CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-SSC-PDD)
Version 03 - in effect as of: 22 December 2006

CONTENTS

Annexes

Revision history of this document

Version Number	Date	Description and reason of revision
01	21 January 2003	Initial adoption
02	8 July 2005	• The Board agreed to revise the CDM SSC PDD to reflect guidance and clarifications provided by the Board since version 01 of this document. • As a consequence, the guidelines for completing CDM SSC PDD have been revised accordingly to version 2. The latest version can be found at <http://cdm.unfccc.int/Reference/Documents>.
03	22 December 2006	• The Board agreed to revise the CDM project design document for small-scale activities (CDM-SSC-PDD), taking into account CDM-PDD and CDM-NM.

SECTION A. General description of small-scale project activity

A.1 Title of the small-scale project activity:

Kolar Biogas Project, version 1, 12 September 2008

A.2. Description of the small-scale project activity:

The proposed project will provide biogas units to households in rural areas of Kolar District in Karnataka State in India. The project will reduce the amount of fuel wood and kerosene used for cooking and heating water and will replace inefficient traditional cooking stoves with cleaner biogas stoves. The project will also reduce methane emissions from cattle manure and will contribute strongly to the sustainable development of the rural households involved in the project.

The biogas technology is tried and tested in rural India. SKG Sangha, an Indian non-governmental organisation (NGO), will implement the project. SKG Sangha has already successfully implemented over 50,000 biogas units in India over the last 15 years. Many of these biogas units were implemented with the help of government subsidies but the availability of these subsidies has reduced dramatically in recent years from around 250,000 units per year to around 5-10,000 units per year for the entire country. As there are over 600 Districts in India, this equates to at best only tens of biogas units per District and an even smaller number at a Taluk level. Similarly, charity or donor financing has contributed to biogas units in the past but such financing is not able to cover the vast need for improving the energy supply to rural households in India. SKG Sangha therefore turned to the Clean Development Mechanism to provide biogas systems to rural households.

The project encompasses 10,000 households in all five Taluks in Kolar District – Srinivaspur, Kolar, Mulbagal, Malur, and Bangarapet.[1]

In each of the 10,000 households covered by the proposed project a family size biogas unit will be installed. The biogas unit will be of either $2m^3$ or $3m^3$ capacity depending on the number and type of cattle owned by the household and the number of people in the household. At least two cattle will be required for a household to be eligible for a $2m^3$ biogas unit and at least 3 cattle will be required for a household to be eligible for a $3m^3$ biogas unit.

The project will result in greenhouse gas (GHG) emission savings in the following ways:

- The biogas will displace GHG emissions from kerosene and fuel wood that are currently used for cooking. The biogas produced from cattle manure is a renewable source of energy as the CO_2 that is absorbed during the growth of the organic matter in the dung equals the CO_2 emitted when the biogas is burnt (see the introduction in chapter 10.1, Volume 4 of the Revised IPCC Guidelines 2006). In accordance with methodology AMS-I.E, emission reductions are calculated for the non-renewable part of the fuel wood and for the share of kerosene that would be used for cooking without the proposed project activity.

- The biogas will displace GHG emissions from cattle manure that is currently dumped in pits near the household. The cattle manure is dumped along with other waste such as straw from the cow

[1] Chikballapur District was created out of Kolar District on 23 August 2007 (http://chikballapur.nic.in/district_profile.html). As a result, Kolar is now comprised of five taluks - Srivinvaspur, Kolar, Mulbagal, Malur and Bangarapet (http://www.karnataka.com/districts/#).

shed, some kitchen waste, crop residues and other organic matter and liquids in the pit. This organic waste is never dry and does not get mixed therefore animal waste is decaying anaerobically and emitting methane. When cattle manure is fed to the biogas reactor, the emissions from the amount of manure that is added to the bioreactor will be avoided.

The project will have multiple sustainable development benefits in addition to the reduction in GHG emissions:

- Efficient cooking stoves fired with biogas will reduce indoor air pollution and respiratory problems currently caused by smoke from inefficient cookstoves burning fuel wood and kerosene;

- Currently the majority of the collected fuel wood used for cooking and heating water represents non-renewable biomass. The installation of a biogas unit will reduce the consumption of fuel wood by participating households and will therefore reduce the pressure on scarce forest resources in the project area;

- Women and children can use time that was otherwise required for collecting fuel wood for education and generating income;

- Biogas provides a more convenient, dependable energy source that is renewable and that reduces cooking time as there is no longer a need to set a fire and get it going;

- Cleaning of the kitchen and pots used for cooking is easier as biogas is a clean burning fuel and does not produce the levels of soot and other particulate matter that is produced by burning fuel wood and kerosene; and

- The slurry produced from the biogas units is a valuable organic fertiliser that can be applied directly to the fields or composted with other organic material to improve crop yields and reduce the use of chemical fertilisers.

SKG Sangha has developed extensive knowledge about biogas units that are suitable for rural households in Karnataka State, what functions well and what may induce problems, as well as knowledge about waste management, sludge application, composting and proper use of sludge or compost. SKG Sangha will conduct a number of meetings with eligible households and provide training to transfer this knowledge.

The project is also applying for Gold Standard accreditation. More details are provided in Annex 6 including the project's assessment against the Gold Standard sustainability matrix.

A.3. Project participants:

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
India (host)	SKG Sangha	No
United Kingdom of Great Britain and Northern Ireland	CarbonAided Ltd	No

SKG Sangha is an Indian NGO that has successfully implemented over 50,000 biogas units in India over the last 15 years. SKG Sangha is the project developer and will be responsible for the implementation of the biogas units. Full contact details for SKG Sangha are provided in Annex 1. Farmers and their families are owners of the land and they will be the operators of the biogas units.

CarbonAided Ltd is working with SKG Sangha to monetise the emission savings from the project, arrange financing for the project and find buyers for the carbon offsets that the project will generate. Full contact details for CarbonAided Ltd are provided in Annex 1.

A.4. Technical description of the small-scale project activity:

A.4.1. Location of the small-scale project activity:

The proposed project activity will be implemented in rural areas of Kolar District, which has five Taluks – Srinivaspur, Kolar, Mulbagal, Malur, and Bangarapet.

A.4.1.1. Host Party(ies):

India

A.4.1.2. Region/State/Province etc.:

Karnataka State

A.4.1.3. City/Town/Community etc:

Rural areas of Kolar District (Srinivaspur, Kolar, Mulbagal, Malur, and Bangarapet Taluks)

A.4.1.4. Details of physical location, including information allowing the unique identification of this small-scale project activity :

The map to the left shows the approximate location of the project on a large scale map of India. The actual project boundaries will be the outer boundaries of Kolar District. Kolar District encompasses the following five Taluks: Srinivaspur, Kolar, Mulbagal, Malur and Bangarapet.

The red line on the Kolar District map below shows the outer District boundaries for Kolar District.

A.4.2. Type and category(ies) and technology/measure of the small-scale project activity:

The project falls into the following categories of small-scale project activities:

I.C – "Thermal energy for the user with or without electricity"
I.E – "Switch from Non-Renewable Biomass for Thermal Applications by the User"
III.R – "Methane recovery in agricultural activities at household/small farm level"

The project will involve using cattle dung for the production of biogas (category III.R), which will displace the use of kerosene (category I.C) and non-renewable biomass (category I.E) for household cooking purposes.

The project conforms to these small-scale categories because:

- Introduced renewable energy technologies – biogas systems – have an aggregate capacity less than 45 MW: the average capacity of the units that will be installed under the proposed project activity is between 1-2kW so the aggregate capacity of the systems is in the order of 10-20MW; and

- Recovery and destruction of methane from manure and agricultural wastes in all systems (all households) results in emission savings of less than 60kt CO_2e annually.

In each household, a family-size biodigester together with a biogas-based cooking stove unit will be installed. The biogas units will be constructed of bricks, sand, cement, pipes, pipe fittings, metal clips, wire and gas burners. Each bioreactor will be a mesophylic fixed dome. The capacity of the biodigesters will be either $2m^3$ or $3m^3$ of biogas per day. The biogas unit size will be chosen based on the number and type of cattle owned by the household and the number of people in the household. SKG Sangha will build the systems with the help of people from the households. Cattle dung and wastewater will be fed into the biodigester daily. Cattle dung and kitchen wastewater will be 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 (the pipe at the top of the biodigester leads to the cooking stove in the household). The biodigester also produces a slurry which is pushed into the outlet tank and displacement chamber as the biogas builds up in the digester and finally exits through the slurry discharge hole. The technology has been tested and widely used in India.

The project activity is also eligible for the Gold Standard – it falls under the category renewable energy supply which is defined as the generation and delivery of energy services (e.g. mechanical work, electricity, heat) from non-fossil and non-depletable energy sources. Methane that would otherwise be emitted into the atmosphere will be captured and used to generate thermal energy for cooking and heating water.

A.4.3 Estimated amount of emission reductions over the chosen crediting period:

Years	**Estimation of annual emission reductions in tonnes of CO_2 e**
2009	10,821
2010	41,737
2011	61,883
2012	61,883
2013	61,883
2014	61,883
2015	61,883
2016	61,883
2017	61,883
2018	61,883
Total estimated reductions (tonnes of CO_2 e)	**547,224**
Total number of crediting years	**10**
Annual average over the crediting period of estimated reductions (tonnes of CO_2 e)	**54,722**

A.4.4. Public funding of the small-scale project activity:

The project does not include public funding. The participating households will make a small in kind contribution of materials and labour but otherwise no other funding or assistance will be available to implement the project. The project will be funded solely from the sale of the offsets created from the project's GHG emission reductions.

A.4.5. Confirmation that the small-scale project activity is not a debundled component of a large scale project activity:

This proposed small-scale project activity is not a debundled component of a large project activity as there is no registered small-scale CDM project activity or a request for registration by another small-scale project activity:

- By the same project participants;
- In the same project category and technology/measure; and
- Registered within the previous 2 years; and
- Whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point.

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the small-scale project activity:

The following approved small scale baseline and monitoring methodologies are applied to the Kolar Biogas Project:

(i) Version 13 of AMS-I.C "Thermal energy for user with or without electricity"

(ii) Version 1 of AMS-I.E "Switch from non-renewable biomass for thermal applications by the user"

(iii) Version 1 of AMS-III.R "Methane recovery in agricultural activities at the household/small farm level"

B.2 Justification of the choice of the project category:

(i) AMS-I.C "Thermal energy for user with or without electricity", version 13

The methodology is applicable to renewable energy technologies that supply individual households or users with thermal energy that displaces fossil fuels.

In the proposed project, this methodology is applied for estimating and monitoring emission reductions from displacing kerosene use (fossil fuel) in household cooking stoves (thermal energy) with the use of biogas generated from cattle dung and organic kitchen waste (renewable sources). The total aggregate capacity of 10,000 biogas systems is less than 45 MW: the average capacity of the units is between 1-2kW so the aggregate capacity of the systems is in the order of 10-20MW.

(ii) AMS-I.E "Switch from non-renewable biomass for thermal applications by the user", version 1

The methodology is applicable to small thermal appliances that displace the use of non-renewable biomass by introducing new renewable energy end-user technologies, such as biogas stoves and solar cookers.

The proposed project will introduce small, family-size biogas systems (bioreactors and cookers) that supply thermal energy for household cooking needs. In the area of the proposed Kolar Biogas Project, 78% of fuel wood used for cooking is considered non-renewable biomass (see section B.4 below for information on how the fraction was calculated). For households participating in this project, their fuel wood use will be replaced with the use of biogas generated in small biogas reactors (renewable energy derived from cattle dung).

According to the methodology, the following conditions also apply:

a) If any similar registered small-scale CDM project activities exist in the same region as the proposed project activity then it must be ensured that the proposed project activity is not saving non-renewable biomass accounted for by other registered project activities; and

b) Project participants are able to show that non-renewable biomass has been used since 31 December 1989, using survey methods.

There is no similar registered CDM project activity in the same region.

A number of studies on bioresource use in Karnataka show that non-renewable biomass has been used since 31 December 1989. In particular, Ramachandra et al in "Bioresource Status in Karnataka" (2004 – see reference 2 in Annex 5) noted that the share of fuel wood in cooking in rural areas increased from 56% in 1989/90 to nearly 62% in 1994/95. This increased demand could not have been met by renewable supplies of fuel wood in Kolar District due to the serious bioresource shortages in Kolar District. A number of studies have shown that Kolar District is a bioresource deficient zone meaning that not only is there insufficient fuel wood to meet cooking and water heating demands, there is also a shortage of other possible bioresource substitutes like animal, crop and horticultural residues. With more than 70% of the population in rural areas, Ramachandra et al (2004 – see reference 2 in Annex 5) note that there is tremendous demand on resources such as fuel wood and agricultural residues to meet people's daily fuel needs. More recent studies on non renewable biomass use in Kolar District including Ramachandra and Rao in "Inventorying, Mapping and Monitoring of Bio-resources Using GIS and Remote Sensing" (2005 – see reference 3 in Annex 5) have noted the high level of non renewable biomass use in Kolar District so the pattern that was established from 1989/90 has continued in more recent years due to the sustained demand on bioresources to meet rural energy needs. This is supported by the baseline survey of a sample of households in the region (see B4 below and Annex 3 for further details) which confirmed that the time for collecting fuel wood and the price for purchasing fuel wood has been increasing, which shows persistent and growing non renewable biomass use.

(iii) AMS-III.R "Methane recovery in agricultural activities at the household/small farm level", version 1

The methodology is applicable to recovery and destruction of methane from manure and wastes from agricultural activities that would be decaying anaerobically emitting methane to the atmosphere in the absence of the project activity. Methane emissions are prevented by: (a) Installing a methane recovery and combustion system to an existing source of methane emissions, or (b) Changing the management practice of a biogenic waste or raw material in order to achieve the controlled anaerobic digestion equipped with methane recovery and combustion system. Further, the methodology is restricted to measures at individual households or small farms, where a single system achieves annual emission reductions of less than or equal to 5 t CO_2e, and is applicable only together with AMS-I.C. Finally, sludge must be handled aerobically. Aggregate annual emission reductions of all systems included shall be less than or equal to 60 kt CO_2e.

In the proposed project activity, animal manure is currently dumped in pits. Each household has a pit in the ground which is at least 1.5 m deep, where waste from the cattle shed – cow dung, straw, green fodder and urine – is dumped. Waste from the cattle shed is dumped in the pit along with some crop waste and any food waste and is not turned or mixed during the year. Cow urine, wastewater from the kitchen and other liquids are added to keep the mass in the pits wet or liquid. During the rainy season the pits also gets filled with rainwater. The animal waste is decaying anaerobically in the pit and emits methane. The pits are cleaned out once a year and the material is applied in the fields as a fertiliser.

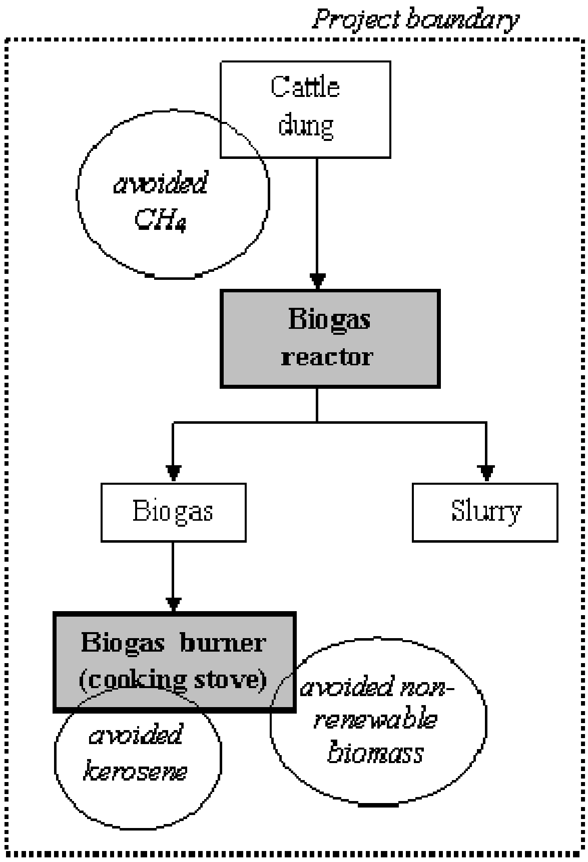
After introducing a biogas unit, the amount of animal manure fed into biodigesters will not be left to decay anaerobically in the pit. Instead the manure that is fed into the biodigester will break down anaerobically in the biodigester. The biogas that is produced will be held in the biodigester until it is combusted in the biogas burners and used for cooking and heating water. Each household must have at least 2 head of cattle to be eligible for a 2m^3 biogas unit and 3 head of cattle to be eligible for a 3m^3

biogas unit. The type of cattle and the number of people in the household will help to determine the size of the biogas unit that is installed.

A single biogas system avoids annually an average of 3.47 t CO_2e due to this methane recovery (see below for calculations) i.e. less than the 5 t CO_2e maximum annual amount from methane recovery permitted under this methodology. The methodology AMS-I-C is applied for the use of methane for thermal energy (cooking and heating water). Aggregate annual emission reductions from avoided methane of all 10,000 households included will be 34,669 t CO_2e which is less than the 60,000t CO2e limit that applies to this methodology. The calculations are based on a projection that 70% of the units will be 3m^3 capacity units and that the remaining 30% of the units will be 2m^3 capacity units.

B.3. Description of the project boundary:

The project boundary is defined by the physical, geographical site of biogas digesters and biogas cookers. The diagram below shows a schematic representation of the project and its boundary:



Sources and gases included in the project boundary:

	Source	Gas	Included?	Justification/explanation
Baseline	Thermal energy need –use of kerosene	CO_2	Yes	Major source of emissions
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
	Thermal energy need –non-renewable biomass share of the fuel wood use	CO_2	Yes	Major source of emissions
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
	Animal waste	CO_2	No	Excluded as emissions from animal waste are CO_2-neutral
		CH_4	Yes	Major source of emissions
		N_2O	No	Excluded for simplification
Project activity	Direct emissions from the biodigester (physical leakage)	CO_2	No	Excluded as emissions from biogas are CO_2 neutral
		CH_4	Yes	Main source of project emissions
		N_2O	No	Excluded for simplification
	Leakage	CO_2	No	Any possible leakage is more than compensated for by unclaimed (a) avoided N_2O emissions from cattle manure that goes into the biodigester, (b) avoided CO_2 emissions from avoided application of fertiliser due to improved fertiliser from the biogas slurry, and (c) avoided emissions of products of incomplete combustion of fuel wood.
		CH_4	No	
		N_2O	No	

B.4. **Description of baseline and its development:**

The baseline parameters were identified using a survey of target households. SKG Sangha, who has initiated the project, has identified two project possibilities in poor rural areas of Karnataka State – the proposed project activity in Kolar District and another proposed project activity in dry Taluks of Hassan District. The selected areas are both dry, have bioresource deficits, and have similar farming systems.

The survey was carried out in 84 households in Hassan Taluk and in 68 households in Channarayapatna Taluk in Hassan District. The survey results show that a typical household has on average 5 persons, an annual income of 23,300 rupees (£290), and 4 or 5 heads of cattle.

A study conducted by the Regional Biogas Development and Training Centre, University of Agriculture Sciences, Bangalore, during May 2006 to May 2007 (see reference 1 in Annex 5) shows a very similar typical household in Kolar district: average family size is 5.36, income 12,350 rupees per year, land holding of 4.13 acres, primary occupation animal husbandry and secondary occupation agriculture and sericulture (silk farming), with about 6 heads of cattle. Therefore results from the baseline survey conducted in Hassan and Channarayapatna Taluks of Hassan District are also applicable for Kolar District. The table with the Hassan District survey results is given in Annex 3.

(i) Kerosene component

According to AMS-I.C "Thermal energy for user with or without electricity", version 13,

> "For renewable energy technologies that displace technologies using fossil fuels, the simplified baseline is the fuel consumption of the technologies that would have been used in the absence of the project activity times an emission coefficient for the fossil fuel displaced. IPCC default values for emission coefficients may be used."

Without the proposed programme activity, households in rural areas of the Kolar District will continue with their current practices of cooking using fuel wood and kerosene (for further discussion on this see section B.5 below).

The baseline survey results show that the average total kerosene consumption of a household in the project area that would potentially be eligible for a biogas unit is 55.7 litres per year. The average amount of kerosene that is used for starting fires and cooking from this total amount is 35.9 litres per year. The balance of the kerosene is used for lighting. The biogas systems will displace the average amount of kerosene used for cooking and starting fires as the kerosene will no longer be required as an accelerant to start cooking fires and for providing a quick convenient fuel used to boiling water for tea for visitors.

Therefore the baseline for the kerosene component of the proposed project activity is considered to be the use of 35.9 litres of kerosene per household per year. The IPCC default value for stationary combustion of kerosene in a residential category is used as the emission factor.

(ii) Non-renewable biomass component

According to AMS-I.E:

> "Switch from non-renewable biomass for thermal applications by the user", it is assumed that in the absence of the project activity, the baseline scenario would be the use of fossil fuels for meeting similar thermal energy needs."

In the proposed project activity, the average participating household uses 3.9 tonnes of fuel wood per year for cooking according to the baseline survey results. Studies at the Karnataka State level have shown that Kolar District is a bioresource deficit zone where the demand for fuel wood and other bioresources far exceeds supply. For example, in the study "*Bioresource Status in Karnataka*" (Ramachandra et al, 2004 – see reference 2 in Annex 5) Kolar District was included in the Eastern Dry Agro Climatic Zone which was identified as having a bioresource availability to demand ratio of 0.39 i.e. only 39% of the bioresources that were used could be considered to be renewable. Similar comments were made in the study "*Bioresource Potential of Karnataka: Technical Report No. 109*" (Ramachandra and Kamakshi, 2005 – see reference 4 in Annex 5). These state level studies support the results of specific studies on bioresource use in Kolar District. The study "*Inventorying, Mapping and Monitoring of Bioresources Using GIS and Remote Sensing (Kolar District)*" (Ramachandra and Rao, 2005 – see reference 3 in Annex 5) assessed bioresource use in Karnataka through 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. This study generated a bioresource availability to demand ratio for each taluk in Kolar District with an average ratio for Kolar District of 0.22. This ratio means that on average only 22% of the bioresources that are used in Kolar District are renewable and that 78% of the bioresources used in Kolar District are non renewable. As this study is specific to Kolar District rather than a more general state level study and given that the study incorporates detailed analysis of villages in the project area these results represent the most accurate and appropriate figure for non renewable biomass use in the Kolar District.

The households will switch to biogas systems which are able to meet all their cooking and some of their water heating needs. All fuel wood that is used for cooking will therefore be replaced once a household has a biogas unit. For the households in the project area, fossil fuels generally are too expensive and/or need expensive equipment for their use for cooking purposes (for more details see the section B.5 on additionality). There is no clear projected fossil fuel to which such families would switch, as the gap between current income and the income needed to afford fossil fuel use for cooking purposes is large. Nevertheless, kerosene could theoretically be considered as a projected fossil fuel, as it does not need expensive cooking equipment, is available in the market, and some kerosene is already used by households as an accelerant in cooking fires.

Therefore the baseline for the non-renewable biomass part of the programme is the use of kerosene for supplying the same amount of thermal energy that 3.26t (i.e., 78% of 3.9t) of non-renewable woody biomass generates.

(iii) Cattle manure component

According to AMS-III.R "Methane recovery in agricultural activities at the household/small farm level", version 1:

> "The baseline scenario is the situation where, in the absence of the project activity, biomass and other organic matter are left to decay anaerobically within the project boundary and methane is emitted to the atmosphere. Baseline emissions (***BEy***) are calculated ex ante using the amount of the waste or raw material that would decay anaerobically in the absence of the project activity, with the most recent IPCC tier 2 approach (chapter 'Emissions from Livestock and Manure Management' under the volume 'Agriculture, Forestry and other Land use' of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories). Country/regional-specific values shall be used if available."
>
> "The amount of waste or raw materials that would decay anaerobically in the absence of the project activity is determined by survey of a sample group of households/small farms with a confidence level of 95%. The survey should determine the baseline animal manure management practices applied. This small-scale methodology is only applicable to the portion of the manure, which would decay anaerobically in the absence of the project activity established by the survey."

The general pattern of manure and waste management was defined during preliminary visits to potentially participating households. In a typical household that will participate in the proposed project activity, animal manure is currently dumped in pits. Households collect animal manure produced when cattle is kept in a shed. Each household has a pit in the ground, which is on average approximately 1.5 m deep, where waste from the cattle shed – cow dung, straw, green fodder and urine – is dumped. Waste from the cattle shed is dumped in the pit along with some crop waste and any food waste. The waste is not turned or mixed during the year. During the rainy season the pits get filled with water. In other times of the year, in order to keep the material in the pit wet or liquid, kitchen waste water is also poured into the pits. The animal waste is therefore decaying anaerobically in the pit and emits methane. The pits are cleaned out once a year and the material is applied in the fields as a fertiliser. Such manure and pit management is also described in the study carried out by the Regional Biogas Development and Training Centre, University of Agriculture Sciences, Bangalore (ref. 1 in Annex 5).

Questions were included in the baseline survey on how long the material in the pits corresponds to (i) an uncovered slurry, (ii) drier cover on top but slurry below the crust, (iii) solid wet material, and (iv) solid dry material. The survey categories correspond to the following manure management systems given in Table 10.18, Chapter 10.4, Volume 4 of the IPCC 2006 Guidelines: (i) liquid/slurry manure management system, (ii) liquid/slurry with crust cover manure management system and (iii) solid storage manure management system. The survey results are backed up by the University of Agriculture Sciences study referred to above.

The survey results have shown that manure is handled in a liquid/slurry manure management system for 6.3 months, in a liquid/slurry with crust cover manure management system for 3.1 months and in a solid storage manure management system for the remaining 2.6 months.

Animal manure is collected primarily when the animals are kept in the sheds that are attached to or close by the house. All the manure from the shed is put into the pit. When animals are grazing outside, dung is only rarely collected and put into the pit. Animals are kept in the sheds on average for 16.5 hours per day, thus 69% of the total manure produced by the cattle is collected and put into the pit as described above. Although some manure that is dropped in the fields is collected and put into the pit, this manure has not been included in the baseline calculations for the sake of conservativeness. A check of the amount of manure going into the pit was incorporated in the survey by measuring the approximate total manure production per day and the amount of manure that is collected and dumped in the pit. This also gives a share of 69%.

The following table summarises how the shares of manure handled in different manure management systems have been defined:

Survey question (For how many months does the material in the pit look…)	**Corresponding manure management system according to IPCC definitions**	**Survey result** (months)	**Share of collected manure from total manure produced**	**Share of manure handled in different manure management systems (MS)**
		A	B	= A /12 * B
… like an uncovered slurry	Liquid/slurry[2]	6.32	0.69	0.36
… like a slurry with a crust cover	Liquid/slurry with crust cover[3]	3.12	0.69	0.18
… solid but wet	Solid storage[4]	2.56	0.69	0.15
… solid but dry	Solid storage	0.01		

After the installation of a biogas system, all the manure collected by an average surveyed household will be fed into the 3m^3 biogas units. For the 2m^3 units, the household will have fewer cattle than the 3m^3 biogas units but in the same proportion of different cattle types. Although the survey results are indicative of an average number of cattle aggregated for both types of households – i.e. those eligible for

[2] Table 10.18 in the IPCC 2006 Guidelines defines this system as the situation when “manure is stored as excreted or with some minimal addition of water in either tanks or earthen ponds outside the animal housing, usually for periods less than one year”.

[3] No separate definition is given for this system in the IPCC 2006 Guidelines compared to the liquid/slurry definition, but the Methane Correction Factor is different when the material has a crust cover.

[4] Table 10.18 in the IPCC 2006 Guidelines defines this system as “The storage of manure, typically for a period of several months, in unconfined piles or stacks. Manure is able to be stacked due to the presence of a sufficient amount of bedding material or loss of moisture by evaporation”.

a 3 m^3 unit and those eligible for a 2 m^3 unit – in ex-ante calculations for the sake of conservativeness it is assumed that only 2/3 of the collected manure of an average surveyed household will be fed into the 2m^3 units (as the 2m^3 units only have 2/3 the capacity of the 3m^3 units). The methane will be captured and used for cooking.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered small-scale CDM project activity:

The proposed project activity has not been announced yet. The project activity is dependent upon receiving carbon credits and this intention was expressed during stakeholder consultation.

Pre-project situation

Families in rural areas of Kolar District use traditional cooking stoves fired with fuel wood and additionally with kerosene. These can be cooking stoves made of three stones or simple design stoves made of clay. The three-stone cooking stove costs almost nothing and traditional constructed stove cost only slightly more at 100 Indian Rupees (£1). The fuel wood is collected from woody shrubs and forested areas. The demand for fuel wood is much higher than the regeneration of the woody biomass so there is a severe shortage of fuel wood and forest resources are depleting. 78% of the collected fuel wood is non-renewable. Additionally, families use some kerosene for enhancing the burning of fuel wood. Each household uses 35.87 litres of kerosene per year for cooking purposes.

The traditional cooking stoves have poor efficiency: a large amount of fuel wood is needed to generate enough thermal energy for the household's cooking needs. Burning of fuel wood in such cooking stoves also results in comparatively large amounts of incomplete combustion products – CH_4, N_2O, CO, and non-methane hydrocarbons (NMHC), which are all greenhouse gases more potent than CO_2.

Project alternatives

Alternatives to the proposed project activity could be:

(a) use of kerosene for all cooking purposes;
(b) installation of Liquid Petroleum Gas (LPG) systems;
(c) the use of sustainable agricultural residues (biomass) as a fuel;
(d) installation of biogas systems without the CDM; or
(e) continuation of the current, pre-project situation.

There are no legal regulations for households to use renewable energy sources for their cooking needs or to capture methane from manure and organic waste. Therefore all the above alternatives are consistent with existing laws and regulations.

Financial/investment analysis

(a) A small amount of kerosene is subsidised by the government at a cost of 10 Rupees per litre. In addition, kerosene is available on the market at a cost of 25 Rupees per litre and some families, who can afford it, buy some kerosene to supplement the subsidised amount. The kerosene is used primarily for enhancing the burning of fuel wood and for lighting. It is not generally used as an alternative primary fuel as most families cannot afford to buy enough kerosene for all their cooking needs and will continue using free fuel wood as their primary cooking fuel in the absence of the project activity.

(b) LPG systems are quite popular in urban areas but are only slowly penetrating into rural areas. The costs of the system together with the running costs are too high for rural families to afford. LPG system cost 4,000 Rupees (£50) and each refill of 14.2kg costs 350 Rupees per refill (for government subsidised refills). Studies have shown that commercial fuels like LPG have achieved little penetration into the domestic sector of rural India with only 1.3% of households in rural India using it for their cooking fuel.

(c) The households which will participate in this project only have small areas of land (the average landholding per family is 2.5 acres). Land is used for subsistence farming, and there are not enough residues for use as a fuel.

(d) Biogas systems have slowly been penetrating into rural India. However, in the majority of cases, this has only been with some form of support from a charity or government subsidies. As noted above the availability of government subsidies has reduced dramatically in recent years from around 250,000 units per year to around 5-10,000 units per year for the entire country which equates to at best only tens of biogas units per District and an even smaller number at Taluk level. Similarly, charity or donor financing has contributed to biogas units in the past but such financing is not able to cover the vast need for improving the energy supply to rural households in India. The average annual household income of the project area is around INR 23,000 (£290), while the initial cost of installing a biodigester, even when it is built from locally available material by trained local workers, is between INR 20,000 (£200) for a $2m^3$ biogas unit and INR 23,200 (£230) for a $3m^3$ biogas unit. Therefore the installation costs are too high for the majority of rural households to afford.

Without the CDM, none of the alternatives to the proposed project activity except the continuation of the current situation would be implemented. Continuation of the pre-project situation would mean further methane and CO_2 emissions from cattle manure and use of kerosene and non-renewable biomass. On the contrary, the installation of biogas units provides the highest health and hygiene benefits compared to other alternatives.

The participating households will make a small in kind contribution of materials and labour but otherwise the project will be funded solely from the sale of the offsets created from the project's GHG emission reductions.

<u>Common practice analysis</u>

The majority of rural households use traditional cooking stoves and burn fuel wood with some kerosene.

Some biogas systems have been installed in poor rural households of Kolar District, but they have been either supported by schemes using charity or development assistance funding or government subsidies. The Indian government used to provide annual subsidies for around 250,000 biogas units per year but now only provides subsidies for around 10,000 biogas units per year for the whole country. This amounts to only a handful of biogas units per year at a Taluk level and SKG Sangha no longer uses government subsidies for installing biogas units.

The biogas units from this project will be installed in villages where there are no initiatives supported by other NGOs or public agencies for the installation of biogas digesters and the proposed biogas project activity will be solely dependent on carbon finance (apart from a small in kind contribution of labour and materials from the beneficiary households). Therefore the project is additional to what would otherwise occur.

<u>Impact of CDM registration</u>

Funding of the proposed project activity is fully dependent upon the project's CDM registration and issuance of CERs.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

Emission reductions are calculated as the difference between the baseline emissions of the three components – (i) displacement of kerosene, (ii) displacement of non-renewable biomass and (iii) the capture and destruction of methane from animal manure – and the project emissions.

Baseline emissions for the kerosene component are calculated based on the amount of kerosene that will be 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 12).

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

$BE_{kerosene}$ – 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)
$\rho_{kerosene}$ – kerosene density (kg/l)
$NCV_{kerosene}$ – net calorific value of kerosene (TJ/Gg)
$EF_{kerosene}$ – emissions factor of kerosene (kg CO_2/TJ)

Baseline emissions for the non-renewable biomass component are calculated based on the use of the biomass (fuel wood) that is replaced, the fraction of the biomass that is non-renewable biomass, 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 quantity of the biomass that is replaced is calculated using option (a) in order to provide a more conservative answer. It is calculated as the product of the number of appliances (biogas units) multiplied by the estimate of average annual consumption of biomass per appliance (i.e. the annual use of fuel wood in an average household) determined based on a survey of a representative sample of households.

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

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 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; and
$EF_{kerosene}$ – 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.

Baseline emissions for the manure component are calculated based on the amount of manure that would decay anaerobically in the pits, using the Tier 2 approach from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (according to AMS-III.R "Methane recovery in agricultural activities at the household/small farm level", version 1). 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 27°C and fractions of total manure handled in these manure management systems.

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

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), (kg CH_4 per animal per year); and
N_T – the number of head of livestock species/category T in an average household.

$$EF_{(T)} = VS_{(T)} * 365 * B_{o(T)} * 0.67 \text{ kg/m}^3 * \sum_{(S,k)} ((MCF_{S,k}) / 100 * MS_{(T,S,k)}) \quad (4)$$

$VS_{(T)}$ – daily volatile solid excreted for livestock category T (kg dry matter per animal per day);
365 – basis for calculating annual VS production (days per year);
$B_{o(T)}$ – maximum methane producing capacity for manure produced by livestock category (T/ m^3 CH_4 per kg of VS excreted);
0.67 – conversion factor for converting m^3 CH_4 to kg CH_4;
$MCF_{(S,k)}$ – methane conversion factors for each manure management system S by climate region k (%); and
$MS_{(T,S,k)}$ – fraction of livestock category T's manure handled using manure management system S in climate region k (dimensionless).

The proposed project lies in one climatic region (with high temperatures). The manure management system is different at different times of the year (see Table in section B.4 to see how fractions of manure handled in different manure managements systems were defined). Therefore the formula used is:

$$EF_{(T)} = VS_{(T)} * 365 * B_{o(T)} * 0.67 \text{ kg/m}^3 * (MCF_{liquid}/100 * MS_{liquid} + MCF_{liquid\ with\ crust}/100 * MS_{liquid\ with\ crust} + MCF_{solid}/100 * MS_{solid}) \quad (5)$$

<u>Project emissions</u> are calculated as a physical leakage of methane from the biogas unit (in the biogas reactor and when biogas is combusted in the burner). No fossil fuels or electricity is used for constructing or managing the biogas units.

$$PE = LF_{AD} * f\_collected * \sum_{(T)} (GWP\_CH_4 * 0.67 \text{ kg/m}^3 * B_{o(T)} * VS_{(T)} * 365) / 1000 \quad (6)$$

PE – annual project emissions from physical leakages in the biogas digesters (t CO_2e/year);
F_collected – fraction of total excreted manure that is collected (dimensionless);
LF_{AD} – methane leakages from anaerobic digesters (dimensionless). Default value of 0.1 specified in the AMS-III.R is used;
0.67 – conversion factor of m^3 CH_4 to kg CH_4;
B_o – maximum methane producing capacity for manure produced by livestock category T (m^3 CH_4 per kg of VS excreted); and
$VS_{(T)}$ – daily volatile solid excreted for livestock category T (kg dry matter per animal per day).

<u>Leakage</u> relating to non-renewable biomass will be assessed from ex-post surveys of users and areas from where biomass is sourced.

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	$F_{kerosene}$
Data unit:	l (litres)
Description:	Annual amount of kerosene used for cooking and starting fires in an average household
Source of data used:	Baseline survey
Value applied:	35.87
Justification of the choice of data or description of measurement methods and procedures actually applied :	The value is defined based on a survey of a representative sample of households. The survey is described in Annex 3.
Any comment:	

Data / Parameter:	$\rho_{kerosene}$
Data unit:	kg/l
Description:	Density of kerosene
Source of data used:	IPCC default value
Value applied:	0.817
Justification of the choice of data or description of measurement methods and procedures actually applied :	Local or regional value for kerosene used in the project area is not available, therefore the IPCC default value is used
Any comment:	

Data / Parameter:	$NCV_{kerosene}$
Data unit:	TJ/Gg
Description:	Net calorific value of kerosene
Source of data used:	Table 1.2 in 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	43.8
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default net calorific value suggested by IPCC
Any comment:	

Data / Parameter:	**$EF_{kerosene}$**
Data unit:	kg CO_2/TJ
Description:	Emissions factor from burning of kerosene in households
Source of data used:	Table 2.5 in 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	71,900
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default emissions factor for stationary combustion in the residential category suggested by IPCC
Any comment:	This value is used for calculating $BE_{kerosene}$. For BE_{NRB}, the default value specified in AMS I.E, 71,500 kg CO_2/TJ, is used

Data / Parameter:	**$B_{biomass}$**
Data unit:	T
Description:	Quantity of biomass that is substituted or replaced in an average household
Source of data used:	Baseline survey
Value applied:	3.9
Justification of the choice of data or description of measurement methods and procedures actually applied :	The value is defined based on a survey of a representative sample of households. The survey is described in Annex 3.
Any comment:	

Data / Parameter:	**f_{NRB}**
Data 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 used:	”Inventorying, Mapping and Monitoring of Bioresources Using GIS and Remote Sensing” study (Ramachandra and Rao 2005 – see reference 3 in Annex 5)
Value applied:	0.78
Justification of the choice of data or description of measurement methods and procedures actually applied :	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 (for details on the calculations see Annex 3).
Any comment:	

Data / Parameter:	GWP_CH_4
Data unit:	t CO_2 / t CH_4
Description:	Global warming potential for methane
Source of data used:	IPCC
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default value suggested by IPCC
Any comment:	

Data / Parameter:	$N_{(T)}$
Data unit:	Dimensionless (number)
Description:	Number of heads per cattle species/category in an average household
Source of data used:	Baseline survey
Value applied:	3.73 for dairy cows, 0.28 for buffalos, 0.52 for other cattle
Justification of the choice of data or description of measurement methods and procedures actually applied :	The values are defined based on a survey of a representative sample of households. The survey is described in Annex 3
Any comment:	

Data / Parameter:	$VS_{(T)}$
Data unit:	kg dry matter / (head * day)
Description:	Daily volatile solid excreted for livestock category T
Source of data used:	Tables 10A-4 to 10A-6 in 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Biogas Technology by B.T. Nijaguna (see reference 5 in Annex 5), Table 2.12 p29.
Value applied:	3.8 for dairy cow, 3.1 for buffalo, 1.4 for other cattle
Justification of the choice of data or description of measurement methods and procedures actually applied :	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 Indian subcontinent values are used for buffalo and other cattle.
Any comment:	

Data / Parameter:	**$B_{o(T)}$**
Data unit:	m^3 CH_4/kg VS
Description:	Maximum methane producing capacity for manure produced by livestock category T
Source of data used:	Tables 10A-4 to 10A-6 in 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	0.13 for diary cattle, 0.1 for buffalo and other cattle
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default values suggested by IPCC
Any comment:	

Data / Parameter:	**MCF_{manure} (MCF_{liquid}, $MCF_{liquid\ with\ crust}$, MCF_{solid})**
Data unit:	%
Description:	Methane correction factor for cattle manure for each manure management system S by climate region k
Source of data used:	Table 10.17 in 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	78 for liquid/slurry manure management system (MCF_{liquid}), 48 for liquid/slurry manure management system with natural crust cover ($MCF_{liquid\ with\ crust}$), 5 for solid storage manure management system (MCF_{solid})
Justification of the choice of data or description of measurement methods and procedures actually applied :	Values corresponding to average annual temperature of 27°C are taken for MCF_{liquid}, $MCF_{liquid\ with\ crust}$ and MCF_{solid}. Temperature data was taken from Natural resources data management system, a Brach of Department of Science and Technology, Government of India
Any comment:	

Data / Parameter:	**MS_{manure} (MS_{liquid}, $MS_{liquid\ with\ crust}$, MS_{solid})**
Data 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 used:	Based on baseline survey
Value applied:	0.36 for liquid/slurry manure management system (MS_{liquid}), 0.18 for liquid/slurry with crust cover manure management system ($MS_{liquid\ with\ crust}$), 0.15 for solid storage manure management system (MS_{solid})
Justification of the choice of data or description of measurement methods and procedures actually applied :	See manure component in section B.4 for the detailed explanation.
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

Project emissions

(i) Avoided kerosene

Annual baseline emissions for 1 operating unit:

$$BE_{kerosene} = F_{kerosene} * \rho_{kerosene} * NCV_{kerosene} * EF_{kerosene} * 10^{-9}$$

The following parameters are used:

Parameter	Value	Unit	Source
$F_{kerosene}$	35.87	l	Baseline survey
$\rho_{kerosene}$	0.817	kg/l	IPCC
$NCV_{kerosene}$	43.8	TJ/Gg	IPCC 2006 T.1.2
$EF_{kerosene}$	71,900	kg CO_2/TJ	IPCC 2006 T.2.5

Therefore:

$$BE_{kerosene} = 35.87 \text{ l} * 0.817 \text{ kg/l} * 43.8 \text{ TJ/Gg} * 71{,}900 \text{ kg } CO_2\text{/TJ} * 10^{-9} = 0.092 \text{ t } CO_2$$

(ii) Avoided non-renewable biomass

Annual baseline emissions for 1 operating unit:

$$BE_{NRB} = B_{biomass} * f_{NRB} * NCV_{NRB} * EF_{kerosene} * 10^{-3}$$

The following parameters are used:

Parameter	Value	Unit	Source
$B_{biomass}$	3.9	T	Baseline survey
f_{NRB}	0.78	-	Study by Ramachandra and Rao 2005, see Annex 5
NCV_{NRB}	0.015	TJ/t	IPCC 2006 T.1.2
$EF_{kerosene}$	71,500	kg CO_2/TJ	AMS I.E

Therefore:

$$BE_{NRB} = 3.9 \text{ t} * 0.78 * 0.015 \text{ TJ/t} * 71{,}500 \text{ kg } CO_2\text{/TJ} * 10^{-3} = 3.263 \text{ t } CO_2$$

(iii) Avoided methane from cattle manure

Annual baseline emissions for 1 operating unit:

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

$$EF_{(T)} = VS_{(T)} * 365 * B_{o(T)} * 0.67 \text{ kg/m}^3 * (MCF_{liquid}/100 * MS_{liquid} + * MCF_{liquid\ with\ crust}/100 *$$

$MS_{liquid\ with\ crust} + MCF_{solid}/100 * MS_{solid})$

The following parameters are used:

Parameter	Value	Unit	Source
GWP_CH_4	21	kg CO_2 / kg CH_4	IPCC
MCF_{liquid}	78	%	IPCC 2006 T. 10A-4 to 10A-6
$MCF_{liquid\ with\ crust}$	48	%	IPCC 2006 T. 10A-4 to 10A-6
MCF_{solid}	5	%	IPCC 2006 T. 10A-4 to 10A-6
MS_{liquid}	0.36	-	Baseline survey
$MS_{liquid\ with\ crust}$	0.18	-	Baseline survey
MS_{solid}	0.15		Baseline survey
	Dairy cow		
N_T	3.73	-	Baseline survey
$VS_{(T)}$	3.8	kg dry matter/(head*day)	Biogas Technology by B.T. Nijaguna
$B_{o(T)}$	0.13	m^3 CH_4/kg VS	IPCC 2006 T. 10A-4 to 10A-6
	Buffalo		
N_T	0.28	-	Baseline 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	0.52	-	Baseline 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 * 0.13 m^3 CH_4/kgVS * 0.67 kg/m^3 *
* (78/100 * 0.36 + 48/100 * 0.18 + 5/100 * 0.15) = 45.26 kgCH_4/year

$EF_{buffalo}$ = 3.1 kg VS/(head*day) * 365 * 0.1 m^3 CH_4/kgVS * 0.67 kg/m^3 *
* (78/100 * 0.36 + 48/100 * 0.18 + 5/100 * 0.15) = 28.40 kgCH_4/year

$EF_{other\ cattle}$ = 1.4 kg VS/(head*day) * 365 * 0.1 m^3 CH_4/kgVS * 0.67 kg/m^3 *
* (78/100 * 0.36 + 48/100 * 0.18 + 5/100 * 0.15) = 12.83 kgCH_4/year

BE_{manure} for a 3m^3 unit = (45.26 kgCH_4/year*3.73 + 28.40 kgCH_4/year*0.28 +
+ 12.83 kgCH_4/year*0.52)* *21 kgCO_2/kgCH_4 / 1000 = 3.85 tCO2e

BE_{manure} for a 2m^3 unit = 3.85 tCO2e * 2/3 = 2.57 tCO2e

Assuming 30% of the units are 2m^3 units and 70% are 3m^3 units, then BE_{manure} for 1 average unit is:

BE_{manure} = 3.85 tCO2e * 0.7 + 2.57 tCO2e * 0.3 = 3.467 t CO_2e

(iv) Total baseline emissions for one operating unit:

$$BE = BE_{kerosene} + BE_{NRB} + BE_{manure} = 0.092\ t\ CO_2 + 3.263\ t\ CO_2 + 3.467\ t\ CO_2e = 6.82\ t\ CO_2e$$

Project emissions

Annual project emissions for one operating unit:

$$PE = LF_{AD} * f\_collected * \sum_{(T)} (GWP\_CH_4 * 0.67\ kg/m^3 * B_{o(T)} * VS_{(T),} * 365) / 1000 =$$
$$= LF_{AD} * f\_collected * GWP\_CH_4 * 0.67\ kg/m^3 * 365 * \sum_{(T)} (B_{o(T)} * VS_{(T)})$$

The same parameters as the ones used for calculating baseline emissions from cattle manure are used.

Therefore PE for one 3 m^3 unit:

$$PE\_3m3 = 0.1 * 0.69 * 21\ kgCO_2/kgCH_4 * 0.67\ kg/m^3 * 365 * (0.13\ m^3\ CH_4/kgVS * 3.8\ kgVS/(head*day) + 0.1\ m^3\ CH_4/kgVS * 3.1\ kgVS/(head*day) + 0.1\ m^3\ CH_4/kgVS * 1.4\ kg\ VS/(head*day)) / 1000 = 0.709\ t\ CO_2e$$

PE for one 2 m^3 unit:

$$PE\_2m3 = 2/3 * PE\_3m3 = 0.473\ t\ CO_2e$$

Assuming 30% of the units are 2m^3 units and 70% of the units are 3m^3 units, then PE for 1 average unit is:

$$PE = 0.709\ t\ CO_2e * 0.7 + 0.473\ t\ CO_2e * 0.3 = 0.639\ t\ CO_2e$$

Emission reductions

Emission reductions for one operating unit:

$$BE = BE – PE = 6.82\ t\ CO_2 – 0.64\ t\ CO_2e = 6.18\ t\ CO_2e$$

Annual emission reductions for the whole project are calculated by multiplying emission reductions for one operating unit by number of biogas units operating in that year. Schedule for construction and operation of biogas units is provided in the table below:

Year	**Units built**	**Units in Operation**
0		
1	3,500	1,750
2	6,500	6,750
3		10,000
4		10,000
5		10,000
6		10,000
7		10,000
8		10,000
9		10,000
10		10,000

B.6.4 Summary of the ex-ante estimation of emission reductions:

Year	Estimation of project activity emissions (tonnes of CO_2e)	Estimation of baseline emissions (tonnes of CO_2e)	Estimation of leakage (tonnes of CO_2e)	Estimation of overall emission reductions (tonnes of CO_2e)
Year 1	1,117	11,938	0.00	**10,821**
Year 2	4,310	46,048	0.00	**41,737**
Year 3	6,385	68,219	0.00	**61,833**
Year 4	6,385	68,219	0.00	**61,833**
Year 5	6,385	68,219	0.00	**61,833**
Year 6	6,385	68,219	0.00	**61,833**
Year 7	6,385	68,219	0.00	**61,833**
Year 8	6,385	68,219	0.00	**61,833**
Year 9	6,385	68,219	0.00	**61,833**
Year 10	6,385	68,219	0.00	**61,833**

B.7 Application of a monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Data / Parameter:	$N_{operating}$
Data unit:	-
Description:	Number of systems (biogas units) operating
Source of data to be used:	SKG Sangha
Value of data	
Description of measurement methods and procedures to be applied:	When SKG Sangha installs biogas systems in a village, it trains a local person to be the main contact with SKG Sangha to maintain and repair biogas systems and to monitor and report the operation of systems. Normally any faults with the biodigesters are resolved by the local contact person on the same day as the complaint is lodged. SKG Sangha will check each unit annually to ensure it is operating.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	$F_{kerosene}$
Data unit:	L
Description:	Amount of kerosene consumed by household after installation of biogas unit
Source of data to be used:	SKG Sangha
Value of data	
Description of measurement methods and procedures to be applied:	Survey of representative sample of villages.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	$B_{biomass}$
Data unit:	T
Description:	Consumption of fuel wood in households participating in the project activities
Source of data to be used:	Surveys
Value of data	
Description of measurement methods and procedures to be applied:	SKG Sangha will survey a sample of households. Currently 22% of an average household fuel wood consumption is renewable biomass and 78% is non-renewable biomass. 3.9 tonnes of fuel wood are used on average for cooking and 3.4 t are used for other purposes (mainly for heating water). Information will be sought on the quantity of biomass consumed after implementation of the project activity – i.e. the difference between the total fuel wood consumption in the baseline (7.3 t) and the total fuel wood consumption after project implementation (monitored value) will be used for calculating emission reductions from saved biomass (applying the fraction of non-renewable biomass).
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	$B_{biomass,non-project}$
Data unit:	T
Description:	Consumption of fuel wood in households not participating in the project activities.
Source of data to be used:	Surveys
Value of data	
Description of measurement methods and procedures to be applied:	SKG Sangha will survey a sample of households. Information will be sought on the quantity of biomass consumed as well as where the biomass is sourced from, in order to identify if any non-renewable biomass saved by the project activities increases the use of non-renewable biomass in households not participating in the project.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	H_{stove}
Data unit:	h
Description:	Annual hours of operation of biogas burner
Source of data to be used:	Surveys
Value of data	
Description of measurement methods and procedures to be applied:	SKG Sangha will survey a sample of households.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	N_T
Data unit:	
Description:	Annual average animal population in a household (number of heads of diary cow, buffalo and other cattle).
Source of data to be used:	Survey of a sample of households.
Value of data	
Description of measurement methods and procedures to be applied:	SKG Sangha will survey a sample of households.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	$B_{manure,generated}$
Data unit:	T
Description:	Average amount of animal manure generated per household per year.
Source of data to be used:	Survey of a sample of households.
Value of data	
Description of measurement methods and procedures to be applied:	SKG Sangha will survey a sample of households.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	**$B_{manure,fed}$**
Data unit:	T
Description:	Average amount of animal manure fed into a biogas digester per year.
Source of data to be used:	Survey of a sample of households.
Value of data	
Description of measurement methods and procedures to be applied:	SKG Sangha will survey a sample of households.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	**$B_{application\ of\ sludge}$**
Data unit:	
Description:	Proper application of the sludge from the biogas unit.
Source of data to be used:	Survey of a sample of households.
Value of data	
Description of measurement methods and procedures to be applied:	SKG Sangha will survey a sample of households to check whether sludge from the biogas unit is applied on the fields correctly.
QA/QC procedures to be applied:	
Any comment:	

The following sustainable development indicators will also be monitored (see Annex 6 for further details):

Sustainable Development Indicator	**Data unit**	**Measured (m), calculated (c) or estimated (e)**
Avoided emissions of products of incomplete fuel wood combustion	Tonnes	Estimated based on monitored biomass use in non-project households and project households
Number of additional employment positions		Estimated
Saved expenses on kerosene and fuel wood purchases	Rupees	Calculated using surveys
Saved time spent collecting fuel wood	Hours	Estimated using surveys
Number of people who received training		Estimated

B.7.2 Description of the monitoring plan:

Through its work with biogas plants over the last 15 years, SKG Sangha has developed a system of installing and maintaining the biogas units. The operational and monitoring plan builds on this experience.

All households participating in the project get training on how to manage and maintain the biogas digester. One person from each village remains the main contact for coordinating with SKG Sangha. This person will be trained in how to:

- supervise project implementation in the village;
- maintain and repair the biogas units;
- monitor the project activities; and
- keep records.

A number of separate training sessions are also run for the households who have biodigesters installed to ensure that beneficiaries use their units correctly.

During installation the household will sign three pieces of paper to confirm that the masonry work, the pipe fitting work and the overall biodigester has been installed satisfactorily. An SKG Sangha representative will check the unit once it has been installed to ensure the biogas unit has been installed correctly and this information will then be recorded and logged in SKG Sangha's records. The records will also include information on the size of each unit – whether it is a 3 m^3 unit or a 2 m^3 unit. 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.

Once the unit is installed village representatives will also record for each participating household any periods that a biogas digester and/or biogas cooker is not functioning. Normally any problems with the biogas units will be resolved the same day as the original complaint. Households also have a separate pre post paid 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. SKG Sangha will monitor the functionality of each biodigester unit once per year.

SKG Sangha will also undertake survey monitoring of the following:

- average amount of kerosene used
- average NRB use of households with unit
- average NRB use of households without unit
- average annual hours of operation of a unit
- average animal population per household
- average amount of manure generated on the farm
- average amount of animal manure fed into the system
- proper soil application of the final sludge

B.8 Date of completion of the application of the baseline and monitoring methodology and the name of the responsible person(s)/entity(ies)

12 September 2008. CarbonAided Ltd (see Annex I for full contact details).

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

Construction of biogas digesters will start in the first half of 2009.

C.1.2. Expected operational lifetime of the project activity:

At least 20 years.

C.2 Choice of the crediting period and related information:

The project activity will use a fixed crediting period.

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period:

C.2.1.2. Length of the first crediting period:

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

01/01/2009

C.2.2.2. Length:

10 years

SECTION D. Environmental impacts

No negative environmental impacts were identified. The project will have the following positive environmental impacts in addition to the reduction in CO_2 and CH_4 emissions:

- The project will reduce consumption of fuel wood reducing pressure on scarce forest resources. Currently the major part of collected fuel wood represents non-renewable biomass;
- Efficient cooking stoves will reduce indoor air pollution;

- Soil quality and its water retention capacity are expected to improve after replacing indiscriminate use of chemical fertilisers with application of high-quality compost; and
- The risk of water pollution will be reduced due to proper management of wastewater and reduced use of chemical fertilisers and pesticides.

D.1. If required by the host Party, documentation on the analysis of the environmental impacts of the project activity:

Environmental impact analysis for the project activity is not required by Indian laws.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

SECTION E. Stakeholders' comments

The local stakeholder consultation was carried out during July and August 2008 in a representative sample of villages. Responses to the consultation show a strong demand for biogas units from households who currently do not have one. This was especially the case in households where people knew someone who already has a biogas unit.

E.1. Brief description how comments by local stakeholders have been invited and compiled:

SKG Sangha has met with potential participating households.

E.2. Summary of the comments received:

The comments received were overwhelmingly positive. Potential beneficiaries noted the time savings from no longer having to spend up to a few hours each day collecting wood. Potential beneficiaries were also keen to reduce the smoke generated while cooking and the soot build up on pots and in the kitchen area. Stakeholders also noted the convenience of biogas as it provides a quick starting cooking fuel which is useful when meals or pots of tea have to be prepared quickly.

E.3. Report on how due account was taken of any comments received:

Comments from the local stakeholder consultation process confirm that there is a strong demand for biogas units that is not being met by current government, charity or other developer efforts.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	SKG Sangha
Street/P.O.Box:	2nd Main Road, Gandhi Nagar
Building:	532
City:	Kolar
State/Region:	Karnataka State
Postfix/ZIP:	563 101
Country:	India
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Last Name:	Devabhaktuni
First Name:	Vidya Sagar
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Personal E-Mail:	president@skgsangha.org

Organization:	CarbonAided Ltd
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City:	London
State/Region:	
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Telephone:	+44 207 953 4051
FAX:	+44 207 953
E-Mail:	dickjones@carbonaided.com
URL:	www.carbonaided.com
Represented by:	Richard Jones
Title:	Mr
Last Name:	Jones
Middle Name:	P
First Name:	Richard
Mobile:	+44 7717 524 044
Direct tel:	+44 207 953 4051
Personal E-Mail:	

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

The proposed project activity does not involve any public funding. The participating households will make a small in kind contribution of materials and labour but otherwise no other funding or assistance will be available to implement the project. The project will be funded solely from the sale of the offsets created from the project's GHG emission reductions.

Annex 3

BASELINE INFORMATION

A. English translation of baseline survey sheet:

Household Energy & Manure Management Survey	
Village: Taluk:	Date: Survey Number in Village:

1. General Data

Name:	
Number of people in household:	
Income:	……………………….Rs per day per week per month per year

2. Fuel Consumption

Kerosene			
Used for	**Amount (litres)**		**Price per litre (Rs)**
Cooking:		per day per week per month per year	Subsidised:
Lighting Fire:		per day per week per month per year	
Lighting:		per day per week per month per year	In the market:
Other:		per day per week per month per year	
Amount subsidised by government:		per day per week per month per year	

Firewood			
Use and Source		**Amount (kg)**	
Used for cooking			per day per week per month per year
Used for other purposes			per day per week per month per year
Purchased			per day per week per month per year
Collected from forests			per day per week per month per year
Collected from private land			per day per week per month per year
Other source (specify).....................			per day per week per month per year
Purchased wood:	Price:	……………….. Rs / kg, or ………………. Rs/tonne	
	Price trend in recent years:	increasing stable decreasing don’t know	
Collected Wood:	Time spent collecting (hours):		per day per week per month
	Trend in time taken to collect wood in recent years:	increasing stable decreasing don’t know	
	Distance to collection area:		
	Distance trend in past years:	increasing stable decreasing don’t know	
	Type of firewood collected (if possible, provide approximate share)	Chopped trees:	
		Chopped branches:	
		Dead wood on ground:	
		Other:	

Other biomass		
Type (specify)	**Amount (kg)**	
		per day per week per month per year
		per day per week per month per year

3. Manure management

Livestock numbers:	Dairy cows: ……		Buffalos: …..	Other cattle: ……
Where do you normally keep the animals?	▯ In a shed	..... ▯ hours per day ..... ▯ share (%)	▯ In the fields	.... ▯ hours per day .... ▯ share (%)
Where is the manure from the shed put?	▯ In a pit ▯ On the fields ▯ Other			
What happens to the manure from the animals when they are in the fields?	▯ Collected and put in pit ▯ Left in the fields ▯ Other..........................			
Total amount of manure produced by animals (approximately, if known):	▯ kg ▯ tonnes ▯ baskets	▯ per day ▯ per week ▯ per month ▯ per year		
Total amount of manure collected from shed and put in pit:	▯ kg ▯ tonnes ▯ baskets	▯ per day ▯ per week ▯ per month ▯ per year		
Total amount of manure collected from fields and put in pit:	▯ kg ▯ tonnes ▯ baskets	▯ per day ▯ per week ▯ per month ▯ per year		

If some dung goes into a compost pit		
(i) What is the depth of the pit (in metres)?	.... m	
(ii) Apart from dung, what else is added to the pit?	▯ Crop waste ▯ Food waste ▯ Toilet waste ▯ Other	
(iii) What share of the pit is made up of this other waste?	Approximately .... % of the total material in the pit	
(iii) For how many months of the year is the material in the pit most like the following state?	▯ An uncovered slurry ▯ A covered slurry or slurry with crust ▯ Solid material but wet ▯ Solid material and dry	.... months .... months .... months .... months
(v) How long does it take the pit to fill up?	.... months	
(vi) What happens to manure and other pit waste once the pit is full?	▯ Manure and other waste is piled on top of the existing pit ▯ A new pit is dug and manure and waste is put in there ▯ Other	
(vii) Does the material in the pit get mixed or turned?	▯ yes ▯ no (if yes please indicate how often)	
(viii) How often does the pit get emptied?	▯ once per year (indicate month(s) when pit emptied.........................) ▯ more than once per year (indicate how often ....)	

4. Interest in biogas

Are you interested in getting a biogas unit?	
If yes, why?	▯ money savings ▯ time savings ▯ cleaner ▯ less smoke ▯ more convenient to cook ▯ other
If no, why?	

B. Survey results:

Nr.	Survey Question	Unit	Value		Average	Corresponding parameter	Value	Unit
			Hassan	Channa-rayapatna				
1	Sample Size	Household	84	68				
2	No. of persons in a HH	Person	5.26	4.99	5.12			
3	Yearly Income	Rupees	23,214	23,456	23,335			
4	Kerosine use per month							
4.1	for cooking	l/month	2.80	2.05	2.43	F_kerosene	35.87	l/year
4.2	for starting fire	l/month	0.99	0.13	0.56			
4.3	for lighting	l/month	1.97	1.34	1.66			
4.4	other usage	l/month						
4.5	Qunatity of kerosene subsidised by Government	l/month	3.10	2.33	2.72			
4.6	Price of subsidised kerosene	Rupees	10	10				
4.7	Market price of kerosene	Rupees	24.76	25.91	25.34			
5	Firewood use per day							
5.1	cooking	kg	11.37	10.00	10.68	B_biomass	3.9	t/year
5.2	other use	kg	11.01	7.74	9.37			
5.3	Purchased	kg	1.45	1.06	1.25			
5.4	Collected from Forests	kg	12.49	6.43	9.46			
5.5	collected from Private lands	kg	5.59	5.54	5.57			
5.6	distance to collection area	km	5.03	1.90	3.47			
6	Animals							
6.1	Dairy cows	head	4.19	3.26	3.73	N_dairy_cow	3.73	
6.2	Buffalo	head	0.27	0.28	0.28	N_buffalo	0.28	
6.3	other cows	head	0.48	0.56	0.52	N_other_cattle	0.52	
6.4	Animals kept in the shed	h/day	16.70	16.21	16.45	f_collected	0.69	
6.5	animals graze in the fields	h/day	7.30	7.79	7.55			
6.6	Animal manure production	kg/day	70.60	73.90	72.25			
6.7	Manure collected and put into pit	kg/day	50.18	50.18	50.18	f_collected	0.69	
7	Manure pits							
7.1	Depth	m	1.42	1.10	1.26			
7.2	Material as uncovered slurry	months	6.45	6.19	6.32	MS_liquid (= F7.2 / 12 * f_collected)	0.36	
7.3	Material as covered slurry	months	3.10	3.15	3.12	MS_liquid_with_crust (=F7.3 / 12 * f_collected)	0.18	
7.4	Solid material but wet	months	2.46	2.66	2.56	MS_solid_storage (=F7.4 / 12 * f_collected)	0.15	
7.5	Solid material but dry	months	0.01	0.00	0.01			
7.6	Time to fill up the pit	months	10.14	7.57	8.86			

Nr.	Survey question	Answer
8	Other information	
8.1	Other sources of biomass	Coconut, arikenut and agricultural residues
8.2	Price of fire wood	1 to 4
8.3	Price trend	Increasing
8.3	Collected wood	Thorny bushes to felled trees
8.4	Collection time trend	Increasing
8.5	Time spent on collection	Varying from 3 hours in a day to few days in a year
8.6	Where do the animal waste ends up	Compost pit
8.7	Manure of animals while grazing	Left out and rarely collected
8.8	What else is added to the pit	Crop waste, animal shed waste with urine, leaves, weeds, etc.
8.9	How often does the pit get emptied?	Once in a year
8.1	What happens to manure and other pit waste once the pit is full?	Gets piled up on top
8.11	Does the material in the pit get mixed or turned?	Never
8.12	Are they interested in getting a biogas unit?	Yes

C. Calculations:

Kerosene component

Methodology: AMS-I.C. "Thermal energy for user with or without electricity", version 13

BE_kerosene = F_kerosene * N * [ro]_kerosene * NCV_kerosene * EF_kerosene * 1.0 E-9

Parameter	Abbr.	Value	Unit
Number of households	N	10000	
Kerosene use per household per year	F_kerosene	35.87	l
Density	[ro]_kerosene	0.817	kg/l
Net calorific value	NCV_kerosene	43.8	TJ/Gg
Emissions factor	EF_kerosene	71900	kgCO2/TJ
Factor to convert units		1.00E-09	
BE annual	BE_kerosene	**922.90**	t CO2e
BE annual for 1 unit		0.092	t CO2e

Non-renewable biomass component

Methodology: AMS-I.E. "Switch from non-renewable biomass for thermal applications by the user", version 1

BE_NRB = B_biomass * N * f * NCV_biomass * EF_kerosene * 1.0 E-3

Parameter	Abbr.	Value	Unit
Number of households	N	10000	
Quantity of biomass substituted per unit per year	B_biomass	3.9	t
Fraction of biomass that is non renewable	f	0.78	
Net calorific value of biomass	NCV_biomass	0.015	TJ/t
Emissions factor of kerosene	EF_kerosene	71500	kgCO2/TJ
Factor to convert units		1.00E-03	
BE annual	BE_NRB	**32,625.45**	t CO2e
BE annual for 1 unit		3.263	

NRB Fraction Calculation - Kolar District

Taluk Name	Bioresource Availability/Demand Ratio
Bagepalli	0.149
Bangarpet	0.1518
Chikballapur	0.422
Chintamani	0.12
Gauribidanur	0.155
Gudibanda	0.159
Kolar	0.3259
Malur	0.2122
Mulbagal	0.184
Sidllaghatta	0.173
Srinivasapur	0.3858
Average	0.22
NRB Fraction	78%

Source: *Inventorying, Mapping and Monitoring of Bio-Resources Using GIS and Remote Sensing (Kolar District)* by T V Ramachandra and G R Rao (see reference 3 in Annex 5).

Manure component

Methodology: AMS-III.R "Methane recovery in agricultural activities at the household/small farm level", version 1

EF =VS*365*Bo*0.67*(MCF_liquid/100*MS_liquid+MCF_liquid_crust/100*MS_liquid_crust+MCF_solid/100*MS_solid)

BE = (EF_dairy_cow * N_dairy_cow + EF_buffalo * N_buffalo + EF_other_cattle * N_other_cattle) *N*GWP_CH4/1000

Parameter	**Abbr.**	**Value for 3 cubic metre unit**	**Value for 2 cubic metre unit**	**Unit**
Number of households	N	10000	10000	
Average number of heads of dairy cattle per unit	N_dairy_cow	3.73	3.73	
Average number of heads of buffalo per unit	N_buffalo	0.28	0.28	
Average number of heads of other cattle per unit	N_other_cattle	0.52	0.52	
Daily volatile solid excreted for dairy cow	VS_dairy_cow	3.8	3.8	kg dry matter/head/day
Daily volatile solid excreted for buffalo	VS_buffalo	3.1	3.1	kg dry matter/head/day
Daily volatile solid excreted for other cattle	VS_other_cattle	1.4	1.4	kg dry matter/head/day
Maximum methane producing capacity for manure produced by dairy cow	Bo_dairy_cow	0.13	0.13	m3 CH4/kg VS
Maximum methane producing capacity for manure produced by buffalo	Bo_buffalo	0.1	0.1	m3 CH4/kg VS
Maximum methane producing capacity for manure produced by other cattle	Bo_other_cattle	0.1	0.1	m3 CH4/kg VS
Methane correction factor for liquid/slurry manure management system	MCF_liquid	78	78	%
Methane correction factor for liquid/slurry with crust manure management system	MCF_liquid_crust	48	48	%
Methane correction factor for solid storage manure management system	MCF_solid	5	5	%
Fraction of manure handles in liquid/slurry manure management system	MS_liquid	0.36	0.36	
Fraction of manure handles in liquid/slurry with crust manure management system	MS_liquid_crust	0.18	0.18	
Fraction of manure handles in liquid/slurry with crust manure management system	MS_solid	0.15	0.15	
Global warming potential of methane	GWP_CH4	21	21	t CO2/t CH4
Scaling factor to represent lower proportion of manure going into 2cu.m. unit			0.67	
Emission factors:				
Emissions factor for dairy cow	EF_dairy_cow	45.26	45.26	kg CH4/animal/year
Emissions factor for buffalo	EF_buffalo	28.40	28.40	kg CH4/animal/year
Emissions factor for other cattle	EF_other_cattle	12.83	12.83	kg CH4/animal/year
BE annual for 1 unit	BE_manure	3.85	2.57	t CO2e/year
BE annual for 70% 3 cubic metre units and 30% 2 cubic metre units	BE_manure		**34,669**	t CO2e
BE annual for 1 average unit			3.467	t CO2e

Annex 4

MONITORING INFORMATION

Through its work with biogas plants over the last 15 years, SKG Sangha has developed a system of installing and maintaining the biogas units. The operational and monitoring plan builds on this experience.

All households participating in the project get training on how to manage and maintain the biogas digester. One person from each village remains the main contact for coordinating with SKG Sangha. This person will be trained in how to:

- supervise project implementation in the village;
- maintain and repair the biogas units;
- monitor the project activities; and
- keep records.

A number of separate training sessions are also run for the households who have biodigesters installed to ensure that beneficiaries use their units correctly.

During installation the household will sign three pieces of paper to confirm that the masonry work, the pipe fitting work and the overall biodigester has been installed satisfactorily. An SKG Sangha representative will check the unit once it has been installed to ensure the biogas unit has been installed correctly and this information will then be recorded and logged in SKG Sangha's records. The records will also include information on the size of each unit – whether it is a 3 m^3 unit or a 2 m^3 unit. 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.

Once the unit is installed village representatives will also record for each participating household any periods that a biogas digester and/or biogas cooker is not functioning. Normally any problems with the biogas units will be resolved the same day of the original complaint. Households also have a separate pre post paid 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.

SKG Sangha will monitor the functionality of each biodigester unit once per year.

SKG Sangha will also undertake survey monitoring of the following:

- average amount of kerosene used
- average NRB use of households with unit
- average NRB use of households without unit
- average annual hours of operation of a unit
- average animal population per household
- average amount of manure generated on the farm
- average amount of animal manure fed into the system
- proper soil application of the final sludge

Annex 5

REFERENCES

1. Kumargoud, V, Report on Manure Management Systems by Regional Biogas Development and Training Centre, University of Agricultural Sciences, Bangalore.

2. Ramachandra, T.V. et al, *Bioresource Status in Karnataka*, Renewable and Sustainable Energy Reviews, Volume 8, Issue 1, February 2004, pages 1-47.

3. Ramachandra T.V. and Rao, G.R, *Inventorying, Mapping and Monitoring of Bioresources Using GIS and Remote Sensing (Kolar District)* (2005).
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4. Ramachandra, T.V. and Kamakshi, G, *Bioresource Potential of Karnataka: Technical Report No: 109*, Energy and Wetlands Research Group, Indian Institute of Science, Bangalore, 560012 (November 2005).

5. Nijaguna, B.T, *Biogas Technology* (New Age International (P) Ltd, 4835/24 Ansari Road, Daryaganj, New Delhi 110 002, 2002).

Annex 6

GOLD STANDARD SUSTAINABILITY MATRIX

Indicators	Mitigation Measure	Relevance to achieving MDG	Chosen parameter and explanation	Preliminary Score
Air quality	n/a	Goal 4 – reduce child mortality. Goal 6 – combat other diseases.	Functionality of biogas units. The project activity will result in a reduction in indoor air pollution especially smoke and particulate matter from inefficient traditional cookstoves which are replaced by cleaner burning biogas stoves. This will help to reduce childhood mortality and combat respiratory and other diseases linked to indoor air pollution.	+
Water quality and quantity	n/a	Goal 7 – ensure environmental sustainability.	No parameter chosen. The project activity should however result in improved water quality due to reduced levels of bacteria from animal waste and household waste water which is added to the biodigester after implementation.	+
Soil condition	n/a	Goal 7 – ensure environmental sustainability.	No parameter chosen. Previous SKG Sangha experience with similar biogas unit projects suggests the project activity will help to improve soil condition due to the application of the slurry from the biodigester. This slurry is a valuable organic fertiliser which can improve crop yields and reduce the use of chemical fertilisers.	+
Other pollutants	n/a		No significant change due to the project activity.	0
Biodiversity	n/a	Goal 7 – ensure environmental sustainability.	Amount of non-renewable fuel wood saved by the project. The reduction in the consumption of fuel wood will reduce pressure on scare forest resources and will help to stop the depletion of renewable forest stocks.	+

Quality of employment	n/a		No parameter chosen. Village representatives will be employed to ensure the functionality of the biogas units. This will give the representatives skills in the maintenance and monitoring of biogas units. The project activity will also result in high quality work for local masons and others involved in the construction of the biogas units.	+
Livelihood of the poor	n/a	Goal 1 – eradicate extreme poverty and hunger Goal 4 – reduce childhood mortality Goal 6 – combat other diseases	Reduction in time spent collecting fuel wood and total amount spent on fuel wood and kerosene. The project activity will alleviate poverty by reducing the need to buy kerosene, fuel wood and chemical fertilisers. The project activity will also help to prevent diseases caused by indoor air pollution as described for the air quality indicator above. The project activity will improve waste management facilities as animal manure and household waste water will be disposed of in a more sanitary manner (i.e. in the biogas unit). The project activity will also improve access to an appropriate quantity, quality and variety of food as the biogas unit and stove make it easier to cook meals (as the biogas stove produces instant heat when lit and burns cleanly) and also as more money will be available for spending on food as less will be spent buying kerosene, fuel wood and chemical fertilisers.	+

Access to clean and affordable energy services	n/a	Goal 1 – eradicate extreme poverty and hunger Goal 4 – reduce childhood mortality Goal 6 – combat other diseases	Functionality of biogas units. The project activity will improve access to clean energy supplies as it replaces inefficient traditional cookstoves that burn fuel wood and kerosene with clean burning renewable biogas. The biogas units are affordable as families make a small in kind contribution of labour and materials (as they are unable to afford the full costs of the unit).	+
Human and institutional capacity	n/a	Goal 2 – achieve universal primary education Goal 3 – empower women	Reduction in time spent collecting fuel wood. The project activity will help to remove the need for women and children to spend time collecting fuel wood (sometimes up to 2-3 hours per day) allowing children more time to spend on education and allowing women more time to spend on activities that generate income.	+
Quantitative employment and income generation	n/a		Number of people employed by the project activity. Masons and others involved in the construction of the biogas units will be employed to implement the project. After implementation village representatives will be required to ensure the functionality of the biogas units on an ongoing basis.	+
Balance of payments and investments	n/a		No parameter chosen. The project will however reduce the need to buy kerosene and chemical fertilisers which may lead to a reduction in the import of these commodities.	0
Technology transfer and technological self reliance	n/a	Goal 7- ensure environmental sustainability	Number of people who received training in operation, maintenance or monitoring of biogas units.	+

Justification of choices, data sources and provision of references	
Air quality	A functioning biogas unit will significantly reduce indoor air pollution compared to the baseline use of fuel wood and kerosene. Given the significant number of households covered by the project activity the most practical parameter to monitor the reduction in indoor air pollution is the functionality of the biogas units.
Water quality and quantity	No parameter chosen for monitoring (although water quality improvements are likely).
Soil condition	Not monitored (although the slurry from the biogas unit is a valuable organic fertiliser which can improve crop yields and reduce the use of chemical fertilisers).
Other pollutants	No significant change due to the project activity.
Biodiversity	The amount of non-renewable fuel wood saved by the project is the most practical parameter to monitor the biodiversity benefits from the project as it will show how well the project is able to promote sustainable use of forest resources (see section B.4 above for details on the data used and references for non-renewable biomass).
Quality of employment	No parameter chosen for monitoring (although high quality work will be provided to masons and others involved in constructing the biogas units and also to village representatives who will maintain the units).
Livelihood of the poor	The reduction in the time spent collecting fuel wood and the total amount spent on fuel wood and kerosene will show the increased livelihood opportunities and financial savings generated by the project and is a practical way to measure improvements in the livelihood of the project households.
Access to clean and affordable energy services	The functionality of the biogas units is the most practical way to demonstrate access to clean and affordable energy services (for more details on the affordability of the biogas units see section B.5 above).
Human and institutional capacity	The reduction in time spent collecting fuel wood will show the improvement in time that is now available to be spent by children on their education and by women on income generating activities.
Quantitative employment and income generation	The number of people employed by the project activity will be monitored as described below.
Balance of payments and investments	No parameter chosen for monitoring (although the project will reduce the need to buy kerosene and chemical fertilisers which may lead to a reduction in the import of these commodities).

Technology transfer and technological self reliance	The number of people who received training in operation, maintenance or monitoring of biogas units will be monitored as described below.

Sustainability Monitoring Plan

Number		1
Indicator		Air quality
Mitigation measure		n/a
Chosen parameter		Functionality of biogas units
Estimation of baseline situation of parameter		No biogas units operating
Future project target for parameter		All biogas units operating
Way of monitoring	How	SKG Sangha will check the functionality of each unit
	When	Annually
	By who	SKG Sangha

Number		2
Indicator		Biodiversity
Mitigation measure		n/a
Chosen parameter		Amount of non-renewable biomass saved
Estimation of baseline situation of parameter		Total amount of fuel wood used in baseline = 3.9t (for cooking) and 3.4t (for other purposes - mainly water heating) i.e. 7.3t in total. 78% of the total wood use is non-renewable i.e. 5.7t of non renewable wood.
Future project target for parameter		Saving of 3.04t of non-renewable biomass (3.9t*0.78)
Way of monitoring	How	SKG Sangha will monitor the biomass use of a sample of project household and non project households
	When	Annually
	By who	SKG Sangha

Number		3
Indicator		Livelihood of the poor
Mitigation measure		n/a
Chosen parameter		Reduction in the amount of time spent collecting fuel wood and the total amount spent on fuel wood and kerosene
Estimation of baseline situation of parameter		The average surveyed household spends 359 Rupees per year on kerosene for cooking and starting fires (35.87litres/year*10Rupees/litre) and purchases 456kg of fuel wood per year. The price of fuel wood varies. Some families spend up to 3 hours per day collecting fuel wood.
Future project target for parameter		No more than 1 hour per day spent collecting fuel wood for any project households and at least a 500 Rupee reduction in the total amount spent on fuel wood and kerosene each year.
Way of monitoring	How	SKG Sangha will monitor the amount spent on kerosene and fuel wood in a sample of households.
	When	Annually
	By who	SKG Sangha

Number		4
Indicator		Access to clean and affordable energy
Mitigation measure		n/a
Chosen parameter		Functionality of biogas units.
Estimation of baseline situation of parameter		No biogas units operating.
Future project target for parameter		All biogas units operating.
Way of monitoring	How	SKG Sangha will check the functionality of each unit.
	When	Annually
	By who	SKG Sangha

Number		5
Indicator		Human and institutional capacity
Mitigation measure		n/a
Chosen parameter		Reduction in time spent collecting fuel wood.
Estimation of baseline situation of parameter		Up to 3 hours per day for some families.
Future project target for parameter		No more than 1 hour per day for any project households.
Way of monitoring	How	SKG Sangha will survey a sample of households.
	When	Annually
	By who	SKG Sangha

Number		6
Indicator		Quantitative employment and income generation
Mitigation measure		n/a
Chosen parameter		Number of people employed by the project activity
Estimation of baseline situation of parameter		None
Future project target for parameter		Significant number of masons and others involved in the construction of the biogas units and a significant number of village representatives to ensure the ongoing functionality of the units.
Way of monitoring	How	SKG Sangha will estimate based on its records.
	When	Annually
	By who	SKG Sangha

Number		7
Indicator		Technology transfer and technological self reliance
Mitigation measure		n/a
Chosen parameter		Number of people who received training in operation, maintenance or monitoring of biogas units.
Estimation of baseline situation of parameter		None
Future project target for parameter		Significant number of households and village representatives to receive training in the maintenance and monitoring of biogas units.
Way of monitoring	How	SKG Sangha will estimate based on its records.
	When	Annually
	By who	SKG Sangha