Project 0121: Bagepalli CDM Biogas Programme

Monitoring Report - Version 1

Dated 5th October 2007

Monitoring Period
1st September 2006 – 31st August 2007
(Both days included)

Project Participants

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TABLE OF CONTENT

1 Context

1.1 Background

The project activity consists of 5,500 biogas plants (digesters) of 2 m^3 capacity each. Each household uses the dung of 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 fed devices.

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

1.2 Change in Start Date of the Project

The project was registered **on 10th December 2005** and the start date of the project activity / crediting period as mentioned in the PDD and applicable was 18th December 2005. The project activity was initiated only after the registration of the project and procuring finances for implementation of the project, as the only revenue from the project activity is CER revenue. The construction is being done in a phased manner and the time scale from start of construction to commission of the biogas plant takes approximately 155 days. Thus as on 18th Dec 05, not a single biogas plant was commissioned.

As per Para 7(b), Annex 31, of the twenty-fourth CDM Executive Board meeting, we made a request to the secretariat to change the start date of the crediting period from the existing 18th December 2005 to **1st September 2006.** Accordingly the change has been done. Hence the first crediting period is from 1st September 2006 – 31 August 2013.

1.3 Emission Reduction/CER Calculation

In the baseline scenario in the project area, 75.6% of the firewood used cannot be considered as renewable source of energy, and by burning this firewood, the users are generating greenhouse gases emissions. In the project scenario, this firewood has been replaced with renewable biogas and thus avoiding greenhouse gas emissions.

Each family was using 2.85 t/year, of which 2.15 t was non-renewable. Also, per year, 31.2 liters of kerosene was used as additional cooking fuel. The CO_2 emission reduction from avoidance of non-renewable wood usage and kerosene was estimated at 3.56 tCO_2/family/year. The calculations are provided in Annex 1 of the PDD.

Thus, the number of CERs generated through the project in one year is basically calculated by multiplying the number of unit operating by the ratio of 3.56.

1.4 Information Monitored

As per the monitoring section of the PDD, the following project specific standards were monitored:

i) Number of systems installed
ii) Number of operating systems
iii) Annual operating time of biogas system
iv) Sample survey for non-renewable wood and kerosene usage
v) Sample survey for energy production

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*

2 Monitoring Period

The monitoring period is from 1st September 2006 to 31st August 2007.

3 Statement to What Extent the Project has been Implemented as Planned

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.

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**

Implementation of the project was only after successful validation and registration as a CDM project since it is financed exclusively from the carbon revenues. As of 31st August 2007, 4,399 biogas units have been commissioned (see *CER calculations.xls*) and the construction of remaining biogas units are in various stages of construction. The status of the project as on 31st August 2007 is as follows:

Taluk	Participating Families	Number of Villages	Units Commissioned	Under Construction
Bagepalli	2,645	130	2027	618
Chickaballapur	6,49	48	568	81
Chintamani	1,006	78	861	145
Siddalaghatta	843	58	607	236
Gudibanda	383	27	336	47
Total	**5,526**[1]	**341**	**4,399**	**1127**

The list of villages in which the project is being implemented is given in Annexure 1.

[1] Though 5526 families have been identified, the emission reductions will be only for 5,500 biogas units. More units are being constructed expecting some dropouts during construction stage.

4 Organization

The project participants, Velcan Energy and Agricultural Development and Training Society (ADATS) are in the process of installing 5,500 biogas (digester) plants of 2 cubic meter (cum) capacity each at a household level.

The Bagepalli Biogas CDM project is being implemented by ADATS, a 29 year old rural development NGO, along with the Coolie Sangha, a beneficiary organization of small and poor peasant families in over 341 villages from 5 taluks i.e. Bagepalli, Chickaballapur, Chintamani, Gudibanda and Siddalaghatta of Kolar district, Karnataka, India.

The primary objective of the project is to provide clean and smoke-free cooking environment to 5,500 Coolie families in the villages with functioning village Coolie Sangha Units (CSUs).

The biogas project involves implementation of the technology, maintenance and monitoring the emission reduction (ER). All the tasks and activities are carried out in 16 designated "Areas[2]" comprising of 341 villages. Each Area Team consists of a Field Worker, Case Worker and Mahila Trainers (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[3]. 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. The women are taught efficient ways of cooking in the Mahila Meetings.

ADATS trained 123 local Masons in the tried and tested construction techniques of biogas plants. 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.

Monitoring of the parameters as mentioned in section 1.3 was conducted jointly by ADATS, Velcan Energy, village level Coolie Sangha members in-charge and selected biogas users.

[2] Area comprises of a group of villages being overlooked by the Area Team
[3] Teachers working at village level who impart informal education to the children.

5 Monitoring and Procedures for Emission Reduction Calculations

The Monitoring and Verification procedures described below defines the project specific standards against which the project's performance (i.e. GHG emissions reductions) and compliance with all relevant criteria was monitored and verified.

The monitoring steps involved for emission reduction calculations were as follows:

Step 1: Monitoring the biogas units installed
Step 2: Monitoring the operating biogas systems and the average annual operational time
Step 3: Sample survey for non-renewable wood and kerosene usage by biogas users
Step 4: Sample survey to establish that ex-ante baseline is still applicable
Step 5: Sample survey for energy produced by the system

5.1 Step 1: Monitoring of the Biogas Units Installed

All activity processes, including financial transactions for construction of biogas units, were digitally monitored using an online intranet solution that is 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 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.

5.1.1 Monitoring during pre-commission and commission of biogas units

The construction of 5,500 biogas plants is being done in a phased manner. The various processes involved in the implementation of the technology are as follows:

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

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

5. Commissioning
6. Generating End User Agreements

These processes are 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 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 biogas units. Very nearly all payments for construction of biogas units are made by cheque and suppliers are irrefutably 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, 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 plants 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 (see Figure below). These evidences validate the construction of the 5,500 biogas plants built in the project area.

***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 is signed with the beneficiary, which is considered as the day the biogas unit was installled. On an average, the agreement was signed after 15-20 days of commissioning of the plant. Thus **from day 1 of the installation of the biogas plant, full account of emission reduction can be considered (3.56 tCO_2/year/unit commissioned)**.

The biogas units commissioned before the start date of crediting period (1st September 2006) under this project is taken as 1st September 2006 and those after that, the actual commission or installed date.

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 family strength, land holding, caste, etc. (see *CER calculations.xls* for details). Other information includes the state date of construction and the date of commissioning.

As of 31st August, 2007, 4,399 biogas units are installed and the remaining biogas units are under various stages of construction. Thus the number of biogas units installed is monitored on a day to day basis and is updated in the database of ADATS.

5.2 Step 2: Monitoring the Operating Biogas Systems and the Average Annual Operational Time

As per the 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[4] (See Annex 1). The first monitoring of operating biogas systems was conducted in February 2007 after 6 months of the start of crediting period. This survey was conducted for a month (28 days). For efficient monitoring, it was decided to continue day to day monitoring. Hence since February 2007 continuously 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[5] 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. The average operational hours for each of the biogas users have been computed based on the daily operational hours (*see CER Calculations.xls*).

All the installed biogas units are operational and the yearly average operational hours are 3 hrs/day. Thus the number of operating biogas units and its average yearly operational hours are being monitored on a day to day basis and is updated in the database of ADATS.

ADATS monitoring system: The additional parameters monitored by ADATS after commission of biogas plants are:
Logging Audit Visits
Logging Repairs
Logging Days not used

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[4] A village health worker from the CSU is appointed for each village.
[5] These Mahila meetings have been held regularly since many years to discuss all issues of coolie sangha

If any biogas unit is faulty or not functional, the report on the problems of the biogas plants 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. This information is entered into the database for each of the beneficiary. **Thus there is a continuous database maintained of all the biogas units.**

Providing for Maintenance: Upfront CER amount of approximately Rs 11,500 per Biogas Unit has been provided. The cost of each is about Rs 9,000. The balance 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 will be used to maintain the 5,500 Units and keep them in good condition – a vital prerequisite for Coolie women to generate CERs and continue enjoying smoke-free cooking.

5.3 Step 3: Sample Survey for Non-renewable Wood and Kerosene Usage

As stated in the registered PDD "Bagepalli CDM Biogas Programme", 75.6% of biomass (excluding agro-residues) used for cooking and water heating is non-renewable. The notion of non-renewable in context of firewood corresponds to a, firewood consumption that contributes to deforestation or forest degradation. The critical factor is that consumption is greater than the increase in sustainable biomass growth. Based on a study conducted in Kolar by Ramachandra and Rao[6] each family uses 2.85 tonnes of firewood per year. Also based on a survey, each family uses 31.2 liters kerosene per year. Thus of the 2.85 tonnes of firewood used per year, 75.6% is non-renewable. The usage of 2.15 tonnes of firewood and 31.2 liters kerosene per year/family is contributing to greenhouse gas emissions. The replacement of the 2.15 tonnes of firewood use and kerosene by biogas are the emission reductions.

To determine the extent of reduction of non-renewable biomass and kerosene by the biogas users, a stratified sample survey was conducted as described in section 5.3.1.

5.3.1 Stratified sampling

All the biogas plants are being 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

[6] 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

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

Thus a stratified random sampling of the 5% of biogas units were conducted with the above mentioned criteria. The survey was conducted in all the 5 taluks covering 5% of the villages. Representative samples for each of the substratum were taken to capture the heterogeneity of population. A questionnaire method was adopted for the survey (Annex 2). Against the baseline scenario, the activity data that was collected are:

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

If fuelwood and kerosene is still being used, the data that was ascertained was the extent of its usage and nature of firewood used. The data collected was entered into Microsoft Excel and analyzed (*see fuelwood survey.xls*).

5.3.2 Extent of fuelwood and kerosene replacement

The extent of replacement of total fuelwood (non-renewable and renewable component) by biogas is 97%. Only 3% fuelwood is being used. But the fuelwood used is renewable in nature. The major species used are *Lantana camara,* which is a wide spreading weed and forms dense thickets; and twigs and branches of fuelwood species - *Eucalyptus* and *Acacia*. Prunings of *Pongamia pinnata* and *Mangifera indica* from their farm land are also used along with crop residue such as red gram, groundnut shells, coconut waste and mulberry stalks (*see fuelwood survey.xls)*. As per the annex 18 of the EB 23, this wood is considered as renewable.

The non-renewable wood previously used by the users is the costliest in terms of time spent to collect or purchase and preparation of the fuel for usage and storage. Thus, by providing a new energy facility to the user which decreases the need for additional fuel usage, the first wood to be replaced is the non-renewable one. Also, renewable wood is available nearer to their homes and fields with less effort and is the first alternative by the user for additional usage.

Non-renewable wood used before CDM project (t/y)	Renewable wood used before CDM project (t/y)	Renewable wood still used after CDM project (t/y)
2.15*	0.7*	0.08**

Kerosene used before CDM project (lts/y)	Kerosene used after CDM project (lts/y)
31.2*	0**

* as per baseline
** as per survey

Kerosene usage is completely replaced by usage of biogas. After the implementation of biogas unit, kerosene usage is zero by all the households.

<u>Thus 100% of non-renewable wood and kerosene is being completely replaced by biogas under the project activity.</u>

5.4 Step 4: Sample Survey to Establish that *ex-ante* Baseline is Still Applicable

A sample survey was conducted to ascertain that the *ex-ante* baseline is still applicable for the project activity. A questionnaire survey (see Annex 3) was conducted covering all the 5 taluks of Kolar. The study shows that the current fuelwood consumption for the users not equipped with biogas units is about 3.82 t/household/yr and the kerosene consumption of the same household is 34.75 lts/household/yr (*see Fuelwood survey.xls*). This is in concurrence with the baseline survey done during the PDD preparation. The major fuel for cooking is fuelwood and kerosene.

<u>Thus the baseline assumption is conservative and still applicable for the project activity.</u>

5.5 Step 5: Sample Survey for Energy Produced by the System

This survey aims at demonstrating that the energy produced by the bio-digester is sufficient to displace the energy previously produced through firewood and kerosene (see PDD p 24). This survey is in a way to substantiate the emission reduction calculated through the ratio of 3.56 CER per unit operating.

The results of the survey do not enter into the calculation of CER to be delivered.

The parameters for energy production by bio-digester, that were monitored are as follows:

(i) Dung input and frequency of dung influent into the digester: This survey was done in about 1% of the households continuously for 1 month.

(ii) Slurry level raise in the displacement chamber: This survey was done twice in the year as per the monitoring plan in 1% of the households.

5.5.1 Dung input into the digester

The quantity of dung fed into the digester was measured in approximately 1% of installed units for a period of 30 days. The cluster secretary of the village in collaboration with the biogas user weighed the dung before feeding into the digester using a spring balance (range 0-50 kg). The information was recorded in the data sheets provided to them (Annex 4). This information was computerized and analyzed (See *energy potential.xls*).

The potential energy content of the dung fed into the digester on an annual basis was calculated as follows:

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

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

Activity data	Value	Reference
VS Excretion dry mass (%)	40%	Laboratory Report
CH_4 production capacity / VS dairy	0.13 m^3 / kg	IPCC, 2006
CH_4 production capacity / VS non-dairy	0.10 m^3 / kg	IPCC, 2006
Calorific value CH_4	35 MJ/m^3	IPCC, 2006
Efficiency of the stove	55%	PDD

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

5.5.2 Biogas production

To obtain the gas production rate of the biogas unit, the displacement of slurry in the displacement chamber was measured. The step-wise procedure was 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 was 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 were recorded on a data sheet given to each of the biogas user (Annex 5).

Step iii: The rate of slurry rise (cm/hr) multiplied by the cross-sectional area of the biogas chamber gives hourly gas production rate and thus daily gas production rates can be calculated.

This procedure is simple and cost effective and was 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 two bi-yearly monitoring was done in 1% of the biogas units covering all the 5 taluks. The potential energy content of biogas based on the data was calculated using Microsoft excel (*see energy potential.xls*).

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

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

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

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

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

5.5.3 Comparison of energy output from biogas digester to baseline scenario

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

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

Where

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

This baseline calculation is based on the approved PDD

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

The energy available in the baseline is

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

The UE_1 and UE_2, was compared to UE_t to cross check the replacement of energy from firewood use and kerosene in the baseline by the energy output from biogas plants (Table 1, from *energy potential.xls*).

Table 1: Energy output from biogas plant compared to that from firewood in the baseline

From Dung Input to digester (using equation 1)		
Data	**Reference**	**Value**
DS (Kg)	Field experiments	**19.30**
VS (%)	Laboratory analysis	40%
D (Days)	-	365
EF (m3/kg)	IPCC, 2006	0.12
CV (MJ/m3)	Nijaguna, 2002	35
Eff (%)	Nijaguna, 2002	55%
Useful energy (MJ/yr)	**Calculated**	**6510**

From Biogas production from slurry displacement (using equation 2)		
Data	**Reference**	**Value**
Biogas production BGP (m3/day)	Field experiments	1.31
Calorific value of biogas CV (MJ/m3)	Nijaguna, 2002	22.1
D (Days)	-	365
Eff (%)	Nijaguna, 2002	55%
Useful energy (MJ/yr)	**Calculated**	**5817**

Energy from Firewood in the baseline		
Data	**Reference**	**Value**
Fuelwood use/yr	PDD	2.85
CV (MJ/Kg)	PDD	15
Eff of traditional stoves	PDD	10%
Kerosene use (lts/yr)	PDD	31.2
Density	PDD	0.7
CV of kerosene (MJ/Kg)	PDD	44.75
Efficiency of kerosene stove		45%
Useful energy (MJ/yr)	**Calculated**	**4715**

As can be seen from Table 1, the energy available from biogas units is approximately 5817 MJ/yr which is able to completely replace the energy obtained from firewood and kerosene in the baseline. Refer to *energy.potential.xls* for the detailed calculations.

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

6 Calculations of Emission Reductions

As described in the PDD, the emission reduction was calculated using a ratio of 3.56 ER/unit operating/year.

The monitoring described in section 3 aids to evaluate the reliability and the consistency of this approximation. As the results obtained by the survey was satisfactory, we have applied the following formula as given in the PDD to estimate the CER to be delivered.

$$CER_y = OS_y \times EM_y$$

Where:

CER_y yearly certified emission reduction

OS_y 2 cum systems operating in year y

EM_y 3.56 tCO_2 Baseline emissions per household with a 2 cum biogas system

The database of conducted survey and ER calculations is maintained in Excel spreadsheet. The emission reduction calculations are transparent and can be easily verified.

As of 31st August 2007, 4399 biogas units have been commissioned and are operational during the monitoring period. The unit-wise calculations of emission reduction are as enclosed in the excel sheet – *CER Calculations.xls*.

The total emission reductions for the period 1st September 2006 to 31st August 2007 for the installed and operational 4,399 biogas units are **12,034 tCO_2.**

The non-achievement of emissions reductions due to repairs of biogas units intermittently is **273 tCO_2**.

The total emission reductions for the period 1st September 2006 to 31st August 2007 for the installed 4,399 biogas units are 12,034 – 273 = 11,761 tCO_2.

The emission reductions are lesser than that projected in the PDD as not all the 5,500 are commissioned. Also, the 4,399 biogas units were commissioned in a phased manner throughout the year.

7 Measure to Ensure the Results / Uncertainty Analysis

The main parameters for calculation of emission reductions are the 2 cum systems operating in a year and the baseline emissions per household. The uncertainty is low due to the following:

- After commissioning and satisfactory functioning of the biogas plant for a minimum of 2 weeks, an end user agreement was signed with the beneficiary, which is taken as the day of commissioning of the biogas plant.
- The biogas units operating in a year has to be monitored just twice in a year at 6 months interval according to the PDD. But daily monitoring of the operating systems is being done since February 2007.
- If the biogas units are not operational due to malfunction, the days not used are not accounted for emission reduction calculations.
- Though the baseline emission was fixed *ex-ante,* a survey was done to ensure that the baseline emission is still valid (section 5.4).
- The energy content of biogas has also been verified through field experiments though they are not part of emission reduction calculations.

Hence the uncertainty is low and emission reduction calculations are conservative.

8 Leakage Monitoring

There is no leakage due to the project activity. As mentioned in the PDD, leakage is not an issue and need not be monitored for the project activity.

9 Monitoring of Sustainable Development of the Project

The main objective of a CDM project is achieving sustainable development in the host country. The main criteria of sustainable development are social, economic, environmental and technological well being. The impact of the CDM project was determined through household survey and group meetings. The various benefits that the rural communities perceived are as follows.

The communities have perceived many benefits of using biogas. Burning biomass based fuels was contributing to indoor pollution leading to domestic health hazards, particularly affecting women and children. The shift to biogas technology has reduced the incidence of many respiratory illnesses through removal of smoke in the kitchen leading to cleaner and more comfortable kitchens. Earlier, women had to sit in a crouched position for long hours in front of the traditional stove, leading to watering of eyes, irritation of throat, long exposure to heat and high levels of smoke. Many women have had severe eye problems leading to bad eye sight.

The cooking time has reduced drastically due to higher efficiency. They are able to prepare timely meals thereby enabling the children to attend school in time. The women are able to take up income generating jobs, as they do not spend a lot of time cooking and getting firewood from the forests.

Biogas has also reduced drudgery to women. They used to travel long distances to collect fuelwood. The benefits in terms of time saved in fuel procurement and cooking, improved kitchens and convenience, and reduction of drudgery of transporting fuelwood, processing them, and storing them for later use is enormous. This time is now being used productively.

Biogas is providing clean and convenient cooking fuel. Use of biogas has reduced smoke. The vessels and kitchen walls do not blacken due to soot. The cost of plastering the walls often has reduced thereby reducing expenditure. There is also monetary saving due to non-purchase of fuelwood.

The communities also perceive benefits in terms of increased crop productivity by use of slurry as organic manure.

At the village level, biogas has reduced the pressure on the already scarce sources of biomass. It has also provided employment through construction of the units to local entrepreneurs, turnkey operators, masons and daily-wage labourers.

10 Roles and Responsibilities

A CDM team has been formed for monitoring and verification of all the monitoring parameters as per the guidelines of VELCAN ENERGY and ADATS. Qualified and trained people monitor the parameters and emission reduction calculations. In the complete implementation and monitoring plan, VELCAN ENERGY and ADATS is the sole agency responsible for implementation and monitoring.

10.1 CDM Team Members

1. Mr. Ram Esteves, Director, ADATS
2. Mr. Mario Esteves, Assistant Director, ADATS
3. Dr. Sudha Padmanabha, VELCAN ENERGY, CDM In-Charge
4. Mr. Jean Baptiste Curien, VELCAN ENERGY, Engineer
5. Mr. Abid Pasha, System Administrator, ADATS

11 Annexure

Annexure 1: List of villages under each Taluk in which the project is being implemented

Bagepalli	Chintamani	Siddalaghatta	Chickballapur	Gudibanda
Muguchinnapalli	Korlaparthi HC	Egava Ganjigunta	Susaipalya	Karaganathamanahalli
Lagumaddepalli	Gajalavaripalli	Digava Ganjigunta	Badaganahalli	Ullodu
Shankavarampalli	Kadirepalli Cross	Venkatapura	Ankanagondhi	Chowtathimannahalli
Somnathpura	Papathimmanahalli HC	Hale Ganjigunta	Hanumanthapura	Chikkathamenahalli
Billur MV	Papathimanahalli MV	Alagurki	Kariganapalya	Koppukatenahalli
Maddalakhane	Nandanahosahalli	Lakkepalli	Reddigollarahalli	Eereddipalli
Sakulavarapalli	Chikka Kattigenahalli	Pedda Bandaragatta	Beeraganahalli	Eeravathanahalli
Devareddipalli	Dodda Katigenahalli MV	Chinna Bandaragatta	Ramaganaparthy	Singanapalli
Banalapalli	Dodda Katigenahalli HC	Vemagal	Maraganahalli	Balepalli
Palyakere MV	Appasanahalli	Kondappagaripalli	Kadiridevarapalli	Ganganapalli
Pedduru	Basavapura	Sadahalli	Yelagalahalli	Jambigemaradahalli
Beerangavanlapalli	Shettinayakanahalli HC	Valasahalli	Haleperesandra	Mallenahalli
Pasupalavarapalli	Shettinayakanahalli MV	Ammorathimmanahalli	Gaggilaralahalli	Pulasanavoddu
Bathalavarapalli	Marabanahalli	Mummenahalli	Korenahalli	Gundlahalli
Gundlapalli	Kariyapalli	Marihalli	Shettivarahalli	Yerrapalli
Venkatapuram	Yerramareddipalli	Chowdireddihalli	Boyanahalli	Ramaganahalli
Iddilavaripalli	Kommepalli	Pallicherla MV	Dommarigudisalu	Chikka Kurubarahalli
Bajjapuram	Vyjakooru	Saddahalli	Tumakunta	Kondavulapalli
Rajavanlapalli	Y. Kapalli	Devappanagudi	Poolavaripalli	Poovalamakalapalli
Neeragantapalli	Hanumaiagaripalli	Byreganahalli	Byreganahalli	Lakkepalli
Shivapuram	Batharahalli	Kotahalli	Kamatanahalli	Nilugumba
Gadivanlapalli	Bommaikal MV	Bayapanahalli	Bommanahalli	Yellodu
Besthalapalli	Bommaikal HC	Devaramallur	Uppuguttahalli	Ambapura
Kurubarapalli	Dodda Gutlahalli	Marappanahalli	Renumakalahalli	Kambalapalli
Doddivaripalli	Thinnakallu	Sonnenahalli	Gowdanahalli	Cholashettihalli
Peyalavaripalli	Burugamakalapalli	Subbarayanahalli	Soppahalli	Thirumani B
Mekalapalli	Gajjiganahalli	K.Mukudahalli	Gundlugurki A	Thirumani
Nallasanampalli	Dodda Kondarahalli	Kanamangala	Gundlugurki B	
Digava Netkuntlapalli	Mailapura HC	Basanparthy	Pathuru	
Rascheruvu HC	Nagdepalli HC	Byraganahalli	Angarekanahalli	
Rascheruvu MV	Nagdepalli MV	Iragappanapalli	Seemanahalli	
Gollapalli	Kendenahalli MV	Rappamalahalli	Avulahalli	
Upparlapalli	Thippanahalli	Kadirinayakanahalli	Mannarpura	
Ramasamipalli	Veerapalli	Nallacheruvapalli	Dodda Kirugambi	
Jangalapalli	Chowdadepalli	Chennahalli	Ajjivara	
Naremaddepalli MV	Raguttahalli	Varahunsenahalli A	Thimmanahalli	
Poolavarapalli	Burudagunte HC	Varahunsenahalli B	Kadiseeganahalli	
Egava Maddalakhane	Mailapura MV	Chikka Dasenahalli	Kondenahalli	
Chencharayanapalli MV	Nallagutlapalli	Gadiminchenahalli	Kuduvathi	
Bommaiagaripalli	Nimakailapalli	Chokkanahalli	Erenahalli	
G. Maddepalli HC	Digavapalli	Somanahalli	Angatta	
Jeekavanlapalli	Muddalahalli	Nallapalli	Gantiganahalli	
G. Cherulopalli	Kothapalli	Egava Jarugahalli	Bandahalli	
D. Kothapalli	Madabahalli	Thimmasandra A	Thirnahalli	
Donnakonda	Hosahudya	Karipalli A	Byranayakanahalli	
Sajjapalli MV	Vempalli	Karipalli B	Kanganahalli	

Bagepalli		Chintamani	Siddalaghatta	Chickballapur
Sajjapalli HC	Kuntlapalli	Digavakota	Shettikere A	Gowchenahalli
Saddapalli Digava Thanda	Paipalya-A	Kondavenakapalli	Kommasandra	Suddahalli
Saddapalli	Paipalya-B	Soonappagutta HC	Turukeshanahalli	
Saddapalli Egava Thanda	Krishnapuram	Soonappagutta	Kondarasanahalli	
Masanapalli	Kempaiah Thanda	Seethahalli	Gundlapalli	
Egava D. Kothapalli	Mittemari A	S. Raguttapalli	Sonaganahalli	
Maraganakunte MV-A	Mittemari B	Palligadda	Kotagal	
Maraganakunte MV-B	Mittemari C	C. Gundlapalli	Kamannahalli	
Maraganakunte HC	Vardaiagaripalli	Kotagal B	S. Kurubarahalli	
Pichilavarapalli	Vanaganapalli	Gudisalapalli	Kudupukunte	
Honnampalli	Buttavarapalli	Gopalapura	Nakkalahalli	
Shastrolapalli	Patrolapalli	Kurumarlapalli		
Pesalaparthi HC	Saprampalli	Chowdareddipalya		
Narayanaswamykote	Giripalli	Lakkepalli		
Gownavaripalli	Chinna Giripalli	Guttapalya		
Boodalapalli	Hanumantharayanapalli	M. Gollahalli		
Puttaparthi	Dommirigudisulu	Kondliganahalli HC		
Madepalli	Pillagutta	Digava Devappalli		
Maddakavaripalli	Singinikuduru	Chennarayanagadda		
Kothakota	Patlopalli	Vangamala		
Byrappanapalli	Chinnarapalli	Yasagalahalli		
Koigutta Thanda	Gwallapalli	Brahmanahalli		
Kondoripalli	Surappalli	Madamangala		
Gorthapalli A	Malligurki	Yerrakota		
Somakapalli	Chinnampalli	Gudarlahalli HC		
Peddarajapalli	Gubbolapalli	Gudarlahalli MV		
Pokamakalapalli	Kanagamakalapalli	Munganapalli HC		
Endrakayalapalli	Nallamallepalli	Munaganapalli MV		
Thimmakalapalli	Kodipalli	Talarolapalli		
Karkur	Papnepalli	Bodampalli		
Kothapalli	Merupalli	Mallikapura		
Sreenivasapuram	Arigepalli	Beerajenahalli		
Pullavandlapalli				
Ragimekalapalli				
Venkateshpalli				
Kothakotavandlapalli				
Vasapparalapalli				
Sreerampura				
Nadimpalli				
Vadigiri				
Bandolapalli				
Chokkampalli				
Utigundi Thanda				
Burugumadagu				
Marapagaripalli				
Polanayakanapalli HC				
Polanayakanapalli MV				
Poolakuntlapalli				
Bommasandra				