

MONITORING REPORT FORM (CDM-MR) *
Version 01 - in effect as of: 28/09/2010

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* as contained within the document entitled "Guidelines for completing the monitoring report form (CDM-MR)" (EB 54 meeting report, annex 34).

MONITORING REPORT
Version 01 dated 03/10/2011I

Hubei Eco-Farming Biogas Project Phase I
CDM Registration Reference Number: 2221
Second Monitoring period (01/09/2009 - 31/12/2010)

SECTION A. General description of the project activity

A.1. Brief description of the project activity: >>

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1. Purpose of the project activity and the measures taken to reduce greenhouse gas emissions

Hubei Eco-Farming Biogas Project Phase I located in Enshi Prefecture, a mountainous poor area of Hubei Province. The purpose of this project is to demonstrate innovative technical approaches and a credible carbon trade process for a household-based Clean Development Mechanism (CDM) biogas digester program.

The project activity is a bundle of 33,000 household-level activities, which recover methane from biogas digesters with pig manure as fermentation material and utilize the generated biogas to displace fossil fuel for cooking and heating. In addition, the recovery and utilization of biogas from digested slurry in a biogas digester reduced CH₄ emission from the manure that would otherwise have been stored in a deep pit.

2. Brief description of the installed technology and equipments

The technology employed by the project activity includes installing “one biogas digester with 3 supplementary renovations” for 33,000 households in Enshi Prefecture, Hubei Province. More specifically, the project installed 10082 biogas digesters with reactor size of 8 m³; 14181 biogas digesters with reactor size of 10 m³; 4167 biogas digesters with reactor size of 12 m³; and 4,570 biogas digesters with reactor size of 15 m³.

3. Relevant dates for the project activity (e.g. construction, commissioning, continued operation periods, etc.)

The project installed 33,000 household biogas digesters during 2007 and 2008, and the installation completed before July 2008. Biogas digesters were commissioned after construction and initial check. All biogas digesters began to generate biogas for daily cooking and heating water before September, 2008. The certified emission reduction for first monitoring (19/02/2009 – 31/08/2009) was issued in 11/05/ 2011.

4. Total emission reductions achieved in the second monitoring period

This monitoring report is for the second monitoring period, which is from 01/09/2009 to 31/12/2010. Total emission reductions achieved in this monitoring period are 74,489 tCO₂e.

A.2. Project Participants

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Table A1: 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)
The People's Republic of China (host)	Hubei Qingjiang Zhongye Company Ltd.	No

State of the Netherlands, acting through the Netherlands' Ministry of Housing, Spatial Planning, and the Environment	The International Bank for Reconstruction and Development (IBRD) as trustee of Community Development Carbon Fund	Yes
Italy	Government of Italy - Ministry for the Environment, Land and Sea	Yes
Luxembourg	Government of Luxembourg - Ministry of Sustainable Development and Infrastructure - Department of Environment	Yes
Norway	Statkraft Carbon Invest AS	Yes
Norway	Statoil ASA	Yes
Spain	Endesa Generación, S.A.	Yes
Spain	Kindgom of Spain - Ministry of Environment and Rural and Marine Affairs, Ministry of Economy and Finance	Yes
Spain	EDP-Energias de Portugal, S.A.	Yes
Spain	Gas Natural SDG, S.A.	Yes
Spain	Hidroeléctrica del Cantábrico, S.A.	Yes
Sweden	Göteborg Energi AB	Yes
Switzerland	Schweizerische Rückversicherungsgesellschafts AG (Swiss RE)	Yes
Germany	BASF SE	Yes
Germany	KfW	Yes
Austria	Kommunalkredit Public Consulting GmbH	Yes
Finland	Rautaruukki Oyj	Yes
Japan	Daiwa Securities Capital Markets Co. Ltd.	Yes
Japan	FUJIFILM Corporation	Yes
Japan	Idemitsu Kosan Co., Ltd.	Yes
Japan	JX Nippon Oil & Energy Corporation	Yes
Japan	The Okinawa Electric Power Corporation, Incorporated	Yes
Belgium	Kingdom of Belgium – Walloon Region	Yes
Belgium	Walloon Air and Climate Agency	Yes
Belgium	Bruxelles Environnement - IBGE	Yes
Canada	Government of Canada - Ministry of Foreign Affairs and International Trade	Yes
Denmark	Aalborg Portland A/S	Yes
Denmark	DONG Naturgas A/S	Yes
Denmark	Danish Ministry of Climate and Energy/Danish Energy Agency	Yes
Denmark	Mærsk Olie og Gas AS	Yes
Denmark	Nordjysk Elhandel A/S	Yes

A.3. Location of the project activity:

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The location of the project is in eight counties including Enshi, Lichuan, Jianshi, Badong, Xuan'en, Xianfeng, Laifeng and Hefeng of Enshi Prefecture, a mountainous poor area of Hubei Province. The location of the activities is shown in Table A2.

Table A2: Location of project counties

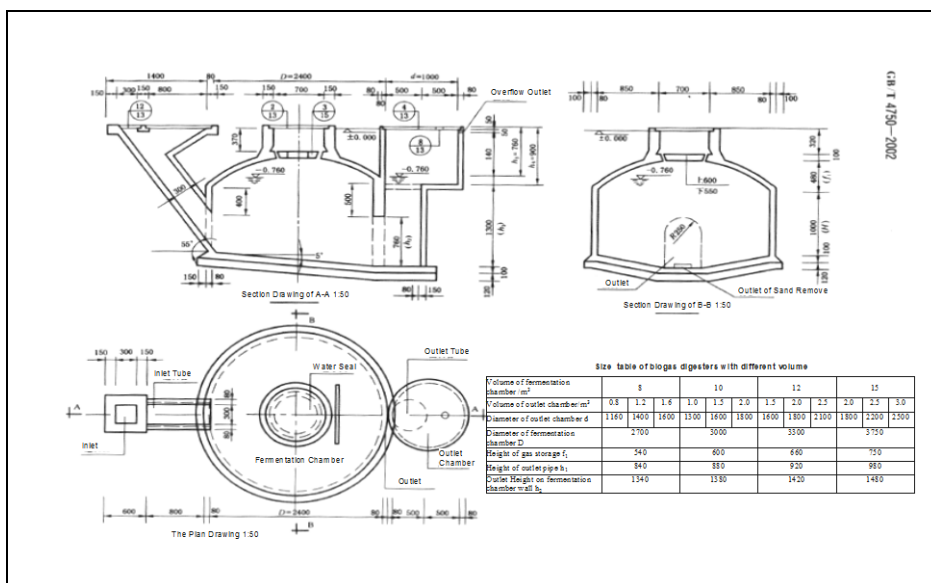
County/ City	County/City capital Latitude	County/City capital Longitude	County/City scope longitude	County/City latitude scope
Enshi	+109.475	+30.270278	+29.8425 - +30.659167	+109.08 - +109.978333
Jianshi	+109.72222 2	+30.603333	+30.101944 - +30.907222	+109.542778 -+110.214167
Badong	+110.345	+31.043889	+30.226944 - +31.4725	+110.068889 - +110.537222
Lichuan	+108.93166 7	+30.298056	+29.710556 - +30.653611	+108.361667 - +109.313056
Xuan'en	+109.47972 2	+29.993333	+29.555 - +30.203611	+109.197778 - +109.926111
Xianfeng	+109.15194 4	+29.696389	+29.324444 - +30.048333	+108.618889 - +109.335556
Laifeng	+109.40277 8	+29.509722	+29.104167 - +29.684722	+109.016667 - +109.429167
Hefeng	+110.01555 6	+29.887778	+29.645556 - +30.247222	+109.755833 - +110.637222

A.4. Technical description of the project

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As per the registered PDD, the project activity includes installation of 33,000 household-based biogas digesters to provide biogas for replacing fossil fuel thermal energy needs of households raising around 4-6 pigs . The project activity comprises of two stages as follows:

Stage 1: Biogas production and Collection: The biogas digesters design was based on the technical standards established by the Chinese government. The preferred and recommended sample design is displayed in Figure A1 but minor modifications are acceptable. The design and construction of the digesters is certified by a technician accredited by the Ministry of Agriculture. The digester is installed below the pig pen (Figure A2). The digester ferment excreta from pigs that are housed in the pens above the digester. To facilitate the supply of excreta, the inlet of biogas digester was directly connected to the pigpen so that the dung can directly drain to the digester. In addition, a toilet was installed in each household next to the pig pen so that human excreta are also treated in the digester. The retention time of slurry inside the biogas digesters is around 3-6 months.



Source: Ministry of Agriculture

Figure A1. Technical Design of Biogas Digesters

The biogas digester is composed of six parts: fermentation chamber, gas storage, inlet tube, outlet chamber, removable or sealed cover, and a gas pipe line (see in Figure A2).

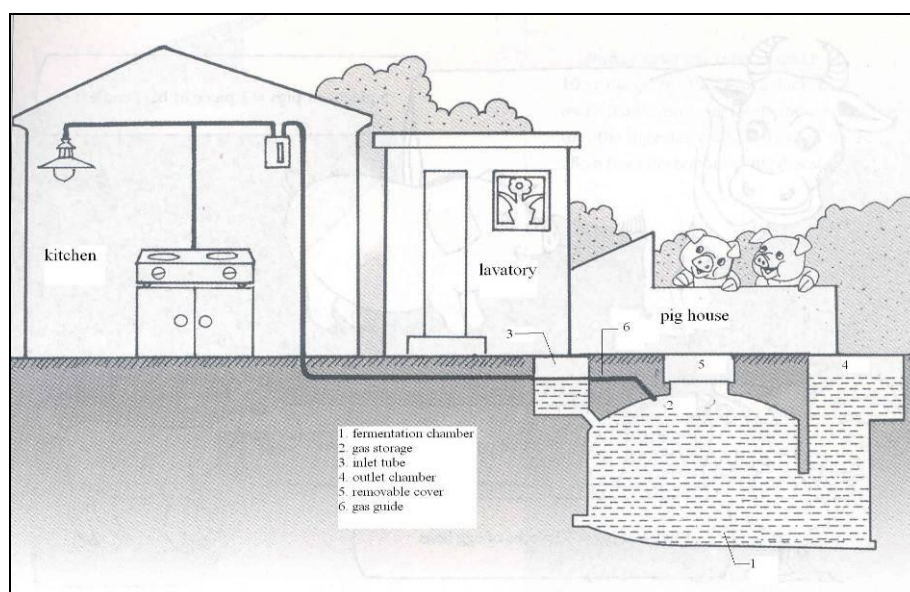


Figure A2. Schematic of “Three in One” combination of Household Biogas Digesters

The mechanics of biogas generation can be described as follows:

- The captured gas is stored in the upper part of the digester tank (gas storage area) which is constructed as an arc ship. Generation of biogas will gradually increase the pressure in the stored area. When the volume of the captured gas is larger than the amount consumed, the pressure in the gas storage will increase and slurry will be pushed into the outlet chamber. If the gas consumed exceed gas availability, the slurry level drops and the fermented slurry flows back into fermentation chamber;
- The placement of the digester tank (underground fermentation) keeps the temperature in the tank relatively stable ensuring that the slurry can be fermented at adequate temperatures throughout the year without requiring additional heating;
- The bottom of the digester inclines from the material-feeding inlet to the material-outlet,

allowing free flow of the slurry;

- The digester has been designed to allow the effluent to be removed without breaking the gas seal, taking the effluent liquid out through the outlet chamber.

●

Stage 2: Biogas Combustion Replacing Coal Burning for Thermal Energy. The captured biogas was directed to a biogas burner stove. A pressure indication device was installed to ensure proper control of gas flow at the flare, by the user. A sulphide capture device was also installed to clean the gas before burning.

Special maintenance procedures have been developed to ensure proper operation of the biogas system and proper utilization of digested slurry throughout the lifetime of the digester. This includes cleaning the sulphide capture device and periodic controls and replacements of burners.

In addition, the project strengthens the capacity of local biogas service and technical extension systems, and improves village level services for biogas operation and maintenance. This includes guidance on biogas installation, supervision of biogas digester and stove operation, provision of training and technical services to local farmers, provision of relevant facilities maintenance, and implementation of a project Monitoring Plan. By working with the farmers on a day to day basis for many years, the project developer ensures that the farmers could acquire appropriate expertise to operate the systems on a sustainable basis.

A.5. Title, reference and version of the baseline and monitoring methodology applied to the project activity:

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Approved methodologies Version 12 of AMS-I.C titled “Thermal energy for the user with or without electricity” and Version 01 of AMS-III.R titled “Methane recovery in agricultural activities at household/farm level’ were applied.

A.6. Registration date of the project activity:

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The registration date of the project activity is 19/02/2009.

A.7. Crediting period of the project activity and related information (start date and choice of crediting period):

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The start date of the crediting period is 19/02/2009, and it has a fixed 10 year crediting period. The crediting period of the project activity is (19/02/2009 - 18/02/2019).

A.8. Name of responsible person(s)/entity(ies):

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Table A3: Name of persons/entity carrying out the monitoring report:

Name/origination	Project participant Yes/No
Chen Shusheng Enshi Energy Bureau 21, Wuyang street , Enshi City, Hubei Province, 445000, China Tel: 0086- 071-88232646 ; FAX: 0086- 071-88232646 E-mail: esznyj@188.com	No
Dong Hongmin Institute of Environment and Sustainable Development in Agriculture Chinese Academy of Agricultural Sciences 12, Zhongguancun South Street, Beijing, 100081, China Tel: 0086-010-82109979 Fax: 0086-010-82109979	No

E-mail: donghm@ieda.org.cn ; donghm@mail.caas.net.cn	
Li Yue Institute of Environment and Sustainable Development in Agriculture, Chinese Academy of Agricultural Sciences. 12, Zhongguancun South Street, Beijing, 100081, China. Tel: 0086-010-82105615 Fax: 0086-010-82105615 E-mail: Yueli@ami.ac.cn ; jinghonglv@gmail.com	No
Carbon Finance Unit International Bank for Reconstruction and Development (IBRD) as a Trustee of Community Development Carbon Fund 1818 H Street, NW Washington DC, 20043, U.S.A Tel: 001-202-458-7658	Yes

SECTION B. Implementation of the project activity

B.1. Implementation status of the project activity

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The installation completed before July 2008. To ensure quality of installed biogas digesters up to the standards and its sustainable operation, all digesters were constructed by certified technicians according to the technical design as described in PDD. Township biogas Project Management Group made initial check, in which the biogas digester construction, biogas stove, biogas tube and the operation of each digesters were checked for each individual household digester. An ID card for each participating household with all relevant information was established. Based on the initial check, the county Project Management Office (PMO) checked the operation status for all the project digesters and submitted the assessment reports as well as the ID cards data base to Prefecture PMO. Biogas digesters were commissioned after construction and initial check. All biogas digesters began to generate biogas for daily cooking and heating water before September, 2008. Table B1. summarized the constructed biogas digesters with different volume in different county in the CDM project.

Table B1: Summary of Constructed Biogas Digesters with Different Volume in Different County in the CDM Project

County/City	No. of biogas digesters with different digester volume				Total no. of biogas installed 2007-2008 in each county
	8 m ³	10 m ³	12 m ³	15 m ³	
Enshi	1,918	2,412			4330
Jianshi	540	4,030			4570
Badong	1,581	2,989			4570
Lichuan	3,043	2,917			5960
Xuan'en		1,833	1,167		3000
Xianfeng				4,570	4570
Laifeng	3,000				3000
Hefeng			3,000		3000
Total	10,082	14,181	4,167	4,570	33000

To ensure the effective operation of biogas digesters established under the project, a four-level technical supporting service system has been established. Enshi Autonomous Prefecture established biogas association and consulting agency. County government established rural energy service center. Township government established rural energy service branch; and village community set rural biogas service network. The four-level service system was proved to work well to deliver timely and adequate services to the farmers and monitor the biogas digester operation for the following reasons: First, the system could provide extensive network services since each level of the service system has been

equipped with communication equipment, such as computer, internet and telephone, as well as the professional staff. The assigned engineers could provide the technical services according to the farmers' needs. Second, the system could provide quick services in short notice. For instance, the requested biogas digester maintenance services could be provided within 2 days no matter how far the household is located. Third, the system would provide timely training services. The prefecture and county PMOs as well as township service branches have TVs, videos, and training materials, as well as technical staff. They could teach farmers biogas digester operation and maintenance related knowledge. Finally each village level service network stocks with special parts and fittings for biogas digester maintenance. One village service network will reach around 300 households. Farmers could easily purchase the needed parts and fittings and receive technical assistance. Besides the four-level service system, the project also distributes Biogas Digester Operation Manual and relevant wall-hanging posters to farmers, which could remind the farmer of safety measures of operating biogas system, ensuring continuous effective operation of household biogas digesters in the crediting period. During this monitoring period, there were not any events or situations that occurred which may impact the applicability of the methodology.

B.2. Revision of the monitoring plan

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Monitoring plan described in PDD was not revised during the implementation of the Project.

B.3. Request for deviation applied to this monitoring period

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No request for deviation to the second monitoring period.

B.4. Notification or request of approval of changes

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Not applicable.

SECTION C. Description of the monitoring system

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1. Monitoring Methodology Applied

The monitoring methodology of version 12 of AMS I.C "Thermal energy for the user with or without electricity" and the monitoring methodology of version 1 of AMS III.R "Methane recovery in agricultural activities at household/small farm level" were applied, which can be found at <http://cdm.unfccc.int/methodologies/PAMethodologies/approved.html>.

Because an expected annual emission reduction is less than 5 tonnes of CO₂ a year per system (biogas digester), option (c) of version 12 of AMS I.C with version 1 of AMS III.R is applied.

In the case of Hubei Biogas Project, the bundled project activity involves installation of 33,000 household biogas digesters, of the same type of technology across eight counties. Therefore, an identical monitoring plan with defined sampling requirements is applicable for this project. The sampling methodology was applied according to the monitoring requirements of the version 12 of AMS I.C, and version 1 of AMS III.R.

2. Sampling Methods for Annual Household Survey

The sampling method for annual household monitoring includes following steps:

Step 1: Select 2750¹ participant households randomly in the database of 33,000 participant households. The number of sampling households needed for monitoring was first calculated proportionally as per total number of biogas digesters in each volume size category. 841 households with 8m³, 1182 households with 10m³, 347 households with 12m³, 380 households with 15m³, respectively, were required for monitoring across 8 counties.

¹ The number of households for the sample is chosen to achieve a 90% confidence with 10% precision for the data collected on the number of households with operating biogas digesters. It is in line with the procedure in "GENERAL GUIDELINES¹ FOR SAMPLING AND SURVEYS FOR SMALL-SCALE CDM PROJECT ACTIVITIES"(Version 01)

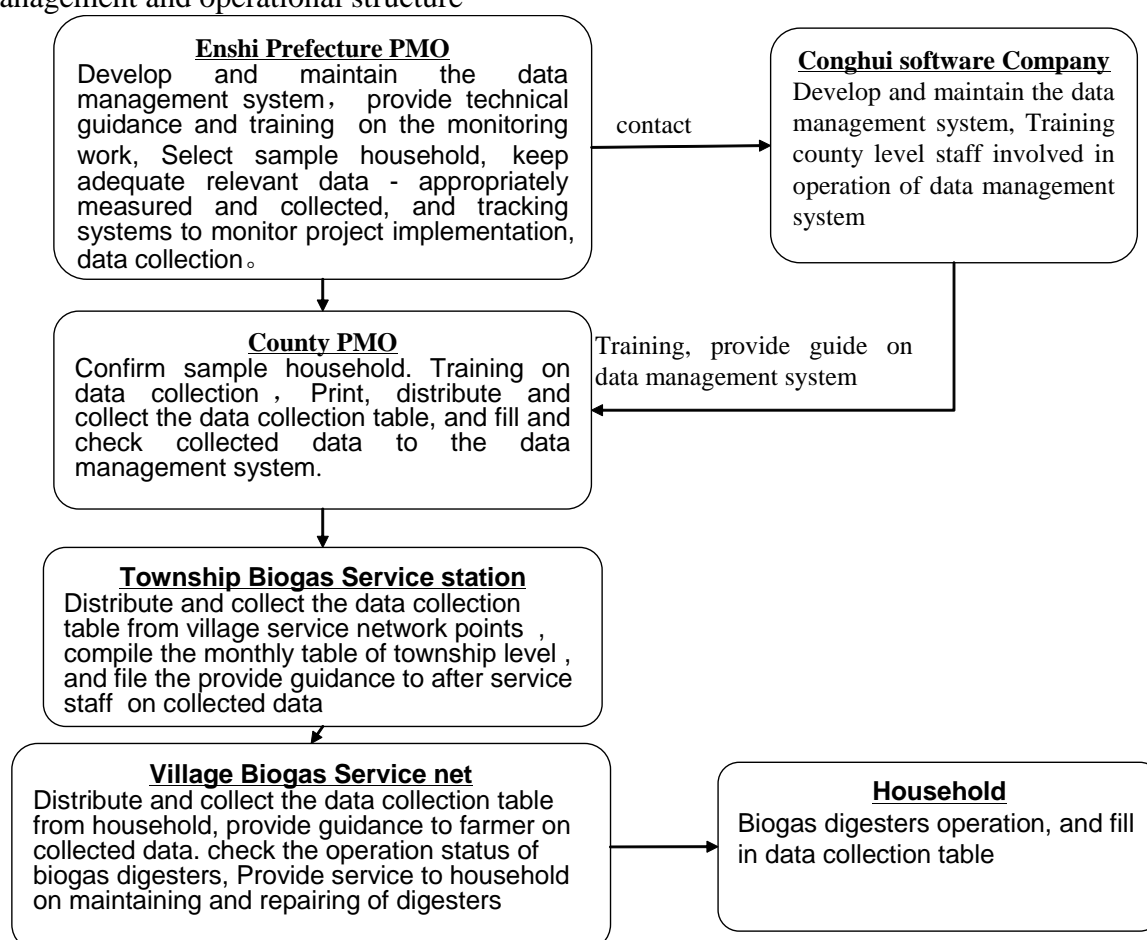
Step 2: According to required numbers of households with different volumes in each county, the database system automatically selected households with different volume for each county on a random basis and the coordination entity will distribute the sample name lists to local energy offices in each county. The distribution of the total number of 2750 sampled households is listed in table C1.

Table C1: Sampling number of households with different biogas digester volume in each county

County/City	No. of households monitored with different digesters' volume				No. of biogas digesters monitored in each county
	8 m ³	10 m ³	12 m ³	15 m ³	
Enshi	160	200			360
Jianshi	46	334			380
Badong	130	250			380
Lichuan	255	245			500
Xuan'en		153	97		250
Xianfeng				380	380
Laifeng	250				250
Hefeng			250		250
Total	841	1182	347	380	2750

3. Quality control (QC) and quality assurance (QA)

3.1 Management and operational structure



3.2 Quality control

(1) The quality control of biogas digesters installation process:

All biogas digesters were installed by certified technicians and required to pass the assessment of county level PMO. All biogas stoves were distributed to households after the equipment suppliers were selected through a public bidding process organized by the government.

(2) The quality control of monitoring data collection:

To ensure reliable field measurements and data collection quality, the following procedures were applied:

- Standard Monitoring Procedures and tables for field data collection were developed and adhered to throughout the monitoring period. According to the monitoring plan in PDD, Enshi Prefecture PMO calculated the sample size (see table C1) for each county based on the distribution of digester numbers and volume size, and then randomly selected the monitoring household as sample from the database which including the 33,000 household information. Enshi Prefecture PMO then informed county PMOs the selected monitoring households through Enshi energy documents No. ([2009] 5), and provided standard data collection tables to the county PMO.
- To improve the quality of data collection, training courses on field data collection and how to use software program for data analysis was organized in 14/08/2009, more than 30 data collection staffs from county level and township level attended the training course. The training was carried out for village service staffs after the county-level course was completed. Training courses ensured that each on-site staff fully understands and masters the whole monitoring procedure, as well as data collection process.
- To clearly define the responsibility of monitoring members at different levels, i.e. prefecture, county, township and village, through formal documents. New staffs have received adequate training. The training courses include project introduction, monitoring plan, monitoring process, and information on new staff responsibility.
- The village service staffs checked the digester operational status and examined whether data were properly filled in by the households for all project digesters in each month during the monitoring period. The staffs of township biogas service station compiled the monthly table based on the data monitored by households, and township level staff visited the monitoring household each month to check the data collected. County PMO staffs also spot-checked monitored households during this monitoring period, and then filed into the database. During data input process, one staff typed in the data in the system and another staff was required to cross check the input data to ensure data accuracy and consistency. Enshi Energy Bureau, as project coordinator kept the monitoring data and records. Data was archived electronically at the end of each month. The electronic files were stored in hard disk and cd-rom. In addition, at the end of the monitoring period, a hard copy print-out of compiled results and relevant evidence was archived. Paper documents such as maps, diagrams, and environmental impact assessments were collected and documented in PMOs and Project Entity. All data records will be kept for a period of 2 years beyond the end of the crediting period.

SECTION D. Data and parameters

D.1. Data and parameters determined at registration and not monitored during the monitoring period, including default values and factors

(Copy this table for each data and parameter. To report multiple values, a table may be used)

Data / Parameter:	MS percent
Data unit:	Fraction
Description:	Fraction of manure handled in system j in the baseline

Source of data used:	Project proponents
Value(s) :	100 percent
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Data on Fraction of manure handled in system j in the baseline are used for baseline emission calculations.
Additional comment:	

Data / Parameter:	LF_{AD}
Data unit:	%
Description:	Methane leakage from Anaerobic digester
Source of data used:	2006 IPCC Guidelines
Value(s) :	10%
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Methane leakage from anaerobic digester was applied in project emission calculation
Additional comment:	

Data / Parameter:	VS
Data unit:	kg dry matter/animal/day
Description:	Volatile solid excretion
Source of data used:	2006 IPCC Guidelines
Value(s) :	0.3
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	VS data was applied both in baseline and project emission calculation
Additional comment:	

Data / Parameter:	Bo
Data unit:	$m^3CH_4/kg\text{-}dm\text{ VS}$
Description:	Maximum methane production
Source of data used:	IPCC 2006 Guidelines
Value(s) :	0.29
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Bo data was applied both in baseline and project emission calculation
Additional comment:	

Data / Parameter:	GWP_{CH_4}
Data unit:	$tCO_2\text{ e}/tCH_4$
Description:	Global warming potential for CH_4
Source of data used:	IPCC
Value(s) :	21
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	GWP_{CH_4} of 21 was applied both in baseline and project emission calculation
Additional comment:	

Data / Parameter:	D_{CH_4}
Data unit:	kg/m ³
Description:	Conversion factor of 1 m ³ CH ₄ to kilograms CH ₄
Source of data used:	2006 IPCC Guidelines
Value(s) :	0.67
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	D_{CH_4} of 0.67 kg/ m ³ was applied both in baseline and project emission calculation
Additional comment:	

Data / Parameter:	$BG_{coal,i,k}$
Data unit:	Kg/household/year
Description:	Average annual coal consumption for household before installation of biogas digesters with volume k, in country i.
Source of data used:	Sample survey
Value(s) :	See TableB5 of regiseted PDD
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Data of $BG_{coal,i,k}$ was applied in baseline emission calculation
Additional comment:	Data was collected as parts of baseline sample survey, sample size was 2,485 households with biogas digesters, 2,485 household is accounted about 7.5 percent of total number of project household.

Data / Parameter:	$PG_{coal,i,k}$
Data unit:	Kg/household/year
Description:	Average annual coal consumption for household after installation of biogas digesters with volume k, in country i.
Source of data used:	Sample survey
Value(s) :	See Table B7of registered PDD
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data of $PG_{coal,i,k}$ was applied in project emission calculation
Additional comment:	Date was collected as parts of baseline sample survey, sample size was 2,485 households with biogas digesters, 2,485 household is accounted about 7.5 percent of total number of project household.

Data / Parameter:	NCV
Data unit:	kJ/kg
Description:	Default net calorific values of cooking coal
Source of data used:	Published data by China NDRC (www.ccchina.gov.cn)
Value(s) :	20908
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data was applied both in baseline and project emission calculation
Additional comment:	

Data / Parameter:	Carbon EF
Data unit:	tC/TJ
Description:	Carbon emission factor per unit of energy of coal that would have been used in the baseline in (tC/ TJ)

Source of data used:	Published data by China NDRC (www.ccchina.gov.cn)
Value(s) :	25.8
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data was applied both in baseline and project emission calculation
Additional comment:	

Data / Parameter:	Fraction oxidized
Data unit:	
Description:	Fraction oxidized
Source of data used:	Published data by China NDRC (www.ccchina.gov.cn)
Value(s) :	1.00
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data was applied both in baseline and project emission calculation
Additional comment:	

D.2. Data and parameters monitored	
<i>(Copy this table for each data and parameter. To report multiple values, a table may be used)</i>	
Data / Parameter:	$ND_{i,k}$
Data unit:	Number
Description:	Total number of operational household biogas digester during the monitoring period
Measured /Calculated /Default:	Calculated based on survey
Source of data:	Project proponents
Value(s) of monitored parameter:	See table D1 below
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data was used for baseline, project emission calculations
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	NA
Measuring/ Reading/ Recording frequency:	Annually
Calculation method (if applicable):	NA
QA/QC procedures applied:	<p>After the start of the project, project coordinator monitored the number of operational biogas installation and established a database containing all relative identification information of each household, such as name, address, date on installation and operation of biogas digester</p> <p>Each month, the village service staff checked the operation of all the project digesters and recorded the numbers of not operating digesters. In August - September, 2010, and December, 2010, Technicians of township service station accompanied by village</p>

	technicians visited all the households to check whether biogas digesters operating or not. If the biogas digester was not operating, the project technical support panel would investigate the reasons. For the biogas digesters which were not operating, if it was not caused by total discharge of biogas residue ² , these biogas digesters were assumed to be not operating.
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Data / Parameter:	H
Data unit:	Hour
Description:	Operational hours of biogas digesters during the monitoring period
Measured /Calculated /Default:	Calculated
Source of data:	Calculated Project proponents
Value(s) of monitored parameter:	See Table D2
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data was used for baseline, project emission calculations
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	NA
Measuring/ Reading/ Recording frequency:	Annually
Calculation method (if applicable):	The average operational hours for each country equals the total hours during the second monitoring period minus the hours when the biogas digester is not operational because of the discharge of residue.
QA/QC procedures applied:	Operational hours of biogas digesters was estimated based on the length of the period that the biogas digesters are not operating while biogas residue was discharged and the biogas digesters restarted. The length of the period that the biogas digesters were not operating was collected by surveying 2,750 household participants. The sample size of household number will ensure a precision needed to give a precision at 95% confidence intervals (T-values).

Data / Parameter:	T
Data unit:	°C
Description:	Annual Average ambient temperature at county weather station nearby project site
Measured /Calculated /Default:	Measured
Source of data:	County weather stations
Value(s) of monitored parameter:	See Table D3
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data was used for baseline, project emission calculations

² Residue discharge means to remove the biogas residue from the digester. The digester will stop producing biogas.

Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Mercury thermometer
Measuring/ Reading/ Recording frequency:	Monthly
Calculation method (if applicable):	Average the monthly mean temperature and get the average temperature during the second monitoring period.
QA/QC procedures applied:	Purchase from County meteorology stations. Archive electronically during project plus 5 years

Data / Parameter:	LN
Data unit:	Number
Description:	Swine population in individual household in project case
Measured /Calculated /Default:	NA
Source of data:	Project proponents
Value(s) of monitored parameter:	See Table D4
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data was used for baseline, project emission calculations
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	NA
Measuring/ Reading/ Recording frequency:	Monthly
Calculation method (if applicable):	Average swine population were calculated based on monthly monitored swine population of each county by volume biogas digester across the 16 months during the monitoring period.
QA/QC procedures applied:	Pig numbers which manure treated in biogas digester for the randomly sampled households in each county was recorded monthly. The average values of monitored data in each month were used as swine stock during monitoring period. Record pig number from 2,750 household participants. The sample size of 2750 household ensures a precision needed to give a precision at 95 % confidence intervals (T-values).

Data / Parameter:	The amount of manure VS generated by pigs in individual household
Data unit:	kg dry matter/day
Description:	Volatile solid contained in the manure generated by pigs in individual household in project case
Measured /Calculated /Default:	NA
Source of data:	Project proponents
Value(s) of monitored parameter:	See Table D5
Indicate what the data are used for (Baseline/ Project/ Leakage emission)	The data was used for baseline, project emission calculations

calculations)	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	NA
Measuring/ Reading/ Recording frequency:	Monthly
Calculation method (if applicable):	The amount of pig manure VS generated in individual household was calculated as product of swine population (LN) in individual household in project case in table D3 times IPCC default VS values of 0.3 kg dry matter/animal/day.
QA/QC procedures applied:	

Data / Parameter:	Sludge
Data unit:	---
Description:	Destination of biogas sludge application
Measured /Calculated /Default:	
Source of data:	Household
Value(s) of monitored parameter:	---
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data was used for baseline, project emission calculations
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	NA
Measuring/ Reading/ Recording frequency:	Monthly
Calculation method (if applicable):	NA
QA/QC procedures applied:	The destination of biogas residue in the sampled households was recorded monthly. All sludge from biogas digesters was applied to the arable land with aerobically conditions at appropriate time, thus no methane emission is generated from land application and the sludge nutrient was fully utilized. The biogas digesters would restart after all sludge was applied to land.

Table D1: Number of operating biogas digesters with different volume in different county during the second monitoring period

County/City	No. of biogas digesters with different volume				The starting date of generating biogas*
	8 m ³	10 m ³	12 m ³	15 m ³	
Enshi	1,918	2,412			01/06/2008
Jianshi	540	4,030			01/08/2008
Badong	1,581	2,988			28/05/2008
Lichuan	3,028	2,905			01/05/2008

Xuan'en		1,815	1,157		01/08/2008
Xianfeng				4,570	06/06/2008
Laifeng	2,997				01/04/2008
Hefeng			2,992		24/06/2008
Total	10,064	14,150	4,149	4,570	

* The starting date of biogas digester operation for each county is defined as the commissioning date of the last constructed biogas digesters in each county. This is conservative. The data is from database titled as "Name List of the Project Household".

Table D2: Operational hours during the second monitoring period

County name	8 m ³ (Hour)	10 m ³ (Hour)	12 m ³ (Hour)	15 m ³ (Hour)
Enshi	11681.4	11682.0		
Jianshi	11685.9	11673.8		
Badong	11687.1	11684.0		
Lichuan	11680.5	11680.3		
Xuan'en		11655.4	11688.0	
Xianfeng				11672.8
Laifeng	11680.8			
Hefeng			11678.5	

Table D3: Average temperature in different counties during the second monitoring period

County	Enshi	Jianshi	Badong	Lichuan	Xuan'en	Xianfeng	Laifeng	Hefeng
(°C)	15.7	15.2	16.7	12.8	15.5	13.9	15.8	15.5

Table D4: Average annual swine stock during the second monitoring period

County name	8 m ³ (Head)	10 m ³ (Head)	12 m ³ (Head)	15 m ³ (Head)
Enshi	4.61	4.72		
Jianshi	4.39	4.47		
Badong	4.54	4.46		
Lichuan	4.11	4.06		
Xuan'en		4.07	4.38	
Xianfeng				4.43
Laifeng	3.72			
Hefeng			4.45	

Table D5: Volatile solid contained in the manure generated by pigs in individual household in project case

County name	8 m ³ kg dry matter/day/head	10 m ³ kg dry matter/day/head	12 m ³ kg dry matter/day/head	15 m ³ kg dry matter/day/head
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Enshi	1.38	1.42		
Jianshi	1.32	1.34		
Badong	1.36	1.34		
Lichuan	1.23	1.22		
Xuan'en		1.22	1.31	
Xianfeng				1.33
Laifeng	1.12			
Hefeng			1.34	

Table D6: Average application times and its destination of sludge during the second monitoring period

County name	Dry land (time)				Vegetable field (time)				Paddy field (time)			
	8m ³	10 m ³	12 m ³	15 m ³	8m ³	10 m ³	12 m ³	15 m ³	8 m ³	10 m ³	12 m ³	15 m ³
Enshi	6.7	7.0			4.8	3.9			0	0		
Jianshi	5.4	5.0			2.4	4.0			0	0		
Badong	4.3	4.7			5.6	5.4			0	0		
Lichuan	5.4	5.4			7.4	7.0			0	0		
Xuan'en		6.2	6.4			5.4	4.4			0	0	
Xianfeng				5.3				4.8				0
Laifeng	4.1				6.1				0			
Hefeng			6.0				8.3				0	

SECTION E. Emission reductions calculation

E.1. Baseline emissions calculation

>>

This section shall include all formulae used and description to calculate the baseline emissions applying actual values. A table may be used and included in this monitoring report or include references to spreadsheet.

The calculation spreadsheet on baseline emission are included in excel file named as Hubei Household biogas CDM-ER calculation-second monitoring period.

Baseline emissions are estimated as follows:

1. Methane emission factor

Methane emission factor for deep pit manure management system is calculated according to IPCC Tier 2 approach (formula (1). Default 2006 IPCC values for Bo and VS were applied because there are no national specific values.

$$EF_i = (VS \times 365) \times [Bo \times 0.67 kg / m^3 \times \sum_j \frac{MCF_{ij}}{100} \times MS_{ij} \%] \quad (1)$$

According to the average temperature during the monitoring period, the MCF_{ij} for each county is listed in table E1.

Table E1: MCF_{ij} and EF_i in each county according to 2006 IPCC Guidelines

County	Enshi	Jianshi	Badong	Lichuan	Xuan'en	Xianfeng	Laifeng	Hefeng
Average T (°C)	15.7	15.2	16.7	12.8	15.5	13.9	15.8	15.5
$MCF_{ij}/100$	0.27	0.27	0.29	0.2	0.27	0.22	0.27	0.27
EF_i (kg CH ₄ /year/head)	5.744	5.744	6.170	4.255	5.744	4.681	5.744	5.744

2. Emission factor of coal combustion

According to the baseline methodology for small-scale CDM project activity categories I.C titled “Thermal energy for the user with or without electricity” 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 displaced fossil fuel. In this project, national specific emission factor provided by National Development and Reform Committee (NDRC) will be adopted (www.ccchina.gov.cn). The emission factor for raw coal is 25.8 tC/TJ. Net Calorific Value (kJ/kg) of raw coal is 20908 kJ/kg. Fraction oxidized is 1.

$$EF_{\text{Rawcoal}} = 25.8 \times 20908 \times 1 \times 44 / 12 / 10^6 = 1.98 \text{ t CO}_2/\text{t coal}.$$

Table E2: IPCC default values and other reference values used in the calculation of emission factors

Parameters	Data variable	Data source	unit	Value
VS_{default}	Default value for the volatile solid excretion per day per animal on a dry matter basis for a defined swine population.	Table 10A-7 and 10A-8, chapter 10, volume 4, IPCC 2006 Guidelines	kg-dm/head/day	0.3
Bo	Maximum methane producing capacity for manure produced by swine	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, and Chapter 10	m ³ CH ₄ kg ⁻¹ of VS excreted	0.29
$MCF_{ij}/100$	Methane conversion factor for deep pit manure management system	IPCC 2006 Guidelines Table 10A-7, chapter 10, volume 4, according to the average T in each county	%	Table E1 above
MS_{ij} %	Fraction of swine manure handled using manure management system j. In this project, 100 percent of manure is stored in deep pit	Project participants	Fraction	100%
LF_{AD}	Methane leakage from Anaerobic digester	IPCC 2006 Guidelines	%	10%
NCV	Default net calorific values of cooking coal	Published data by China NDRC (www.ccchina.gov.cn)	kJ/kg	20908
Carbon EF	Carbon emission factor per unit of energy of coal that would have been used in the baseline	Published data by China NDRC (www.ccchina.gov.cn)	tC/ TJ	25.8

3. Baseline emission

1) CH₄ emission from manure management

$$BE_{CH_4,i,k} = GWP_{CH_4} \times \frac{1}{1000} \times LN_{i,k} \times EF_i \quad (2)$$

Table E3: Baseline CH₄ emission during the second monitoring period(t CO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	0.74	0.71	0.79	0.49			0.60	
10 m ³	0.76	0.72	0.77	0.48	0.65			
12 m ³					0.70			0.72
15 m ³						0.58		

2) CO₂ emission from coal consumption

$$BE_{CO_2,i,k} = BG_{Coal,i,k} \times EF_{Rawcoal} \quad (3)$$

Table E4: Baseline CO₂ emission from coal burning during monitoring period (tCO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	3.74	3.85	3.66	3.83			3.42	
10 m ³	3.81	3.95	3.53	3.94	3.84			
12 m ³					3.97			4.42
15 m ³						4.19		

3) Baseline GHG emission calculation per household

$$BE_{y,i,k} = BE_{CH_4,i,k} + BE_{CO_2,i,k} \quad (4)$$

Table E5: Total GHG emission under baseline activity during monitoring period (tCO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	4.48	4.56	4.45	4.32			4.02	
10 m ³	4.57	4.67	4.30	4.42	4.49			
12 m ³					4.68			5.14
15 m ³						4.77		

4) Total baseline GHG emission during monitoring period

$$BE_y = \sum_i \left(\sum_{k=1} (ND_{i,k} * BE_{y,i,k}) \right) \quad (5)$$

Table E6: Total baseline emission during monitoring period (t CO₂ e)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng	Total
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8 m ³	8593	2464	7035	13098			12048		43238
10 m ³	11014	18823	12853	12848	8152				63691
12 m ³					5413			15370	20783
15 m ³						21811			21811
Total	19607	21287	19888	25946	13565	21811	12048	15370	149522

Table E7: Parameters, value and data source for calculating baseline GHG emissions

Parameters	Data variable	Data source	unit	Value
GWP_{CH_4}	Global warming potential for CH ₄	IPCC	tCO ₂ e/tCH ₄	21
$LN_{i,k}$	Average swine population for household before the installation of biogas digester with different volume k, in County i.	Survey	Number	see table D4 above
EF_i	CH ₄ emission factor for deep pit swine manure management in county i	Calculated using equation (1)	kg CH ₄ /swine/yr	see Table E1 above
$BG_{Coal,i,k}$	Average annual coal consumption for household before the installation of digester with volume k, in county i, t coal of each household	Baseline survey	t coal/household/yr	see PDD
$EF_{Rawcoal}$	Emission factor of raw coal	INDRC	t CO ₂ /t coal	1.98
$ND_{i,k}$	Numbers of operational digester with volume k, in county i	Monitoring results	Number	See table D1 above

E.2. Project emissions calculation

The calculation spreadsheet are included in excel file named as Hubei Household biogas CDM-ER calculation-second monitoring period.

Project emissions are calculated as follows:

- 1) CH₄ emission from physical leakages of anaerobic digesters

$$PE_{ly} = LF_{AD} [GWP_{CH_4} \times D_{CH_4} \times B_o \times VS_{m,y}] / 1000 \quad (6)$$

Table E8: CH₄ emission from leakage under project activity during the second monitoring period (t CO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	0.27	0.26	0.27	0.24			0.22	
10 m ³	0.28	0.27	0.27	0.24	0.24			
12 m ³					0.26			0.27
15 m ³						0.26		

2) Project CO₂ emission from coal combustion

$$PE_{CO_2,i,k} = PG_{Coal,i,k} \times EF_{Rawcoal} \quad (7)$$

Table E9: CO₂ emission from coal burning under project activity during the second monitoring period (t CO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	2.14	2.18	1.92	2.22			1.61	
10 m ³	1.87	2.07	1.62	2.03	2.03			
12 m ³					1.95			2.44
15 m ³						2.14		

3) Project GHG emission calculation

$$PE_{y,i,k} = PE_{CO_2,i,k} + PE_{ly} \quad (8)$$

Table E10: Project emission from under project activities during the second monitoring period (t CO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	2.41	2.45	2.19	2.47			1.83	
10 m ³	2.16	2.34	1.89	2.28	2.27			
12 m ³					2.22			2.71
15 m ³						2.40		

4) Total project GHG emission

$$PE_y = \sum_i \left(\sum_{k=1} (ND_{i,k} * PE_{y,i,k}) \right) \quad (9)$$

Table E11: Total emission under project activity during the second monitoring period(t CO₂ e)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng	Total
8 m ³	4624	1321	3469	7481			5491		22385
10 m ³	5200	9419	5639	6616	4121				30995
12 m ³					2564			8106	10670
15 m ³						10984			10984
Total	9823	10740	9108	14096	6685	10984	5491	8106	75034

Table E12: Parameters, value and data source for calculating GHG emissions under project activity

Parameters	Data variable	Data source	unit	Value
LF_{AD}	Methane leakages from Anaerobic digesters	Table 10A-8 of 2006 IPCC Guidelines Volume 4, and Chapter 10.	%	0.10

D_{CH_4}	Conversion factor of m ³ CH ₄ to kilograms CH ₄	2006 IPCC guideline, See Volume 4, Chapter 10, Page 10.42	kg/m ³	0.67
Bo	Maximum methane producing capacity for manure produced by swine	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, and Chapter 10	m ³ CH ₄ kg ⁻¹ of VS excreted	0.29
$VS_{m,y}$	Annual amount of volatile solid treated in the biogas digesters on a dry matter weight basis	Calculated accord default value in 2006 IPCC Guidelines, Volume 4, and Chapter 10	kg of dm per year	0.3
$PG_{coal,i,k}$	Average annual coal consumption of the household after installation of digester with volume k, in county i	Baseline survey	t coal of each household	See PDD
$EF_{Rawcoal}$	Emission factor of raw coal	Calculated according to AMS I.C.	t CO ₂ /t coal	1.98
$ND_{i,k}$	Numbers of operational digesters with volume k, in county i	Monitoring results	numbers	see table D1 above

E.3. Leakage calculation

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According to version 12 of AMS I.C and version 1 of AMS III.R, the biogas digesters were newly build for this project, rather than transferred from outside of the project. The swine manure is produced within the project boundary, not transported or collected from outside the project. Therefore, leakage emission is not required to be calculated.

E.4. Emission reductions calculation / table

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1) GHG emission reduction per household

$$ER_{y,i,k} = BE_{y,i,k} - PE_{y,i,k} \quad (10)$$

Table E13: Emission reduction per household during the second monitoring period (t CO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	2.07	2.12	2.26	1.86			2.19	
10 m ³	2.41	2.33	2.41	2.15	2.22			
12 m ³					2.46			2.43
15 m ³						2.37		

2) Total bundled project GHG emission reductions(ER_y)

$$ER_y = \sum_i \left(\sum_{k=1} (ND_{i,k} * ER_{y,i,k}) \right) \quad (11)$$

Table E14: Emission reduction during monitoring period (t CO₂ e)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng	Total
8 m ³	3969	1143	3566	5618			6557		20853
10 m ³	5814	9404	7214	6232	4031				32696
12 m ³					2849			7264	10112
15 m ³						10827			10827
Total	9784	10547	10780	11850	6880	10827	6557	7264	74489

Table E15: Summary of emissions under baseline, project activities and emission reduction

Year	BEy (tCO ₂ e)	PEy (tCO ₂ e)	ERy (tCO ₂ e)
01/09/2009 - 31/12/2010	149522	75034	74489

E.5. Comparison of actual emission reductions with estimates in the CDM-PDD

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The ex-ante estimate of annual emission reduction of the project is 58,444 tCO₂e in the registered PDD. It leads to a calculated amount of emission reductions of 77,978 tCO₂e for the second monitoring period (01/09/2009-31/12/2010), which is higher than the actual measured emission reduction of 74,489 tCO₂e for the same period of time. The major reasons for this lower measured emission reduction are that some biogas digesters were not operational and the colder climate in the region that resulted in lower average temperature affecting biogas digesters' operations during the monitoring period.

Item	Values applied in ex-ante calculation of the registered CDM-PDD	Actual values reached during the monitoring period
Emission reductions (tCO ₂ e)	77,978	74,489

E.6. Remarks on difference from estimated value in the PDD

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There was no increase from actual values compared with estimated values.

History of the document

Version	Date	Nature of revision
01	EB 54, Annex 34 28 May 2010	Initial adoption.
Decision Class: Regulatory Document Type: Guideline, Form Business Function: Issuance		