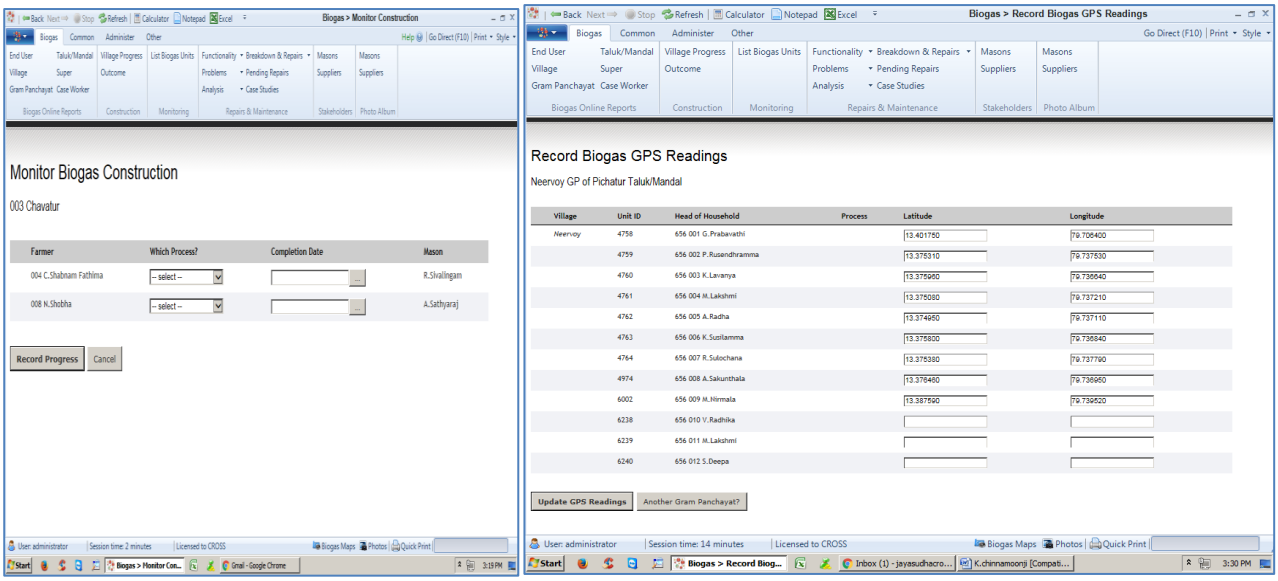
  - Filling dung
  - Supplying & Fixing Pipes and Stove
  - Fixing the Safety Grill
- Commissioning the Biogas Units
- Generating End User Agreements
- Monitoring operating units
- Logging Breakdowns & Repairs – Non usage days

Project Staff ensures quality of installed Biogas Units. They check the quality and ensure that the required quantities of material are used during construction. All payments are made by cheque and Suppliers irrefutably identified with personal data and digital photographs fed into the computerized databank.

Each Biogas Unit is marked with a unique Identification Number. Along with the Village Code and Family Code, these irrefutably identify each of the installed biogas units on the digitized monitoring database.

After commissioning and satisfactory functioning of the Biogas Unit an End User Agreement is signed with the Participating Family. Full account of emission reduction is considered from Day 1 of commissioning. GPS coordinates of the units are also taken and entered into the monitoring solution.

Monitoring after Commissioning of biogas units: A Daily monitoring book is maintained in each of the villages where the volunteers record the problem with the biogas units and the number of non-usage days. This data is fed into the individual Biogas User's monitoring database solution, once a month, for days not used and reasons and the day it was repaired.



Snapshot of the TRISTLE Monitoring Database Solution for breakdown log

If any Biogas Unit is faulty or not functional, the problem report is automatically passed on to the Area Team for action. There is continuous database maintained of all the Biogas Units not operational on a day-to-day basis. The computerized solution provides all the details at the Participating Family level for the number of non-operational days, and the reasons of non-operation. This monitoring gives the operational Biogas Units and serve to triangulate the data.

This monitoring solution positively impacts Staff and Volunteers to enhance Performance and produce good Results. Project staffs understand exactly where they stand in terms of progress and results, like number of commissioned Units, recording of breakdowns, conducting timely repairs, etc. is used to measure their performance. The totally open and transparent reports track progress from marking to commissioning. These, along with budget realisations keep a wider audience

constantly informed on progress and financial health. They also give up-to-date information on the volume of CERs generated and thereby serve as an indicator on financial viability and feasibility. Verification data needed by the DoE is generated as Excel files from the monitoring solution. All data are archived and stored throughout the crediting period and an additional 2 years.

End User Agreements: After commissioning each Biogas Unit (i.e. after the satisfactory functioning of the unit), a legally binding End User Agreement is signed between the Project Proponent (CROSS) and every single End User. These formally spell out the roles, entitlements and responsibilities of both parties.

Maintenance and Servicing: Volunteers record daily Monitoring data. They are the point persons who immediately identify problems. Minor repairs ae conducted either by the End User family or the Volunteer herself, since she is trained and given a kit with tools and spare parts. If the repair involves the expenditure of monies for the purchase of material, the matter is discussed in the End User Group and resources obtained. If the problem is beyond their scope, the Biogas Field Worker is informed and the problem attended to.

Trainings have been conducted before project implementation at various stages to orient the end-users on the effects of climate change, CDM processes and about biogas. Women are trained on use and maintenance of bio-gas units and also on repair and maintenance of biogas units. The village volunteers are also trained for monitoring and repair of the units.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

Data/Parameter	**Rating Biogas**
Unit	kW_{th}/digester
Description	Thermal capacity of a digester
Source of data	Calculated as shown in Section B.2 of the PDD
Value(s) applied	1.69
Choice of data or measurement methods and procedures	Calculated as shown in Section B.2 of the PDD
Purpose of data/parameter	Qualifies as a micro-scale project activity. This parameter is fixed for the entire crediting period
Additional comments	All the constructed units are of 2 cum and hence the value remains the same.

Data/Parameter	**B_y**
Unit	Tonnes /year
Description	Quantity of woody biomass that is substituted or displaced in tonnes
Source of data	Survey
Value(s) applied	3.97 tonnes/year/family and 19,850 t/year for 5,000 families
Choice of data or measurement methods and procedures	Based on survey conducted to estimate the average annual consumption of woody biomass. The details of the study are described in Annex 3 of the PDD. The average annual consumption of biomass is 3.58±0.73 kg/capita/day. The lower bound of 95/5 confidence/precision level of per capita consumption is 3.48 kg/capita/yr. The adult equivalent per family in the project area is 3.13. B_y = 3.48 kg/capita/day x 365 days x 3.13 adult equivalent/family = **3.97 t/family/yr**. B_y for 5,000 biogas units is 3.97 x 5000 = 19,850 t/year.

Purpose of data/parameter	To estimate the emission reductions for the project activity
Additional comments	This parameter is fixed for the entire crediting period

Data/Parameter	$f_{NRB, y}$
Unit	-
Description	Fraction of woody biomass used in the absence of the project activity in year y that can be established as non-renewable biomass
Source of data	Assessment of Non Renewable Biomass based on data provided by Forest Survey of India, 2011, Ministry of Environment and Forests, Govt of India.
Value(s) applied	0.95
Choice of data or measurement methods and procedures	Based on data from State of Forest Report, 2011. Forest Survey of India, Ministry of Environment and Forests, Government of India. The data gives the consumption of fuel wood and production of fuel wood from forests and from trees outside forests. This data is assessed at the state level. Thus the f_{NRB} for Andhra Pradesh is applied for the project activity.
Purpose of data/parameter	To estimate the emission reductions for the project activity
Additional comments	This parameter is fixed for the entire crediting period

Data/Parameter	**$NCV_{biomass}$**
Unit	TJ/tonne
Description	Net Calorific Value of Biomass
Source of data	AMS_I.E., Version 4 methodology
Value(s) applied	0.015
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	To estimate the emission reductions for the project activity
Additional comments	This parameter is fixed for the entire crediting period

Data/Parameter	**$EF_{projected\_fossilfuel}$**
Unit	tCO_2/TJ
Description	Emission Factor for fossil fuel. Emission factor for substitution of non-renewable woody biomass by similar consumers.
Source of data	AMS-I.E., Version 4 methodology
Value(s) applied	81.6
Choice of data or measurement methods and procedures	Based on the methodology, this value represents the emission factor of the substitution fuels likely to be used by similar users on a weighted average basis. It is assumed that the mix of present and future fuels would consist of a solid, liquid and gaseous fossil fuel.
Purpose of data/parameter	To estimate the emission reductions for the project activity
Additional comments	This parameter is fixed for the entire crediting period

Data/Parameter	**Diversion of non-renewable biomass saved under the project activity by non-project households**
Unit	tonnes / year
Description	Diversion of non-renewable biomass saved under the project activity by non-project households
Source of data	Based on the methodology B_y will be multiplied by a net to gross adjustment factor of 0.95 to account for leakages.

Value(s) applied	Biomass (t) - 3.97 x 0.95 = 3.77 t/yr. The biomass diversion is 3.97 – 3.77 = 0.20 t/family/yr or 1000 t/yr for 5,000 families. Emissions (tCO_2) - 4.61 - 4.38 = 0.23 tCO_2/family/yr; 0.23 x 5000 = 1150 tCO_2/year
Choice of data or measurement methods and procedures	According to I.E, Version 4, B_y can be multiplied by a net to gross adjustment factor of 0.95 to account for leakages, in which case surveys are not required. 3.97 x 0.95 = 3.77 t/Household/yr. Thus the diversion is 3.97 – 3.77 = 0.20 t/family/yr or 1000 t/yr for 5000 families. In terms of leakage of emissions, 4.61 - 4.38 = 0.23 tCO_2/family/yr and 0.23 x 5000 = 1150 tCO_2/year.
Purpose of data/parameter	To estimate the leakage for the project activity
Additional comments	This parameter is fixed for the entire crediting period. Surveys will not be conducted to determine leakage

D.2. Data and parameters monitored

Data/Parameter	**Biogas Units constructed**
Unit	Number
Description	Number of biogas units constructed
Measured/calculated/ default	Measured. Monitoring of construction of biogas units and its start date of operation will be from the on-line monitoring solution of CROSS
Source of data	Data recorded at site based on the progress of construction and installation and entered into the online monitoring Solution
Value(s) of monitored parameter	3095 till 31/12/2020
Monitoring equipment	Continuous
Measuring/reading/recording frequency	100% of the units are monitored from the procurement of material till construction and commissioning of the biogas units
Calculation method (if applicable)	The emission reductions are calculated for the constructed and operational units for operational days.
QA/QC procedures	- The biogas units built for the households was monitored on field and entered into the on-line monitoring database. - The beneficiaries have signed an End User agreement with CROSS with all details of the family to identify the user irrefutably.
Purpose of data/parameter	To estimate the emission reductions for the project activity
Additional comments	The timeline of construction of the units is monitored and database maintained

Data/Parameter	**Number of biogas plants operating**
Unit	Number
Description	Number of plants operating in year (t)
Measured/calculated/ default	Measured
Source of data	Log books maintained and entered in the digitized monitoring database for Daily monitoring of the biogas units operating. In every village, the Village Level Volunteers monitor the biogas units that are operating for every single day.
Value(s) of monitored parameter	Of the 3095 units constructed, 2640 units are operational by 31/12/2020, which accounts to 85.30% operational units of the constructed units.

Monitoring equipment	No monitoring equipment, The biogas case workers and village level volunteers monitor on daily basis.
Measuring/reading/recording frequency	The non-usage of biogas units are measured on daily basis and entered into the online monitoring database, which determines the operating biogas unit.
Calculation method (if applicable)	The operating biogas units are those that have not been dysfunctional and are functioning. The non-operational days are also recorded and ER not accounted for those days.
QA/QC procedures	Log books and digitized database are checked regularly by project staff and CDM coordinator.
Purpose of data/parameter	Estimate emission reductions for the project activity for the operational units and on operational days.
Additional comments	The uncertainty of emission reduction is very low as there is continuous monitoring of all units for operational units and operational days.

Data/Parameter	**Non-usage of biogas plants**
Unit	Days
Description	Usage of non-renewable biomass in case of non-performance of biogas units
Measured/calculated/ default	Measured.
Source of data	The days not used from the daily monitoring report for each of the unit done at the village level and data maintained on the digitized monitoring database. Dependent on the number of days the biogas units are under repair
Value(s) of monitored parameter	

Problems	Number of biogas units with issues	Non-operational biogas days[3] for the monitoring period (1st August 2019 – 31st Dec 2020)
Biogas Dried	380	175,922
Empty and Re-plaster Dome	223	107,408
Not Feeding the Biogas	203	99,041
Unit Demolished	164	84,038
Cattle Sold	88	34,687
Kitchen not Used	72	32,990
Repair Outlet Tank	20	7,936
Repair Gas Pipe	45	7,161
Gate Valve Broken	50	5,087
Burners Repair	18	4,924
Replace Stove	8	1,850
Replace Gate Valve	21	1659
Biogas Slurry Too Watery	11	1486
Replace Gas Pipe	9	895
Needs Minor Repair	5	791
Nozzle Jet	21	632
Drain Water in Gas Pipe	4	621

[3] This is the total number of days in the monitoring period for all the biogas units which were under repair and not operational. Thus for a month of 30 days, the total biogas days for 3095 units are 3095 x 30 days = 92,850 days

	<table><tr><td>Change Nozzle</td><td>23</td><td>404</td></tr><tr><td>CIM Tube</td><td>3</td><td>348</td></tr><tr><td>Stove Repair</td><td>5</td><td>6</td></tr><tr><td>Grand Total</td><td>1,373</td><td>567,886</td></tr></table>
Monitoring equipment	There is no monitoring equipment. As and when the biogas units are not functional, the beneficiaries report to the village level volunteer, who in turn report to the Biogas Field Worker of the project for the repair of the unit. A log book is maintained for the reason of non-function and days under repair.
Measuring/reading/recording frequency	On a day to day basis
Calculation method (if applicable)	ERs are not estimated for non-functional days.
QA/QC procedures	Though the methodology does not require monitoring this parameter, it has been done for a credible estimation of ERs.
Purpose of data/parameter	To calculate emission reductions for only the operational days for operational biogas unit.
Additional comments	The main objective of the project is to provide sustainable energy sources to the rural households with good repair and maintenance. Hence a robust monitoring system is in place.

Data/Parameter	**Confirmation that non-renewable biomass has been substituted**
Unit	-
Description	Confirmation that non-renewable biomass has been substituted
Measured/calculated/ default	Measured
Source of data	Sample survey
Value(s) of monitored parameter	From the survey it can be seen than 100% of the renewable biomass is replaced for the monitoring period. To account for non-renewable still used for emission reduction calculations, real time data has been used. The quantity of fuelwood displaced in the monitoring period accounts for 1605030 biogas days x (3.97/365) = 17457.44 t. Based on real time data, the actual fuelwood displaced considered for emission reduction calculations is 11,280.72 t. This accounts for 11280.72/17457.44 = 65%. Thus this is much more conservative than that determined from sample survey. The survey shows that biogas has been used by the participating families, thus replacing non-renewable biomass. Some families use crop residues such as coconut tree fronts and spent shells, sugarcane waste, Red gram and fallen twigs and branches occasionally for heating water and other fallen twigs and branches from their farmland.
Monitoring equipment	Annual
Measuring/reading/recording frequency	Annual simple random sampling conducted for the period August 2019- July 2020 and August 2020 - December 2020.
Calculation method (if applicable)	The calculation method is shown in ER calculations sheet and presented in section D.3.
QA/QC procedures	The daily monitoring of biogas units for non-operational days results in estimation of credible emission reductions with low uncertainty. The relative precision or reliability is within 10%. Hence the data is within the required specification.
Purpose of data/parameter	Not used for Emission Reduction calculations Confirmation of replacement of non-renewable biomass

Additional comments	

Data/Parameter	**Average annual hours of operation of a system**
Unit	Hrs
Description	Average annual hours of operation of a biogas unit
Measured/calculated/ default	Measured. Based on annual sample survey that will be conducted on statistically determined number of households.
Source of data	Based on the survey conducted annually
Value(s) of monitored parameter	**2019-20 (August-July 2020)**: 2.35; **2020 (July-Dec)**: 2.48; **For the Monitoring Period**: 2.41
Monitoring equipment	A household level sample survey was conducted to estimate the average hours of operation of a biogas system for a day. Survey sheets were given to sample households to record the start and finish time of use of biogas units in a day for a period of 7 days.
Measuring/reading/recording frequency	Annually
Calculation method (if applicable)	This survey was done annually for a statistically determined number of households at 90/10 precision confidence level.
QA/QC procedures	The procedure was monitored by the biogas case workers and the FCN Tech team for QA/QC.
Purpose of data/parameter	This is not included for ER Calculations
Additional comments	No additional comments

D.3. Implementation of sampling plan

>>

The various parameters that need to be monitored as described in section B.7 are:

(i) Biogas units constructed
(ii) Number of biogas plants operating
(iii) Non-usage days of biogas plants
(iv) Average annual hours of operation of a system
(v) Confirmation that non-renewable biomass has been substituted

The parameters (i), (ii) and (iii) are monitored for all the biogas plants constructed and in operation and the parameter (iv) and (v) were monitored based on sample survey.

(a) Sampling Design

(i) Objectives and Reliability Requirements: The objective of the sampling effort is to determine the mean yearly value of the following parameters with 90/10 confidence/precision during the crediting period:

(i) Average annual hours of operation of a system
(ii) Confirmation that non-renewable biomass has been substituted

To determine the average annual hours of operation, the household filled in the time of start and end of cooking for all the meals cooked at home for a period of 7 days. The survey was conducted yearly once for a period of 7 days and extrapolated for the year. The same households were also surveyed through questionnaire method to confirm the substitution of non-renewable biomass. The estimated value of parameter was determined through a random sample survey. Due to the

pandemic, during August-Sept 2020, telephonic and physical interviews were conducted. At the end of December-January 2021, only physical surveys were conducted.

(ii) Target Population: The target population is the rural households for which biogas is constructed and operational in Chittoor district of Andhra Pradesh State, India. These rural households are from all the Mandals in which the project has been implemented.

(iii) Sampling Method: The sampling method chosen for the project area is simple random sampling as the target population is homogeneous in nature. A simple random sample is a subset of a population chosen randomly, such that each biogas of the population has the same probability of being selected. The sample-based estimate of mean is an unbiased estimate of the population parameter. It is easy to implement as the sampling frame (household details for which biogas has been implemented) is collected and stored in the monitoring database.

(iv) Sample Size: The sample size for "Confirmation that non-renewable biomass" has been substituted" was determined use the equation

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

Where:

$$V = \frac{p(1-p)}{p^2}$$

n	Sample size
N	Total number of households
p	the proportion (based on results of previous MR survey)
1.645	Represents the 90% confidence required
0.1	Represents the 10% relative precision

Substituting the values for the project activity,

The sample size annually is as follows:

Year	**2019-20**	**2020**
Sample size (n)	0	0
Total number of households (N)	3095	3095
The proportion (p)	0	0%
90% Confidence required (1.645)	1.645	1.645
10% relative precision (0.1)	0.1	0.1
V	0.011	0.033
Sample size @80% response	0	0

As the sample size returns a value of zero, more than 30 samples were sampled each year.

The sample size calculations for "Average annual hours of operation of a system" was determined using the equation

$$n \geq \frac{1.645^2 NV}{(N-1)\times 0.1^2 + 1.645^2 V} \quad where\ V = \left(\frac{SD}{mean}\right)^2$$

Based on the results of the survey conducted during the last monitoring period and substituting the values for the project activity, the sample size annually is as follows:

Year	2019-20 (Aug 2019 –July 2020)	2020 (Aug-Dec 2020)
Total number of households	3095	3095
Mean	3.14	3.14
Standard Deviation	1.01	1.01
Represents the 90% confidence required	1.645	1.645
Represents the 10% relative precision	0.1	0.1
V	0.103	0.103
Sample size	28	28
@80% response rate	35	35

The sample was drawn at random from the sampling frame using the random number generator in Microsoft Excel Sheet. The sampling details are as follows:

Mandals	Number of HHs	Number of Villages	Number of HHs	Number of Villages
	2019-20 (August – July 2020)		2020 (August – December 2020)	
G.D.Nellore	13	12	11	9
Karvetnagaram	8	7	6	6
Nagalapuram	3	3	4	2
Nagari	1	1	3	2
Narayanavanam	2	1	0	0
Nindra	2	2	2	2
Pitchatur	6	4	5	4
Puttur	2	2	2	2
S.R.Puram	5	5	6	5
Vedurukuppam	8	7	7	5
Total	**50**	**44**	**46**	**37**

The same households were sampled for both the parameters. The total households sampled is 50 households for the year 2019-20 and 46 for the year 2020.

(***v) Sampling Frame:*** The sampling frame used is the complete listing of all the rural households for which biogas has been built under the project activity in all the Mandals of Chittoor district, Andhra Pradesh State, where the biogas units have been built.. Each of the household has a unique identify number with all the required details of the family.

(b) Data:

(i) Field Measurements: The variables recorded on field are

(i) Average annual hours of operation of a system
(ii) Confirmation that non-renewable biomass has been substituted

A household level questionnaire was designed to collect information for the parameters of interest. The frequency of measurement was once a year during the monitoring period and was done for 7 days for the sample households. Each household was given the questionnaire to fill in the data for the parameters. They were guided by the biogas case workers to fill in the data under the supervision of the FCN technical expertise.

The average annual hours of operation of a system was monitored by recording the time of start and switch off biogas units each time it is used by the household for a period of 7 days. The same household was also surveyed to confirm the substitution of non-renewable biomass.

(ii) Quality Assurance/Quality Control: The QA/QC procedure was followed to achieve good quality data through field measurements. The household level questionnaire was designed and field tested by the FCN Technical team before administering the actual questionnaire survey. The biogas case workers were trained to administer the questionnaire at the household level. The households were trained to collect and fill in the questionnaire. The case workers were trained to conduct and supervise data collection at the household level. This reduced non-response from the households.

The data collected was entered by the case workers, which was checked and verified further for any typographic mistakes. A valuator further cross-checked each entry with the physical form for any typographic mistakes or to clarify any sort of confusion in the data. The field staff, the data entry staff and the valuators are literate to collect good quality data.

(iii) Analysis: The data was entered into Microsoft excel sheet and cross checked with the filled in questionnaire by Valuators as QA/QC procedure. The data was analyzed for the mean annual value of the parameters.

The mean and average hours of use was estimated for the two surveys conducted.

Standard error of the mean was calculated for simple random sampling as follows

$\sqrt{(1-f)\frac{s^2}{n}}$, where f is the sampling fraction; s2 is the sample variance (s in the sample standard deviation; and n is the sample size.

t value was calculated using Microsoft excel using TIVN function

Precision associated with the estimate was calculated as t-value x standard error of the mean

The parameter of interest – the proportion of biogas households that have replaced non-renewable biomass in the whole population was estimated from the sample proportion and calculated as r/n, where r is the number of households where non-renewable biomass was replaced and n is the total number of biogas houses sampled.

The 90% confidence interval for the population is given by the equation sample population ± 1.645 x standard error of the proportion. The precision was calculated as 1.645 x standard error of the proportion, which needs to be within 10%.

The standard error of the proportion as calculated as $\sqrt{(1-f)\frac{pq}{n}}$, where f is the sample fraction, p is the sample proportion and q is (1-p)

The precision was calculated z-value x standard error of the proportion. The ratio of this relative to the proportion is the calculated as the relative precision or reliability.

(iv) Results: Based on the survey, the average annual hours of operation of a system was as follows:

Details	2019-20 (August-July 2020)	2020 (July-Dec)	For the Monitoring Period
Mean (Number of operational days)	2.35	2.48	2.41
Standard Deviation	0.51	0.58	0.55
Number of Sample Recordings	50	46	96
Total Number of Systems	3095	3095	3095
Standard Error of Mean	0.0716	0.0851	0.0549

t value	1.6766	1.6794	1.6611
Confidence Level	0.1188	0.1411	0.0918
Precision	0.1201	0.1430	0.0912
Reliability (Ratio to mean)	5.10%	5.77%	3.78%

The relative precision or reliability is within 10%. Hence the data is within the required specification.

Based on the survey, the results of the proportion of families replacing non-renewable biomass are as follows:

Year of Survey	**2019-20 (Aug-July)**	**2020 (Aug-Dec)**
Total Population	3095	3095
Number of HHs with non-renewable biomass replaced	50	46
Number of samples	50	46
f (sampling fraction)	0.016	0.015
1-f	0.984	0.985
P	1.000	1.000
Q	0.000	0.000
Standard error of proportion	0.000	0.000
Precision	0.000	0.000
Reliability	0.00%	0.00%

As can be seen the data is within the required specification of 10%.

(c) Implementation:

(i) Implementation Plan: The implementation of sampling effort was done by the NGO in consultation with CDM Team of Fair Climate Network (FCN). The FCN has the skill and resources to implement the sampling procedure. The team is experienced with rural energy CDM projects implemented for the rural poor for more than 10 years. The FCN team trained the case workers to conduct the survey along with the randomly selected households. The collected data was analysed by the FCN for inclusion in the monitoring report.

SECTION E. Calculation of emission reductions or net anthropogenic removals

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

>>

It is assumed that in the absence of the project activity, the baseline scenario would be the use of fossil fuels for meeting similar thermal energy needs and emission reductions is calculated as:

$$ER_y = B_y * f_{NRB,y} * NCV_{biomass} * EF_{projected\_fossilfuel}$$

Where:

ER_y	Emission reductions during the year y in tCO2e
B_y	Quantity of woody biomass that is substituted or displaced in tonnes
$f_{NRB,y}$	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
$NCV_{biomass}$	Net calorific value of the non-renewable woody biomass that is substituted (IPCC default for wood fuel, 0.015 TJ/tonne)

$EF_{projected\_fossilfuel}$ Emission factor for the substitution of non-renewable woody biomass by similar consumers. Use a value of 81.6 tCO2/TJ

Emissions Reductions for the Monitoring Period (01/08/2019 to 31/12/2020)		
Activity Data	**Value**	**ID Ref**
Quantity of Biomass that is substituted (t/yr)	11,280.72	B_y
Fraction of NRB	0.95	$f_{NRB,y}$
NCV Biomass (TJ/t)	0.015	$NCV_{biomass}$
Emission factor (tCO_2/TJ)	81.6	$EF_{projected\_fossilfuel}$
Emission Reductions (tCO_2/Monitoring Period)	**13,117**	ER_y

The total emission reductions for the monitoring period **01/08/2019 to 31/12/2020** for the installed and operational 3095 biogas units are 13,117 tCO_2. The unit-wise calculations of emission reduction are as enclosed in the ER Calculations excel sheet.

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

>>
There are no project emissions in the project activity

E.3. Calculation of leakage emissions

>>

Leakage related to the non-renewable woody biomass saved by the project activity shall be assessed based on ex post surveys of users and the areas from which this woody biomass is sourced (using 90/30 precision for a selection of samples). The following potential source of leakage shall be considered:

(a) *The use/diversion of non-renewable woody biomass saved under the project activity by non-project households/users that previously used renewable energy sources. If this leakage assessment quantifies an increase in the use of non-renewable woody biomass used by the non-project households/users, that is attributable to the project activity, then* B_y *is adjusted to account for the quantified leakage. Alternatively,* B_y *is multiplied by a net to gross adjustment factor of 0.95 to account for leakages, in which case surveys are not required.*

If the equipment currently being utilised is transferred from outside the boundary to the project boundary, leakage is to be considered.

There will not be any transfer of equipment being currently utilized transferred from outside the project boundary to the project boundary. All the biogas units will be constructed at site. Thus leakage from equipment transfer need not be monitored.

B_y is multiplied by a net to gross adjustment factor of 0.95 to account for leakages, in which case surveys will not be required.

According to the methodology, Version 4, after considering leakage, the emission reduction calculations are as follows:

Activity Data	Value
B_y	11.280.72
B_y adjusted for leakage (B_y x 0.95)	10,716.68
f_{NRBy}	0.95
$NCV_{biomass}$ (TJ/tonne)	0.015

$EF_{projected\ fossilfuel}$ (tCO_2/TJ)	81.6
ER generated for the monitoring period (tCO_2)	**12,461**

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

	Baseline GHG emissions or baseline net GHG removals (t CO_2e)	Project GHG emissions or actual net GHG removals (t CO_2e)	Leakage GHG emissions (t CO_2e)	GHG emission reductions or net anthropogenic GHG removals (t CO_2e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	13,117	0	656	0	12,461	12,461

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_2e)	Amount estimated ex ante for this monitoring period in the PDD (t CO_2e)
12,461	31,140

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

>>
The emission reductions for the monitoring period is estimated based on the assumption that the targeted 5,000 biogas units would be constructed by this period. Hence the emission reduction estimated ex-ante is estimated as follows:

August 2019- July 2020	For 366 days = 21,960 tCO_2
July 2020 – December 2020	21,900 tCO_2/365 x 275 days = 9,180 tCO_2
Total	**31,140 tCO_2**

E.6. Remarks on increase in achieved emission reductions

>>
There is no increase in the achieved emission reductions.

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

>>
The project is only Type 1 category. Based on the number of biogas units built, the capacity of the project activity is 5.23 MW_{th} (1.69 kW x 3095 units = 5.23 MW_{th}). Hence, it is within the confines of a small scale project.

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Document information

Version	*Date*	*Description*
07.0	31 May 2019	Revision to: • 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: • 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: • 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: • 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 *F-CDM-MR* to *CDM-MR-FORM*; • 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).
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.

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