CLEAN DEVELOPMENT MECHANISM
SIMPLIFIED PROJECT DESIGN DOCUMENT
FOR SMALL-SCALE PROJECT ACTIVITIES (SSC-CDM-PDD)
Version 02

CONTENTS

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>.

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

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

>> Bagepalli CDM Biogas Programme
Version 3
Dated: 22 August 2012

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

>> The purpose of the project activity is to set up 5500 biogas plants (digesters) of 2 m^3 capacity each for single households. Each household will utilise the dung of its cows to feed the digester for the production of biogas for cooking purpose and heating of hot water. The aim of the project is to replace the commonly used inefficient wood fired mud stoves technology, with clean, sustainable and efficient biogas. In our household surveys, [Appendix 2] and [Ref 2,3,3a], we found that households use anything between 1.3 to 2.5 kg of fuelwood per person per day. This relatively high consumption compared to energy actually used is due to the low level of efficiency of the traditional stoves.

Families have to walk 2-5 km to collect this firewood as Kolar District, like many other regions of India, is a fuelwood deficit region. [Ref 3a]. 75.6% of biomass in Kolar District is non-renewable [Ref 3a], which means that 75.6 % of the fuelwood cannot be considered a renewable source of energy, and by burning this firewood, the users are causing the emission of greenhouse gases. If the fuelwood is replaced with the renewable biogas the users will avoid the greenhouse gas emissions in the baseline case. Each family will also replace 31.2 litres of kerosene annually which is used as supplementary cooking fuel today.

The project will be carried out in Kolar District. In this semi-arid region wood resources are very scarce, but yet they are the main cooking fuel for the very poor population. As these fuelwood users are very poor, there is no incentive on anyone's part to grow biomass for cooking for them. Thus there is acute fuelwood scarcity combined with lack of cooking energy in any form, as they are too poor to pay for it.

A list of suitable and interested households who wish to switch from firewood to biogas has already been established. Implementation of the project depends on the successful validation and registration of the project as a CDM project since the project is financed almost exclusively from the carbon revenues.

The project contributes to sustainable development of the region and the country by:

a) Saving GHG (Greenhouse Gas) emissions by avoiding the uncontrolled burning of unsustainable fuelwood (non-renewable biomass) while switching to biogas;
b) saving emissions from kerosene, which is avoided when switching to biogas;
c) increase women and children's overall health situation by reducing smoke in kitchen (more women in India die from respiratory diseases caused by fumes in kitchens than from malaria);
d) protecting the local environment by reducing the uncontrolled deforestation in the project area; helping women by saving cooking time.

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)	Agricultural Development and Training Society Bagepalli 561207 Kolar District Karnataka India www.adats.com adats@vsnl.com	No

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

>> Technology:

The biogas plant (Deenbandhu Model) consists of a digester with a fixed, non-movable gas space. Families load the raw cow dung through the inlet into the fixed dome made of bricks and cement, located outside the kitchen. Gas is produced through anaerobic digestion of the dung and stored in the upper part of the digester before being piped to the biogas stove in the kitchen. The gas pressure displaces the digested slurry into the compensating tank, ready to be used as excellent manure.

Advantages:

- low construction cost, locally available material and technology;
- no moving parts, no rusting steel parts, hence long life (25 years or more);
- safe and secure underground construction;
- low indoor emissions (pollution) from biogas combustion, families benefit immensely from smoke-free kitchens, quick, easy and clean operation, and relief of drudgery;
- construction creates locally employment.

Disadvantages:

- needs to be emptied every 5 years (build- up of mud, sand and pebbles);
- needs to be fed and maintained regularly to provide constant gas flow.

The size of the biogas digester depends on the family (household) size and the number of cows per household. For this project activity we evaluated average systems which best fit the conditions and needs of the users.

The technology used in this project activity is already available in India – thus no environmentally safe and sound technology and know-how will be transferred to the host party (country).

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

\>> Narsamma
Chinganapalli
562104 Varlakonda Post
Gudibanda Taluk
Kolar District
Karnataka
India

Plus homes of 5499 other participants in Kolar District listed in Appendix 1 [Ref 9].

A.4.1.1. Host Party(ies):

\>> India

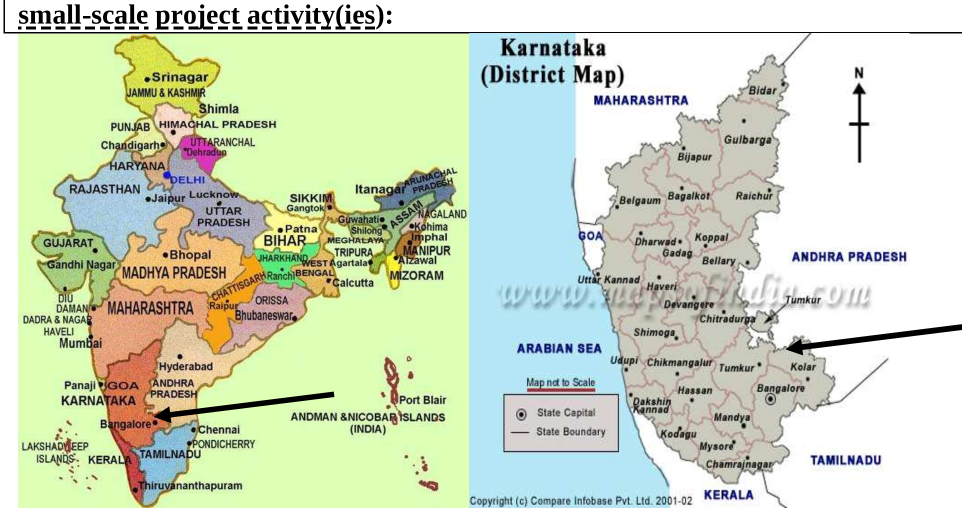
A.4.1.2. Region/State/Province etc.:

\>> Kolar District, Karnataka

A.4.1.3. City/Town/Community etc:

\>> Chinganapalli, 562104 Varlakonda Post, Gudibanda Taluk, Kolar District, Karnataka, India, Plus other villages in Kolar District as listed in Appendix 1

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



Maps of India and Karnataka with arrows indicating Kolar District

Map of Kolar District

The ADATS office is at ADATS Campus, Bagepalli 561207, Kolar District, Karnataka, India

The latitude and longitude of Bagepalli is:
Latitude: 13° 47' North
Longitude: 77° 47' East

Kolar district lies between
Latitude: 12° 46' to 13° 58' North
Longitude:77° 21' to 78° 35' East

and extends over an area of 8225 sq. km divided into 11 taluks.

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

>> Type and Category of the project activity:

The relevant project type and category is: Type I. RENEWABLE ENERGY PROJECTS, Category I.C. - Thermal energy for the user (according to: Appendix B of the simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories)[1]

The project activity is a bundle of small biogas plants of a total of less than 15 MW total generating capacity, supplying thermal energy directly to users.

Justification how the proposed activity conforms with the project type from Appendix B:

I.C. Thermal energy for the user
1. This category comprises renewable energy technologies that supply individual households or users with thermal energy that displaces fossil fuel or non-renewable sources of biomass. Upgrading of existing equipment is not allowed. Examples include solar thermal water heaters and dryers, solar cookers, energy derived from biomass for water heating, space heating, or drying, and other technologies that provide thermal energy that displaces fossil fuel. Biomass-based co-generating systems that produce heat and electricity for use on-site are included in this category.

[1] Note: In this PDD all reference to the Simplified Small-scale Methodology I.C. refer to the version 05, 25 February 2005.

2. Where generation capacity is specified by the manufacturer, it shall be less than 15MW.

1. Biogas digesters are renewable energy technologies that supply individual households or users with thermal energy that displaces fossil fuel or non-renewable sources of biomass: they are systems that use energy derived from biomass for water heating (and cooking). The biomass is agro-residues. This is fed to cows which in turn provide the dung for the biogas plant. This thermal energy from a renewable biomass source replaces non-renewable biomass (fuelwood collected from sources which are not replanted) and a fossil-fuel (kerosene) (see baseline fuelwood and kerosene surveys Appendix 2). The definition of non-renewable biomass and applicability for this project activity is based on studies of the national, state level, district level and household level non-renewable biomass consumption pattern.

2. Generation capacity where generation capacity is specified by the manufacturer, it shall be less than 15MW.

Table 1: provides the underlying data and assumptions for calculating generation capacity

Table 1:

Biogas plant size	Benefiting households	Average persons per household	Average cows per household	Average cooking hours
2 m^3	5500	5	4	4

Since no detailed information on the capacity of the biogas plants is available, we suggest a rough estimation based on the methane production potential of cow-dung according to IPCC guidelines (see Annex 4). We assume that the lower methane IPCC production value from dung reflects best the situation in Kolar district, since the cows owned by the families are typically small, similar to non-dairy cows, feeding on crop-residues. The calculations are given in Table 2. The total capacity of the biogas systems is calculated as the sum of the estimated capacity of all plants built by the project activity, and is approx.: 6MW and thus below the limit for small-scale CDM project.

Table 2: Summarised capacity of all 2 m^3 biogas plants in the project activity (reference values see Annex 4)

CH4 energy from cow dung (IPCC conservative value)	MJ / cow / year	1421.9
Energy derived from 4 cows	kWh / year	1579.8
Family cooking hours per day	H	4.0
Capacity of one system	KW	1.1
Capacity of all 5500 plants	**MW**	**~6**

A.4.3. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed small-scale project activity, including why the emission reductions would not occur in the absence of the proposed small-scale project activity, taking into account national and/or sectoral policies and circumstances:

>> This project will achieve the reduction of anthropogenic greenhouse gas emissions by replacing an energy source under Annex 1 of the Kyoto Protocol with renewable energy. The sector is other sector,

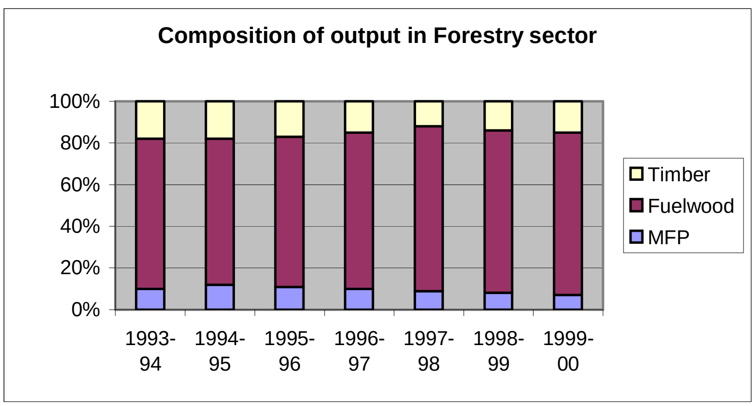
energy, fuel combustion, the other sector being non-renewable biomass fuel combustion using inefficient wood/stoves. This form of fuel combustion creates local pollution and leads to greenhouse gas emissions from the combustion of non-renewable biomass fuel.

This activity will be replaced with renewable biogas systems. Biogas based thermal energy generation using cow dung is a clean energy technology as the biomass for the cow fodder is coming from renewable sources of biomass in the form of agro-residue. Thus biogas is a zero-emission fuel as the CO_2 emitted during combustion of the biogas is again absorbed by the plants that are the fodder for the animal producing the dung.

In the absence of the proposed project activity, non-renewable biomass fuel would be used. The evidence that this fuelwood is to a large extent non-renewable comes from national, state level, district and household level biomass fuel source studies and surveys. The evidence can be summarised as follows:

National level: The State of the Forest Report 1988 reported that 19 Mt of fuelwood in India came from the recorded harvests in forests, and 30 Mt from forest degradation. An additional unexplained gap of 100 Mt of fuelwood in 1986 was estimated to come from illegal extraction of fuelwood which cannot be considered renewable as it is not planned for and therefore not replanted at planned rates. (Quoted in N.H. Ravindranath, Biomass Energy and Environment, Oxford University Press 1995, chpt 3).

More recently, the Contribution of Forestry Sector to Gross Domestic Product (GDP) in India Report, [Ref 1] shows that more than 70% of forest produce in India today is biomass for fuel combustion.



from *Contribution of Forestry Sector to Gross Domestic Product (GDP) in India Report* by Kanchan Chopra, B B Bhattacharya, Pushpam Kumar, December 2001, Institute of Economic Growth, Delhi University Enclave, Delhi 110007, sponsored by the Ministry to Environment and Forests, Government of India, chapter 2, The Forestry Sector In Resource And Income Accounting – figure 2.2. page 9.

This fuelwood is necessarily extracted illegally as there is a ban on fuelwood extraction from forests. The conclusion must follow that this biomass fuel production and consumption is non-renewable, in the sense that the Forest Department is not able to plan, and therefore not keep up anywhere near the required level of replanting to supply sufficient biomass fuel for combustion for cooking and water heating. The forest cover is therefore diminishing and number and size of trees are reducing. For this reason Forest department lands are barren, and devoid of tree cover, despite being nominally labelled as Forest.

State level: [Ref 2]: Presently about 20% of Karnataka's lands are under the forest department and in that only 11% is wooded. Of this forest area nearly 75% of the area suffers from an absence of regeneration.

The bioresource potential and demand (from forests, plantations, agriculture, horticulture and animal residues) for Karnataka across the agroclimatic zones was computed. The ratio of the availability to demand indicates the bioresource status of various agroclimatic zones in the state. These values reveal that among the 10 agroclimatic zones, 6 are biomass deficient zones. The eastern dry zone in which the most part of Kolar District falls is also bioresource deficient as the availability to demand ratio is 0.39.

District level: [Ref 3]: The land use details for Kolar District are (in % of total area): Forest 2.77 %, Plantation 3.07 %, Agriculture 46.69 %, Wastelands 42.32 %, Built-up 4.61 % and Water-bodies 0.53 %. The District is characterised by severe aridity and soil depletion. In Gauribidanur taluk Prosopis juliflora patches are estimated to meet about 32.2 % of annual fuel wood demand. In others it is similar, and over all the biomass availability ration is even less. The Prosopis patches are on wastelands where at the best of times natural regeneration takes place, and in the worst case no generation at all, whether by the government or by private parties. Ramachandra et al in [Ref 3a] estimate an overall fuelwood availability of 24.4% in Kolar District.

Household level: In [Appendix 2]: The fact that biomass fuel for combustion for cooking and water heating is non-renewable overall for the participants in the Bagepalli CDM Biogas Programme can also be established on an individual household level. We asked for the source of the fuelwood, and whether there is hardship and scarcity. Generally the reply for source was Forest Department (96%), plus road side trees (also Forest Department) and farm trees (4%). Own source meant small amounts of agro-residues which are not accounted here. Generally in response to questions about scarcity, there was a need expressed for biogas because fuelwood is *very scarce*, and people have to collect fuelwood from 2-5 kilometres away. Only households who have expressed this *bitter need* are being covered under the Bagepalli CDM Biogas Programme. Individuals surveyed expressed a lack of firewood. More than 70% of the village population covered by the programme are landless and do not have any control over land; therefore they cannot replant themselves. Thus it can be concluded that for our target group, who depend exclusively on the Forest department, the Forest Department is not able to keep up with replanting at the required rates, whether on land under Forest or on Wasteland, and the biomass fuel combustion which is currently carried out for cooking and water heating is being done with non-renewable biomass.

It can be seen that estimates of the proportion of non-renewable to renewable biomass vary depending on whether one considers national, regional, area-specific or household data. In the circumstances, we propose to use an area-specific (Kolar District) study done by Ramachandra et al [Ref 3a] , which supplements the other study [3] referred to above, and which estimate the percentage of non-renewable and renewable firewood for cooking and water heating in Kolar District. Detailed analysis was done and the status of bio-resources in Kolar District can be summarised as follows:

" Table - XIV Talukwise bioresource status

Taluk Name	Resource/Demand
Bagepalli	0.1490
Bangarpet	0.1518
Chikballapur	0.4220
Chintamani	0.1200
Gauribidanur	0.1550
Gudibanda	0.1590
Kolar	0.3259
Malur	0.2122
Mulbagal	0.1840
Sidlaghatta	0.1730

Srinivasapur 0.3858

This ratio (which means that only an average of 24.4% of fuelwood required in Kolar District is actually available from within the District). was derived after looking at various parametres. The approach is summerised by the authors as follows:

“ Land cover analyses show that Kolar District has a vegetative cover (Forest, Agriculture and Plantation) of 47.41% and non-vegetative cover of 52.59%. [In terms of forest cover,] Talukwise land use analyses show that among 11 taluks, Bangarpet has maximum forest cover of 10.46 %, followed by Srinivasapur (6.61%), Chikballapur (4.78%) and Gauribidanur with 0.58%. Area under plantation ranges from 8.81 % (Bangarpet) to 0.08% (Gauribidanur). Area under agriculture ranges from 63.91% (Malur) to 32.21% (Bagepalli). Wasteland in the district is about 42.33 % and talukwise it ranges from 25.97% (Malur) to 56.99% (Gauribidanur) to 57.60% (Bagepalli).

“ Kolar has an average standing biomass of 116.53 [tonnes/ha] and it is unevenly distributed. Many villages are dominated by monocultures like Eucalyptus plantation and other plantations like *Acacia auriculiformis, Acacia nilotica, Tamarindus indica, Mangifera indica* and relatively few other trees. Hence, large part of SB is human induced and not from naturally grown trees. However, this has a serious disadvantage since this system does not promote diversity, which is a vital necessity for a healthy ecosystem. This can be seen in reserve forests like Thondala, Singireddy plantation, and many others. Reserve forests like Antaraganga have high SB with high Shannon value due to large number of native tree species with monoculture plantation. Majority of smaller forests of Kolar district is fully degraded with low standing biomass and diversity like Karadubadehosahalli, Muduvadi and few others. Reserve forests of Chikballapur like Narasimhadevarabetta, Nandhi etc, though having large number of trees, their SB are not so high due to the relatively lower basal area of trees, with girth usually not more than 30-50 cm GBH. Human activities like logging, charcoal making and manmade forest fire add to the decrease in SB.

“ Large numbers of villages have a very low diversity and high dominance due to sparse forest area and wide cultivation of monoculture plantation. Few villages like Vibhuthipura and Singireddyhalli have slightly good Shannon value compared to other villages, though largely planted. They mainly consist of reserve forests planted with large numbers of native species and as a result there is increase in diversity. The original forests have long been degraded and what remain now are few patches of secondary forests, scrub vegetation and plantations. Chikballapur taluk has retained some good patches of forests due its relatively higher rainfall and lesser aridity. Nandhi forest alone harbors 82 species of trees showing the species richness of the area. Some of the valleys like Narasimhadevarabetta range exhibit very large species heterogeneity not only in valley bottoms but also along the slopes enhancing their conservation value. There are many more forests around Nandhi and other places of Chikballapur, which if conserved properly and restored to their original state, large number of resources including firewood and timber can be utilized, and can prove to be of immense value for the dry and arid district.

“ Assessment of bioresource status considering the availability of resource and the demand shows that all the taluks situated in Kolar district are facing bioresource scarcity. This is mainly due to mismanagement of resources, neglect of appropriate conservation, over exploitation and grazing.”

The average ratio from all the taluks is 0.24377. This means that for every kg of firewood required, only 0.24377 kg is available, or only 24.4% of the required biomass for fuelwood. This is also not taking any other wood use into account. Another way of putting it is that:

- seeing as people do have to cook, and they are managing to find fuelwood from somewhere, and we may thus conclude that the firewood is coming from other sources outside the District; and
- as we are not in a position to prove that all the biomass from outside the District is sustainable, and
- as the Karnataka level study shows a ratio of 0.39 for the entire agro-climatic zone in which Kolar is; and

- as the Indian national figures show that more than 70% of biomass comes from non-renewable Forest Department sources; and
- as the household level survey also shows that there is acute scarcity as people cannot walk for ever to collect firewood; and
- as Kolar is a very dry place and people do not have the financial capacity to buy fuelwood; and
- thus there is no commercial incentive for fuelwood to be generated in the region; thus

given all these factors, it is reasonable to assume that the ratio given in the study [Ref 3a] is the ratio of non-renewed biomass. In other words, 24.4% of biomass in Kolar District is renewable, and 75.6% non-renewable, and this can also be taken as the level of renewable/non-renewable biomass available to the consumers irrespective of where it comes from. It is not possible to analyse the inflow and outflow of fuelwood into Kolar District with the given resources of the present project proponents, nor is such a methodology available. But all the studies quoted indicate that this % is the accurate estimate of non-renewable to renewable biomass available to the potential users of the biogas plants in this project activity.

Thus in the Bagepalli CDM Biogas Programme we estimate that 75.6% of biomass (excluding agro-residues) used for cooking and water heating is non-renewable.

Combustion of non-renewable biomass fuel for cooking and water heating on the commonly used woodstove in Kolar District (traditional or improved mud stoves) contributes to climate change in two ways: on the one hand the stoves are fired with non-renewable biomass fuel sources, and on the other hand the burning process of these highly inefficient and primitive stoves causes relatively high rates of emissions of products of incomplete combustion (CH_4, N_2O, CO, NMHC), which partly have a higher Global Warming Potential (GWP) than CO_2 [Ref 4]. By promoting the use of biogas plants (and therefore switching to a highly efficient, clean and renewable source based on sustainable agro-residues) the Greenhouse Gas emissions can be completely eliminated provided the users avoid the use of non-renewable biomass fuel for combustion completely.

Other baseline scenarios that could have been possible and that could have been found during the baseline surveys [Appendix 2] are kerosene for all cooking requirements, Liquid Petroleum Gas (LPG) for all cooking requirements, and a mixture of kerosene and/or LPG and/or unsustainable fuelwood and/or sustainable fuelwood and /or sustainable agro-residues. The chosen baseline scenario represents the reality after conducting the surveys. The amount of fuelwood consumed is addressed below.

Greenhouse Gas emissions from existing cooking practices in India is a very complex subject, and has been studied extensively [Ref 4,5]. The underlying assumptions and values used for the calculations of the emissions reductions in this project are discussed in detail in the baseline section.

Biogas offers potentially attractive opportunities for true win-win interventions that achieve important global benefits in the form of GHG reductions, while providing even greater benefits for the local population by saving the local environment and increasing the health situation. In some areas of Kolar District where water is very saline this is especially important as families will have enough cooking energy to boil water, allow the salt to settle, and make the water potable.

Biogas digesters use environmentally sound fuel in the form of cow dung produced from sustainably grown biomass in the form of agro-residues fed to cows. The GHG emissions of the combustion process, mainly CO_2, is consumed by plant species during growth, representing a cyclic process. Since, the biogas contains only negligible quantities of other elements like Nitrogen, Sulphur etc. release of other

GHGs during burning are considered as negligible. The biogas fuel is thus CO_2 neutral and thus environmentally benign as it limits the greenhouse effect as well as providing immense health benefits to the user in the form of avoided smoke.

Why the emission reductions would not occur in the absence of the proposed small-scale project activity, taking into account national and/or sectoral policies and circumstances

More than 2 million digesters of different sizes have been constructed in India during the National Project on Biogas Development (started in 1981), most of them in rural parts of the country. In a country with half a billion cows, the conservative biogas potential could be around 25 million 2 m^3 biogas plants generating 125 million CERs per annum. Despite the fact that this technology is widely spread in India, the proposed project has to overcome various barriers like prevailing practice or other more economically attractive 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.

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 the market price or below it. The public distribution system for subsidised fossil fuel in the cooking fuel sector (including LPG) is working very well, and expanding rapidly. However, in many cases the kerosene is still too expensive for families and only three (3) litres per month are available through the public distribution system– too little for an average household, and therefore supplemented with an additional 0.8 litres on average per month. 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. Thus a fossil-fuel based least cost approach has come to dominate National and State level cooking fuel policy. The Central and State Government supported only 500 biogas plants in Kolar District in 2005, whereas the demand may easily exceed 50 000 plants.

The capital cost of a 2 m^3 biogas plant is about 6 times the cost of LPG. The commonly and widely used wood fired stoves or ovens ("traditional mud stoves" or "improved vented mud stoves") cost around 5 Euros, a basic "3-rock stove" almost zero. In cities and in rural municipalities with some level of income, LPG is the preferred cooking fuel of all the classes, upper, middle and lower middle class and working class. To some extent this technology is also slowly penetrating the villages. But this is beyond the reach of this project's target population. Taking all this information into account, it is very unlikely that any of the new users who will be installing biogas plants under this project activity will be able to afford a biogas plant. Even though, compared to the other options, it is in the long-term a cheaper, cleaner and locally and globally more beneficial technology.

The reason why some biogas plants are built at all is because idealistic investors and to a limited extent the central government are willing to make efforts to:

a) support rural technologies;
b) support distributed and decentralised thermal heat generation in order to reduce women's health problems and provide affordable cooking fuel, and
c) to support the rural biomass economy.

The hope is that the CDM will enable biogas technology for cooking to overcome the described barriers and reactivate and enforce the programmes to promote biogas plants in Kolar District.

The described project activity is clearly additional because it is financed almost completely through the revenues from the CER sales, and cannot be realised without the revenues from the carbon credits.

Details of the underlying assumptions and calculation of the baseline and the emission reductions are provided in section B and E of this PDD.

A.4.3.1 Estimated amount of emission reductions over the chosen crediting period:

>>

Year	CER
2006	19,553
2007	19,553
2008	19,553
2009	19,553
2010	19,553
2011	19,553
2012	19,553
Total estimated reductions (tonnes of CO_{2e})	**136,874**
Total number of crediting years	7
Annual average over the crediting period of estimated reductions (tonnes of $CO_{2\,e}$)	19,553

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

>> No public funding involved

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

>> The small-scale project activity is not a debundled component of a large project activity since there is no registered small-scale CDM project activity or an application to register another small-scale CDM project activity:

- With the same project participants;
- In the same project category or technology; and
- Registered within the previous two 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 methodology:

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

>> Small-scale CDM Project, Type I – RENEWABLE ENERGY PROJECTS, I.C. Thermal energy for the user (according to: Annex B of simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories)

Baseline

5. 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.

6. For renewable energy technologies that displace non-renewable sources of biomass, the simplified baseline is the non-renewable sources of biomass consumption of the technologies times an emission coefficient for the non-renewable sources of biomass displaced. IPCC default values for emission coefficients may be used.

B.2 Project category applicable to the small-scale project activity:

>> A) This methodology is applicable as per definition in the Annex B of the simplified methodologies for selected small-scale CDM project activity categories, Type I.C Thermal energy for the user:

Para 1.: This category comprises renewable energy technologies that supply individual households or users with thermal energy that displaces fossil fuel or non-renewable sources of biomass. Examples include solar thermal water heaters and dryers, solar cookers, energy derived from biomass for water heating, space heating, or drying, and other technologies that provide thermal energy that displaces fossil fuel. Biomass-based co-generating systems that produce heat and electricity for use on-site are included in this category.

B) Qualification under small-scale CDM according to:

Para 2.: Where generation capacity is specified by the manufacturer, it shall be less than 15 MW.

Since no detailed information on the capacity of the biogas plants is available, we suggest a rough estimation based on the methane production potential of cow-dung according to IPCC guidelines (see Annex 4). The calculations are given in Table 2. The total capacity of the biogas systems is calculated as the sum of the estimated capacity of all plants build by the project activity, and is approx.: 6MW and thus below the limit for small-scale CDM project.

Table 3: Summarised capacity of all 2 m^3 biogas plants in the project activity (reference values see Annex 4)

CH4 energy from cow dung (IPCC conservative value)	MJ / cow / year	1421.9
Energy derived from 4 cows	kWh / year	1579.8
Family cooking hours per day	h	4.0
Capacity of one system	kW	1.1
Capacity of all 5500 plants	**MW**	**~6**

C) The baseline is applied in accordance with Paragraph 5 and 6 of the definitions.

For non-renewable wood:

Type 1.C., Para 6.: For renewable energy technologies that displace non-renewable sources of biomass, the simplified baseline is the non-renewable sources of biomass consumption of the technologies times *an emission coefficient for the non-renewable sources of biomass displaced. IPCC default values for emission coefficients may be used.*

and for kerosene:

Type 1.C., Para 5.: 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.

Non-renewable source of biomass (wood) and fuelwood consumption

Recent surveys show that of total domestic fuel needs in India, 60% in rural areas and 40% in urban areas are met from wood fuel. [3] 70% of forest extraction occurs for fuelwood. [1]. In Karnataka, the eastern dry zone in which Kolar District falls is a bioresource deficient zone [2]. In rural areas of Kolar district traditional fuel such as wood, agriculture and animal residues, still meets 85-95% of the demand [3]. The studies by Ramachandra et al. for Kolar [3. 3a] state that the biomass (wood) produced in the semi-arid region of Kolar district does not supply the fuelwood demand of the population and is therefore, as per definition, coming from a non-renewable source of biomass. Detailed information is available from the papers [3,3a]. As Kolar District has less than 3% forest cover, and other studies and surveys from national, State level and household level are also considered, it is concluded that this biogas project activity will reduce emissions associated with biomass fuel combustion based on non-renewable biomass. In order to establish the non-renewable component of the biomass combusted, we propose to use the exhaustive Kolar District study done by Ramachandra et al [Ref 3a] , which estimates that 75.6% of the firewood for cooking and water heating in Kolar District comes from non-renewable biomass sources.

Thus in the Bagepalli CDM Biogas Programme we estimate that 75.6% of biomass (excluding agro-residues) used for cooking and water heating is non-renewable.

Fuelwood consumption:
The studies [2,3,3a] showed the following estimated average consumption of fuelwood for a medium size family of 5 people: [Ref 2]: 5.24 tonnes per year ; [Ref 3]: A range from 3.2 to 4.6 tonnes per family per year with an average of 2.38 tonnes per family per year for Kolar District.; [Ref 3a]: A range from 1.3 to 2.5 kg/person/day = 2.4 tonnes to 3.3 tonnes per family per year, so the average is 2.85 tonnes/year.

If we take the average of these four figures, viz. 5.24 tonnes/year, 2.38 tonnes per year, and 2.85 tonnes per year, we get 3.49 tonnes/family. Based on the local experience of WSD and SKGS, five separate surveys with focus on 5 villages in Kolar District and the specific project region were carried out [Appendix 2]. The following average consumption values for wood and kerosene present were found: for a single household, 5 persons: 3.37 t fuelwood per year. However, to ensure consistency with Ramanchandra's findings [Ref 3a] for biomass availability, which are determined based on his surveyed fuelwood consumption figures, and as these are also more conservative than the surveyed fuelwood consumption data by us [Appendix 2], we take the average from Ramachandra's range [Ref 3a], which is 2.85 tonnes per family per year.

Kerosene consumption

Families receive 3 litres of kerosene per month through the public distribution system, and all of it goes for cooking and water heating. A small additional 0.8 litres on average is purchased in addition. It is all being replaced with biogas energy. But nevertheless, a survey of the kerosene consumption in the project region per person and household was carried out in the same surveys as described above [Appendix 2]. The following average value of reduction in kerosene consumption has been calculated:
Single Household, 5 persons: 31.2 litres kerosene per year.

Details on the emission coefficient for non-renewable sources of biomass
Smith et al. have published different studies over the last years, dealing with the GHG emission of different stove/fuel combinations commonly used in households in rural regions of India. Interesting in the context of this project activity are the findings for the combinations of basic mud stoves and wood fuel, since this project activity takes place in a rural and poor region of India and uses non-renewable biomass (wood) as its baseline.
Detailed information about the methods and results of these studies are available in the respective papers and will not be discussed here in detail (see references [4.5]).
However, Smith et al. suggest in their publication [4] not to restrict to the standard gases in the estimation of GHG emissions from household stoves. According to this report, the standard calculations do not reflect the real situation, due to the additional contribution to global warming from products of incomplete combustion (PIC: CO, CH4, NMHC, N2O), which occurs at a high rate in the inefficient stoves. Basically they propose two adjustments:

1. Include CO and NMHC in the estimation of the GHG emissions. Many of the tested stove/wood combinations produced a high amount of these PICs, mainly CO. The fact that CO can oxidise relatively fast to CO_2 under certain conditions should be considered accordingly.
2. Instead of standard GWP for each gas slightly different GWP shall be used. Including relatively high GWPs for CO and NMHC.

Smith et al. calculated an average emission coefficient for traditional mud stoves fired with wood is of 866 g CO_2e per MJ delivered Energy (to pot), which is relatively high compared to the value calculated according to IPCC [2] rules (~560 g CO_2e per MJ delivered Energy). Table 4 provides some of the measured emission data from Smith et al. [4,5] on a pollutant mass by fuel mass basis (g pollutant / kg wood) and on a pollutant by delivered energy to pot basis (g pollutant / MJ del) for typical stove/wood combinations.

Table 4: Measured GHG emissions from typical wood/stove combinations in India. Eucal = wood from eucalyptus three, Acacia = wood from acacia three, 3R = 3-rock-stove, IVM = improved vented mud stove, TM = traditional mud stove (for a detailed description see paper Smith et al.[4,5])

[2] A list of the official values and parameters used as well as some basic calculations are available in Annex 4

Wood/stove combinations	CO2	CO	CH4	NMHC	N2O
	g pollutant / kg wood				
Eucal 3R	1’536.00	60.15	2.83	7.98	0.07
Eucal IVM	1’338.00	139.10	11.45	25.13	0.16
Acacia 3R	1’374.00	64.70	9.40	9.65	0.18
Acacia IVM	1’391.00	66.47	3.94	7.76	0.09
Acacia TM	1’260.00	125.80	10.79	11.94	0.19
	g pollutant / MJ del to pot				
Eucal 3R	566.10	22.17	1.04	2.94	0.03
Eucal IVM	396.70	41.26	3.40	7.45	0.05
Acacia 3R	502.80	23.67	3.44	3.53	0.07
Acacia IVM	506.30	24.19	1.43	2.82	0.03
Acacia TM	355.00	35.45	3.04	3.37	0.05

Despite this attractive approach (from the view of the resulting high emission reductions) we decide to use more conservative data and assumptions [2] in our baseline calculations, and focus only on the official IPCC emission coefficients of the three main GHGs: CO_2, CH_4 and N_2O, and on the commonly used GWP of 21 for CH_4 and 310 for N_2O. Table 5 compares the official IPCC values [6] and the calculated average emission coefficient from the Smith et al. data in Table 4.

Table 5: Official IPCC GHG emissions coefficient for wood [2] and calculated average emissions coefficients for India specific wood/stove combinations (average from Table 4)

	g pollutant / kg wood		
	CO_2	CH_4	N_2O
IPCC official	1661.00	5.00	0.06
in CO2e	*1661.00*	*105.00*	*18.60*
in % CO2	*100%*	*6.3%*	*1.1%*
Average from Table 4	1379.80	7.68	0.14

As we see in Table 5 the IPCC value for CO_2 emission from wood combustion is higher than the average value from Smith et al. because of the higher CO emission in the Smith et al. studies. Our approach is now, to use only the CO_2 emission as the baseline emissions.

CH_4 and N_2O times the respective GWP makes 7.4% of the CO2 emissions, but is not considered in the baseline to compensate for possible leakage in the project activity (details see leakage section).

The full calculation sheet for calculating the emission reduction from the project activity are given in Appendix 4. The CO_2 reductions achieved by one family are 3.56 tonnes CO_2/year.

B.3. 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:

>> According to the Guidelines for completing CDM SSC PDD, this section should provide a justification that the proposed project activity qualifies to use simplified methodologies and is additional using attachment A to Appendix B of the simplified modalities and procedures for small-scale CDM project activities.) National policies and circumstances relevant to the baseline of the proposed project activity can also be considered.

(a) Investment barrier: a financially more viable alternative to the project activity would have led to higher emissions;

Alternative 1) The commonly and widely used wood fired stoves or ovens (“traditional mud stoves” or “improved vented mud stoves”) cost around 5 Euros, a basic “3-rock stove” almost zero. This the baseline scenario and represents 3.56 t CO2 emission per family per year. 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, some farm field borders, and it is free. 24.4% of firewood is estimated to be renewable, with the balance 75.6% being non-renewable [Ref 3a].

Alternative 2) Kerosene is very expensive at around Rs 10.00 per litre in the fair price shop and around 20.00 Rs / litre in the open market if available. Around 1 kg would be needed per day, which is the equivalent of a daily labourer’s daily salary. Thus it is not feasible for the target users in this project activity to use kerosene.

Alternative 3) LPG: The capital cost of a 2 m^3 biogas plant is about 6 times the cost of LPG. In cities and in rural municipalities with some level of income, LPG is the preferred cooking fuel of all the classes, upper, middle and lower middle class and working class. Running cost is around Rs 10.00 per day, again about half the daily wage of a agricultural labourer. To some extent this technology is also 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.

Taking all this information into account, it can be seen that Alternative 1) the continued combustion of non-renewable biomass fuel for cooking and water heating is the cheapest option, leading to higher emissions.

(b) Technological barrier: a less technologically advanced alternative to the project activity involves lower risks due to the performance uncertainty or low market share of the new technology adopted for the project activity and so would have led to higher emissions;

The commonly and widely used wood fired stoves or ovens ("traditional mud stoves" or "improved vented 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. Biogas plants on the other hand have to be constructed very carefully. This takes skill, diligence, careful working, 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. There are not many good biogas gas manufacturers in India for the household user size plant, and thus the technology has low market share in the villages compared to the baseline cooking technology..

(c) Barrier due to prevailing practice: prevailing practice or existing regulatory or policy requirements would have led to implementation of a technology with higher emissions;

The prevailing practice is for poor households to depend on free sources of firewood from the "commons" – either the Forest department (illegal collection is very common though under-reported), Panchayat Land, where the poor are entitled to collect firewood but there are no programmes for reforestation or replacement of biomass removed. Thus all these sources of biomass are non-renewable to large extent; yet this is the prevailing practice. See Refs [1,2,3, 3a].

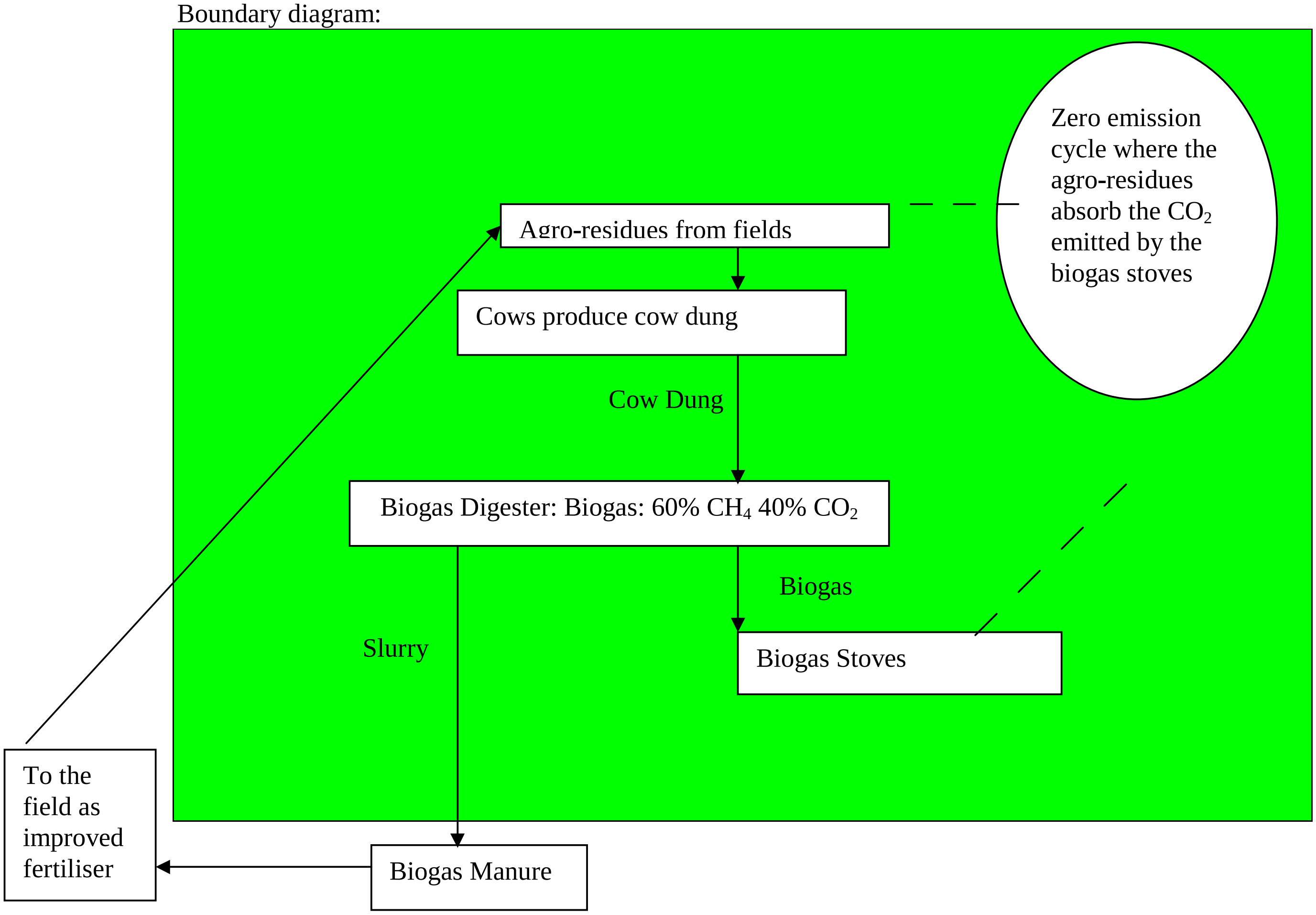
(d) Other barriers: without the project activity, for another specific reason identified by the project participant, such as institutional barriers or limited information, managerial resources, organizational capacity, financial resources, or capacity to absorb new technologies, emissions would have been higher.

It takes quite special organisational and management skills and coordination amongst various implementing agencies to organise decentralised supply of small cooking systems of the kind envisaged under this project activity. Not only do the plants have to be built to suit local soil conditions, but service and maintenance crews have to be trained and stationed in all the villages to ensure smooth running of the plants. Emissions from the combustion of non-renewable biomass fuel can only be avoided through efforts on the part of a supplier to give professional attention to this rural renewable energy technology and manage it efficiently with sufficient resource inputs on all fronts. As the local market is not willing to pay the additional cost of biogas plants compared to other forms of baseline activities, these barriers can only be overcome with CDM support. A biogas plant of 2 cubic metres capacity can be financed with a 5 year advance on CERs if the CER price is 15 Euros. This illustrates the win-win opportunity under CDM compared to the baseline situation.

B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the small-scale project activity:

>> The physical, geographical site of the renewable energy technologies generating the thermal energy and the equipment that uses the thermal energy produced delineates the project boundary. The project boundary encompasses the sum of all the 5 500 physical geographical sites of all individual biogas plants (digester system, pipe leading to the stove and the stove itself) realised by the project activity.

Boundary diagram:



B.5. Details of the baseline and its development:

>> The relevant project type and categories are: Type I. RENEWABLE ENERGY PROJECTS, Category I.C. - Thermal energy for the user

Date of completion 28/10/2005

Contact information:

Private entity and project participant
Anandi Sharan-Meili Chief Functionary Women for Sustainable Development 32/2 Kempapura Road Hebbal Bangalore 560024 Karnataka India Tel + 91 80 23637007 www.climateindia.com anandi@climateindia.com

The person/entity who completed the baseline is also a project participant listed in Annex 1.

SECTION C. Duration of the project activity / Crediting period:

C.1. Duration of the small-scale project activity:

>> 21-y-0-m

C.1.1. Starting date of the small-scale project activity:

>> 18/12/2005

C.1.2. Expected operational lifetime of the small-scale project activity:

>> 21-y-0-m

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

>> Renewable

C.2.1. Renewable crediting period:

>> 3 x 7-y-0-m

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

>> 18/12/2005

C.2.1.2. Length of the first crediting period:

>> 7-y-0-m

C.2.2. Fixed crediting period:

>> not applicable

C.2.2.1. Starting date:

>> not applicable

C.2.2.2. Length:

>> not applicable

SECTION D. Application of a monitoring methodology and plan:

>>

Type I. RENEWABLE ENERGY PROJECTS, Category I.C. - Thermal energy for the user

Monitoring

According to I.C methodology, Version 5, monitoring shall consist of:

a) Metering the energy produced by a sample of the systems where the simplified baseline is based on the energy produced multiplied by an emission coefficient.

OR

b) Metering the thermal and electrical energy generated for co-generation projects. In the case of co-fired plants, the amount of fossil fuel input shall be monitored;

   OR

c) If the emissions reduction per system is less than 5 tonnes of CO_2 a year:
   (i) Recording annually the number of systems operating (evidence of continuing operation, such as on-going rental/lease payments could be a substitute); and
   (ii) Estimating the annual hours of operation of an average system, if necessary using survey methods. Annual hours of operation can be estimated from total output (e.g. tonnes of grain dried) and output per hour if an accurate value of output per hour is available.

Monitoring plan and procedures

The Monitoring and Verification procedures define project specific standards against which the project's performance (i.e. GHG emissions) and conformance with all relevant criteria will be monitored and verified. They include developing suitable data collection methods including a computerised data capture system, and techniques for data interpretation for monitoring and verifying GHG emission reductions with specific focus on technical/efficiency/performance parameters. They also allows scope for review, scrutiny and benchmarking against established norms for monitoring and verification.

The M&V protocol provides a range of data estimation, measurement and collection options and techniques, in each case indicating preferred options consistent with good practice to allow project managers, and operational staff, auditors and verifiers to apply the most practical and cost effective measurement approaches to the project. The aim is to enable this project to have clear, credible and accurate monitoring, evaluation and verification procedures. The purpose of the procedures is to direct and support continuous monitoring of project performance and project indicators, to determine project outcomes and GHG reductions.

Project specific standards

Emissions reduction per system is less than 5 tonnes of CO_2 a year. Thus ADATS will set up systems according to option C of I.C methodology, wherein it will;

- record annually the number of systems operating; and
- estimate the annual hours of operation of an average system using survey methods.

Plan

The 5 500 biogas plants installed under this programme do not generate any revenue. The only incentive for users to keep the plants operational is the benefit of the clean cooking fuel.

The emission reductions are assumed to occur against the baseline non-renewable biomass energy combustion and kerosene consumption. Provided the plant is fully functional throughout the year the emission reduction will be assumed to occur against this baseline. Thus the the simplified baseline is not based on the energy produced multiplied by an emission coefficient but rather on non-renewable biomass fuel consumed multiplied by the emission factor.

The cost of installing physical gas metres to measure production of gas, and specialist metres for measuring the quality of the biogas (CH_4 content) in order to determine the exact energy quantity is quite high. According to the methodology, it is also not necessary to install metres for measuring quantity of gas produced.

Energy produced can be measured by measuring a) the quality, b) the quantity of gas generated, c) the amount of gas consumed, and checked against d) the amount of dung fed into the digesters. Surveys for these parameters were done consecutively for 3 years during the crediting period in I and II monitoring reports for the years 2006 – 2009. A stratified random sample was conducted to demonstrate that the energy produced by the bio-digester is sufficient to displace the energy previously produced through firewood and kerosene . This survey was in a way to substantiate the emission reduction calculated through the ratio of 3.56 CER per unit operating. The results of the survey do not enter into the calculation of CER to be delivered. Accordingly, the energy produced through the dung fed and quantity of gas generated was calculated as follows:

$$UE_1 = DS * VS * D * EF * CV * E_{ff} \quad \text{...Equation 1}$$

Where

UE_1 = Useful energy measured through quantity of dung fed into the bio-digester (MJ/year)
DS = Dung fed into the digester (kg)
VS = Volatile Solids produced/kg of dung (kg)
D = No. of days dung fed into the digester
EF = CH_4 production capacity/VS m^3/kg
CV = Calorific Value of methane MJ/m^3
E_{ff} = Efficiency of the stove

The following values were used to derive the energy produced by the quantity of dung fed.

Activity data	Value	Reference
VS Excretion dry mass (%)	40%	Laboratory Report
CH_4 production capacity / VS dairy	$0.13\ m^3$ / kg	IPCC, 2006

CH_4 production capacity / VS non-dairy	0.10 m^3 / kg	IPCC, 2006
Calorific value CH_4	35 MJ/m^3	IPCC, 2006
Efficiency of the stove	55%	BIS

Based on the survey conducted approximately 19.3-21.4 kgs of dung is being fed into the digester every day. The useful energy applying the equation 1 for the year is about 6510-7217 MJ/year as shown below:

Data	Reference	2007	2008	2009
Dung Input DS (Kg)	Field experiments	**19.30**	**21.4**	**19.6**
VS (%)	Laboratory analysis	40%	40%	40%
D (Days)	-	365	365	365
EF (m^3/kg)	IPCC, 2006	0.12	0.12	0.12
CV (MJ/m^3)	Nijaguna, 2002	35	35	35
Eff (%)	Nijaguna, 2002	55%	55%	55%
Useful energy (MJ/yr)	**Calculated**	**6510**	**7217**	**6610**

The potential energy content of biogas production on an annual basis was calculated as follows:

$$UE_2 = BGP * CV*D*E_{ff} \text{ .... } \textbf{Equation 2}$$

Where
- UE_2 = Useful energy measured (MJ/year)
- BGP = Biogas production (m^3/day)
- D = No. of days (365)
- CV = Net Calorific Value of biogas (MJ/m^3)
- Eff = Efficiency of the stove (%)

The following values were used to derive the energy produced from the measured biogas production.

Activity data	Value	Reference
Net Calorific Value of biogas	22.1 MJ/m^3	Nijaguna, B.T. 2002. Biogas Technology, New Age International Publishers. New Delhi
Efficiency of the stove	55%	PDD

Based on annual surveys, biogas production is approximately 1.31-1.64 m^3/day. The useful energy applying equation 2 for the year is about 5817-7275 MJ/year.

From Biogas production from slurry displacement (using equation 2)				
Data	**Reference**	**2007**	**2008**	**2009**
Biogas production BGP (m^3/day)	Field experiments	1.31	1.34	1.64
Calorific value of biogas CV (MJ/m^3)	Nijaguna, 2002	22.1	22.1	22.1

D (Days)	-	365	365	365
Eff (%)	Nijaguna, 2002	55%	55%	55%
Useful energy (MJ/yr)	**Calculated**	**5817**	**5945**	**7275**

The energy production in the baseline from firewood and kerosene is as follows:

$$\mathbf{UE_t = (FW * CV_f * E_{fw} + K * CV_k * E_k)}$$

Where

UE_t = useful energy delivered to the cooking pot (MJ/yr)
FW = firewood consumption for cooking at family level (t/yr)
CV_f = calorific value of firewood
E_{fw} = Efficiency of the stove
K = liters of kerosene used (lts/yr)
CV_k = calorific value of kerosene
E_k = Efficiency of the kerosene stove

This baseline calculation is based on the approved PDD

Activity data	**Units**	**Value**
Family wood consumption per year	kg / year	2,850.00
Calorific value wood	MJ / kg wood	15.00
Family kerosene consumption/year	lts/year	31.20
Density of kerosene	kg/l	0.75
Liters of kerosene	Kg/year	23.31
Net calorific value of kerosene	MJ / kg	44.75
Efficiency of traditional stove	Percentage	10%
Efficiency of kerosene stove	Percentage	45%

The energy available in the baseline is

UE_t = (2850*15*10%) + (23.31*44.75*45%)
= 4715 MJ/yr

Comparing UE_1 and UE_2, to UE_t shows that the energy available from biogas units is able to completely replace the energy obtained from non-renewable fire wood and kerosene in the baseline.

These calculations are not used in emission reduction calculations. But it substantiates the application of the 3.56 ER per unit/year due to the availability of the same energy output from the biogas units.

The annual surveys for energy output from biogas involves high transaction costs, Thus, these surveys would not be conducted as the 3 years consecutive surveys shows enough dung availability and energy generation to replace non-renewable biomass used in the baseline. Also these calculations are not used in emission reduction calculations. Further, if for non-availability of dung, biogas is not used, these days will be recorded and emission reductions reduced for those days.

Project specific standards

- Average amount of non-renewable biomass used based on sample survey.
- Average amount of kerosene used based on sample survey.
- Annual hours of operation of an average system based on sample survey.

These numbers will be established in the following way:

- Non-renewable biomass: Annual statistically determined sample survey method based on household questionnaire survey.

Kerosene consumption: Annual statistically determined sample survey based on household questionnaire survey.

On-site emissions: Direct on-site emissions after the implementation of the project would arise from continued combustion of non-renewable biomass fuel or kerosene. This will be monitored to make reliable emission reductions and have low uncertainty levels.

Direct off site emissions: None. To the extent that some cow dung may still be left outside the project boundary, this is not required to be measured.

Indirect on site emissions: None

Fuel requirement, availability and utilisation: In this project it is assumed that new plant owners already own cows, but did not have the finances to install biogas plants and avoid the emissions from non-renewable fuelwood use. Thus the dung needed for the biogas plant is already available in the households where the plants are installed. The question of indirect emissions – for example from methane emissions from decomposition of organic manure which is not for example completely utilised in the new biogas plants - does not need to be considered. We consider that by neglecting to account for some avoided methane emissions through improved cow dung management we are further demonstrating a conservative baseline.

Biogas used for non-domestic purposes: This is not relevant as the baseline, viz. combustion of non-renewable biomass fuel is the same.

Biogas sold for commercial purposes: Not relevant

Efficiency of the biogas plant: See performance standards above.

Health and safety: With air, the lower explosive limit and the upper explosive limit for methane are 5.4 and 13.9% respectively on volume basis. As biogas is 60% methane, these values for biogas are 9% and 23% respectively. The density of the biogas is an important factor in assessing the dangers if it leaks. The density of air is 1.29 gm/litre. When CO_2 content is 45.7% of the biogas, the density will be equivalent to that of air, and will not rise. In the present project activity, cow dung is the feedstock. This will maintain the density of the biogas at a level below that of air, and so the methane will rise. The temperature needed to cause an explosion is about 650 – 750^{o} C. A spark or lighted match will be hot enough to cause an explosion if the methane has not risen. But if proper ventilation is provided, biogas will be quickly diluted in the air. WSD will not provide a biogas connection for a kitchen which does not have a window and will endeavour to install windows so that a maximum number of poor families can benefit from the programme.

Total ERs: This will be continuously monitored by updating the various survey sheets on a monthly basis.

All the above parameters will demonstrate the performance of the project at any given time.

D.1. Name and reference of approved monitoring methodology applied to the small-scale project activity:

>> Type I. RENEWABLE ENERGY PROJECTS, Category I.C. - Thermal energy for the user .

D.2. Justification of the choice of the methodology and why it is applicable to the small-scale project activity:

>> Type I. RENEWABLE ENERGY PROJECTS, Category I.C. - Thermal energy for the user

As the plants reduce 3.56 tonnes of CO2e per annum through the avoidance of combustion of non-renewable biomass fuel, the chosen methodology is applicable to the project activity as reductions per plant in this category are below 5 tonnes CO2e /plant / year.

D.3 Data to be monitored:

>>

ID	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data to be kept?	Comment
1	*Number of installed 2 m^3 systems*	*IS*	*Units*	*m*	*Daily basis*	*All*	*e & p*	*Crediting period plus 2 years*	*ERs will be calculated only for installed units*
2	*Number of operating 2 m^3 systems*	*OS*	*Units*	*m*	*Daily basis*	*All*	*e & p*	*Crediting period plus 2 years*	*Non usage days will be recorded on daily basis and ERs not calculated for non-operational days*
3	*2 m^3 system average annual operating time*	*T*	*Hours*	*e*	*Annually*	*Random sample*	*e & p*	*Crediting period plus 2 years*	*Not used for calculation of the emission reductions*
4	*Non-usage days of installed*		*Days*	*m*	*Daily basis*	*All*	*e & p*	*Crediting period plus 2 years*	*ERs will be deducted for non-operational*

	and operational biogas plants								*days.*

Data / Parameter:	**Number of installed 2 m^3 systems**
Data unit:	Units
Description:	Number of biogas units installed under the project activity
Source of data to be used:	Monitored on a daily basis and entered into the monitoring database
Value of data	5,500
Description of measurement methods and procedures to be applied:	The construction processes are monitored on a day to day basis and database maintained from its initiation to completion dates for each of the biogas unit.
QA/QC procedures to be applied:	All activity processes, including financial transactions for construction of biogas units, are digitally monitored using the online intranet solution that is integrated into ADATS's intranet based monitoring system InfoNeeds. This provides verification for the construction of biogas units
Any comment:	ERs are calculated for only the installed and operational biogas units.

Data / Parameter:	**Number of operating 2 m^3 systems**
Data unit:	Units
Description:	For each of the day, the biogas units that are operational
Source of data to be used:	Monitored on a daily basis and entered into the monitoring database
Value of data	5,500
Description of measurement methods and procedures to be applied:	The non-operational days of all the installed units will be monitored to record the number of units operational in a year on a daily basis.
QA/QC procedures to be applied:	ERs will be deducted for non-operational days. ERs will be calculated only for those units which are operational for the days used.
Any comment:	To reduce uncertainty and make conservative emission reduction calculations, emission reductions will be deducted for non-operational days for each of the installed units.
Any comment:	CERs will be reduced for the non-functional days of the units.

Data / Parameter:	**2 m3 system average annual operating time**
Data unit:	Hours
Description:	Hours of operation of biogas units/day
Source of data to be used:	Sample survey conducted 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:	**Non-usage days of installed and operational 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 for each of the unit 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 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:	
Any comment:	CERs will be reduced for the non-functional days of the units.

D.4. Qualitative explanation of how quality control (QC) and quality assurance (QA) procedures are undertaken:

>>

ID number	Uncertainly level of data (High/medium/low)	Are QA/QC procedures planned for these data?	Outline explanation of why QA/QC procedures are/are not being planned.
D.3.1.	Low	Yes	The emission reductions by project activity will be for the units installed; there is 100% accuracy of this number.
D.3.2.	Low	Yes	This data will be used to calculate the emission reductions by project activity; there is 100% accuracy of this number.
D.3.3.	Low	Yes	This data will be used as supporting information for calculation of emission reduction by project activity.
D.3.4	Low	Yes	Monitoring this parameter will reduce uncertainty and make conservative emission reduction calculations.

D.5. Please describe briefly the operational and management structure that the project participant(s) will implement in order to monitor emission reductions and any leakage effects generated by the project activity:

>>

Management

ADATS is in charge of the Programme overall. ADATS is in charge of construction, service and maintenance, and data collection for preparation of monitoring reports.

ADATS will provide support in the villages through the Bagepalli Coolie Sangha Units and coordinate for training users.

Suitable project data collection methods:

ADATS is the project implementing agency and manufacturers of the biogas plants. They bring 300 masons and supervisors to the consortium activities, who will be responsible for plant supervision, maintenance, and monitoring.

Users are also part of the local management of this project. By being given user education which imparts a sense of pride and responsibility in the users, they will understand the need for perfect plant operation on a daily basis.

The users will be firmly told that they must keep their plants 100% operational, and make use of the provisions under the service and maintenance contract for any support.

ADATS maintains a list of all the users who have installed plants under this project activity on their InfoNeeds Database. In this database every household with a biogas plant has a unique identifier and updated information taken from the individual plant logbooks concerning parameters listed below. The number of installed and operating systems is updated monthly at the ADATS office. The differentiation between installed and operating systems is made to control the over-all performance of the project activity. ADATS will have trained the family members of the households as above. In addition, ADATS will run internal training programmes for supervisors and masons to ensure that both the service and maintenance procedures, and the collection of monitoring data described below is understood by all, and is reliable and transparent. There will be a supervisor for every 50 plants or so, or at least for every village. This system is already in place and is simple and cost effective. The reports on the problems of the biogas plants are passed on by the local supervisor to the office team and other masons at the ADATS office in case the local supervisor cannot rectify the fault within 24 hours on his own. The service contract obliges the office to respond to complaints within 24 hours and rectify any problems within 1 week. ADATS provides normative operation and maintenance procedures which must be adopted by families after installation. ADATS will ensure that the service contract provisions are used by the users – thus ensuring that all the biogas plants installed under this project activity are guaranteed to be operational.
All information is recorded on paper and electronically. Once a year all reported information will be compiled for the detailed annual monitoring report, which will be sent to the DOE verification team.

Data: The data to be collected in addition to the project specific standards data referred to above, consist of the monitoring data listed in table D.3.: Number of installed 2 m^3 systems, Number of operating 2 m^3 systems, and 2 m^3 systems' average daily operating time and non-usage days. ADATS has a system in place which builds on the current practice already in place and supplements and strengthens it as required.

<u>Number of installed systems</u>: Survey sheet “Installed systems” will list name of householder, date of installation and supervisor responsible for plant service and maintenance.

<u>Number of operating systems</u>: Survey sheet “operating systems” will list name pf householder, date of installation, dates of supervisor visit and maintenance activities if any. It will cross reference to the plant log book being maintained for each plant by the supervisor in charge. Non usage days will be recorded to estimate ERs only for days the systems were operational.

Average daily operating time in order to establish annual operating hours of the average system : Survey sheet "Average daily operating time" will be completed for a random sample plants only annually, in the same locations where data collection for "project specific standards" is carried out.

Project performance review:
This will be carried out on a monthly basis on the basis of the review of the performance standard tests and the monthly aggregated logbooks from all the plants.

Baseline: Non-renewable biomass means fuelwood which is not being re-grown. To check the quantity, the "baseline and the project unsustainable firewood and kerosene consumption survey sheet" (Appendix 2 and 3) will be used. The assumption that all non-renewable biomass fuel combustion will be eliminated will be verified by use of the survey methods. To prove that the baseline firewood consumption is 75.6% non-renewable, Ref [1,2,3, 3a and Appendix 2] is referred to. This estimation is based on latest GIS survey data [Ref 3a]. Our stakeholder consultation process revealed profound dissatisfaction with availability of fuel wood. There is a severe scarcity.

Techniques for data interpretation for monitoring and verifying GHG emission reductions with specific focus on technical/efficiency/performance parameters:

ADATS will maintain the Bagepalli CDM Biogas Programme project activity in such a way as to eliminate variance in terms of GHG reductions between plants. The aim is to establish accurate average values for a) non-renewable biomass fuel combustion in the baseline case and b) eliminate all together non-renewable biomass and kerosene consumption in the project case. This will be done by ensuring correct assessment of needs and management practices prior to installation of plant.
Cows: ADATS will have a system in place to ensure that all cows are well maintained, that cow owners make use of the government veterinary service, that cows are insured so that in case of the death of a cow the biogas plant does not have to be run down, and ADATS will also make sure that if a cow does have to be replaced the new cow is also chosen on the basis of the need for dung for the biogas plant, by giving advice on cows and their qualities and characteristics. ADATS has been doing this already in other villages and will expands this system for the present project activity.

Review, scrutiny and benchmarking against established norms for monitoring and verification – internal audit for GHG compliance:

This refers mainly to service and maintenance norms: it will be ADATS's task to ensure that every plant owner is fully aware of their rights and obligations under this project activity in terms of ensuring 100% functioning of their plant. Intensive user education is the first step, followed by education and training of supervisors, and rigorous checking of follow-up action at the ADATS office office to ensure immediate rectification of faults. A system of rewards for efficiency will be introduced, and owners, supervisors, and office staff will be given incentives to meet the 100% success target. Random checking of operating plants will be a key internal quality assurance measure to ensuring the veracity of the monitoring data, and to ensure that there are no surprises during verification. The CERs will be computed from this value.

All monitoring and control functions will be thus be done as per the internal standards and norms of ADATS. There are no instruments that need calibrating.

The quantity of emission reductions claimed by the project will only be a fraction of the potential from biogas in Kolar District. Hence authentic data related to measurement, recording, monitoring and control of the plants installed under this project activity is essential (though not many other biogas projects are currently running with the exception of the MNES scheme covering 500 or so new users last year).

Leakage:

Appendix B of the Simplified Methodologies for Small-scale CDM Project Activities states in Section A Paragraph 8: In the case of the project activities using biomass, leakage shall be considered.

Leakage may occur from different sources:

Direct emissions related to the biogas system (project emissions)

- Day to day handling: It is possible that a amount of CH_4 will be emitted due to the day to day handling like cooking, loading of cow dung through the inlet or taking out the manure from the compensating tank. But it is assumed that this amount is relatively small compared to the used/ combusted amount of CH_4.
- Emission from the defective digesters: CH_4 emissions may occur in case a system is damaged and the digester has cracks. With the stringent monitoring plan such faults will be recognised and avoided in a early stage and therefore leading to only minor emissions compared to over-all reductions from the project activity.
- Digester clean up: As described in the technical section, some CH_4 will be emitted all 5 years when the digester has to be emptied and cleaned from mud, sand and pebbles.

Indirect emissions avoided related to the biogas system

- There will certainly be some CH_4 and N_2O avoided by removing the cow dung from the ground and putting it into the closed digester, instead of leaving it to decay, (manure management). This is not accounted separately. But the emissions which may be associated with the project activity can be considered to be completely offset by the emissions avoided by the improved manure management with biogas digesters.
- The manure coming from the digester also replaces chemical fertiliser used by some families. Thus some GHG emissions from the energy consumption for the fertiliser production may be avoided.

It is difficult to estimate the exact amount of leakage and direct related emissions resulting from this project activity, and it would be to expensive to perform detailed studies in this context. We assume that all in all there is a certain amount of physical leakage at the sites which may in fact also however be offset by the emissions avoided by the improved dung management (say 10% as per IPCC 4.43). In order to account for this uncertainty, CH_4 and N_2O emission reduction from the combustion of non-renewable biomass in the baseline case, have not been considered. These account for 7.4% of the CO_2 emissions from the combustion of non-renewable biomass fuel. Thus a conservative approach is adopted where only CO_2 reductions are taken in the final baseline number. CH_4 and N_2O are ignored in order to compensate for possible leakage. Only CO_2, emissions from non-renewable biomass combustion and kerosene combustion are considered in the baseline. Leakage is addressed in this way.

D.6. Name of person/entity determining the monitoring methodology:

>>

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Richmond Town,
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+91 99801 99225

SECTION E.: Estimation of GHG emissions by sources:

E.1. Formulae used:

>> Type I. RENEWABLE ENERGY PROJECTS, Category I.C. - Thermal energy for the user

E.1.1 Selected formulae as provided in appendix B:

>>
Type I. RENEWABLE ENERGY PROJECTS, Category I.C. - Thermal energy for the user

Since the project emissions come from a renewable source, the emission reductions are equal to the net baseline emissions, which are calculated as:

Type 1.C.; Para 6.: For renewable energy technologies that displace non-renewable sources of biomass, the simplified baseline is the non-renewable sources of biomass consumption of the technologies times an emission coefficient for the non-renewable sources of biomass displaced. IPCC default values for emission coefficients may be used

And also:

Type 1.C.; Para 5.: 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.

The following formula and values are used to obtain the total yearly emission reduction from the project activity:

$$CER_y = \sum_{n=1}^{5500} (OS_y \times \frac{EM_y}{365} \times number.of.operational.days)$$

where:
CER_y : yearly Certified Emission Reductions
OS_y : 2 m^3 operating system in year y.
EM_y = 3.56 t CO2e = Baseline emissions per household with a 2 m^3 biogas system. Calculated as the average yearly wood consumption times the emission coefficient for (non-renewable) wood, plus average yearly kerosene consumption times the emission coefficient for kerosene. Details see Annex 4.
Number of Operational days = 365 - Non-usage days of installed biogas.

E.1.2 Description of formulae when not provided in appendix B:

>> not applicable

E.1.2.1 Describe the formulae used to estimate anthropogenic emissions by sources of GHGs due to the project activity within the project boundary:

>> not applicable

E.1.2.2 Describe the formulae used to estimate leakage due to the project activity, where required, for the applicable project category in appendix B of the simplified modalities and procedures for small-scale CDM project activities

>> not applicable

E.1.2.3 The sum of E.1.2.1 and E.1.2.2 represents the small-scale project activity emissions:

>> not applicable

E.1.2.4 Describe the formulae used to estimate the anthropogenic emissions by sources of GHGs in the baseline using the baseline methodology for the applicable project category in appendix B of the simplified modalities and procedures for small-scale CDM project activities:

>> not applicable

E.1.2.5 Difference between E.1.2.4 and E.1.2.3 represents the emission reductions due to the project activity during a given period:

>> not applicable

E.2 Table providing values obtained when applying formulae above:

>>

Year	CER
2006	19,553
2007	19,553
2008	19,553
2009	19,553
2010	19,553
2011	19,553
2012	19,553
Total estimated reductions (tonnes of CO_{2e})	**136,874**
Total number of crediting years	7
Annual average over the crediting period of estimated reductions (tonnes of $CO_{2\,e}$)	19,553

SECTION F.: Environmental impacts:

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

>>

not applicable

SECTION G. Stakeholders' comments:

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

>>

ADATS has 15 000 members in 800 villages in Kolar District who have suffered from acute shortage of biomass fuel for combustion over the years. ADATS and WSD carried out a improved cookstove programme to address the issues in a partial manner. SKGS has built 100 000 plants all over South India to address this problem. Interviews with 1000s of families have been conducted over the years by WSD and ADATS and SKGS, including a fuelwood and kerosene consumption survey of 200 households on a random basis to ascertain the interest level in Kolar District. The final list of members who will be building biogas plants in the project activity are provided in Appendix 1 to this PDD.

The project participants are active members of the local community with in depth knowledge of the cooking problems faced in drought prone villages. The stakeholders were consulted in the following way: Families: All 5500 families in Kolar in this programme area experience at first hand the conditions in their own homes. ADATS has 29 years of interaction with members of the local community in Kolar District and have been dealing with the fuelwood crisis for many years. SKGS have conducted numerous camps to educate the public on the benefits of biogas. WSD have participated actively in CDM in order to bring the problem of non-renewable biomass fuel combustion dependence to the attention of the international community. Numerous women and children have been to hospital with respiratory illnesses such as coughs, bronchial illness and other illnesses and weaknesses due to smoke exposure. Hundreds of papers have been published on this problem in India. The Ministry of Non-Conventional Energy representatives attended the DNA meeting during the host country approval process and praised the project participants for their initiative. The Karnataka State Government representatives welcome the project and attended various meetings at which the project proponents presented the project activity idea and the concept. The Kolar District administration welcomes the project and provided letters of support at the time when the Central Government Letter of Approval was being sought. The Taluk level government machinery has extended all support. The Gram Panchayat Secretaries and elected members in the participating villages have extended all support. Thus all levels of the government are actively welcoming this project and extending as much support as they can.

G.2. Summary of the comments received:

>>

The pre-project phase has showed that there is a high interest of the families and that the project is realised as fast as possible. The project participants have been flooded with requests to supply plants. Various NGOs have asked for the project to be run in their areas of operation. Thousands of families have asked for plants to be built in their homes. There is a high level of knowledge of the benefits of these systems, and there is absolutely no hesitation by any of the families participating in the scheme. As the rains are expected to be good this year many families are again expecting their cows to be healthy and give plenty of dung.

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

>>

This project activity itself was launched in response to popular demand for clean and efficient cooking facilities. The project participants have been waiting for the methodologies for Small Scale CDM projects to become available and for the Kyoto Protocol, to come into force for many years. There is an urgent need to approve this project so that it can be replicated in many more Districts and States.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Agricultural Development and Training Society
Street/P.O.Box:	ADATS Campus
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

This is a unilateral CDM project and no Annex 1 country with CER requirements has as yet been identified. The declaration regarding public funding will be made once the official Annex 1 country buyers are identified.

Annex 3

REFERENCES

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3. Ramachandra T.V et al.; Mapping of Fuel Wood Trees in Kolar District Using Remote Sensing Data and GIS, Online: http://wgbis.ces.iisc.ernet.in/energy/paper/fuelwood/fuelwood.html

3a. Inventorying, Mapping and Monitoring of Bio-Resources Using GIS and Remote Sensing (Kolar District), By T.V. Ramachandra and G.R.Rao
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6. IPCC Guidelines for National Greenhouse Gas Inventories - Reference Manual - Volume3, 1996

7. Biogas Technologies, B.T. Nijaguna, New Age International Publishers, New Delhi, 2002

Appendices:

WSD List of Participants – Appendix 1

WSD Fuelwood Survey 2005 – Appendix 2

Annex 4

	Description	Unit	Value	in % of CO2 from wood combustion	Source
Factors and reference values					
	Family wood consumption per year (1)	**kg / year**	**2,850.00**		Ramachandra [3a]
	Calorific value wood	MJ / kg wood	15.00		IPCC 1.45
	CO2 wood IPCC Standard	g / MJ wood	110.00		IPCC 1.45
	CO2 wood IPCC Standard	**g / kg wood**	**1,650.00**		
	CO2 wood India Dataset (average)	g / kg wood	1,479.00		Smith [1,2]
	CH4 wood IPCC Standard	**g / kg wood**	**5.00**		**IPCC / Smith**
	CH4 wood India Dataset MIN	g / kg wood	2.80		Smith [1,2]
	CH4 wood India Dataset MAX	g / kg wood	11.50		Smith [1,2]
	N2O wood IPCC Standard	**g / kg wood**	**0.06**		**IPCC / Smith**
	N2O wood India Dataset MIN	g / kg wood	0.07		Smith [1,2]
	N2O wood India Dataset MAX	g / kg wood	0.20		Smith [1,2]
	CH4 GWP (IPCC)		21.00		IPCC
	N2O GWP (IPCC)		310.00		IPCC
CO2 wood combustion					
	Family wood consumption per year	kg / year	2,850.00		
	Energy production	MJ / year	42,750.00		
	Wood/stove combustion efficiency	optimistic average value	0.20		Smith [1]
	Usable energy	MJ / year	8,550.00		
	CO2 emission per year Gross	t CO2 / year	4.70	100.0%	
	Renewable component 24.4%	t CO2 / year	1.15		Ramachandra [3a]
	CO2 emission per year Net	**t CO2 / year**	**3.56**	75.6%	
CH4 wood combustion					
	Family wood consumption per year (1)	kg / year	2,850.00		
	CH4 emission per year	**kg CO2e / year**	**299.25**	**6.4%**	
N2O wood combustion					
	Family wood consumption per year (1)	kg / year	2,850.00		
	N2O emission per year	**kg CO2e / year**	**53.01**	**1.1%**	
CO2 kerosene combustion					
	Family kerosene consumption reduction / year (1)	l / year	31.20		WSD
	Density of kerosene	kg/l	0.75		
	litres of kerosene	l/year	23.31		
	Net calorific value of kerosene	MJ / kg	44.75		IPCC 1.23
	Carbon emission factor of kerosene	t C / TJ	19.60		IPCC 1.13
	CO2 emission from kerosene per year	**t CO2 / year**	**0.08**	**1.6%**	
CO2 total emissions					
	from wood + kerosene consumption	**t CO2 / year / family**	**3.56**	**75.6%**	
CH4 enteric fermentation					
	Non-dairy cattle (2)	kg CH4 / cow / year	31.00		IPCC 4.33
		kg CO2e / cow / year	651.00	13.8%	
CH4 manure management					
	Average systems / Non-dairy cattle	kg CH4 / cow / year	2.00		IPCC 4.44
		kg CO2e / cow /year	42.00	0.9%	
CH4 potential cow dung (2) & (3)					
	Calorific value CH4	MJ /m3	35.00		[7]
	Density CH4	kg / m3	0.70		[7]
	VS Excretion dry mass / dairy cattle	kg (dry mass) / cow / day	2.64		IPCC 4.41
	VS Excretion dry mass / non-dairy cattle	kg (dry mass) / cow / day	1.59		IPCC 4.41
	CH4 production capacity / VS dairy	m3 / kg	0.13		IPCC 4.41
	CH4 production capacity / VS non-dairy	m3 / kg	0.10		IPCC 4.41
	MIN CH4 production	m3 CH4 / cow / year	58.04		
	MAX CH4 production	m3 CH4 / cow / year	125.27		
	MIN CH4 production	kg CH4 / cow / year	40.62		
	MAX CH4 production	kg CH4 / cow / year	87.69		
	MIN CO2e production	kg CO2e / cow / year	853.11	18.1%	
	MAX CO2e production	kg CO2e / cow / year	1,841.44	39.2%	
	MIN CH4 energy	MJ / year	1,421.86		
	MAX CH4 energy	MJ / year	3,069.07		
IPCC:	IPCC, Reference Manual, Vol. 3; 1996 (Section)				
(1):	Family = 5 persons				
(2):	Dataset for Indian Subcontinent				
(3):	VS = Volatile solids = degradable organic material				