



Monitoring report form (Version 03.1)

MONITORING REPORT

Title of the project activity	HUBEI ECO-FARMING BIOGAS PROJECT PHASE I
Reference number of the project activity	2221
Version number of the monitoring report	01
Completion date of the monitoring report	28/10/2012
Registration date of the project activity	19/02/2009
Monitoring period number and duration of this monitoring period	Monitoring period number : 3 rd monitoring period Duration of this monitoring period: 01/01/2011 - 31/12/2011
Project participant(s)	<ol style="list-style-type: none"> 1. China: Hubei Qingjiang Zhongye Company Ltd. 2. Netherlands: Netherlands' Ministry of Infrastructure and the Environment (IenM) 3. Japan: Daiwa Securities Capital Markets Co. Ltd.; FUJIFILM Corporation; Idemitsu Kosan Co., Ltd.; JX Nippon Oil & Energy Corporation; The Okinawa Electric Power Corporation, Incorporated 4. Belgium: Kingdom of Belgium - Walloon Region: Walloon Air and Climate Agency; Bruxelles Environnement - IBGE 5. Canada: Government of Canada - Ministry of Foreign Affairs and International Trade 6. Denmark: Aalborg Portland A/S; Danish Ministry of Climate and Energy/Danish Energy Agency; Dong Naturgas A/S; Maersk Olie og Gas AS; Nordjysk Elhandel A/S 7. Italy: Government of Italy - Ministry for the Environment, Land and Sea

	<p>8. Luxembourg: Government of Luxembourg - Ministry of Sustainable Development and Infrastructure - Department of Environment</p> <p>9. Norway: Stratkraft Carbon Invest AS; Statoil ASA</p> <p>10. Spain: Endesa Generación S.A.; Kingdom of Spain - Ministry of Environment and Rural and Marine Affairs & Ministry of Economy and Finance; EDP-Energias de Portugal, S.A.; Gas Natural SDG, S.A.; Hidroeléctrica del Cantábrico, S.A.</p> <p>11. Sweden: Göteborg Energi AB</p> <p>12. Switzerland: Schweizerische Rückversicherungsgesellschafts AG (Swiss RE)</p> <p>13. Germany: BASF SE; KfW</p> <p>14. Austria: Kommunalkredit Public Consulting GmbH</p> <p>15. Finland: Ruukki Metals Oy</p>
Host Party(ies)	China
Sectoral scope(s) and applied methodology(ies)	<p>Sectoral scopes: 1-Energy industries (renewables-/non-renewable sources); 15- Agriculture</p> <p>Applied methodology(ies): Version 12 of AMS-I.C: "Thermal energy for the user with or without electricity" Version 01 of AMS-III.R: "Methane recovery in agricultural activities at household/farm level"</p>
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	58,444 tCO ₂ e
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	55,764 tCO ₂ e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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 equipment

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 (CERs) for first monitoring (19/02/2009 – 31/08/2009) were issued in 11/05/2011. The CER issuance request for second monitoring period (01/09/2009 – 31/12/2010) is awaiting approval.

4. Total emission reductions achieved in this monitoring period.

This monitoring report is for the third monitoring period, which is from and including 01/01/2011 to 31/12/2011. Total emission reductions achieved in this monitoring period are 55,764 tCO₂e. T

A.2. Location of project activity

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	+30.0667 - +30.65	+109.0667 - +109.9667
Jianshi	+109.7222	+30.603333	+30.1 - +30.9	+109.5333 - +110.2
Badong	+110.345	+31.043889	+30.2167 - +31.4667	+110.0667 - +110.5333
Lichuan	+108.931667	+30.298056	+29.7 - +30.65	+108.35 - +109.3
Xuan'en	+109.479722	+29.993333	+29.55 - +30.2	+109.1833 - +109.9167
Xianfeng	+109.151944	+29.696389	+29.3167 - +30.05	+108.6333 - +109.3333

Laifeng	+109.402778	+29.509722	+29.1 - +29.6667	+109 - +109.45
Hefeng	+110.015556	+29.887778	+29.6333- +30.2333	+109.75 - +110.6333

A.3. Parties and project participant(s)

Party involved (host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
China	Hubei Qingjiang Zhongye Company Ltd.	No
Netherlands	Netherlands' Ministry of Infrastructure and the Environment (IenM)	Yes
Japan	Daiwa Securities Capital Markets Co. Ltd.; FUJIFILM Corporation; Idemitsu Kosan Co., Ltd.; JX Nippon Oil & Energy Corporation; The Okinawa Electric Power Corporation, Incorporated	No
Belgium	Kingdom of Belgium - Walloon Region: Walloon Air and Climate Agency; Bruxelles Environnement - IBGE	Yes
Canada	Government of Canada - Ministry of Foreign Affairs and International Trade	Yes
Denmark	Aalborg Portland A/S; Danish Ministry of Climate and Energy/Danish Energy Agency; Dong Naturgas A/S; Maersk Olie og Gas AS; Nordjysk Elhandel A/S	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	Stratkraft Carbon Invest AS; Statoil ASA	No

Spain	Endesa Generación S.A.; Kingdom of Spain - Ministry of Environment and Rural and Marine Affairs & Ministry of Economy and Finance; EDP-Energias de Portugal, S.A.; Gas Natural SDG, S.A.; Hidroeléctrica del Cantábrico, S.A.	Yes
Sweden	Göteborg Energi AB	No
Switzerland	Schweizerische Rückversicherungsgesellschafts AG (Swiss RE)	No
Germany	BASF SE; KfW	No
Austria	Kommunalkredit Public Consulting GmbH	No
Finland	Ruukki Metals Oy	No
Netherlands	Netherlands' Ministry of Infrastructure and the Environment (IenM)	Yes
Belgium	Kingdom of Belgium - Walloon Region Ministry of the Environment; Bruxelles Environnement - IBGE	Yes
Canada	Government of Canada - Ministry of Foreign Affairs and International Trade	Yes
Denmark	Aalborg Portland A/S; Danish Ministry of Climate and Energy/Danish Energy Agency; Dong Naturgas A/S; Maerskolie og Gas A/S ; Nordjysk Elhandel A/S	Yes

A.4. Reference of applied methodology

Approved methodologies Version 12 of AMS-IC 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. These baseline methodologies can be downloaded from the Executive Board (EB) website: <http://cdm.unfccc.int/methodologies/PAMethodologies/approved.html>.

A.5. Crediting period of project activity

The crediting period of the project activity is 19/02/2009 - 18/02/2019.

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

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 digester 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 counties in the CDM project

County/City	No. of biogas digesters with different digester volume				Total no. of biogas installed 2007-2008 in each county	Data sources
	8 m ³	10 m ³	12 m ³	15 m ³		
Enshi	1,918	2,412			4330	Name list of Enshi CDM project, provided by Enshi Prefecture PMO on 16, March. 2012.
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-tier technical supporting service system has been established. At prefecture level, biogas association and consulting agency was established by Enshi Autonomous Prefecture. Rural energy service center was established at county level. Township government established rural energy service branch; and village community set rural biogas service network. The four-tier service system was proven to work well in delivering timely and adequate services to farmers and monitoring the biogas digester operation. The reasons are as follow: 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 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 is able to reach around 300 households. Farmers could easily purchase the needed parts and fittings and receive technical assistance. Besides the four-tier 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. There were 419 biogas digesters not operating due to migration to cities for temporary employment and digester breakdown etc.

B.2. Post registration changes

B.2.1. Temporary deviations from registered monitoring plan or applied methodology

NA.

B.2.2. Corrections

NA.

B.2.3. Permanent changes from registered monitoring plan or applied methodology

NA .

B.2.4. Changes to project design of registered project activity

NA.

B.2.5. Changes to start date of crediting period

NA.

B.2.6. Types of changes specific to afforestation or reforestation project activity

NA.

SECTION C. Description of monitoring system

1. Data collection procedure

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.

1) Recording the number of operating biogas digesters

After the project start, the project technical support panel would work with Project Entity to monitor the number of operational biogas installation and operation, and establish a database containing all relative identification information of each household, such as name, address, date on installation and operation of biogas digester. In the same time, the quality of the biogas digester installed under the project would also be checked according to the project technical design. The readout records of the number of operating biogas digesters and list of biogas stove delivered by county energy bureau will be recorded for DOE review.

2) Estimation of annual operational hours of biogas digesters

Operational hours of biogas digesters was estimated based on the length of the period that the biogas digesters are not operating while they are discharged annually and restart. The length of the period that the biogas digesters are not operating will be collected by surveying a sample of 2,750 household participants. This sample size will ensure a precision at 95% confidence intervals (T-values). The files containing the

estimation of Annual operational hours of biogas digesters will be recorded for DOE review.

3) Swine population

Pig numbers which manure treated in biogas digester for the 2,750 random sample households will be recorded and reported to Enshi Energy Bureau.

4) Amount of pig manure VS generated and fed into the biogas digester

Amount of pig manure VS generated in individual household will be calculated as the product of swine population of individual household multiplied by IPCC default VS values.

As described in A4.2, all the manure generated will be fed into biogas digesters directly. Therefore the amount of pig manure VS fed into the biogas digesters is same to what the pig manure VS generated.

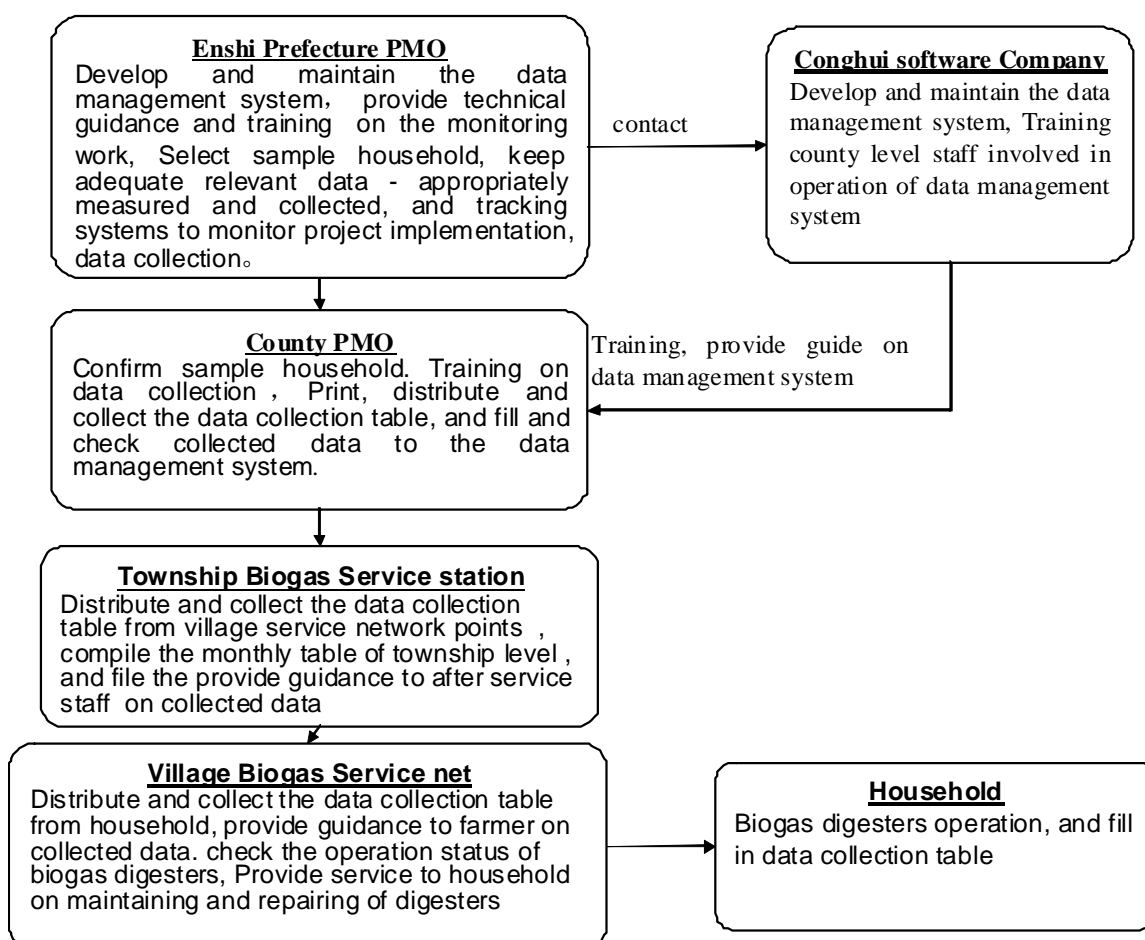
5) Application of biogas residue

The destination of biogas residue for the 2,750 random sample households will be recorded and reported to Enshi Energy Bureau.

6) Climatic parameters

Monthly average temperatures will be brought from monitored by Enshi Meteorological Station.

2. Organizational structure



3. 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:

- I 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. ([2010]6)¹, and provided standard data collection tables to the county PMO².
- I 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 07/12/2010, 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.³
- I 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.
- I 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 fixed ex ante or at renewal of crediting period

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	Data on Fraction of manure handled in system j in the baseline are

¹ Notification of household list for the third monitoring period, provided by Enshi PMO, issued on 3 Dec., 2010.

² Please see the document "Monitoring Manual" provided by Enshi Prefecture PMO, issued on 10 July, 2009.

³ Notification of Prefectural Training Course on Household CDM Project was issued on 3 Dec. 2010.

used for (Baseline/ Project/ Leakage emission calculations)	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 ³ CH ₄ /kg-dm 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 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 _{CH₄} 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 registered 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 B7 of 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

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 D2 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):	In this monitoring period, number of operating biogas digesters with different volume in each county was calculated based on the difference between the total number of constructed biogas digesters within different volume and the number of biogas digesters that are not functional due to reasons other than biogas residue discharge.
QA/QC procedures applied:	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. In the

	<p>same time, the quality of the biogas digester installed under the project was checked according to the project technical design. The readout records of the number of operating biogas digesters and list of biogas stove delivered by county energy bureau was recorded for DOE review.</p> <p>Each month, the village service staff checked the operation of all the project digesters and recorded the numbers of not operating digesters. Technicians of township service station accompanied by village technicians visited all the households one time to check whether biogas digesters operating or not. It was conducted during 22 Dec., 2011 to 10, Jan., 2012⁴. 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 residue⁵, these biogas digesters were assumed to be not operating.</p>	
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 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:	Annually	
Calculation method (if applicable):	It was calculated based on survey. The average operational hours for biogas digesters with different volume in each county equate to total hours of the third monitoring period (365 days*24hours) minus the average hours that are not functional (Table D3*24 hours) of each biogas digester with different volume in that county due to residue discharge or other temporary repairing.	
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 or other maintenance and repairing happens. The length of the period that the biogas digesters were not operating was collected by surveying 2,750 household participants.	

⁴ Notification for the investigation of operational biogas digesters during the third monitoring period. It was issued by Enshi PMO 16 Dec., 2011.

⁵ Residue discharge means to remove the biogas residue from the digester. The digester will stop producing biogas.

	<p>The sample size of household number will ensure a precision needed to give a precision at 95 % confidence intervals (T-values). A three-tier approach is applied to determine the length of non-operational period.</p> <p>First, the trained village service staff checked the digesters on site and examined whether operational status is properly recorded by households on monthly basis. During monthly site check, staff cross-checked the non-operational hours filed in the monthly form. In addition, they verified the digester status by turning on biogas stove. If there is no flare when lighting, it means no biogas flowing and the digester is not operating, and the non-operational hours will be recorded as the whole month if it is inconsistent with the recorded data.</p> <p>On second level, staff of township service station compiled the monthly table based on the recorded household data and visited the sampled household each month to check the filed data.</p> <p>Third, county PMO staff spot-checked sampled households during this monitoring period.</p>
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 D5
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)	Mercury thermometer
Measuring/ Reading/ Recording frequency:	Monthly
Calculation method (if applicable):	Average the monthly mean temperature and get the average temperature during the third 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 D6
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 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 2,750 household ensures a precision needed to give a precision at 95% confidence intervals (T-values). It is the safety measure to cross check and make sure there is no biogas during repairing and residues discharging period
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 D7
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):	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 D6 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:	See Table D8
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:	Every application
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.

ITable D1: Number of not operating biogas digesters with different volume in different county during the third monitoring period

	8 m ³	10 m ³	12 m ³	15 m ³	Total	Data Sources
Enshi	0	0			0	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Jianshi	0	0			0	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Badong	1	2			3	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Lichuan	19	13			32	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xuan'en		54	39		93	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xianfeng				242	242	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Laifeng	42				42	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

Hefeng			7		7	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Total	62	69	46	242	419	

Table D2: Number of operating biogas digesters with different volume in different county during the third monitoring period*

County/City	No. of operating biogas digesters with different volume					Date sources
	8 m ³	10 m ³	12 m ³	15 m ³	Total	
Enshi	1918	2412				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Jianshi	540	4030				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Badong	1580	2987				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Lichuan	3024	2904				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xuan'en		1779	1128			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xianfeng				4328		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Laifeng	2958					Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Hefeng			2993			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Total	10020	14112	4121	4328	32581	

* In this monitoring period, number of operating biogas digesters with different volume in each county was calculated based on the difference between the total number of constructed biogas digesters within different volume and the number of biogas digesters that are not functional due to reasons other than biogas residue discharge (Table B1-Table D1).

Table D3: Non-operational days during the third monitoring period of operational biogas digesters*

County name	8 m ³ (days)	10 m ³ (days)	12 m ³ (days)	15 m ³ (days)	Data Source
Enshi	0.98	1.09			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Jianshi	0.17	0.29			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Badong	0.63	0.45			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

					Mar. 2012.
Lichuan	0.29	0.4			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xuan'en	2.29	2.63			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xianfeng				0.45	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Laifeng	0.54				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Hefeng			0.26		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

* The non-operational days for biogas digesters with different volume in each county equate to total non-operational days, due to residue discharge or other temporary repair, of all the monitored biogas digesters under each volume divided by the total number of monitored and operational biogas digester with the same volume.

Table D4: Operational hours during the third monitoring period*

County name	8 m ³ (Hour)	10 m ³ (Hour)	12 m ³ (Hour)	15 m ³ (Hour)
Enshi	8736.5	8733.8		
Jianshi	8755.9	8753.0		
Badong	8744.9	8749.2		
Lichuan	8753.0	8750.4		
Xuan'en		8696.9	8760.0	
Xianfeng				8749.2
Laifeng	8747.0			
Hefeng			8753.8	

* The operational hours for biogas digesters with different volume in each county equate to total hours of the third monitoring period (365 days*24hours) minus the average hours that are not functional (Table D3*24 hours) of each biogas digester with different volume in that county due to residue discharge or other temporary repair.

Table D5: Average temperature in different counties during the third monitoring period

County	Enshi	Jianshi	Badong	Lichuan	Xuan'en	Xianfeng	Laifeng	Hefeng
(°C)	16.1	15.4	17.1	13.1	15.7	14.2	15.7	15.4
Data sources on Monthly average temperature of each county/city								
Organization of the evidence provision	Meteoro-logical Station of Enshi	Meteoro-logical Station of Jianshi	Meteoro-logical Station of Badong	Meteoro-logical Station of Lichuan	Meteoro-logical Station of Xuan'en	Meteoro-logical Station of Xianfeng	Meteoro-logical Station of Laifeng	Meteoro-logical Station of Hefeng
Date of the provision	2012-2-15	2012-2-22	2012-2-20	2012-2-23	2012-1-2	2012-1-10	2012-2-22	2012-2-15

Table D6: Average annual swine stock during the third monitoring period

County	8 m ³	10 m ³	12 m ³	15 m ³	Data Source
--------	------------------	-------------------	-------------------	-------------------	-------------

name	(Head)	(Head)	(Head)	(Head)	
Enshi	4.1	4.02			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Jianshi	4.04	4.36			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Badong	4.86	4.74			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Lichuan	4.23	4.11			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xuan'en		3.88	3.8		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xianfeng				3.92	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Laifeng	4.14				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Hefeng			4.05		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

Table D7: Daily volatile solid contained in the manure generated by pigs in individual household in project case*

County name	8 m ³ kg dry matter/day/hea d	10 m ³ kg dry matter/day/hea d	12 m ³ kg dry matter/day/hea d	15 m ³ kg dry matter/day/hea d
Enshi	1.23	1.21		
Jianshi	1.21	1.31		
Badong	1.46	1.42		
Lichuan	1.27	1.23		
Xuan'en		1.16	1.14	
Xianfeng				1.18
Laifeng	1.24			
Hefeng			1.22	

* Daily volatile solid contained in the manure generated by pigs in individual household is calculated as the average annual swine stock during the third monitoring period (Table D6) times 0.3, which is the IPCC VS defaults value provided by 2006 IPCC guideline.

Table D8: Average application times and its destination of sludge during the third monitoring period

County name	Dry land (time)				Vegetable field (time)				Paddy field (time)				Data Source
	8m ³	10m 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	6.3	5.9			6.2	5.8			0	0			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Jianshi	10.2	4.9			0.8	5.4			0	0			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

Badong	5.6	4.2			5.2	5.6			0	0		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Lichuan	7.2	6.5			7.8	7.5			0	0		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xuan'en		3.2	3.8			2.9	3.9			0	0	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xianfeng				3.0				2.6			0	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Laifeng	4.7				6.9				0			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Hefeng			5.2				4.2				0	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

D.3. Implementation of sampling plan

The sampling method for annual household monitoring includes following steps:

Step 1: Select 2750⁶ 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.

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 D9.

Table D9: 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	Data sources
	8 m ³	10 m ³	12 m ³	15 m ³		

⁶ The number of households for the sample is chosen to achieve a 95% confidence level for the data collected on the number of households with operating biogas digesters. It is in line with the procedure in "GENERAL GUIDELINES FOR SAMPLING AND SURVEYS FOR SMALL-SCALE CDM PROJECT ACTIVITIES"(Version 01)

Enshi	160	200			360	Notification of name list of monitored household during third monitoring period, provided by Enshi Prefectural PMO. The document was issued on 3 Dec. 2010.
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					2750	

SECTION E. Calculation of emission reductions or GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

This section shall include all formula used and description to calculate the baseline emissions applying actual values. The calculation spreadsheet on baseline emission are included in excel file named as “Hubei Household biogas CDM-ER calculation-third 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.

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

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)	16.1	15.4	17.1	13.1	15.7	14.2	15.7	15.4
$MCF_{ij}/100$	0.29	0.27	0.32	0.22	0.27	0.25	0.27	0.27
EF_i (kg CH ₄ /year/head)	6.170	5.744	6.808	4.681	5.744	5.319	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	$\text{m}^3 \text{CH}_4 \text{ kg}^{-1}$ 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 third monitoring period (t CO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	0.53	0.49	0.69	0.42			0.50	
10 m ³	0.52	0.53	0.68	0.40	0.46			
12 m ³					0.46			0.49
15 m ³						0.44		

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 the third monitoring period (tCO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	2.80	2.89	2.74	2.87			2.56	
10 m ³	2.85	2.96	2.64	2.95	2.86			
12 m ³					2.98			3.31
15 m ³						3.14		

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 the third monitoring period (tCO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	3.33	3.38	3.44	3.29			3.06	
10 m ³	3.37	3.49	3.32	3.35	3.33			
12 m ³					3.44			3.80
15 m ³						3.58		

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 the third monitoring period (t CO₂ e)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng	Total
	6379	1823	5428	9949			9054		32634
	8119	14062	9919	9741	5922				47763
					3876			11380	15257
						15493			15493
	14498	15885	15347	19691	9798	15493	9054	11380	111146

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 D6 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 D2 above

E.2. Calculation of project emissions or actual net GHG removals by sinks

The calculation of project emissions is included in excel file named as Hubei Household biogas CDM-ER calculation - third 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 third monitoring period (t CO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	0.18	0.18	0.22	0.19			0.18	
10 m ³	0.18	0.19	0.21	0.18	0.17			
12 m ³					0.17			0.18
15 m ³						0.17		

- 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 third monitoring period (t CO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	1.60	1.64	1.44	1.67			1.21	
10 m ³	1.40	1.55	1.21	1.52	1.51			
12 m ³					1.47			1.83

15 m ³						1.60		
-------------------	--	--	--	--	--	------	--	--

3) Project GHG emission calculation

$$PE_{y,i,k} = PE_{CO_2,i,k} + PE_{ly}$$

(8)

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

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	1.78	1.82	1.66	1.86			1.39	
10 m ³	1.58	1.75	1.43	1.71	1.69			
12 m ³					1.63			2.01
15 m ³						1.78		

4) Total project GHG emission

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

(9)

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

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng	Total
8 m ³	3414	981	2616	5615			4114		16740
10 m ³	3813	7043	4259	4961	2999				23074
12 m ³					1844			6025	7869
15 m ³						7698			7698
Total	7227	8025	6875	10576	4843	7698	4114	6025	55382

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.	%	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	m ³ CH ₄ kg ⁻¹ of VS excreted	0.29

		Inventories, Volume 4, and Chapter 10		
$VS_{m,y}$	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 D2 above

E.3. Calculation of leakage

According to version 12 of AMS I.C and version 1 of AMS III.R, neither methane recovery and equipment used in the project activity is transferred from another activity, nor the existing equipment is transferred to another activity. Therefore, leakage emissions are not considered in the project activity.

E.4. Summary of calculation of emission reductions or net anthropogenic GHG removals by sinks

Time Period	Baseline emissions or baseline net GHG removals by sinks (tCO ₂ e)	Project emissions or actual net GHG removals by sinks (tCO ₂ e)	Leakage (tCO ₂ e)	Emission reductions or net anthropogenic GHG removals by sinks (tCO ₂ e)
Total	111,146	55,382		55,764

E.5. Comparison of actual emission reductions or net anthropogenic GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex-ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (t CO₂e)	58,444	55,764

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

According to the registered PDD, the expected emission reduction of the project was estimated to be 58,444 tCO₂e per year. During the monitoring period (01/01/2011-31/12/2011), the measured annual emission reduction was 55,764 tCO₂e which is 4.6% lower than the ex-ante calculated result. The main reason is the number of the un-operational biogas and decrease of swine population in Xuan'en and Xianfeng counties.

E.7. Actual emission reductions or net anthropogenic GHG removals by sinks during the first commitment period and the period from 1 January 2013 onwards

Item	Actual values achieved up to 31 December 2012	Actual values achieved from 1 January 2013 onwards
Emission reductions or GHG removals by sinks (t CO ₂ e)		

Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net anthropogenic GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01	28 May 2010	EB 54, Annex 34. Initial adoption.
Decision Class: Regulatory Document Type: Form Business Function: issuance Keywords: monitoring report, performance monitoring		



Monitoring report form (Version 03.1)

MONITORING REPORT

Title of the project activity	HUBEI ECO-FARMING BIOGAS PROJECT PHASE I
Reference number of the project activity	2221
Version number of the monitoring report	01
Completion date of the monitoring report	28/10/2012
Registration date of the project activity	19/02/2009
Monitoring period number and duration of this monitoring period	Monitoring period number : 3 rd monitoring period Duration of this monitoring period: 01/01/2011 - 31/12/2011
Project participant(s)	<ol style="list-style-type: none"> 1. China: Hubei Qingjiang Zhongye Company Ltd. 2. Netherlands: Netherlands' Ministry of Infrastructure and the Environment (IenM) 3. Japan: Daiwa Securities Capital Markets Co. Ltd.; FUJIFILM Corporation; Idemitsu Kosan Co., Ltd.; JX Nippon Oil & Energy Corporation; The Okinawa Electric Power Corporation, Incorporated 4. Belgium: Kingdom of Belgium - Walloon Region: Walloon Air and Climate Agency; Bruxelles Environnement - IBGE 5. Canada: Government of Canada - Ministry of Foreign Affairs and International Trade 6. Denmark: Aalborg Portland A/S; Danish Ministry of Climate and Energy/Danish Energy Agency; Dong Naturgas A/S; Maersk Olie og Gas AS; Nordjysk Elhandel A/S 7. Italy: Government of Italy - Ministry for the Environment, Land and Sea

	<p>8. Luxembourg: Government of Luxembourg - Ministry of Sustainable Development and Infrastructure - Department of Environment</p> <p>9. Norway: Stratkraft Carbon Invest AS; Statoil ASA</p> <p>10. Spain: Endesa Generación S.A.; Kingdom of Spain - Ministry of Environment and Rural and Marine Affairs & Ministry of Economy and Finance; EDP-Energias de Portugal, S.A.; Gas Natural SDG, S.A.; Hidroeléctrica del Cantábrico, S.A.</p> <p>11. Sweden: Göteborg Energi AB</p> <p>12. Switzerland: Schweizerische Rückversicherungsgesellschafts AG (Swiss RE)</p> <p>13. Germany: BASF SE; KfW</p> <p>14. Austria: Kommunalkredit Public Consulting GmbH</p> <p>15. Finland: Ruukki Metals Oy</p>
Host Party(ies)	China
Sectoral scope(s) and applied methodology(ies)	<p>Sectoral scopes: 1-Energy industries (renewables-/non-renewable sources); 15- Agriculture</p> <p>Applied methodology(ies): Version 12 of AMS-I.C: "Thermal energy for the user with or without electricity" Version 01 of AMS-III.R: "Methane recovery in agricultural activities at household/farm level"</p>
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	58,444 tCO ₂ e
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	55,764 tCO ₂ e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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 equipment

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 (CERs) for first monitoring (19/02/2009 – 31/08/2009) were issued in 11/05/2011. The CER issuance request for second monitoring period (01/09/2009 – 31/12/2010) is awaiting approval.

4. Total emission reductions achieved in this monitoring period.

This monitoring report is for the third monitoring period, which is from and including 01/01/2011 to 31/12/2011. Total emission reductions achieved in this monitoring period are 55,764 tCO₂e. T

A.2. Location of project activity

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 longitude scope	County/City latitude scope
Enshi	+109.475	+30.270278	+30.0667 - +30.65	+109.0667 - +109.9667
Jianshi	+109.7222	+30.603333	+30.1 - +30.9	+109.5333 - +110.2
Badong	+110.345	+31.043889	+30.2167 - +31.4667	+110.0667 - +110.5333
Lichuan	+108.931667	+30.298056	+29.7 - +30.65	+108.35 - +109.3
Xuan'en	+109.479722	+29.993333	+29.55 - +30.2	+109.1833 - +109.9167
Xianfeng	+109.151944	+29.696389	+29.3167 - +30.05	+108.6333 - +109.3333

Laifeng	+109.402778	+29.509722	+29.1 - +29.6667	+109 - +109.45
Hefeng	+110.015556	+29.887778	+29.6333- +30.2333	+109.75 - +110.6333

A.3. Parties and project participant(s)

Party involved (host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
China	Hubei Qingjiang Zhongye Company Ltd.	No
Netherlands	Netherlands' Ministry of Infrastructure and the Environment (IenM)	Yes
Japan	Daiwa Securities Capital Markets Co. Ltd.; FUJIFILM Corporation; Idemitsu Kosan Co., Ltd.; JX Nippon Oil & Energy Corporation; The Okinawa Electric Power Corporation, Incorporated	No
Belgium	Kingdom of Belgium - Walloon Region: Walloon Air and Climate Agency; Bruxelles Environnement - IBGE	Yes
Canada	Government of Canada - Ministry of Foreign Affairs and International Trade	Yes
Denmark	Aalborg Portland A/S; Danish Ministry of Climate and Energy/Danish Energy Agency; Dong Naturgas A/S; Maersk Olie og Gas AS; Nordjysk Elhandel A/S	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	Stratkraft Carbon Invest AS; Statoil ASA	No

Spain	Endesa Generación S.A.; Kingdom of Spain - Ministry of Environment and Rural and Marine Affairs & Ministry of Economy and Finance; EDP-Energias de Portugal, S.A.; Gas Natural SDG, S.A.; Hidroeléctrica del Cantábrico, S.A.	Yes
Sweden	Göteborg Energi AB	No
Switzerland	Schweizerische Rückversicherungsgesellschafts AG (Swiss RE)	No
Germany	BASF SE; KfW	No
Austria	Kommunalkredit Public Consulting GmbH	No
Finland	Ruukki Metals Oy	No
Netherlands	Netherlands' Ministry of Infrastructure and the Environment (IenM)	Yes
Belgium	Kingdom of Belgium - Walloon Region Ministry of the Environment; Bruxelles Environnement - IBGE	Yes
Canada	Government of Canada - Ministry of Foreign Affairs and International Trade	Yes
Denmark	Aalborg Portland A/S; Danish Ministry of Climate and Energy/Danish Energy Agency; Dong Naturgas A/S; Maersk Olie og Gas A/S ; Nordjysk Elhandel A/S	Yes

A.4. Reference of applied methodology

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. These baseline methodologies can be downloaded from the Executive Board (EB) website: <http://cdm.unfccc.int/methodologies/PAMethodologies/approved.html>.

A.5. Crediting period of project activity

The crediting period of the project activity is 19/02/2009 - 18/02/2019.

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

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 digester 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 counties in the CDM project

County/City	No. of biogas digesters with different digester volume				Total no. of biogas installed 2007-2008 in each county	Data sources
	8 m ³	10 m ³	12 m ³	15 m ³		
Enshi	1,918	2,412			4330	Name list of Enshi CDM project, provided by Enshi Prefecture PMO on 16, March. 2012.
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-tier technical supporting service system has been established. At prefecture level, biogas association and consulting agency was established by Enshi Autonomous Prefecture. Rural energy service center was established at county level. Township government established rural energy service branch; and village community set rural biogas service network. The four-tier service system was proven to work well in delivering timely and adequate services to farmers and monitoring the biogas digester operation. The reasons are as follow: 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 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 is able to reach around 300 households. Farmers could easily purchase the needed parts and fittings and receive technical assistance. Besides the four-tier 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. There were 419 biogas digesters not operating due to migration to cities for temporary employment and digester breakdown etc.

B.2. Post registration changes

B.2.1. Temporary deviations from registered monitoring plan or applied methodology

NA.

B.2.2. Corrections

NA.

B.2.3. Permanent changes from registered monitoring plan or applied methodology

NA .

B.2.4. Changes to project design of registered project activity

NA.

B.2.5. Changes to start date of crediting period

NA.

B.2.6. Types of changes specific to afforestation or reforestation project activity

NA.

SECTION C. Description of monitoring system

1. Data collection procedure

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.

1) Recording the number of operating biogas digesters

After the project start, the project technical support panel would work with Project Entity to monitor the number of operational biogas installation and operation, and establish a database containing all relative identification information of each household, such as name, address, date on installation and operation of biogas digester. In the same time, the quality of the biogas digester installed under the project would also be checked according to the project technical design. The readout records of the number of operating biogas digesters and list of biogas stove delivered by county energy bureau will be recorded for DOE review.

2) Estimation of annual operational hours of biogas digesters

Operational hours of biogas digesters was estimated based on the length of the period that the biogas digesters are not operating while they are discharged annually and restart. The length of the period that the biogas digesters are not operating will be collected by surveying a sample of 2,750 household participants. This sample size will ensure a precision at 95% confidence intervals (T-values). The files containing the

estimation of Annual operational hours of biogas digesters will be recorded for DOE review.

3) Swine population

Pig numbers which manure treated in biogas digester for the 2,750 random sample households will be recorded and reported to Enshi Energy Bureau.

4) Amount of pig manure VS generated and fed into the biogas digester

Amount of pig manure VS generated in individual household will be calculated as the product of swine population of individual household multiplied by IPCC default VS values.

As described in A4.2, all the manure generated will be fed into biogas digesters directly. Therefore the amount of pig manure VS fed into the biogas digesters is same to what the pig manure VS generated.

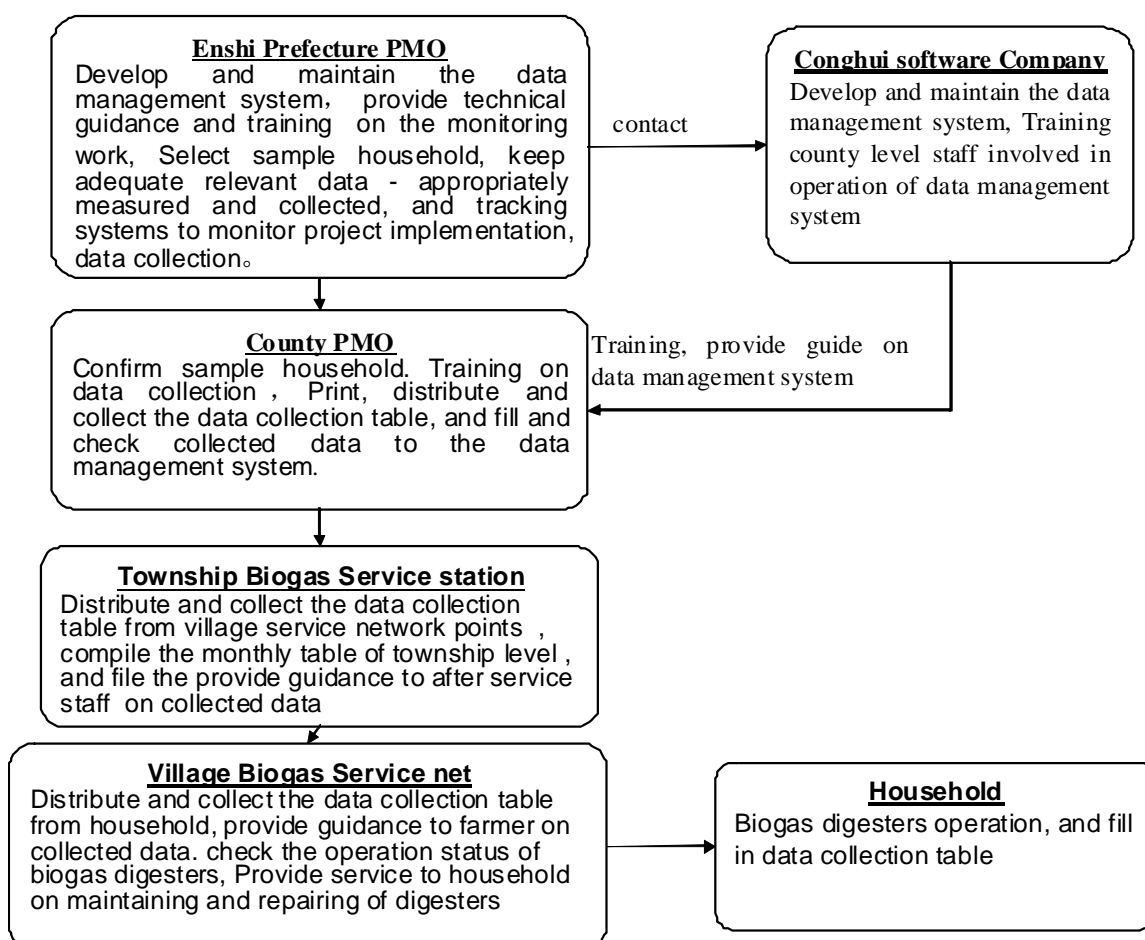
5) Application of biogas residue

The destination of biogas residue for the 2,750 random sample households will be recorded and reported to Enshi Energy Bureau.

6) Climatic parameters

Monthly average temperatures will be brought from monitored by Enshi Meteorological Station.

2. Organizational structure



3. 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:

- I 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. ([2010]6)¹, and provided standard data collection tables to the county PMO².
- I 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 07/12/2010, 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.³
- I 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.
- I 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 fixed ex ante or at renewal of crediting period

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	Data on Fraction of manure handled in system j in the baseline are

¹ Notification of household list for the third monitoring period, provided by Enshi PMO, issued on 3 Dec., 2010.

² Please see the document "Monitoring Manual" provided by Enshi Prefecture PMO, issued on 10 July, 2009.

³ Notification of Prefectural Training Course on Household CDM Project was issued on 3 Dec. 2010.

used for (Baseline/ Project/ Leakage emission calculations)	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 _{CH₄} 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 registered 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 B7 of 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	
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 D2 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):	In this monitoring period, number of operating biogas digesters with different volume in each county was calculated based on the difference between the total number of constructed biogas digesters within different volume and the number of biogas digesters that are not functional due to reasons other than biogas residue discharge.
QA/QC procedures applied:	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. In the

	<p>same time, the quality of the biogas digester installed under the project was checked according to the project technical design. The readout records of the number of operating biogas digesters and list of biogas stove delivered by county energy bureau was recorded for DOE review.</p> <p>Each month, the village service staff checked the operation of all the project digesters and recorded the numbers of not operating digesters. Technicians of township service station accompanied by village technicians visited all the households one time to check whether biogas digesters operating or not. It was conducted during 22 Dec., 2011 to 10, Jan., 2012⁴. 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 residue⁵, these biogas digesters were assumed to be not operating.</p>	
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 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:	Annually	
Calculation method (if applicable):	It was calculated based on survey. The average operational hours for biogas digesters with different volume in each county equate to total hours of the third monitoring period (365 days*24hours) minus the average hours that are not functional (Table D3*24 hours) of each biogas digester with different volume in that county due to residue discharge or other temporary repairing.	
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 or other maintenance and repairing happens. The length of the period that the biogas digesters were not operating was collected by surveying 2,750 household participants.	

⁴ Notification for the investigation of operational biogas digesters during the third monitoring period. It was issued by Enshi PMO 16 Dec., 2011.

⁵ Residue discharge means to remove the biogas residue from the digester. The digester will stop producing biogas.

	<p>The sample size of household number will ensure a precision needed to give a precision at 95 % confidence intervals (T-values). A three-tier approach is applied to determine the length of non-operational period.</p> <p>First, the trained village service staff checked the digesters on site and examined whether operational status is properly recorded by households on monthly basis. During monthly site check, staff cross-checked the non-operational hours filed in the monthly form. In addition, they verified the digester status by turning on biogas stove. If there is no flare when lighting, it means no biogas flowing and the digester is not operating, and the non-operational hours will be recorded as the whole month if it is inconsistent with the recorded data.</p> <p>On second level, staff of township service station compiled the monthly table based on the recorded household data and visited the sampled household each month to check the filed data.</p> <p>Third, county PMO staff spot-checked sampled households during this monitoring period.</p>
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 D5
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)	Mercury thermometer
Measuring/ Reading/ Recording frequency:	Monthly
Calculation method (if applicable):	Average the monthly mean temperature and get the average temperature during the third 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 D6
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 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 2,750 household ensures a precision needed to give a precision at 95% confidence intervals (T-values). It is the safety measure to cross check and make sure there is no biogas during repairing and residues discharging period
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 D7
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):	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 D6 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:	See Table D8
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:	Every application
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.

ITable D1: Number of not operating biogas digesters with different volume in different county during the third monitoring period

	8 m ³	10 m ³	12 m ³	15 m ³	Total	Data Sources
Enshi	0	0			0	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Jianshi	0	0			0	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Badong	1	2			3	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Lichuan	19	13			32	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xuan'en		54	39		93	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xianfeng				242	242	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Laifeng	42				42	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

Hefeng			7		7	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Total	62	69	46	242	419	

Table D2: Number of operating biogas digesters with different volume in different county during the third monitoring period*

County/City	No. of operating biogas digesters with different volume					Date sources
	8 m ³	10 m ³	12 m ³	15 m ³	Total	
Enshi	1918	2412				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Jianshi	540	4030				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Badong	1580	2987				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Lichuan	3024	2904				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xuan'en		1779	1128			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xianfeng				4328		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Laifeng	2958					Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Hefeng			2993			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Total	10020	14112	4121	4328	32581	

* In this monitoring period, number of operating biogas digesters with different volume in each county was calculated based on the difference between the total number of constructed biogas digesters within different volume and the number of biogas digesters that are not functional due to reasons other than biogas residue discharge (Table B1-Table D1).

Table D3: Non-operational days during the third monitoring period of operational biogas digesters*

County name	8 m ³ (days)	10 m ³ (days)	12 m ³ (days)	15 m ³ (days)	Data Source
Enshi	0.98	1.09			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Jianshi	0.17	0.29			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Badong	0.63	0.45			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

					Mar. 2012.
Lichuan	0.29	0.4			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xuan'en	2.29	2.63			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xianfeng				0.45	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Laifeng	0.54				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Hefeng			0.26		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

* The non-operational days for biogas digesters with different volume in each county equate to total non-operational days, due to residue discharge or other temporary repair, of all the monitored biogas digesters under each volume divided by the total number of monitored and operational biogas digester with the same volume.

Table D4: Operational hours during the third monitoring period*

County name	8 m ³ (Hour)	10 m ³ (Hour)	12 m ³ (Hour)	15 m ³ (Hour)
Enshi	8736.5	8733.8		
Jianshi	8755.9	8753.0		
Badong	8744.9	8749.2		
Lichuan	8753.0	8750.4		
Xuan'en		8696.9	8760.0	
Xianfeng				8749.2
Laifeng	8747.0			
Hefeng			8753.8	

* The operational hours for biogas digesters with different volume in each county equate to total hours of the third monitoring period (365 days*24hours) minus the average hours that are not functional (Table D3*24 hours) of each biogas digester with different volume in that county due to residue discharge or other temporary repair.

Table D5: Average temperature in different counties during the third monitoring period

County	Enshi	Jianshi	Badong	Lichuan	Xuan'en	Xianfeng	Laifeng	Hefeng
(°C)	16.1	15.4	17.1	13.1	15.7	14.2	15.7	15.4
Data sources on Monthly average temperature of each county/city								
Organization of the evidence provision	Meteoro-logical Station of Enshi	Meteoro-logical Station of Jianshi	Meteoro-logical Station of Badong	Meteoro-logical Station of Lichuan	Meteoro-logical Station of Xuan'en	Meteoro-logical Station of Xianfeng	Meteoro-logical Station of Laifeng	Meteoro-logical Station of Hefeng
Date of the provision	2012-2-15	2012-2-22	2012-2-20	2012-2-23	2012-1-2	2012-1-10	2012-2-22	2012-2-15

Table D6: Average annual swine stock during the third monitoring period

County	8 m ³	10 m ³	12 m ³	15 m ³	Data Source
--------	------------------	-------------------	-------------------	-------------------	-------------

name	(Head)	(Head)	(Head)	(Head)	
Enshi	4.1	4.02			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Jianshi	4.04	4.36			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Badong	4.86	4.74			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Lichuan	4.23	4.11			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xuan'en		3.88	3.8		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xianfeng				3.92	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Laifeng	4.14				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Hefeng			4.05		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

Table D7: Daily volatile solid contained in the manure generated by pigs in individual household in project case*

County name	8 m ³ kg dry matter/day/hea d	10 m ³ kg dry matter/day/hea d	12 m ³ kg dry matter/day/hea d	15 m ³ kg dry matter/day/hea d
Enshi	1.23	1.21		
Jianshi	1.21	1.31		
Badong	1.46	1.42		
Lichuan	1.27	1.23		
Xuan'en		1.16	1.14	
Xianfeng				1.18
Laifeng	1.24			
Hefeng			1.22	

* Daily volatile solid contained in the manure generated by pigs in individual household is calculated as the average annual swine stock during the third monitoring period (Table D6) times 0.3, which is the IPCC VS defaults value provided by 2006 IPCC guideline.

Table D8: Average application times and its destination of sludge during the third monitoring period

County name	Dry land (time)				Vegetable field (time)				Paddy field (time)				Data Source
	8m ³	10m 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	6.3	5.9			6.2	5.8			0	0			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Jianshi	10.2	4.9			0.8	5.4			0	0			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

Badong	5.6	4.2			5.2	5.6			0	0		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Lichuan	7.2	6.5			7.8	7.5			0	0		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xuan'en		3.2	3.8			2.9	3.9			0	0	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xianfeng				3.0				2.6			0	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Laifeng	4.7				6.9				0			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Hefeng			5.2				4.2				0	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

D.3. Implementation of sampling plan

The sampling method for annual household monitoring includes following steps:

Step 1: Select 2750⁶ 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.

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 D9.

Table D9: 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	Data sources
	8 m ³	10 m ³	12 m ³	15 m ³		

⁶ The number of households for the sample is chosen to achieve a 95% confidence level for the data collected on the number of households with operating biogas digesters. It is in line with the procedure in "GENERAL GUIDELINES FOR SAMPLING AND SURVEYS FOR SMALL-SCALE CDM PROJECT ACTIVITIES"(Version 01)

Enshi	160	200			360	Notification of name list of monitored household during third monitoring period, provided by Enshi Prefectural PMO. The document was issued on 3 Dec. 2010.
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					2750	

SECTION E. Calculation of emission reductions or GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

This section shall include all formula used and description to calculate the baseline emissions applying actual values. The calculation spreadsheet on baseline emission are included in excel file named as “Hubei Household biogas CDM-ER calculation-third 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.

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

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)	16.1	15.4	17.1	13.1	15.7	14.2	15.7	15.4
$MCF_{ij}/100$	0.29	0.27	0.32	0.22	0.27	0.25	0.27	0.27
EF_i (kg CH ₄ /year/head)	6.170	5.744	6.808	4.681	5.744	5.319	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	$\text{m}^3 \text{CH}_4 \text{ kg}^{-1}$ 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 third monitoring period (t CO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	0.53	0.49	0.69	0.42			0.50	
10 m ³	0.52	0.53	0.68	0.40	0.46			
12 m ³					0.46			0.49
15 m ³						0.44		

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 the third monitoring period (tCO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	2.80	2.89	2.74	2.87			2.56	
10 m ³	2.85	2.96	2.64	2.95	2.86			
12 m ³					2.98			3.31
15 m ³						3.14		

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 the third monitoring period (tCO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	3.33	3.38	3.44	3.29			3.06	
10 m ³	3.37	3.49	3.32	3.35	3.33			
12 m ³					3.44			3.80
15 m ³						3.58		

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 the third monitoring period (t CO₂ e)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng	Total
	6379	1823	5428	9949			9054		32634
	8119	14062	9919	9741	5922				47763
					3876			11380	15257
						15493			15493
	14498	15885	15347	19691	9798	15493	9054	11380	111146

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 D6 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 D2 above

E.2. Calculation of project emissions or actual net GHG removals by sinks

The calculation of project emissions is included in excel file named as Hubei Household biogas CDM-ER calculation - third 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 third monitoring period (t CO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	0.18	0.18	0.22	0.19			0.18	
10 m ³	0.18	0.19	0.21	0.18	0.17			
12 m ³					0.17			0.18
15 m ³						0.17		

- 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 third monitoring period (t CO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	1.60	1.64	1.44	1.67			1.21	
10 m ³	1.40	1.55	1.21	1.52	1.51			
12 m ³					1.47			1.83

15 m ³						1.60		
-------------------	--	--	--	--	--	------	--	--

3) Project GHG emission calculation

$$PE_{y,i,k} = PE_{CO_2,i,k} + PE_{ly}$$

(8)

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

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	1.78	1.82	1.66	1.86			1.39	
10 m ³	1.58	1.75	1.43	1.71	1.69			
12 m ³					1.63			2.01
15 m ³						1.78		

4) Total project GHG emission

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

(9)

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

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng	Total
8 m ³	3414	981	2616	5615			4114		16740
10 m ³	3813	7043	4259	4961	2999				23074
12 m ³					1844			6025	7869
15 m ³						7698			7698
Total	7227	8025	6875	10576	4843	7698	4114	6025	55382

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.	%	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	m ³ CH ₄ kg ⁻¹ of VS excreted	0.29

		Inventories, Volume 4, and Chapter 10		
$VS_{m,y}$	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 D2 above

E.3. Calculation of leakage

According to version 12 of AMS I.C and version 1 of AMS III.R, neither methane recovery and equipment used in the project activity is transferred from another activity, nor the existing equipment is transferred to another activity. Therefore, leakage emissions are not considered in the project activity.

E.4. Summary of calculation of emission reductions or net anthropogenic GHG removals by sinks

Time Period	Baseline emissions or baseline net GHG removals by sinks (tCO ₂ e)	Project emissions or actual net GHG removals by sinks (tCO ₂ e)	Leakage (tCO ₂ e)	Emission reductions or net anthropogenic GHG removals by sinks (tCO ₂ e)
Total	111,146	55,382		55,764

E.5. Comparison of actual emission reductions or net anthropogenic GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex-ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (t CO₂e)	58,444	55,764

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

According to the registered PDD, the expected emission reduction of the project was estimated to be 58,444 tCO₂e per year. During the monitoring period (01/01/2011-31/12/2011), the measured annual emission reduction was 55,764 tCO₂e which is 4.6% lower than the ex-ante calculated result. The main reason is the number of the un-operational biogas and decrease of swine population in Xuan'en and Xianfeng counties.

E.7. Actual emission reductions or net anthropogenic GHG removals by sinks during the first commitment period and the period from 1 January 2013 onwards

Item	Actual values achieved up to 31 December 2012	Actual values achieved from 1 January 2013 onwards
Emission reductions or GHG removals by sinks (t CO ₂ e)		

Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net anthropogenic GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01	28 May 2010	EB 54, Annex 34. Initial adoption.
Decision Class: Regulatory Document Type: Form Business Function: issuance Keywords: monitoring report, performance monitoring		



Monitoring report form (Version 03.1)

MONITORING REPORT

Title of the project activity	HUBEI ECO-FARMING BIOGAS PROJECT PHASE I
Reference number of the project activity	2221
Version number of the monitoring report	01
Completion date of the monitoring report	28/10/2012
Registration date of the project activity	19/02/2009
Monitoring period number and duration of this monitoring period	Monitoring period number : 3 rd monitoring period Duration of this monitoring period: 01/01/2011 - 31/12/2011
Project participant(s)	<ol style="list-style-type: none"> 1. China: Hubei Qingjiang Zhongye Company Ltd. 2. Netherlands: Netherlands' Ministry of Infrastructure and the Environment (IenM) 3. Japan: Daiwa Securities Capital Markets Co. Ltd.; FUJIFILM Corporation; Idemitsu Kosan Co., Ltd.; JX Nippon Oil & Energy Corporation; The Okinawa Electric Power Corporation, Incorporated 4. Belgium: Kingdom of Belgium - Walloon Region: Walloon Air and Climate Agency; Bruxelles Environnement - IBGE 5. Canada: Government of Canada - Ministry of Foreign Affairs and International Trade 6. Denmark: Aalborg Portland A/S; Danish Ministry of Climate and Energy/Danish Energy Agency; Dong Naturgas A/S; Maersk Olie og Gas AS; Nordjysk Elhandel A/S 7. Italy: Government of Italy - Ministry for the Environment, Land and Sea

	<p>8. Luxembourg: Government of Luxembourg - Ministry of Sustainable Development and Infrastructure - Department of Environment</p> <p>9. Norway: Stratkraft Carbon Invest AS; Statoil ASA</p> <p>10. Spain: Endesa Generación S.A.; Kingdom of Spain - Ministry of Environment and Rural and Marine Affairs & Ministry of Economy and Finance; EDP-Energias de Portugal, S.A.; Gas Natural SDG, S.A.; Hidroeléctrica del Cantábrico, S.A.</p> <p>11. Sweden: Göteborg Energi AB</p> <p>12. Switzerland: Schweizerische Rückversicherungsgesellschafts AG (Swiss RE)</p> <p>13. Germany: BASF SE; KfW</p> <p>14. Austria: Kommunalkredit Public Consulting GmbH</p> <p>15. Finland: Ruukki Metals Oy</p>
Host Party(ies)	China
Sectoral scope(s) and applied methodology(ies)	<p>Sectoral scopes: 1-Energy industries (renewables-/non-renewable sources); 15- Agriculture</p> <p>Applied methodology(ies): Version 12 of AMS-I.C: "Thermal energy for the user with or without electricity" Version 01 of AMS-III.R: "Methane recovery in agricultural activities at household/farm level"</p>
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	58,444 tCO ₂ e
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	55,764 tCO ₂ e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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 equipment

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 (CERs) for first monitoring (19/02/2009 – 31/08/2009) were issued in 11/05/2011. The CER issuance request for second monitoring period (01/09/2009 – 31/12/2010) is awaiting approval.

4. Total emission reductions achieved in this monitoring period.

This monitoring report is for the third monitoring period, which is from and including 01/01/2011 to 31/12/2011. Total emission reductions achieved in this monitoring period are 55,764 tCO₂e. T

A.2. Location of project activity

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 longitude scope	County/City latitude scope
Enshi	+109.475	+30.270278	+30.0667 - +30.65	+109.0667 - +109.9667
Jianshi	+109.7222	+30.603333	+30.1 - +30.9	+109.5333 - +110.2
Badong	+110.345	+31.043889	+30.2167 - +31.4667	+110.0667 - +110.5333
Lichuan	+108.931667	+30.298056	+29.7 - +30.65	+108.35 - +109.3
Xuan'en	+109.479722	+29.993333	+29.55 - +30.2	+109.1833 - +109.9167
Xianfeng	+109.151944	+29.696389	+29.3167 - +30.05	+108.6333 - +109.3333

Laifeng	+109.402778	+29.509722	+29.1 - +29.6667	+109 - +109.45
Hefeng	+110.015556	+29.887778	+29.6333- +30.2333	+109.75 - +110.6333

A.3. Parties and project participant(s)

Party involved (host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
China	Hubei Qingjiang Zhongye Company Ltd.	No
Netherlands	Netherlands' Ministry of Infrastructure and the Environment (IenM)	Yes
Japan	Daiwa Securities Capital Markets Co. Ltd.; FUJIFILM Corporation; Idemitsu Kosan Co., Ltd.; JX Nippon Oil & Energy Corporation; The Okinawa Electric Power Corporation, Incorporated	No
Belgium	Kingdom of Belgium - Walloon Region: Walloon Air and Climate Agency; Bruxelles Environnement - IBGE	Yes
Canada	Government of Canada - Ministry of Foreign Affairs and International Trade	Yes
Denmark	Aalborg Portland A/S; Danish Ministry of Climate and Energy/Danish Energy Agency; Dong Naturgas A/S; Maersk Olie og Gas AS; Nordjysk Elhandel A/S	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	Stratkraft Carbon Invest AS; Statoil ASA	No

Spain	Endesa Generación S.A.; Kingdom of Spain - Ministry of Environment and Rural and Marine Affairs & Ministry of Economy and Finance; EDP-Energias de Portugal, S.A.; Gas Natural SDG, S.A.; Hidroeléctrica del Cantábrico, S.A.	Yes
Sweden	Göteborg Energi AB	No
Switzerland	Schweizerische Rückversicherungsgesellschafts AG (Swiss RE)	No
Germany	BASF SE; KfW	No
Austria	Kommunalkredit Public Consulting GmbH	No
Finland	Ruukki Metals Oy	No
Netherlands	Netherlands' Ministry of Infrastructure and the Environment (IenM)	Yes
Belgium	Kingdom of Belgium - Walloon Region Ministry of the Environment; Bruxelles Environnement - IBGE	Yes
Canada	Government of Canada - Ministry of Foreign Affairs and International Trade	Yes
Denmark	Aalborg Portland A/S; Danish Ministry of Climate and Energy/Danish Energy Agency; Dong Naturgas A/S; Maersk Olie og Gas A/S ; Nordjysk Elhandel A/S	Yes

A.4. Reference of applied methodology

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. These baseline methodologies can be downloaded from the Executive Board (EB) website: <http://cdm.unfccc.int/methodologies/PAMethodologies/approved.html>.

A.5. Crediting period of project activity

The crediting period of the project activity is 19/02/2009 - 18/02/2019.

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

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 digester 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 counties in the CDM project

County/City	No. of biogas digesters with different digester volume				Total no. of biogas installed 2007-2008 in each county	Data sources
	8 m ³	10 m ³	12 m ³	15 m ³		
Enshi	1,918	2,412			4330	Name list of Enshi CDM project, provided by Enshi Prefecture PMO on 16, March. 2012.
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-tier technical supporting service system has been established. At prefecture level, biogas association and consulting agency was established by Enshi Autonomous Prefecture. Rural energy service center was established at county level. Township government established rural energy service branch; and village community set rural biogas service network. The four-tier service system was proven to work well in delivering timely and adequate services to farmers and monitoring the biogas digester operation. The reasons are as follow: 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 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 is able to reach around 300 households. Farmers could easily purchase the needed parts and fittings and receive technical assistance. Besides the four-tier 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. There were 419 biogas digesters not operating due to migration to cities for temporary employment and digester breakdown etc.

B.2. Post registration changes

B.2.1. Temporary deviations from registered monitoring plan or applied methodology

NA.

B.2.2. Corrections

NA.

B.2.3. Permanent changes from registered monitoring plan or applied methodology

NA .

B.2.4. Changes to project design of registered project activity

NA.

B.2.5. Changes to start date of crediting period

NA.

B.2.6. Types of changes specific to afforestation or reforestation project activity

NA.

SECTION C. Description of monitoring system

1. Data collection procedure

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.

1) Recording the number of operating biogas digesters

After the project start, the project technical support panel would work with Project Entity to monitor the number of operational biogas installation and operation, and establish a database containing all relative identification information of each household, such as name, address, date on installation and operation of biogas digester. In the same time, the quality of the biogas digester installed under the project would also be checked according to the project technical design. The readout records of the number of operating biogas digesters and list of biogas stove delivered by county energy bureau will be recorded for DOE review.

2) Estimation of annual operational hours of biogas digesters

Operational hours of biogas digesters was estimated based on the length of the period that the biogas digesters are not operating while they are discharged annually and restart. The length of the period that the biogas digesters are not operating will be collected by surveying a sample of 2,750 household participants. This sample size will ensure a precision at 95% confidence intervals (T-values). The files containing the

estimation of Annual operational hours of biogas digesters will be recorded for DOE review.

3) Swine population

Pig numbers which manure treated in biogas digester for the 2,750 random sample households will be recorded and reported to Enshi Energy Bureau.

4) Amount of pig manure VS generated and fed into the biogas digester

Amount of pig manure VS generated in individual household will be calculated as the product of swine population of individual household multiplied by IPCC default VS values.

As described in A4.2, all the manure generated will be fed into biogas digesters directly. Therefore the amount of pig manure VS fed into the biogas digesters is same to what the pig manure VS generated.

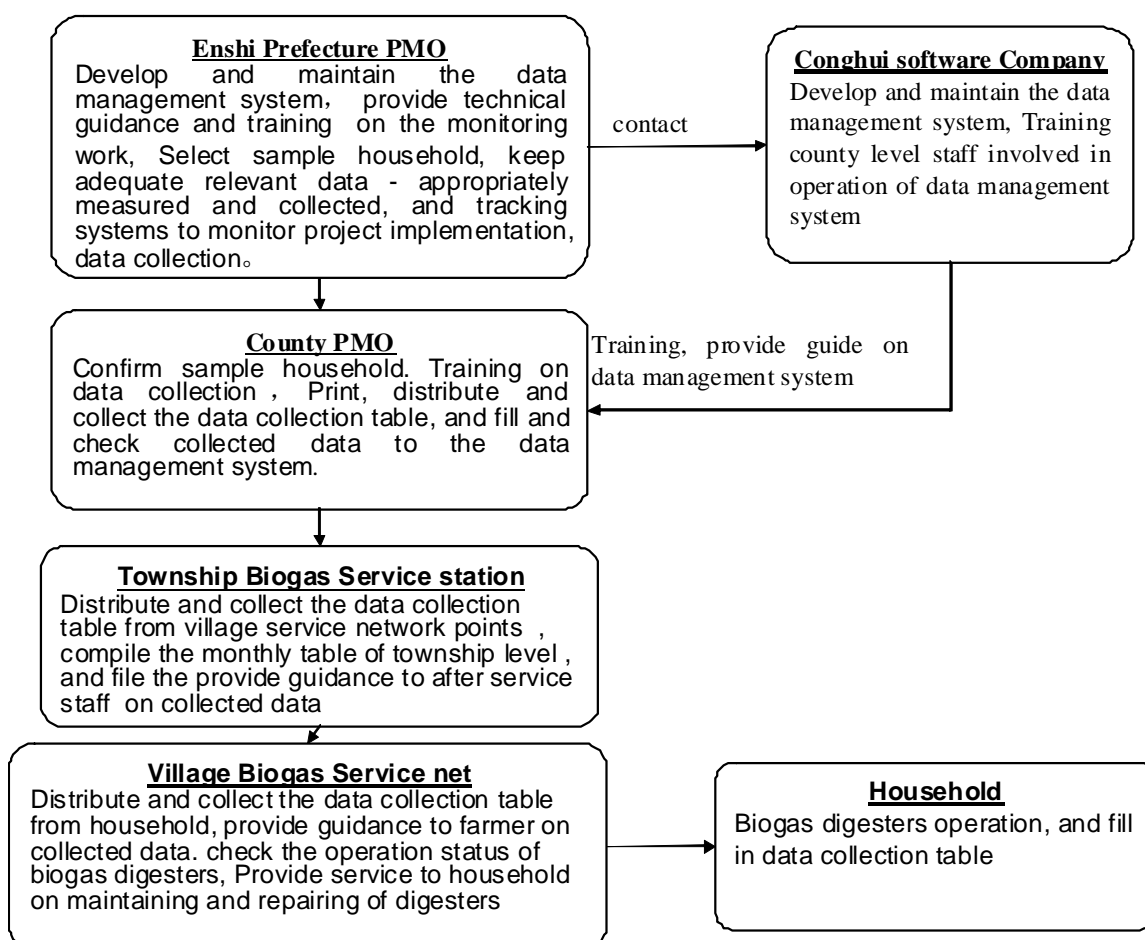
5) Application of biogas residue

The destination of biogas residue for the 2,750 random sample households will be recorded and reported to Enshi Energy Bureau.

6) Climatic parameters

Monthly average temperatures will be brought from monitored by Enshi Meteorological Station.

2. Organizational structure



3. 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:

- I 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. ([2010]6)¹, and provided standard data collection tables to the county PMO².
- I 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 07/12/2010, 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.³
- I 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.
- I 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 fixed ex ante or at renewal of crediting period

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	Data on Fraction of manure handled in system j in the baseline are

¹ Notification of household list for the third monitoring period, provided by Enshi PMO, issued on 3 Dec., 2010.

² Please see the document "Monitoring Manual" provided by Enshi Prefecture PMO, issued on 10 July, 2009.

³ Notification of Prefectural Training Course on Household CDM Project was issued on 3 Dec. 2010.

used for (Baseline/ Project/ Leakage emission calculations)	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 _{CH₄} 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 registered 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 B7 of 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	
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 D2 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):	In this monitoring period, number of operating biogas digesters with different volume in each county was calculated based on the difference between the total number of constructed biogas digesters within different volume and the number of biogas digesters that are not functional due to reasons other than biogas residue discharge.
QA/QC procedures applied:	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. In the

	<p>same time, the quality of the biogas digester installed under the project was checked according to the project technical design. The readout records of the number of operating biogas digesters and list of biogas stove delivered by county energy bureau was recorded for DOE review.</p> <p>Each month, the village service staff checked the operation of all the project digesters and recorded the numbers of not operating digesters. Technicians of township service station accompanied by village technicians visited all the households one time to check whether biogas digesters operating or not. It was conducted during 22 Dec., 2011 to 10, Jan., 2012⁴. 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 residue⁵, these biogas digesters were assumed to be not operating.</p>	
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 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:	Annually	
Calculation method (if applicable):	It was calculated based on survey. The average operational hours for biogas digesters with different volume in each county equate to total hours of the third monitoring period (365 days*24hours) minus the average hours that are not functional (Table D3*24 hours) of each biogas digester with different volume in that county due to residue discharge or other temporary repairing.	
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 or other maintenance and repairing happens. The length of the period that the biogas digesters were not operating was collected by surveying 2,750 household participants.	

⁴ Notification for the investigation of operational biogas digesters during the third monitoring period. It was issued by Enshi PMO 16 Dec., 2011.

⁵ Residue discharge means to remove the biogas residue from the digester. The digester will stop producing biogas.

	<p>The sample size of household number will ensure a precision needed to give a precision at 95 % confidence intervals (T-values). A three-tier approach is applied to determine the length of non-operational period.</p> <p>First, the trained village service staff checked the digesters on site and examined whether operational status is properly recorded by households on monthly basis. During monthly site check, staff cross-checked the non-operational hours filed in the monthly form. In addition, they verified the digester status by turning on biogas stove. If there is no flare when lighting, it means no biogas flowing and the digester is not operating, and the non-operational hours will be recorded as the whole month if it is inconsistent with the recorded data.</p> <p>On second level, staff of township service station compiled the monthly table based on the recorded household data and visited the sampled household each month to check the filed data.</p> <p>Third, county PMO staff spot-checked sampled households during this monitoring period.</p>
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 D5
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)	Mercury thermometer
Measuring/ Reading/ Recording frequency:	Monthly
Calculation method (if applicable):	Average the monthly mean temperature and get the average temperature during the third 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 D6
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 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 2,750 household ensures a precision needed to give a precision at 95% confidence intervals (T-values). It is the safety measure to cross check and make sure there is no biogas during repairing and residues discharging period
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 D7
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):	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 D6 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:	See Table D8
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:	Every application
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.

ITable D1: Number of not operating biogas digesters with different volume in different county during the third monitoring period

	8 m ³	10 m ³	12 m ³	15 m ³	Total	Data Sources
Enshi	0	0			0	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Jianshi	0	0			0	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Badong	1	2			3	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Lichuan	19	13			32	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xuan'en		54	39		93	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xianfeng				242	242	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Laifeng	42				42	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

Hefeng			7		7	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Total	62	69	46	242	419	

Table D2: Number of operating biogas digesters with different volume in different county during the third monitoring period*

County/City	No. of operating biogas digesters with different volume					Date sources
	8 m ³	10 m ³	12 m ³	15 m ³	Total	
Enshi	1918	2412				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Jianshi	540	4030				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Badong	1580	2987				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Lichuan	3024	2904				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xuan'en		1779	1128			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xianfeng				4328		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Laifeng	2958					Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Hefeng			2993			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Total	10020	14112	4121	4328	32581	

* In this monitoring period, number of operating biogas digesters with different volume in each county was calculated based on the difference between the total number of constructed biogas digesters within different volume and the number of biogas digesters that are not functional due to reasons other than biogas residue discharge (Table B1-Table D1).

Table D3: Non-operational days during the third monitoring period of operational biogas digesters*

County name	8 m ³ (days)	10 m ³ (days)	12 m ³ (days)	15 m ³ (days)	Data Source
Enshi	0.98	1.09			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Jianshi	0.17	0.29			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Badong	0.63	0.45			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

					Mar. 2012.
Lichuan	0.29	0.4			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xuan'en	2.29	2.63			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xianfeng				0.45	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Laifeng	0.54				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Hefeng			0.26		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

* The non-operational days for biogas digesters with different volume in each county equate to total non-operational days, due to residue discharge or other temporary repair, of all the monitored biogas digesters under each volume divided by the total number of monitored and operational biogas digester with the same volume.

Table D4: Operational hours during the third monitoring period*

County name	8 m ³ (Hour)	10 m ³ (Hour)	12 m ³ (Hour)	15 m ³ (Hour)
Enshi	8736.5	8733.8		
Jianshi	8755.9	8753.0		
Badong	8744.9	8749.2		
Lichuan	8753.0	8750.4		
Xuan'en		8696.9	8760.0	
Xianfeng				8749.2
Laifeng	8747.0			
Hefeng			8753.8	

* The operational hours for biogas digesters with different volume in each county equate to total hours of the third monitoring period (365 days*24hours) minus the average hours that are not functional (Table D3*24 hours) of each biogas digester with different volume in that county due to residue discharge or other temporary repair.

Table D5: Average temperature in different counties during the third monitoring period

County	Enshi	Jianshi	Badong	Lichuan	Xuan'en	Xianfeng	Laifeng	Hefeng
(°C)	16.1	15.4	17.1	13.1	15.7	14.2	15.7	15.4
Data sources on Monthly average temperature of each county/city								
Organization of the evidence provision	Meteoro-logical Station of Enshi	Meteoro-logical Station of Jianshi	Meteoro-logical Station of Badong	Meteoro-logical Station of Lichuan	Meteoro-logical Station of Xuan'en	Meteoro-logical Station of Xianfeng	Meteoro-logical Station of Laifeng	Meteoro-logical Station of Hefeng
Date of the provision	2012-2-15	2012-2-22	2012-2-20	2012-2-23	2012-1-2	2012-1-10	2012-2-22	2012-2-15

Table D6: Average annual swine stock during the third monitoring period

County	8 m ³	10 m ³	12 m ³	15 m ³	Data Source
--------	------------------	-------------------	-------------------	-------------------	-------------

name	(Head)	(Head)	(Head)	(Head)	
Enshi	4.1	4.02			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Jianshi	4.04	4.36			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Badong	4.86	4.74			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Lichuan	4.23	4.11			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xuan'en		3.88	3.8		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xianfeng				3.92	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Laifeng	4.14				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Hefeng			4.05		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

Table D7: Daily volatile solid contained in the manure generated by pigs in individual household in project case*

County name	8 m ³ kg dry matter/day/hea d	10 m ³ kg dry matter/day/hea d	12 m ³ kg dry matter/day/hea d	15 m ³ kg dry matter/day/hea d
Enshi	1.23	1.21		
Jianshi	1.21	1.31		
Badong	1.46	1.42		
Lichuan	1.27	1.23		
Xuan'en		1.16	1.14	
Xianfeng				1.18
Laifeng	1.24			
Hefeng			1.22	

* Daily volatile solid contained in the manure generated by pigs in individual household is calculated as the average annual swine stock during the third monitoring period (Table D6) times 0.3 , which is the IPCC VS defaults value provided by 2006 IPCC guideline.

Table D8: Average application times and its destination of sludge during the third monitoring period

County name	Dry land (time)				Vegetable field (time)				Paddy field (time)				Data Source
	8m ³	10m 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	6.3	5.9			6.2	5.8			0	0			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Jianshi	10.2	4.9			0.8	5.4			0	0			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

Badong	5.6	4.2			5.2	5.6			0	0			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Lichuan	7.2	6.5			7.8	7.5			0	0			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xuan'en		3.2	3.8			2.9	3.9			0	0		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xianfeng				3.0				2.6				0	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Laifeng	4.7				6.9				0				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Hefeng			5.2			4.2					0		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

D.3. Implementation of sampling plan

The sampling method for annual household monitoring includes following steps:

Step 1: Select 2750⁶ 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.

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 D9.

Table D9: 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	Data sources
	8 m ³	10 m ³	12 m ³	15 m ³		

⁶ The number of households for the sample is chosen to achieve a 95% confidence level for the data collected on the number of households with operating biogas digesters. It is in line with the procedure in "GENERAL GUIDELINES FOR SAMPLING AND SURVEYS FOR SMALL-SCALE CDM PROJECT ACTIVITIES"(Version 01)

Enshi	160	200			360	Notification of name list of monitored household during third monitoring period, provided by Enshi Prefectural PMO. The document was issued on 3 Dec. 2010.
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					2750	

SECTION E. Calculation of emission reductions or GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

This section shall include all formula used and description to calculate the baseline emissions applying actual values. The calculation spreadsheet on baseline emission are included in excel file named as “Hubei Household biogas CDM-ER calculation-third 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.

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

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)	16.1	15.4	17.1	13.1	15.7	14.2	15.7	15.4
$MCF_{ij}/100$	0.29	0.27	0.32	0.22	0.27	0.25	0.27	0.27
EF_i (kg CH ₄ /year/head)	6.170	5.744	6.808	4.681	5.744	5.319	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	$\text{m}^3 \text{ CH}_4 \text{ kg}^{-1}$ 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 third monitoring period (t CO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	0.53	0.49	0.69	0.42			0.50	
10 m ³	0.52	0.53	0.68	0.40	0.46			
12 m ³					0.46			0.49
15 m ³						0.44		

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 the third monitoring period (tCO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	2.80	2.89	2.74	2.87			2.56	
10 m ³	2.85	2.96	2.64	2.95	2.86			
12 m ³					2.98			3.31
15 m ³						3.14		

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 the third monitoring period (tCO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	3.33	3.38	3.44	3.29			3.06	
10 m ³	3.37	3.49	3.32	3.35	3.33			
12 m ³					3.44			3.80
15 m ³						3.58		

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 the third monitoring period (t CO₂ e)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng	Total
	6379	1823	5428	9949			9054		32634
	8119	14062	9919	9741	5922				47763
					3876			11380	15257
						15493			15493
	14498	15885	15347	19691	9798	15493	9054	11380	111146

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 D6 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 D2 above

E.2. Calculation of project emissions or actual net GHG removals by sinks

The calculation of project emissions is included in excel file named as Hubei Household biogas CDM-ER calculation - third 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 third monitoring period (t CO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	0.18	0.18	0.22	0.19			0.18	
10 m ³	0.18	0.19	0.21	0.18	0.17			
12 m ³					0.17			0.18
15 m ³						0.17		

- 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 third monitoring period (t CO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	1.60	1.64	1.44	1.67			1.21	
10 m ³	1.40	1.55	1.21	1.52	1.51			
12 m ³					1.47			1.83

15 m ³						1.60		
-------------------	--	--	--	--	--	------	--	--

3) Project GHG emission calculation

$$PE_{y,i,k} = PE_{CO_2,i,k} + PE_{ly}$$

(8)

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

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	1.78	1.82	1.66	1.86			1.39	
10 m ³	1.58	1.75	1.43	1.71	1.69			
12 m ³					1.63			2.01
15 m ³						1.78		

4) Total project GHG emission

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

(9)

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

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng	Total
8 m ³	3414	981	2616	5615			4114		16740
10 m ³	3813	7043	4259	4961	2999				23074
12 m ³					1844			6025	7869
15 m ³						7698			7698
Total	7227	8025	6875	10576	4843	7698	4114	6025	55382

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.	%	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	m ³ CH ₄ kg ⁻¹ of VS excreted	0.29

		Inventories, Volume 4, and Chapter 10		
$VS_{m,y}$	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 D2 above

E.3. Calculation of leakage

According to version 12 of AMS I.C and version 1 of AMS III.R, neither methane recovery and equipment used in the project activity is transferred from another activity, nor the existing equipment is transferred to another activity. Therefore, leakage emissions are not considered in the project activity.

E.4. Summary of calculation of emission reductions or net anthropogenic GHG removals by sinks

Time Period	Baseline emissions or baseline net GHG removals by sinks (tCO ₂ e)	Project emissions or actual net GHG removals by sinks (tCO ₂ e)	Leakage (tCO ₂ e)	Emission reductions or net anthropogenic GHG removals by sinks (tCO ₂ e)
Total	111,146	55,382		55,764

E.5. Comparison of actual emission reductions or net anthropogenic GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex-ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (t CO₂e)	58,444	55,764

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

According to the registered PDD, the expected emission reduction of the project was estimated to be 58,444 tCO₂e per year. During the monitoring period (01/01/2011-31/12/2011), the measured annual emission reduction was 55,764 tCO₂e which is 4.6% lower than the ex-ante calculated result. The main reason is the number of the un-operational biogas and decrease of swine population in Xuan'en and Xianfeng counties.

E.7. Actual emission reductions or net anthropogenic GHG removals by sinks during the first commitment period and the period from 1 January 2013 onwards

Item	Actual values achieved up to 31 December 2012	Actual values achieved from 1 January 2013 onwards
Emission reductions or GHG removals by sinks (t CO ₂ e)		

Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net anthropogenic GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01	28 May 2010	EB 54, Annex 34. Initial adoption.
Decision Class: Regulatory Document Type: Form Business Function: issuance Keywords: monitoring report, performance monitoring		



Monitoring report form (Version 03.1)

MONITORING REPORT

Title of the project activity	HUBEI ECO-FARMING BIOGAS PROJECT PHASE I
Reference number of the project activity	2221
Version number of the monitoring report	01
Completion date of the monitoring report	28/10/2012
Registration date of the project activity	19/02/2009
Monitoring period number and duration of this monitoring period	Monitoring period number : 3 rd monitoring period Duration of this monitoring period: 01/01/2011 - 31/12/2011
Project participant(s)	<ol style="list-style-type: none"> 1. China: Hubei Qingjiang Zhongye Company Ltd. 2. Netherlands: Netherlands' Ministry of Infrastructure and the Environment (IenM) 3. Japan: Daiwa Securities Capital Markets Co. Ltd.; FUJIFILM Corporation; Idemitsu Kosan Co., Ltd.; JX Nippon Oil & Energy Corporation; The Okinawa Electric Power Corporation, Incorporated 4. Belgium: Kingdom of Belgium - Walloon Region: Walloon Air and Climate Agency; Bruxelles Environnement - IBGE 5. Canada: Government of Canada - Ministry of Foreign Affairs and International Trade 6. Denmark: Aalborg Portland A/S; Danish Ministry of Climate and Energy/Danish Energy Agency; Dong Naturgas A/S; Maersk Olie og Gas AS; Nordjysk Elhandel A/S 7. Italy: Government of Italy - Ministry for the Environment, Land and Sea

	<p>8. Luxembourg: Government of Luxembourg - Ministry of Sustainable Development and Infrastructure - Department of Environment</p> <p>9. Norway: Stratkraft Carbon Invest AS; Statoil ASA</p> <p>10. Spain: Endesa Generación S.A.; Kingdom of Spain - Ministry of Environment and Rural and Marine Affairs & Ministry of Economy and Finance; EDP-Energias de Portugal, S.A.; Gas Natural SDG, S.A.; Hidroeléctrica del Cantábrico, S.A.</p> <p>11. Sweden: Göteborg Energi AB</p> <p>12. Switzerland: Schweizerische Rückversicherungsgesellschafts AG (Swiss RE)</p> <p>13. Germany: BASF SE; KfW</p> <p>14. Austria: Kommunalkredit Public Consulting GmbH</p> <p>15. Finland: Ruukki Metals Oy</p>
Host Party(ies)	China
Sectoral scope(s) and applied methodology(ies)	<p>Sectoral scopes: 1-Energy industries (renewables-/non-renewable sources); 15- Agriculture</p> <p>Applied methodology(ies): Version 12 of AMS-I.C: "Thermal energy for the user with or without electricity" Version 01 of AMS-III.R: "Methane recovery in agricultural activities at household/farm level"</p>
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	58,444 tCO ₂ e
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	55,764 tCO ₂ e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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 equipment

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 (CERs) for first monitoring (19/02/2009 – 31/08/2009) were issued in 11/05/2011. The CER issuance request for second monitoring period (01/09/2009 – 31/12/2010) is awaiting approval.

4. Total emission reductions achieved in this monitoring period.

This monitoring report is for the third monitoring period, which is from and including 01/01/2011 to 31/12/2011. Total emission reductions achieved in this monitoring period are 55,764 tCO₂e. T

A.2. Location of project activity

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	+30.0667 - +30.65	+109.0667 - +109.9667
Jianshi	+109.7222	+30.603333	+30.1 - +30.9	+109.5333 - +110.2
Badong	+110.345	+31.043889	+30.2167 - +31.4667	+110.0667 - +110.5333
Lichuan	+108.931667	+30.298056	+29.7 - +30.65	+108.35 - +109.3
Xuan'en	+109.479722	+29.993333	+29.55 - +30.2	+109.1833 - +109.9167
Xianfeng	+109.151944	+29.696389	+29.3167 - +30.05	+108.6333 - +109.3333

Laifeng	+109.402778	+29.509722	+29.1 - +29.6667	+109 - +109.45
Hefeng	+110.015556	+29.887778	+29.6333- +30.2333	+109.75 - +110.6333

A.3. Parties and project participant(s)

Party involved (host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
China	Hubei Qingjiang Zhongye Company Ltd.	No
Netherlands	Netherlands' Ministry of Infrastructure and the Environment (IenM)	Yes
Japan	Daiwa Securities Capital Markets Co. Ltd.; FUJIFILM Corporation; Idemitsu Kosan Co., Ltd.; JX Nippon Oil & Energy Corporation; The Okinawa Electric Power Corporation, Incorporated	No
Belgium	Kingdom of Belgium - Walloon Region: Walloon Air and Climate Agency; Bruxelles Environnement - IBGE	Yes
Canada	Government of Canada - Ministry of Foreign Affairs and International Trade	Yes
Denmark	Aalborg Portland A/S; Danish Ministry of Climate and Energy/Danish Energy Agency; Dong Naturgas A/S; Maersk Olie og Gas AS; Nordjysk Elhandel A/S	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	Stratkraft Carbon Invest AS; Statoil ASA	No

Spain	Endesa Generación S.A.; Kingdom of Spain - Ministry of Environment and Rural and Marine Affairs & Ministry of Economy and Finance; EDP-Energias de Portugal, S.A.; Gas Natural SDG, S.A.; Hidroeléctrica del Cantábrico, S.A.	Yes
Sweden	Göteborg Energi AB	No
Switzerland	Schweizerische Rückversicherungsgesellschafts AG (Swiss RE)	No
Germany	BASF SE; KfW	No
Austria	Kommunalkredit Public Consulting GmbH	No
Finland	Ruukki Metals Oy	No
Netherlands	Netherlands' Ministry of Infrastructure and the Environment (IenM)	Yes
Belgium	Kingdom of Belgium - Walloon Region Ministry of the Environment; Bruxelles Environnement - IBGE	Yes
Canada	Government of Canada - Ministry of Foreign Affairs and International Trade	Yes
Denmark	Aalborg Portland A/S; Danish Ministry of Climate and Energy/Danish Energy Agency; Dong Naturgas A/S; Maerskolie og Gas A/S ; Nordjysk Elhandel A/S	Yes

A.4. Reference of applied methodology

Approved methodologies Version 12 of AMS-IC 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. These baseline methodologies can be downloaded from the Executive Board (EB) website: <http://cdm.unfccc.int/methodologies/PAMethodologies/approved.html>.

A.5. Crediting period of project activity

The crediting period of the project activity is 19/02/2009 - 18/02/2019.

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

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 digester 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 counties in the CDM project

County/City	No. of biogas digesters with different digester volume				Total no. of biogas installed 2007-2008 in each county	Data sources
	8 m ³	10 m ³	12 m ³	15 m ³		
Enshi	1,918	2,412			4330	Name list of Enshi CDM project, provided by Enshi Prefecture PMO on 16, March. 2012.
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-tier technical supporting service system has been established. At prefecture level, biogas association and consulting agency was established by Enshi Autonomous Prefecture. Rural energy service center was established at county level. Township government established rural energy service branch; and village community set rural biogas service network. The four-tier service system was proven to work well in delivering timely and adequate services to farmers and monitoring the biogas digester operation. The reasons are as follow: 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 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 is able to reach around 300 households. Farmers could easily purchase the needed parts and fittings and receive technical assistance. Besides the four-tier 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. There were 419 biogas digesters not operating due to migration to cities for temporary employment and digester breakdown etc.

B.2. Post registration changes

B.2.1. Temporary deviations from registered monitoring plan or applied methodology

NA.

B.2.2. Corrections

NA.

B.2.3. Permanent changes from registered monitoring plan or applied methodology

NA .

B.2.4. Changes to project design of registered project activity

NA.

B.2.5. Changes to start date of crediting period

NA.

B.2.6. Types of changes specific to afforestation or reforestation project activity

NA.

SECTION C. Description of monitoring system

1. Data collection procedure

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.

1) Recording the number of operating biogas digesters

After the project start, the project technical support panel would work with Project Entity to monitor the number of operational biogas installation and operation, and establish a database containing all relative identification information of each household, such as name, address, date on installation and operation of biogas digester. In the same time, the quality of the biogas digester installed under the project would also be checked according to the project technical design. The readout records of the number of operating biogas digesters and list of biogas stove delivered by county energy bureau will be recorded for DOE review.

2) Estimation of annual operational hours of biogas digesters

Operational hours of biogas digesters was estimated based on the length of the period that the biogas digesters are not operating while they are discharged annually and restart. The length of the period that the biogas digesters are not operating will be collected by surveying a sample of 2,750 household participants. This sample size will ensure a precision at 95% confidence intervals (T-values). The files containing the

estimation of Annual operational hours of biogas digesters will be recorded for DOE review.

3) Swine population

Pig numbers which manure treated in biogas digester for the 2,750 random sample households will be recorded and reported to Enshi Energy Bureau.

4) Amount of pig manure VS generated and fed into the biogas digester

Amount of pig manure VS generated in individual household will be calculated as the product of swine population of individual household multiplied by IPCC default VS values.

As described in A4.2, all the manure generated will be fed into biogas digesters directly. Therefore the amount of pig manure VS fed into the biogas digesters is same to what the pig manure VS generated.

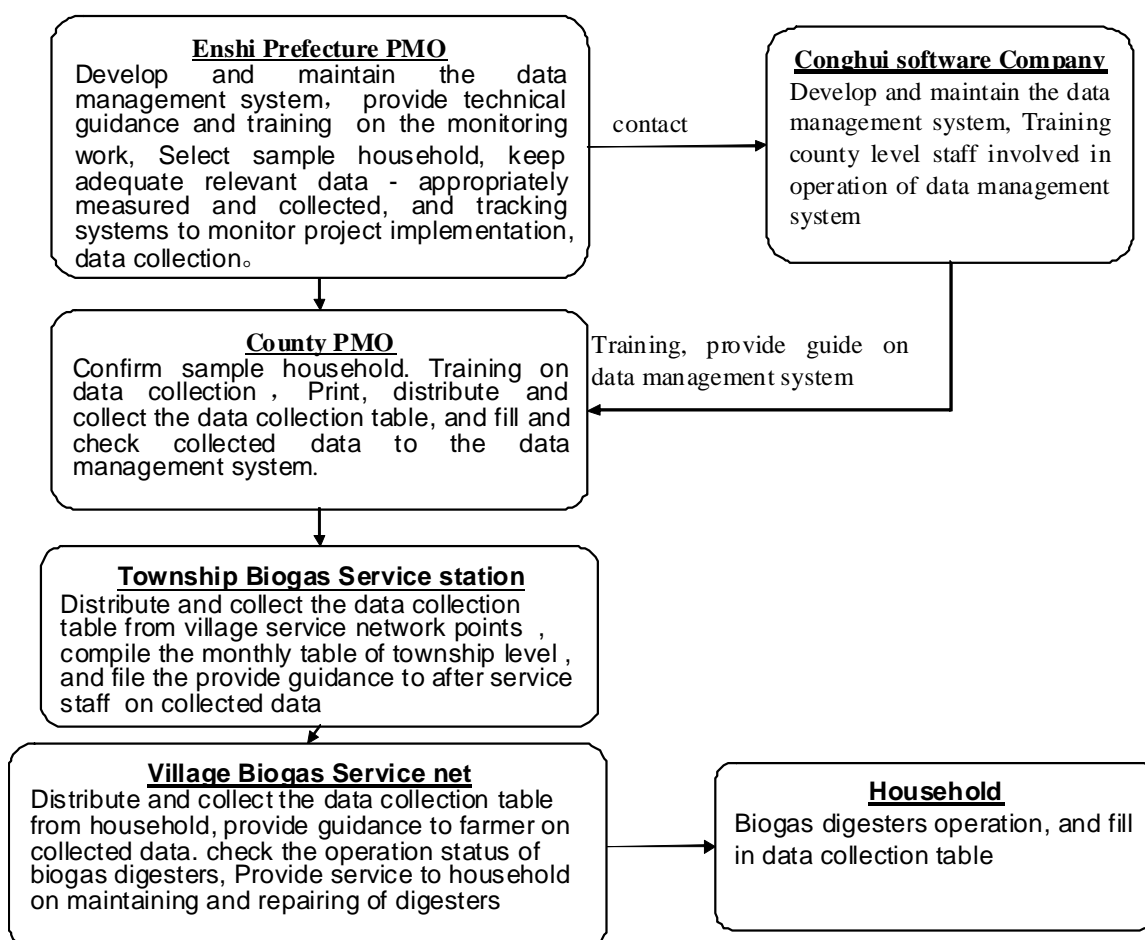
5) Application of biogas residue

The destination of biogas residue for the 2,750 random sample households will be recorded and reported to Enshi Energy Bureau.

6) Climatic parameters

Monthly average temperatures will be brought from monitored by Enshi Meteorological Station.

2. Organizational structure



3. 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:

- I 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. ([2010]6)¹, and provided standard data collection tables to the county PMO².
- I 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 07/12/2010, 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.³
- I 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.
- I 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 fixed ex ante or at renewal of crediting period

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	Data on Fraction of manure handled in system j in the baseline are

¹ Notification of household list for the third monitoring period, provided by Enshi PMO, issued on 3 Dec., 2010.

² Please see the document "Monitoring Manual" provided by Enshi Prefecture PMO, issued on 10 July, 2009.

³ Notification of Prefectural Training Course on Household CDM Project was issued on 3 Dec. 2010.

used for (Baseline/ Project/ Leakage emission calculations)	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 _{CH₄} 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 registered 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 B7 of 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	
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 D2 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):	In this monitoring period, number of operating biogas digesters with different volume in each county was calculated based on the difference between the total number of constructed biogas digesters within different volume and the number of biogas digesters that are not functional due to reasons other than biogas residue discharge.
QA/QC procedures applied:	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. In the

	<p>same time, the quality of the biogas digester installed under the project was checked according to the project technical design. The readout records of the number of operating biogas digesters and list of biogas stove delivered by county energy bureau was recorded for DOE review.</p> <p>Each month, the village service staff checked the operation of all the project digesters and recorded the numbers of not operating digesters. Technicians of township service station accompanied by village technicians visited all the households one time to check whether biogas digesters operating or not. It was conducted during 22 Dec., 2011 to 10, Jan., 2012⁴. 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 residue⁵, these biogas digesters were assumed to be not operating.</p>	
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 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:	Annually	
Calculation method (if applicable):	It was calculated based on survey. The average operational hours for biogas digesters with different volume in each county equate to total hours of the third monitoring period (365 days*24hours) minus the average hours that are not functional (Table D3*24 hours) of each biogas digester with different volume in that county due to residue discharge or other temporary repairing.	
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 or other maintenance and repairing happens. The length of the period that the biogas digesters were not operating was collected by surveying 2,750 household participants.	

⁴ Notification for the investigation of operational biogas digesters during the third monitoring period. It was issued by Enshi PMO 16 Dec., 2011.

⁵ Residue discharge means to remove the biogas residue from the digester. The digester will stop producing biogas.

	<p>The sample size of household number will ensure a precision needed to give a precision at 95 % confidence intervals (T-values). A three-tier approach is applied to determine the length of non-operational period.</p> <p>First, the trained village service staff checked the digesters on site and examined whether operational status is properly recorded by households on monthly basis. During monthly site check, staff cross-checked the non-operational hours filed in the monthly form. In addition, they verified the digester status by turning on biogas stove. If there is no flare when lighting, it means no biogas flowing and the digester is not operating, and the non-operational hours will be recorded as the whole month if it is inconsistent with the recorded data.</p> <p>On second level, staff of township service station compiled the monthly table based on the recorded household data and visited the sampled household each month to check the filed data.</p> <p>Third, county PMO staff spot-checked sampled households during this monitoring period.</p>
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 D5
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)	Mercury thermometer
Measuring/ Reading/ Recording frequency:	Monthly
Calculation method (if applicable):	Average the monthly mean temperature and get the average temperature during the third 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 D6
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 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 2,750 household ensures a precision needed to give a precision at 95% confidence intervals (T-values). It is the safety measure to cross check and make sure there is no biogas during repairing and residues discharging period
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 D7
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):	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 D6 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:	See Table D8
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:	Every application
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.

ITable D1: Number of not operating biogas digesters with different volume in different county during the third monitoring period

	8 m ³	10 m ³	12 m ³	15 m ³	Total	Data Sources
Enshi	0	0			0	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Jianshi	0	0			0	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Badong	1	2			3	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Lichuan	19	13			32	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xuan'en		54	39		93	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xianfeng				242	242	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Laifeng	42				42	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

Hefeng			7		7	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Total	62	69	46	242	419	

Table D2: Number of operating biogas digesters with different volume in different county during the third monitoring period*

County/City	No. of operating biogas digesters with different volume					Date sources
	8 m ³	10 m ³	12 m ³	15 m ³	Total	
Enshi	1918	2412				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Jianshi	540	4030				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Badong	1580	2987				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Lichuan	3024	2904				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xuan'en		1779	1128			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xianfeng				4328		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Laifeng	2958					Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Hefeng			2993			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Total	10020	14112	4121	4328	32581	

* In this monitoring period, number of operating biogas digesters with different volume in each county was calculated based on the difference between the total number of constructed biogas digesters within different volume and the number of biogas digesters that are not functional due to reasons other than biogas residue discharge (Table B1-Table D1).

Table D3: Non-operational days during the third monitoring period of operational biogas digesters*

County name	8 m ³ (days)	10 m ³ (days)	12 m ³ (days)	15 m ³ (days)	Data Source
Enshi	0.98	1.09			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Jianshi	0.17	0.29			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Badong	0.63	0.45			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

					Mar. 2012.
Lichuan	0.29	0.4			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xuan'en	2.29	2.63			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xianfeng				0.45	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Laifeng	0.54				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Hefeng			0.26		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

* The non-operational days for biogas digesters with different volume in each county equate to total non-operational days, due to residue discharge or other temporary repair, of all the monitored biogas digesters under each volume divided by the total number of monitored and operational biogas digester with the same volume.

Table D4: Operational hours during the third monitoring period*

County name	8 m ³ (Hour)	10 m ³ (Hour)	12 m ³ (Hour)	15 m ³ (Hour)
Enshi	8736.5	8733.8		
Jianshi	8755.9	8753.0		
Badong	8744.9	8749.2		
Lichuan	8753.0	8750.4		
Xuan'en		8696.9	8760.0	
Xianfeng				8749.2
Laifeng	8747.0			
Hefeng			8753.8	

* The operational hours for biogas digesters with different volume in each county equate to total hours of the third monitoring period (365 days*24hours) minus the average hours that are not functional (Table D3*24 hours) of each biogas digester with different volume in that county due to residue discharge or other temporary repair.

Table D5: Average temperature in different counties during the third monitoring period

County	Enshi	Jianshi	Badong	Lichuan	Xuan'en	Xianfeng	Laifeng	Hefeng
(°C)	16.1	15.4	17.1	13.1	15.7	14.2	15.7	15.4
Data sources on Monthly average temperature of each county/city								
Organization of the evidence provision	Meteoro-logical Station of Enshi	Meteoro-logical Station of Jianshi	Meteoro-logical Station of Badong	Meteoro-logical Station of Lichuan	Meteoro-logical Station of Xuan'en	Meteoro-logical Station of Xianfeng	Meteoro-logical Station of Laifeng	Meteoro-logical Station of Hefeng
Date of the provision	2012-2-15	2012-2-22	2012-2-20	2012-2-23	2012-1-2	2012-1-10	2012-2-22	2012-2-15

Table D6: Average annual swine stock during the third monitoring period

County	8 m ³	10 m ³	12 m ³	15 m ³	Data Source
--------	------------------	-------------------	-------------------	-------------------	-------------

name	(Head)	(Head)	(Head)	(Head)	
Enshi	4.1	4.02			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Jianshi	4.04	4.36			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Badong	4.86	4.74			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Lichuan	4.23	4.11			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xuan'en		3.88	3.8		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xianfeng				3.92	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Laifeng	4.14				Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Hefeng			4.05		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

Table D7: Daily volatile solid contained in the manure generated by pigs in individual household in project case*

County name	8 m ³ kg dry matter/day/hea d	10 m ³ kg dry matter/day/hea d	12 m ³ kg dry matter/day/hea d	15 m ³ kg dry matter/day/hea d
Enshi	1.23	1.21		
Jianshi	1.21	1.31		
Badong	1.46	1.42		
Lichuan	1.27	1.23		
Xuan'en		1.16	1.14	
Xianfeng				1.18
Laifeng	1.24			
Hefeng			1.22	

* Daily volatile solid contained in the manure generated by pigs in individual household is calculated as the average annual swine stock during the third monitoring period (Table D6) times 0.3, which is the IPCC VS defaults value provided by 2006 IPCC guideline.

Table D8: Average application times and its destination of sludge during the third monitoring period

County name	Dry land (time)				Vegetable field (time)				Paddy field (time)				Data Source
	8m ³	10m 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	6.3	5.9			6.2	5.8			0	0			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Jianshi	10.2	4.9			0.8	5.4			0	0			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

Badong	5.6	4.2			5.2	5.6			0	0		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Lichuan	7.2	6.5			7.8	7.5			0	0		Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xuan'en		3.2	3.8			2.9	3.9			0	0	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Xianfeng				3.0				2.6			0	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Laifeng	4.7				6.9				0			Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.
Hefeng			5.2				4.2				0	Survey result on operating of biogas digester, provided by Ehshi PMO on 16, Mar. 2012.

D.3. Implementation of sampling plan

The sampling method for annual household monitoring includes following steps:

Step 1: Select 2750⁶ 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.

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 D9.

Table D9: 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	Data sources
	8 m ³	10 m ³	12 m ³	15 m ³		

⁶ The number of households for the sample is chosen to achieve a 95% confidence level for the data collected on the number of households with operating biogas digesters. It is in line with the procedure in "GENERAL GUIDELINES FOR SAMPLING AND SURVEYS FOR SMALL-SCALE CDM PROJECT ACTIVITIES"(Version 01)

Enshi	160	200			360	Notification of name list of monitored household during third monitoring period, provided by Enshi Prefectural PMO. The document was issued on 3 Dec. 2010.
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					2750	

SECTION E. Calculation of emission reductions or GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

This section shall include all formula used and description to calculate the baseline emissions applying actual values. The calculation spreadsheet on baseline emission are included in excel file named as “Hubei Household biogas CDM-ER calculation-third 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.

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

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)	16.1	15.4	17.1	13.1	15.7	14.2	15.7	15.4
$MCF_{ij}/100$	0.29	0.27	0.32	0.22	0.27	0.25	0.27	0.27
EF_i (kg CH ₄ /year/head)	6.170	5.744	6.808	4.681	5.744	5.319	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	$\text{m}^3 \text{CH}_4 \text{ kg}^{-1}$ 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 third monitoring period (t CO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	0.53	0.49	0.69	0.42			0.50	
10 m ³	0.52	0.53	0.68	0.40	0.46			
12 m ³					0.46			0.49
15 m ³						0.44		

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 the third monitoring period (tCO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	2.80	2.89	2.74	2.87			2.56	
10 m ³	2.85	2.96	2.64	2.95	2.86			
12 m ³					2.98			3.31
15 m ³						3.14		

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 the third monitoring period (tCO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	3.33	3.38	3.44	3.29			3.06	
10 m ³	3.37	3.49	3.32	3.35	3.33			
12 m ³					3.44			3.80
15 m ³						3.58		

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 the third monitoring period (t CO₂ e)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng	Total
	6379	1823	5428	9949			9054		32634
	8119	14062	9919	9741	5922				47763
					3876			11380	15257
						15493			15493
	14498	15885	15347	19691	9798	15493	9054	11380	111146

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 D6 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 D2 above

E.2. Calculation of project emissions or actual net GHG removals by sinks

The calculation of project emissions is included in excel file named as Hubei Household biogas CDM-ER calculation - third 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 third monitoring period (t CO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	0.18	0.18	0.22	0.19			0.18	
10 m ³	0.18	0.19	0.21	0.18	0.17			
12 m ³					0.17			0.18
15 m ³						0.17		

- 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 third monitoring period (t CO₂ e/household)

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	1.60	1.64	1.44	1.67			1.21	
10 m ³	1.40	1.55	1.21	1.52	1.51			
12 m ³					1.47			1.83

15 m ³						1.60		
-------------------	--	--	--	--	--	------	--	--

3) Project GHG emission calculation

$$PE_{y,i,k} = PE_{CO_2,i,k} + PE_{ly}$$

(8)

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

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng
8 m ³	1.78	1.82	1.66	1.86			1.39	
10 m ³	1.58	1.75	1.43	1.71	1.69			
12 m ³					1.63			2.01
15 m ³						1.78		

4) Total project GHG emission

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

(9)

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

County	Enshi	Jianshi	Badong	Lichuan	Xuanen	Xianfeng	Laifeng	Hefeng	Total
8 m ³	3414	981	2616	5615			4114		16740
10 m ³	3813	7043	4259	4961	2999				23074
12 m ³					1844			6025	7869
15 m ³						7698			7698
Total	7227	8025	6875	10576	4843	7698	4114	6025	55382

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.	%	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	m ³ CH ₄ kg ⁻¹ of VS excreted	0.29

		Inventories, Volume 4, and Chapter 10		
$VS_{m,y}$	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 D2 above

E.3. Calculation of leakage

According to version 12 of AMS I.C and version 1 of AMS III.R, neither methane recovery and equipment used in the project activity is transferred from another activity, nor the existing equipment is transferred to another activity. Therefore, leakage emissions are not considered in the project activity.

E.4. Summary of calculation of emission reductions or net anthropogenic GHG removals by sinks

Time Period	Baseline emissions or baseline net GHG removals by sinks (tCO ₂ e)	Project emissions or actual net GHG removals by sinks (tCO ₂ e)	Leakage (tCO ₂ e)	Emission reductions or net anthropogenic GHG removals by sinks (tCO ₂ e)
Total	111,146	55,382		55,764

E.5. Comparison of actual emission reductions or net anthropogenic GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex-ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (t CO₂e)	58,444	55,764

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

According to the registered PDD, the expected emission reduction of the project was estimated to be 58,444 tCO₂e per year. During the monitoring period (01/01/2011-31/12/2011), the measured annual emission reduction was 55,764 tCO₂e which is 4.6% lower than the ex-ante calculated result. The main reason is the number of the un-operational biogas and decrease of swine population in Xuan'en and Xianfeng counties.

E.7. Actual emission reductions or net anthropogenic GHG removals by sinks during the first commitment period and the period from 1 January 2013 onwards

Item	Actual values achieved up to 31 December 2012	Actual values achieved from 1 January 2013 onwards
Emission reductions or GHG removals by sinks (t CO ₂ e)		

Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net anthropogenic GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01	28 May 2010	EB 54, Annex 34. Initial adoption.
Decision Class: Regulatory Document Type: Form Business Function: issuance Keywords: monitoring report, performance monitoring		