Monitoring report form
(Version 03.2)

Monitoring report

Title of the project activity	Kolar Biogas Project
Reference number of the project activity	4058
Version number of the monitoring report	01
Completion date of the monitoring report	25/6/2014
Registration date of the project activity	24/11/2011
Monitoring period number and duration of this monitoring period	1st Monitoring period 01/04/2012 – 31/12/2013 (including both days)
Project participant(s)	SKG Sangha Foundation myclimate – The Climate Protection Partnership
Host Party(ies)	India
Sectoral scope(s) and applied methodology(ies)	Sectorial Scope 1, Energy industries (renewable-/non-renewable sources) Sectorial Scope 15 Agriculture AMS.I.C – "Thermal energy for the user 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
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	65,687
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	29,537
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved during the period up to 31 December 2012(if applicable)	6,953
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved during the period from 1 January 2013 onwards (if applicable).	22,585

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

The project provides biogas units to 10,000 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

(2) to avoid methane emissions from cattle manure

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 $2m^3$ 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.

Figure 1: DeenBandhu Biogas plant model under construction.

Relevant dates for the project activity:
The starting date of bio-digester construction is: 01/04/2012. Since then, bio-digesters have been constructed continuously.
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
……..
9th CDM Monitoring Period: 01/01/2021 – 31/03/2022 (last monitoring period)

Up to 31/12/2013 4080 bio-digesters have been started functioning.

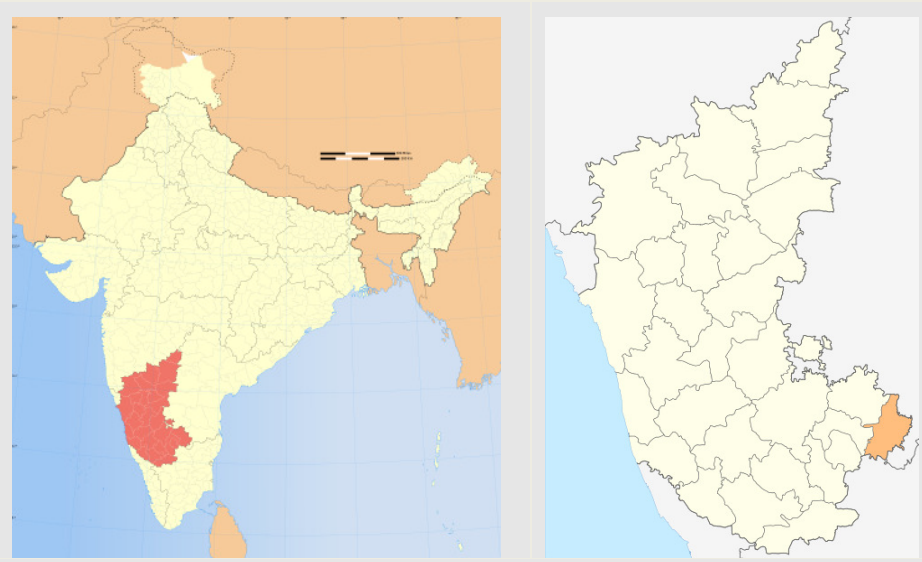
Actual GHG emission reductions in this monitoring period: 29,537 t CO_2e

A.2. Location of project activity

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.

A.3. Parties and project participant(s)

Party involved **((host) indicates a host Party)**	**Private and/or public entity(ies) project participants (as applicable)**	**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. Reference of applied methodology

Component 1, Thermal energy generation:

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

AMS.I.E – "Switch from Non-Renewable Biomass for Thermal Applications by the User" ver.5
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 of project activity

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 registered project activity

The construction of Bio-digester has started on 01/04/2012.
Until the end of 1st monitoring period 4080 units have been functioning under the project activity.

B.2. Post registration changes

B.2.1. Temporary deviations from registered monitoring plan or applied methodology

Not applicable

B.2.2. Corrections

Not applicable

B.2.3. Permanent changes from registered monitoring plan or applied methodology

Not applicable

B.2.4. Changes to project design of registered project activity

Not applicable

B.2.5. Changes to start date of crediting period

The crediting period has been change 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.2.6. Types of changes specific to afforestation or reforestation project activity

Not applicable

SECTION C. Description of monitoring system

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 m3 unit or a 2 m3 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 m3 and 3 m3 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

Project/district level	Project coordinator Team of 4-5 people	Project coordinator has an overall responsibility for the project. The team includes the main monitoring officers and supporting officers, who: • Collect monthly (paper) monitoring reports from taluks, • Enter all data to a database • Organise annual surveys • Conduct random checks at the village level to check the monitoring data (over the year visits 5% of participating households) • Compile annual project level reports • Organise and conducts training for taluks and village level monitoring team
Taluk level	Supervisor 2-3 assistants	Supervisor coordinates and supervises monitoring in villages of a taluk. The team: • Collects monthly reports from villages • Compiles monthly taluk level reports (on paper): keeps on copy and send one copy to the project level • Conducts annual surveys (under the supervision of the project monitoring officers
Village level	Motivator	The motivator is the main direct contact with the beneficiaries: • Records any periods of biogas unit non-functioning (beneficiaries contact the motivator in case of any problem with a biogas digester or the burner) • Checks functioning of all units at least once per month • Makes records in two copies, stores one copy and sent one cop to the taluk level at the end of each month

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante or at renewal of crediting period

(Copy this table for each piece of data and 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
Purpose of data:	Baseline Kerosene Emission Calculation

Additional comment:	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
Purpose of data:	Baseline Kerosene Emission Calculation
Additional comment:	Default net calorific value suggested by IPCC

Data / Parameter:	**$EF_{kerosene}$**
Unit:	Kg CO_2/TJ (kilogrammes of CO_2 per terajoule)
Description:	Net calorific value of kerosene
Source of data:	Table 2.5 in 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 2.
Value(s) applied):	71,900
Purpose of data:	Baseline Kerosene Emission Calculation
Additional comment:	Default emissions factor for stationary combustion in the residential category suggested by IPCC. This value is used for calculating BEkerosene. For BENRB, the default value specified in AMS I.E, 71,500 kg CO2/TJ, is used

Data / Parameter:	**$F_{kerosene, baseline}$**
Unit:	L (liters)/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
Purpose of data:	Calculation of Baseline
Additional comment:	

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
Purpose of data:	Baseline Fuel wood Emission Calculation
Additional comment:	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
Purpose of data:	Calculation of Baseline emissions
Additional comment:	

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:	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied):	25
Purpose of data:	Baseline Methane Avoidance Calculation
Additional comment:	Default value suggested by IPCC

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
Purpose of data:	Baseline Methane Avoidance Calculation
Additional comment:	Default value suggested by IPCC

Data / Parameter:	**$B_{o(T)}$**
Unit:	m3 CH4/kg VS
Description:	Maximum methane producing capacity for manure produced by livestock category T
Source of data:	Tables 10A-4 to 10A-6 in 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied):	0.13 for dairy cattle, 0.1 for buffalo and other cattle
Purpose of data:	Baseline Methane Avoidance Calculation
Additional comment:	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}, $MCF_{liquid\ with\ crust}$, MCF_{solid}** and **MCF_{dry})**
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}) and 2 for dry storage manure management system (MCF_{dry})
Purpose of data:	Baseline Methane Avoidance Calculation
Additional comment:	Values corresponding to average annual temperature of 29.6 °C are taken for MCF_{liquid} and MCF_{liquid} with crust. Temperature data was taken from the Indian Meteorological Department, Government of India.

D.2. Data and parameters monitored

(Copy this table for each piece of data and parameter.)

Data / Parameter:	**$N_{operating}$**
Unit:	Dimensionless
Description:	Number of systems (biogas units) operating
Measured/ Calculated / Default:	Calculated
Source of data:	Motivator report/Taluk level report
Value(s) of monitored parameter:	4080
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 nun-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:	Baseline and Project Emission Calculation
Additional comment:	-

Data / Parameter:	**H_{stove}**
Unit:	H (hours)/year
Description:	Annual hours of operation of an average system (hours of burner functioning)
Measured/ Calculated / Default:	Calculated
Source of data:	Monitoring survey
Value(s) of monitored parameter:	1,066.35
Monitoring equipment:	N.A.

Measuring/ Reading/ Recording frequency:	Monthly.
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 2.92 h/d, thus 2.92 * 365 = 1066.35 h/y
QA/QC procedures:	Interpretation?
Purpose of data:	The parameter is used for checking whether the biodigester produced enough biogas to substitute previous use of non-renewable biomass and kerosene.
Additional comment:	

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:	0
Monitoring equipment:	Monitoring questionnaire
Measuring/ Reading/ Recording frequency:	Annually
Calculation method (if applicable):	N.A.
QA/QC procedures:	N.A.
Purpose of data:	Leakage Calculation
Additional comment:	

Data / Parameter:	**$B_{biomass, project}$**
Unit:	T (Tonnes) /year
Description:	Annual quantity of biomass consumed by household after installation of biogas unit
Measured/ Calculated / Default:	Measured
Source of data:	Monitoring Survey
Value(s) of monitored parameter:	0.01
Monitoring equipment:	questionnaire
Measuring/ Reading/ Recording frequency:	annually
Calculation method (if applicable):	According to monitoring survey average household is using 0.01 kg of fuel wood per day for cooking. i.e. 0.01*365 days = 4.456 kg per year or 0.004456 t/year
QA/QC procedures:	xxx

Purpose of data:	Leakage calculations
Additional comment:	

Data / Parameter:	$B_{biomass, non-project}$
Unit:	T (Tonnes)
Description:	Consumption of fuel wood for cooking in households not participating in the project activities.
Measured/ Calculated / Default:	Measured
Source of data:	Monitoring Survey
Value(s) of monitored parameter:	9.49
Monitoring equipment:	Monitoring Survey in households not participating in the project activity.
Measuring/ Reading/ Recording frequency:	Survey of 100 non-project households that use fuel wood. The surveys are carried out once per year by the taluk level monitoring team.
Calculation method (if applicable):	N.A.
QA/QC procedures:	Monitoring team from the project level does random checks to check whether the data recorded by the taluk level team is reasonable and correct.
Purpose of data:	Calculation of fuel wood leakage
Additional comment:	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.

Item	Baseline	Non-Project
Fire wood use for cooking in Kg	12.9	9.5
Fire wood use for water heating	8.6	5.9
Total fire wood use	21.5	15.4

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.

Data / Parameter:	MS_{manure} (MS_{liquid},$MS_{liquid\ with\ crust}$, MS_{solid} and MS_{dry})
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, and fraction of livestock manure handled using solid storage manure management system)
Measured/ Calculated / Default:	Calculated
Source of data:	Monitoring survey

Value(s) of monitored parameter:	0.35 for liquid/slurry manure management system (MS_{liquid}), 0.22 for liquid/slurry with crust cover manure management system (MS_{liquid} with crust), 0.18 for solid storage manure management system (MS_{solid})
Monitoring equipment:	Monitoring Questionnaire
Measuring/ Reading/ Recording frequency:	Annually
Calculation method (if applicable):	MS_liquid = Months per year when material in the pits uncovered slurry divided by number of month per year times f_collected: 5.32/12* 0.79 = 0.35 MS_liquid_with_crust = Months per year when material in the pits covered slurry divided by number of month per year times f_collected: 3.24/12* 0.79 = 0.21 MS_solid_storage = Months per year when material in the pits uncovered slurry divided by number of month per year times f_collected: 2.72/12* 0.79 = 0.18
QA/QC procedures:	-
Purpose of data:	Baseline Methane Avoidance Calculation
Additional comment:	-

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:	Measured
Source of data:	Monitoring Survey
Value(s) of monitored parameter:	2.37 for dairy cows, 0.33 for buffalos, 0.47 for other cattle
Monitoring equipment:	Monitoring Questionnaire
Measuring/ Reading/ Recording frequency:	Annually
Calculation method (if applicable):	N.A.
QA/QC procedures:	-
Purpose of data:	Baseline Methane Avoidance Calculations
Additional comment:	-

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:	18.81
Monitoring equipment:	Questionnaire

Measuring/ Reading/ Recording frequency:	Annually
Calculation method (if applicable):	Total Dung form shed produced (kgs/day) times days per year: 51.54 * 365/1000 = 18.81
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:	To know the efficiency of the biogas unit
Additional comment:	

Data / Parameter:	$B_{manure,fed}$
Unit:	T (Tonnes)/year
Description:	Average amount of animal manure fed into biogas digester per year.
Measured/ Calculated / Default:	
Source of data:	Monitoring Survey
Value(s) of monitored parameter:	17.46
Monitoring equipment:	Questionnaire
Measuring/ Reading/ Recording frequency:	Annually
Calculation method (if applicable):	Out of 51.54 kg generated in the shed 47.83 kg will be fed to the biogas plant and the remaining 3.71 kg per day will be dumped in the compost pits. 47.83 * 365 = 17.46 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:	To know the efficiency of the biogas unit
Additional comment:	

D.3. Implementation of sampling plan

Description of implemented sampling design

Taluk level monitoring teams will carry out annual surveys 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

367 households have been surveyed

Sample size:

According to the monitoring plan described in registered PDD the maximum sample size for any of the

sampling parameter was 168. In the monitoring survey 367 households were surveyed to get more accurate data.

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 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.

Drawing of sample: sample size has been decided as 300. 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 4050 units meant for this verification period (number of plants that were installed and functioning until 31/12/2014). Out of these 4080 units there were 787 plants with 3 cubic meter capacity and 3293 plants of 2 cubic meter size.

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

Sl. no	Item	Bangarpet	Kolar	Malur	Mulbagal	Srinivaspur	Total
1	Total plants	1427	594	465	989	605	4080
2	2 cubic meter size plants	1174	459	373	781	506	3293
3	3 cubic meter size plants	253	134	92	208	99	786
4	12 cubic meter size plant		1				1
5	Plants to be monitored	122.41	51	39.89	84.84	51.89	300
6	2 M3 to be monitored	86.32	33.8	27.43	57.42	37.20	242.13
7	3 M3 to be monitored	18.60	9.85	6.765	15.29	7.27	57.79
5	Plants monitored - total	135	49	40	92	51	367
6	Plants monitored 2M3	108	38	32	72	41	291
7	Plants monitored 3 M3	27	11	8	20	10	76

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 has been monitored. To monitor the required number of 2/3 size plants more villages has been added to the monitoring list. Total 367 plants have been surveyed to achieve the required numbers.

The survey has been conducted in three phases i.e in December 2013, February 2014 and again in June 2014 to get realistic biogas generation and operation of stoves.

Surveys of non-project households

Taluk level monitoring teams has surveyed 100 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.

Collected data (electronic spreadsheets may be attached and referenced)

All the collected data was compiled electronically in a spreadsheet. Please see the Monitoring Survey Emission Reduction Calculation Excel Sheet.

Analysis of the collected data

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. The collected data has been fed to Excel sheet and net values have been arrived at 95% confidence level.

Item	Baseline	Non-Project
Fire wood use for cooking in Kg	12.9	9.5
Fire wood use for water heating	8.6	5.9
Total fire wood use	21.5	15.4

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 households to be surveyed is 58 (please refer registered PDD page 58). 100 households have been surveyed to achieve more accuracy.

SECTION E. Calculation of emission reductions or GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

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 tCO_2e) 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.

$$BE_{kerosene} = F_{kerosene} * N * \rho_{kerosene} * NCV_{kerosene} * EF_{kerosene} * 10^{-9} \quad (1)$$

$BE_{kerosene}$	Baseline emissions from burning of kerosene for household cooking needs (t CO_2e/year)
$F_{kerosene}$	Annual amount of kerosene used for cooking in an average household participating in the Kolar District 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
$F_{kerosene}$	24.12	L/year	Baseline Survey
N	4080	Number of devices (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:

$BE_{kerosene}$ = 24.12l * 4080 * 0.817kg/l * 43.8TJ/t * 71, 900kg CO_2/TJ * 10^{-9} = **253 t /CO_2e/y**

Total Baseline Emissions from use of Kerosene for the first crediting period = 253/365*400 = **277 t /CO_2e**

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 *tCO_2e*) 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):

$$BE_{NRB} = B_{biomass} * N * f_{NRB} * NCV_{biomass} * EF_{kerosene} * 10^{-3} \quad (2)$$

BE_{NRB}	Baseline emissions from the combustion of non-renewable part of the fuel wood used for cooking in households (t CO_2e/year)
$B_{biomass}$	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 71.500 kg CO_2/TJ specified in AMS I.E. is used.

Calculation applying the actual values:

The following values are used:

Parameter	Value	Unit	Source
$B_{biomass}$	4.74	T/year	Baseline Survey
N	4228	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
$EF_{kerosene}$	81,600	kg CO2/TJ	AMS I.E.

Therefore:
BE = 4.74 t * 4080 * 0.78 * 0.015 TJ/t * 81,600kg CO_2/TJ * 10^{-3} = **18,469 t /CO_2e/y**

Total Baseline Emissions from use of wood fuel for the first crediting period = 18469/365*400 = **20,240 t/CO_2e**

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 (*BEmanure* in *tCO_2e*) 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℃ 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:

$$BE_{manure} = \sum_{(T)}(EF_T * N_T) * N * GWP\_CH_4/1000 \quad (3)$$

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 climatec region. The manure management system is different at different times of the year. The formula used for EF_T is:

$$EF_{(T)} = VS_{(T)} * 365 * B_{o(T)} * 0.67\ kg/m^3 * \left(\frac{MCF\ liquid}{100} * MS_{liquid} + \frac{MCF\ liquid\ with\ crust}{100} * MS_{liquid\ with\ crust} + \frac{MCF_{solid}}{100} * MS_{solid}\right) \quad (4)$$

$EF_{(T)}$	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:

In the monitoring survey has shown that in the project activity the average number of animals per household are 2.297 heads for dairy cow, 0.404 heads for buffalos and 0.515 heads for other cattle.

The following values are used:

Parameter	Value	Unit	Source
GWP_CH_4	25	Kg CO_2/kg CH_4	IPCC
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}	0.35	-	Baseline Survey
$MS_{liquid\ with\ crust}$	0.22	-	Baseline Survey
MS_{solid}	0.18	-	Baseline Survey
Dairy Cow			
N_T	2.37	-	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	0.33		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	0.47		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:

$EF_{dairy\ cow}$ = 3.8 kg VS/(head*day) * 365 * 0.15 m3 CH4/kgVS * 0.67 kg/m3 * (80/100 * 0.35 + 50/100 * 0.21 + 5/100 * 0.18) = 55.39 kgCH4/year

$EF_{buffalo}$ = 3.1 kg VS/(head*day) * 365 * 0.1 m3 CH4/kgVS * 0.67 kg/m3 * (80/100 * 0.35 + 50/100 * 0.21 + 5/100 * 0.18) = 30.12 kgCH4/year

$EF_{other\ cattle}$ = 1.4 kg VS/(head*day) * 365 * 0.1 m3 CH4/kgVS * 0.67 kg/m3 * (80/100 * 0.35 + 50/100 * 0.21 + 5/100 * 0.18) = 13.60 kgCH4/year

BE_{manure} annual for a 3m^3 unit = (55.39 kgCH4/year*2.37+ 30.12 kgCH4/year*0.33 + 13.60 kgCH4/year*0.47)* 25 kgCO2/kgCH4 / 1000 = 3.69 tCO2e

BE_{manure} annual for a 2m^3 unit = 3.69 tCO2e * (2/3) = 2.46 tCO2e

Total BE_{manure} = 3.69 tCO2e * 787 + 2.46 tCO2e * 3293 = **10,998 tCO2e/y**

Total Baseline Emissions from use methane for the first crediting period = 10,998/365*400 = **12,053 t CO2 e**

Total Baseline emissions for the first monitoring period (400 days): 277 t /CO_2e + 20,240 t /CO_2e + 12,053 tCO2e **= 32,570 tCO2e**

E.2. Calculation of project emissions or actual net GHG removals by sinks

For component 1: Kerosene component

There are no project emissions generated.

For component 2: Non-renewable biomass component

There are no 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:

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	2.37	-	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	0.33		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	0.47		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 * (2.37 *0.15 * 3.8 +0.33 * 0.1 * 3.1 + 0.47 * 0.1 * 1.4)/1000 * 365 = **0.929 tCO2e**

PE annual for a 2m^3 unit =0..929 tCO2e * (2/3) = **0.619 tCO2e**

Total PE = 0.929 tCO2e * 787 + 0.619 tCO2e * 3293 = **2,768 tCO2e**

Total Project emissions for the first monitoring period (400 days): 2768/365*400 **= 3033 tCO2e**

E.3. Calculation of leakage

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

100 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 signifcant 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:

$$LE_y = (B_{biomass,non\text{-}project,y} - \text{Total } B_{biomass,y,}) * f_{NRB,y} * NCV_{biomass} * EF_{projected\_fossilfuel} \quad (8)$$

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

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	Non-Project
Fire wood use for cooking in Kg	12.9	9.5
Fire wood use for water heating	8.6	5.9
Total fire wood use	21.5	15.4

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.**

The project households fuel wood consumption for cooking needs has been surveyed during the monitoring survey. Average household is using 0.0396 kg fuel wood per day for cooking needs. This is coming to 14.454 kg per year. As this amount is negligible it has been left out from leakage calculations.

E.4. Summary of calculation of emission reductions or net anthropogenic GHG removals by sinks

The total emission reductions are calculated as follows:

$ER_y = (BE_{kerosene} + BE_{NRB} + BE_{manure}) – PE_y – LE_y$

Where,

$BE_{kerosene}$	Baseline emissions for use of kerosene for cooking
BE_{NRB}	Baseline emissions for use of non-renewable biomass for cooking
BE_{manure}	Methane emissions avoided during the monitoring period from preventing decay of cattle manure in pits during the monitoring period (tCO2e).
S PE_y	Project emissions during the monitoring period y (tCO2e)
LE_y	Leakage emissions during the monitoring period y (tCO2e)

In conclusion, the total of the emission reductions achieved during the 1st monitoring period are:

Baseline emissions from component 1: Kerosene replacement:	277
Baseline emissions from component 2: non-renewable biomass replacement:	20240
Baseline emissions from component 3: Methane Avoidance of cattle manure:	12053
Total Baseline emissions:	32570
Total Project emissions:	3033
Total leakage:	0
Total emission reductions:	29537

Item	Baseline emissions or baseline net GHG removals by sinks (t CO_2e)	Project emissions or actual net GHG removals by sinks (t CO_2e)	Leakage (t CO_2e)	Emission reductions or net anthropogenic GHG removals by sinks (t CO_2e)
Total	32,570	3033	0	29,537

E.5. Comparison of actual emission reductions or net anthropogenic GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex-ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (t CO_2e)	65,687 (24'978/4*3 + 46'954)	29,537

E.6. Remarks on difference from estimated value in registered PDD

The implementation schedule as originally planned and given in the PDD was that in the first year 2500 units will be installed and in the second year 3500 units will be installed. But in the Project activity implementation

of units went much slower than originally expected, so only 4228 units have been installed and can be accounted for in the first monitoring period. The main reasons why the construction did not move as fast, were droughts in the Kolar district, thus there was no water available for brick construction and for curing of civil works

E.7. Actual emission reductions or net anthropogenic GHG removals by sinks during the first commitment period and the period from 1 January 2013 onwards

Item	Actual values achieved up to 31 December 2012	Actual values achieved from 1 January 2013 onwards
Emission reductions or GHG removals by sinks (t CO_2e)	6,953	22,585

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Document information

Version	*Date*	*Description*
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 anthropogenic GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, 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).
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