**Avoidance of methane production from biomass decay through controlled pyrolysis**

## Technology/measure

1. This project category comprises measures that avoid the production of methane from biogenic or other organic matter that would have otherwise been left to decay anaerobically in a solid waste disposal site without methane recovery. Due to the project activity, decay is prevented through controlled pyrolysis[1]. Measures shall both reduce anthropogenic emissions by sources, and directly emit less than 15 kilo tones of carbon dioxide equivalent annually.

2. The project activity shall take measures to recover and combust or decompose non-$CO_2$ greenhouse gases produced during pyrolysis. If the pyrolysis facility is used for heat and electricity generation for use outside the project boundary the project can use a corresponding methodology under type I project activities.

3. The project activity shall ensure that the carbon content of the pyrolysis residue remains biologically inert. If pyrolysis residues are submitted to permanent storage the project can use a corresponding methodology (*Chemical and biological stabilization of solid waste carbon content for permanent storage, through controlled pyrolysis*; submission date: 30/10/2006).

4. If the waste would be submitted to landfill disposal in the absence of the project activity, a methodology under type II (energy efficiency) might be used to account lesser fossil fuel usage in landfilling, due to waste mass and volume reductions achieved by the pyrolysis process.

5. This category is applicable for project activities resulting in annual emission reductions lower than 25,000 ton $CO_2$eq. If the emission reduction of a project activity exceeds the reference value of 25,000 ton $CO_2$eq in any year of the crediting period, the annual emission reduction for that particular year is capped at 25,000 ton $CO_2$eq.

[1] Pyrolysis is herein defined as the thermo-chemical decomposition of organic materials into a carbon rich residue, non-condensable combustible gases, and condensable vapors, by heating in the total absence or in lack of oxygen, without any other reagents, except possibly steam

**Boundary**

6. The project boundary are the physical, geographical sites:

   a) where the chemical and biologically labile solid waste would have been disposed, or where the wastes would have been controlled combusted in the baseline scenario;

   b) where the treatment of solid waste through controlled pyrolysis takes place;

   c) the storage site of the pyrolysed residues,

   d) and the itineraries between them, where the transportation of wastes and pyrolysis residues occurs.

**Project Activity Direct Emissions**

7. Total annual project activity related emissions consist of :

   a) Direct $CO_2$ emissions generated by the pyrolysis of the non-biogenic carbon content of the waste (plastics, rubber and fossil derived carbon). $CO_2$ emissions from the combustion or flaring of gases and vapors originated during the pyrolysis of the non-biogenic carbon content of the waste, shall be considered as well;

   b) $CO_2$ emissions from the consumption of auxiliary fossil fuels by the pyrolysis facility;

   c) Incremental $CO_2$ emissions due to incremental distances between the collection points to the controlled pyrolysis site and to the baseline disposal site as well as transportation of pyrolysed residues from the pyrolysis facility to the disposal site;

   d) $CO_2$ emissions related to the power used by the project activity facilities, including the equipments for air pollution control required by regulations. In case the project activity consumes grid-based electricity, the grid emission factor ($kg_{CO2_{eq}}$/kWh) is used, or it is assumed that diesel generators would have provided a similar amount of electric power, calculated as described in category I.D.

$$PE_y = PE_{y,pyro} + PE_{y,fuel} + PE_{y,transp} + PE_{y,power}$$

Where:

$PE_y$ Project activity direct emissions in the year "y" (tones of $CO_2$ equivalent);

$PE_{y,pyro}$ Direct $CO_2$ emissions generated by the pyrolysis of the non-biogenic carbon content of the waste (plastics, rubber and fossil derived carbon), in the year "y". $CO_2$ emissions, in the year "y", from the combustion or flaring of gases and vapors originated during the pyrolysis of the non-biogenic carbon content of the waste;

$PE_{y,fuel}$ Emissions due to the consumption of auxiliary fossil fuels by the pyrolysis facility in the year "y";

$PE_{y,transp}$ Emissions through fossil fuel consumption due to incremental transportation activity in the year "y";

$PE_{y,power}$ Emissions through electricity or diesel consumption in the year "y".

8. The expected annual amount and composition of the waste pyrolysed by the project activity during the crediting period shall be described in the project design document, including the quantities of biogenic and non-biogenic waste ($Q_{y,biogenic}$ and $Q_{y,non\text{-}biogenic}$). Also the expected auxiliary fossil fuel consumption for the pyrolysis process ($Q_{fuel}$) should be reported in the project design document. $CO_2$ emissions from the pyrolysis of the non-biogenic carbon content of the wastes, including those emissions originated from burning of gases liberated in the process will be accounted as project direct emissions ($PE_{y,pyro}$). These data will be used to estimate the annual baseline emissions, and the *ex-post* project activity emissions.

$$PE_{y,fuel} = Q_{y,\ fuel} * E_{fuel}$$

Where:

$Q_{y,fuel}$ Quantity of fuel used in the year "y" (tones);

$E_{y,fuel}$ $CO_2$ emission factor for the combustion of the auxiliary fossil fuel (tones of $CO_2$ per tone of fuel, according to IPCC Guidelines).

$$PE_{y,pyro} = Q_{y,non\text{-}biogenic} * E_{non\text{-}biogenic}$$

Where:

$Q_{y,non\text{-}biogenic}$ Quantity of non-biogenic waste pyrolysed in the year “y” (tones);

$E_{non\text{-}biogenic}$ $CO_2$ emission factor for the pyrolysis of the non-biogenic fraction of the waste processed by the project (tones $CO_2$ per tone non-biogenic waste), including the combustion or flaring of the gases and vapors originated from the non-biogenic waste.

Alternately,

$$PE_{y,pyro} = (Q_{y,non\text{-}biogenic} / Q_{y,total}) * Q_{y,CO_2,pyr}$$

Where:

$Q_{y,non\text{-}biogenic}$ Quantity of non-biogenic waste pyrolysed in the year “y” (tones);

$Q_{y,\ total}$ Total quantity of waste pyrolysed in the year “y” (tones);

$Q_{y,CO_2,pyr}$ Tones of $CO_2$ emitted by the pyrolysis process in the year “y”, including the combustion or flaring of the gases and vapors originated from the waste.

Project activity emissions from trucks for incremental collection activities will be estimated and considered as project activity emissions.

$$PE_{y,transp} = (Q_y/CT_y) * DAF_w * EF_{CO2} + (Q_{y,pyro\text{-}residues}/CT_{y,pyro\text{-}residues}) * DAF_{pyro\text{-}residues} * EF_{CO2}$$

Where:

$Q_y$ Quantity of waste pyrolysed in the year “y” (tones);

$CT_y$ Average truck capacity for waste transportation (tones/truck);

DAF Average incremental distance for waste transportation (km/truck);

$EF_{CO2}$ $CO_2$ emission factor from fuel use due to transportation (kg$CO_2$/km, IPCC default values or local values can be used);

$Q_{y,pyro\text{-}residues}$ Quantity of pyrolysis residues produced in the year “y” (tones);

$CT_{y,\ pyro\text{-}residues}$ Average truck capacity for pyrolysis residues transportation (tones/truck);

$DAF_{pyro\text{-}residues}$ Average distance for pyrolysis residues transportation (km/truck).

**Baseline**

9. The baseline scenario is the situation where, in the absence of the project activity, biogenic and other organic matter are left to anaerobically decay within the project boundary and methane is emitted to the atmosphere. The baseline emissions are the amount of methane from the decay of the biogenic content of the waste treated in the project activity. The Yearly Methane Generation Potential is calculated using the first order decay model based on the discrete time estimate method of the IPCC Guidelines, as described in category AMS III-G. Baseline emissions shall exclude methane emissions that would have to be removed to comply with national or local safety requirement or legal regulations.

$$BE_y = MB_y * GWP\_CH_4 – MD_{y,reg} * GWP\_CH_4$$

Where:

| | |
|---|---|
| $MB_y$ | Methane generation potential in the year "y" (tonnes of $CH_4$), estimated as in AMS III-G; |
| $MD_{y,reg}$ | Methane that would be destroyed or removed in the year "y" for safety or legal regulation; |
| $CH_4\_GWP$ | GWP for $CH_4$ (value of 21 is used for the first commitment period). |

If the baseline scenario includes waste disposition in sites categorized differently from "Controlled Landfill", the methane correction factors (MCF) in the following table should be used:

| Table 1. SWDS Classification and Methane Correction Factors (MCF)[2] | |
|---|---|
| **Type of Site** | **Methane Correction Factor (MCF) Default Values** |
| Managed – anaerobic [3] | 1.0 |
| Managed – semi-aerobic[4] | 0.5 |
| Unmanaged[5] – deep ( >5 m waste) and /or high water table | 0.8 |
| Unmanaged[6] – shallow (<5 m waste) | 0.4 |

## Leakage

10. If the controlled pyrolysis technology is equipment transferred from another activity or if the existing equipment is transferred to another activity, leakage effects at the site of the other activity are to be considered.

## Monitoring

12. Since the pyrolysed residues no longer should be prone to anaerobical decomposition, measures to ensure the biological inertness shall be taken. The volatile-carbon/fixed-carbon/ashes/humidity content ratio of the pyrolysed wastes must be determined. The pyrolysed residues will only be considered biologically inert if the volatile-carbon/fixed-carbon ratio is equal or lower than 50%.

13. The emission reduction achieved by the project activity will be measured as the difference between the baseline emission and the sum of the project emission and leakage.

$$ER_y = BE_y - (PE_y + Leakage_y)$$

Where:

$ER_y$ Emission reduction in the year "y" (tonnes of $CO_2$ eq.)

[2] Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

[3] Anaerobic managed solid waste disposal sites: These must have controlled placement of waste (i.e., waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) levelling of the waste.

[4] Semi-aerobic managed solid waste disposal sites: These must have controlled placement of waste and will include all of the following structures for introducing air to waste layer: (i) permeable cover material; (ii) leachate drainage system; (iii) regulating pondage; and (iv) gas ventilation system.

[5] Unmanaged solid waste disposal sites – deep and/or with high water table: All SWDS not meeting the criteria of managed SWDS and which have depths of greater than or equal to 5 meters and/or high water table at near ground level. Latter situation corresponds to filling inland water, such as pond, river or wetland, by waste.

[6] Unmanaged shallow solid waste disposal sites; All SWDS not meeting the criteria of managed SWDS and which have depths of less than 5 meters.

14. The amount of waste pyrolysed in the project activity in each year ($Q_y$) shall be measured and recorded, as well as its composition through representative sampling, to provide information for estimating the *ex-post* baseline emissions. The fuel used ($Q_{y,fuel}$) will be measured and registered, and the quantity non-biogenic waste pyrolysed ($Q_{y,non\text{-}biogenic}$) will be measured by sampling, to yield the project activity emission through pyrolysis. The total quantity of waste pyrolysed ($Q_y$) and the average truck capacity ($CT_y$) will be measured to yield the project activity emission through transportation. The power consumption and/or generation will be measured and registered. The monitoring will also record the distance for transporting the waste in baseline and the project scenarios.

15. As stated previously, the composition of the waste shall be determined by sampling. The composition of the waste must be defined in the following two categories: biogenic and non-biogenic (fossil-derived). The size and frequency of sampling should be statistically significant with a maximum uncertainty range of 20% at a 95% confidence level. As a minimum, sampling should be undertaken four times a year.

16. Although the amount of non-$CO_2$ greenhouse gases, including methane, produced in the pyrolysis process does not need to be monitored, the project activity shall ensure that all non-$CO_2$ greenhouse gases produced in the process will not be emitted, by combustion or flaring of the gases and vapors generated by the project.

17. The project participants will demonstrate annually that the amount of waste pyrolysed in the project activity facilities would have been disposed in a solid waste disposal site without methane recovery in the absence of the project activity.