The Gold Standard
Premium quality carbon credits

THE GOLD STANDARD

Project Design Document for small-scale CDM projects

(GS-SSC-PDD)

NOTE This title page shall *not* be submitted to the validator and the CDM EB, as the template of the PDD shall not be altered outside the grey boxes. Text inside the grey boxes shall be deleted or overwritten by the project participant prior to submission for validation.

Explanatory information on how to complete the PDD and how to obtain Gold Standard registration can be found in the project developer manual, section 3.1 and 3.5, available on the Gold Standard website.

For more information, please contact The Gold Standard:

http://www.cdmgoldstandard.org
info@cdmgoldstandard.org
phone +41 61 283 09 16
fax +41 61 271 10 10

April 2006

Developed by Ecofys for The Gold Standard

This GS-PDD and the Gold Standard Project Developer's Manual are available through http://www.cdmgoldstandard.org. The original PDD can be obtained electronically through the UNFCCC website http://cdm.unfccc.int/Reference/Documents, by email (cdm-info@unfccc.int) or in print from the UNFCCC secretariat (Fax: +49-228-815-1999).

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:

Title: Bagepalli CDM Biogas Programme
Version: 1
Date: 25/02/2008

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

The purpose of the project activity is to set up 5,500 biogas plants (digesters) of 2 m^3 capacity each for single households. Each household will utilize 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 household surveys, 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. The 75.6% of biomass in Kolar District is non-renewable, which means that 75.6 % of the fuelwood cannot be considered a renewable source of energy, and by burning this firewood the users were causing the emission of greenhouse gases. The fuelwood replaced with the renewable biogas, the users avoid the greenhouse gas emissions in the baseline case. Each family also replaces 31.2 liters of kerosene annually which is used as supplementary cooking fuel everyday.

The project is being 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 wished to switch from firewood to biogas was established before PDD submission through extensive stakeholder consultation. Implementation of the project was only after the successful validation and registration of the project as a CDM project since the project is financed exclusively from carbon revenues. The project was registered and forward CERs of 1.1 million Euros from VELCAN ENERGY (project participant from Annex I country) financed the project.

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 and the drudgery of collecting fuelwood.
e) Creating employment to the local communities

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD

Additionality Screen: Gold standard projects must result in technology transfer and or/knowledge innovation.

Deenabandhu model was developed by Action for Food Production (AFPRO), a voluntary organization based in Delhi[1], the capital of India. The project was implemented in the rural areas of Kolar. The local 128 masons were trained by ADATS. The original Deenabandhu biogas model was introduced by the Block Development Offices in these Taluks. About 50 fixed doom biogas units were built, though not a single unit is functional.

There as been knowledge innovation in the design of the Deenbandhu biogas plant under the CDM project. Every single aspect of the Deenabandhu Model was modified and new measurements have been followed. These include the depth of the saucer shaped base, the diameter of the dome, and also the inlet and outflow tanks. More importantly, there was emphasis on quality and cost cutting was not done. The biogas stove used are stainless steel ones, on par with what you is used of LPG gas. The LPG burner has been designed to suit biogas flow. The gas pipes to flow gas from the digester to the houses are metal reinforced and guaranteed. Burnt bricks instead of half baked bricks from local kilns, proper size of stone jelly for concreting and 10 bags of cement per unit were used to construct good quality biogas plants. To prevent untoward incidences, a steel mesh has been designed to fit the outlet tank, which was not part of the original design. This prevents any one stepping on the displacement chamber, especially children from drowning in the slurry, while the biogas unit is being filled with dung or chamber is open for cleaning. Thus there has been innovation in the biogas plant that has been built compared to the original Deenabandhu model. These innovations ensure better efficiency and longer operational years for the biogas units.

Maintenance of the biogas units has been given high priority in the project to sustainably achieve emission reductions. Upfront CER amount of approximately Rs. 2,500 per unit, totalling to Rs. 13.75 million has been placed in a long term Fixed Deposit to generate Rs 1.17 million each year. This amount is used to maintain the 5,500 units and keep them in good condition – a vital prerequisite for Coolie women to achieve emission reductions and continue enjoying smoke-free cooking.

SUSTAINABLE DEVELOPMENT SCREEN

In order for the project to be eligible for the Gold Standard, the project activity must be assessed against a matrix of sustainable development indicators. The list of indicators and the methodology as provided in Section 3.4 of the Gold Standard Project Developer's Manual have been used for assessing the project activity against these indicators as follows:

1. LOCAL/REGIONAL/GLOBAL ENVIRONMENT

1a: **Water quality and quantity**

The project activity has led to improvement in water quality. The most common pollutant in water is organic matter from human and animal waste, which increases suspended solid particles and BOD and COD of water. By converting to slurry, the large number of bacteria such as pathogenic and salmonella types (which causes typoid in humans and salmonellosis in poultry and cattle) and Brucella which causes brucellosis are destroyed[2].

There has been a decrease in the quantity of water used for washing vessels after implementation of Biogas CDM Project. The vessels are not covered with soot unlike in the baseline when fuel wood was used for cooking purposes, requiring more water to scrub and clear the vessels.

---

[1] http://www.afpro.org/Innovations.htm; Nijaguna 2002.

[2] Nijaguna, B.T (2002). Chapter 7: Utilization systems of Biogas. In: Biogas Technology. New Age International Publishers, New Delhi.

Thus the project activity has positive impacts, attaining a score of +2.

1b: Air quality (emissions other than GHGs)

Biogas being a clean fuel does not cause air pollution. It has eliminated indoor air pollution and the air quality under project scenario is very good. It has been estimated that the cooking from the unprocessed soil fuels release at least 50 times more noxious pollutants than gas. The incomplete combustion of biomass releases complex mixture of organic compounds, which include suspended particulate matter, carbon monoxide, poly organic material, poly aromatic hydrocarbons, formaldehyde, sulphur, trace metals etc. These cause many health hazards such as respiratory infections, eye infections, otitis media, chronic obstructive pulmonary diseases, lung cancer, pulmonary tuberculosis, cataract and also adverse pregnancy outcome[3]. There are several publications by Smith, K.R. which highlights the ill-health caused by biomass burning[4]. The impacts can best be summarized by a study conducted by WHO and Smith *et al*, 2004 which shows that indoor smoke from solid fuels is the third health risk factor among Indians[5].

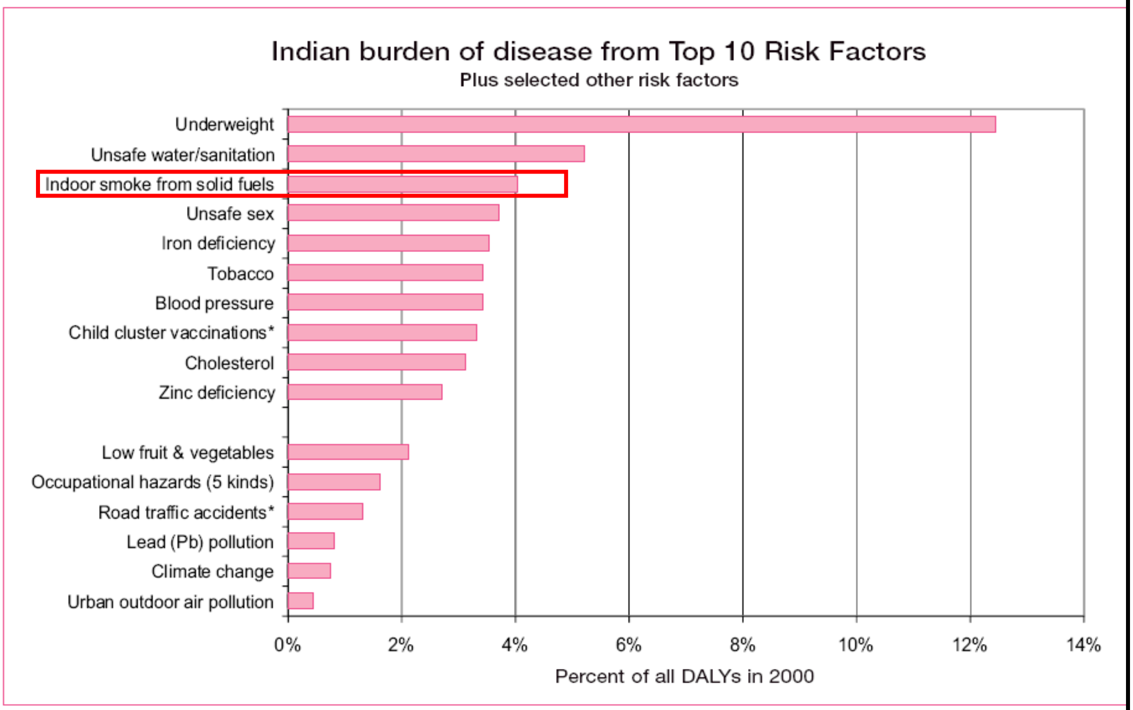


Figure 7. Indian burden of disease from major risk factors: Data from (WHO 2001; WHO 2002; Smith, Mehta et al. 2004)
** Denotes disease-based risk.*

Based on the survey of the stakeholders, most common ailments were eye inflammation, lung infections, coughs, headaches, skin problems etc. Many older women have impaired eye sight and lung problems

[3] ICMR. (2001). Indoor air pollution in India – A major environmental and public health concern. ICMR Bulletin.
[4] See website http://ehs.shp.berkeley.edu/krsmith/page.asp?id=1 for publications on impacts of biomass burning in traditional stoves on indoor pollution and health.
[5]WHO (2001). World Health Report. Geneva, World Health Organization; World Health Organization (2002). World Health Report: Reducing Risks, Promoting Healthy Life. Geneva, World Health Organization.
Smith, K. R., S. Mehta, et al. (2004). Indoor Smoke from Household Solid Fuels. Comparative Quantification of Health Risks: Global and Regional Burden of Disease due to Selected Major Risk Factors. M. Ezzati, A. D., Rodgers, A. D., Lopez and C. J. L. Murray. Geneva, World Health Organization. 2: 1437-1495.

due to constant exposure to smoke and fumes from traditional stoves. A study conducted by TERI, India also showed that traditional stoves led to eye inflammation (41% of users), headache (25%), cough (23%), and skin problems (11%)[6].

Biogas is considered a better fuel than even natural gas and liquefied petroleum gas because it does not contain Sulphur. Sulphur on burning gets converted to sulphur dioxide which is responsible for many lung diseases. Also the danger of explosion is less as it contains carbon dioxide which acts as a fire extinguisher[8].

Additionally, odours are controlled since all the gas is burned prior to release into the atmosphere. Pathogens and weed seeds are destroyed. Coliform bacteria, other pathogens, insect eggs and internal parasites also are destroyed or reduced to acceptable levels by anaerobic treatment. The enclosed anaerobic digestion systems for biogas production are not subject to pronounced influences of the weather, making effluents from digesters more stable and uniform. The potential for non point source pollution resulting from heavy rainfall is lessened since the influent to the holding pond will have undergone complete digestion[7].

Thus the project activity has major positive impacts, attaining a score of +2.

1c: Other pollutants

Reduction of pathogens in slurry: The slurry has lesser number of pathogens compared to dung. Most of the disease-causing organisms are killed. This serves as an effective control of parasitic diseases, hookworm, roundworm, etc[8]. There is four-fold log reduction of daily dose of the pathogens after digestion. Chitra and Ramasamy[9] observed that enteric pathogens were eliminated after two weeks of digestion. This was also proved through experiments conducted by researchers. Gadre *et al*[10] reported that the pathogenic *Salmonella* sp. introduced to the cattle dung-fed digester at the start of the digestion process was eliminated in nine days of digestion. Kunte *et al*[11] also reported that *Salmonella typhi* added to cattle dung-fed digesters as single dose at the start of the digestion was completely eliminated after 12 days of digestion. Mosquitoes and flies do not breed in digested slurry. Thus Biogas Units improve sanitation[8].

These pathogens can get dispersed into soil, water and air, impacting animal and human health, especially children. Dung spread in the land is a serious danger of infection to animals which graze in the field[2]. If the period between application and resumption of grazing is insufficient, the danger of infection increases. A period of one month is said to be necessary to avoid infection.

Thus the project activity has major positive impacts, attaining a score of +2.

1d: Soil condition

Increase in crop productivity: The slurry manure is considered far more superior to farm yard manure in respect of NPK contents. It reduces the use of chemical fertilizers to a great extent. It increases crop production because of higher nutritional value compared to traditional manure. Also wet dung is prone to frequent plant diseases. An evaluation study of biogas conducted by the Government of India showed

---

[6] Improved cookstoves programme in North India. TERI Report. http://teriin.org/case_inside.php?=17062#PC92
[7] Engler *et al*. http://tammi.tamu.edu/Engler2.pdf

[8] Benefits of Biogas, Chapter 2. By Bheeshma Raju, KSCST.
[9] Chitra, V. and Ramasamy, K., *Energy Biomass Wastes*, 1992, 26, 14–21.
[10] Gadre, R. V., Ranade, D. R., Godbole, S. H., *J. Appl. Bacteriol*., 1986, 60, 93–96.
[11] Kunte, D. P., Yeole, T. Y., Chiplonkar, S. A. and Ranade, D. R., *J. Appl. Microbiol.*, 1998, 84, 138–142.

that over 70% households perceived the improvement in the crop production as a result of application of slurry manure in the field.[12]. The C and N of slurry on application to soil are immediately mineralized with increasing incubation period. The application of slurry improves the physical, chemical, and biological characters of the soil[13]. Balasubramanian and Kasturi Bai[14] evaluated nutrient status of slurry and observed that the total Kjeldahl nitrogen and total K were recovered after biogas production and ammonia N showed a 70% increase compared to the influent. A significant correlation was observed between solids and N, P, and K after anaerobic digestion. Balasubramanian and Kasturi Bai[15] also reported increase of biomass production after application of biogas slurry.

Gnanamani and Kasturi Bai[16] also observed that the addition of 40 t/ha slurry together with recommended dose of NPK, increased the grain yield by 80.5 per cent over control, and the cultivation of black gram in the same plot also showed an increase in the yield of gram. Gnanamani and Kasturi Bai[17] applied the slurry @ 20 and 40 t/ha along with inorganic fertilizer supplements for rice-black gram-rice cultivation. They reported that with 40 t/ha slurry together with recommended doses of NPK, the yield of second and third crops was comparable to conventional cultivation without requiring addition of fertilizers.

The Government of India study showed that saving in the cost of chemical fertilizers when replaced by use of slurry manure in the field, is Rs. 185 per month calculated on the basis of Rs. 30 per quintal for 74 quintals of manure produced in a plant per year[12].

Improvement in soil fertilization: A unique feature of biogas technology is that it simultaneously reduces the need for firewood, reducing forest degradation and degradation. This leads to improved soil fertilization, thus substantially reducing the threat of soil erosion in forest areas. Firewood consumption in rural households is one of the major factors contributing to deforestation in developing countries. Most firewood is acquired by cutting off individual branches and also obtained by way of illegal felling. According to the ICAR paper (report issued by the Indian Council of Agricultural Research, New Delhi), a single biogas system with a volume of 2.8 m^3 can save as much as 0.12 ha woodland each year[18] thus avoiding soil erosion and increasing soil fertilization.

Reduction of soil erosion: The humic matter and humic acids present in the slurry contribute to a more rapid humification, which in turn helps reduce the rate of erosion (due to rain and dry scatter) while increasing the nutrient supply, hygroscopicity, etc. The humic content is especially important in low-humus tropical soils. The relatively high proportion of stable organic building blocks such as lignin and certain cellulose compounds contributes to an unusually high formation rate of stable humus. The amount of stable humus formed with digested sludge amounts to twice the amount that can be achieved with decayed dung. It has also been shown that earthworm activity is stimulated more by fertilizing with slurry than with barnyard dung. Digested slurry decelerated the irreversible bonding of soil nutrients with the aid of its ion-exchanger contents in combination with the formation of organo-mineral compounds. At the same time, the buffering capacity of the soil increases, and temperature fluctuations are better compensated[18].

---

[12] Evaluation Study On National Project on Biogas Development, Programme Evaluation Organisation Planning Commission, Government of India, New Delhi, May, 2002

[13] Nagamani and Ramasamy. Biogas production technology: An Indian perspective. http://www.ias.ac.in/currsci/jul10/articles13.htm

[14] Balasubramanian, P. R. and Kasturi Bai, R., *Biomass Bioenergy*, 1992, 3, 377–380.

[15] Balasubramanian, P. R. and Kasturi Bai, R., *Pollut. Res.*, 1992, 11, 1–11.

[16] Gnanamani, A. and Kasturi Bai, R., *Biores Technol.*, 1992, 41, 217–221.

[17] Gnanamani, A. and Kasturi Bai, R., *Int. J. Tropical Agric.*, 1994, 12, 25–32.

[18] Biogas Digest: Volume I. Biogas Basics Information and Advisory Service on Appropriate Technology. ISAT and GTZ. http://www.gtz.de/de/dokumente/en-biogas-volume1.pdf

Reduction of nitrogen washout: The elevated ammonium content of digested slurry helps reduce the rate of nitrogen washout as compared to fertilizers containing substantial amounts of more water-soluble nitrates and nitrites (dung, compost). Soil nitrogen in nitrate or nitrite form is also subject to higher denifrication losses than is ammonium, which first requires nitrification in order to assume a denitrificable form. Ammonium constitutes the more valuable form of nitrogen for plant nutrition. The N-efficiency of digested slurry may be regarded as comparable to that of chemical fertilizers. In addition to supplying nutrients, slurry also improves soil quality by providing organic mass. The porosity, pore-size distribution and stability of soil aggregates are becoming increasingly important as standards of evaluation in soil-quality analyses[18].

Thus the project activity has major positive impacts, attaining a score of +2.

1e: Biodiversity (species and habitat conservation)

Fuel wood collection and consumption are intricately linked to natural resource management. Demand for fuel wood from commons and forests cause resource degradation on one hand and leads to a situation of fuel wood scarcity. In addition there are a number of other adverse consequences of forest degradation, including loss of biodiversity, deterioration of watershed management functions, soil erosion in addition to release of greenhouse gas emissions. This has been evidenced by rigorous empirical studies done on the determinants of fuel wood demand the interaction between fuel wood collection and forest degradation in developing countries[19]. Substitution by alternative sources of rural domestic energy such as biogas reduces pressure on natural forests and common property resources, in turn arresting degradation of forests and deforestation, leading to a positive impact on biodiversity and habitat conservation. This also leads to regeneration of not only trees, but also native shrubs and herbs.

Many of the natural resource management and biodiversity conservation programmes are integrated with the implementation of alternative energy sources, of which biogas is most effective. According to the ICAR paper (report issued by the Indian Council of Agricultural Research, New Delhi), a single biogas system with a volume of 2.8 m^3 can save as much as 0.12 ha woodland each year[18]. The stakeholder consultation has also show that the communities are no more dependants on forests and common property resources for fuel wood.

Thus the project activity has major positive impacts, attaining a score of +2.

2. SOCIAL SUSTAINABILITY AND DEVELOPMENT

2a: Employment (including job quality, fulfillment of labour standards)

Job quality: The Biogas CDM Project has created job opportunities to the local communities. ADATS trained 123 local masons, who were made responsible for each of the Biogas Unit built. Extensive personal information was collected on each biogas mason and entered into the computerized database. These provide irrefutable identification and responsibility for each Biogas Unit fixed to a particular mason. They were evaluated regularly for the quality of work. The emphasis of the project has been on building quality Biogas Units and rather than cost-cutting. The biogas stoves used are stainless steel ones, on par with that used of LPG gas in urban areas. The burner has been replaced to suit biogas flow. The gas pipes connected from the digester to the stoves are metal reinforced and guaranteed. Burnt bricks instead of half baked ones from local kilns, proper size of stone jelly for concreting, 10 bags of cement, etc. were used to maintain quality. To prevent untoward incidences, the outlet tank has been provided with a steel mesh, which was not part of the original design. Thus job quality has been of high standards

[19] Heltberg et al., 2000. Fuel wood consumption and forest degradation: A household model for domestic energy substitution in Rural India. Land Economics, Vol 76, No.2, pp 213-232.

compared to the original Deenabandhu model. The units are being maintained with dedicated funds (unlike many other schemes).

No "labourers" are used in the construction of Biogas Units. The participating family (End Users) themselves work with the Biogas Masons to excavate the pits, mix cement, hand over bricks, etc. Moreover, the Biogas Masons are from the local community. They are treated with respect and affection. During the 2-4 days they take to complete each unit, they eat and sleep in the houses of the participating family.

The project has created a dignified and non-alienating employment with a high sense of ownership. Biogas Masons are proud to be identified with the physical as well and socio-economic results of their work. ADATS refer these masons to other Biogas CDM Projects, thus sustaining the expertise that local masons have acquired during this project.

Thus the project activity has major positive impacts, attaining a score of +2.

2b: Livelihood of the poor (including poverty alleviation, distributional equity, and access to essential services)

Monetary savings: The use of the Biogas Unit has helped the households in three ways. Firstly, in case of households where cooking fuel was being purchased prior to installation of Biogas Unit, the use of Biogas Unit has eliminated the quantity of purchased fuel. Of course this benefit of "replacement of purchased fuel wood" has been for few households, as primarily, in rural areas, biomass fuels are collected from forest areas and common lands. But replacement of kerosene has been in 100% of the households. A study done by TERI also showed the same results. Secondly, cash savings also accrue when commercial fertilizer is replaced by biogas slurry. Thirdly, the use of slurry brings about an increase in the yield of crops and a higher income for the farmer.

Improvement in the quality of life: The human effort involved in gathering fuel wood is a cause of drudgery for women and children who travel long distances in search of fuel wood. It has been estimated that at the national level, the average number of hours spent in gathering biomass is about two hours per day per household (Ravindranath and Hall, 1995)[20]. This has been avoided with the Biogas CDM Project.

The use of biogas as a cooking fuel brings an improvement in the overall quality of life in many ways for the user families and for women in particular. The benefits are in terms of time saved in fuel procurement and cooking, improved kitchens and convenience, and reduction of drudgery of transporting fuel wood to the homesteads, processing them (cutting them into smaller pieces to be used in the cook stoves) and storing them for later use. These benefits mean more to women as they have traditionally been responsible for the procurement, processing and use for cooking fuel for their families. Since the work time has reduced considerably, this time is utilized to earn livelihood or to look after children. Women are able to have more time for agricultural activities earning more wages. There is more time for leisure at homes and cooking and eating together has become a greater social pleasure, as the home is smoke-free. A major impact of the Biogas CDM Project has been prompt attendance of children to school. The women are able to cook and serve breakfast to the children in time to attend school. In the baseline, children very often missed school.

The national level evaluation study showed the following benefits of biogas as perceived by the users[12].

[20] Ravindranath, N.H and Hall, 1995. Biomass, Energy and Environment: A developing country perspective from India. 376 pp. New York: Oxford University Press.

Benefit of biogas	Percent of households
Provides clean fuel for cooking	96
Cleanliness of environment	73
Improvement in the health of ladies	50
Saving in manure cost	74
Employment generation	8
Saving in cooking time	79
Saving in traditional fuel	60
Other benefits	3

Carbon revenue: Annual income from the sale of 19,800 CERs will, for the few years, go to meet the construction cost of the 5,500 Biogas Units and the carbon investor will recover his initial investment. After that, CER revenues are a pure income that will be shared by both, the Carbon Investor as well as 5,500 rural women[21].

Thus the project activity has major positive impacts, attaining a score of +2.

2c: Access to energy services

Women have better and clearer access to energy for cooking and heating water. Fossil fuels (kerosene) and non-renewable wood is being replaced by biogas which is a clean, healthy and is easy access to energy. At the turn of a knob, they have access to energy for cooking. While in the baseline they faced hardship to collect fuel wood and also get kerosene once a month through the public distribution system. The cascading affects of the easy access to energy are those elaborated in the various sections.

Thus the project activity has major positive impacts, attaining a score of +2.

2d: Human and institutional capacity (including empowerment, education, involvement, gender)

The Biogas CDM Project has been implemented by ADATS, the NGO, for the village level Coolie Sangha Units (CSUs). ADATS is working in this region for the past 30 years. It is staffed by 17 Area teams, each comprising 3 staff members who are longstanding workers, many of them with 15-20 years tenure in the organization. Together, they have an intimate knowledge of each and every Member Coolie family. They maintain a congenial atmosphere that is so vital for the implementation of the project.

A CSU is a group of 30-35 small and poor peasant families (out of a total population of 70 to 100 households) that organize themselves. These village associations are the primary units of the grassroots organization, the Coolie Sangha. The Coolie Sangha is a highly structured, disciplined and self-financed membership driven organization which, though created by ADATS, now enters into a formal working relationship with ADATS to undertake various development activities. 38,344 small and poor peasant families from 913 villages have formed Coolie Sangha Units. 19,118 Coolies families from 529 village CSUs are presently active. 40% of the population of villages with CSUs is in the Coolie Sangha. A range of comprehensive rural development projects, programmes and activities are together taken up. These include Community Organization, Adult Literacy, Children's Education, Youth Development, Community & Referral Health, support to issues and struggles with Legal Aid & Aid Distress, Dry Land Development, Agriculture, alternate Credit, Women's Programmes, etc. Together, they also work on issues of gender justice, secularism and democratisation. All these are efforts to empower the Coolie caste-class in village society, and build an authentic people's organization, the Coolie Sangha, at the Village, Cluster and Taluk levels. Please see http://www.adats.com/cs/ for more information.

[21] http://www.adats.com/cdm/cdm.php

Community empowerment and involvement: The Biogas CDM Project involves implementation of the technology, maintenance and monitoring emission reduction. All the tasks and activities are carried out in 16 designated Areas[22] comprising of 341 villages. Each Area Team consists of a Field Worker, Case Worker and Mahila Trainers of ADATS (The organization chart of ADATS can be seen at http://www.adats.com/misc/Organogram.pdf). Each Area Team is "in-charge" of the processes in their respective villages. The Area Team transfers as much as this charge to the village level cadre of the Coolie Sangha – i.e. elected Cluster Secretaries, elected Representatives, Village Health Workers and Balakendra Teachers[23]. Such a "transfer of ownership" is markedly visible in the actual selection of participating families and assisting individual families in the actual construction activities. Village level Coolie Sangha Units (CSUs), and especially the Mahila Meetings, play a vital role in selecting appropriate sites for the actual construction and pitch in with manual labour to help dig pits. This had led to a second "transfer of ownership". Village CSUs, in turn, made the participating families the true owners of all the processes affecting the final output. Similarly, it is family labour that voluntarily assisted the skilled masons during actual construction.

Education: Meetings were conducted at every village and Taluk level by ADATS staff to educate the communities about the project. In the CSU and Mahila Meetings, since the conception of the project, they have been briefed about the progress of the project. In the Mahila Meetings, the women have also been trained to effectively use biogas for cooking. Training in chemistry of biogas for masons and users have led to improved scientific temper in community. ADATS trained 123 local Masons in the tried and tested construction techniques of Biogas Units.

Institutional capacity: All activity processes, including financial transactions for construction of Biogas Units, were digitally monitored using an online intranet solution that is integrated into ADATS' intranet – the monitoring system that tracks various Coolie Sangha building/running activities for the past 23 years. Open and transparent online reports are used by everyone – ADATS Staff, Coolie Sangha functionaries and all other secondary stakeholders to know exactly where they stand in terms of progress and results. Reports are generated at all levels i.e. Super (overall), Taluk, Area, Cluster, Village and individual Family level. Efficiency was constantly checked (and Area-wise comparisons were made) to determine which processes were lagging, where, and for what reasons. The database is updated on an every day basis, as and when Field Staff return from their respective villages. The monitoring of various processes during pre-commission and commission of Biogas Units involved the following:

1. Selection of participating families
2. Defining Masons
3. Defining Material Suppliers
4. Monitoring Construction Progress
    - Marking
    - Excavation
    - Supplying crushed stone Jelly
    - Supplying Sand
    - Supplying Bricks
    - Supplying Cement
    - Supplying Hardware
    - Concreting
    - Brick work
    - Plastering

[22] An Area comprises of a group of about 30 villages being overlooked by the Area Team

[23] CSU appointed Teachers working at each village to impart supplementary education to school going children.

- Filling Gobar
- Supplying Stove
- Fixing Pipe & Stove
- Fixing Safety Grill

5. Commissioning
6. Generating End User Agreements

These processes were monitored on a day to day basis and database maintained from its initiation to completion dates for each of the Biogas Unit. Quality Control Supervisors comprising of the Audit Team and Case Workers of ADATS are the key persons to conduct the overall supervision of installed plants. They check the quality of installed Biogas Units and ensure that the required materials are used for the construction of Biogas Units. Very nearly all payments for construction of Biogas Units were made by cheque and suppliers are irrefutably identified with personal data and digital photographs fed into the computerized databank of ADATS.

Statutory reports, including Trial Balance, Receipts & Payments statement, Income & Expenditure statement and Balance Sheet, are also generated. The books of accounts are audited by a certified Chartered Accountant once every 6 months. This financial accounting system gives proof of the construction of these Biogas Units under the CDM Project activity. Each of the Biogas Unit has been marked as "ADATS-VELCAN" and the date of construction on the doom, which makes it distinct. These evidences validate the construction of the 5,500 Biogas Units built in the project area.

Community involvement in monitoring: As per the registered PDD, the number of operational Biogas Units and the average operating hours need to be monitored twice a year. A user friendly survey sheet for each of the biogas user is maintained at the village level by the Village Health Worker[24]. Day-to-day monitoring of the operational units is being done. The information on the daily operational time is gathered by the Village Health Worker from its users on a day to day basis or during the weekly Mahila Meetings[25] held in every village. The information is updated to the individual biogas user's on-line data base maintained by ADATS by the Case Worker on monthly basis. This information is used to compute the annual emission reductions achieved by the project.

Gender: The main beneficiaries of the Biogas CDM Project have been the women. They have been involved from the selection of the households, implementation of the project and now are involved in monitoring of the Biogas Units. The women have benefited from the clear and smokeless energy for cooking, which has had a positive impact on the health and environment of the house. They are relieved of the drudgery and time spent to collect fuel wood. They have more time to take up other vocation and earn a better livelihood. They are able to spend quality time with their families at home.

ADATS and the Coolie Sangha believe in total and exception-less transparency in all matters, including personal finances. ADATS does not take up any project or programme on its own, unless and until it has come from the bottom-up, through extensive grassroots discussions. At every stage of the project, the communities are totally involved.

Thus the project activity has major positive impacts, attaining a score of +2.

3. ECONOMIC AND TECHNOLOGICAL DEVELOPMENT

---

[24] A Village Health Worker is appointed by each village CSU to take care of preventive and reproductive health issues

[25] These Mahila Meetings have been held regularly since many years to discuss all issues of Coolie Sangha

3a: Employment

Construction of Biogas Units has created good employment opportunities in rural areas. It has provided regular means of livelihood to a large number of entrepreneurs and turnkey operators and has provided employment to masons and daily-wage labourers. 123 masons have been trained under the CDM Project. Some of these masons are operating as independent turnkey operators now and are building the improved Deenabhadu model for other rural development projects.

In the project area, the CDM Project has generated employment. This includes
- 16,500-22,000 person-days of masonry work
- 44,000 person-days of daily wage labour to excavate the pits and assist the masons
- incalculable person-days of work for the supporting staff!

Technological development at the taluk and village level has been enormous. Implementation of 5,500 Biogas Units in a span of 2 years has not taken place in these taluks so far. Though a few Biogas Units were built in these taluks by the government, now of them are functional. Implementation was not followed up by capacity building of the communities for repairs and maintenance. Also, there are no dedicated staffs to overlook the project. In the CDM Project, there is continuous monitoring of these Biogas Units. If any Biogas Unit is faulty or not functional, the report on the problems is passed on by the Audit Team to the Area Team. The Treasurer of the Coolie Sangha has been entrusted with the task of audit. The unit is immediately repaired and made operational.

Thus the project activity has major positive impact, attaining a score of +2.

3b: Balance of payments (sustainability)

Implementation of Biogas CDM Project has reduced the consumption of kerosene for cooking. In the baseline, each household was using 31.2 litres of kerosene/year. The total consumption of kerosene by 5,500 households in the baseline was 11,388 litres. Due to implementation of Biogas CDM Project, it has reduced the usage of 11,388 litres of imported kerosene/yr, which will account to 227,760 litres of kerosene for a period of 20 years – the operational lifetime of the Biogas Units.

India depends on exported crude oil. Kerosene imports nearly doubled to 6,65,000 tonnes in the first seven months of 2003-04 as opposed to 3,96,000 tonnes in the previous year[26]. Currently, India's crude oil import bill has jumped 29.5% to $48.027 billion in first nine months of 2007 fiscal on increased volume of imports. From April-December 2007, India imported 19,78,000 tonnes of kerosene for Rs 6,445 crore ($1.603 billion)[27]. The project may not make considerable impact the balance of payments at the national level, but at the village level has decreased the usage of kerosene for cooking, which is an imported commodity. The project provides savings to the national economy by providing renewable cooking fuel instead of kerosene or LPG which has to be imported at great cost as fuel wood is scarce and no longer socially acceptable.

Thus the project activity has a minor positive impact, attaining a score of +1.

3c: Technological self reliance (including project replicability, hard currency liability, skills development, institutional capacity, technology transfer)

The project is implemented, executed and monitored by ADATS and CSUs in a transparent way. All the processes, monetary transactions and monitoring are documented, which is accessible to anyone. The

[26] http://www.assocham.org/prels/shownews.php?id=646
[27] http://www.livemint.com/2008/02/19163306/Crude-oil-import-bill-jumps-ov.html

project can be replicated very conveniently, if the NGO has the same institutional capacity as ADATS. In fact, the project is being replicated in other parts of the district.

The project proponents are totally self reliant for implementation of the project in terms of technology, institutional capacity and monitoring. Thus all the processes are done in-house and the required skills and institutional capacity is available with the project proponents.

Thus the project activity has major positive impacts, attaining a score of +2.

The summary of scores for each of the component described above is as follows:

Component • Indicators	Score (-2 to 2)
Local/regional/global environment	
• Water quality and quantity	+2
• Air quality (emissions other than GHGs)	+2
• Other pollutants	+2
• Soil condition	+2
• Biodiversity (species and habitat conservation)	+2
Sub total	**+10**
Social sustainability and development;	
• Employment (including job quality, fulfillment of labour standards	+2
• Livelihood of the poor (including poverty alleviation, distributional equity, and access to essential services)	+2
• Access to energy services	+2
• Human and institutional capacity (including empowerment, education, involvement, gender)	+2
Sub total	**+8**
Economic and technological development	
• Employment	+2
• Balance of payments (sustainability)	+1
• Technological self reliance (including project replicability, hard currency liability, skills development, institutional capacity, technology transfer)	+2
Sub total	**+5**
Total	**+23**

Thus the project activity attains a total score of 23/24.

EIA REQUIREMENTS

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.

The EB also does not specify an EIA for the project activity.

Based on the Sustainable Development Assessment Matrix none of the indicators have scored -1. Also based on initial stakeholders consultation there was no negative impacts of the project activity.

Thus an EIA is not necessary.

PUBLIC CONSULTATION PROCEDURES

Consultation of local stakeholders in the design phase (Initial Stakeholder Consultation):

ADATS has been working with the CSUs since 30 years. Each and every case worker of ADATS knows each and every household and CSU members. The implementation of CDM biogas project has been the result of several years of rapport with the CSU members. They are aware of the severe shortage of fuelwood in the region and the hardship faced by them. The communities always wanted to have good energy option for cooking. LPG is very expensive for the Coolie Sangha Members and was not very easily accessible. Thus it can be stated that it is the coolie sangha's aspiration for biogas plants, which has been realized through the CDM project. ADATS has been the facilitating NGO to realize their desire with carbon financing.

As mentioned in the above section, all the tasks and activities carried out in 16 designated Areas comprising of 341 villages have transferred as much as this charge to the village level cadre of the Coolie Sangha, resulting in transfer of ownership in the actual selection of participating families. Village level and Cluster level meetings were organized with the stakeholders during the design phase. The minutes of the meetings have the details of the decisions taken by the stakeholders at the village and cluster level.

Village level Coolie Sangha Units (CSUs), and especially the Mahila Meetings, played a vital role in selecting appropriate sites for the actual construction and pitch in with manual labour to help dig pits. Village CSUs, in turn, made the participating families the true owners of all the processes affecting the final output. Similarly, it is family labour that voluntarily assisted the skilled Masons during actual construction. The women were taught efficient ways of cooking in the Mahila Meetings. A list of suitable and interested households who wish to switch from firewood to biogas was established as follows.

Taluk	Participating Families	Number of Villages
Bagepalli	2,645	130
Chickaballapur	6,49	48
Chintamani	1,006	78
Siddalaghatta	843	58
Gudibanda	383	27
Total	**5,526**	**341**

In addition, emphasis was also given to households that have livestock or could ensure sufficient quantity of dung availability on a daily basis as influent for biogas plant. Only families willing to voluntarily participate in the project were included. A database was first prepared of all the willing families, with details of the family, membership status, livestock holding, land holding, etc.

Consultation of (local) stakeholders on the PDD (Main Stakeholder Consultation)

a. The main consultation was done through publication of the PDD on the UNFCCC website for 30 days. There were no comments from local or global stakeholders.
b. Local NGOs, WSD and SKGS were involved in the initial stakeholders' consultation as highlighted in the PDD.
c. The local policy makers were consulted during the stakeholders meeting. All the local stakeholders i.e. Ministry of Non-Conventional Energy representatives that attended the DNA meeting during the host country approval process praised the project participants for their initiative.
d. The Karnataka State Government representatives welcomed the project and attended various meetings at which the project proponents presented the project activity idea and the concept.

e. The Kolar District administration welcomed the project and provided letters of support.
f. The Taluk level government machinery extended all support.
g. The Gram Panchayat Secretaries and elected members in the participating villages have extended all support.

Thus all levels of the government actively welcomed this project and extended support.

h. The locally active Gold Standard supporter NGO, Winrock International India, 788, Udyog Vihar, Phase V, Gurgaon – 122001, India was invited to provide their input on the CDM project. Their input on the project has been included.
i. The project has won the world clean energy award for 2007.

Bagepalli Biogas CDM Project won the World Clean Energy Award[28] among 72 nominee projects

The Bagepalli Biogas Project won the **World Clean Energy Award - Jury Special Award 2007** for its innovative financing solutions using Clean Development Mechanism. The World Clean Energy Awards recognizes achievement and innovation in renewable energy and the integrated use of energy efficiency. The Nominating Institutions and the Jury for the Awards comprise internationally renowned institutions and recognized experts in the energy field. The Awards provide a showcase for new standards in applying clean and renewable energy solutions. The focus is on implementation projects, which assist in moving from experimental and scientific research in cleaner energy technologies to integrated, broad use of these technologies. Thus the project has been adjudged among 72 nominee projects.[29]

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
France	**Velcan Energy** 75, Boulevard Haussmann, 75008 Paris, France	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

[28] http://www.cleanenergyawards.com/top-navigation/nominees-projects/nominee-detail/project/55

[29] http://www.cleanenergyawards.com/top-navigation/nominees-projects/listed-according-to-countries/

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.

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:

A.4.1.1. Host Party(ies):

India

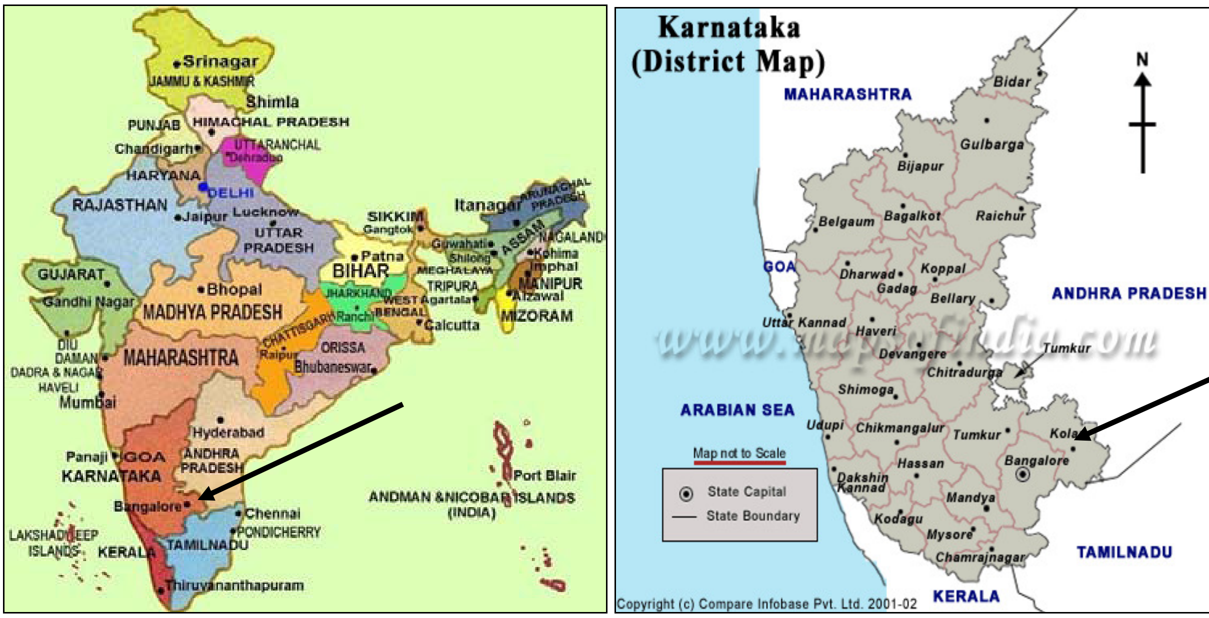
A.4.1.2. Region/State/Province etc.:

Taluks – Bagepalli, Chintamani, Chikkaballapur, Gudibanda and Sidlaghatta
District - Kolar District,
State - Karnataka

A.4.1.3. City/Town/Community etc:

See Appendix 1 for details of villages

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

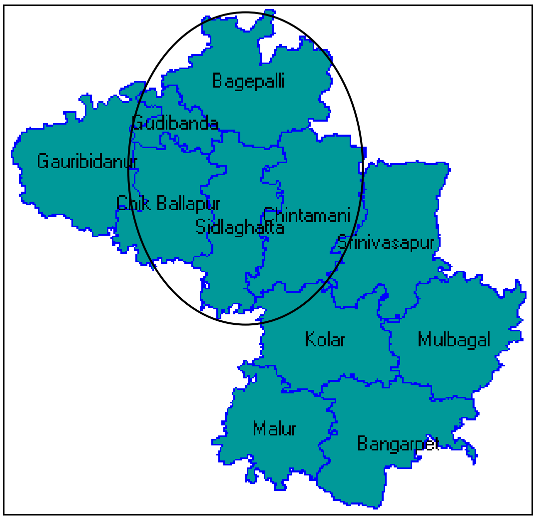


Figure 1: Map of Kolar district and taluks

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)[30].

Justification how the proposed activity conforms to 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.

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

[30]In this PDD all reference to the Simplified Small-scale Methodology I.C. refer to the version 05, 25 February 2005. The PDD has been registered as a CDM project on 10th Dec 2005 with reference to version 5.

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 cooking and water heating. 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). The definition of nonrenewable 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 15 MW.

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

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

The energy estimation of all the 5,500 biogas plants is based on the methane production potential of cow-dung according to IPCC guidelines (see Annex 3). 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 approximately 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

CH_4 energy from cow dung (IPCC conservative value)	**MJ/cow/year**	**1421.9**
Energy derived from 4 cows	**kWh/year**	**1579.9**
Family cooking hours per day	**H**	**4.0**
Capacity of one system	**kW**	**1.1**
Capacity of all 5500 plants	**MW**	**~6**

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD

Eligibility of project activity under the Gold Standard

For the project activity to be eligible for the Gold Standard, it must fall into one of the types of project activities listed in Appendix A of the Gold Standard Project Developer's Manual[31] and comply with the appropriate requirements.

According to Appendix A, the eligible project types correspond to categories I.A - I.D of those qualifying for small-scale project status under the CDM. Since the CDM project activity fall under I.C version 5, and complies with the appropriate requirements, it is eligible under the Gold Standard.

[31] The Gold Standard - Manual for CDM project developers.Version 3, May 2006. http://www.cdmgoldstandard.org

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 from non-renewable source with renewable energy. This form of fuel combustion creates local pollution and leads to greenhouse gas emissions from the combustion of non-renewable biomass fuel.

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD

The project needs to comply with the requirements of sections 3.3.1, 3.3.2 and 3.3.4 of the Gold Standard Project Developer Manual. Reference to the UNFCCC's "Tool for the demonstration and assessment of additionality" (see http://cdm.unfccc.int/EB/Meetings/016/eb16repan1.pdf) must be used for evaluating projects under the Gold Standard.

Previously announced projects screen

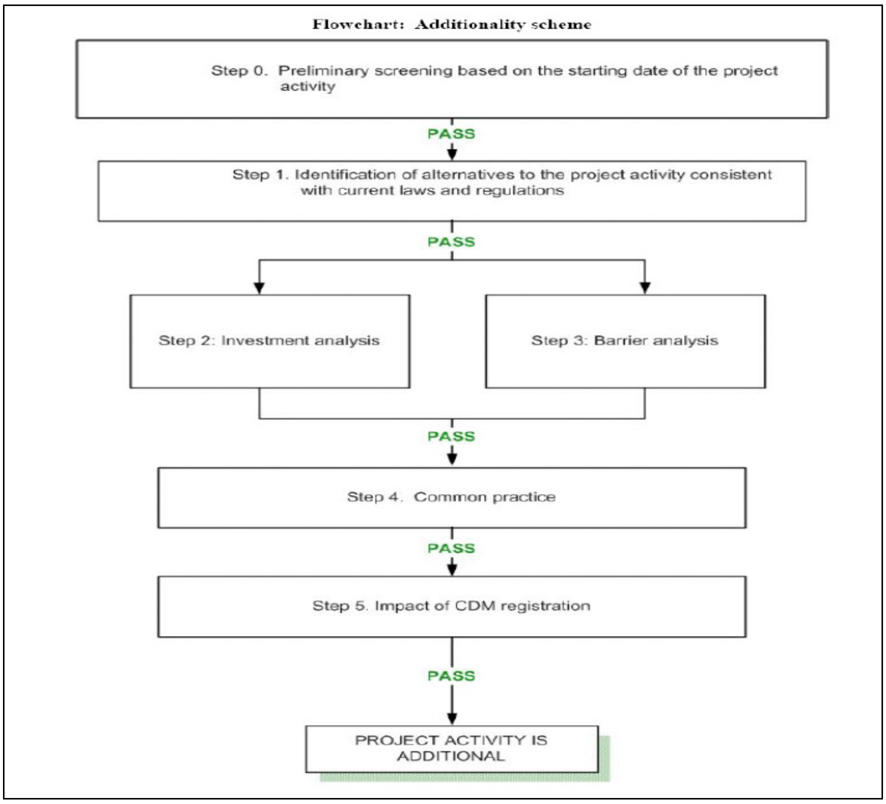
The project was conceived to be implemented as a CDM project by ADATS, the NGO. There was no previously announced biogas project by any government department, NGOs or any public or private agencies. The Deenabandhu model of biogas plant was earlier generally built either with a large part of own funds (for richer rural households) and subsidies, or with a large part of own labor and subsidies (for poorer households). The availability of the product was limited by the subsidy amount available to each District every year through the Ministry of Non-Conventional Energy Sources.

The baseline and monitoring methodology under the Clean Development Mechanism established by the project promoters allowed a new source of funds to be tapped, which not only allowed more plants to be built in the 5 Blocks of Kolar District in one year than in all the previous 5 years put together, but the promoters also were able to reduce their dependence on government, and enter into commercial agreements from the sale of CERs. The new idea implemented here is the tapping of new source of funds, namely sale of CERs to construct biogas plants for poor households in rural areas. In fact, in June 2007, the Bagepalli CDM Biogas Project received the Jury Special Award 2007 from the World Clean Energy Award for its innovative financing solutions using Clean Development Mechanism (CDM)[32].

Additionality tool

The following flowchart for additionality scheme as given by the gold standard manual has been followed:

[32] http://www.cleanenergyawards.com/top-navigation/nominees-projects/nominee-detail/project/55



Step 0: Preliminary screening based on the start date of the project activity

The project activity was successfully registration as a CDM project on 10th Dec 2005. The implementation of the project was only after securing forward CER finance from Velcan Energy, France. Thus the implementation of the project is after January 2000.

Satisfied/Pass – Proceed to Step 1

Step 1: Identification of alternatives to the project activity consistent with current laws and regulations

Sub-step 1a: Define alternatives to the project activity:

The alternative to the project activity is the continuation of usage of fuelwood and kerosene to cook or use LPG for cooking or implementation of the project not as a CDM project.

Sub-step 1b: Enforcement of applicable laws and regulations:

Both the project activity and the alternative scenarios are in compliance with all regulations.

Satisfied/Pass – Proceed to Step II

Step 2. Investment analysis

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

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. Thus the baseline scenario represents 3.56 t CO_2 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[38].

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.

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 an 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 the continued combustion of non-renewable biomass fuel for cooking and water heating is the cheapest option, leading to higher emissions.

The capital cost of a 2 m^3 biogas plant is about Rs.9,000, 6 times the cost of LPG. The commonly and widely used wood fired stoves or ovens ("traditional mud stoves" or "improved vented mud stoves") costs around Rs.250, 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. 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 installed 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. Even individually, banks do not provide loans for such projects. 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. This can be evidenced by the low rate of biogas units installed and running so far in the taluks.

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

Satisfied/Pass – Proceed to Step III

Step 3: Barrier analysis

(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[35, 36, 37, 38].

(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 organizational and management skills and coordination amongst various implementing agencies to organize decentralized 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 cum 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.

Kolar District has a biogas potential, which can satisfy as much as 30- 40 % of domestic energy need in rural areas. But only about 5% of the potential is been tapped so far. 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 Ramachandra (2000)[33], the various reasons for not installing biogas plants in Kolar are as listed in Figure 2. First biogas in Kolar was installed in 1970. But since then its promotion has many constraints. As evident from Figure 2, based on a survey, as much as 60% of the rural population responded to not availing biogas plant because of economic barriers. They are not able to save or get loans to build biogas plants. Other barriers have been lack of awareness, convenience, raw material, space problem, peoples' interest, etc. that has hampered spread of biogas technology. 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.

[33] Dabrase, P.S and Ramachandra, T.V. (2000). Integrated Renewable Energy System - Perspectives and Issues. Millenium International Conference on Renewable Energy Technologies, IIT, Chennai. 9-11 Feb, 2000.

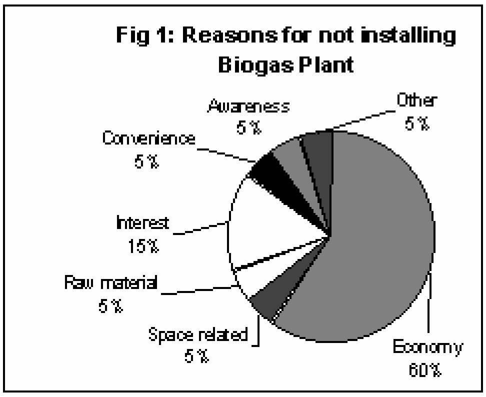


Figure 2: Reasons for not installing biogas plants in Kolar region[33]

The project has been implemented among the Coolie Sangha members of the five taluks of Kolar. The 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. The Coolie Sangha activities embrace every facet of its Member Coolie families' day to day living. It is not based on the principle of unity-at-times-of-need. It is much more than a "functional grouping" of the poor to solve pressing problems, that has been born through ADATS' community organization efforts. The Coolie Sangha gives an identity and protection to it's 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 decentralised credit activity, agricultural development, etc.

Thus this project is reaching the very poor families of the village, who otherwise would not have been 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. 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 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 completely through the revenues from the CER sales, and cannot be realized without the revenues from the carbon credits.

Satisfied/Pass – Proceed to Step IV

Step 4 Common Practice Analysis

The common practice analysis is a credibility check to complement the barrier analysis discussed above. The National Project on Biogas Development (NPBD) of the Ministry of Non-Conventional Energy Sources (MNES) was started in 1981-82 for promotion of family type biogas plants, the current potential of which is estimated at 24 million based on bovine population, to provide clean alternate fuel to the rural masses and enriched organic manure for agriculture. The implicit objective of the programme was to reduce the use of non-renewable fuels and fuel wood. It is a central sector scheme covered under 20-point programme. In order to help the poor and the disadvantaged who can not own and operate family type biogas plants, the programme for promoting large biogas plants at the community level was taken up in 1982-83. But through the programme, only 28.63 lakh biogas plants have been constructed. Further, based on an evaluation study conducted, only 45% were functional. Further, the project does not seem to have significant impact, as only 7% households in the sample villages were found to be using biogas, often as a supplementary source of fuel. Obviously, the impact is not significant even though the programme has remained operational for about two decades. The findings of the study tend to suggest that realization of the potential will remain a distant dream[33].

Futher looking at the energy consumption pattern at district level of Kolar based on a study conducted by Dabrase and Ramachandra[33], especially in rural areas, reveals that about 84% of the energy need in the district is satisfied by biomass and its use is not sustainable. Domestic firewood needs ranges from 1.7 to 2.5 kg per person per day. Higher level of consumption is mainly due to inefficient traditional cook stoves. Use of kerosene and electricity use is restricted due to economic reasons and availability constraints. Animate energy in the form of human energy contributes significantly in domestic sector. Domestic activities such as cooking, fuel collection and chopping, fetching water, cloth washing, utensils washing, marketing etc, consumes as much as 7.74 hrs/day/household. Women contribute about 5.6 hrs, men and child contributes 1.12 and 1.02 hrs respectively[33].

Kolar District has a biogas potential, which can satisfy as much as 30- 40% of domestic energy need in rural areas. But unfortunately only about 5% of the potential is been tapped so far due to the various barriers mentioned above[33]. This is just the implementation. In terms of actual usage, it is less than 1% of the potential.

Thus it is clear that, in the absence of CDM project, which has brought the upfront investment for the establishment of 5,500 biogas plants for the rural poor, this project would not have occurred.

Satisfied/Pass – Proceed to Step V

Step 5- Impact of CDM registration

The implementation of the project has showcased the possibility of emission reductions and sustainable development through CDM mechanism without depending on government funds. This project has paved way for similar projects to be implemented.

Satisfied/Pass – Project activity is additional

Adoption of conservative approach

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[34].

More recently, the Contribution of Forestry Sector to Gross Domestic Product (GDP) in India Report[35], shows that more than 70% of forest produce in India today is biomass for fuel combustion.

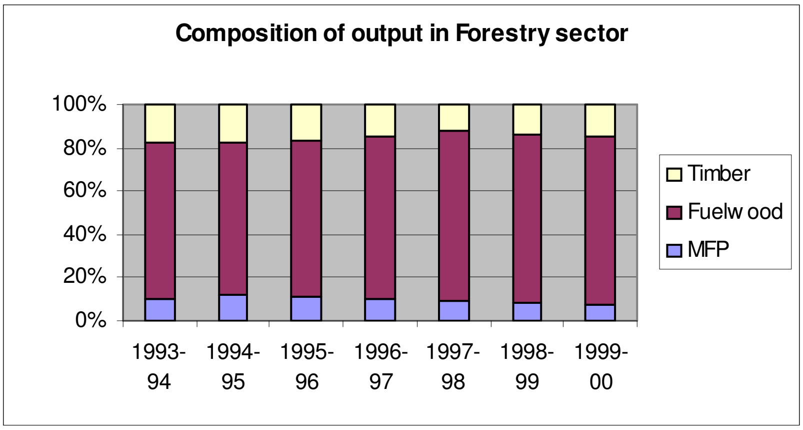


Figure 3: The Forestry Sector In Resource And Income Accounting[35]

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[36]: 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

[34] N.H. Ravindranath, Biomass Energy and Environment, Oxford University Press 1995, chapter 3.

[35] 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. http://envfor.nic.in/nfap/chap02.html

[36] Ramachandra T.V. et al.; Bioresource status in Karnataka; Renewable and Sustainable Energy Reviews, Volume 8, Issue 1, February 2004, Pages 1-47

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[37]: According to Ramachandra *et al*., 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 characterized 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*[38] estimate an overall fuelwood availability of 24.4% in Kolar District.

Household level[39]: 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 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*[38], which supplements the other study[37] 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

[37] 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

[38] Inventorying, Mapping and Monitoring of Bio-Resources Using GIS and Remote Sensing (Kolar District), By T.V. Ramachandra and G.R.Rao. http://wgbis.ces.iisc.ernet.in/energy/paper/Biores_using_RS_GIS/index.htm

[39] Appexdix II

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 parameters. The approach is summarized 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,] Taluk wise 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[38] 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[40]. 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 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 in section B.2, which shows the conservative approach adopted to estimate the baseline emissions.

Greenhouse Gas emissions from existing cooking practices in India is a very complex subject, and has been studied extensively[40, 41]. 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

[40] Smith et al.; Greenhouse Implications of Household Stoves: An Analysis for India; Annu. Rev. Energy Environ. 2000. 25:741-63
[41] Smith et al.; Greenhouse Gases from Small-scale Combustion Devices in Developing Countries, Household Stoves in India, EPA/600/R-00/052, 2000

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, are 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.

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

Please indicate the chosen crediting period and provide the total estimation of emission reductions as well as annual estimates for the chosen crediting period in the following table.

Years	**Annual estimation of emission reductions in tonnes of CO_2 e**
2006-07	11,761*
2007-08	19,553
2008-09	19,553
2009-10	19,553
2010-11	19,553
2011-12	19,553
2012-13	19,553
Total emission reductions (tonnes of CO_2 e)	**129,079**
Total number of crediting years	7
Annual average over the crediting period of estimated reductions (tonnes of CO_2 e)	**18,439**

* CERs issued; applying for retroactive gold standards

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

There is no public funding from Parties included in Annex I involved in the project activity.

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:

ODA Additionality Screen

After registration of the project forward CER funding was provided by VELCAN ENERGY, France, which is an Independent Clean Power Producer specialising in renewable electricity generation in emerging markets from hydroelectric power and biomass combustion[42] and also the project participant from Annex-I country. Forward CER funding of 1.1 million Euros was provided for the project. Thus no ODA funding has been used for the project.

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

[42] http://www.velcan.fr/eng/

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:

The baseline has been constructed in a conservative manner in order to reduce the risk of artificially inflating the number CERs received by the project activity. This has also been substantiated during the validation of the project by the DOE. The conservative approve taken has been elaborated in section A.4.3. The assumptions are made explicitly and choices are substantiated. All the values of variables and parameters are conservative and do not lead to overestimation of emission reductions attributable to the CDM project activity.

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

The project was registered as a CDM project under the approved baseline methodology

"Small-scale CDM Project, Type I – RENEWABLE ENERGY PROJECTS, I.C. Thermal energy for the user – Version 5 (according to: Annex B of simplified baseline and monitoring methodologies for selected small scale CDM project activity categories)

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

A) This methodology was applicable during registration of the project 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 - Version 5:

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, a rough estimation based on the methane production potential of cow-dung according to IPCC guidelines was considered (see Annex 3). The calculations are given in Table 3. 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.: 6 MW and thus below the limit for small-scale CDM project.

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

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[37]. 70% of forest extraction occurs for fuelwood[35]. In Karnataka, the eastern dry zone in which Kolar District falls is a bioresource deficient zone[36]. In rural areas of Kolar district traditional fuel such as wood, agriculture and animal residues, still meets 85-95% of the demand[37]. The studies by Ramachandra *et al.* for Kolar[37, 38] 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[37, 38]. 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 used the exhaustive Kolar District study done by Ramachandra *et al*[38], 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 agroresidues) used for cooking and water heating is non-renewable.

Fuelwood consumption: The studies[36, 37, 38] showed the following estimated average consumption of fuelwood for a medium size family of 5 people: 5.24 tonnes per year[36] ; 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[37].; 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[38].

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. 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[38] 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, we take the average from Ramachandra's range, 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.

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[40,41] and will not be discussed here in detail.

However, Smith et al. suggest in their publication 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, CH_4, NMHC, N_2O), 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 oxidize 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 IPCC2 rules (~560 g CO_2e per MJ delivered Energy). Table 4 provides some of the measured emission data from Smith *et al*. 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*.[40, 41])

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[36] 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 and the calculated average emission coefficient from the Smith et al. data in Table 4.

Table 5: Official IPCC GHG emissions coefficient for wood[36] 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 CO_2e	*1661.00*	*105.00*	*18.60*
in % CO_2	*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 CO_2 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 3. 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.

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 is the baseline scenario and represents 3.56 t CO_2 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.

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.

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 the continued combustion of non-renewable biomass fuel for cooking and water heating is the cheapest option, leading 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..

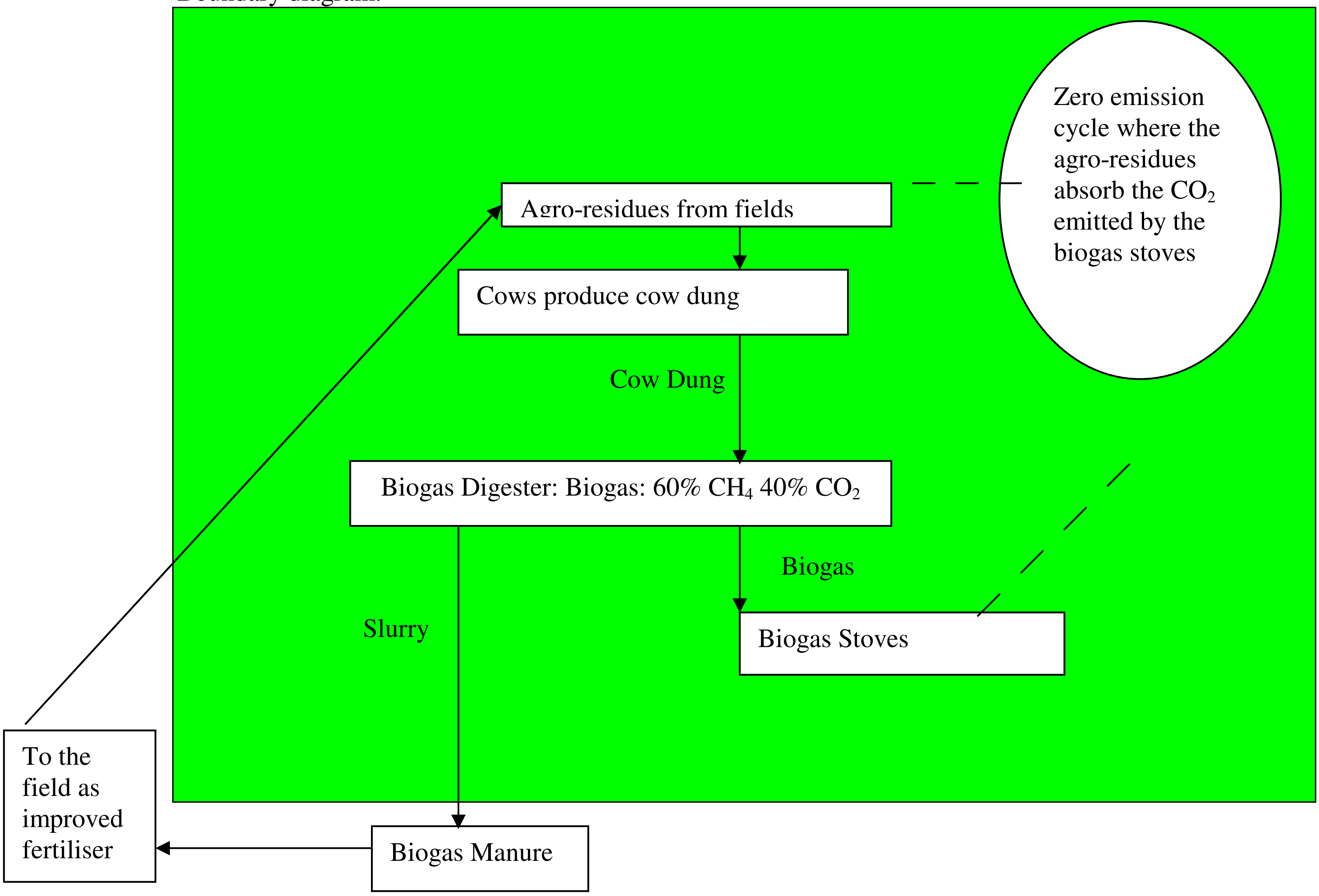
The prevailing practice is for poor households to depend on free sources of firewood from the "commons" – either the Forest department (illegal collection is very common though under-reported), Panchayat Land, where the poor are entitled to collect firewood but there are no programmes for reforestation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

It takes quite special organizational and management skills and coordination amongst various implementing agencies to organize decentralized 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:



Define the project boundary for the project activity using the guidance specified in the applicable project category for small-scale CDM project activities contained in appendix B of the simplified M&P for small-scale CDM project activities.

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: Mr. Ram Esteves, ADATS & Dr. Sudha Padmanabha, Velcan Energy.

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:

1st September 2006

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:

7-y-0-m x 3 times = 21 years

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

1st September 2006

C.2.1.2. Length of the first crediting period:

7y - 0m

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
9. 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 CO2 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 allow 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. The monitoring will include

i) Recording annually the number of systems operating and
(ii) Estimating the annual hours of operation of an average system, using survey methods.

Annual hours of operation will also be estimated from total output – amount of biogas generated based on amount of cow dung fed into the digester; and output per hour will also be estimated by doing a regular random survey of operating systems which will record energy to the stove.

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.

However, the energy produced by a sample of the systems will be measured in order to provide a control value for the ERs derived.

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. It may not however be necessary to install metres for measuring quantity of gas produced.

Energy produced will 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.

This data can be collected without using expensive physical metres. Energy produced by a sample of the systems will be measured and calculated using data collected using a procedure described below.

Monitoring of the biogas units installed

All activity processes, including financial transactions for construction of biogas units, will be digitally monitored using an online intranet solution that will be integrated into ADATS's intranet based monitoring system that tracks various Coolie Sangha building/running activities for the past 20 years. Open and transparent online reports will be used by everyone – ADATS Staff, Coolie Sangha functionaries and all other secondary stakeholders to know exactly where they stand in terms of progress and results. Reports will be generated at all levels i.e. Super (overall), Taluk, Area, Cluster, Village and individual Family level. Efficiency will be constantly checked (and Area-wise comparisons made) to determine which processes were lagging, where, and for what reasons. The database will be updated on **an every day basis**, as and when Field Staff return from their respective villages. This will ensure a continuous monitoring of the biogas units installed, which is in line with the requirement of the PDD.

Monitoring during Year 1 – Pre-commission and commission for units installed was maintained. These processes were monitored on a day to day basis and database maintained from its initiation to completion dates. Quality Control Supervisors comprising of the Audit team and the case worker of ADATS are the key persons to conduct the overall supervision of installed plants. They check the quality of installed biogas plants and ensure that the required materials are used for the construction of the biogas plant. Very nearly all payments for construction of biogas plants was made by cheque and suppliers are identified with personal data and digital photographs fed into the computerized databank.

Statutory reports, including Trial Balance, Receipts & Payments statement, Income & Expenditure statement and Balance Sheet, will be generated for verification. The books of accounts will be audited by a certified Chartered Accountant once every 6 months.

Establishing the date of commission of a biogas unit

After commissioning and satisfactory functioning of the biogas plant for a minimum of 2 weeks, an end user agreement on a legal paper was signed with the beneficiary, which is taken as the day of commissioning of the biogas plant. Thus from day 1 of the commissioning of the biogas plant, full account of emission reduction can be considered (3.56 tCO_2/year/unit commissioned).

The list of biogas users are identified by a User ID, the name of the beneficiary, the CSU membership number, the village and taluk, and other details such as land and cattle holding. As soon as a participating family is identified, an User ID was allotted and all details of the participating family entered into ADATS database. The priority will be to allot the biogas plants to the members of the coolie sangha. Of course, interested non-sangha members were also be allotted the biogas units in the village.

Monitoring the operating biogas systems and the average annual operational time

The number of operational biogas units and the average operating hours will to be monitored twice a year. A user friendly survey sheet for each of the biogas user has been prepared. The information on the operational time is collected by the village health worker along with the users in the weekly Mahila meetings held in every village. The operational hours for each of the biogas unit will be updated to the individual biogas user's on-line data base maintained by ADATS by the case worker. This information will be analyzed by the CDM Team of VELCAN ENERGY for emission reduction calculations.

Additionally, after commission of biogas plants ADATS will also monitor the biogas units which are under repair. If any biogas unit is faulty or not functional, the problems of the biogas plants will be passed on by the Audit Team to the Area Team. They will ensure that the unit is immediately repaired. This information will be entered into the ADATS database for verification by the GHG audit team.

Sample survey of monitoring parameters

A stratified sampling will be conducted to monitor the energy content

Stratified sampling

All the 5500 biogas plants of 2 cum are built of similar technical features, with similar materials used for construction, piping and stoves. The project area is governed by similar climatic conditions being in 35 kms radius in northern Kolar district. The biogas users have been given training for proper maintenance of the biogas plants. The influent fed into the digester is also standardized with dung to water ratio of 1:3. Thus with similar bio-digesters and climatic conditions, the parameter that will govern the total output of the unit are i) influent quantity fed into the digester and ii) requirement of the user. This in turn is dependent on the following:

- Family size
- Geography of the village
- Number of cattle per household
- Landholding size
- Caste

Thus a stratified random sampling of the 5% of biogas units will be conducted with the above mentioned criteria. The survey will be conducted in all the 5 taluks covering 5% of the villages. Representative samples for each of the substratum will be taken to capture the heterogeneity of population. A questionnaire method will be adopted for the survey. Against the baseline scenario, the activity data that will be collected are:

- Extent of replacement of firewood
- Extent of replacement of kerosene

If fuelwood and kerosene is still being used, the data that will be collected are the extent of its usage and nature of firewood used. The data collected will be further analyzed to ascertain if the firewood used is renewable or not.

Survey team

We will ensure that the survey team would be a third party. It could be college students, research students or any other NGO involved in the field of environment. Training will be given to the survey team before the start of the survey. The survey team along with ADATS staff, Mahila trainers and if required, biogas users will conduct the survey. Questionnaires will be prepared, field tested and then implemented on the field.

Parameters to be monitored

1. Usage of firewood and kerosene by the biogas users
2. Energy produced by the system through the slurry level raise in the displacement chamber
3. Dung input into the digester

Sample size

The sample size for the usage of firewood and kerosene by the biogas users will be done in 5% of the sample, while the energy content and dung input into the digester will be conducted in about 1% of the households.

Dung input into the digester

This survey will be done for a period of 30 days. The cluster secretary of the village in collaboration with the biogas user will weigh the dung before feeding into the digester using a spring balance (range 0-50 kg). The information will be recorded in the data sheets provided to them and further analyzed by the CDM Team.

The potential energy content of the dung fed into the digester on an annual basis was will be 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
CV = Calorific Value of methane
E_{ff} = Efficiency of the stove

As per the PDD, the following values will be 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%	PDD

Biogas production

To obtain the gas production rate of the biogas unit, the displacement of slurry in the displacement chamber will be measured as follows:
Step i: The level of slurry in the morning after preparation of meals was marked.
Step ii: The raise in level of slurry will be measured on hourly basis till the next meal preparation in the evening or till the complete raise of slurry in the displacement chamber. The measurements will be recorded on a data sheet given to each of the biogas user.
Step iii: The rate of slurry rise (cm/hr) multiplied by the cross-sectional area of the biogas chamber will give the hourly gas production rate and thus daily gas production rates can be calculated.

This procedure is simple and cost effective and will be done by the Balakendra teachers and other literate women who had biogas units in their homes under the guidance and supervision of Velcan Energy team, CSU cluster secretary and ADATS case workers.

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

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

Where

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

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

Activity data	Value	Reference
Net Calorific Value of biogas	20 MJ/m^3	Nijaguna, B.T. 2002. Biogas Technology, New Age International Publishers. New Delhi
Efficiency of the stove	55%	PDD

Comparison of energy output from biogas digester to baseline scenario

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

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

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

The energy obtained from the sample surveys will be compared with the baseline energy available from firewood. These calculations will not be used in emission reduction calculations, but will substantiate the application of the 3.56 ER per unit/year due to the availability of the same energy output from the biogas units.

Provided biogas plants are functional, there will thus clearly be more than enough biogas to cover the energy needs of the users. This will be checked.

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. But this possibility is avoided as described in the management plan below.

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.

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.

Determination of baseline

A sample survey will be conducted to ascertain that the ex-ante baseline is still applicable for the project activity. A questionnaire survey will be conducted periodically covering all the 5 taluks of Kolar. The study will be conducted to see if the *ex-ante* baseline is still applicable.

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:

Data to be collected in order to monitor the project's performance on the sustainable development indicators:

The actual project performance will be assessed against the projected outcomes of the sustainable development assessment. A sample survey of the local stakeholders will be conducted to assess the projected outcome of sustainable development from the project. Laboratory analysis will be carried out for parameters as mentioned in section D.3. Suitable indicators have been identified to study the impact of the project on sustainable development, which is listed in section D.3.

As mentioned in the earlier section, estimation of leakage is not considered.

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:

The project has been registered under:

Type I. RENEWABLE ENERGY PROJECTS, Category I.C. - Thermal energy for the user – Version 5.

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 CO_2e 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 CO_2e /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	*Energy produced by a sample of the systems*	*EP*	*MJ/day*	*m*	*Every six (6) months*	*Random sample*	*e & p*	*Crediting period plus 2 years*	*Not used for calculation of the emission reductions*
2	*Number of installed 2* m^3 *systems*	*IS*	*Units*	*m*	*Every six (6) months*	*All*	*e & p*	*Crediting period plus 2 years*	*Not used for calculation of the emission reductions*
3	*Number of operating 2* m^3 *systems*	*OS*	*Units*	*m*	*Every six (6) months*	*All*	*e & p*	*Crediting period plus 2 years*	
4	*2* m^3 *system average annual operating time*	*T*	*Hours*	*e*	*Every six (6) months*	*Random sample*	*e & p*	*Crediting period plus 2 years*	*Not used for calculation of the emission reductions*

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:

Sustainable Development Indicator	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Comments
Local/regional/global environment					
Water quality and quantity	- Quantity of water saved	- Water saved in washing vessels compared to baseline as perceived by the communities	- Percent reduction in water usage	- Measured - Estimated	- Based on sample survey
Air quality	Indoor smoke and suspended particles	Indoor air quality as perceived by the community	- Qualitative (dimensionless)	- Estimated	Sample survey will be conducted in households having biogas and still using traditional stoves
Other pollutants	Pathogen levels	- Quantity of pathogens in slurry compared to that of dung	- no. of pathogens/gm	- Measured	- Laboratory analysis of slurry and dung
Soil condition	Fertility of soil	- NPK content of soil treated with slurry and dung - Increase in crop productivity	- % - As perceived by community through sample survey	- Measured - Estimated	- Laboratory analysis of soil
Biodiversity	Collection of fuelwood from forests	Frequency of fuel wood collection from forests	- No. of trips/yr	- Estimated	Derived through sample survey in villages
Social sustainability and development					
Employment	Job quality	- Non-functional biogas units due to structural problems of biogas units	No. of units repaired/year	- Measured	Database of ADATS
Livelihood of the poor	Improvement in quality of life	- poverty alleviation, avoidance of drudgery, convenience, leisure	- dimensionless (as perceived by the community through a sample survey)	- Estimated	Sample survey will be conducted in households having biogas and still using traditional stoves
Access to energy services	- Usage of biogas for cooking	No. of biogas units operational	Nos.	- Measured	Database of ADATS
Human and institutional capacity	- Empowerment - Involvement - Gender	Involvement of community especially women in the project activity	- dimensionless (as perceived by the community through a sample survey	-Estimated	Derived through sample survey in villages

Economic and technological development					
Employment	Employment generated	- Monetary benefits	- Rs/family - Calculated based on a sample survey)	- Estimated	Based on surveys and ADATS database
Balance of payments	Avoidance of kerosene usage	- Kerosene replaced by biogas	litres	- Calculated	Based on the sample survey
Technological self reliance	Self reliance in implementation and execution of the project	Skill development and institutional capacity	- dimensionless (as perceived by the community through a sample survey	- Estimated	Based on the sample survey

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.	Medium	Yes	This data will be used as control data to compare with ERs calculated using the method outlined in Annex 3. This date will not be used to calculate the emission reductions of the project activity.
D.3.2.	Low	Yes	This data will not 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 to calculate the emission reductions by project activity; there is 100% accuracy of this number.
D.3.4.	Low	Yes	This data will be used as supporting information for calculation of emission reduction by project activity.

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

Velcan Energy India Pvt. Ltd, (VEI) a subsidiary of VELCAN ENERGY, is in charge of the Overall Monitoring Programme along with ADATS.

ADATS is in charge of construction, service and maintenance, and data collection for supporting VEI in the 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 are the project implementing agency and manufacturers of the biogas plants. They have trained 123 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 are 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. 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 on a daily basis at the ADATS office. The differentiation between installed and operating systems is made to control the over-all performance of the project activity. The consortium have trained the family members of the households as above. In addition, the consortium has 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 is a supervisor for every 50 plants or so, or at least for every village. This system 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 consortium head 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.

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.

Note: The estimated daily operating time of the system (cooking time) is not required for the calculation of the emission reduction. But it will be reported on an estimated basis by the family for possible later calculations of efficiencies.

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.: Energy generated, Number of installed 2 m^3 systems, Number of operating 2 m^3 systems, and 2 m^3 systems' average daily operating time. The VEI has a system in place which builds on the current practice already in place and supplements and strengthens it as required.

Energy generated: measuring as detailed above, followed by calculations to convert into MJ/day.

Number of installed systems: Survey sheet "Installed systems" will list name of householder, date of installation and supervisor responsible for plant service and maintenance.

Number of operating systems: Survey sheet 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. The service and maintenance contract between ADATS and plant owner specifies visit to faulty plant within 24 hours and rectification of fault within 7 days. The assumption is thus that every operating system will have been 100% operational during the year.

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, in the same locations where data collection for "project specific standards" is carried out.

Project performance review:

This will carried out by ADATS 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 surveys will be conducted. The assumption that all non-renewable biomass fuel combustion will be eliminated will be verified by use of the survey methods.

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

The project proponents 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 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.

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 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. A system of rewards for efficiency has been introduced, and owners, supervisors, and office staff are given incentives to meet the 100% success target. Random checking of operating plants is 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 and VEI. 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: <u>In the case of the project activities using biomass, leakage shall be considered.</u>

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:

Dr. Sudha Padmanabha
Velcan Energy India Pvt. Ltd.
19/1, II Floor, Vittal Malya Road
Bangalore – 560 001,
Karnataka, India

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:

$$CER_y = OS_y \ x \ EM_y$$

where:
CER_y : yearly Certified Emission Reductions
OS_y : 2 m^3 systems operating in year y. Calculated as the average value of the semi-yearly monitored operating system in one year, based on average annual operating hours of plants.
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 3.

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:

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD

The project proponent needs to perform an EIA if:

1. the host country legislation or the EB requires an EIA to be performed;
2. Additional guidance from the Gold Standard requires an EIA to be performed as per section 3.4.2 of the Gold Standard Project Developer's Manual)

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.

The EB also does not specify an EIA for the project activity.

Based on the Sustainable Development Assessment Matrix none of the indicators have scored -1. Also based on initial stakeholders consultation there was no negative impacts of the project activity.

Thus an EIA is not necessary.

SECTION G. Stakeholders' comments:

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

ADATS has 15,000 Coolie Sangha Members in 800 villages in Kolar District who have suffered from acute shortage of biomass fuel for combustion over the years. ADATS and an NGO Women for Sustainable Development (WSD) carried out an improved cookstove programme to address the issues in a partial manner. Another NGO 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 for whom biogas plants will be built 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 5,500 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 welcomed the project and attended various meetings at which the project proponents presented the project activity idea and the concept. The Kolar District administration welcomed 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 actively welcomed this project and extended as much support as they can during project concept and design stage.

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:

In addition to the stakeholder consultation requirements contained in the CDM PDD, the Gold Standard Public Consultation Process requires at least two public consultations and gives additional minimum requirements for the consultation process.

PUBLIC CONSULTATION PROCEDURES

Consultation of (local) stakeholders on the PDD (Main Stakeholder Consultation)

The locally active Gold Standard supporter NGO, Winrock International India, 788, Udyog Vihar, Phase V, Gurgaon – 122001, India was invited to provide their input on the CDM project.

Public comments on the project were also invited through the local newspapers.

Local policy makers were invited to give their inputs on the project.

G.2. Summary of the comments received:

The pre-project phase 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.

Annex 1

CONTACT INFORMATION FOR PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Agricultural Development and Training Society
Street/P.O.Box:	ADATS Campus
Building:	Bagepalli
City:	Kolar District
State/Region:	Karnataka
Postcode/ZIP:	561207
Country:	INDIA
Telephone:	+91 8150282175
FAX:	+91 8150282376
E-Mail:	adats@vsnl.com
URL:	www.adats.com
Represented by:	
Title:	Project Director
Salutation:	Mr
Last Name:	Esteves
Middle Name:	-
First Name:	Ram
Department:	-
Mobile:	+91 9448524696
Direct FAX:	+91 8150282376
Direct tel:	+91 8150282175
Personal E-Mail:	adats@vsnl.com

Organization:	VELCAN ENERGY SA
Street/P.O.Box:	75 BLD HAUSSMANN
Building:	------
City:	PARIS
State/Region:	-------
Postfix/ZIP:	75008
Country:	FRANCE
Telephone:	33 (0) 142685108
FAX:	33 (0) 142685110
E-Mail:	decitre@velcan.fr
URL:	www.velcan.fr
Represented by:	Antoine DECITRE
Title:	General Manager
Salutation:	Mr
Last Name:	DECITRE
Middle Name:	-----
First Name:	Antoine
Department:	-----
Mobile:	33 (0) 607661786
Direct FAX:	33 (0) 155273815
Direct tel:	33 (0) 155273610
Personal E-Mail:	decitre@velcan.fr

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There is no public funding for this project.

Annex – 3

	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				

- - - - -