

CDM-MP89-A04

Draft Small-scale Methodology

Methane recovery from livestock and manure management at households and small farms in agricultural activities at household/small farm level

Version 05.0

Sectoral scope(s): 15

DRAFT



United Nations
Framework Convention on
Climate Change

COVER NOTE

1. Procedural background

1. The recommended draft revision of “AMS-III.R.: Methane recovery in agricultural activities at household/small farm level” (hereinafter referred as methodology) is based on the request for revision “SSC_826: Revision of AMS-III.R. to provide further clarity on monitoring requirements for biogas digester systems”.

2. Purpose

2. The purpose of this revision is to provide further clarity on monitoring requirements for biogas digester systems as requested by SSC_826.

3. Key issues and proposed solutions

3. The proposed revision will:
 - (a) provide clarity on the two options to calculate emission reductions i.e. Option 1 where baseline emissions are determined based on the monitoring of the animal population and Option 2 where baseline emissions are determined based on monitoring of the net quantity of biogas consumed by the thermal application;
 - (b) change the title of the methodology to "AMS-III.R.: Methane recovery from livestock and manure management at households and small farms";
 - (c) make editorial improvements such as consistent use of data/parameters in the methodology.
4. While considering the bottom-up submission SSC_826, the Methodologies Panel (MP) noted the following two additional issues that were outside the scope of SSC_826 but agreed to bring to the attention of the Board:
 - (a) The existing approach to determine baseline emissions using IPCC default values of methane emission factors were based on 2006 IPCC Guidelines for National Greenhouse Gas Inventories, whereas Tier 1 and Tier 2 approaches in this area have been updated in 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories¹.
 - (b) Some studies found that fugitive methane leakage from biogas digesters may in some instances exceed the default value (10%) assumed in the CDM methodologies/tools unless concrete measures are taken by project activities to prevent these leakages. Further analysis may be necessary to review literature

¹ While methane emission factors are provided (per head) by livestock species type, region and temperature in the 2006 IPCC Guidelines, they are provided (per kg VS) by livestock species type, productivity class (high or low), manure storage system and climate zone (cool, temperate, warm, etc) in the 2019 Refinement.

and consider whether any revision to strengthen the requirements on accounting for physical leakage of methane from biogas digesters would be necessary.

5. The MP noted that both issues above are not necessarily related to AMS-III.R alone but may also be relevant to other CDM methodologies and tools such as AMS-III.R., “AMS-III.D.: Methane recovery in animal manure management systems”, “AMS-I.I.: Biogas/biomass thermal applications for households/small users” and “TOOL14: Project and leakage emissions from anaerobic digesters”.
6. The MP agreed to seek a guidance from the Board if further analysis and recommendations on revisions to the relevant CDM methodologies/tools would be necessary.

4. Impacts

7. The proposed improvement of the methodological approaches in AMS-III.R. will provide more clarity on the approach to calculate emission reductions and facilitate the implementation of CDM project activities and PoAs introducing biogas digester systems.

5. Subsequent work and timelines

8. The draft revised methodology is recommended by the MP for consideration and approval by the Board at its 116th meeting.
9. Further work will be undertaken on different issues flagged in paragraph 4, should the Board provide a mandate.

6. Recommendations to the Board

10. The MP recommends that the Board adopt this draft revised methodology which has addressed the issues raised in SSC_826, to be made effective at the time of the Board’s approval.
11. In addition, the MP recommends that the Board consider the two additional issues described in paragraph 4 above, and possible revisions to the relevant CDM methodologies/tools such as AMS-III.R., “AMS-III.D.: Methane recovery in animal manure management systems”, “AMS-I.I.: Biogas/biomass thermal applications for households/small users” and “TOOL14: Project and leakage emissions from anaerobic digesters”.

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1. Introduction

1. The following table describes the key elements of the methodology:

Table 1. Methodology key elements

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

2. Scope, applicability, and entry into force

2.1. Scope

2. This project category comprises methodology covers project activities involving the recovery and combustion destruction of methane from manure or mixture of manure and other agricultural wastes² from agricultural activities that would be decaying anaerobically and emitting methane to the atmosphere in the absence of the project activity. Methane emissions are prevented. It can be achieved either by:

- Installing methane recovery and combustion system to an existing source of methane emissions; or
- Changing the a manure management practice of a biogenic waste or raw material in order to achieve the controlled anaerobic digestion equipped with methane recovery and combustion system.

2.2. Applicability

3. The methodology is applicable under the following conditions:
- The category is limited to measures methane recovery and combustion systems are installed at individual households or small farms (e.g. installation of a domestic biogas digester);
 - This project category methodology is only applicable 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

² 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.

“AMS-I.E.: Switch from non-renewable biomass for thermal applications by the user”.

(c) This methodology is applicable only to the portion fraction of the manure which would decay anaerobically in the absence of the project activity. The fraction of the manure decaying anaerobically that should be is established by a survey in accordance with paragraph 12.

(d) The annual average temperature of the 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 methane recovery and combustion systems that achieve an annual emission reduction of is less than or equal to five tonnes of CO₂e per system³; are included in this category. Systems with annual emission reduction higher than five tonnes of CO₂e are eligible under “AMS-III.D.: Methane recovery in animal manure management systems”.

(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 verified during operation of the project activity; The sludge must be handled aerobically. In case of soil application of the final sludge, the proper conditions and procedures that ensure that there are no methane emissions must be ensured.

(c) Measures shall be used (e.g. combusted or burnt in a biogas burner for cooking needs) to ensure that all the methane collected by the recovery system is combusted; destroyed.

(d) Aggregated annual emission reductions of all systems included shall be less than or equal to 60 kt CO₂ equivalent.

2.3. Entry into force

5. The date of entry into force is the date of the publication of the EB XX meeting report on the dd mm yyyy.

2.4. Applicability of sectoral scopes

6. For validation and verification of CDM projects and programme of activities by a designated operational entity (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” (hereinafter referred to as TOOL22)

³ Systems with annual emission reduction higher than five tonnes of CO₂e are eligible under “AMS-III.D.: Methane recovery in animal manure management systems”.

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, and 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” (hereinafter referred to as AMS-III.D.);
 - (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” (hereinafter referred to as TOOL03);
 - (g) “TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (hereinafter referred to as TOOL05);
 - (h) “TOOL14: Project and leakage emissions from anaerobic digesters” (hereinafter referred to as TOOL14).

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. ~~The baseline scenario is the situation where, in the absence of the project activity, biomass and other organic matter manure and wastes from agricultural activities are left to decay anaerobically within the project boundary and methane is emitted to the atmosphere.~~
12. The amount fraction of ~~waste or raw materials~~ manure and wastes from agricultural activities that would decay anaerobically in the absence of the project activity (f) is determined by survey of a sample group of households/small farms in the vicinity of the project area with a 90% confidence interval and 10% margin of error. The survey should determine the baseline animal manure management practices applied. This fraction shall be estimated as a weighted average value. If the livestock is raised in shared centralized

farms⁴, the project proponent shall be able to show the baseline animal manure management practices at each farm, either individually or through sampling. The annual average number of animals ($N_{LT,y}$) is the aggregate population of the animals in all participating entities and shall be determined, following the requirements in Data / Parameter Table 1.

13. Baseline emissions (BE_y) are calculated **ex-ante**, using one of the following **methods options**.

5.2.1. Option 1

14. Under Option 1, the baseline emissions of the project activity are determined based on the monitoring of the animal population, using one of the following methods:

- (a) A simplified method with the **most recent IPCC Tier 1 approach**⁵ (please refer to the chapter 'Emissions from Livestock and Manure Management' under the volume 'Agriculture, Forestry and other Land use' of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories) that only requires livestock population data by animal species/category and climate region or temperature; or
- (b) The **most recent IPCC Tier 2 approach**⁶ (please refer to the chapter 'Emissions from Livestock and Manure Management' under the volume 'Agriculture, Forestry and other Land use' of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories) to calculate the amount of the waste or raw material that would decay anaerobically in the absence of the project activity. Country/region specific values shall be used if available. The **corresponding** option in AMS-III.D., shall be used to calculate baseline emissions.

15. If option in paragraph **1418** (a) is chosen, baseline emissions are determined as follows:

$$BE_y = GWP_{CH_4} \times UF_b \times \sum_{LT} \left(\frac{EF_{LT} \times N_{LT,y}}{10^6} \right) \times f \quad \text{Equation (1)}$$

Where:

BE_y = Baseline emission during the year y (tCO₂e)

GWP_{CH_4} = Global Warming Potential (GWP) of CH₄ applicable to the relevant period (t CO₂e/t CH₄)

⁴ In shared centralized farms systems, multiple households raise their animals in a centralized farm, e.g. 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.

⁵ Refer to the chapter 'Emissions from Livestock and Manure Management' under the volume 'Agriculture, Forestry and other Land use' of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

⁶ Refer to the chapter 'Emissions from Livestock and Manure Management' under the volume 'Agriculture, Forestry and other Land use' of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

EF_{LT}	=	Emission factor for the defined livestock population as referred from table 10.14 and 10.15 of chapter 'Emissions from Livestock and Manure Management' under the volume 'Agriculture, Forestry and other Land use' of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (kg CH ₄ /head)
$N_{LT,y}$	=	Annual average number of animals of type <i>LT</i> in year <i>y</i> (numbers)
UF_b	=	Net-to-gross adjustment factor to account for uncertainties. The value applied is 0.89 ⁷
f	=	The average fraction of manure and wastes from agricultural activities that would decay anaerobically in the absence of the project activity (weighted average) estimated as per procedures mentioned in paragraph 12

5.2.2. Option 2

16. Under Option 2, the ~~emission reductions~~ baseline emissions of the project activity ~~are should be~~ determined based on monitoring of the net quantity of biogas consumed by the thermal application as follows:

$$ER_y = \sum_k N_{k,0} \times n_{k,y} \times UF_b \times BS_{k,y} \times EF \times n_{PI/BL} \times NCV_{biogas} - LE_y \quad \text{Equation (2)}$$

$$BE_y = \sum_k (N_{k,0} \times n_{k,y} \times UF_b \times BS_{k,y} \times w_{CH_4,y} \times D_{CH_4,y} \times GWP_{CH_4})$$

Where:

$N_{k,0}$	=	Number of biogas collection and associated combustion systems thermal applications <i>k</i> commissioned (number)
$n_{k,y}$	=	Proportion of $N_{k,0}$ that remain operating in year <i>y</i> (fraction) Proportion of biogas collection and associated combustion systems <i>k</i> commissioned that remain operating in year <i>y</i> (fraction)
UF_b	=	Net-to-gross adjustment factor. Apply 0.89 ⁸ in cases where the operability ($n_{k,y}$) is determined based on questionnaire survey. In other cases, apply 1.0
$BS_{k,y}$	=	The net quantity of biogas consumed by the thermal application combustion system <i>k</i> in year <i>y</i> (mass or volume units, dry basis)
EF	=	CO ₂ emission factor (tCO ₂ /GJ)

⁷ This is to account for uncertainties of the method (See "Annex III Table of conservativeness factors", FCCC/SBSTA/2003/10/Add.2, page 25).

⁸ This is to account for uncertainties of the questionnaire survey method, estimated to be in the range 30-50% (See "Annex III Table of conservativeness factors", FCCC/SBSTA/2003/10/Add.2, page 25).

$n_{PJ/BL}$	=	Ratio of efficiencies of project equipment and baseline equipment (e.g. cook stove using coal) measured once prior to validation applying the same test procedure (e.g. lab test), as per a national or an international standard. Official data or scientific literature can be used for cross-check purposes.
NCV_{biogas}	=	Net calorific value of the biomass (GJ/unit mass or volume, dry basis). Use default value: 0.0215 GJ/m ³ biogas (assuming NCV of the methane: 0.0359 GJ/m ³ , default methane content in biogas: 60%)
$w_{CH_4,y}$	=	Methane content ⁹ of the biogas in the year y (volume fraction, dry basis).
D_{CH_4}	=	Density of methane at the temperature and pressure of the biogas in the year y (t/m ³)

The CO₂ emission factor is calculated as follows:

$$EF = \sum_j x_j \times EF_{FFj}$$

Where:

x_j	=	fraction representing fuel type j used by the baseline thermal applications displaced by biomass/biogas
EF_{FFj}	=	CO ₂ emission factor of fossil fuel type j (tCO ₂ /GJ)

17. For ex-post determination, the value BE_y calculated using Equation 2 shall be capped by the value estimated by Equation 1 after removing the parameter UF_b from the calculation.

5.3. Project emissions

18. Project emissions due to physical leakage of methane from biogas digester is are estimated using one of the two options indicated in AMS-III.D.
19. Project emissions consist of CO₂ emissions from use of fossil fuels or electricity for the operation of the system and the physical leakages of methane from the recovery system shall be estimated using The relevant methodological tools TOOL03 and TOOL05 shall be followed. When applying the above tools, default values contained in TOOL14 may be used.

⁹ Biogas volume and methane content measurements shall be on the same basis (wet or dry).

5.4. Leakage

20. 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

5.5.1. Option 1

21. The emission reductions achieved by the project activity should be calculated are determined based on the monitoring of the animal population, and the baseline emissions are determined using the methods in paragraphs 14 and 15 as below under this option:

$$ER_y = BE_y \times n_{k,y} - PE_y - LE_y \quad \text{Equation (3)}$$

Where:

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

5.5.2. Option 2

22. The emission reductions¹⁰ achieved by the project activity are determined based on monitoring of the net quantity of biogas consumed by the thermal application using the method in paragraph 16:

$$ER_y = BE_y - PE_y - LE_y \quad \text{Equation (4)}$$

6. Monitoring methodology

23. Emission reductions can only be applied to claimed if the systems that are demonstrated to be operational and commissioned in compliance with standards and/or manufacturer's requirements and in compliance with the manufacturer's required maintenance procedures. Survey methods are used to determine the annual average animal population (N_{LT}), the amount of waste/animal manure generated on the farm and the amount of waste/animal manure fed into the system e.g. biogas digester. It shall be verified if the amount of manure fed to the digester is consistent with the animal population and with the capacity of the system. In case of discrepancy, proponents shall apply the requirements of the CDM Project Standard. If the livestock is raised in the shared centralized farms, the

¹⁰ The emission reductions achieved by energy displacement are estimated and monitored according to one of the methodologies listed in paragraph 3 (b).

project proponent shall also determine the number of families/households sharing the farm and the annual average animal population (N_{LT}) belonging to each household.

24. The proper soil-land application (not resulting in negligible methane emissions) of the digestate final sludge shall be verified on a sampling basis following requirements in the “Standard for sampling and surveys for CDM project activities and programme of activities”.

6.1. Data and parameters monitored

Data / Parameter table 1.

Data / Parameter:	$N_{LT,y}$
Data unit:	Number
Description:	Annual average number of animals of type LT for the year y
Source of data:	-
Measurement procedures (if any):	The PDD should describe the system for monitoring the number of livestock population. Photographic evidence with timestamps and 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 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 programme of activities” shall be followed
Any comment:	-

Data / Parameter table 2.

Data / Parameter:	$N_{k,0}$
Data unit:	Number
Description:	Number of biogas collection and associated combustion systems thermal applications 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 3.

Data / Parameter:	$n_{k,y}$
Data unit:	Fraction
Description:	Proportion of $N_{k,0}$ that remain operating at year y (fraction)

Source of data:	-
Measurement procedures (if any):	<p>Monitoring of operationality of the biogas systems shall be conducted using one of the following methods:</p> <p>(a) Census of users or survey of the users at randomly selected sample sites;</p> <p>(b) Based on on-going rental/lease payments or a recurring maintenance fee by users;</p> <p>(c) Measurement campaigns using biogas flow meters.</p> <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 “Standard: Sampling and surveys for CDM project activities and programme of activities”. The selected samples should take into account possible stratification of the population according to the capacity, biogas digester 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).</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 operationality is determined based on user reported questionnaire survey i.e. using option (a) above to account for uncertainties
Any comment:	-

Data / Parameter table 4.

Data / Parameter:	$BS_{k,y}$
Data unit:	mass or volume units
Description:	The net quantity of biogas consumed by the combustion system (thermal application) k in year y
Source of data:	Direct measurement or conservative default

Measurement procedures (if any):	<p>(a) In the specific case of biogas project activities using biogas flow meters 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 possible stratification, or not, 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 disjoint periods are not practical or too expensive, then a single period may be chosen, from which an annualised 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. <p>(b) Alternatively, for biogas project activities, project proponents may use a default biogas generation rate of 0.13 Nm³.m⁻³.day⁻¹ (i.e. volume of biogas generated in normal conditions of temperature and pressure per unit useful volume of the digester per day) for regions/countries where annual average ambient temperature is higher than 20°C</p>
Monitoring frequency:	Annual
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 5.

Data / Parameter:	W_{CH4}
Data unit:	%
Description:	Methane content in biogas in the 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 Programme of Activities”. Alternatively, a default value of 60% 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 a biogas flow measurement takes place, and on the same basis (wet or dry)</p>
Monitoring frequency:	Continuously or periodically
QA/QC procedures:	-
Any comment:	The option chosen should be clearly specified in the PDD.

6.2. Project activity under a Programme of Activities

25. The methodology is applicable to a programme of activities, no additional leakage estimations are necessary other than that indicated under leakage section above.

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Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
05.0	11 October 2022	MP89, Annex 4 To be considered by the Board at EB 116. Revision to: <ul style="list-style-type: none"> • Revision to provide further clarity on monitoring requirements for biogas digester systems; and • Change title to “Methane recovery from livestock and manure management at households and small farms”.
04.0	27 May 2021	EB 110, Annex 7 Revision to allow the use of biogas flow meters to demonstrate operability of the biogas system remotely.
03.0	13 September 2012	EB 69, Annex 23 To introduce the IPCC Tier 1 approach as an alternative method for calculation of baseline emissions.
02	18 February 2011	EB 59, Annex 4 <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.
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