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Federal Ministry
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Ministry of Climate, Energy and Environment
Greenhouse Gas Inventory
and Research Center

Topic 3.1: Quantifying the impact of PaMs

Asia Regional Workshop:
Taking stock of 1st BTRs and getting ready for 2nd BTRs
26/02/2026
Bangkok, Thailand

Fernando Farias
UNEP-Copenhagen Climate Centre



Ministry of Sustainability
and the Environment
— SINGAPORE —

NCCS
NATIONAL CLIMATE CHANGE SECRETARIAT
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STRATEGY GROUP
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United Nations
Framework Convention on
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Agenda Topic 3.1

- Presentation of main concepts
- Exercise: case studies on example policies using GACMO



Policies, measures, actions and mitigation plans (PMAP)

Mitigation policies or mitigation plans generally refer to a decision or set of decisions that a government makes to achieve certain objectives .

Actions or measures generally refer to a specific activity or set of activities undertaken by a government to implement a policy or plan.



Source: UNFCCC: UNFCCC BTR REVIEW TRAINING: COURSE C (2023)



Data and sources



- Data
- Assumptions
- Methodologies , Models and Tools
- Baselines and Scenarios
- Mitigation potential

Type of analysis	Associated action	Timeline	Results	CTF Table 5	Indicators, metrics
Ex-ante	Assessment	Future situation	eventual impact	GHG emissions achieved	Qualitative, Quantitative
Ex-Post	Follow-up	Current or past	Effective impact	Projected GHG emissions	Baseline



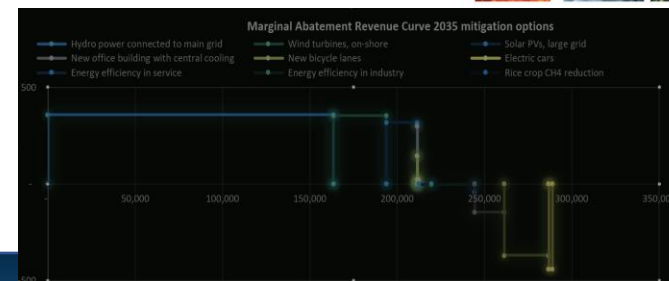
Use or adaptation of existing methodologies and models

Methodologies

- National models (for an entire country)
- Sectoral models:
- Top-down methods (e.g., econometric models, regression analysis, computable general equilibrium models);
- Bottom-up methods (e.g., engineering models, marginal cost abatement [MCA] curves)

Contents

- Simple equations (e.g., simple extrapolation);
- Complex models (e.g., simulation models, integrated assessment models);
- A combination of methods





Use or adaptation of existing methodologies

Methodology

Create a new methodology

Existing methodologies

Adopt an existing methodology
Adapt an existing methodology

CDM

- As part of the implementation of the CDM, a series of methodologies were defined and approved to estimate the GHG reduction impact of mitigation projects.
- Robust but complex methodologies
- Transition from existing CDM methodologies to the Article 6.4 mechanism





CDM Methodologies

Library of methodologies for all GHG emissions sectors. Latest version: 2022 with more than 200 methodologies for accounting for emissions reductions

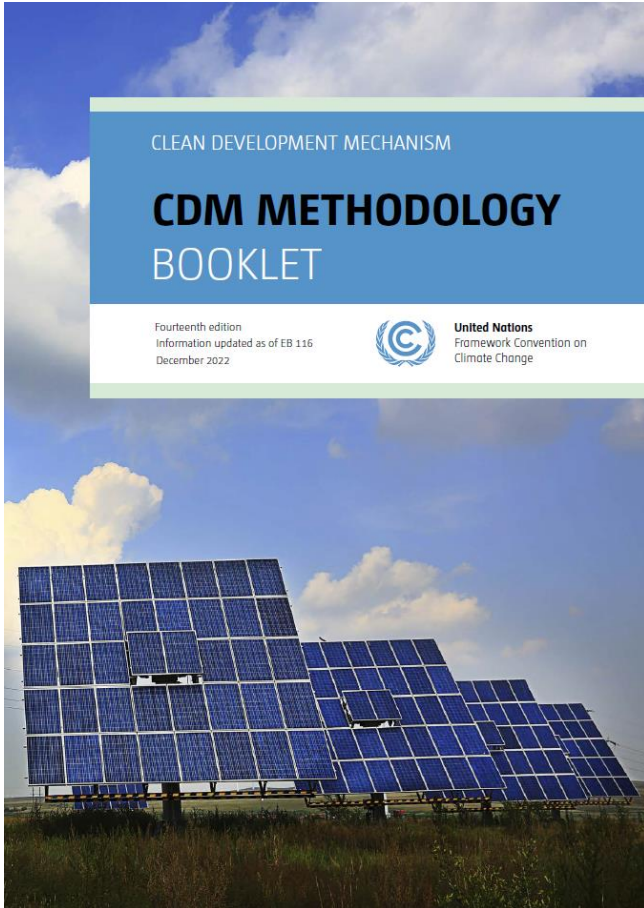


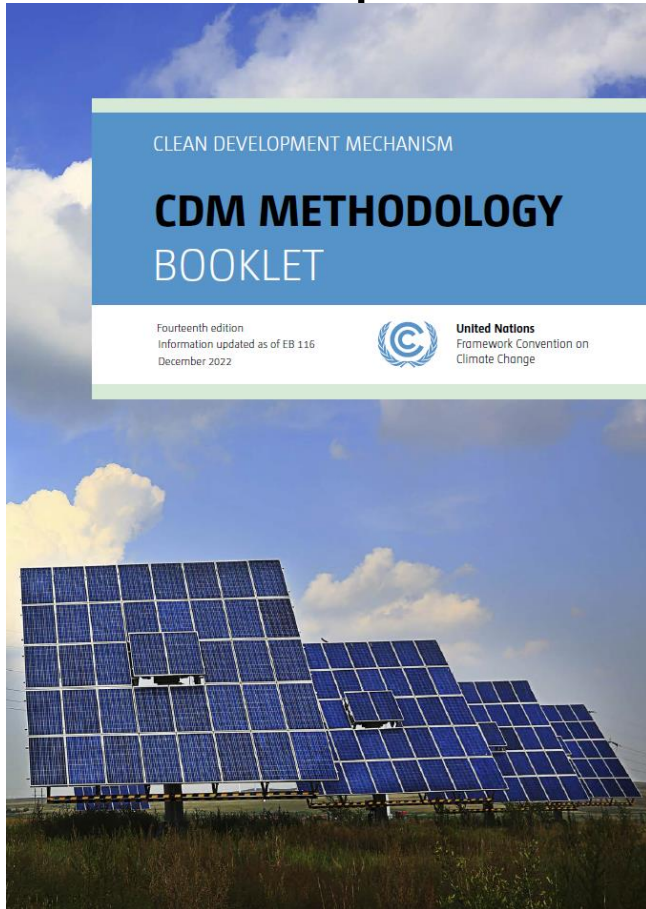
Table 1: Methodology selection

Shortlisted CDM methodologies (medium to high likelihood of additionality)	
ACM0005: Clinker replacement	AMS-III.E.: Biomass power generation
AMS-I.D.: Small-scale renewable power generation	ACM0018: Biomass power generation
AM0034: Nitrous oxide (N ₂ O) abatement from nitric acid production	AMS-III.F.: Composting
AMS-I.E.: Cooking with renewable energies	AM0025: Alternative waste treatment
ACM0019: N ₂ O abatement from nitric acid production	AMS-I.C.; AMS-III.E.: Biomass power generation
AMS-I.C.: Small-scale renewable energy generation	AMS-III.AV.: Water purification
AMS-II.C.: Energy efficient household appliances	AMS-I.A.: Household renewable energy
ACM0006: Biomass power generation	





Example of CDM methodologies

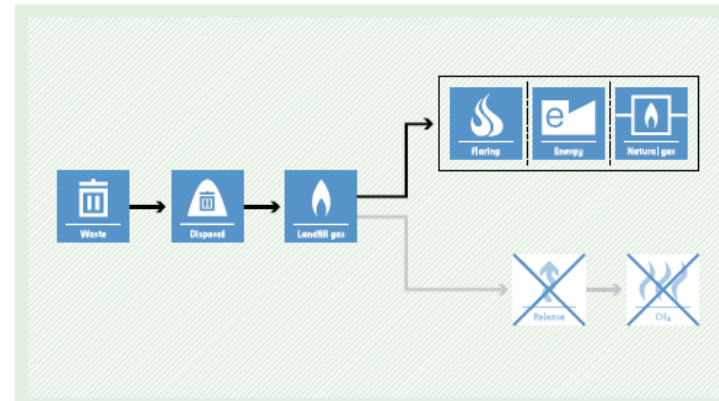


CLEAN DEVELOPMENT MECHANISM

- **ACM0001:** Large-scale Consolidated Methodology: Flaring or use of landfill gas
- Version 19.0
- It applies to venting systems, flaring systems, or to improve existing capture systems.

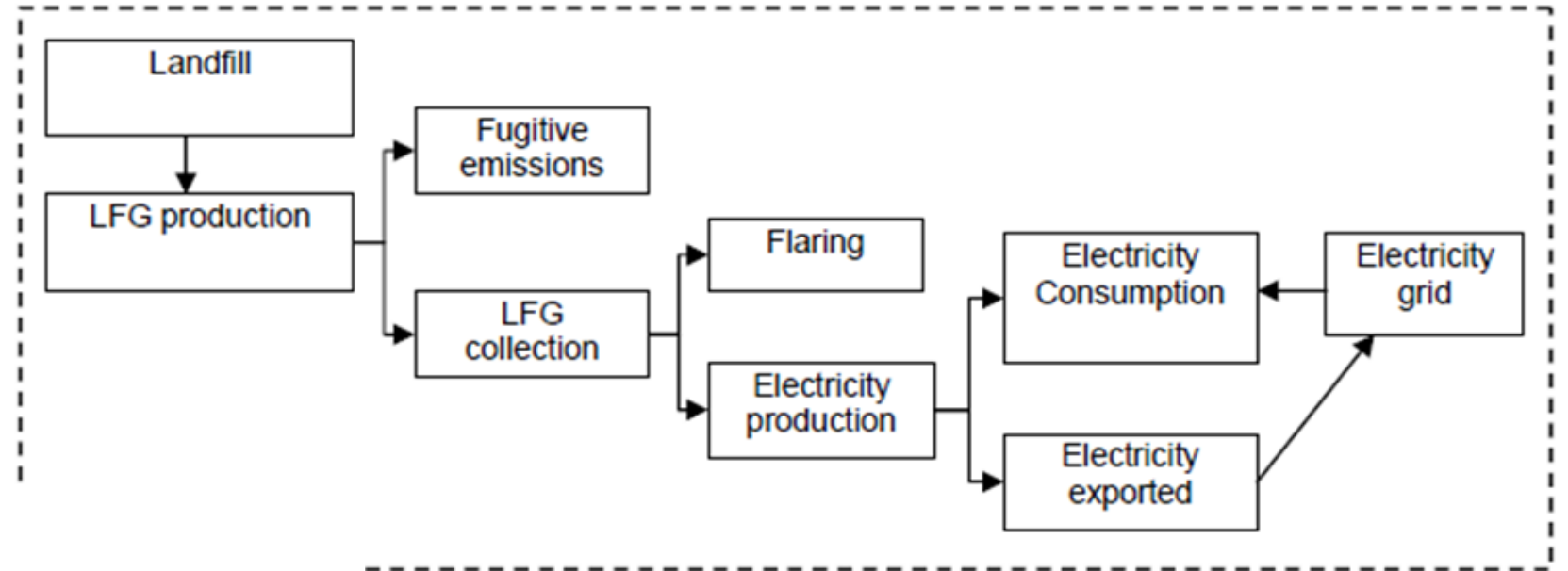
Options:

- Burning of LFG/ BioGas
- To produce energy (mainly electricity)
- BioGas for later consumption (network, transport by truck)

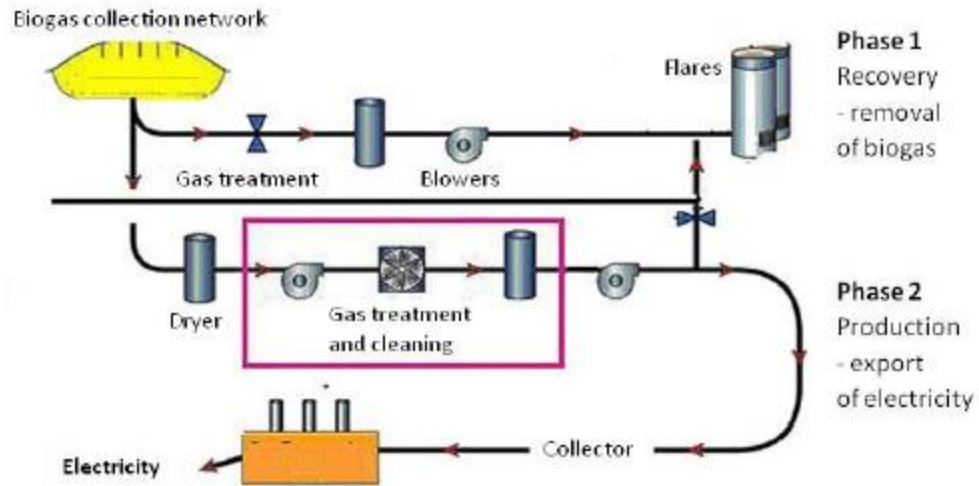




Flowcharts



Technical diagram





Emissions estimate

Emissions reduced or avoided as a result of the projects:

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y$$

Equation (26)

Where:

ER_y = Emission reductions in year y (t CO₂e/yr)

BE_y = Baseline emissions in year y (t CO₂e/yr)

PE_y = Project emissions in year y (t CO₂/yr)

In this specific case:

Baseline : estimates the emissions captured by the project and the amount that would have been captured due to previous causes (regulation for example), mainly CH₄ that is released into the atmosphere

Project emissions : refers to emissions generated by the project other than LG: primarily GHG emissions associated with the specific implementation of the project, such as electricity consumption, fossil fuels, and LFG distribution.





Emissions estimate

Emissions from the methodology baseline:

$$BE_y = BE_{CH_4,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y} \quad \text{Equation (1)}$$

Where:

- BE_y = Baseline emissions in year y (t CO₂e/yr)
- $BE_{CH_4,y}$ = Baseline emissions of methane from the SWDS in year y (t CO₂e/yr)
- $BE_{EC,y}$ = Baseline emissions associated with electricity generation in year y (t CO₂/yr)
- $BE_{HG,y}$ = Baseline emissions associated with heat generation in year y (t CO₂/yr)
- $BE_{NG,y}$ = Baseline emissions associated with natural gas use in year y (t CO₂/yr)

($BE_{CH_4,y}/2$) emissions between the methane captured by the project and the amount that would have been captured due to previous causes (regulation for example),

- ($BE_{EC,y}$) How much CO₂ does generating electricity produce?
- ($BE_{HG,y}/17$) sum of CH₄ emissions sent to heat generation
- ($BE_{NG,y}/21$) CH₄ emissions sent to LFG network

$$BE_{CH_4} = \left((1 - OX_{top_layer}) \times F_{CH_4,PJ,y} - F_{CH_4,BL,y} \right) \times GWP_{CH_4} \quad \text{Equation (2)}$$

Where:

- $BE_{CH_4,y}$ = Baseline emissions of methane from the SWDS in year y (t CO₂e/yr)
- OX_{top_layer} = Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline (dimensionless)
- $F_{CH_4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used in the project activity in year y (t CH₄/yr)
- $F_{CH_4,BL,y}$ = Amount of methane in the LFG that would be flared in the baseline in year y (t CH₄/yr)
- GWP_{CH_4} = Global warming potential of CH₄ (t CO₂e/t CH₄)





Emissions estimate

Emissions from the project implementation:

$$PE_y = PE_{EC,y} + PE_{FC,y} + PE_{DT,y} + PE_{SP,y}$$

Equation (22)

Where:

PE_y = Project emissions in year y (t CO₂/yr)

$PE_{EC,y}$ = Emissions from consumption of electricity due to the project activity in year y (t CO₂/yr)

$PE_{FC,y}$ = Emissions from consumption of fossil fuels due to the project activity for purpose other than electricity generation, in year y (t CO₂/yr)

$PE_{DT,y}$ = Emissions from the distribution of compressed/liquefied LFG trucks, in year y (t CO₂/yr)

$$BE_{CH_4} = ((1 - OX_{top_layer}) \times F_{CH_4,PJ,y} - F_{CH_4,BL,y}) \times GWP_{CH_4}$$

Equation (2)

Where:

$BE_{CH_4,y}$ = Baseline emissions of methane from the SWDS in year y (t CO₂e/yr)

OX_{top_layer} = Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline (dimensionless)

$F_{CH_4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used in the project activity in year y (t CH₄/yr)

$F_{CH_4,BL,y}$ = Amount of methane in the LFG that would be flared in the baseline in year y (t CH₄/yr)

GWP_{CH_4} = Global warming potential of CH₄ (t CO₂e/t CH₄)





Emissions estimate

Emissions from the project implementation:

The methodology uses an **ex-ante estimate** based primarily on formulas

ex post estimate , based on on-site measurements of **variables** :
volumetric flows, temperature...
and **parameters** : composition of household waste

where:

$MD_{flare,y}$ is the quantity of methane destroyed by flaring in year y (measured in tCH₄)

$$(4) MD_{flare,y} = (LFG_{flare,y} * w_{CH_4,y} * D_{CH_4}) - \left(\frac{PE_{flare,y}}{GWP_{CH_4}}\right)$$

Where:

$LFG_{flare,y}$	Quantity of landfill gas flared during the year measured in cubic meters (m ³)
$w_{CH_4,y}$	Average methane fraction of the landfill gas
D_{CH_4}	Methane density expressed in tCH ₄ /m ³ CH ₄
$PE_{flare,y}$	Emissions from flaring of the residual gas stream in year y
GWP_{CH_4}	Global Warming potential of CH ₄



Emissions estimate

Methodology : equations

$BE_{CH_4,SWDS,y}$ is the methane generation from the landfill in the absence of the project activity at year y (tCO_2e), calculated as per the *Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site*.

$$BE_{CH_4,SWDS,y} = \varphi (1-f) * GWP_{CH_4} * (1-OX) * 16/12 * F * DOC_f * MCF * \sum \sum w_{j,x} * DOC_j * e^{-k_j(y-x)} * (1-e^{-k_j})$$

Where:

- φ = Model correction factor to account for model uncertainties (90%)
- f = Fraction of methane captured at the SWDS and flared, combusted or used in another manner
- GWP_{CH_4} = Global Warming Potential (GWP) of methane
- OX = Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
- F = Fraction of methane in the SWDS gas (volume fraction) (50%)
- DOC_f = Fraction of degradable organic carbon (DOC) that can decompose
- MCF = Methane correction factor
- $w_{j,x}$ = Amount of organic waste type j prevented from disposal in the SWDS in the year x (tons)
- DOC_j = Fraction of degradable organic carbon (by weight) in the waste type j
- k_j = Decay rate for the waste type j
- j = Waste type category (index)
- x = Year during the landfill lifetime: x runs from the first year of the landfill opening ($x = 1$) to the year y for which avoided emissions are calculated ($x = y$)
- y = Year for which methane emissions are calculated



Emissions estimate

Methodology ex-ante : parameters

1. Fixed parameters

	Variable	Value
Model correction factor	φ	90%
Model adjustment factor	f	0
Global Warming Potential of LFG	GWP_{CH_4}	21
Oxidation factor: there is NO soil or compost cover	OX	0
Fraction of methane in the LFG	F	50%
Fraction of degradable organic content (DOC) that can decompose	DOC_f	50%
Anaerobic managed site	MCF	1
$\varphi (1-f) * GWP_{CH_4} * (1-OX) * 16/12 * F * DOC_f * MCF =$		6.3

2. Waste composition w_j & degradable organic content DOC_j in waste type j

According to the *Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site*, we can apply IPCC 2006 Guidelines for National Greenhouse Inventories default values for the site waste composition and the value of DOC_j :

IPCC Table 2.3 Municipal Solid Waste Composition

Region	Food	Paper Cardboard	Wood	Textile	Rubber Leather	Plastic Metal Glass	Other
Caribbeans	46.9%	17.0%	2.4%	5.1%	1.9%	20.6%	6.1%
Central America	43.8%	13.7%	13.5%	2.6%	1.8%	13.0%	11.6%
South America	44.9%	17.1%	4.7%	2.6%	0.7%	17.0%	13.0%

Region of the proposed project activity landfills: South America							
Sites waste composition w_j	44.9%	17.1%	4.7%	2.6%	0.7%	17.0%	13.0%

DOC_j (from Tool)	15%	40%	43%				
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On-site measurement

- The ex-post methodology can be used for an MRV tracking system





Use or adaptation of existing methodologies

Type of PMAP :

Introduction of renewable energy sources

Improving the energy efficiency of buildings (commercial sector).

Mitigation potential :

Emission reduction = Electricity generation using renewable sources * CO₂ emissions from energy generation using fossil fuels.

Energy savings are estimated by the difference in energy consumption of new buildings constructed according to the BAU and WEM scenarios.



Use or adaptation of existing methodologies

Type of PMAP :

Promotion of the introduction of facilities and equipment with high energy saving performance (residential sector).

Inclusion of new generation vehicles and improvement of fuel efficiency.

Mitigation potential :

Energy reductions are estimated based on energy savings and the incremental number of units installed since the start of the measure. Emission reductions are estimated by multiplying the reduction in energy consumption (electricity, fossil fuels) by the emission factor.

Difference between energy consumption based on average fuel efficiency when measures are applied and energy consumption based on average fuel efficiency when they are not applied.



Thank you for your time

For more information:
<https://climate-transparency-platform.org>

Fernando Farias
Senior Advisor
UNEP Copenhagen Climate Center

