

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

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Revision history of this document

Version Number	Date	Description and reason of revision
01	21 January 2003	Initial adoption
02	8 July 2005	<ul style="list-style-type: none">• 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	<ul style="list-style-type: none">• 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.

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

Biogas CDM Project of Bagepalli Coolie Sangha
 Version: 9
 Dated: 23rd May 2013

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

The Bagepalli Coolie Sangha is a 25 year-old membership based people's organization formed by small and poor peasant families (landed and landless agricultural labourers) in their respective villages. 38,615 small and poor peasant families have formed village level Coolie Sangha Units (CSUs) in 915 villages. The Coolie Sangha is self-financed through a system of Sangha Fund contributions made by the Member families. The Coolie Sangha gives an identity and protection to its Members and supports them in issues and struggles aimed at their empowerment. The Coolie Sangha implements various grassroots planned developmental activities, including children's education, community and referral health, petty credit for Coolie women, activities to support young widows and deserted women, a village level decentralized credit activity, agricultural development, etc.

The purpose of this Biogas CDM Project activity is to set up 18,000 biogas plants (digesters) of 2 m³ capacity each for single households in 5 Taluks of Chickballapur District¹ by the Coolie Sangha, and in this way replace Kerosene and Non-Renewable Biomass with biogas for cooking and hot water heating. A biogas plant of 2 m³ capacity is sufficient for providing cooking fuel to a family of four to five². These biogas units will be installed in a phased manner; 6,000 units/year for a period of 3 years. This is one of the most backward Districts of India and deserves a special attention and proper planning for all out development.

Each household will install a 2 m³ biogas plant and feed cow dung, organic waste and biomass waste into the anaerobic digester. The technology is tried and tested in India, and has been in use for many years. By utilizing these various sources of biogenic waste in a controlled anaerobic digestion and combustion system, biogas will be available for cooking energy and heating hot water. The biogas will be used on a two-ring gas stove with a flame temperature of 870oC, supplied as part of the project activity. All households willing to collect biogenic waste from agriculture and household can participate in the project. The list of 18,000 suitable and interested households is given in Appendix 1 (Excel sheet provided to DOE). Implementation of the project depends on the successful validation and registration of the project as a CDM project activity since the project will be financed completely from carbon revenues. There are social, environmental, economic and technological benefits which contribute to sustainable development.

¹ 6 taluks of former Kolar district have been separately and named Chickballapur district. Chickballapur district was carved out of Kolar district on 23th August 2007 (http://chikballapur.nic.in/district_profile.html). The 6 taluks includes Gowribidanur, Gudibanda, Bagepalli, Chintamani, Sidlaghatta and Chickballapur taluks. Many of the discussions in the PDD are done for Kolar District, as statistics have been compiled for the formerly Kolar District, which is inclusive of the project area.

² <http://www.techno-preneur.net/technology/New-technologies/Energy/biogas.htm>

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Social benefits:

- Avoided health hazards associated with unmanaged waste in back yards and village streets
- Avoided health hazards from indoor air pollution; and reduced drudgery

Environmental benefits:

- Avoided local environmental pollution through a better waste management system; and soil improvement by providing high quality manure
- Avoided global and local environmental pollution and environmental degradation by switching from kerosene and non-renewable biomass to renewable energy, leading to reduction of GHG emissions

Economic benefits:

- Savings to national economy by providing renewable cooking fuel instead of fossil fuels
- Higher productivity of workers as they have adequate cooking fuel supply

Technological benefits:

- Better biogas digester models, thus improving biogas yield.
- Training in chemistry of biogas for masons and users leading to improved scientific temper in community and more jobs.

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 a project participant (Yes/No)
India (host)	Bagepalli Coolie Sangha (BCS)	No
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.		

A.4. Technical description of the small-scale project activity:**A.4.1. Location of the small-scale project activity:**

Bagepalli, Chintamani, Sidlaghatta, Gudibanda and Chickballapur Taluks of Chickballapur District

A.4.1.1. Host Party(ies):

India

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

Karnataka

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A.4.1.3. City/Town/Community etc:

A list of the identified beneficiaries, Taluks and Villages are given in Appendix 1.

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

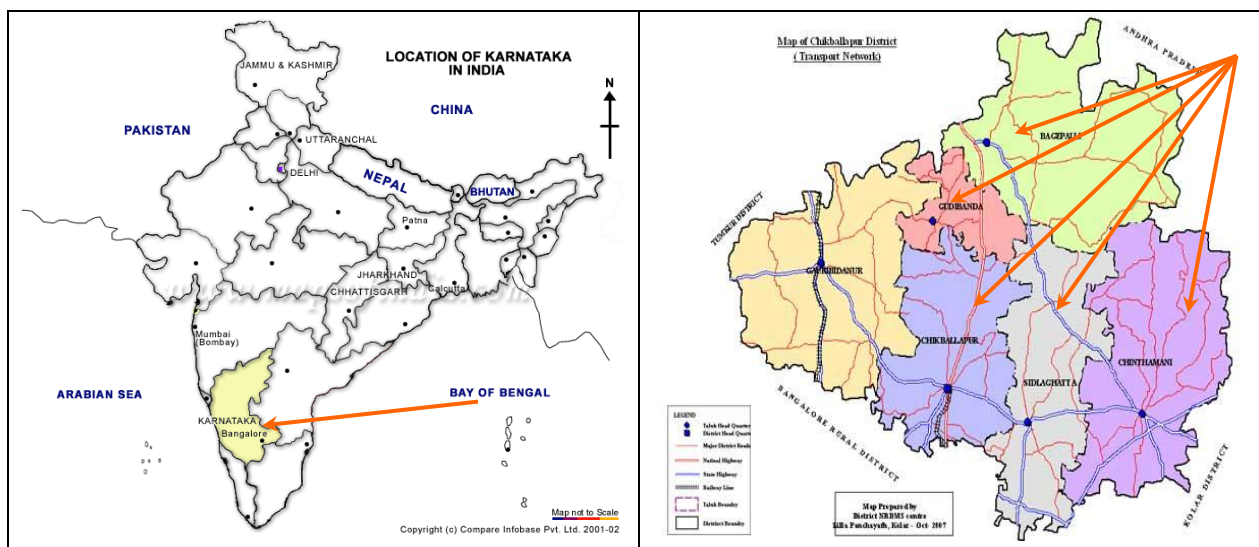


Figure 1: Map showing Karnataka State and the 5 taluks in Chickballapur district where the project will be implemented.

The geographical coordinates of the taluks are as follows.

Taluks	Coordinates
Bagepalli	13° 47' 5" North, 77° 47' 35" East
Chikballapur	13° 26' 3" North, 77° 43' 27" East
Chintamani	13° 24' 0" North, 78° 4' 0" East
Gudibanda	13° 40' 10" North, 77° 41' 54" East
Sidlaghatta	13° 23' 17" North, 77° 51' 46" East

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

The chosen type and category is TYPE I - RENEWABLE ENERGY PROJECTS, I.E. Switch from Non-Renewable Biomass for Thermal Applications by the User, version 01, EB 37 and TYPE – I – RENEWABLE ENERGY PROJECTS, I.C. Thermal energy for the user with or without electricity, Version 13, EB 38. The chosen technology is a domestic biogas plant. It is a small thermal appliance that displaces the use of kerosene and non-renewable biomass by introducing a system for utilising renewable biomass and converting it into renewable energy by means of a digester in which the substrate undergoes acidification and methanation. This end-user technology involves the switch from kerosene and non-renewable biomass to a renewable source of energy. Biogas is included in the specified methodology as

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an example of a suitable end user technology: biogas stoves are deemed a measure that involves the switch to renewable biomass from fossil fuel (kerosene) and non-renewable biomass in the baseline.

Technology/measure

Biogas is a mixture of methane and carbon dioxide. It also has traces of hydrogen sulphide, ammonia, oxygen, hydrogen, water vapour etc., depending upon feed materials and other conditions. Biogas is generated by fermentation of cellulose rich organic matter under anaerobic conditions. In anaerobic conditions, the methane-producing bacteria become more active. Thus, the gas produced becomes rich in methane. The optimum utilization depends upon the successful physical installations, which in turn depend upon plant design and its selection. The basic conversion principle is that when a non-ligneous biomass is kept in a closed chamber for a few days, it ferments and produces an inflammable gas. The anaerobic digestion consists of three stages:

- I Hydrolysis
- II Acid formation
- III Methane fermentation

The processes are carried out by two sets of bacteria namely acid forming bacteria and methane formers. The acidogenic phase I is the combined hydrolysis and acid formation stages in which the organic wastes are converted mainly into acetate, and phase II is the methanogenic phase in which methane and carbon dioxide are formed. The better the three stages merge with each other, the shorter the digestion process. A valve ensures that no gas flows to the stove when the stove is not lit.

Users prepare batches of slurry in the mixing tank, before allowing the final mixture to flow into the digester for methane formation phase. After digestion, evacuated slurry may be re-used in the process. The recovered gas is combusted and used for cooking and water heating. The chosen methane recovery and combustion system is the time tested Deenabandhu model biogas technology which is well-known in India. The project activity will organise the 18,000 users to collect biogenic household and agricultural waste and utilise it in individual household methane recovery systems. The 18,000 individual plants consist a mixing chamber where waste water, cow dung and leachate from organic waste are mixed, an inlet pipe to feed the slurry into the reactor, the main biogas reactor / digester where methane formation / recovery takes place, a slurry outlet pipe, an outlet chamber, and a slurry platform. The outlet pipe and tank are provided to remove the digested / treated sludge or fermentation residue, and the slurry platform is provided to maintain the treated slurry in clean condition and allow it to be recycled back into the digester.

A.4.3 Estimated amount of emission reductions over the chosen crediting period:
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Please indicate the chosen crediting period and provide the estimation of total emission reductions as well as annual estimates for the chosen crediting period. Information of the emission reductions shall be indicated using the following tabular format.
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Years	Estimation of annual emission reductions in tonnes of CO ₂ e
2010-11	16,666
2011-12	33,332
2012-13	49,998
2013-14	49,998
2014-15	49,998

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2015-16	49,998
2016-17	49,998
Total estimated reductions (tonnes of CO ₂ e)	299,988
Total number of crediting years	7
Annual average of the estimated reductions over the crediting period	42,855

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

No ODA will be received by the project.

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.

According to Para 7 of “Guidelines on assessment of debundling for SSC project activities”, Version 3, Annex 13, EB 54, if each of the independent subsystems/measures (e.g., biogas digesters, residential solar energy systems, kerosene or incandescent lighting replacements) included in one or more CDM project activities is no greater than 1% of the small scale thresholds defined by the applied methodology and the subsystems/measures are indicated in the PDDs to be each implemented at or in multiple locations (e.g., installed at or in multiple homes) then these CDM project activities are exempted from performing a de-bundling check, i.e., considered as being not a de-bundled component of a large scale activity.

- Each of the independent biogas unit is having an installed capacity of 1.84 kW_{th} (Section B.2). This is not greater than 1% of small scale thresholds defined by the applied methodology I.E. under Type I – renewable energy project activity, i.e. not greater than 0.45 MW_{th} or 450 kW_{th}.

Thus the small-scale project is not a debundled component of a large scale project activity.

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:

Scope 1; TYPE I - RENEWABLE ENERGY PROJECTS, I.E. Switch from Non-Renewable Biomass for Thermal Applications by the User, version 01, EB 37.

Scope 1; TYPE I - RENEWABLE ENERGY PROJECTS, I.C. Thermal energy for the user with or without electricity, Version 13, EB 38.

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

This project is applicable as per the definition in the Annex B of the simplified methodologies for selected small-scale CDM project activity categories, Type I.E. Switch from Non-Renewable Biomass for Thermal Applications by the User, version 01 and TYPE I.C. Thermal energy for the user with or without electricity, Version 13, EB 38:

- The project activity comprises of biogas units that displaces the use non-renewable biomass and fossil fuel (kerosene) by introducing new renewable biogas stoves.
- The communities are using the non-renewable biomass since 31st December 1989.
- The proposed project activity is not saving the non-renewable biomass accounted for by the other registered project activity.
- The capacity of the project activity is below 45 MW_{th} and will remain under the limits of small-scale project activity during every year of the crediting period as shown below.

Activity Data	Value	Unit	Reference
$E = \eta \cdot H_b \cdot V_b$			
Where:			
E = Energy available from a biogas digester			
η = combustion efficiency of burners	60%		Reference: Biogas Technology, B.T. Nijajuna, New Age International Publishers, New Delhi, 2002
H_b = heat of combustion per unit volume of biogas	22.1	MJ/m ³	Deenabandhu Model, of 2 cum, construction
V_b = Volume of the biogas	2	m ³ /day	Calculated $E = \eta \cdot H_b \cdot V_b$
	E = 26.52	MJ/day	Calculated @ 1 megajoule = 0.277 777 778 kilowatt hour
	E = 7.37	kWh/day	Calculated installed capacity of biogas
	E = 1.84	kW thermal Capacity	Calculated for 18,000 biogas units
	E = 33	MW, thermal	

The calculations shown above are in concurrence with the study Dr. Jason Yapp; Development of Sectoral CDM Project: A Case Study for Small Scale Biogas Project³, where the rating per digester of 2 cum for India is 1.81 kW_{th}/digester.

B.3 Description of the project boundary:

The project boundary is the physical, geographical area where the renewable energy in 18,000 biogas digesters is being generated and used. Each digester comprises the following main installed components made of brick and cement:

- A digester measuring 2.1 metres in diameter, and 1.545 metres internal height from bottom of digester to top of dome
- 45 cm high mixing tank with internal wall length of 45 cm
- An optional additional acidification tank for pre-treatment of substrate may be built
- An outlet tank with an outlet opening of 60 cm and a height of 25.7 cm above the ground, covered by a cement slab of 7 cm thickness and area of 1 m x 1.17 m
- A pipe of between 5 and 100 metres in length leading from the top of the dome to the stove

³ http://www.snm.nl/pdf/0500_2.1_development_of_sectoral_cdm_project_background_paper.pdf

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- A 2-ring stove inside the house

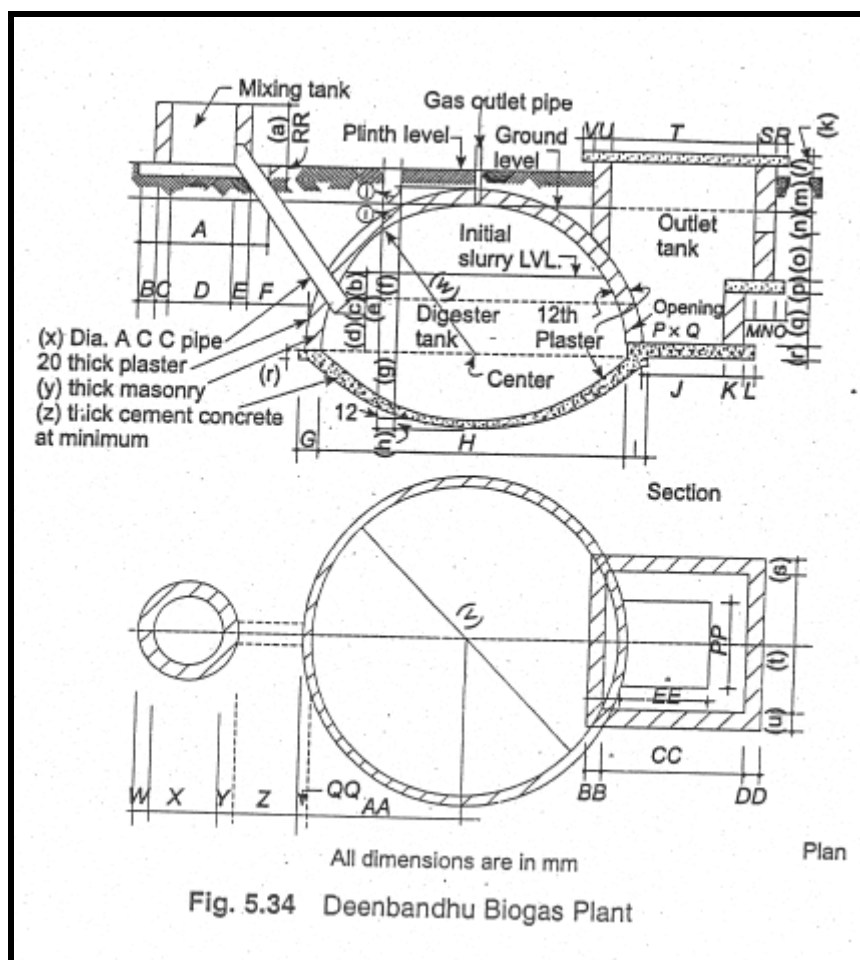


Figure 2: The Biogas model

B.4. Description of baseline and its development:

The baseline of the project is usage of fuelwood and kerosene. The project activity will replace the usage of non-renewable biomass and Kerosene.

For the methodology, Scope 1; TYPE I - RENEWABLE ENERGY PROJECTS, I.E. Switch from Non-Renewable Biomass for Thermal Applications by the User, version 01, EB 37.

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. The emission reductions are calculated as:

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$$ER_y = B_y * f_{NRB,y} * NCV_{Biomass} * EF_{projected_fossilfuel}$$

where:

ER_y = Emission reductions during the year y in tCO₂e

B_y = Quantity of biomass that is substituted or displaced in tonnes

$f_{NRB,y}$ = Fraction of biomass used in the absence of the project activity in year y that can be established as non renewable biomass using survey methods

$NCV_{Biomass}$ = Net calorific value of the non-renewable biomass that is substituted (IPCC default for wood fuel, 0.015 TJ/tonne)

$EF_{projected_fossilfuel}$ = Emission factor for the projected fossil fuel consumption in the baseline. The fossil fuel likely to be used by similar consumers is taken: 71.5 tCO₂/TJ for Kerosene.

Step 1: B_y is determined:

A survey was conducted to quantify the fuelwood use by the families. According to the survey, the fuelwood use by a family is 3.57 t/year. A third party study by Ramachandra *et al.*, 2005⁴ was conducted to assess the quantity of fuelwood that is used for cooking and water heating in the district encompassing the 5 taluks of the project area. The details of the survey from the study are as follows:

Taluk	Fuelwood for cooking (kg/capita/day)			Fuelwood for water heating (kg/capita/day)			Fuelwood for cooking (t/family/yr)
	Monsoon	Summer	Winter	Monsoon	Summer	Winter	
Bagepalli	1.35	1.31	1.36	0.68	0.66	0.7	3.6865
Chickballapur	1.29	1.23	1.29	0.57	0.5	0.57	3.3154
Chintamani	1.25	1.25	1.25	0.11	0.11	0.11	2.4820
Gudibanda	1.42	1.42	1.42	0.55	0.5	0.58	3.5831
Sidlaghatta	1.13	1.13	1.13	0.13	0.13	0.13	2.2995
Average							3.0733

Table 1: Fuelwood use for cooking and water heating in the 5 taluks of the project area

The fuelwood use from the study is 3.0733 t/family/year. The study being a third party assessment and conservative; has been considered to determine B_y. Based on the study, the quantity of biomass that is substituted by the project is as shown below.

Quantity of biomass that is substituted or displaced in tonnes	
Item	Value
Number of plants	18,000
Biomass per plant/year (tonnes/plant/yr)	3.0733
Quantity of Biomass that is substituted (B_y) (tonnes/yr)	55,319

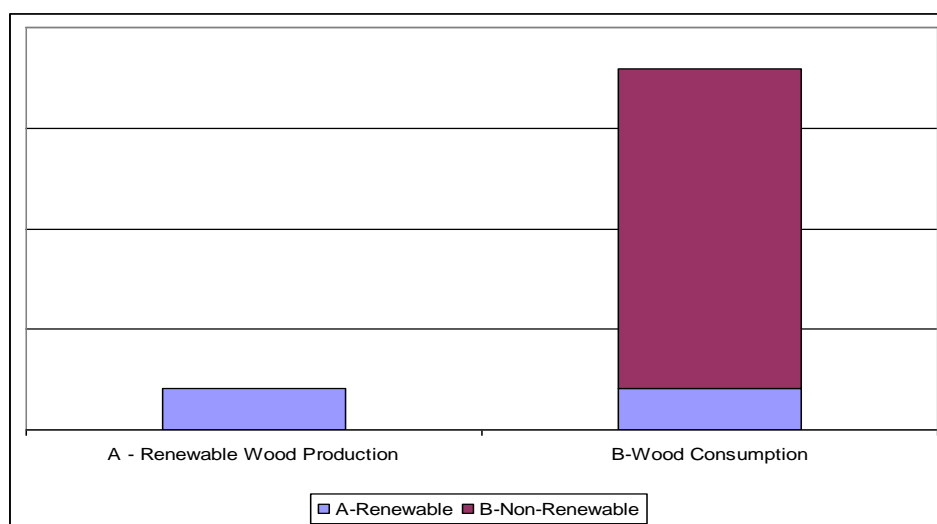
Thus the total quantity of biomass that is substituted from project is 55,319 tonnes/year.

⁴ Ramachandra, T.V., Vamshee Krishna S and Shruthi, B.V. 2005. Decision support system for regional domestic energy planning. Journal of Scientific and Industrial Research. Vol 64, pp 163-174.

Step 2: Determining $f_{NRB,y}$:

To differentiate between non-renewable and renewable biomass the share of renewable and non-renewable biomass in the total biomass consumption for the 5 taluks is calculated using surveys and government data, to determine $f_{NRB,y}$ as shown below. This is based on the principles given in the methodology I.E. on Annex 18, EB 23 for renewable and non-renewable biomass. The data is based on the latest land areas and standing biomass information as shown below. Accordingly, the $f_{NRB,y}$ is 91%. The notion of non-renewable in the context of fuelwood consumption is understood as fuelwood consumption that contributes to deforestation or degradation. The critical factor is whether the consumption is greater than the increase in sustainable biomass growth. Biomass would be reduced in absolute terms beginning at the point where the consumption exceeds the rate of growth, as shown below:

$$\frac{G_b}{D_b} < 1; \text{ Where } G_b = \text{growth in biomass}; D_b = \text{use of biomass}$$



Concept of renewable and non-renewable wood

- It is this concept based on which national study was conducted by the Forest Survey of India, Ministry of Environment and Forests, Government of India to assess the fuelwood demand and availability at the state and national level in India during 1995.
- As shown in the figure above, non-renewable fuel wood consumption (B) is defined as any wood consumption (C) beyond the level of renewable wood production (A). The household fuelwood consumption in India is a driver for forest deforestation/degradation. The household fuelwood consumption is far greater than the annual increment of wood in forests and on non-forest land.
- Based on national, local, remote sensing data and peer-reviewed research papers, the renewable and non-renewable component of biomass has been established as detailed below in accordance to the guidance given for renewable biomass in the AMS I.E.v01.

Renewable Biomass

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I. The biomass is originating from land areas that are forests where:

- i. The land area remains a forest; and
- ii. Sustainable management practices are undertaken on these land areas to ensure, in particular, that the level of carbon stocks on these land areas does not systematically decrease over time (carbon stocks may temporarily decrease due to harvesting); and
- iii. Any national or regional forestry and nature conservation regulations are complied with.

The area classified as forests is as follows:

- (a) The total area under forests is 45,372 ha. This area will remain as forests.
- (b) These forests are classified as Tropical Dry Deciduous and thorny scrub. Undertaking sustainable management practices on these land areas to ensure that there is no systematic decrease of carbon stocks, the sustainable rate of extraction from tropical dry deciduous forests are 0.22 t/ha/yr (Ravindranath *et al.* 2001⁵).
- (c) Thus the renewable biomass component from the project area is $\text{Area (ha)} \times \text{sustainable harvest (t/ha/yr)} = 45,372 \times 0.22 = 9,982 \text{ t/year}$.

II. The biomass is woody biomass and originates from croplands and/or grasslands where:

- i. The land area remains cropland and/or grasslands or is reverted to forest; and
- ii. Sustainable management practices are undertaken on these land areas to ensure in particular that the level of carbon stocks on these land areas does not systematically decrease over time (carbon stocks may temporarily decrease due to harvesting); and
- iii. Any national or regional forestry, agriculture and nature conservation regulations are complied with.

Along with (a) cropland, the other land use categories that have woody biomass are (b) Land put to agricultural land; (c) Permanent pastures & other grazing lands, (d) Cultivable waste (e) Other fallow lands, (f) Current fallows and (g) Net area sown.

- The total area under (a) to (g) is 267,364 ha.
- The total number of trees on these lands is 11.6 trees/ha⁶. This is based on studies conducted by Forest Survey of India, Ministry of Environment and Forests, Govt. of India, for the trees on culturable non-forest land (FSI, 2008).
- Total Culturable Non-Forest land⁷ (CNFA) is defined as the net geographical area lying outside recorded forest and forest cover, which can support tree vegetation (excluding areas under wetlands, riverbeds, perennial snow covered mountains, etc.). Thus this area includes all lands other than forests.
- Average standing biomass of CNFA in the project area is 2.78 t/ha. This is based on the following calculations:
 - o The project area falls under SOUTH DECCAN physiographic zone (FSI, 2008)
 - o Based on the number of trees and standing stock of South Deccan, the standing biomass per tree is 0.24 t (FSI, 2008⁸)

⁵ Ravindranath, N.H., Sudha, P & Sandhya Rao. 2001. Forestry for sustainable biomass production and carbon sequestration in India. *Mitigation and Adaptation Strategies for Global Change* 6: 233-256.

⁶ FSI, 2008. <http://www.fsi.nic.in/sfr2005/chapter5.pdf>

⁷ FSI, 2008. <http://www.fsi.nic.in/sfr2005/glossary.pdf>

⁸ FSI, 2008. <http://www.fsi.nic.in/sfr2005/chapter6.pdf>

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- Thus total standing biomass is 11.6 trees/ha x 0.24 t/tree = 2.78 t/ha
- The mean annual increment is 2.84% of the standing biomass (Shailaja and Sudha, 1987⁹). Thus the mean annual increment is 0.08 t/ha/yr
- The sustainable harvest = mean annual increment = 0.08 t/ha/yr
- Thus the renewable biomass component for this land use for the project area is
Area (ha) x sustainable harvest (t/ha/yr) = 267,364 ha x 0.08 t/ha/yr = 21,139 t/year.
- (a) Misc. Tree crops & groves not included in net area sown
 - The total area under tree crops is 5,038 ha.
 - Sustainable extraction rate is 2 t/ha/yr (Ravindranath *et al*, 2001)⁵.
 - Total sustainable biomass is 5,038 ha x 2 t/ha/yr = 10,076 t/yr.

The fuelwood requirement of the taluk is based on the number of rural households and proportion of families dependent on fuelwood. This is based on the statistics available from the Department of Economics and Statistics of Karnataka.

Thus summarizing the above steps, the table below shows the renewable biomass available as fuelwood. Thus the total non-renewable biomass used as fuelwood is 91%.

NRB Calculations			
Item	Value	Unit	Source
RENEWABLE BIOMASS IN THE PROJECT AREA			
Total Geographical Area of 5 taluks	317,774	ha	Department of Economics and Statistics, Govt of Karnataka, 2007
I. Renewable biomass from forests			
Forest Land	45,372	ha	Department of Economics and Statistics, Govt of Karnataka, 2007
% of forest land classified as tropical dry deciduous and thorny scrub	100%		Ravindranath et al. 2001
Sustainable rate of fuelwood extraction from Tropical Dry Deciduous Forests	0.22	t/ha/yr	Ravindranath et al. 2001
Renewable biomass extraction from forests	9982	t/yr	Area x sustainable rate of extraction
II. Renewable biomass from Culturable non-forest land			
Total Culturable Non-Forest land	267,364	ha	Department of Economics and Statistics, Govt of Karnataka, 2007
No of trees/ha of Culturable Non Forest Area	11.6	trees/ha	Based on FSI, 2008 report
Mean Annual Increment	2.84%	of standing Biomass	Shailaja and Sudha, 1987
Average Standing biomass/tree	0.24	tonnes	Based on FSI, 2008 report
Average Standing biomass/ha	2.78	tonnes	Calculated
Mean Annual Increment	0.08	tonnes/ha	Calculated
Sustainable extraction from trees on CNFA	21,139	tonnes	Area x sustainable rate of extraction
III. Renewable biomass from Plantation			
Total Plantation area including misc tree crops and groves	5,038	ha	Department of Economics and Statistics, Govt of Karnataka, 2007
sustainable extraction rate from plantations	2.00	t/ha/year	Ravindranath et al. 2001
Sustainable extraction from plantations	10,076	tonnes	calculated
Total Sustainable Biomass Available	41,197	tonnes/year	calculated
FUELWOOD REQUIREMENT FOR THE 5 taluks			
Population	192,740	Households	Department of Economics and Statistics, Govt of Karnataka, 2006
% of households reliant on biomass for cooking	77.7%		Department of Economics and Statistics, Govt of Karnataka, 2007
Fuelwood requirement per HH	3.0733	tonnes/year	Based on Ramachandra et al., 2005 study
Total fuelwood requirement	460,077	tonnes/year	calculated
Availability ratio	0.09		calculated
NRB	91%		calc

The above study is in line with the nationally conducted study by the Forest Survey of India, Ministry of Environment and Forests, Govt. of India.

⁹ Shailaja Ravindranath and Sudha Premnath. 1997, Biomass Studies. Field Methods for Monitoring Biomass. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.

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The approach adopted nationally by the Ministry of Environment and Forests, Government of India is as follows.

- The extent of production and demand of fuelwood was assessed by the Forest Survey of India, Ministry of Environment and Forests, Government of India. The study is entitled Demand and supply of fuelwood, timber and fodder in India” Forest Survey of India, Ministry of Environment and Forests, Government of India, 1996”
- This study is based on growing stock of the country and its annual increment to determine the annual availability of fuelwood for different forest types. The percentage production of fuelwood is considered as 30% of the annual increment. This is compared to the total fuelwood required at the state level by the rural and urban population for the year 1996, 2001 and 2006.
- According to the study, in Karnataka State, the total annual consumption of fuelwood during 2006 is 13 million tonnes of which only 1.33 million tonnes is sustainably available. Thus at the state level, the renewable fuelwood available accounts to 10%. Thus the non-renewable wood is 90%.

A study was done by Ramachandra and Rao, to inventory, map and monitor the bioresources using GIS and remote sensing for Kolar district, including the 5 taluks of study area for 2005¹⁰. The ratio of demand to availability of sustainable biomass was assessed at taluk level based on detailed field investigation, remote sensing data analysis, village-wise inventory of tree diversity and mapping of resources using GPS and GIS and computation of standing biomass of trees and its sustainable harvest. Accordingly the following resource/demand has been computed, for the taluks of project area. The features of the Ramachandra and Rao study are as follows:

The bio-energy status assessment is based on compilation and computation of bio-resource supply.

- 1) The land use pattern was determined using remote sensing imagery. The data used were spatial (village, taluk, district maps) and non-spatial data (demography, population, etc.)
 - o Remote sensed data of land cover and land use analyses was used from National Remote Sensing Agency, Hyderabad. Mutli-spectral LISS III imagery scenes of IRS-IC were used in the analysis.
 - o Survey of India topography of scale 1:250,000 and 1:50,000 were digitized to generate vector layers.
 - o Village level revenue maps – digitized to map resources at village level was used.
 - o Village wise vector layer showing all trees (species wise) was prepared through an extensive field survey using GPS.
- 2) The area of various crop types and yield of various crops (agriculture and horticulture), plantations and forest biomass productivities was obtained from government records.
 - o The taluk-wise area of dominant crops cultivated was collected from the State Agriculture Department.
 - o The area under horticulture plantations were obtained from the State Horticulture Department.

¹⁰ T.V. Ramachandra and G.R. Rao. Inventorying, Mapping and Monitoring of Bioresources using GIS and Remote Sensing. In: Geospatial Technology for Developmental Planning. Eds. SM Ramasamy, CJ Kumanan, K. Palanivel and Bhoop Singh. pp 49-76.

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- The yield figures of the district were used to compute the production at the taluk level.
- The biomass productivity of the different types of forests was collected through primary field surveys in selected plots and from Karnataka Forest Department. The forest area by type, given division wise in the forest records were used to compute the forest type at the Taluk level.
- The area under plantations raised by the forest department under various schemes for fuelwood purposes were obtained from State Forest Department.
- The biomass that could be obtained for fuelwood species was calculated using 30% as the production level. This is according to the national level survey conducted by the Forest Survey of India, Ministry of Environment and Forests, Government of India.
- The ratio of productivity (mean annual increment) and fuelwood demand was computed to derive the level of bioresource availability in the various taluks of Kolar. This is the approach adopted at the national level to estimate nationally and at state level.
- Thus the study conducted is based on field surveys, Government records and GIS studies at the taluk level.

Taluk	Resource/Demand
Bagepalli	0.1490
Chickballapur	0.4220
Chintamani	0.1200
Gudibanda	0.1590
Sidlaghatta	0.1730
Fraction of Renewable biomass	20%
Fraction of Non-Renewable biomass	80%

Table 2: Fraction of renewable and non-renewable used for cooking and water heating in the 5 taluks of project area.

According to the study, the fraction of non-renewable biomass is 80%.

Conclusion

- Based on the data which is available it can be seen that 80-90% of the biomass is non-renewable.
- The analysis conducted by the Project Proponent and Forest Survey of India shows similar results.
- To be conservative in approach, 80% is considered as the $f_{NRB,y}$ for the calculations of emission reductions.
- The share of renewable and non-renewable biomass in the total biomass consumption has been computed using nationally approved methods.

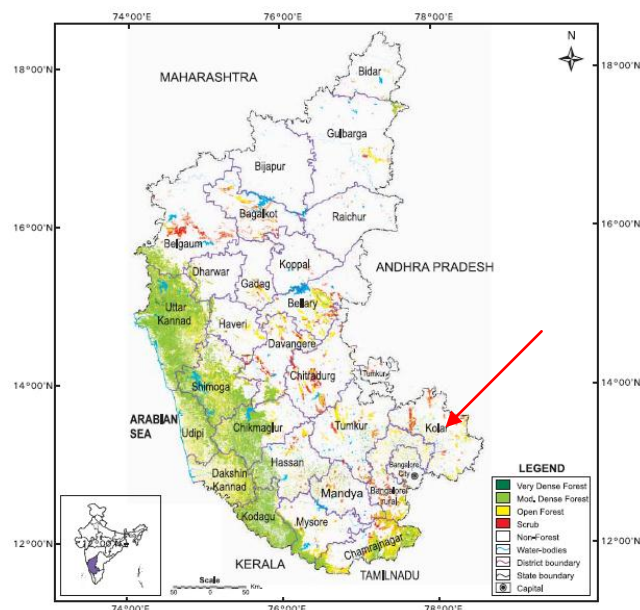


Fig 3: Forest Cover Map of Karnataka showing the district of project area

This is further evidenced by the fact that forests account for only 6.5% of the geographic area of the district based on remote sensing satellite imagery. These forests are of scrub and stunted dry deciduous type with meagre standing biomass¹¹.

Use of non-renewable biomass since 31st December 1989

A study was conducted by Forest Survey of India, Ministry of Environment and Forests during 1987 to assess the wood consumption in Kolar district¹². Based on the study, the fuelwood requirement in 1987 was 8 lakh tonnes/annum against the production of 0.31 lakh tonnes. Thus the $f_{NRB,y}$ in 1987 was 96%.

Not saving non-renewable biomass accounted for by another registered project activity

The proposed project activity is not saving the non-renewable biomass accounted for by the other registered project activity (Bagepalli CDM Biogas Programme - Project No. 0121 of 5,500 biogas units), due to the following reasons:

- The proposed villages are different from the villages of the registered project activity.
- The catchment area of fuelwood collection is different from that of the registered project, as the implementing villages are different.
- A few adjacent villages may depend on the same forest area for fuelwood from both the projects. But the extent to which the proposed project activity will save the non-renewable

¹¹ FSI, 2007. State of Forest Report. Forest Survey of India, Ministry of Environment and Forests, Government of India, Dehradun.

¹² FSI, 1989. Report on wood consumption study in Kolar District, Karnataka. Forest Survey of India, Southern Zone, Bangalore, Ministry of Environment and Forests, Department of Environment, Forests and Wildlife, Government of India.

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biomass accounted for by the other registered project activity is insignificant. The reason being:

- The registered CDM project has been implemented on an average in only 16 (17%) households of a village with an average of 95 households/village. A large number of households in these villages are still dependant on non-renewable wood for their biomass needs. Thus at the village ecosystem level, the impact of the registered CDM project is marginal.

Through this post registration changes, under this project activity, we would want to include villages in which CDM Project Activity 0121: “Bagepalli CDM Biogas Programme” has been implemented by ADATS (an NGO) and built biogas units for those who have cattle and space to built them. These villages are in the project boundary of this project activity too. These households are different from those which have are already provided with biogas under the CDM project activity 0121. The construction phase of CDM project 0121 is completed. The families using fuel wood in these villages will be provided with biogas and thus leakage is not an issue as the rest of the households will be using biogas already. A survey will be done to account for leakages, if any.

- According to Annex 5, Clean Development Mechanism Project Standard, EB 65, Version 1, Paragraph 217, the post registration change is with regard to project design of a registered project activity.
- As per Para 218, the change is with regard to addition of multiple sites.

The proposed change is to build biogas units for households in those villages, in which the CDM project activity 0121: “Bagepalli CDM Biogas Programme” has been implemented. As of now, only 17% of the families in each village have been covered under this 0121 project activity. The families in these villages are from the Community Development Organization (CBO), the Bagepalli Coolie Sangha. These communities are being denied the benefit of biogas under the current CDM programme though they are part of the CBO, as the project (PDD) wanted to address leakage issues by not building biogas in these villages. Now this will be addressed by conducting survey.

The actual change to the registered CDM project activity does not have any impact to the following:

(a) The applicability and application of the applied methodology under which the project activity has been registered;

- The project activity has been registered under AMS.I.E. Version 1. The changes will not impact the applicability criteria of the project activity and hence the applicability and application of the applied methodology.
 - The project activity will continue to comprise of biogas units that displaces the use of non-renewable biomass by introducing new renewable end-user technology, the biogas stoves.
 - The proposed project activity will continue to save non-renewable biomass which is currently being used in the baseline by the beneficiaries.
 - As shown in section B.4, the communities are using the non-renewable biomass since 31st December 1989.
 - The capacity of the project activity will remain below 45 MW_{th} and under the limits of small-scale project activity during every year of the crediting period as the number of units are the same.

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(b) *Compliance of the monitoring plan with the applied methodology;*

- There will not be changes to the monitoring plan. The monitoring plan remains the same and is in compliance with the applied methodology.

(c) *The level of accuracy and completeness in the monitoring of the project activity;*

- The level of accuracy and completeness in the monitoring of the project activity is not going to be altered. The parameters monitored will be as done as described in section B.7.

(d) *The additionality of the project activity;*

- There are no changes to the additionality of the project activity. In addition, there are no investment analysis and the barriers as discussed in section B.5 is still valid under the circumstances.

(e) *The scale of the project activity.*

- The scale of the project activity remained unaltered, as the number of biogas units will remain the same at 18,000 units.

Step 3: Choosing $EF_{\text{projected_fossilfuel}}$

In principle $EF_{\text{projected_fossilfuel}}$ could be LPG or Kerosene. None of the participating users can afford LPG as it represents substantial cost to the poor families. A lack of infrastructural support (e.g. lack of facilities for refilling at doorstep) further prohibits the widespread adoption of LPG in the rural context. Due to logistical problems the few rural LPG users that exist often have to wait up to 3 months to get a cylinder refilled. Due to such circumstances it is impossible for even a wealthy rural household to rely on LPG as its main cooking fuel. Further, kerosene is sold at a subsidized price to the ration card holders in the rural areas. This is substantiated by the study in the project area (Ramachandra *et al*, 2005⁴) which shows that kerosene is the dominant fuel after fuelwood (see Table 4). Except for very few families, LPG is not used in project area. Taking all of this into account kerosene is the likely fossil fuel to be consumed by the project participants and is taken as the projected fossil fuel.

Taluk	LPG consumption for cooking (kg/capita/month)			LPG consumption for cooking (kg/family/yr)
	Monsoon	Summer	Winter	
Bagepalli	0	0	0	0.00
Chickballapur	0.31	0.22	0.22	15.00
Chintamani	0	0	0	0.00
Gudibanda	0	0	0	0.00
Sidlaghatta	0	0	0	0.00

Table 3: LPG use for cooking and water heating in the 5 taluks of the project area

Step 4: Calculating ER_y

$$ER_y = B_y * f_{NRB,y} * NCV_{\text{Biomass}} * EF_{\text{projected_fossilfuel}}$$

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Emissions from the use of Non-renewable biomass for meeting similar thermal energy needs		
Activity Data	Value	ID Ref
Quantity of Biomass that is substituted (t/yr)	55,319	B_y
Fraction of NRB	80%	$f_{NRB, y}$
NCV Biomass (TJ/t)	0.015	$NCV_{biomass}$
Emission factor Kerosene (tCO ₂ /TJ)	71.5	$EF_{projected\ fossilfuel}$
Emission Reductions (tCO ₂ /yr)	47,191	ER_y

Scope 1; TYPE I - RENEWABLE ENERGY PROJECTS, I.C. Thermal energy for the user with or without electricity, Version 13, EB 38.

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. The kerosene used in the baseline is based on the study by Ramachandra et al., 2005⁴ as shown below.

Taluk	Kerosene for cooking (l/capita/month)			Kerosene for water heating (l/capita/month)			Kerosene for cooking (l/family/yr)
	Monsoon	Summer	Winter	Monsoon	Summer	Winter	
Bagepalli	0.9	0.85	0.9	0.8	0.8	0.8	101.00
Chickballapur	0.76	0.75	0.75	0.19	0.19	0.19	56.60
Chintamani	1.00	0.99	1.00	0	0	0	59.80
Gudibanda	0.84	0.79	0.84	0	0	0	49.40
Sidlaghatta	0.63	0.63	0.63	0	0	0	37.80
Average							60.92

Table 4: Kerosene used for cooking and water heating in the 5 taluks of the project area

For replacement of kerosene with biogas, the emission reductions are estimated as follows:

Emissions from the use of Kerosene for meeting similar thermal energy needs	
Family level kerosene consumption reduction/year (litres)	60.92
Density of Kerosene(kg/l) ¹³	0.7782
Kgs of Kerosene (kg)	47.41
Net Calorific value of kerosene (MJ/kg) (IPCC Values)	43.8
Carbon emission factor for kerosene (tCO ₂ /TJ)	75.1
CO ₂ emission from kerosene per family/yr (tCO ₂)	0.16
CO ₂ emissions from kerosene for the project of 18,000 units (tCO ₂)	2,807

Total emission reduction from replacement of non-renewable biomass (I.E) and kerosene (I.C) is as follows:

Activity Data

¹³ <http://www.pera.org:80/English/ogcf/auditesco.htm>

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Emissions from the use of Non-renewable biomass (tCO₂/yr)	47,191
Emissions from the use of Kerosene (tCO₂/yr)	2,807
Total CO₂ emissions in the baseline (tCO₂/yr)	49,998
Emission per family (tCO₂/family/yr)	2.78

Step 5: Leakage

The project activity includes substitution of non-renewable biomass by biogas. There is no equipment transfer. Thus there is no leakage involved in the project activity.

The project activity does not include substitution of non-renewable biomass by renewable biomass through its production. Thus leakage is not applicable.

Leakage relating to the non-renewable biomass shall be assessed from ex-post surveys of users and areas from where biomass is sourced. The following potential sources of leakage will be identified:

- (a) Use/diversion of non-renewable biomass saved under the project activity by non-project households/users who previously used renewable energy sources. If this leakage assessment quantifies an increase in the use of non-renewable biomass used by the non project households/users attributable to the project activity then By is adjusted to account for the quantified leakage.
- (b) Use of non-renewable biomass saved under the project activity to justify the baseline of other CDM project activities can also be potential source of leakage. If this leakage assessment quantifies a portion of non-renewable biomass saved under the project activity that is used as the baseline of other CDM project activity then By is adjusted to account for the quantified leakage.
- (c) Increase in the use of non-renewable biomass outside the project boundary to create non renewable biomass baselines can also be potential source of leakage. If this leakage assessment quantifies an increase in use of non-renewable biomass outside the project boundary then By is adjusted to account for the quantified leakage.

1

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 <u>small-scale</u> CDM project activity:

Below, in accordance with Attachment A of Appendix B of the simplified modalities and procedures for small-scale CDM project activities, is an analysis which demonstrates that the project activity would not be implemented without CDM financing due to the existence of the following barriers.

a) Investment Barrier

The commonly and widely used wood fired traditional mud stoves cost around Rs. 200 and a basic 3-rock stove almost zero. The running costs of these systems are zero as the time a person spends is not counted as an opportunity cost, and the non-renewable biomass is collected from various open areas – Government Revenue, Forest Department, Panchayat lands, farm field borders, and is free.

Kerosene is very expensive at around Rs 10.00/litre in the fair price shop (subsidized by the government) and around Rs. 20.00/litre in the open market. Around 1 litre would be needed per day, which is

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unaffordable by the target families, as only 3 litres/family is provided at subsidized rate by the Government. Thus it is not feasible for the target users in this project activity to use kerosene.

The capital cost of a LPG is Rs. 2,400. Running cost is around Rs.400 per month, again about half the daily wage of an agricultural labourer. This technology is slowly penetrating the villages. But this is also beyond the reach of this project's target population, especially also considering the remoteness of the villages. This is evidenced by the fact that penetration of LPG in the project area is very low (Table 3).

The capital cost of a 2 m³ biogas plant is about Rs.12,500¹⁴ (inclusive of cook stove and pipe), 5 times the cost of LPG. Compared to the other options, it is in the long-term a cheaper, cleaner and locally and globally more beneficial technology. But the target group do not have the access to capital costs. Individually, banks do not provide loans for such projects. This can be evidenced by the low rate of biogas units installed and running so far in the taluks. Thus at the state level 1.1% and in kolar district, 0.99% of the households use biogas for cooking (including rural and urban areas)¹⁵.

Kolar District has a biogas potential, which can satisfy as much as 60% of domestic energy need in rural areas¹⁶. But less than 1% of the households use biogas for cooking. If the untapped potential is tapped properly then energy crisis in rural Kolar can be minimised to large extent and tree felling can be stopped to a significant extent. As researched by Dabrase and Ramachandra¹⁷ the various reasons for not installing biogas plants in Kolar are as listed in Figure 4. The dominant reason is the economic barriers. They are not able to save or get loans to build biogas plants. The study conducted by the authors reveals the willingness of the people to install biogas plant provided they get help on economic front. Thus lack of investment is the foremost barrier for the implementation of the project. Even at the national level the affordability continues to remain the main barrier in rural areas and added to it most renewable systems/devices require appropriate support levels for their promotion.¹⁸

¹⁴ <http://www.solutionexchange-un.net.in/environment/cr-public/cr-se-wes-18070601-public.pdf>
The conservative estimation of 80% is considered for $f_{NRB,y}$ calculations for the PDD.

¹⁵ Karnataka at a glance 2006-07. Directorate of Economic and Statistics, Government of Karnataka.

¹⁶ Ramachandra, T.V. 2008. Geographical Information System Approach for Regional Biogas Potential Assessment. Research Journal of Environmental Sciences 2 (3):170-184.

¹⁷ Dabrase, P.S and Ramachandra, T.V. (2000). Integrated Renewable Energy System - Perspectives and Issues. Millennium International Conference on Renewable Energy Technologies, IIT, Chennai.

¹⁸ Annual Report, 2006-07. Ministry of New and Renewable Energy. Government of India.
http://mnes.nic.in/annualreport/2006_2007_English/HTML/ch4_pg1.htm

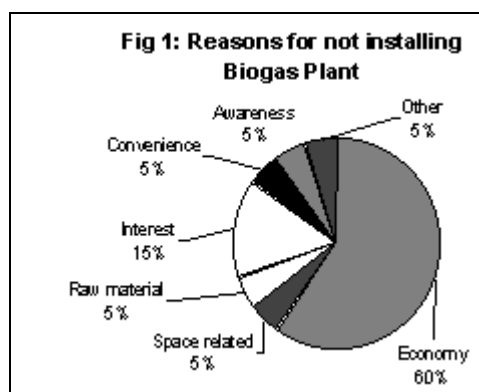


Figure 4: Reasons for not installing biogas plants in Kolar region

Taking all this information into account, it can be seen that the continued combustion of non-renewable biomass fuel for cooking and water heating is the cheapest option, leading to higher emissions. Thus even now 97.92% of the households use traditional fuel wood stoves for cooking and water heating in the rural areas of the district⁴. At the district level, 78% of the households still use fuelwood (including rural and urban areas)¹⁵. There is an investment barrier preventing this project activity taking place in the absence of CDM: no debt funding is available. Bagepalli Coolie Sangha (BCS) approached the local and nationalized banks for a loan for the construction of the biogas plants. The banks refused to provide loans without guarantee. The combination of no guarantees, no equity, no security, and CER price risk means the loan is not available. No banks are willing to gamble on CER price and thus there is no risk-free income stream in this project and banks are not willing to lend anyway, even leaving aside the problem of guarantees.

Thus the most likely option is continuation of usage of fuelwood and kerosene for cooking.

(b) Barrier due to prevailing practice:

The prevailing practice by the public sector in India today is to make kerosene as cooking fuel available to families below the poverty line through the public distribution system at subsidized prices. The public distribution system for subsidised fossil fuel in the cooking fuel sector (including LPG) is working well, and expanding rapidly. However, in many cases the kerosene is still too expensive for families and only 3 litres per month are available through the public distribution system – too little for an average household, and therefore supplemented with an additional 2 litres on average per month (purchased in the open market) along with the use of non-renewable biomass. In spite of such subsidies for many decades they have failed to shift fuel consumption patterns away from biomass in rural areas¹⁹. This is evidenced by the fact that at the national level 75% of the rural households and at state level of Karnataka 89% of the rural households still use fuelwood²⁰. An important reason for this is that subsidized fuel is not always available to the poor. In rural India, biomass is more easily available and access to LPG more difficult than in urban areas. This explains the lower use of LPG among all expenditure class of the rural areas. Also LPG is not sufficient to meet even the urban demand. It is not therefore easily available to villagers.

¹⁹ Shubhashis Gangopadhyay, Bharat Ramaswami, and Wilima Wadhwa. 2005. Reducing subsidies on household fuels in India: how will it affect the poor? *Energy Policy* 33 (2005) 2326–2336.

²⁰ NSSO 2007. *Energy Sources of Indian Households for Cooking and Lighting, 2004-05 National Sample Survey Organisation Ministry of Statistics and Programme Implementation Government of India, 2007.*

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Since firewood is obtained practically free of cost, there is no inducement to shift their energy source. Thus their dependence on fuelwood is likely to continue.

The potential for biogas in India is 12 million. But only 3.71 million are being built so far²¹. At the state level, during 2001 census only 1.5% of rural households were using biogas²², while in 2006 it still remains a low of 6.5%²⁰. On the other hand the government programme for providing biogas plants for the poor has been reduced at the State level in all states, and thus the capital shortfall prevents the continued expansion of the biogas programme in India. For the year 2008-09, the target for the whole of Karnataka state has been fixed at 2,500 units²³. The Central and State Government through subsidies has just supported about 3,500 biogas units, on an average of 700 biogas plants annually in Kolar District in the past 5 years²⁴, which is just 5% of the potential of the district. These were largely implemented by rich farmers and the poor have not been able to afford them even with subsidies²⁵. Thus inadequate government support (like loans, subsidies) and government programs not reaching the needy and escalating installation and operation costs are the other economical barriers for the low rate of penetration of biogas technology¹⁶. The common practice is for poor households to depend on free sources of firewood. Thus a fossil-fuel based approach has come to dominate National and State level cooking fuel policy.

(c) Other Barriers:

Other than economic (as discussed above), there are other technical/operational, and cultural aspects, which potentially hinder biogas projects.

In the baseline, the commonly and widely used traditional mud stoves are very primitive, but any one can build them. The basic '3-rock stove' requires practically no skill to construct, though it does take some skill to cook on such an awkward cooking arrangement.

Dung varies in its availability due to climatic instability. The occurrence of drought may reduce dung availability, by forced sale of cattle, or even death of cattle. (ii) The plants become non-functional after construction as they could be faulty in their construction, or due to shoddy construction which is more relevant to the fixed-dome models. The main reasons are lack of quality control in raw material and accessory, water scarcity in dry arid region and lack of trained manpower¹⁶. An evaluation study of biogas conducted by the Government of India also showed only 45% of the biogas plants constructed under the National Biogas Programme was working²⁵. (iii) The main reasons for biogas plants becoming non-functional are structural and operational problems, failure of dissemination strategy, lack of users training and follow-up services which needs to be attended to for continuous operation of the biogas units. Further, when complications have arisen in the functioning of plants, a common complaint is lack

²¹ Ministry of Non-Conventional Energy Sources, Government of India, <http://mnes.nic.in/booklets/Book1-e.pdf>

²² Housing Profile. Karnataka State. Census of India, Government of India. 2001.

²³ Implementation of National Biogas and Manure Management Programme (NBMMP) during 2008-09 – Sanction Order. Ministry of New and Renewable Energy, Government of India, <http://mnes.nic.in/adm-approvals/biogasscheme.pdf>

²⁴ Annual Reports, Rural Development & Panchayat Raj Department, Government of Karnataka, 2003-2008.

²⁵ Evaluation Study On National Project on Biogas Development, Programme Evaluation Organisation Planning Commission, Government of India, New Delhi, 2002.

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of available technical support. As researched by Ramachandra, 2008¹⁶, ineffective repair and maintenance strategy, poor service backup to handle the technical hiccups in field during operation and delay in the payments are the main institutional barriers to this technology. Despite several initiatives of the MNES, operation and maintenance services for bio-energy devices are not available, particularly in the rural areas²⁶. (iii) Cultural practices also hinder general uptake, due to reluctance to adopt different behavior, particularly regarding the use of cow dung in biogas systems. Further, women are not necessarily the decision makers in a household, and the men of the household may not consider benefits, which mainly accrue to women, to be of significant urgency.

The barriers to implementation of a successful biogas project for the rural poor above will be overcome through the CDM project activity. The Bagepalli Collie Sangha members will provide help to families without dung if there is a shortage of substrate. Technical expertise is required for design, manufacture, operation and maintenance services of these systems. Biogas plants need to be constructed very carefully. This takes skill, diligence, careful working, and attention to detail, design care for each plant so that it is suited to the local conditions at each plot of land where it is to be constructed^{27,28}. Local masons will be trained under the project activity to build these units. This ensures that they are available for any further repairs as and when required.

It takes also quite special organizational and management skills and coordination to organize decentralized supply of small cooking systems of the kind envisaged under this project activity. Local expertise will be developed for the project. Not only will the plants be built to suit local soil conditions, but service and maintenance crews will be trained and stationed in all the villages to ensure smooth running of the plants. Proper extension and support services will be provided at the village level. In this way, plants will not be allowed to fall into disrepair, when their functioning may depend upon adequate maintenance skills, which should be available in every village. The emphasis will be to promote the participation of local people in the whole process of education, planning and monitoring, so that the renewable technology is viable and sustainable in the communities it is designed to serve. Coordinated management information systems will be developed as part of biogas development, in order for problems to be identified and remedial measures undertaken. A portion of the CER revenues received as forward funding by the project will be set aside for such repair and maintenance for the biogas units.

Emissions from the combustion of non-renewable biomass fuel can only be avoided through efforts on the part of the institution to give professional attention to this rural renewable energy technology and manage it efficiently with sufficient resource inputs on all fronts. The CDM project will overcome these barriers by providing continuous support for monitoring and maintenance of the biogas units.

The project will be implemented among the Coolie Sangha members formed by small and poor peasant families (landed and landless agricultural labourers) in their respective villages. The Coolie Sangha activities embrace every facet of its Member Coolie families' day to day living. It is much more than a "functional grouping" of the poor to solve pressing problems, that has been born through community

²⁶ Usha Rao, K and Ravindranath, N.H.2002. Policies to overcome barriers to the spread of bioenergy technologies in India. Energy for Sustainable Development I Volume VI No. 3 1 September 2002.

²⁷ Shaikh et al., Barriers to dissemination of renewable energy technologies for cooking. Centre for Energy Studies, Indian Institute of Technology, Delhi, Hauz Khas, New Delhi 110 016, India.

²⁸ N. H. Ravindranath and D. O. Hall. 1995. Biomass, Energy, and Environment: A Developing Country Perspective from India, Oxford University Press.

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organization efforts. The Coolie Sangha gives an identity and protection to its Members and supports them in issues and struggles aimed at their empowerment. Thus this project is reaching the very poor families of the village, who otherwise will not be able to afford a biogas plant.

Taking into account the national and or sectoral policies and circumstances, the emissions reductions would not occur in the absence of the proposed small-scale project activity. Despite the fact that this technology is widely spread in India, the proposed project has to overcome various barriers like prevailing practice and economically viable options. Barriers make it unlikely that biogas plants are built today in Kolar District, and in the absence of the CDM these barriers would automatically lead to an implementation of a technology with higher emissions. As discussed above, currently the biogas technology has low market share in the villages compared to the baseline cooking technology. Thus the traditional mud stove which is financially a more viable alternative to the project activity and is less technologically advanced has lower risks to performance uncertainty leading to higher emissions. On the other hand, the project activity has low market share and is technologically more advanced, requiring skilled labour to build them. This is evidenced by low penetration of biogas for cooking in rural households of Karnataka.

The project as a CDM activity will enable biogas technology for cooking to overcome the described barriers and promote biogas plants in the District. The described project activity is clearly additional because it is financed completely through the revenues from forward financing of CER sales, and cannot be realized without the revenues from the carbon credits. Thus it is clear that, in the absence of CDM project, which will provide the upfront investment for the establishment of 18,000 biogas plants for the rural poor, this project will not happen. The project will achieve a target of 18,000 biogas units, which put together is many more times than that achieved in the past 2 decades in the district.

B.6. Emission reductions:**B.6.1. Explanation of methodological choices:**

Scope 1; TYPE I - RENEWABLE ENERGY PROJECTS, I.E. Thermal energy for the user, Version 1, EB 37 and Scope 1; TYPE I - RENEWABLE ENERGY PROJECTS, I.C. Thermal energy for the user with or without electricity, Version 13, EB 38 lays down the step-wise approach for projects for which the methodology is applicable. These are followed, as demonstrated above.

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

Data / Parameter:	By
Data unit:	Tonnes / year
Description:	Biomass substituted
Source of data used:	Based on the study conducted in the project area detailed in "Ramachandra, T.V., Krishna, S.V. and Shruthi, B.V. 2005. Decision support system for regional domestic energy planning. Journal of Scientific and Industrial Research. Vol 64, pp 163-174."
Value applied:	3.0733 tonnes/year/family
Justification of the choice of data or description of	Third Party Assessment based on extensive studies on village level domestic energy consumption pattern considering regional and seasonal variations and

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measurement methods and procedures actually applied :	major energy end use activities. Per Capita consumption/day based on the study x 365 (days) x 5 (average persons per family)
Any comment:	

Data / Parameter:	Kerosene usage in baseline
Data unit:	Litres/year
Description:	Kerosene substituted
Source of data used:	Based on the study conducted in the project area detailed in “Ramachandra, T.V., Krishna, S.V. and Shruthi, B.V. 2005. Decision support system for regional domestic energy planning. Journal of Scientific and Industrial Research. Vol 64, pp 163-174.”
Value applied:	60.92 litres/year/family
Justification of the choice of data or description of measurement methods and procedures actually applied :	Third Party Assessment based on extensive studies on village level domestic energy consumption pattern considering regional and seasonal variations and major energy end use activities. Per Capita consumption/month based on the study x 12 (months) x 5 (average persons per family)
Any comment:	

Data / Parameter:	$f_{NRB, y}$
Data unit:	-
Description:	Fraction of Non Renewable Biomass
Source of data used:	Based on the study conducted in the project area detailed in “T.V. Ramachandra and G.R. Rao. Inventorying, Mapping and Monitoring of Bioresources using GIS and Remote Sensing. In: Geospatial Technology for Developmental Planning. Eds. SM Ramasamy, CJ Kumanan, K. Palanivel and Bhoop Singh. pp 49-76.”
Value applied:	80%
Justification of the choice of data or description of measurement methods and procedures actually applied :	Third Party Assessment based on the ratio of demand to availability of sustainable biomass at taluk level based on detailed field investigation, remote sensing data analysis, village-wise inventory of tree diversity and mapping of resources using GPS and GIS and computation of standing biomass of trees and its sustainable harvest.
Any comment:	

Data / Parameter:	Rating Biogas
Data unit:	kW/digester
Description:	Capacity of a digester
Source of data used:	Calculated as shown in Section B.2
Value applied:	1.84
Justification of the	

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choice of data or description of measurement methods and procedures actually applied :	Based on the calculations as given in section B.2. This is based on the reference: Biogas Technology, B.T. Nijajuna, New Age International Publishers, New Delhi, 2002.
Any comment:	

Data / Parameter:	$NCV_{biomass}$, $NCV_{kerosene}$
Data unit:	TJ/tonne
Description:	Net Calorific Value of Biomass and kerosene
Source of data used:	IPCC
Value applied:	0.015, 0.0438
Justification of the choice of data or description of measurement methods and procedures actually applied :	-
Any comment:	

Data / Parameter:	$EF_{projected_fossilfuel}$
Data unit:	tCO ₂ /TJ
Description:	Emission Factor Kerosene
Source of data used:	IPCC
Value applied:	71.5
Justification of the choice of data or description of measurement methods and procedures actually applied :	-
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

Scope 1; TYPE I - RENEWABLE ENERGY PROJECTS, I.E. Thermal energy for the user, Version 1, EB 37

Emissions from the use of Non-renewable biomass for meeting similar thermal energy needs		
Activity Data	Value	ID Ref
Quantity of Biomass that is substituted for 18,000 units (t/yr)	55,319	B_y
Fraction of Non Renewable Biomass	80%	$f_{NRB, y}$
NCV Biomass (TJ/t)	0.015	$NCV_{biomass}$
Emission factor Kerosene (tCO ₂ /TJ)	71.5	$EF_{projected_fossilfuel}$

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Emission Reductions (tCO ₂ /yr)	47,191	ER _y
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Scope 1; TYPE I - RENEWABLE ENERGY PROJECTS, I.C. Thermal energy for the user with or without electricity, Version 13, EB 38

Emissions from the use of Kerosene for meeting similar thermal energy needs	
Family level kerosene consumption reduction/year (litres)	60.92
Density of Kerosene(kg/l) ¹³	0.7782
Kgs of Kerosene (kg)	47.41
Net Calorific value of kerosene (MJ/kg) (IPCC Values)	43.8
Carbon emission factor for kerosene (tCO ₂ /TJ)	75.1
CO ₂ emission from kerosene per family/yr (tCO ₂)	0.16
CO ₂ emissions from kerosene for the project of 18,000 units (tCO ₂)	2,807

Total emission reduction from replacement of non-renewable biomass and kerosene is as follows:

Activity Data	
Emissions from the use of Non-renewable biomass (tCO₂/yr)	47,191
Emissions from the use of Kerosene (tCO₂/yr)	2,807
Total CO₂ emissions in the baseline (tCO₂/yr)	49,998
Emission per family (tCO₂/family/yr)	2.78

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

Year	Estimation of project activity Emissions (tCO₂)	Estimation of Baseline Emissions (tCO₂)	Estimation of leakage (tCO₂)	Estimation of overall emission reductions (tCO₂)
2010-11	0	16,666	0	16,666
2011-12	0	33,332	0	33,332
2012-13	0	49,998	0	49,998
2013-14	0	49,998	0	49,998
2014-15	0	49,998	0	49,998
2015-16	0	49,998	0	49,998
2016-17	0	49,998	0	49,998
Total estimated reductions (tonnes of CO _{2e})	0	299,988	0	299,988
Total number of crediting years	7			
Annual average over the crediting period of estimated reductions (tonnes of CO _{2e})	0	42,855		42,855

The 18,000 units will be constructed in a phased manner @ 6000 units/year in the initial 3 years.

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B.7 Application of a monitoring methodology and description of the monitoring plan:
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B.7.1 Data and parameters monitored:

Data / Parameter:	Biogas Units constructed
Data unit:	Number
Description:	Number of biogas units constructed
Source of data to be used:	Monitoring of construction of biogas units and its start date of operation
Value of data	6,000 units/year for 3 years totalling 18,000
Description of measurement methods and procedures to be applied:	The timeline of construction of the units will be monitored and database maintained
QA/QC procedures to be applied:	100% of the units will be monitored from the procurement of material till construction and commissioning of the biogas units
Any comment:	

Data / Parameter:	Number of biogas plants operating
Data unit:	Number
Description:	Number of plants operating in year (t)
Source of data to be used:	Daily monitoring of the biogas units operating
Value of data	6,000 in Yr 1; 12,000 in Yr 2, 18,000 in Yr 3, and 18,000 every following year.
Description of measurement methods and procedures to be applied:	In every village, the Balakendra Teacher or Village Health Worker will monitor the biogas units that are operating.
QA/QC procedures to be applied:	Additional internal check by the audit team will be done.
Any comment:	The CERs will be deducted for the days biogas is not operational

Data / Parameter:	By
Data unit:	Tonnes / yr
Description:	Confirmation that non-renewable biomass has been substituted
Source of data to be used:	Sample survey
Value of data	80% of 3.07 t/family/year i.e. 2.45 t/family/year is substituted
Description of measurement methods and procedures to be applied:	Sample survey
QA/QC procedures to be applied:	Annual stratified sampling will be conducted.
Any comment:	

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Data / Parameter:	Non-usage of biogas plants
Data unit:	Days
Description:	Usage of kerosene and non-renewable biomass in case of non-performance of biogas units
Source of data to be used:	The days not used from the daily monitoring report for each of the unit done at the village level and data maintained on the digitized monitoring database.
Value of data	Dependent of the number of days the biogas units are under repair
Description of measurement methods and procedures to be applied:	As and when the biogas units are not functional, the beneficiaries will report to the village level volunteer, who in turn will report to the Biogas Field Worker of the project for the repair of the unit. A log book will be maintained for the reason of non-function and days under repair.
QA/QC procedures to be applied:	Triangulated by the audit report of biogas units under repair.
Any comment:	CERs will be reduced for the non-functional days of the units.

Data / Parameter:	Annual hours of operation on an average system
Data unit:	Hours
Description:	Hours of operation of biogas units/day
Source of data to be used:	Sample survey yearly once.
Value of data	Hours of usage of biogas for cooking and water heating /day/family
Description of measurement methods and procedures to be applied:	Sample survey
QA/QC procedures to be applied:	Annual stratified sampling will be conducted.
Any comment:	The value will not be used for CER calculations. Is part of monitoring requirements under I.C

Data / Parameter:	Diversion of non-renewable biomass saved under the project activity by non-project households
Data unit:	tonnes / year
Description:	Diversion of non-renewable biomass saved under the project activity by non-project households
Source of data to be used:	Leakage data
Value of data	0
Description of measurement methods and procedures to be applied:	Annual Sample Survey in 5 taluks
QA/QC procedures to be applied:	
Any comment:	Annual stratified sampling will be conducted.

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B.7.2 Description of the monitoring plan:

Organisational setup of the project – Project management:

This Biogas CDM Project will be implemented/monitored by the 25 year old membership based people's organisation formed by 38,419 small and poor peasant families in 913 villages, using the systems, discipline and procedures of the Bagepalli Coolie Sangha.

This Biogas CDM Project will be implemented for 18,000 Member Coolie families in 533 villages.

There will be 3 types of secondary stakeholders (project delivery personnel) in this Project:

- a. CDM Coordinator: The Board of Trustees of the Bagepalli Coolie Sangha will appoint a full time CDM Coordinator who will manage the project.
- b. Staff: 5 Extension Workers (one for each Taluk), 1 Data Manager, and 8 Biogas Field Workers will be appointed by the CDM Coordinator.
- c. Masons: There are a few trained Biogas Masons within the membership base of the Bagepalli Coolie Sangha. They will be contracted to train more masons for construction of these 18,000 units.
- d. Volunteers: 533 Village level Mahila Meetings held weekly (consisting of one woman from each Member Coolie household) will monitor the functioning of the Biogas Units, throughout the crediting period. Each Mahila Meeting will appoint a literate woman Volunteer (either their Balakendra Teacher or Village Health Worker) to maintain the Daily Usage Registers and enter them into the digitized monitoring system.

An online digitized system, custom built for monitoring this Biogas CDM Project, will be used to enter data on an everyday basis and generate real-time online Progress Reports. Inputting data into this intranet solution will be permission driven – i. e. each Biogas Field Worker can record construction progress of only those villages entrusted to her/him; Volunteers can record daily usage only for their respective village; etc. Progress and Analytical Reports will be totally transparent, open for one and all. These reports will be perused by:

- 85 Cluster Meets, held on fixed days every week and attended by elected village functionaries of the Coolie Sangha, will discuss progress made in their respective villages, identify bottlenecks and find creative solutions.
- 5 Taluk Coolie Sangha Meetings, held on a fixed weekend, for 2 days and attended by 300-400 village functionaries at each taluk headquarter, every month, will hear the Cluster Reports on the progress of the Biogas CDM Project.
- 5 Executive Committee Meetings, held every fortnight and attended by the elected Cluster Secretaries, Women's Committee Members and elected Taluk Secretary at each taluk headquarter, will act on and monitor recommendations made by their respective Taluk Coolie Sangha Meetings.
- Project Staff will meet every week to ensure the smooth supply of material and timely construction of the Biogas Units.

The actual construction of the Biogas Units consists of 6 Activity Processes:

Activity Process	Task
1. Selection of participating families	
2. Defining Masons	
3. Defining Material Suppliers	
4. Monitoring Construction Progress	a) Marking

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		b) Excavation
		c) Supplying crushed stone Jelly
		d) Supplying Sand
		e) Supplying Bricks
		f) Supplying Cement
		g) Supplying Hardware
		h) Concreting
		i) Brick work
		j) Plastering
		k) Filling Gobar
		l) Supplying Stove
		m) Fixing Pipe & Stove
		n) Fixing Safety Grill
5.	Commissioning	
6.	Generating End User Agreements	

Maintenance of the Biogas Units:

Users of this Biogas CDM Project are Members of their respective village Coolie Sangha Units (CSUs) and receive support from each other. The post-construction Daily Usage Monitoring will immediately identify dysfunctional units and specific problems faced by End Users.

Repairs and maintenance will be undertaken by BCS Staff and problems fixed within 7 working days. A portion of the CER revenues received as forward funding by the project will be set aside for such repair and maintenance during the ERPA period. During these initial years major breakdowns are not foreseen. After fulfilling the ERPA contract, the entire CER revenues will immediately be paid out to each woman running her Biogas Unit. She will herself set aside a portion of this income for repairs and maintenance.

In the eventuality of a particular End User facing a cash flow crunch, the village CSU's Sangha Funds will be used to quickly fix her problem.

Families facing a shortage of cow dung/substrate to feed into their digesters will be supported by the entire village CSU. This could happen due to loss or death of cattle, temporary shortage of fodder faced by a particular family, etc.

Servicing:

Volunteers appointed by the respective Mahila Meetings in each project village will undertake daily usage monitoring. The moment they find a dysfunctional Unit, they will inform the Biogas Field Worker. She/he will visit the unit and assess requirements. If necessary, the Mason who built the Unit will be sent to fix the problem. Costs will be covered as described above.

System for dealing with emergencies:

All emergencies will be dealt with as described above.

Authority for Review:

In addition to the established systems and procedures by which daily usage is monitored and problems identified, the CDM Coordinator and 5 Extension Workers will randomly check to ensure that the monitoring systems actually work. They will listen to End User complaints and obtain feedback on

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performance. These observations will be discussed in the weekly Staff Meetings in order to improve standard operating practices.

Training:

In the past few years, all the primary and secondary stakeholders have gained an appreciation of the requirements of Biogas CDM Project. The details of this particular CDM Project, including revenue flows, costing, selection of End Users, maintenance fund generation/management, monitoring requirements, etc. will be communicated in an open and transparent manner in all 533 villages.

Specific training sessions for skill upgradation, monitoring capacity, and usage/maintenance will be imparted to Project Staff, Masons and End Users. A manual that contains the information needed for project implementation and monitoring will be used in this exercise.

Monitoring Report to be provided to Verification Entity:

The CDM Coordinator is responsible for preparing the Monitoring Report. The monitoring consists of consolidating the daily monitoring reports submitted by the 533 Village Mahila members month-wise to the CDM Coordinator. The CDM Coordinator will prepare half-yearly reports on the status of the project, which will be available for verification by the DOE.

Monitoring Plan:

- The single relevant project aspect deemed necessary to monitor and report reliable emission reductions is the continued use of the biogas plant. The number of systems operating annually will be recorded through evidence of continuous monitoring at the village level by the Mahila Health Worker or the Balakendra teacher of the village.
- The annual hours of operation of an average system will be monitored using survey method annually.
- Provided all plants are in continuous use throughout the project period, and emergency preparedness arrangements are recorded as having been used, it is expected that the ex-ante emission reductions will be achieved.
- To monitor this single most important project aspect, the CDM Coordinator will depend on the continued servicing and maintenance management done by the project and documented in the database.
- All monitored data required for verification and issuance will be kept for two years after the end of the crediting period or the last issuance of CERs for the project activity, whichever occur later.

Frequency of Monitoring:

- 100% of plants will be monitored every day for operation of the biogas units and monitoring report prepared for verification.
- For estimating the annual hours of operation, stratified sample survey will be conducted, annually.

Leakage:

Leakage relating to the non-renewable biomass is assessed by doing surveys of users and areas from where biomass was previously being sourced. The following potential sources of leakage are monitored:

- a) Use/diversion of non-renewable biomass saved under the project activity by non-project households/users who previously used renewable energy sources. If this leakage assessment quantifies an increase in the use of non-renewable biomass used by the non-project households/users attributable to the project activity then *By* is adjusted to account for the quantified leakage. Data on the amount of biomass saved under the project activity that is used by non-project households or users (who

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- previously used renewable energy sources), if any, will be collected and presented.
- b) Use of non-renewable biomass saved under the project activity to justify the baseline of other CDM project activities can also be a potential source of leakage. If this leakage assessment identifies/quantifies a portion of non-renewable biomass saved under the project activity that is being used as the baseline of other CDM project activity then *By* is adjusted to account for the quantified leakage. Evidence of web check and DNA checks to see whether the non-renewable biomass is used as baseline somewhere else will be presented.
 - c) Increase in the use of non-renewable biomass outside the project boundary to create non-renewable biomass baselines can also be potential source of leakage. If this leakage assessment quantifies an increase in use of non-renewable biomass outside the project boundary and this is being used as a baseline for another CDM project, then *By* is adjusted to account for the quantified leakage. Evidence of web check, DNA checks, and own data use will be presented to show that the non-renewable biomass is/is not used as baseline in this way.
2. No equipment will be transferred to another activity and this need not be monitored.
 3. As detailed in “Monitoring report provided to verification agency” above, the monitoring report will include monitoring of, and confirmation of, the substitution of the non-renewable biomass.

Quality check:

In addition to daily monitoring which identifies the number of days used, not used, reasons for the latter, etc. an additional process is the "Audit". An independent team will make the rounds and visit installed Biogas Units at random to receive End User feedback.

Apart from making spot assessments on satisfaction, dissatisfaction, problems like the temporary non-availability of dung for a particular family, etc. they will also check if the Biogas Units are functioning at optimum efficiency. Problems they find will be recorded into the digitized monitoring system with the Found Date, Problem Description & Fixed Date.

This additional Process will provide a fresh data on usage which can be used to triangulate the data that emerges from the entering of Daily Usage every month.

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

Thursday, 10 April 2008
 Mr. Venkatanarasappa, President
 For Bagepalli Coolie Sangha, the entity is the project participant

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:

1st November 2008. Likely start date.

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

25 years

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

C.2.1. Renewable crediting period

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

1st January 2010

C.2.1.2. Length of the first crediting period:

7-y-0-m

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

N/A

C.2.2.2. Length:

N/A

SECTION D. Environmental impacts

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

The project activity does not fall under the purview of the Environmental Impact Assessment (EIA) notification of the Ministry of Environment and Forest, Government of India, 2006. Hence, it is not required by the host party.

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:

Not applicable

SECTION E. Stakeholders' comments

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

Stakeholders' meeting was held at the cluster level (group of villages) between 1st-10th April 2008 in all the 5 taluks. The project was discussed by the Bagepalli Coolie Sangha. The Coolie Sangha units in each village discussed the project and made a list of users. The users put down their name only once the village level worker had explained the project in detail and demonstrated the use and functioning of an existing biogas plant in a nearby village. The cluster secretaries ensured that it was made clear to all the potential users that they must have at least one cow, and at least 20 kg of substrate in the form of dung plus biomass such as Parthenium grass, straw or hyacinth. Everyone agreed to the saving scheme for emergency preparedness for shortage of substrate. The minutes from most of the village level stakeholder meeting are provided in each of the village Coolie Sangha Unit / Gram Panchayat Sub-committee minute books.

Comments from the public were also invited through an announcement in the local newspaper. It was also hosted on the website for comments. The local policy makers were also given a non-technical description of the project to provide their inputs on the project.

E.2. Summary of the comments received:

Numerous participants expressed their inability to participate because they do not own cattle.

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

The Coordinators agreed to organise another programme to meet their needs, either getting money for cows, or doing an alternate suitable zero emission (smokeless + renewable biomass) cooking stoves project. The rest of the users expressed their appreciation and need for the project.

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Annex 1**CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY**

Organization:	Bagepalli Coolie Sangha
Street/P.O.Box:	
Building:	ADATS Campus
City:	Bagepalli
State/Region:	Karnataka
Postfix/ZIP:	561207
Country:	India
Telephone:	+91 (8150) 282375, 282376
FAX:	-
E-Mail:	cooliesangha@gmail.com
URL:	http://www.adats.com/cs
Represented by:	
Title:	President
Salutation:	Mr.
Last Name:	Venkatanarasappa
Middle Name:	-
First Name:	-
Department:	-
Mobile:	+91 (94489) 452477
Direct FAX:	-
Direct tel:	-
Personal E-Mail:	-

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

NO ODA WILL BE DIVERTED FOR THIS PROJECT

Annex 3**BASELINE INFORMATION**

The study conducted by Ramachandra *et al*, 2005 and Ramachandra and Rao, 2005 has provided all the baseline information for the project. This is also substantiated by a study conducted by Forest Survey of India in 1989, which shows the use of non-renewable biomass in the project area.

Annex 4**MONITORING INFORMATION**

The monitoring report to the verification agency will contain:

- Evidence that the biogas units were constructed and are functioning
- Monitoring of dysfunctional biogas units and shift to use of non-renewable biomass.
- Leakage information as per monitoring plan above.
- Emission reduction calculation based on data collected in items above and applying ex-ante methodology.
