

AMS-III.R.

Small-scale Methodology

Methane recovery from livestock and manure management at households and small farms

Version 05.0

Sectoral scope(s): 15



United Nations
Framework Convention on
Climate Change

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1. Introduction

- The following table describes the key elements of the methodology:

Table 1. Methodology key elements

Typical project(s)	Recovery and combustion of methane from manure or a mixture of manure and other agricultural wastes through: <ul style="list-style-type: none"> • Installation of a methane recovery and combustion system to an existing source of methane emissions; or • Change in the management practice for manure to achieve controlled anaerobic digestion (domestic biogas digester) that is equipped with a methane recovery and combustion system.
Type of GHG emissions mitigation action	GHG destruction: <ul style="list-style-type: none"> • Combustion of methane and displacement of more-GHG-intensive energy generation

2. Scope, applicability, and entry into force

2.1. Scope

- This methodology covers project activities involving the recovery and combustion of methane from manure or a mixture of manure and other agricultural wastes¹ that would decay anaerobically and emit methane to the atmosphere in the absence of the project activity. Recovery and combustion of methane can be achieved either by:
 - Installing a methane recovery and combustion system to an existing source of methane emissions; or
 - Changing a manure management practice to achieve controlled anaerobic digestion by installing a domestic biogas digester equipped with a methane recovery and combustion system.

2.2. Applicability

- The methodology is applicable under the following conditions:
 - The domestic biogas digester, methane recovery and combustion systems are installed at individual households or small farms ;
 - This methodology may be applied in combination with “AMS-I.C.: Thermal energy production with or without electricity” and/or “AMS-I.I.: Biogas/biomass thermal applications for households/small users” and/or “AMS-I.E.: Switch from non-renewable biomass for thermal applications by the user”;
 - This methodology is applicable only to the fraction of the manure which would decay anaerobically in the absence of the project activity. The fraction of the

¹ A small amount of “other agricultural wastes” can be mixed but the baseline emissions arising from “other agricultural waste” cannot be reflected in the emission reductions.

manure decaying anaerobically is established by a survey in accordance with paragraph 12 below;

- (d) The annual average temperature of the site where manure would have decomposed anaerobically in the baseline is higher than 5 °C.

4. The project activity shall satisfy the following conditions:

- (a) The average annual emission reductions achieved by each domestic biogas digester, methane recovery and combustion system is less than or equal to five tonnes of carbon dioxide equivalent (tCO₂e) per system;²
- (b) Final digestate must be handled aerobically, and the conditions and procedures of the aerobic handling of the final digestate (e.g. land application) shall be described in the project design document (PDD) and subsequently checked upon verification;
- (c) Measures shall be used (e.g. combustion in a biogas burner for cooking needs) to ensure that all the methane collected by the recovery system is combusted;.
- (d) In order to mitigate risks for physical leakage and venting, project participants shall provide documentation in the PDD which:
 - (i) Ensures that biodigesters are appropriately designed in terms of their sizing, considering manure inputs and the thermal energy requirements of households. Justifications shall be provided in the PDD and monitoring reports to demonstrate that gasholders are sufficiently large to capture and store all the biogas that would be generated until consumption;
 - (ii) Ensures that the construction or installation of biodigesters (in the case of prefabricated plants) complies with relevant national and/or international standards and that a quality assurance/quality control (QA/QC) system is put in place for the construction or installation;
 - (iii) Ensures that trainings are conducted for all users of biodigesters prior to their commissioning or installation and that the trainings shall be documented in a verifiable manner (e.g. protocol of trainings, documentation of on-site visits);
 - (iv) Ensures that a plan for periodic inspection and maintenance is in place and rehabilitation services are available throughout the crediting period. Description of such technical support system shall be provided in the PDD and verified by the designated operational entity (DOE) during verification. If the rehabilitation is undertaken, the details (e.g. parts replaced, specifications followed, personnel conducting the repairs and date of retrofitting) on each domestic biogas digester, methane recovery and combustion system shall be documented.
- (e) Aggregated annual emission reductions of all systems included shall be less than or equal to 60 kilotonnes of CO₂e.

² Systems with annual emission reductions higher than five t CO₂e are eligible under “AMS-III.D.: Methane recovery in animal manure management systems”.

2.3. Entry into force

5. The date of entry into force is the date of the publication of the EB 117 meeting report on 24 March 2023.

2.4. Applicability of sectoral scopes

6. For validation and verification of clean development mechanism (CDM) projects and programmes of activities by a DOE using this methodology, application of sectoral scope 13 is mandatory and application of sectoral scope 1 is conditional.

3. Normative references

7. Project participants shall apply the General guidelines for SSC CDM methodologies, "TOOL21: Demonstration of additionality of small-scale project activities" and "TOOL22: Leakage in biomass small-scale project activities" available at <<http://cdm.unfccc.int/Reference/Guidclarif/index.html#meth>> mutatis mutandis.
8. This methodology also refers to the latest approved versions of the following approved methodologies, tools and standard:
 - (a) "AMS-I.C.: Thermal energy production with or without electricity";
 - (b) "AMS-I.E.: Switch from non-renewable biomass for thermal applications by the user";
 - (c) "AMS-I.I.: Biogas/biomass thermal applications for households/small users";
 - (d) "AMS-III.D.: Methane recovery in animal manure management systems";
 - (e) "Standard for sampling and surveys for CDM project activities and programme of activities";
 - (f) "TOOL03: Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion";
 - (g) "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation";
 - (h) "TOOL14: Project and leakage emissions from anaerobic digesters".

4. Definitions

9. The definitions contained in the Glossary of CDM terms shall apply.

5. Baseline methodology

5.1. Project boundary

10. The project boundary is the physical, geographical site of the methane recovery and combustion systems.

5.2. Baseline

11. In the absence of the project activity, manure and wastes from agricultural activities are left to decay anaerobically within the project boundary and methane is emitted to the atmosphere.
12. The fraction of total annual volatile solids for each livestock type LT that is treated in a manure management system MS in climate region k ($AWMS_{LT,MS,k}$) is determined by a survey of a sample group of households/small farms participating in the project activity with a 90 per cent confidence interval and 10 per cent margin of error. The survey should determine the baseline animal manure management practices applied. If the livestock is raised in shared centralized farms,³ the project participant shall be able to show the baseline animal manure management practices at each farm, either individually or through sampling.
13. Baseline emissions (BE_y) are calculated as follows⁴:

$$BE_y = \sum_{LT,MS,PS,k} \left(N_{LT,PS,y} \times \frac{AM_{LT,PS}}{10^3} \times VS_rate_{LT,PS} \times 365 \times Bo_{LT,PS} \times 0.67 \times 10^{-3} \times \frac{MCF_{LT,MS,k}}{100} \times AWMS_{LT,MS,k} \right) \times GWP_{CH4} \times UF_b \quad \text{Equation (1)}$$

Where:

- BE_y = Baseline emission during the year y (tCO₂e)
- $N_{LT,PS,y}$ = Annual average number of animals of livestock type LT in year y for productivity system⁵ PS (i.e. high or low) (numbers), determined as per **Data/parameter table 1**
- $AM_{LT,y}$ = Animal mass for livestock type LT (kilogram (kg) per animal), determined as per **Data/parameter table 2**
- $VS_rate_{LT,PS}$ = Daily volatile solid excretion per head of livestock type LT , for productivity system PS (i.e. high or low) (kg VS per 1,000 kg animal mass per day). Use default values as provided in **Table 10.13A** of chapter ‘Emissions from Livestock and Manure Management’ under the volume ‘Agriculture, Forestry and other Land use’ of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
- 365 = Days per year

³ In shared centralized farms systems, multiple households raise their animals in a centralized farm, for example in separate barns of a centralized farm. In the project activity, each family collects the manure of animals raised by it at the centralized farm and uses the collected manures as feedstock for the biodigester situated at the household.

⁴ Refer to the chapter ‘Emissions from Livestock and Manure Management’ in the volume ‘Agriculture, Forestry and other Land use’ of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

⁵ For the definition of high and low productivity systems, refer to chapter ‘Emissions from Livestock and Manure Management’ under the volume ‘Agriculture, Forestry and other Land use’ of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

Bo_{LT}	= Maximum methane producing capacity for manure produced by livestock type LT , (cubic metres (m^3) methane (CH_4) per kg of VS excreted). Use default values as provided in Table 10.16 of chapter ‘Emissions from Livestock and Manure Management’ under the volume ‘Agriculture, Forestry and other Land use’ of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
0.67	= Conversion factor of $m^3 CH_4$ to kg CH_4
$MCF_{LT,MS,k}$	= Methane conversion factors for each manure management system MS by climate region k (per cent) Use default values as provided in Table 10.17 of chapter ‘Emissions from Livestock and Manure Management’ under the volume ‘Agriculture, Forestry and other Land use’ of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, following the definitions of manure management systems provided in Table 10.18 .
$AWMS_{LT,MS,k}$	= Fraction of total annual VS for each livestock type LT that is treated in manure management system MS in climate region k , estimated as per procedures mentioned in paragraph 12 above
GWP_{CH_4}	= Global warming potential (GWP) of CH_4 applicable to the relevant period (t $CO_2e/t CH_4$)
UF_b	= Net-to-gross adjustment factor to account for uncertainties. The value applied is 0.89 ⁶

5.3. Project emissions

14. Project activity emissions consist of:

- (a) Physical leakage of biogas ($PE_{PL,y}$);
- (b) CO_2 emissions from use of fossil fuels for the operation of all the installed facilities ($PE_{FC,y}$);
- (c) CO_2 emissions from use of electricity for the operation of all the installed facilities ($PE_{EC,y}$);

$$PE_y = PE_{PL,y} + PE_{FC,y} + PE_{EC,y} \quad \text{Equation (2)}$$

Where:

PE_y	= Project emissions in year y (t CO_2e)
$PE_{PL,y}$	= Emissions due to physical leakage of biogas in year y (t CO_2e)
$PE_{FC,y}$	= Emissions from the use of fossil fuel for the operation of the system in the year y (t CO_2e)
$PE_{EC,y}$	= Emissions from the use of electricity for the operation of the system in the year y (t CO_2e)

⁶ This is to account for uncertainties of the method (See Annex III (Table of conservativeness factors), FCCC/SBSTA/2003/10/Add.2).

15. Project emissions due to physical leakage of methane from biogas digesters are estimated as 10 per cent of the maximum methane-producing potential of the manure fed into the management systems implemented by the project activity:⁷.

$$PE_{PL,y} = 0.10 \times \sum_{LT,MS,PS,k} \left(N_{LT,PS,y} \times \frac{AM_{LT,PS}}{10^3} \times VS_rate_{LT,PS} \times 365 \right. \\ \left. \times Bo_{LT,PS} \times 0.67 \times 10^{-3} \times \frac{MCF_{LT,MS,k}}{100} \times AWMS_{LT,MS,k} \right) \\ \times GWP_{CH4}$$
Equation (3)

16. Project emissions from use of fossil fuels ($PE_{FC,y}$) or electricity ($PE_{EC,y}$) for the operation of the system shall be estimated using TOOL03 and TOOL05. When applying the above tools, default values contained in TOOL14 may be used.

5.4. Leakage

17. The applicable requirements from TOOL22 shall be followed to calculate leakage related to use of biomass (other agricultural wastes), if applicable.

5.5. Emission reductions

18. Project participants shall undertake direct measurement of the amount of biogas consumed by the thermal application. The emission reductions⁸ achieved in any year are the lowest value of the following:

$$ER_y = \min[(BE_y \times n_{k,y} - PE_{PL,y} - PE_{FC,y} - PE_{EC,y}), (MD_y - PE_{FC,y} - PE_{EC,y})] - LE_y$$
Equation (4)

Where:

ER_y	= Emission reductions achieved by the project activity for year y (tCO ₂ e)
$n_{k,y}$	= Proportion of domestic biogas digester, methane recovery and combustion systems k commissioned that remain operating in year y (fraction)
MD_y	= Methane combusted by the project activity in year y (tCO ₂ e)
PE_y	= Project emissions for year y (tCO ₂ e)
LE_y	= Leakage for year y (tCO ₂ e)

⁷ Leakage rate of 0.1 for low quality biogas digesters provided in the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories is proposed for conservativeness.

⁸ The emission reductions achieved by energy displacement are estimated and monitored according to one of the methodologies listed in paragraph 3 (b).

MD_y = Biogas consumed by the thermal application in year y (tCO₂e)

19. Methane combusted (MD_y) shall be determined as follows.

$$MD_y = \sum_k (N_{k,0} \times n_{k,y} \times UF_b \times BS_{k,y} \times w_{CH4,y} \times D_{CH4,y} \times GWP_{CH4})$$

Equation (5)

Where:

$N_{k,0}$	= Number of domestic biogas digester, methane recovery and combustion systems of category k commissioned (number)
$n_{k,y}$	= Proportion of domestic biogas digester, methane recovery and combustion systems of category k commissioned that remain operating in year y (fraction)
UF_b	= Net-to-gross adjustment factor. Apply 0.89 ⁹ in cases where $n_{k,y}$ is determined based on questionnaire survey. In other cases, apply 1.0
$BS_{k,y}$	= The average quantity of biogas combusted in domestic biogas digester, methane recovery and combustion systems of category k in year y (volume units, dry basis)
$w_{CH4,y}$	Methane content ¹⁰ of the biogas in year y (volume fraction, dry basis)
D_{CH4}	Density of methane at the temperature and pressure of the biogas in year y (t/m ³)

6. Monitoring methodology

20. Emission reductions can only be claimed if the systems are demonstrated to be operational and commissioned in compliance with standards and/or manufacturer's requirements. It shall be verified if the amount of manure generated and fed to the digester, which is estimated as per paragraph 13 above, is consistent with the capacity of the biogas digester system.
21. The proper land application (resulting in negligible methane emissions) of the digestate shall be verified on a sampling basis following requirements in the "Standard for sampling and surveys for CDM project activities and programme of activities".

⁹ This is to account for uncertainties of the questionnaire survey method, estimated to be in the range 30–50 per cent (See Annex III (Table of conservativeness factors), document FCCC/SBSTA/2003/10/Add.2).

¹⁰ Biogas volume and methane content measurements shall be on the same basis (wet or dry).

6.1. Data and parameters monitored

Data/parameter table 1.

Data/parameter:	$N_{LT,PS,y}$
Data unit:	Number
Description:	Annual average number of animals of livestock type LT in year y for productivity system PS (i.e. high or low)
Source of data:	-
Measurement procedures (if any):	The project design document should describe the system for monitoring the number of livestock. Photographic evidence with timestamps and geographic information system (GIS) coordinates could also be used to determine average number of animals. The consistency between the value and indirect information (e.g. records of sales, records of feed purchases) should be assessed.
Monitoring frequency:	Annually, based on monthly records
QA/QC procedures:	For all cases where sampling is applied, the "Standard: Sampling and surveys for CDM project activities and programmes of activities" shall be followed.
Any comment:	If the livestock is raised in the shared centralized farms, the project participant shall also determine the number of families/households sharing the farm and the annual average animal population ($N_{LT,PS,y}$) belonging to each household.

Data/parameter table 2.

Data/parameter:	$AM_{LT,y}$
Data unit:	kg per animal
Description:	Animal mass for livestock type LT
Source of data:	-
Measurement procedures (if any):	Determined using one of the following two options: a) Sampling measurement with a 90% confidence interval and 10% margin of error in accordance with the "Standard for sampling and surveys for CDM project activities and programmes of activities"; b) Use of default values for "Low PS" for conservativeness, as provided in Table 10A.5 of the chapter 'Emissions from Livestock and Manure Management' in the volume 'Agriculture, Forestry and other Land use' of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
Monitoring frequency:	For option (a), annually For option (b), once at the beginning of crediting period.
QA/QC procedures:	-
Any comment:	-

Data/parameter table 3.

Data/parameter:	$N_{k,0}$
Data unit:	Number
Description:	Number of domestic biogas digester, methane recovery and combustion systems of category k commissioned
Source of data:	Installation records
Measurement procedures (if any):	At the time of installation all project activity systems shall be inspected and undergo acceptance testing (commissioning) for proper operation in compliance with specifications. The installation date of each system shall be recorded
Monitoring frequency:	Once, at the time of installation
QA/QC procedures:	-
Any comment:	-

Data/parameter table 4.

Data/parameter:	$n_{k,y}$
Data unit:	Fraction
Description:	Proportion of domestic biogas digester, methane recovery and combustion systems of category k commissioned that remain operating at year y (fraction)
Source of data:	-
Measurement procedures (if any):	<p>Monitoring of operability of the biogas systems, including domestic biogas digester, methane recovery and combustion system, shall be conducted using one of the following methods:</p> <ul style="list-style-type: none"> (a) Census of users or survey of the users at randomly selected sample sites; (b) Based on ongoing rental/lease payments or a recurring maintenance fee by users; (c) Measurement campaigns using biogas flow meters. <p>For all cases where sampling is applied, the "Standard: Sampling and surveys for CDM project activities and programme of activities" shall be used for determining the sample size to achieve 90/10 (for annual monitoring) or 95/10 (for biennial monitoring) confidence/precision levels.</p> <p>For the case of measurement campaigns using biogas flow meters which record usage on a daily or more frequent interval, it may be undertaken at randomly selected sample sites in accordance with the "Standard: Sampling and surveys for CDM project activities and programme of activities".</p> <p>For each measurement campaign at each site, continuous measurement shall be carried out for at least 30 days.</p> <p>The operational rate of each system is determined by dividing the number of days in operation by the length of the campaign. An operational day is a day in which biogas is consumed.</p>
Monitoring frequency:	At least once every two years (biennial) during the crediting period

QA/QC procedures:	Net-to-gross adjustment factor of 0.89 is applicable in cases where the operability is determined based on a user-reported questionnaire survey (i.e. using option (a) above to account for uncertainties).
Any comment:	If the biogas digester is found to be operating but the associated combustion systems are not, then the entire biogas production of the unit must be considered as project emissions. Equation 1 shall be used to estimate the project emissions from the biogas digester.

Data/parameter table 5.

Data/parameter:	$BS_{k,y}$
Data unit:	Volume units, dry basis
Description:	The average quantity of biogas combusted in domestic biogas digester, methane recovery and combustion systems of category k in year y
Source of data:	Direct measurement or conservative default
Measurement procedures (if any):	<p>(a) Biogas flow meters shall be used to monitor accumulated biogas supplied to thermal energy equipment:</p> <ul style="list-style-type: none"> • Measurement campaigns shall be undertaken at randomly selected sample sites in each year of the crediting period; • The “Standard: Sampling and surveys for CDM project activities and programme of activities” shall be used for determining the sample size to achieve 90/10 confidence/precision levels; • The selected samples should take into account the need for stratification, as deemed appropriate, of the population according to the capacity, types and region where the digesters are installed (e.g. 6 cubic metre or 8 cubic metre capacity, fixed dome or floating dome type, regions where seasons influence average ambient temperature); • For each measurement campaign at each site, continuous measurement shall be carried out for at least 30 days; • To account for seasonal variation in biogas generation from biogas digesters, it may be measured over a year during several disjointed periods (e.g. one week per quarter), but still covering at least 30 days for a year. These figures are then turned into an annual figure for a biogas digester. However, if disjointed periods are not practical or too expensive, then a single period may be chosen, from which an annualized figure is derived taking into account seasonality. If adjustment for seasonality is not possible, then a conservative approach shall be taken where a single period is chosen corresponding to the least amount of biogas generation, which is then scaled.
Monitoring frequency:	Annual
QA/QC procedures:	-
Any comment:	-

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Data/parameter table 6.

Data/parameter:	wCH₄
Data unit:	%
Description:	Methane content of the biogas in year y
Source of data:	Measurements by project participants
Measurement procedures (if any):	<p>The fraction of methane in the biogas should be measured with a continuous analyser (values are recorded with the same frequency as the flow) or with periodical measurements at a 90/10 confidence/precision level by following the "Standard for sampling and surveys for CDM project activities and programmes of activities". Alternatively, a default value of 60 per cent methane content can be used.</p> <p>It shall be measured using equipment that can directly measure methane content in the biogas; the estimation of methane content of biogas based on measurement of other constituents of biogas such as CO₂ is not permitted. The methane content measurement shall be carried out close to a location in the system where biogas flow measurement takes place, and on the same basis (e.g. wet or dry).</p>
Monitoring frequency:	Continuously or periodically
QA/QC procedures:	-
Any comment:	The option chosen should be clearly specified in the project design document.

Data/parameter table 7.

Data/parameter:	Sizing of the digester
Data unit:	-
Description:	As per paragraph 4 (d) (i) above
Source of data:	Design specification of biogas digesters
Measurement procedures (if any):	<p>Confirm that biodigesters are appropriately designed in terms of their sizing, considering manure inputs and the thermal energy requirements of households.</p> <p>Justifications shall be provided in the project design document and monitoring reports to demonstrate that gasholders are sufficiently large to capture and store all the biogas that would be generated until consumption.</p>
Monitoring frequency:	Once at construction or installation of biogas digesters
QA/QC procedures:	-
Any comment:	-

Data/parameter table 7.

Data/parameter:	Compliance with standards and QA/QC system
Data unit:	-
Description:	Check against standards and implementation of a QA/QC system
Source of data:	<ul style="list-style-type: none">- Comparison against national and/or international standards followed for biogas digesters- QA/QC system

Measurement procedures (if any):	As per paragraph 4 (d) (ii) above, confirm that the construction or installation of biodigesters (in the case of prefabricated plants) complies with relevant national and/or international standards and that a QA/QC system is put in place for the construction or installation.
Monitoring frequency:	Once at construction or installation of biogas digesters
QA/QC procedures:	-
Any comment:	-

Data/parameter table 8.

Data/parameter:	Training for all users of biodigesters
Data unit:	-
Description:	As per paragraph 4 (d) (iii) above
Source of data:	Training records
Measurement procedures (if any):	Confirm that trainings are conducted for all users of biodigesters prior to their commissioning or installation. The trainings shall be documented in a verifiable manner (e.g. protocol of trainings, documentation of on-site visits)
Monitoring frequency:	At least once, prior to commissioning or installation of biogas digesters
QA/QC procedures:	-
Any comment:	-

Data/parameter table 9.

Data/parameter:	Periodic inspection and maintenance
Data unit:	-
Description:	Check as per paragraph 4 (d) (iv) above
Source of data:	Project implementation plan and monitoring surveys
Measurement procedures (if any):	Confirm that a plan for periodic inspection and maintenance is in place and rehabilitation services are available throughout the crediting period. Description of such technical support system shall be provided in the project design document and verified by the designated operational entity during verification.
Monitoring frequency:	Once at construction or installation of biogas digesters and annually
QA/QC procedures:	If the rehabilitation is undertaken, the details (e.g. parts replaced, specifications followed, personnel conducting the repairs and date of retrofitting) on each domestic biogas digester, methane recovery and combustion system shall be documented
Any comment:	-

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Document information

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05.0	24 March 2023	<p>EB 117, Annex 5</p> <p>Revision to</p> <ul style="list-style-type: none">• Provide further clarity on monitoring requirements for biogas digester systems;• Address the fugitive methane emissions from biogas digesters and the use of updated Intergovernmental Panel on Climate Change (IPCC) methods. <p>Title change: From "Methane recovery in agricultural activities at household/small farm level" to "Methane recovery from livestock and manure management at households and small farms".</p>
04.0	27 May 2021	<p>EB 110, Annex 7</p> <p>Revision to allow the use of biogas flow meters to demonstrate operationality of the biogas system remotely.</p>
03.0	13 September 2012	<p>EB 69, Annex 23</p> <p>To introduce the IPCC Tier 1 approach as an alternative method for calculation of baseline emissions.</p>
02	18 February 2011	<p>EB 59, Annex 4</p> <ul style="list-style-type: none">• To allow the combination of this category with AMS-I.I. and/or AMS-I.E.;• To revise the guidance on calculation of project emissions from physical leakage and baseline emissions;• To revise sampling requirements;• To remove the conditions for PoA.
01	19 October 2007	<p>EB 35, Annex 27</p> <p>Initial adoption.</p>

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