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	Kolar Biogas Project	
UNFCCC reference number of the project activity	4058	
Version number of the PDD applicable to this monitoring report	14	
Version number of this monitoring report	1.1	
Completion date of this monitoring report	20/10/2020	
Monitoring period number	Sixth Monitoring period	
Duration of this monitoring period	01/01/2018– 31/12/2019 (including both days)	
Monitoring report number for this monitoring period	01	
Project participants	SKG Sangha Foundation myclimate – The Climate Protection Partnership	
Host Party	India	
Applied methodologies and standardized baselines	AMS.I.C – "Thermal energy production with or without electricity" ver. 18 AMS.I.E – "Switch from Non-Renewable Biomass for Thermal Applications by the User" ver.3 AMS.III.R – "Methane recovery in agricultural activities at household/small farm level" ver.1	
Sectoral scopes	Sectoral Scope 1, Energy industries (renewable-/non-renewable sources) 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
	N/A	103,309 t CO2e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	112,454 t CO2e	

SECTION A. Description of project activity

A.1. General description of project activity

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The project provides biogas units to 9,380 households in rural areas of Kolar District in Karnataka State in India. The project reduces the amount of fuel wood and kerosene used for cooking and heating water and replaces inefficient traditional cooking stoves with cleaner biogas stoves. The project also reduces methane emissions from cattle manure and contributes strongly to the sustainable development of the rural households involved in the project. Measures taken for GHG emission reductions are:
(1) to replace fuel wood and kerosene for cooking with biogas. The non-renewable biomass used for cooking and water heating replaced by the renewable biogas will reduce GHGs
(2) to avoid methane emissions from cattle manure Project saves methane emissions caused by the animal dung fermenting in anaerobic condition in traditional compost pits. This will be avoided feeding the dung into biogas plant and by burning the generated methane in biogas burners to be used for cooking and heating water.

Brief description of the installed technology and equipment:
In each household, a Deen Bandhu Biogas plant model together with a biogas-based cooking stove unit will be installed. The biogas units are constructed of bricks, sand, cement, pipes, pipe fittings, metal clips, wire and gas burners. Each bioreactor is a mesophylic fixed dome. The capacity of the bio-digesters is either 2m3 or 3m3 of biogas per day. The biogas unit size for a particular household is chosen based on the number and type of cattle owned by the household and the number of people in the household. Cattle dung and wastewater is fed into the biodigester daily. Cattle dung and kitchen wastewater is added to a mixing tank above ground which has an inlet pipe to a digester chamber which is below ground. The dung and wastewater slurry remains in the chamber for approximately 40 days and breaks down anaerobically producing biogas. This biogas builds up above the slurry and remains in the chamber until it is released through the gas outlet pipe at the top of the dome when the gas burner in the household is turned on.

Figure 1: DeenBandhu Biogas plant model under construction.

Relevant dates for the project activity:
Registration date of the project activity: 24/11/2011
1st CDM Monitoring Period: 01/04/2012 – 31/12/2013
2nd CDM Monitoring Period: 01/01/2014 – 31/12/2014
3rd CDM Monitoring Period: 01/01/2015 – 31/12/2015
4th CDM Monitoring Period: 01/01/2016 – 31/12/2016
5th CDM Monitoring Period: 01/01/2017 – 31/12/2017
6th CDM Monitoring Period: 01/01/2018 – 31/12/2019

Up to 31/12/2019 7944 bio-digesters have been started functioning. Total GHG emission reductions achieved in this monitoring period is 103,309 t CO2e.

Relevant dates for the project activity:

Date of first biodigester construction	January 2012
Date of first biodigester commissioning	10/01/2012
Numbers of biodigesters operating at the end of 6th monitoring period	7944

A.2. Location of project activity

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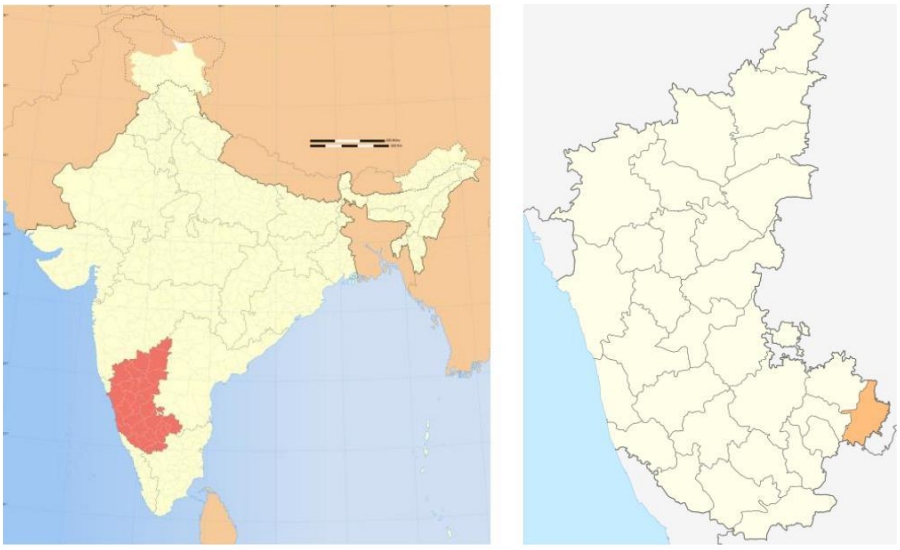
The project is located in the rural areas of Kolar District, which is a district located in south-east of Karnataka State Karnataka State is located in the south West of India. Kolar district has an area of 4.011 km² and is divided in five Taluks – Srinivaspur, Kolar, Mulbagal, Malur, and Bangarapet.

The geographical coordinates of the Kolar District are:

North Latitudes: 77° 49' 26" and 78° 33' 13"

East Latitudes: 12° 44' 45" and 13° 26' 28"



Figures 2: Location of Karnataka State in India and location of Kolar district within Karnataka State of India.

The geographical coordinates of the taluk centres are given below:

Centre	Latitude N	Longitude, E
Kolar Taluk	13º08´12.04´´	78º08´20.44´´
Bangarapet Taluk	12º59´04.97´´	78º10´42.40´´
Malur Taluk	12º59´20.71´´	77º55´42.12´´
Mulbagal Taluk	13º09´39.22´´	78º23´19.11´´
Srinivaspur Taluk	13º20´19.13´´	78º12´38.15´´

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: SKG Sangha	No
Switzerland	Private entity: Foundation myclimate – The Climate Protection Partnership	No

A.4. References to applied methodologies and standardized baselines

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Component 1, Thermal energy generation:

AMS.I.C – "Thermal energy production with or without electricity" ver. 18 http://cdm.unfccc.int/methodologies/DB/6EL4AG49US2S1DNH55Y4S7GDQFA2JF

"Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" ver.2 http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v2.pdf

"Tool to calculate baseline, project and/or leakage emissions from electricity consumption" ver.1 http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v1.pdf

"Tool for the demonstration and assessment of additionality" ver. 05.2 http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v5.2.pdf

AMS.I.E – "Switch from Non-Renewable Biomass for Thermal Applications by the User" ver.3 http://cdm.unfccc.int/methodologies/DB/WHTQUFLWCVNB9CIUZC198A712WGQR4

Component 2, Methane-emissions-avoidance:

AMS.III.R – "Methane recovery in agricultural activities at household/small farm level" ver. 1 https://cdm.unfccc.int/methodologies/DB/JQHRMGL23TWZ081T6G7G1RZ63GM1BZ

A.5. Crediting period type and duration

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The project has a fixed crediting period.
The crediting Period starts from 01/04/2012 - 31/03/2022

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

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a. Description of the installed technology, technical processes and equipment

The functioning date of first Bio-digester is 10/01/2012.
Until the end of 6th monitoring period 7944 units has been functioning under the project activity.

In each household, a Deen Bandhu Biogas plant model together with a biogas-based cooking stove unit will be installed. The biogas units are constructed of bricks, sand, cement, pipes, pipe fittings, metal clips, wire and gas burners. Each bioreactor is a mesophylic fixed dome. The capacity of the bio-digesters is either $2m^3$ or $3m^3$ of biogas per day. The biogas unit size for a particular household is chosen based on the number and type of cattle owned by the household and the number of people in the household. Cattle dung and wastewater is fed into the biodigester daily. Cattle dung and kitchen wastewater is added to a mixing tank above ground which has an inlet pipe to a digester chamber which is below ground. The dung and wastewater slurry remains in the chamber for approximately 40 days and breaks down anaerobically producing biogas. This biogas builds up above the slurry and remains in the chamber until it is released through the gas outlet pipe at the top of the dome when the gas burner in the household is turned on.

b. Information on the implementation and actual operation of the project activity, including relevant dates (e.g. construction, commissioning, start of operation, etc). For project activities that consist of more than one site, project participants shall describe the status of implementation and start date of

operation for each site. For project activities with phased implementation, project participants shall indicate the progress of the project activity achieved in each phase.

Construction of first unit took place in January 2012.
Commissioning of first unit was on 10/01/2012.

The goal of the project activity is to install 9380 biodigester. Until 31/12/2013 4069 units have been installed. Until 31/12/2014 5264 units have been installed. Until 31/12/2015 6403 units have been installed. Until 31/12/2016 7614 units have been installed. Until 31/12/2017 8000 units have been functioning under the project activity. Until 31/12/2018 7963 units have been functioning under the project activity. Until 31/12/2019 7944 units have been functioning under the project activity.

Whereof 1781 units are $3m^3$ size units and 6113 units are $2m^3$ size units.

c. Description of the events or situation that occurred during the monitoring period that may impact the applicability of the applied methodology and, where applicable, the applied standardized baseline.

No event or situation occurred during the monitoring period which could have had impact the applicability of the applied methodology.

A Post Registration Change (PRC) was submitted to the Board on 15/07/2015 and approved on 01/10/2015.

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, applied methodology or applied standardized baseline

B.2.2. Corrections

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No corrections are sought during this monitoring period. There was a PRC in the first monitoring period. Instead after 12 months, first monitoring period has been made for 1 year 9 months and after that the monitoring has been conducted yearly. The PRC has been approved by the CDM board on 01/10/2015.

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

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The crediting period has been changed from: 24/11/2011 – 23/11/2021 to 01/04/2012 – 31/03/2022 (Fixed).
The change has been approved: http://cdm.unfccc.int/Projects/DB/SGS-UKL1287587238.03/view

B.2.4. Inclusion of monitoring plan

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No inclusion of a monitoring plan into the PDD was submitted together with this monitoring report.

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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A PRC was approved in 01/10/2015.

B.2.6. Changes to project design

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Changes to project design of registered project activity have been made during the first monitoring period. This PRC is related to the change in first monitoring period and the PRC was approved on 01/10/2015.

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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SKG Sangha has developed a system of installing and maintaining the biogas units. The operational and monitoring plan builds on this experience. Monitoring is done in a hierarchical manner with a large number at the village level reporting to and supervised by a small team at each taluk in turn reporting to the project coordinator and his team at the main office.
The scheme below shows the distribution of monitoring tasks and responsibilities between different levels of project implementation: the project level (the main SKG Sangha office: project coordinator with a team), the taluk level (supervisor with a team) and the village level (motivator).

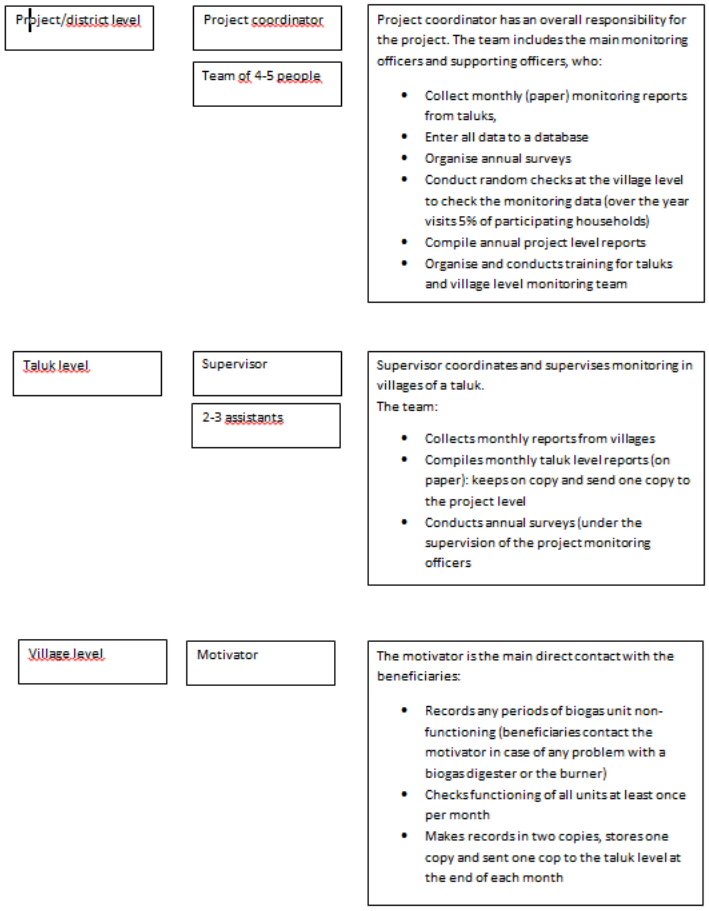
In each village cluster where SKG Sangha starts installing biodigesters, a local person is selected to be the motivator. The motivators are trained in how to:

- supervise project implementation in the village;
- maintain and repair the biogas units;
- monitor the functionality of biogas units;
- keep records; and
- report to Taluk level

A number of separate training sessions are also run for the households who have biodigesters installed to ensure that beneficiaries use their units correctly. All users receive training from SKG Sangha for the use of the digester as soon as it is installed. The motivator participates in the training sessions to ensure all beneficiaries are familiar with the main contact in the village. The beneficiaries are instructed to report any faults or problems with the units to the motivator.
During installation the household signed three pieces of paper to confirm that the masonry work, the pipe fitting work and the overall biodigester has been installed satisfactorily. A technician from SKG Sangha checked the unit once it has been installed to ensure the biogas unit has been installed correctly and this information was then recorded and logged in SKG Sangha's records as well as in paper monitoring journals of the relevant motivator. The records also include information on the size of each unit – whether it is a 3 m^3 unit or a 2 m^3 unit. During project implementation, SKG Sangha made records of every biogas unit installed, and calculation of real emission reductions may be adjusted according to the actual ratio of 2 m^3 and 3 m^3 biogas units if the ratio turns out to be slightly different than is currently planned. Each biodigester is given a unique identification marking to indicate:

- who sponsored the biodigester;
- who built the biodigester;
- which year the biodigester was built in; and
- which number biodigester it is for that village for that year.

Monitoring scheme



Monitoring of biogas unit functionality

Once the unit is installed and checked by the technician, the motivator marks the start of unit operation. Beneficiaries are instructed to report any faults or problems with a biodigester or a burner to the motivator. Normally any problems with the biogas units will be resolved the same day as the original complaint. The motivator will record any periods (in days) when the unit was not operating. Households also have a separate pre-paid post form that they can send directly to SKG Sangha to inform SKG Sangha of any problems in the event that they experience any problems with their village representative. The fact that households make an in-kind contribution to the construction of biogas units also makes them more interested in making proper use of these units. Besides recording problems, the motivator will check all project units in the village at least once per month to record whether they are functioning properly. The records will be made by handwriting, on two copies of a monitoring journal. At the end of each month one copy will be delivered to the taluk level monitoring team, and one copy remains with the motivator.

The taluk level monitoring team collects monitoring journals from the villages in their taluk, and compiles monthly taluk-level reports, which include:

- Number of units that started operations before the monitoring period (i.e. before the beginning of the relevant monitoring month), separately for 2 m^3 and 3 m^3 sizes;
- Detailed records of units installed during the monitoring month, including the location, the beneficiary, the size of the biodigester, and the date of start of operations;
- Sum of non-operational days of a 2 m^3 unit and a 3 m^3 unit (i.e. if there were 10 units of 2 m^3 size that were not operational for 1 day, the record is that a 2 m^3 unit was not operational for 10 days.

The monthly reports are made in two copies, one of which is delivered to the project level (main SKG Sangha office), and another one remains at the taluk level.

The project level monitoring team collects the monthly reports. Throughout the year it makes random visits to villages to check whether the data recorded by the motivator is correct.

The project level monitoring team enters all data into the central project database, which includes:

- Records of every unit installed, including the location, the beneficiary, the size of the biodigester, the date of start of operations, and the end of operations in case the unit broke down.
- Records of non-operational days, separately for 2 m^3 and 3 m^3 sizes, for every village (corrected after the random visits if needed).

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

(Copy this table for each data or parameter.)

Data/Parameter	**$\rho_{kerosene}$**
Unit	kg/l (kilogrammes per litre)
Description	Density of kerosene
Source of data	http://www.simetric.co.uk/si_liquids.htm
Value(s) applied	0.817
Choice of data or measurement methods and procedures	Default value
Purpose of data/parameter	Calculation of Baseline and Project Emissions
Additional comments	N.A.

Data/Parameter	**$NCV_{kerosene}$**
Unit	TJ/Gg (terajoules per gigagram)
Description	Net calorific value of kerosene
Source of data	Table 1.2 in 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 1.
Value(s) applied	43.8
Choice of data or measurement methods and procedures	Default value
Purpose of data/parameter	Calculation of Baseline and Project Emissions
Additional comments	-

Data/Parameter	**$EF_{kerosene}$**
Unit	Kg CO_2/TJ (kilogrammes of CO_2 per terajoule)
Description	Emission factor from burning kerosene in households
Source of data	Table 2.5 in 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 2.
Value(s) applied	71,900
Choice of data or measurement methods and procedures	Default value
Purpose of data/parameter	Calculation of Baseline and Project Emissions
Additional comments	Default emissions factor for stationary combustion in the residential category suggested by IPCC. This value is used for calculating BEkerosene. For BE_{NRB}, the default value specified in AMS I.E, 71,500 kg CO2/TJ, is used. For Project Emissions based on AMS.I.C, as per defined tool the upper value of 73,700 kg CO2/TJ for kerosene is used.

Data/Parameter	$F_{kerosene, baseline}$
Unit	L (litres)/year
Description	Annual amount of kerosene used for cooking and starting fires in an average household
Source of data	Baseline Survey
Value(s) applied	24.12
Choice of data or measurement methods and procedures	Survey
Purpose of data/parameter	Calculation of Baseline Emissions
Additional comments	

Data/Parameter	f_{NRB}
Unit	Dimensionless
Description	Fraction of biomass used in the absence of project activity that can be established as non-renewable biomass using survey methods
Source of data	”Inventorying, Mapping and Monitoring of Bioresources Using GIS and Remote Sensing” study (Ramachandra and Rao 2005)
Value(s) applied	0.78
Choice of data or measurement methods and procedures	The study by Ramachandra and Rao is both recent and specific to Kolar District. It uses remote sensing data analyses, field surveys involving village level inventorying of the tree diversity and mapping of resources using geographic information systems and global positioning systems in villages in the project area. The 0.78 value is obtained from the average bioresource availability to demand ratio for the Taluks in Kolar District
Purpose of data/parameter	Calculations of Baseline and Project Emission
Additional comments	N.A.

Data/Parameter	$B_{Biomass, Baseline}$
Unit	Tonnes/year
Description	Quantity of biomass that is substituted or replaced in an average household
Source of data	Baseline survey
Value(s) applied	4.74
Choice of data or measurement methods and procedures	Baseline Survey
Purpose of data/parameter	Calculations of Baseline Emissions
Additional comments	

Data/Parameter	GWP CH_4
Unit	t CO2 / t CH4 (tonnes of CO2 per tonne of CH4)
Description	Global warming potential for methane
Source of data	IPCC Guidelines for National Greenhouse Gas Inventories,
Value(s) applied	25
Choice of data or measurement methods and procedures	Default value

Purpose of data/parameter	Calculations of Baseline Emissions
Additional comments	Default value suggested by IPCC

Data/Parameter	**$N_{(T)}$**
Unit	Dimensionless (number)
Description	Number of heads per cattle species/category in an average household
Source of data	Baseline survey
Value(s) applied	2.56 for dairy cows, 1.17 for buffalos, 0.55 for other cattle
Choice of data or measurement methods and procedures	The values are defined based on a survey of a representative sample of households.
Purpose of data/parameter	Calculations of Baseline and Project Emissions
Additional comments	The parameters ensure a precision at 95% confidence level

Data/Parameter	**$VS_{(T)}$**
Unit	kg (kilogrammes) dry matter / (head * day)
Description	Daily volatile solid excreted for livestock category T
Source of data	Tables 10A-4 to 10A-6 in 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 4, Chapter 10), Biogas Technology by B.T. Nijaguna (see reference 5 in Annex 5), Table 2.12 p29.
Value(s) applied	3.8 for dairy cow, 3.1 for buffalo, 1.4 for other cattle
Choice of data or measurement methods and procedures	India specific value taken for dairy cows from Biogas Technology by B.T. Nijaguna. As nationally published values are not available for other cattle, IPCC default Indian subcontinent values are used for buffalo and other cattle.
Purpose of data/parameter	Calculation of Baseline and Project Emissions
Additional comments	Default value suggested by IPCC

Data/Parameter	**$B_{o(T)}$**
Unit	m3 CH4/kg VS (cubic meters of CH4 per kilogramme Volatile Solid)
Description	Maximum methane producing capacity for manure produced by livestock category T
Source of data	India specific value taken for dairy cows from Biogas Technology by B.T. Nijaguna (Nijaguna, B.T, Biogas Technology (New Age International (P) Ltd, 4835/24 Ansari Road, Daryaganj, New Delhi 110 002, 2002). As nationally published values are not available for other cattle, IPCC default values are used for buffalo and other cattle. Tables 10A-4 to 10A-6 in 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.15 for dairy cattle, 0.1 for buffalo and other cattle
Choice of data or measurement methods and procedures	India specific value taken for dairy cows from Biogas Technology by B.T. Nijaguna (see reference 5 in annex 5). As nationally published values are not available for other cattle, IPCC default values are used for buffalo and other cattle. Tables 10A-4 to 10A-6 in 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 10.
Purpose of data/parameter	Calculation of Baseline and Project Emissions
Additional comments	India specific value taken for dairy cows from Biogas Technology by B.T. Nijaguna. As nationally published values are not available for buffalo and other cattle, IPCC default values are used for buffalo and other cattle. Tables 10A-4 to 10A-6 in 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 10.

Data/Parameter	MCF_{manure} (MCF_{liquid}, $MCF_{liquid\ with\ crust}$ and MCF_{solid})
Unit	% (percentage)
Description	Methane correction factor for cattle manure for each manure management system S by climate region k
Source of data	Table 10.17 in 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 10.
Value(s) applied	80 for liquid/slurry manure management system (MCF_{liquid}), 50 for liquid/slurry manure management system with natural crust cover (MCF_{liquid} with crust), 5 for solid storage manure management system (MCF_{solid}).
Choice of data or measurement methods and procedures	Default value
Purpose of data/parameter	Calculation of Baseline Emissions
Additional comments	Values corresponding to average annual temperature of 29.6 □C are taken for MCFliquid and MCFliquid with crust. Temperature data was taken from the Indian Meteorological Department, Government of India.

Data/Parameter	MS_{manure} (MS_{liquid}, $MS_{liquid\ with\ crust}$, MS_{solid})
Unit	Dimensionless
Description	Fraction of livestock category T's manure handled using manure management system S in climate region k (fraction of livestock manure handled using liquid/slurry manure management system, fraction of livestock manure handled using liquid/slurry with natural crust cover and fraction of livestock manure handled using solid storage manure management system)
Source of data	Based on baseline survey
Value(s) applied	0.32 for liquid/slurry manure management system (MSliquid), 0.20 for liquid/slurry with crust cover manure management system (MSliquid with crust), 0.16 for solid storage manure management system (MSsolid)
Choice of data or measurement methods and procedures	0.32 for liquid/slurry manure management system (MSliquid), 0.20 for liquid/slurry with crust cover manure management system (MSliquid with crust), 0.16 for solid storage manure management system (MSsolid)
Purpose of data/parameter	Calculation of Baseline Emissions
Additional comments	The parameters ensure a precision at 95% confidence level.

D.2. Data and parameters monitored

(Copy this table for each data or parameter.)

Data/Parameter	$N_{operating}$
Unit	Dimensionless
Description	Number of systems (biogas units) operating
Measured/calculated/ Default	Measured
Source of data	SKG Sangha
Value(s) of monitored parameter	End of 2018: 7963 End of 2019: 7944

Monitoring equipment	N.A.
Measuring/reading/recording frequency	Continuously
Calculation method (if applicable)	N.A.
QA/QC procedures	The level of uncertainty of recording this parameter is low. The methodology requires recording the number of systems operating annually. In this case, the recording was done monthly, and any periods of non-functioning where recorded. Beneficiaries are not likely not to report faults, as any non-functioning means non availability of clean and simple cooking. Normally beneficiaries want to resolve any problems as soon as they appear. Nevertheless, monitoring team from the project level did random checks to check whether the data recorded by the motivator is correct.
Purpose of data/parameter	Baseline and Project Emission Calculation
Additional comments	

Data/Parameter	**H_{stove}**
Unit	H (hours)/year
Description	Annual hours of operation of an average system (hours of burner functioning)
Measured/calculated/ default	Measured
Source of data	Monitoring survey
Value(s) of monitored parameter	MP 01/01/2018-31/12/2018: 1161.30 h/y MP 01/01/2019-31/12/2019: 1123.80 h/y
Monitoring equipment	N.A.
Measuring/reading/recording frequency	Annually
Calculation method (if applicable)	Beneficiaries made records for a week writing down each day hours when a burner is functioning. They wrote down the time of starting cooking and finishing cooking and noted whether one or two burners were used. Average use was 3.18 h/d, thus 3.18 *365 = 1161.30 h/y. Average use was 3.18 h/d, thus 3.08 *365 = 1123.80 h/y.
QA/QC procedures	-
Purpose of data/parameter	The parameter is not used for ER calculation. The parameter is used for checking whether the biodigester produced enough biogas to substitute previous use of non-renewable biomass and kerosene.
Additional comments	The survey result shows that the digester produces enough biogas to substitute the previous energy needs.

Data/Parameter	**$F_{kerosene, project}$**
Unit	l (litres)/year
Description	Annual amount of kerosene consumed by household after installation of biogas unit
Measured/calculated/ Default	Measured
Source of data	Monitoring Survey
Value(s) of monitored parameter	MP 01/01/2018-31/12/2018: 0.00 MP 01/01/2019-31/12/2019: 0.00
Monitoring equipment	Monitoring questionnaire
Measuring/reading/recording frequency	Annually

Calculation method (if applicable)	N.A.
QA/QC procedures	Monitoring team did random checks to check whether the data recorded by the Taluk level team is reasonable.
Purpose of data/parameter	Project Emissions Calculation
Additional comments	The monitoring surveys have shown that no kerosene is consumed for cooking by households after installation of biogas units. Thus, no project emissions related to use of kerosene for cooking have to be considered in the emission reduction calculations. No kerosene is used to start the fire in water heating stove because Government is not supplying subsidised kerosine and hence people stopped using.

Data/Parameter	**$B_{biomass, project}$**
Unit	T (Tonnes) /year
Description	Consumption of fuel wood for cooking in households participating in the project activities
Measured/calculated/ default	Measured
Source of data	Monitoring Survey
Value(s) of monitored parameter	MP 01/01/2018-31/12/2018: 0.071 MP 01/01/2019-31/12/2019: 0.033
Monitoring equipment	Spring balance was used to measure the weight of the fuel wood used on the day of the monitoring survey for different uses and the same was recorded
Measuring/reading/recording frequency	Annually
Calculation method (if applicable)	N.A.
QA/QC procedures	-Monitoring team did random checks to check whether the data recorded by the Taluk level team is reasonable
Purpose of data/parameter	Project Emission calculations
Additional comments	Statistical precision has not been met - there are only 14 data sets out of 269. The monitoring surveys have shown that very little amount of biomass is consumed for cooking by households after installation of biogas units. Thus, project emissions related to use of biomass have to be considered in the emission reduction calculations (see section E.2 component 2: Non-renewable biomass component).

Data/Parameter	**$B_{biomass, non-project}$**
Unit	T (tonnes)/year
Description	Consumption of fuel wood in households not participating in the project activities.
Measured/calculated/ default	Calculated
Source of data	Monitoring Survey
Value(s) of monitored parameter	MP 01/01/2018-31/12/2018: 5.06 MP 01/01/2019-31/12/2019: 4.76
Monitoring equipment	The amount of fuel wood used for different uses was measured using spring balance on the day the monitoring survey in sampled HH and in the remaining HH it has been decided with discussion with the HH members.
Measuring/reading/recording frequency	Survey of 122 and 150 non-project households that use fuel wood for each period. The surveys are carried out once per monitoring period by the taluk level monitoring team.

<table>
<tr><td>Calculation method
(if applicable)</td><td>N.A.</td></tr>
<tr><td>QA/QC procedures</td><td>Monitoring team from the project level does random checks to check whether the data recorded by the taluk level team is reasonable and correct.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of fuel wood leakage</td></tr>
<tr><td>Additional comments</td><td>The non-project households are survey to make sure that there is no increase in fuel wood consumption in non-project households due to higher fuel wood availability based on project activity.
Following fuel wood consumption was measured in the baseline and in the non-project households.

MP 01/01/2018-31/12/2018
<table>
<tr><td>Item</td><td>Baseline HH fuel wood consumption</td><td>Non-Project HH fuel wood consumption</td></tr>
<tr><td>Firewood use for cooking in Kg/day</td><td>12.9</td><td>9.39</td></tr>
<tr><td>Firewood use for water heating</td><td>8.6</td><td>4.48</td></tr>
<tr><td>Total firewood use</td><td>21.5</td><td>13.87</td></tr>
</table>
MP 01/01/2019-31/12/2019
<table>
<tr><td>Item</td><td>Baseline HH fuel wood consumption</td><td>Non-Project HH fuel wood consumption</td></tr>
<tr><td>Firewood use for cooking in Kg/day</td><td>12.9</td><td>8.96</td></tr>
<tr><td>Firewood use for water heating</td><td>8.6</td><td>4.07</td></tr>
<tr><td>Total firewood use</td><td>21.5</td><td>13.03</td></tr>
</table>
It is clear that that the consumption of firewood from cooking and for water heating in the non-project households is lower than in the baseline, and thus there is no leakage due to project activity.</td></tr>
</table>

Data/Parameter	**$N_{(T)}$**
Unit	Dimensionless (number)
Description	Annual average animal population in a household (number of heads of dairy cow, buffalo and other cattle).
Measured/calculated/ default	Calculated
Source of data	Monitoring Survey
Value(s) of monitored parameter	MP 01/01/2018-31/12/2018: 2.61 for dairy cows 0.08 for buffalos 0.04 for other cattle MP 01/01/2019-31/12/2019: 2.43 for dairy cows 0.09 for buffalos 0.04 for other cattle
Monitoring equipment	Monitoring Questionnaire
Measuring/reading/recording frequency	Annually
Calculation method (if applicable)	N.A.
QA/QC procedures	-

Purpose of data/parameter	Calculations of Baseline and Project Emissions
Additional comments	-

Data/Parameter	**$B_{manure,generated}$**
Unit	T (Tonnes)
Description	Average amount of animal manure generated per household per year.
Measured/calculated/ default	Measured
Source of data	Monitoring Survey
Value(s) of monitored parameter	MP 01/01/2018-31/12/2018: 17.48 MP 01/01/2019-31/12/2019: 16.42
Monitoring equipment	Amount of total dung generated is not measured but the dung generated in the confinement area is measured using spring balance. The basket used to handle the dung is measured with dung in it in sampled HHs and in the remaining HH the baskets were counted by discussion with the HH members. Dung excreted when the animals were grazing was decided based on the information provided by the HH members.
Measuring/reading/recording frequency	Annually
Calculation method (if applicable)	Total Dung form shed produced (kgs/day) times days per year: 47.89 * 365/1000 = 17.48 44.98 * 365/1000 = 16.42
QA/QC procedures	One day accumulation of dung in the confined shed area in selective households was measured. In other households the basket in which HH collects the dung is measured.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	**$B_{manure,fed}$**
Unit	T (Tonnes)/year
Description	Average amount of animal manure fed into biogas digester per year.
Measured/calculated/ default	Measured
Source of data	Monitoring Survey
Value(s) of monitored parameter	MP 01/01/2018-31/12/2018: 16.70 MP 01/01/2019-31/12/2019: 16.13
Monitoring equipment	The amount of dung fed into the biogas plant is measured using spring balance on the day of the monitoring survey in sampled HHs. The basket used to handle the dung is measured with dung in it in sampled HHs and in the remaining HH the baskets were counted by discussion with the HH members.
Measuring/reading/recording frequency	Annually
Calculation method (if applicable)	Out of 47.89 kg generated in the shed 45.75 kg will be fed to the biogas plant and the remaining 2.14 kg per day will be dumped in the compost pits. 45.75 * 365/1000 = 16.70 tons/y will be fed to biogas plant. Out of 44.98 kg generated in the shed 44.18 kg will be fed to the biogas plant and the remaining 0.80 kg per day will be dumped in the compost pits. 44.18 * 365/1000 = 16.13 tons/y will be fed to biogas plant.
QA/QC procedures	One day accumulation of dung in the confined shed area in selective households was measured. In other households the basket in which HH collects the dung is measured.

Purpose of data/parameter	Calculations of baseline emissions
Additional comments	-

Data/Parameter	**Application of sludge**
Unit	n/a (qualitative information)
Description	Proper application of the sludge from the biogas unit
Measured/calculated/ default	Measured
Source of data	Survey of a sample of households by SKG Sangha (taluk level monitoring team)
Value(s) of monitored parameter	MP 01/01/2018-31/12/2018: 100% 6.53 tons/year MP 01/01/2019-31/12/2019: 100% 6.97 tons/year
Monitoring equipment	Survey
Measuring/reading/recording frequency	Yearly
Calculation method (if applicable)	-
QA/QC procedures	Monitoring team from the project level randomly checked the data collected and found to be reasonable.
Purpose of data/parameter	The data is not used for calculation of emission reductions but to check if the produced slurry is applied to the agricultural lands
Additional comments	SKG Sangha has conducted number of training programmes with the beneficiaries and trained them on application of sludge. The monitored results can be found in the ER spread sheet Kolar 6 and Kolar 7 under the monitoring survey excel page under the column BA.

D.3. Implementation of sampling plan

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Description of implemented sampling design

Taluk level monitoring teams carried out an annual survey of a sample of beneficiaries to determine the following parameters and information

- Annual hours of operation of a unit (operation of a burner)
- Annual amount of kerosene used
- Annual amount of fuel wood used
- Animal population per household (for each type of cattle)
- Amount of manure generated on the farm
- Amount of animal manure fed into the system
- Proper soil application of the final sludge

For monitoring period 01/01/2018-31/12/2018

269 households have been surveyed

Sample size:

According to the data collected during this monitoring period the maximum sample size for any of the sampling parameter was 200. Hence a sample size of 200 has been taken to collect the data for MP 01/01/2018-31/12/2018 and 269 households were surveyed to cover all 2 & 3 size samples (211 samples for 2 size and 58 samples for 3 size). Therefore, the surveys collected per units (78% of 2 size vs 22% of 3 size) have the same share as installed units (78% of 2 size vs 22% of 3 size).

The sample size has been calculated with 90% precision and 10% error as mentioned in the methodology using the following formula:
n = (Zα/2 * σ/E)2
Where:
N= sample size
Zα/2 = required precision value. i.e 1.65 for 90% precision
σ = standard deviation of the parameter
E= 10% of the average monitored value

Drawing of sample: sample size has been decided as 200. There are 5 taluks in Kolar district. Project units have been installed in all the 5 taluks. Basing on the number of units installed in that particular taluk the sample size has been decided on pro rata basis. There were 7963 units meant for this verification period (number of plants that were installed and functioning until 31/12/2018). Out of these 7963 units there were 1783 plants with 3 cubic meter capacity and 6180 plants of 2 cubic meter size.

Precision: All the parameters were calculated with 95% confidence and 5% deviation. The surveyed data has been fed to the Excel sheet. Using Microsoft Excel formulas total and average value has been drawn for all the parameters which are having numeric values. Later in the same way standard deviation and square root for the number of surveyed households was calculated. Using the statistical methodology, the net value has been derived. The standard deviation has been divided with the square root of HH surveyed and the resultant has been multiplied with 1.96 (the number for the 95% confidence level) later the product has been deducted from the average value to get the net value.

According to the "Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities" (EB 65, Annex 2)" the sample size shall be chosen for a 95/10 level of precision (a 95% confidence interval and 10% margin of error). According to the baseline survey the maximum sample size is 155. It is planned to survey 200 households to get a better precision. To cover all the 2 and 3 size units the number of surveyed households went up to 269.

The following formula has been used to know whether the data collected achieved the desired precision:

n = (Zα/2 * σ/E)2
Where:
n = the sample size
Zα/2= 1.96 for a confidence interval of
95% σ = the standard deviation
E = the maximum error of estimate – in this case 10% of the average value of the specific parameter

The following table shows the different parameters and required sample size for those parameters with justification:

Sl	Parameter	Average	Standard Deviation	Required sample size	Justification
1	Amount of fuel wood used for cooking in kg/day/HH	0.13	0.57	5397	Not met - there are only 14 data sets out of 269
2	Kerosene used to start fire	0.0	0.0	-	Not accounted
3	Amount of dung generated - Kg/day/HH	47.89	17.09	34	Precision met
4	Animal confinement time	23.65	1.29	1	Precision met
5	Total heads of cattle - number/HH	2.83	1.53	78	Precision met
6	Dairy cow -number/HH	2.61	1.45	84	Precision met
7	Buffalo -number/HH	0.13	0.47	3268	Not met - there are only 23 data sets out of 269 and standard deviation is higher than the average and hence no relevance.

8	Other cattle -number/HH	0.09	0.41	5796	There were 12 samples out of 269 i.e. less than 50%. Hence no relevance
9	Dung entering into pit – kg/day/HH	2.14	8.57	4337	There were 18 samples out of 269 i.e. less than 50%. Hence no relevance

Valid maximum sample size required for parameters that affect the ERs is 96, number of dairy cows in a household whereas the monitoring survey captured data from 285 sampled households. From the above table it is clear that the monitoring survey achieved desired precision and sample size.

The following table will provide the information about the sample deduction:

Monitorig plan and installed units				
Sl	Taluk	2 Cu.M	3 Cu.M.	Total
1	BANGARAPET	2055	483	2538
2	KOALR	831	241	1072
3	MALUR	493	152	645
4	MULABAGAL	1684	496	2180
5	SRINIVASAPUR	1117	411	1528
Totals		6180	1783	7963

Planned sample size				200
Sl	Taluk	2 Cu.M	3 Cu.M.	Total
1	BANGARAPET	51.6	12.1	63.7
2	KOALR	20.9	6.1	26.9
3	MALUR	12.4	3.8	16.2
4	MULABAGAL	42.3	12.5	54.8
5	SRINIVASAPUR	28.1	10.3	38.4
Totals		155.2	44.8	200

Actual Monitored Samples					
Sl	Taluk	2 Cu.M	3 Cu.M.	not counted	Total
1	BANGARAPET	63	12	0	75
2	KOALR	22	6	0	28
3	MALUR	3	1	0	4
4	MULABAGAL	59	21	0	80
5	SRINIVASAPUR	64	18	0	82
Totals		211	58	0	269

Monitoring survey started in the month of September 2018 and continued until December 2018. The monitoring period is from 01/01/2018 to 31/12/2018. By the time the monitoring survey has been stated all the plants were installed. To decide the sample size for each taluk an anticipated units installation until the end of the monitoring period has been considered and sample size for each taluk has been decided. Above 1st table shows the anticipated sample size for each taluk.

Later table above shows the actual plants installed and whether the sample size for the actual installed units is sufficient or not. From the above table it is clear that the actual installed units and the sample of HH surveyed is sufficient.

As per plan above villages where the plants have been installed were selected randomly covering most of the area of the taluk. Once the village has been selected randomly, all the plants in that village have been monitored. To monitor the required number of 2/3 size plants more villages has been added to the monitoring list. Total 269 plants have been surveyed to achieve the required numbers.

The survey has been conducted over a period of almost three months from 18/09/2018 – 29/12/2018. Every day a few plants were surveyed until the required number of plants was reached. The precision level achieved is 95% confidence.

The maximum sample size required for any parameter that affects the ER calculation in this monitoring period is 84 (number of dairy cows in a household). Whereas 269 HH were surveyed to get more accurate data.

Surveys of non-project households

Taluk level monitoring teams has surveyed 122 non-project households in the project area to determine the amount of biomass uses for various purposes, the sources of biomass and trends in sourcing the biomass

According to the number of units installed in that particular taluk the sample of non-project households was taken. Randomly households were visited by the monitoring team with pre-printed survey sheets and data has been collected.

The non-project households were surveyed to make sure that there is no increase in fuel wood consumption of non-project households due to higher fuel wood availability because of the project activity. Following fuel wood consumption was measured in the baseline and in the non-project households. The collected data has been fed to Excel sheet and net values have been arrived at 95% confidence level.

Item	Baseline HH	Non-Project HH	Units	Source
Firewood use for cooking	12.9	9.39	Kg/d	Baseline and monitoring surveys
Firewood use for water heating	8.6	4.48	Kg/d	Baseline and monitoring surveys
Total firewood use	21.5	13.87	Kg/d	Calculated

It is clear that that the consumption of firewood from cooking and for water heating in the non-project households is lower than in the baseline, and thus there is no leakage due to project activity. Demonstration on whether the required confidence/precision has been met

To achieve 90% confidence and at 10% margin of error number of non-project households to be surveyed is 58 (Baseline Survey). According to the non-project HH survey carried out during this monitoring survey the maximum sample size required is 48 (fuel wood consumption for water heating). 112 households have been surveyed to achieve more accuracy.

For monitoring period 01/01/2019-31/12/2019

282 households have been surveyed

Sample size:
According to the data collected during this monitoring period the maximum sample size for any of the sampling parameter was 200. Hence a sample size of 200 has been taken to collect the data for the monitoring period 01/01/2019-31/12/2019 and 282 households were surveyed to cover all 2 & 3 size samples (212 samples for 2 size and 70 samples for 3 size, 2 surveys were not counted). Therefore, the surveys collected per units (75% of 2 size vs 25% of 3 size) have almost the same share as installed units (78% of 2 size vs 22% of 3 size).

The sample size has been calculated with 90% precision and 10% error as mentioned in the methodology using the following formula:
$n = (Z\alpha/2 * \sigma/E)2$
Where:
N= sample size
$Z\alpha/2$ = required precision value. i.e 1.65 for 90% precision
σ = standard deviation of the parameter
E= 10% of the average monitored value

Drawing of sample: sample size has been decided as 200. There are 5 taluks in Kolar district. Project units have been installed in all the 5 taluks. Basing on the number of units installed in that particular taluk the sample size has been decided on pro rata basis. There were 7944 units meant for this verification period (number of plants that were installed and functioning until 31/12/2019). Out of these 7944 units there were 1781 plants with 3 cubic meter capacity and 6163 plants of 2 cubic meter size.

Precision: All the parameters were calculated with 95% confidence and 5% deviation. The surveyed data has been fed to the Excel sheet. Using Microsoft Excel formulas total and average value has been drawn for all the parameters which are having numeric values. Later in the same way standard deviation and

square root for the number of surveyed households was calculated. Using the statistical methodology, the net value has been derived. The standard deviation has been divided with the square root of HH surveyed and the resultant has been multiplied with 1.96 (the number for the 95% confidence level) later the product has been deducted from the average value to get the net value.

According to the "Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities" (EB 65, Annex 2)" the sample size shall be chosen for a 95/10 level of precision (a 95% confidence interval and 10% margin of error). According to the baseline survey the maximum sample size is 155. It is planned to survey 200 households to get a better precision. To cover all the 2 and 3 size units the number of surveyed households went up to 282.

The following formula has been used to know whether the data collected achieved the desired precision:

o = (Zα/2 * σ/E)2
Where:
n = the sample size
Zα/2= 1.96 for a confidence interval of
95% σ = the standard deviation
E = the maximum error of estimate – in this case 10% of the average value of the specific parameter

The following table shows the different parameters and required sample size for those parameters with justification:

Sl	Parameter	Average	Standard Deviation	Required sample size	Justification
1	Amount of fuel wood used for cooking in kg/day/HH	0.05	0.35	13744	Not met - there are only 6 data sets out of 282
2	Kerosene used to start fire	0.0	0.0	-	Not accounted
3	Amount of dung generated - Kg/day/HH	44.98	15.03	30	Precision met
4	Animal confinement time	23.37	1.74	2	Precision met
5	Total heads of cattle - number/HH	2.67	1.28	62	Precision met
6	Dairy cow -number/HH	2.43	1.27	74	Precision met
7	Buffalo -number/HH	0.16	0.57	3515	Not met - there are only 26 data sets out of 282 and standard deviation is higher than the average and hence no relevance.
8	Other cattle -number/HH	0.09	0.40	6088	There were 12 samples out of 282 i.e. less than 50%. Hence no relevance
9	Dung entering into pit – kg/day/HH	0.80	7.66	24862	There were 16 samples out of 282 i.e. less than 50%. Hence no relevance

Valid maximum sample size required for parameters that affect the ERs is 74, number of dairy cows in a household whereas the monitoring survey captured data from 282 sampled households. From the above table it is clear that the monitoring survey achieved desired precision and sample size.

The following table will provide the information about the sample deduction:

Monitorig plan and installed units				
Sl	Taluk	2 Cu.M	3 Cu.M.	Total
1	BANGARAPET	2054	483	2537
2	KOALR	827	241	1068
3	MALUR	493	152	645
4	MULABAGAL	1684	496	2180
5	SRINIVASAPUR	1105	409	1514
Totals		6163	1781	7944

Planned sample size				200
Sl	Taluk	2 Cu.M	3 Cu.M.	Total
1	BANGARAPET	51.7	12.2	63.9
2	KOALR	20.8	6.1	26.9
3	MALUR	12.4	3.8	16.2
4	MULABAGAL	42.4	12.5	54.9
5	SRINIVASAPUR	27.8	10.3	38.1
Totals		155.2	44.8	200

Actual Monitored Samples					
Sl	Taluk	2 Cu.M	3 Cu.M.	not counted	Total
1	BANGARAPET	99	15	0	114
2	KOALR	18	8	0	26
3	MALUR		1	0	1
4	MULABAGAL	58	27	0	85
5	SRINIVASAPUR	37	19	0	56
Totals		212	70	0	282

Monitoring survey started in the month of September 2019 and continued until December 2019. The monitoring period is from 01/01/2019 to 31/12/2019. By the time the monitoring survey has been stated not all the plants were installed. To decide the sample size for each taluk an anticipated units installation until the end of the monitoring period has been considered and sample size for each taluk has been decided. Above 1st table shows the anticipated sample size for each taluk.

Later table above shows the actual plants installed and whether the sample size for the actual installed units is sufficient or not. From the above table it is clear that the actual installed units and the sample of HH surveyed is sufficient.

As per plan above villages where the plants have been installed were selected randomly covering most of the area of the taluk. Once the village has been selected randomly, all the plants in that village have been monitored. To monitor the required number of 2/3 size plants more villages has been added to the monitoring list. Total 285 plants have been surveyed to achieve the required numbers.

The survey has been conducted over a period of almost three months from 16/09/2019 – 31/12/2019. Every day a few plants were surveyed until the required number of plants was reached. The precision level achieved is 95% confidence.

The maximum sample size required for any parameter that affects the ER calculation in this monitoring period is 74 (number of dairy cows in a household). Whereas 282 HH were surveyed to get more accurate data.

Surveys of non-project households

Taluk level monitoring teams has surveyed 150 non-project households in the project area to determine the amount of biomass uses for various purposes, the sources of biomass and trends in sourcing the biomass

According to the number of units installed in that particular taluk the sample of non-project households was taken. Randomly households were visited by the monitoring team with pre-printed survey sheets and data has been collected.

The non-project households were surveyed to make sure that there is no increase in fuel wood consumption of non-project households due to higher fuel wood availability because of the project activity. Following fuel wood consumption was measured in the baseline and in the non-project households. The collected data has been fed to Excel sheet and net values have been arrived at 95% confidence level.

Item	Baseline HH	Non-Project HH	Units	Source

Firewood use for cooking	12.9	8.96	Kg/d	Baseline and monitoring surveys
Firewood use for water heating	8.6	4.07	Kg/d	Baseline and monitoring surveys
Total firewood use	21.5	13.03	Kg/d	Calculated

It is clear that that the consumption of firewood from cooking and for water heating in the non-project households is lower than in the baseline, and thus there is no leakage due to project activity. Demonstration on whether the required confidence/precision has been met
To achieve 90% confidence and at 10% margin of error number of non-project households to be surveyed is 58 (Baseline survey). According to the non-project HH survey carried out during this monitoring survey the maximum sample size required is 54 (fuel wood consumption for water heating). 150 households have been surveyed to achieve more accuracy.

SECTION E. Calculation of emission reductions or net anthropogenic removals

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

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For component 1: Kerosene component

Description: The project activity generates thermal heat through bio-digesters in rural households in the Kolar district. That heat would have been otherwise generated by burning kerosene and fuel wood for cooking purposes.

Baseline emissions from burning kerosene ($BE_{kerosene}$ in *tCO2e*) are determined based on the amount of kerosene that has been displaced, its density, net calorific value and the emissions factor for stationary combustion of kerosene in the residential category according to AMS-I.C “Thermal energy for user with or without electricity”, version 18. Only the kerosene used for cooking and staring fire was taken into account for the baseline calculations.

$BE_{kerosene} = F_{kerosene,\ baseline} * N * \rho_{kerosene} * NCV_{kerosene} * EF_{kerosene} * 10^{-9}$ (1)	
$BE_{kerosene}$	Baseline emissions from burning of kerosene for household cooking needs (t CO_2e/year)
$F_{kerosene,baseline}$	Annual amount of kerosene used for cooking in an average household participating in the Kolar Biogas Project (l/year)
N	Number of devices (biodigesters)
$\rho_{kerosene}$	Kerosene density (kg/l)
$NCV_{kerosene}$	Net calorific value of kerosene (TJ/Gg)
$EF_{kerosene}$	Emissions factor of kerosene (kg CO_2/TJ)

Calculation applying the actual values:

Parameter	Value	Unit	Source
$F_{kerosene,\ baseline}$	24.10	L/year	Baseline Survey
N	8000	Number of bio-digesters	Taluk level reports
$\rho_{kerosene}$	0.817	Kg/l	IPCC
$NCV_{kerosene}$	43.8	TJ/Gg	IPCC 2006 T.1.2
$EF_{kerosene}$	71,900	kg CO2/TJ	IPCC 2006 T.2.5

Therefore:

For monitoring period 01/01/2018-31/12/2018

$BE_{kerosene}$ = 24.10 l * 7963 * 0.817kg/l * 43.8TJ/t * 71,900kg CO_2/TJ * 10^{-9} = 494 t /CO_2e/y BE for 1 unit per day: 494/7963/365 = 0.00017 t /CO_2e/day

Total Baseline Emissions from use of Kerosene for this monitoring period = 0.00017 *2906495 (total functioning days) = **493.82 t CO_2e**

Kerosene used for cooking and used as start-up fuel is considered to calculate baseline emissions. Whatever the amount of kerosene use for cooking and used as startup fuel by the households is treated as leakage. In this monitoring period kerosene use for cooking by the project households found to be '0' and kerosene use to start fire in wood stove is found to be 0, therefore no leakage for this source.

For monitoring period 01/01/2019-31/12/2019

$BE_{kerosene}$ = 24.10 l * 7944 * 0.817kg/l * 43.8TJ/t * 71,900kg CO_2/TJ * 10^{-9} = 493 t /CO_2e/y BE for 1 unit per day: 493/7944/365 = 0.00017 t /CO_2e/day

Total Baseline Emissions from use of Kerosene for this monitoring period = 0.00017 *2899560 (total functioning days) = **492.64 t CO_2e**

Kerosene used for cooking and used as start-up fuel is considered to calculate baseline emissions. Whatever the amount of kerosene use for cooking and used as startup fuel by the households is treated as leakage. In this monitoring period kerosene use for cooking by the project households found to be '0' and kerosene use to start fire in wood stove is found to be 0, therefore no leakage for this source.

For component 2: Non-renewable biomass component

Description: The project activity generates thermal heat through bio-digesters in rural households in the Kolar district. That heat would have been otherwise generated by burning fuelwood and kerosene for cooking purposes.

Baseline emissions from burning non-renewable biomass (BE_{NRB} in *tCO2e*) are calculated based on the use of the biomass (fuel wood) that is replaced, the fraction of the biomass that is non-renewable, and the emissions factor of kerosene as a projected alternative fuel (according to AMS-I.E "Switch from non-renewable biomass for thermal applications by the user") The following formula is for one device (biodigester):

$BE_{NRB} = B_{biomass,\ baseline} * N * f_{NRB} * NCV_{biomass} * EF_{kerosene} * 10^{-3}$ (2)	
BE_{NRB}	Baseline emissions from the combustion of non-renewable part of the fuel wood used for cooking in households (t CO_2e/year)
$B_{biomass\ ,baseline}$	Quantity of biomass per household that is substituted or replaced in an average household (t/year)
N	Number of households
f_{NRB}	Fraction of biomass used in the absence of project activity that can be established as non-renewable biomass using survey methods
$NCV_{biomass}$	Net calorific value of the non-renewable biomass that is substituted (TJ/tonne). Default value of 0.015 TJ/tonne specified in AMS I.E. is used.
$EF_{kerosene}$	Emissions factor for kerosene combustion in households as kerosene is the most reasonable projected fossil fuel in the absence of project activity (kg CO_2/TJ). Default value for kerosene of 71.500 kg CO_2/TJ as per AMs. I .E is used.

Calculation applying the actual values:

For monitoring period 01/01/2018-31/12/2018

The following values are used:

Parameter	Value	Unit	Source

$B_{biomass, baseline}$	4.74	T/year	Baseline Survey
N	7963	Units	Taluk level reports
f_{NRB}	0.78	%	Study by Ramachandra and Rao 2005
$NCV_{biomass}$	0.015	TJ/t	IPCC 2006 T.1.2
$EF_{kerosene}$	71,500	kg CO2/TJ	AMS I.E.

Therefore:
BE = 4.74 t * 7963 * 0.78 * 0.015 TJ/t * 71,500kg CO_2/TJ * 10^{-3} = 31,595 **t /CO_2e/y** BE for 1 unit per day: 31,595/7963/365 = 0.0109 t /CO_2e/d

Total Baseline Emissions from use of wood fuel for this monitoring period = 0.0109 * 2906495 (average functioning days/unit) = **31,594.99 t/CO_2e**

Firewood use for water heating and other purpose is monitored to know whether savings in cooking lead to increased use for water heating and found that there is no leakage. Apart from this it is found that few households are using biogas for water heating. In the baseline firewood use for cooking alone is considered for ER calculations.

For monitoring period 01/01/2019-31/12/2019

The following values are used:

Parameter	Value	Unit	Source
$B_{biomass, baseline}$	4.74	T/year	Baseline Survey
N	7944	Units	Taluk level reports
f_{NRB}	0.78	%	Study by Ramachandra and Rao 2005
$NCV_{biomass}$	0.015	TJ/t	IPCC 2006 T.1.2
$EF_{kerosene}$	71,500	kg CO2/TJ	AMS I.E.

Therefore:
BE = 4.74 t * 7944 * 0.78 * 0.015 TJ/t * 71,500kg CO_2/TJ * 10^{-3} = 31,520 **t /CO_2e/y** BE for 1 unit per day: 31,520/7944/365 = 0.0109 t /CO_2e/d

Total Baseline Emissions from use of wood fuel for this monitoring period = 0.0109 * 2899560 (average functioning days/unit) = **31,519.60 t/CO_2e**

Firewood use for water heating and other purpose is monitored to know whether savings in cooking lead to increased use for water heating and found that there is no leakage. Apart from this it is found that few households are using biogas for water heating. In the baseline firewood use for cooking alone is considered for ER calculations.

For component 3: Cattle manure component
The project activity avoids the methane emissions from cattle manure that would have otherwise been left to decay under clearly anaerobic conditions in pits. The manure is used instead in controlled combustion for biogas generation.

Baseline emissions (BE_{manure} in *tCO2e*) are determined according AMS-III.R "Methane recovery in agricultural activities at the household/small farm level", version 1.
This methodology does not provide an equation. Instead it states that emission reductions should be calculated using the Tier 2 approach from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories). Emission factors for manure of different cattle categories (dairy cows, buffalo and other cattle) are calculated based on nationally published (where available) and IPCC default values (where nationally published values are not available) for volatile solid excreted by each animal category, maximum methane producing capacity for manure of each animal category, methane correction factors for liquid/slurry,

liquid/slurry with natural crust cover and solid storage manure management systems in a warm climate with average temperature of 29.7°C and fractions of total manure handled in these manure management systems.

The proposed project will involve N households and will avoid methane emissions which has to be converted into CO_{2e} with the global potential warming for methane:

$BE_{manure} = \sum_{(T)}(EF_T * N_T) * N * GWP\_CH_4/1000$ (3)	
BE_{manure}	Baseline emissions from methane emissions from anaerobic decay of manure (t CO_2e/year)
T	Species/category of livestock
EF_T	Emissions factor for a defined livestock population (category T), (kg CH_4/animal/year)
N_T	The number of head of livestock species/category T in an average household
N	Number of households involved in the project
GWP_CH_4	Global potential warming for methane

The proposed project lies in one climate region. The manure management system is different at different times of the year. The formula used for EF_T is:

$EF_{(T)} = VS_{(T)} * 365 * B_{o(T)} * 0.67\ kg/m^3 * (\frac{MCF\ liquid}{100} * MS_{liquid} + \frac{MCF\ liquid\ with\ crust}{100} * MS_{liquid\ with\ crust} + \frac{MCF_{solid}}{100} * MS_{solid})$ (4)	
$EF_{(T)}$	Emissions factor for a defined livestock population (category T), (kg CH_4/animal/year)
$VS_{(T)}$	Daily volatile solid excreted for livestock category T (kg dry matter/animal/day)
365	Basis for calculating annual VS production (days/year)
$B_{o(T)}$	Maximum methane producing capacity for manure produced by livestock category m^3 CH_4/kg per VS
0.67	Conversion factor for converting m^3 CH_4 to kg CH_4
MCF_{liquid}	Methane conversion factor for the liquid/slurry manure management system [note: liquid/slurry is a type of manure management system]
MS_{liquid}	Faction of livestock category T's manure handled using liquid/slurry manure management system
$MCF_{liquid\ with\ crust}$	Methane conversion factor for the liquid/slurry manure management system with natural crust cover
$MS_{liquid\ with\ crust}$	Faction of livestock category T's manure handled using liquid/slurry manure management system with natural crust cover
MCF_{solid}	Methane conversion factor for the solid storage manure management system
MS_{solid}	Faction of livestock category T's manure handled using solid storage manure management system

Calculation applying the actual values:

For monitoring period 01/01/2018-31/12/2018

In the monitoring survey has shown that in the project activity the average number of animals per household are 2.61 heads for dairy cow, 0.08 heads for buffalos and 0.04 heads for other cattle.

The following values are used:

Parameter	Value	Unit	Source
GWP_CH_4	25	Kg CO_2/kg CH_4	IPCC, for second commitment period
MCF_{liquid}	80	%	IPCC 2006 T. 10A-4 to 10A-6
$MCF_{liquid\ with\ crust}$	50	%	IPCC 2006 T. 10A-4 to 10A-6

MCF_{solid}	5	%	IPCC 2006 T. 10A-4 to 10A-6
MS_{liquid}	0.32	-	Baseline Survey
$MS_{liquid\ with\ crust}$	0.20	-	Baseline Survey
MS_{solid}	0.16	-	Baseline Survey
Dairy Cow			
N_T	2.61	-	Monitoring survey
$VS_{(T)}$	3.8	Kg dry matter/(head*day)	Biogas Technology by B.T. Nijaguna
$B_{o(T)}$	0.15	$m^3 CH_4$ /kg VS	Biogas Technology by B.T. Nijaguna
Buffalo			
N_T	0.08		Monitoring survey
$VS_{(T)}$	3.1	Kg dry matter/(head*day)	IPCC 2006 T. 10A-4 to 10A-6
$B_{o(T)}$	0.1	$m^3 CH_4$ /kg VS	IPCC 2006 T. 10A-4 to 10A-6
Other Cattle			
N_T	0.04		Monitoring survey
$VS_{(T)}$	1.4	Kg dry matter/(head*day)	IPCC 2006 T. 10A-4 to 10A-6
$B_{o(T)}$	0.1	$m^3 CH_4$ /kg VS	IPCC 2006 T. 10A-4 to 10A-6

Therefore:
EFdairy cow = 3.8 kg VS/(head*day) * 365 * 0.15 m3 CH4/kgVS * 0.67 kg/m3 * (80/100 * 0.32 + 50/100 * 0.20 + 5/100 * 0.16) = 50.74 kgCH4/year

EFbuffalo = 3.1 kg VS/(head*day) * 365 * 0.1 m3 CH4/kgVS * 0.67 kg/m3 * (80/100 * 0.32 + 50/100 * 0.20 + 5/100 * 0.16) = 27.60 kgCH4/year

EFother cattle = 1.4 kg VS/(head*day) * 365 * 0.1 m3 CH4/kgVS * 0.67 kg/m3 * (80/100 * 0.32 + 50/100 * 0.20 + 5/100 * 0.16) = 12.46 kgCH4/year

BE_{manure}annual for a 3m3 unit = (50.74 kgCH4/year * 2.61+ 27.60 kgCH4/year * 0.08 + 12.46 kgCH4/year * 0.04) * 25 kgCO2/kgCH4 / 1000 = 3.38 tCO2e
BE_{manure} annual for a 2m3 unit = 3.38 tCO2e * (2/3) = 2.25 tCO2e

Based on the PDD the Emission reductions will be calculated based on the time of animal confinement.
The baseline animal confinement is 17.68 hours/day and whereas the monitored confinement time is 23.49/day. Hence the adjustment factor for this monitoring period = 23.49/17.68 = 1.32
Adjusted BE_{manure}annual for a 3m3 unit = 3.38 * 1.32 = 4.49 tCO2e
Adjusted BE_{manure}annual for a 2m3 unit = 2.25 * 1.32 = 2.99 tCO2e

BE annual for 1 average unit = (3.38 * 1.32 *1783 +2.25 * 1.32 * 6180)/7963 = 3.33 tCO2e
BE emissions for 1 unit per day = 3.33/365 =0.00912 tCO2e

Total Baseline Emissions from use methane for the monitoring period = 0.00912 * 2906495 (average functioning days) = **26,510.81 t CO2 e**

Total Baseline emissions for this monitoring period: 493.82 t /CO2e + 31,594.99 t /CO2e + 26,510.81 tCO2e = **58,600 tCO2e**

For monitoring period 01/01/2019-31/12/2019

In the monitoring survey has shown that in the project activity the average number of animals per household are 2.43 heads for dairy cow, 0.09 heads for buffalos and 0.04 heads for other cattle.

The following values are used:

Parameter	Value	Unit	Source
GWP_CH_4	25	Kg CO_2 /kg CH_4	IPCC, for second commitment period
MCF_{liquid}	80	%	IPCC 2006 T. 10A-4 to 10A-6
$MCF_{liquid\ with\ crust}$	50	%	IPCC 2006 T. 10A-4 to 10A-6
MCF_{solid}	5	%	IPCC 2006 T. 10A-4 to 10A-6
MS_{liquid}	0.32	-	Baseline Survey
$MS_{liquid\ with\ crust}$	0.20	-	Baseline Survey
MS_{solid}	0.16	-	Baseline Survey
Dairy Cow			
N_T	2.43	-	Monitoring survey
$VS_{(T)}$	3.8	Kg dry matter/(head*day)	Biogas Technology by B.T. Nijaguna
$B_{o(T)}$	0.15	m^3 CH_4 /kg VS	Biogas Technology by B.T. Nijaguna
Buffalo			
N_T	0.09		Monitoring survey
$VS_{(T)}$	3.1	Kg dry matter/(head*day)	IPCC 2006 T. 10A-4 to 10A-6
$B_{o(T)}$	0.1	m^3 CH_4 /kg VS	IPCC 2006 T. 10A-4 to 10A-6
Other Cattle			
N_T	0.04		Monitoring survey
$VS_{(T)}$	1.4	Kg dry matter/(head*day)	IPCC 2006 T. 10A-4 to 10A-6
$B_{o(T)}$	0.1	m^3 CH_4 /kg VS	IPCC 2006 T. 10A-4 to 10A-6

Therefore:
EFdairy cow = 3.8 kg VS/(head*day) * 365 * 0.15 m3 CH4/kgVS * 0.67 kg/m3 * (80/100 * 0.32 + 50/100 * 0.20 + 5/100 * 0.16) = 50.74 kgCH4/year

EFbuffalo = 3.1 kg VS/(head*day) * 365 * 0.1 m3 CH4/kgVS * 0.67 kg/m3 * (80/100 * 0.32 + 50/100 * 0.20 + 5/100 * 0.16) = 27.60 kgCH4/year

EFother cattle = 1.4 kg VS/(head*day) * 365 * 0.1 m3 CH4/kgVS * 0.67 kg/m3 * (80/100 * 0.32 + 50/100 * 0.20 + 5/100 * 0.16) = 12.46 kgCH4/year

BE_{manure}annual for a 3m3 unit = (50.74 kgCH4/year * 2.43+ 27.60 kgCH4/year * 0.09 + 12.46 kgCH4/year * 0.04) * 25 kgCO2/kgCH4 / 1000 = 3.15 tCO2e
BE_{manure} annual for a 2m3 unit = 3.15 tCO2e * (2/3) = 2.10 tCO2e

Based on the PDD the Emission reductions will be calculated based on the time of animal confinement.
The baseline animal confinement is 17.68 hours/day and whereas the monitored confinement time is 23.17/day. Hence the adjustment factor for this monitoring period = 23.17/17.68 = 1.31
Adjusted BE_{manure}annual for a 3m3 unit = 3.15 * 1.31 = 4.13 tCO2e
Adjusted BE_{manure}annual for a 2m3 unit = 2.10 * 1.31 = 2.75 tCO2e

BE annual for 1 average unit = (3.15 * 1.31 *1781 +2.10 * 1.31 * 6163)/7944 = 3.06 tCO2e
BE emissions for 1 unit per day = 3.06/365 =0.00839 tCO2e

Total Baseline Emissions from use methane for the monitoring period = 0.00839 * 2899560 (average functioning days) = **24,331.20 t CO2 e**

Total Baseline emissions for this monitoring period: 492.64 t /CO2e + 31,519.60 t /CO2e + 24,331.20 tCO2e = **56,343 tCO2e**

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

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For monitoring period 01/01/2018-31/12/2018

The project household's kerosene consumption for cooking needs has been surveyed during the monitoring survey. Average household is using 0.0 liter kerosene per month. Thus, no PE have to be considered for kerosene consumption.

Sl.No.	Parameter	Quantity	unit	Result	Reference
1	**Kerosene use**	0.00	l/month		monitoring survey
2		0	l/y		Calculated
3	Emission savings	494	t/y		Baseline
4	**Leakage**	**0**	**t/y**		Calculated
	Leakage	0.00000000	t/hh/d		
PE for crediting period		**0**	**t CO2e**		

There are **0.0 t CO2e** project emissions generated.

For component 2: Non-renewable biomass component
The project household's fuelwood consumption for cooking needs has been surveyed during the monitoring survey. Average household is using 0.19 kg fuel wood per day for cooking needs. Thus, PE have to be considered for biomass consumption.

Sl.No.	Parameter	Quantity	unit	Result	Reference
1	**Fire wood use**	0.19	kg/d		monitoring survey (higher bound value)
2		0.070800038	t/y		Calculated
3	Emission leakage	471.6307453	t CO2 e		Baseline
4	Leakage	0.000162268	t/hh/d		Calculated
PE for crediting period		**471.6307453**	**t CO2e**		

There are **471.631 t CO2e** project emissions generated.

For component 3: Cattle manure component

Project emissions are calculated under methodology AMS-III.R "Methane recovery in agricultural activities at the household/small farm level", version 1 as a physical leakage of methane from the biogas unit (in the biogas reactor and when biogas is combusted in the burner).

$$PE = LF_{AD} * (GWP\_CH_4 * D_{CH4} * B_{o(T)} * VS_{(T)})/1000 \quad (5)$$

PE	Annual project emissions from physical leakages in the biogas digesters (t CO_2e/year)
LF_{AD}	Methane leakages from anaerobic digesters (dimensionless). Default value of 0.1 specified in the AMS-III.R is used.
D_{CH4}	CH4 density (0.00067 t/m3 at room temperature (20 ºC) and 1 atm pressure)
B_o	Maximum methane producing capacity for manure produced by livestock category T (m^3 CH_4/kg of VS excreted)
GWP_CH_4	Global Warming Potential of CH_4
$VS_{(T)}$	Daily volatile solid excreted for livestock category T (kg dry matter/animal/day)

Calculation applying the actual values:
PE = LFAD * □(T) (GWP_CH4 * 0.67 kg/m3 * Bo(T) * N(T) * VS(T) * 365) / 1000 (9)
PE – annual project emissions from physical leakages in the biogas digesters (t CO2e/year);

LFAD – methane leakages from anaerobic digesters (dimensionless). Default value of 0.1 specified in the AMS-III.R is used;
0.67 – conversion factor of m3 CH4 to kg CH4;
Bo – maximum methane producing capacity for manure produced by livestock category T (m3 CH4 per kg of VS excreted)
N(T) - Average number of heads by livestock category T; and
VS(T) – daily volatile solid excreted for livestock category T (kg dry matter per animal per day).
GWPCH4 - Global Warming Potential of CH4 - is 25.

Parameter	Value	Unit	Source
LF_{AD}	0.1	dimensionless	AMS-III.R
D_{CH4}	0.67	Kg/m^3	AMS- III.D
GWP_CH_4	25		
Dairy Cow			
N_T	2.61	-	Monitoring survey
$VS_{(T)}$	3.8	Kg dry matter/(head*day)	Biogas Technology by B.T. Nijaguna
$B_{o(T)}$	0.15	m^3 CH_4 /kg VS	Biogas Technology by B.T. Nijaguna
Buffalo			
N_T	0.08		Monitoring survey
$VS_{(T)}$	3.1	Kg dry matter/(head*day)	IPCC 2006 T. 10A-4 to 10A-6
$B_{o(T)}$	0.1	m^3 CH_4 /kg VS	IPCC 2006 T. 10A-4 to 10A-6
Other Cattle			
N_T	0.04		Monitoring survey
$VS_{(T)}$	1.4	Kg dry matter/(head*day)	IPCC 2006 T. 10A-4 to 10A-6
$B_{o(T)}$	0.1	m^3 CH_4 /kg VS	IPCC 2006 T. 10A-4 to 10A-6

Therefore:

PE annual for a 3m^3 unit = 0.1 * 25 * 0.67 * (2.61 *0.15 * 3.8 +0.08 * 0.1 * 3.1 + 0.04 * 0.1 * 1.4)/1000 * 365 = 0.928 **tCO2e**

PE annual for a 2m^3 unit =0.9281 tCO2e * (2/3) = 0.619 **tCO2e**

Correction factor based on animal confinement time (confinement factor project[1] / confinement factor baseline) = (23.49 ÷ 24) / (17.67 ÷ 24) = 1.33. For conservatism is considered 1.

Correction factor based on dung generated at confinement and ratio of dung fed to biogas plant = (1-2.14/47.89) = 0.96

PE annual for a 3m^3 unit after correction =0.928 * 1.00 * 0.96 = 0.97 **tCO2e**
PE annual for a 2m^3 unit after correction =0.97 * (2/3) = 0.65 **tCO2e**

PE annual for 1 average unit = (0.97 * 1783 +0.65 * 6180)/7963 = 0.720 tCO2e

Total PE = 0.720/365 *7963 * 2906495 (total functioning days) = **5,735.71 tCO2e**

Total Project emissions for this monitoring period = 0.0 tCO2e + 471.63 tCO2e + 5,735.71 tCO2e = 6207.34 tCO2e

[1] For conservativeness is used the lower bound value for confinement time in project scenario.

For monitoring period 01/01/2019-31/12/2019

The project household's kerosene consumption for cooking needs has been surveyed during the monitoring survey. Average household is using 0.0 liter kerosene per month. Thus, no PE have to be considered for kerosene consumption.

Sl.No.	Parameter	Quantity	unit	Result	Reference
1	**Kerosene use**	0.00	l/month		monitoring survey
2		0	l/y		Calculated
3	Emission savings	494	t/y		Baseline
4	**Leakage**	**0**	**t/y**		Calculated
	Leakage	0.00000000	t/hh/d		
PE for crediting period		**0**	**t CO2e**		

There are **0.0 t CO2e** project emissions generated.

For component 2: Non-renewable biomass component
The project household's fuelwood consumption for cooking needs has been surveyed during the monitoring survey. Average household is using 0.09 kg fuel wood per day for cooking needs. Thus, PE have to be considered for biomass consumption.

Sl.No.	Parameter	Quantity	unit	Result	Reference
1	**Fire wood use**	0.09	kg/d		monitoring survey (higher bound value)
2		0.03322099	t/y		Calculated
3	Emission leakage	220.7718585	t CO2 e		Baseline
4	Leakage	7.61398E-05	t/hh/d		Calculated
PE for crediting period		**220.7718585**	**t CO2e**		

There are **220.77 t CO2e** project emissions generated.

For component 3: Cattle manure component

Project emissions are calculated under methodology AMS-III.R "Methane recovery in agricultural activities at the household/small farm level", version 1 as a physical leakage of methane from the biogas unit (in the biogas reactor and when biogas is combusted in the burner).

$$PE = LF_{AD} * (GWP\_CH_4 * D_{CH4} * B_{o(T)} * VS_{(T)})/1000 \quad (5)$$

PE	Annual project emissions from physical leakages in the biogas digesters (t CO_2e/year)
LF_{AD}	Methane leakages from anaerobic digesters (dimensionless). Default value of 0.1 specified in the AMS-III.R is used.
D_{CH4}	CH4 density (0.00067 t/m3 at room temperature (20 ºC) and 1 atm pressure)
B_o	Maximum methane producing capacity for manure produced by livestock category T (m^3 CH_4/kg of VS excreted)
GWP_CH_4	Global Warming Potential of CH_4
$VS_{(T)}$	Daily volatile solid excreted for livestock category T (kg dry matter/animal/day)

Calculation applying the actual values:
PE = LFAD * □(T) (GWP_CH4 * 0.67 kg/m3 * Bo(T) * N(T) * VS(T) * 365) / 1000 (9)
PE – annual project emissions from physical leakages in the biogas digesters (t CO2e/year);
LFAD – methane leakages from anaerobic digesters (dimensionless). Default value of 0.1 specified in the AMS-III.R is used;
0.67 – conversion factor of m3 CH4 to kg CH4;
Bo – maximum methane producing capacity for manure produced by livestock category T (m3 CH4 per kg of VS excreted)
N(T) - Average number of heads by livestock category T; and

VS(T) – daily volatile solid excreted for livestock category T (kg dry matter per animal per day).
GWPCH4 - Global Warming Potential of CH4 - is 25.

Parameter	Value	Unit	Source
LF_{AD}	0.1	dimensionless	AMS-III.R
D_{CH4}	0.67	Kg/m^3	AMS- III.D
GWP_CH_4	25		
Dairy Cow			
N_T	2.43	-	Monitoring survey
$VS_{(T)}$	3.8	Kg dry matter/(head*day)	Biogas Technology by B.T. Nijaguna
$B_{o(T)}$	0.15	m^3 CH_4 /kg VS	Biogas Technology by B.T. Nijaguna
Buffalo			
N_T	0.09		Monitoring survey
$VS_{(T)}$	3.1	Kg dry matter/(head*day)	IPCC 2006 T. 10A-4 to 10A-6
$B_{o(T)}$	0.1	m^3 CH_4 /kg VS	IPCC 2006 T. 10A-4 to 10A-6
Other Cattle			
N_T	0.04		Monitoring survey
$VS_{(T)}$	1.4	Kg dry matter/(head*day)	IPCC 2006 T. 10A-4 to 10A-6
$B_{o(T)}$	0.1	m^3 CH_4 /kg VS	IPCC 2006 T. 10A-4 to 10A-6

Therefore:

PE annual for a 3m^3 unit = 0.1 * 25 * 0.67 * (2.43 *0.15 * 3.8 + 0.09 * 0.1 * 3.1 + 0.04 * 0.1 * 1.4)/1000 * 365 = 0.866 **tCO2e**

PE annual for a 2m^3 unit =0.881 tCO2e * (2/3) = 0.577 **tCO2e**

Correction factor based on animal confinement time (confinement factor project[2] / confinement factor baseline) = (23.17 ÷ 24) / (17.67 ÷ 24) = 1.31. For conservatism is considered 1.

Correction factor based on dung generated at confinement and ratio of dung fed to biogas plant = (1-0.80/44.98) = 0.98

PE annual for a 3m^3 unit after correction =0.866 * 1.00 * 0.98 = 0.88 **tCO2e**
PE annual for a 2m^3 unit after correction =0.88 * (2/3) = 0.59 **tCO2e**

PE annual for 1 average unit = (0.88 * 1781 +0.59 * 6163)/7944 = 0.653 tCO2e

Total PE = 0.653/365 *7944 * 2899560 (total functioning days) = **5,191.39 tCO2e**

Total Project emissions for this monitoring period = 0.0 tCO2e + 220,77 tCO2e + 5,191.39 tCO2e = 5412,16 tCO2e

E.3. Calculation of leakage emissions

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For monitoring period 01/01/2018-31/12/2018

[2] For conservativeness is used the lower bound value for confinement time in project scenario.

Leakage relating to non-renewable biomass was assessed from ex-post surveys of users and areas from where biomass is sourced.

122 Non-project households within the project boundary have been surveyed to assess to the quantity of biomass consumed. The amount of biomass consumed per household is compared to the amount of biomass consumed in the baseline survey. In case the biomass consumption in non-project households is significantly higher than the biomass consumption in the baseline, it must be presumed that the increase of biomass consumption is attributed to easier access to fuelwood, due to the project activity.

Increase in the use of non-renewable woody biomass outside the project boundary.

Non-project households were surveyed in the monitoring to know whether their wood usage has been increased compared to the baseline. If at all the survey shows a significant increase of "$B_{biomass\ non\text{-}project}$" in comparison to "Total $B_{biomass,y}$" due to the project activity, than the difference between "Total $B_{biomass,y}$" and "$B_{biomass\ non\text{-}project}$" will be considered for leakage calculation.

Leakage due to increased use of fuelwood in non-project households will be calculated as follows:

$$LE_y = (B_{biomass,non\text{-}project,y} - B_{biomass,y}) * f_{NRB,y} * NCV_{biomass} * EF_{kerosene}$$

Where:

LE_y	Project emissions due to leakage during the year y in tCO_2e
$B_{biomass\ non\text{-}project,y}$	Quantity of woody biomass that is used during Project Activity in non-project household in tonnes
$B_{biomass\ y}$	Total Quantity of woody biomass that is used in Baseline in tonnes
f_{NRB}	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 (According to AMS.I.E. para 5, IPCC default for wood fuel, 0.015 TJ/tonne)
$EF_{kerosene}$	Emission factor for the substitution of non-renewable woody biomass by similar consumers.

The non-project households were surveyed to make sure that there is no increase in fuel wood consumption in non-project households due to higher fuel wood availability based on project activity.
Following fuel wood consumption was measured in the baseline and in the non-project households. The collected data has been fed to Excel sheet and net values have been arrived at 95% confidence level.

Item	Baseline HH	Non-Project HH	Units
Firewood use for cooking	12.9	9.39	Kg/d
Firewood use for water heating	8.6	4.48	Kg/d
Total firewood use	21.5	13.87	Kg/d

It is clear that that the consumption of firewood from cooking and for water heating in the non-project households is lower than in the baseline, and thus there is no leakage due to project activity.

Leakage because of non-functioning of units:

Apart from these project emissions there is another component that is non-functioning of few biogas plants during the repair of the units. All the units were monitored continuously by the local level supervisors and repair of units also will be taken up by them. They will send monthly monitoring reports to the project office and the repair activity will be reported in the reports. Which plant has been repaired, what type of problem

has been rectified, what type and quantity of material is replaced or used during the repairs will be reported in these monthly reports. During this monitoring period 19 units of 2 cubic meter gas generation per day and 3 units of 3 cubic meter gas generation/day were repaired. During the repair all the 2 cubic meter size units put together did not function for 274 days and 3 cubic meter size units all put together did not function for 31 days. As the 3 cubic meter size unit is 1.5 times bigger than the 2 cubic meter plant total non-functioning days of one 2 cubic meter size equivalent days came to 320.5. Total baseline emissions were calculated based on the total functioning days of all the units. As one 2 cubic meter equivalent plant does not function for 320.5 days the baseline emissions related to 320.5 days i.e 5.78 t CO2 e have been deducted from the total baseline emissions as leakage.
More details were provided in the ER spread sheet.

LE = 5.78 t CO2e

For monitoring period 01/01/2019-31/12/2019

Leakage relating to non-renewable biomass was assessed from ex-post surveys of users and areas from where biomass is sourced.

150 Non-project households within the project boundary have been surveyed to assess to the quantity of biomass consumed. The amount of biomass consumed per household is compared to the amount of biomass consumed in the baseline survey. In case the biomass consumption in non-project households is significantly higher than the biomass consumption in the baseline, it must be presumed that the increase of biomass consumption is attributed to easier access to fuelwood, due to the project activity.

Increase in the use of non-renewable woody biomass outside the project boundary.

Non-project households were surveyed in the monitoring to know whether their wood usage has been increased compared to the baseline. If at all the survey shows a significant increase of "$B_{biomass\ non\text{-}project}$" in comparison to "Total $B_{biomass,y}$" due to the project activity, than the difference between "Total $B_{biomass,y}$" and "$B_{biomass\ non\text{-}project}$" will be considered for leakage calculation.

Leakage due to increased use of fuelwood in non-project households will be calculated as follows:

$$LE_y = (B_{biomass,non\text{-}project,y} - B_{biomass,y}) * f_{NRB,y} * NCV_{biomass} * EF_{kerosene}$$

Where:

LE_y	Project emissions due to leakage during the year y in tCO_2e
$B_{biomass\ non\text{-}project,y}$	Quantity of woody biomass that is used during Project Activity in non-project household in tonnes
$B_{biomass\ y}$	Total Quantity of woody biomass that is used in Baseline in tonnes
f_{NRB}	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 (According to AMS.I.E. para 5, IPCC default for wood fuel, 0.015 TJ/tonne)
$EF_{kerosene}$	Emission factor for the substitution of non-renewable woody biomass by similar consumers.

The non-project households were surveyed to make sure that there is no increase in fuel wood consumption in non-project households due to higher fuel wood availability based on project activity.
Following fuel wood consumption was measured in the baseline and in the non-project households. The collected data has been fed to Excel sheet and net values have been arrived at 95% confidence level.

Item	Baseline HH	Non-Project HH	Units
Firewood use for cooking	12.9	8.96	Kg/d

Firewood use for water heating	8.6	4.07	Kg/d
Total firewood use	21.5	13.03	Kg/d

It is clear that that the consumption of firewood from cooking and for water heating in the non-project households is lower than in the baseline, and thus there is no leakage due to project activity.

Leakage because of non-functioning of units:

Apart from these project emissions there is another component that is non-functioning of few biogas plants during the repair of the units. All the units were monitored continuously by the local level supervisors and repair of units also will be taken up by them. They will send monthly monitoring reports to the project office and the repair activity will be reported in the reports. Which plant has been repaired, what type of problem has been rectified, what type and quantity of material is replaced or used during the repairs will be reported in these monthly reports. During this monitoring period 16 units of 2 cubic meter gas generation per day and 1 unit of 3 cubic meter gas generation/day were repaired. During the repair all the 2 cubic meter size units put together did not function for 394 days and 3 cubic meter size units all put together did not function for 21 days. As the 3 cubic meter size unit is 1.5 times bigger than the 2 cubic meter plant total non-functioning days of one 2 cubic meter size equivalent days came to 425.5. Total baseline emissions were calculated based on the total functioning days of all the units. As one 2 cubic meter equivalent plant does not function for 425.5 days the baseline emissions related to 425.5 days i.e 7.47 t CO2 e have been deducted from the total baseline emissions as leakage.
More details were provided in the ER spread sheet.

LE = 7.47 t CO2e

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	**114,943**	**11,620**	**13**	**-**	**103,309**	**103,309**

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)
103,309	112,454

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

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The calculation of the amount estimated ex-ante considers the emission reductions for the monitoring period of the PDD which already assumed the installation of the 9380 biogas units in both years, each period estimated 56,227 t CO_2. Therefore, the total amount for two years would be 112,454 t CO_2.

E.6. Remarks on increase in achieved emission reductions

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The actual values of ER achieved during this monitoring period are below the values estimated in the ex - ante calculation of the registered PDD. This is due to the fact that the implementation of Bio digesters in the field moved forward slower than originally planned in the PDD.

The GHG emission reduction achieved during this sixth monitoring period which includes the year 6 and 7 of the project is clearly below the expected amount in the PDD. The reason for this is that the implementation of the biogas units took place much slower than originally planned, due to several external reasons (i.e. drought, staff capacity etc). At the end of the year 7 the project has installed 7944 which is below than expected (9380) according the PDD. This factor explains why the emission reductions achieved during sixth monitoring period is clearly below the projected emission reductions in the PDD.

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

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According Standard CDM project standard for project activities Version 02.0 the small-scale project type applicable to the generic small-scale project Type III: Other project activities not included in Type I or Type II that result in GHG emission reductions not exceeding 60 kt CO2e per year in any year of the crediting period which is accomplished by the project as demonstrated in the table below.

Monitoring Period	Amount achieved during this monitoring period (t CO_2e)
01/01/2018-31/12/2018	52,386
01/01/2019-31/12/2019	50,923
Total	**103,309**

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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).

Version	*Date*	*Description*
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.

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