

***Annual Emission Reduction Report  
for  
Biogas Support Programme – Nepal (BSP-Nepal)  
Activity 1 (CDM project 0136)***



***(Biogas to Save  
This Village in  
Nepal and the  
World from  
Environmental  
Disaster)***

Submitted to:  
The World Bank

Through:  
Alternative Energy Promotion Centre (AEPC)

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## **1. Background**

All the good work done by the Biogas Support Programme (BSP) of Nepal, particularly in terms of its contribution in helping rural people of Nepal in improving their life in different fronts and in contributing to the protection of the global environment, has been widely recognized in Nepal and abroad. The programme modality developed in BSP has become a model for dissemination of biogas and other similar products to rural areas not only in Nepal but also in other parts of the world. The modality is integrated, effective and efficient as well. It has all the elements for delivery with quality, sustainability, check-and-balance, expanding its outreach to remote areas and reaching to the poorer households.

In this context, an MoU was signed by the Alternative Energy Promotion Centre (AEPC) and the World Bank in 2004 to develop CDM project in the BSP of Nepal, starting from development of a methodology. The MoU included trading of Emission Reduction equivalent to 1 million tons of CO<sub>2</sub>. Two small scale CDM Projects with a total of 19,396 biogas plants were registered with the CDM Executive Board in December 2005 and approved.

Consequently, an Emission Reduction Purchase Agreement (ERPA) was signed by the AEPC and the World Bank in May 2006 for trading of the Emission Reductions (ERs) from the two CDM Projects for 7 years. An Implementation Agreement was also signed in May 2006 between AEPC and Biogas Sector Partnership-Nepal (BSP-Nepal).

Though crediting period started from August 1, 2004, this is the first time this reporting is being carried out. There is another report being submitted together for reporting on community benefits, including environmental mitigation.

The reporting should have taken place in August or September 2006. However, it took quite some time as reporting is being done for the first time and BSP-Nepal took longer time than expected to complete activities that were necessary to effectively report.

## **2. Description of the Small Scale Project Activity in General**

The project activity reduces Green House Gas (GHG) emissions by displacing conventionally used fuel sources for cooking, such as fuel wood, kerosene, dung cakes and agricultural residues. The proposed project activity is a sub-project of the national biogas programme called Biogas Support Programme (BSP), which currently is in its Phase IV (2003-2009). Since it is the sub-activities of the umbrella biogas program, the sub-project is named as BSP-Nepal Activity-1.

Table 1: Summary of Plants with Different Sizes and Constructed in Different District Categories in the CDM Project.

<b>Total Plants Registered Under CDM</b>						
<b><i>Project Activity 1 (Construction Date: 1 Nov 2003 to 15-Jun-2004)</i></b>						
<b>Location</b>	<b>4 m3</b>	<b>6 m3</b>	<b>8 m3</b>	<b>10 m3</b>	<b>Total</b>	<b>Grand Total</b>
<i>Terai</i>	199	3807	988	111	<b>5,105</b>	
<i>Hill</i>	1284	3137	106	6	<b>4,517</b>	
<i>Remote Hill</i>	19	44	7	0	<b>70</b>	
<b>Total</b>	<b>1,502</b>	<b>6,988</b>	<b>1,101</b>	<b>117</b>	<b>9,708</b>	<b>9,708</b>

Out of the above plants, 16 of them constructed in Makwanpur district and included in the Project Activity 1 have been reported to be non-existing by the company. Hence these plants have been excluded from the Emission Reduction Calculation.

## **2.1. Types of the Project Activities**

Type I: Renewable Energy Projects  
Category I. C. Thermal Energy for the User

## **2.2. Technology of the Project Activity**

The household biogas digester plants constructed under this project activity provide biogas for the thermal energy needs of households with 2 heads of cattle (cow or buffalo) and displace fossil fuel and/or non-renewable biomass products (firewood). Farming households living in villages in remote areas are the primary buyers of biogas plants. The biogas plants are based on a uniform technical design and are manufactured and installed following established technical standards in Nepal. The households feed dung of cattle (cows or buffaloes) mixed with water into the biogas plant, which through anaerobic digestion produce biogas.

## **2.3. Biogas Support Program-Nepal (BSP-Nepal) Activity 1**

As part of contributing to the overall goals of the umbrella program, the proposed project activity has installed a total of 9,708 small biogas digesters from November 1, 2003 to June 15, 2004 in a number of districts of Nepal. as shown below in Table A.1. A biogas plant produces biogas, thermal energy for cooking. The power equivalent of the installed biogas plants ranges from 1.16 KW to 2.32 KW and the total installed equivalent generation capacity of the proposed project activity totals 14.73 MW.

Table 2: District Wise Distribution of Biogas Plants in Project Activity 1

Districts	Number of Plants	Districts	Number of Plants	Districts	Number of Plants
Arghakhachi	21	Kabrepalanchowk	190	Rasuwa	23
Baglung	11	Kailali	571	Rautahat	70
Baitadi	1	Kanchanpur	469	Rupandehi	279
Banke	148	Kapilbastu	220	Sankhuwasabha	31
Bara	124	Kaski	573	Saptari	8
Bardiya	264	Kathmandu	70	Sarlahi	181
Bhaktapur	60	Lalitpur	101	Sindhuli	200
Chitawan	575	Lamjung	249	Sindhupalchowk	29
Dadeldhura	10	Mahottari	45	Siraha	11
Dang	352	Makawanpur	612	Solukhumbu	10
Darchula	29	Morang	398	Sunsari	226
Dhading	54	Myagdi	26	Surkhet	81
Dhankuta	135	Nawalparasi	423	Syangja	273
Dhanusa	13	Nuwakot	103	Tanahu	694
Dolakha	112	Palpa	215	Taplejung	9
Doti	5	Panchther	41	Terathum	3
Gorkha	171	Parbat	74	Udayapur	91
Gulmi	74	Parsa	21	<b>Total</b>	<b>9,708</b>
Ilam	107	Pyuthan	19		
Jhapa	707	Ramechhap	96		

## 2.4. Project Commissioning

Biogas plants are constructed and commissioned immediately after construction with initial feeding of the plants with a large amount of cattle dung mixed with water. Feeding at specified quantity is done every day for regular gas generation to make gas available for cooking and lighting daily.

## 3. Monitoring Period

Quality Control & Monitoring of newly constructed plants and that of After Sales Service (ASS) of one or two years old plants, including use of bio-slurry, toilet connection, etc. is the regular and main activity in BSP even before becoming a CDM Project. However, as some of the things, including the Monitoring Plan were still being developed, the monitoring period that covered all parameters has been from 1<sup>st</sup> of January, 2006 to 31<sup>st</sup> of July, 2006.

## **4. Parameters & Process Used for Emission Reduction Calculation**

### **4.1. Emission Reduction Calculation**

The systematic surveillance of the project's performance is done by measuring and recording performance-related indicators relevant to the project or activity. This methodology contains the Emission Reduction Calculation process for the two registered sub-projects, Project Activity 1. A process consisting of five steps is followed to determine the net emission reduction.

### **4.2. ER Calculation Process**

Step 1: Identification of baseline and project emission sources;  
Step 2: Identification of emission factors;  
Step 3: Identification of activity volumes;  
Step 4: Calculations of emissions per source;  
Step 5: Calculation of emission reduction factors per plant per region.

#### **Step 1: Identification of baseline and project emission sources:**

In this project, the baseline is GHG emission from burning of fuel wood and kerosene. The GHG emissions are CO<sub>2</sub> emissions from burning of kerosene and unsustainable fuel wood and CH<sub>4</sub> emission from burning of fuel wood. For the project emission there is no direct GHG emission from the biogas plant. The only emission that needs to be looked at is the fugitive emission when methane leaks from the digester.

**Step 2, Step 3, Step 4: Identification of emission factors, Identification of activity volumes and Calculation of emission per source.**

#### **Fuel baseline**

1. CO<sub>2</sub> emissions from kerosene burning
2. CO<sub>2</sub> emissions from fuel wood burning
3. CH<sub>4</sub> emissions from fuel wood burning

**Step 5: Aggregation of emissions per source into standardized emission reduction factor**

Emission reduction factor for a biogas plant of a particular size in a particular region =  
+ CO<sub>2</sub> emission reduction from kerosene savings in t-CO<sub>2</sub> equivalent (I)  
+ CO<sub>2</sub> emission reduction from fuel wood savings in t-CO<sub>2</sub> equivalent (II)  
+ CH<sub>4</sub> emissions reduction from fuel wood savings in t- CO<sub>2</sub> equivalent (III)  
- CH<sub>4</sub> emissions from biogas leakage from the digester in t-CO<sub>2</sub> equivalent (IV)

### 4.3. Total Emission Reduction Calculation

The approach to the baseline is based on the calculation of a standardized net emission reduction factor per biogas plant per region. The following are the steps to calculate the emission reductions due to the project activity during a given period.

1) Number of installed biogas plants under the project = N

2) Determine annual performance ratio of the installed biogas plants in year 1 given by  
 $P_1 = \text{Total Number of Biogas Plants that are operational} / \text{Total Number of Biogas Plants Sold}$

Whereby  $0 < P_1 < 100\%$

3) Determine Emission Reduction Factor applicable to the installed biogas plants

a) Calculate the net emission reduction factor for a biogas plants of size a in region b in a given period, say year 1, by

$[ERF_{(a,b,1)}] = \text{CO}_2 \text{ emissions from kerosene savings in tCO}_2\text{eq} + \text{CO}_2 \text{ emissions of fuel wood savings in tCO}_2\text{eq (II)} + \text{CH}_4 \text{ emissions from fuel wood savings} - \text{CH}_4 \text{ leakage emissions from biogas digester and incomplete combustion in tCO}_2\text{eq (V)}$

b) Determine the geographic and size distribution (in %) of the installed biogas plants

c) Determine weighted average emission reduction factor of all installed biogas plants in year 1 =  $ERF_{(w,1)}$

*If the weighted ER factor is  $> 5 \text{ t-CO}_2 / \text{bio-digester/year}$ , apply the ER factor of  $4.99 \text{ t-CO}_2/\text{plant/year}$*

*If the weighted ER factor is  $< 5 \text{ t-CO}_2 / \text{bio-digester/year}$ , apply that weighted ER factor*

Therefore,

<b>Total emission reductions of the project activity in year 1 = <math>N * P * ERF_{(w, 1)}</math></b>
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## 5. Monitoring Methodology

### 5.1. Sampling Methods for the Annual Biogas Users' Survey and Regular Quality Control and Monitoring

#### 5.1.1. Random Sampling for Annual Biogas Users' Survey (BUS)

Sampling or the BUS was done by BSP-Nepal with the help of a multi-tiered random sampling. For this, BSP-Nepal added a Random Sampling facility in the existing BSP Database. Completely randomized samples were selected using the software. A four tiered system was followed in which 15 clusters were defined in the basis of 5 Development

Regions and 3 categories of districts (terai, hill and remote hill) in each Development Region.

In each cluster, districts were randomly sampled and in each sampled districts Village Development Committees (VDCs) were again randomly sampled. Samples of households were finally taken from households in sampled VDCs. Cluster wise distribution of plant was then generated by defining plant construction period as follows:

**Step 1:**

Data input: Define Plant Construction Period.  
Report to be generated: Cluster Wise Distribution of Plants.

Period: from ----- to -----

Cluster Name	No. of Districts	No. of VDC	No. of Plants

In the second step, district wise distribution of plants was generated by defining number of districts to be randomly sampled within a selected cluster.

**Step 2:**

Data input: Define Plant Construction Period.  
Select a Cluster.  
Define No. of Districts to be randomly sampled.  
Report to be generated: List of Sampled Districts with No. of Plants

Cluster Name: ..... Period: from ----- to -----

Sampled District Name	No. of VDC	No. of Plants

In the third step, list of sampled VDCs with no. of plants was generated by defining number of VDCs to be randomly sampled from the sampled districts.

**Step 3:**

Data input: Select the previously sampled districts in Step 2. Define No. or Percentage of VDCs to be randomly sampled from the already sampled district(s) in Step 2.

Report to be generated: List of Sampled VDC with No. of Plants

Cluster Name: ..... Period: from ----- to -----

District Name	Name of VDCs	No. of Plants



Finally, detail list of sampled households was generated from the sampled VDCs in step 3.

**Step 4:**

Data input:                      Select the previously sampled districts in Step 2  
   Define the Total No. or Percentage of Plants to be sampled from the  
   sampled VDC(s) in Step 3

Report to be generated:        Detail List of Sampled Households

Cluster Name: .....                      Period: from ----- to -----

District Name	VDC /NP Name	Plant Name	Owner	Address ....

The actual survey and reporting was done by a consultant hired by AEPC.

#### **5.1.2. Sampling for Regular Quality Control & Monitoring in BSP**

The purpose of this regular task is to check the quality of the biogas plants and the after-sales service provided, including training for use and use of bio-slurry. Newly constructed plants are inspected for construction and operation qualities. This is done for 5% randomly sampled households. Another 5% of the randomly sampled households are inspected in the second year for quality of ASS and use of slurry. The same is repeated in the third year. At least 5% of plants are checked with a minimum of two plants per branch per company.

This task is linked to three questionnaires; all are included in the overall performance evaluation of biogas companies termed as Biogas Performance Index (BPI).

The data collected from the Biogas User Survey and from the regular Quality Control & Monitoring of new and ASS plants are entered in the oracle based on BSP Database system. The next step is the data generation for ER calculations in CDM.

## **6. ER Calculation Process in BSP Database System**

1. The BSP Database has the facility to record both the Summary Tabular data and detail Individual Plant Survey Data received from the User Survey.
2. The system has the facility for ER calculation from data received from Quality Control & Monitoring System.
3. Format of data received from the Summary Data form of the User Survey and the Quality Control & Monitoring is as follows:

**a. Average Firewood Consumption**

Region		Terai / Hills							
Plant Size	Avg. Family Size	Average Firewood Consumption per HH (Kgs/day)						Avg. Firewood Saving kg / Day	Firewood Saving/ Year
		Summer			Winter				
		Before	After	Saving	Before	After	Saving		

**b. Average Kerosene Consumption**

Region		Terai / Hills							
Plant Size	Avg. Family Size	Average Firewood Consumption per HH (Liters/day)						Avg. Kerosene Saving Litres / Day	Kerosene Saving/ Year
		Summer			Winter				
		Before	After	Saving	Before	After	Saving		

**c. Methane Leakage**

Methane Leakage							
GWP							
Methane Density							
% Methane in Biogas							
Size	M3 Biogas / Day	M3/Yr	M3-ch4/year	leakage	tCh4/plant/year	tCO2eq/plant /year	

**4. Data Received For Individual Plant from Annual User Survey is as follows:**

Plant Code					
Owner Name					
Survey Date					
Family Size					
1 Bhari = ..... Kg					
Firewood Consumption (Bhari/Month)	Before Biogas		After Biogas		
	Summer	Winter	Summer	Winter	
Kerosene		Before Biogas		After Biogas	

Consumption (Litre /Month)	Summer	Winter	Summer	Winter
Firewood Cost (NRS Per Bhari)				
Fuelwood Cost (NRS Per Litre)				

3.1 Based on the individual data the system generates a table similar to the tables mentioned in point 2.

3.2 For converting month to day. 1 month = 30 days should be assumed.

5. The system has the option for defining the following parameters for each ER Calculation period.

- Methane Leakage (in %)
- GWP
- Methane Density
- % Methane in Biogas
- MW Capacity for Size 4, 6, 8 or 10 M<sup>3</sup>

6. Based upon the above system, the following reports are generated.

6.1 Net CO<sub>2</sub> Emission Saving from kerosene for cooking

	<b>Terai</b>	<b>Hill</b>	<b>Mountain</b>	<b>Average (Terai and hills)</b>	<b>Weighted Average</b>
4M3					
6M3					
8M3					
10M3					

6.2 Net CO<sub>2</sub> Emission Saving from Firewood for cooking

	<b>Terai</b>	<b>Hill</b>	<b>Mountain</b>	<b>Average (Terai and hills)</b>	<b>Weighted Average</b>
4M3					
6M3					
8M3					
10M3					

6.3 Net CH<sub>4</sub> Emission Saving from Firewood

	<b>Terai</b>	<b>Hill</b>	<b>Mountain</b>	<b>Average (Terai and hills)</b>	<b>Weighted Average</b>
4M3					
6M3					
8M3					
10M3					

6.4 Net Emission Reduction from Fuel Saving

	<b>Terai</b>	<b>Hill</b>	<b>Mountain</b>	<b>Average (Terai and hills)</b>	<b>Weighted Average</b>
4M3					
6M3					
8M3					
10M3					

#### 6.5 Methane Emission

	<b>Terai</b>	<b>Hill</b>	<b>Mountain</b>	<b>Average (Terai and hills)</b>	<b>Weighted Average</b>
4M3					
6M3					
8M3					
10M3					

#### 6.6 Net GHG savings per digester (t-CO<sub>2</sub> e/plant/year)

	<b>Terai</b>	<b>Hill</b>	<b>Mountain</b>	<b>Average (Terai and hills)</b>	<b>Weighted Average</b>
4M3					
6M3					
8M3					
10M3					

#### 6.7 Annual t-CO<sub>2</sub> eq Emission Reduction

	<b>Terai</b>	<b>Hill</b>	<b>Mountain</b>	<b>Average (Terai and hills)</b>
4M3				
6M3				
8M3				
10M3				

7. The system has the facility to calculate ER for any period as defined.

## 7. Summary Report on Emission Reduction

### 7.1. Details of Emission Reduction Calculation

The following chart is directly generated from the BSP Database, which shows details of the Emission Reduction calculation. For the Project Activity 1, the calculation is done for the monitoring periods August 1, 2004 to July 31, 2005 and August 1, 2005 to July 31, 2006.

Table 4: Details of Emission Reduction Calculation for Project Activity 1

Emission Reduction Calculation for Project Activity 1				
<b>A.</b>	<b>Annual Performance Rate</b>			
	Crediting Period		1	2
	Fiscal Years		August 1, 04 to July 31, 05	August 1, 05 to July 31, 06
	Total Number of Existing Plants		9692	9692
	Annual Performance Rate		98.70%	98.70%
<b>B.</b>	<b>Annual Emission Reduction Factor</b>			
	Annual Weighted ER Factor		8.9975	8.9975
	Applied ER Factor		4.99	4.99
<b>C.</b>	<b>Emission Reductions</b>			
	Size/Region (Terai/Hills)	Units	<b>ER1 (tCO2)</b>	<b>ER2 (tCO2)</b>
	4m3 Hill (*)	1287	6338.64	6338.64
	4m3 Terai	199	980.10	980.10
	<b>4m3 Total</b>	<b>1486</b>	<b>7318.74</b>	<b>7318.74</b>
	6m3 Hill	3181	15666.84	15666.84
	6m3 Terai	3807	18749.97	18749.97
	<b>6m3 Total</b>	<b>6988</b>	<b>34416.81</b>	<b>34416.81</b>
	8m3 Hill	113	556.54	556.54
	8m3 Terai	988	4866.03	4866.03
	<b>8m3 Total</b>	<b>1101</b>	<b>5422.57</b>	<b>5422.57</b>
	10m3 Hill	6	29.55	29.55
	10m3 Terai	111	546.69	546.69
	<b>10m3 Total</b>	<b>117</b>	<b>576.24</b>	<b>576.24</b>
	<b>Total</b>	<b>9692</b>	<b>47734.36</b>	<b>47734.36</b>
	<b>Total ERs from Activity-1 during Aug 1, 04 to July 31, 06</b>			<b>95,468</b>

\* 16 plants reported to be non-existing have not been considered in the calculation of ERs

## 7.2 Total Emission Reduction Claimed for Project Activity 1

The overall Emission Reduction from the two Projects is calculated discounting the values calculated and presented below.

Table 6: Summary of Total Net Emission Reduction Calculation for Project Activity 1

Crediting Period	1	2
Date	August 1, 04 to July 31, 05	August 1, 05 to July 31, 06
Total Number of Existing	9,692	9,692

<b>Plants</b>		
<b>Annual Performance Rate</b>	98.7%	98.7%
<b>Annual Weighted ER factor</b>	8.9975	8.9975
<b>Applied ER factor</b>	4.99	4.99
<b>Total Annual ER claimed from Project activity 1</b>	47,734.36	47,734.36
<b>Grand Total ER claimed from project activity 1</b>		<b>95,468</b>

Thus, the total Emission Reduction claimed from the Project in the period from August 1, 2004 to July 31, 2006 is 95,468.

#### **Annex 1. Summary of Emission Reduction Factors Calculated for Each Plant Size in Each District Category**

Summary of Emission Reduction Factors for PA1 & PA2				
Unit: t-CO2 equivalent per plant per year				
A. Fuel Savings				
1. Net CO2 Emission Saving from Kerosene for cooking				
Location	Terai	Hill+Remote Hill	Average	Weightage Average
Size Code	Total Value	Total Value		
4	0.1100	0.0423	0.0761	
6	0.0211	0.1867	0.1039	
8	-	-	-	
10	0.1759	-	0.0880	0.0793
2. Net CO2 Emission Saving from firewood for cooking				
Location	Terai	Hill+Remote Hill	Average	Weightage Average
Size Code	Total Value	Total Value		
4	7.2447	8.1258	7.6852	
6	9.9071	8.4288	9.1680	
8	10.6148	8.6834	9.6491	
10	10.6872	-	5.3436	9.1865
3. Net MH4 Emission Saving from firewood				
Location	Terai	Hill+Remote Hill	Average	Weightage Average
Size Code	Total Value	Total Value		
4	0.3286	0.3685	0.3486	
6	0.4493	0.3823	0.4158	
8	0.4814	0.3998	0.4376	
10	0.4847	-	0.2424	0.4167
Net Emission Reductions from Fuel Saving				
Location	Terai	Hill+Remote Hill	Average	Weightage Average
Size Code	Total Value	Total Value		
4	7.6832	8.5366	8.1099	
6	10.3776	8.9978	9.6877	
8	11.0962	9.0832	10.0897	
10	11.3479	-	5.6739	9.5735
B. Project Emissions: Fugitive Emissions including leakage from biogas digester and CH4 emissions from incomplete combustion				
Location	Terai	Hill+Remote Hill	Average	Weightage Average
Size Code	Total Value	Total Value		
4	0.4100	0.4100	0.4100	
6	0.5900	0.5900	0.5900	
8	0.7600	0.7600	0.7600	
10	0.9600	0.9600	0.9600	0.5861
C. Net GHG Savings per Digester (t-CO2 e/plant/year)				
Location	Terai	Hill+Remote Hill	Average	Weightage Average
Size Code	Total Value	Total Value		
4	7.2732	8.1266	7.8519	
6	9.7876	8.4078	9.3346	
8	10.3362	8.3232	9.3297	
10	10.3879	-	5.1939	8.9975

**Annex 2: Summary of Quality Control & Monitoring for FY 2005/06 That Forms the Basis for Emission Reduction Calculation**

S. NO.	Particulars	Fiscal Years			Average
		2003/04	2004/05	2005/06	
1	Number of Total Plants Constructed	11,259	17,803	16,118	
2	Number of Plants Which Received After Sales Service (ASS carried out in FY 2005/06 for plants constructed in FY 2003/04 and 2004/05)	10,710	17,060	X	
3	Number of Plants Inspected for Quality of ASS	570	901		
4	ASS Progress Made (%)	95.12	95.83		95.48
5	Number of Newly Constructed Plants Inspected for Quality			855	
6	Total Quality Control & Monitoring Progress (%)	5.32	5.28	5.31	5.30