VII NEW CDM TOOLS FOR WASTE MANAGEMENT PROJECTS

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EXECUTIVE SUMMARY

Experts estimate that 8 to 12 % of greenhouse gas (GHG) emissions in developing and threshold countries are due to waste management activities. The major sources are methane emissions from disposal of untreated municipal solid waste, which in those countries contains a large portion of degradable organics. The Clean Development Mechanism (CDM) offers the opportunity to get emission reductions certified and to make them sellable. However, the CDM methodologies do not generally promote enhanced technologies in waste management. The financial contribution from carbon trade to the enhanced climate mitigating technologies like MBT and combustion does not crack the invest barriers nor recover the higher operation costs. Most recent activities target on improving existing CDM methodologies and on developing new concepts. Three different methods have been used to develop new tools for CDM:

New Methodology (NM) according to the terminology of UNFCCC

Refined baseline concept for modelling the methane generation

Program of activities (PoA) according to the terminology of UNFCCC

A new methodology is proposed for the so called methane oxidation layer (MOL). MOL is a landfill cover system which facilitates microbiological activity in the cover layer. Due to the biological decay processes methane, which passes the layer, is being oxidised and turned into CO_2. The efficiency of a methane oxidation layer depends on the quality and biochemical relevance of the cover material. A typical soil layer with low carbon content shows rates of 2.5 – 12 l CH4/m2*h. Compost and stabilized biomass from biological waste treatment succeed 12 – 30 l CH4/m2*h. The baseline calculations for covering old landfills are similar to new landfills. The methodology AMS III.F (Avoidance of methane production from decay of biomass through composting) serves as the base of the baseline study and the monitoring concept for Methane Oxidation Layer (MOL) project. For calculations an appropriate separate tool is available, the „ Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site". The formula contains one term modelling oxidation effects of landfill covers (1 – OX). A default value for landfills covered by soil is OX = 0.1. For the new methodology it is proposed to calculate the project emissions (remaining emissions after implementation) by using the same formula.

The methane generation is commonly described by the first order decay model. It is a very simple model and reflects a conservative scenario. Real gas generation can happen much quicker, particularly under tropical climate conditions. Since the crediting period is limited to a certain time (10 years or 3 x 7 years) the velocity of gas generation is of particular interest, because it effects the emission reductions. With the aim to more exact determine the emission reduction a research project has been started to develop a technical simulation of decay processes. The method shall replace the first order decay. During the 90ies, a number of investigations on technical simulation of landfill processes have been carried out in Germany. As a first step, the results of the tests have been confronted to the first order decay model. It can be seen that the real gas generation develops 5times higher during the first year.

A program of activities allows establishing an umbrella framework with many individual projects under one/more approved methodologies. The PoA is a strong new concept under the CDM with the potential to literally bring the benefits of the CDM into the houses of people in developing and Least Developed Countries (LDC). PoA facilitates programs in numerous small applications to be developed and implemented over a longer period of 28 years. Contrary to bundled CDM projects, PoA allows adding units to the project after its registration. Thus, no registration fee is payable on CPAs which are added subsequently to validation.

Compared to bundling of small﹣scale projects into one single CDM project, the PoA has significant benefits:

The individual project activities need not to be defined in advance

The exact sites of the project activities (CPAs) need not to be defined in advance

The individual project activities can be included into the PoA at any time without undertaking the validation process afresh.

1 INTRODUCTION

1.1 Background

Experts estimate that 8 to 12 % of greenhouse gas (GHG) emissions in developing and threshold countries are due to waste management activities. The major sources are methane emissions from disposal of untreated municipal solid waste, which in those countries contains a large portion of degradable organics. The Clean Development Mechanism (CDM) offers the opportunity to get emission reductions certified and to make them sellable. However, the CDM methodologies do not generally promote enhanced technologies in waste management. Moreover, simple end of pipe technologies like landfill degasification may have higher revenues due to administrative specifics. Despite the fact that advanced waste treatment measures create up to four times higher climate mitigation effects, their revenues from carbon trade are fairly equal to low cost landfill gas projects. The financial contribution from carbon trade to the enhanced climate mitigating technologies does not crack the invest barriers nor recover the higher operation costs. This results in creating structures and reserving funds for finally out targeted end-of-pipe strategies, which block the implementation of advanced measures for a longer period. Hence, it is in contradiction to the goal of the FCCC (framework convention on climate change) promoting the transfer of up to date climate mitigation technologies.

1.2 Research objectives

Most recent activities target on improving existing CDM methodologies and on developing new concepts.

2 METHODOLOGY

Three different methods have been used to develop new tools for CDM:
New Methodology (NM) according to the terminology of UNFCCC
Refined baseline concept for modelling the methane generation
Program of activities (PoA) according to the terminology of UNFCCC

3 NEW METHODOLOGY FOR METHANE OXIDATION LAYER

3.1 CLEAN DEVELOPMENT MECHANISM (CDM)

Generally waste management activities generate Greenhouse Gases, both methane (landfills) and CO_2. Therefore, improvements in waste management may result in significant reduction of GHGs. Climate relevant waste management projects may be registered as emission reduction projects, according to the regulations of the UN-Framework Convention on Climate Change (UNFCCC). Beside the political-symbolic aspect this measure has also significant economic criteria. CERs (Certified Emission Reductions) are to be produced and sold to the international market, to lift the total profitability of the project over a critical investment threshold. The legal basis of Certified Emission Reduction (CER) trading is the Article 12 of the Kyoto Protocol, called the Clean Development Mechanism (CDM). The CDM mechanism allows industrial nations to meet their quantitative reduction goals for greenhouse gas emissions by carrying out emission reduction projects in developing countries. The trading market for the CERs is basically governed by European legislation and its conversion to the member states. Particularly the EU emission trading system with its participants from energy-intensive enterprises and power plants offer the opportunity to pool the CERs into the EU-system and to sell them to other participants. The Federal Republic of Germany administrates the national conversion of the EU guidelines by the Projekt-Mechanismen-Gesetz (ProMechG, Project-Mechanism-Law). The law permits operators of large power plants to cover up to 22% of the granted emission rights in the period 2008-2012 by emission certificates from Kyoto projects. That corresponds with approximately 90 million tons of CO_2-equivalents per year in Germany.

In accordance with Article 17 of the Kyoto protocol CERs from climate protection projects may be also subject to national purchase programs of countries, which may accomplish a part of their obligations to reduce greenhouse gas emissions. States like e.g. the Netherlands, Austria, Japan or Spain are strongly involved with national purchase programs from CDM projects. Currently CERs from CDM projects are traded in the European Union market and in national purchase programs for approx. 8-10 € per ton CO_2-equivalent, on basis of future delivery obligations (*forward contracts*). A third option for carbon trade is provided by the voluntary market for the compensation of CO_2-emissions. By investing in emission certificates from climate protection projects, unavoidable emissions may be compensated and neutralized, like for flights, fair meetings or production enterprises. The price is self regulated by the market and reflects the quality of the projects and the demand of the market.

Within the validation process the emission reduction process will be monitored, validated and finally certified. For the approval as a climatic protection project it requires several steps involving various institutions. The process opens with compiling a draft report, the so called PDD (Project Design Document). The PDD explains how and in what amount the greenhouse gases are going to be reduced. Beyond the technical concept other project-relevant aspects such as additionality, sustainability, environmental impact and socio-economic benefits are addressed in the PDD. One important element of the PDD is the monitoring concept, which facilitates how real greenhouse gas reductions during the lifespan of the project later will be determined. The project presented in the PDD must be officially validated by an independent UN-accredited institution (a so called DOE, Designated Operational Entity). At the same time the host country is requested to approve the project. After the validation by the DOE and the „Kyoto permission" of the host country's authorities the project can be submitted for registration at the UNFCCC. A registration is finalized automatically after 8 weeks, if no veto is inserted by the expert panel of the CDM executive board.

Generally, CDM projects may be acknowledged and registered only in case they meet the so called additionality-criteria. In order to prevent from "stick-in effects", it must be ensured that the designed project faces certain barriers, which would not be overcome without the CDM implementation. The additionality can be proven economically (e.g. lack of profit) or by outlining technical barriers.

After establishing the waste management project, the real avoided emissions will be measured and calculated as determined in the approved monitoring concept, then verified by a further DOE and registered as CERs at a temporary account of the UNFCCC. Then the CERs can be transferred to accounts of international buyers.

In waste management are two large groups of potential CDM projects, direct reduction of the generation of methane and improvements in energy efficiency. There are a number of measures to improve the energy efficiency of waste management activities, such as material recycling instead of energetic reutilization or substitution of fossil energy resources and so on. Compared to direct methane reduction those measures are technically more complex and economically less reasonable. Most activities take place in industrial countries.Direct reduction of methane generation or emission shows a significantly larger potential for CDM due to the poor present emission situation. Basically 4 different project activities may be attractive for CDM:

- Gas extraction and flaring/recovery for old, existing and new landfill sites
- Methane avoidance due to mechanical biological pre-treatment or composting
- Methane avoidance due to urban mining (removing waste from existing lansfills)
- Methane avoidance due to methane oxidation of residual emissions from old landfills

For all gas extraction and biological treatment consolidated methodologies are available from UNFCCC. For urban mining a New methodology has been recently approved by UNFCCC. For the methane oxidation a new methodology has been developed but not registered at UNFCCC, yet. Since there is a quick progress in developing CDM methodologies, more project ideas may be expected.

3.2 Methane oxidation layer

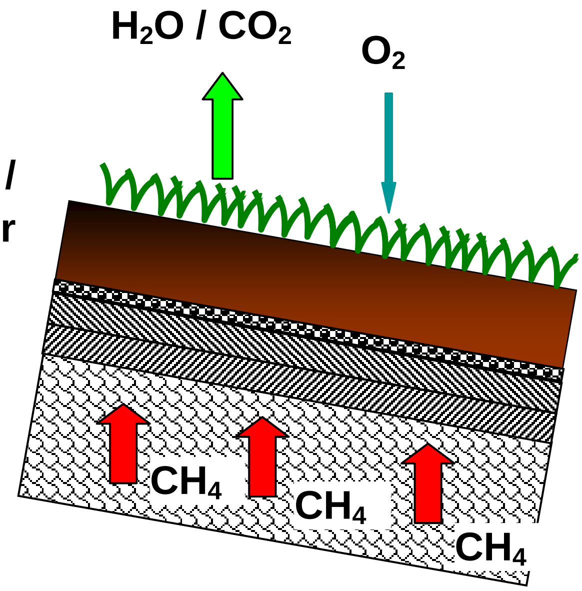

FIGURE 1 Landfill cover with methane oxidation layer – cross section

A so called methane oxidation layer is a landfill cover system which facilitates microbiological activity in the cover layer. Due to the biological decay processes methane, which passes the layer, is being oxidised and turned into CO_2. Figure 1 illustrates the cross-section of a landfill cover consisting of a methane oxidation layer. The efficiency of a methane oxidation layer depends on the quality and biochemical relevance of the cover material. In general, those materials, which provide better milieu conditions to the micro organisms, generate higher decay rates. A typical soil layer with low carbon content shows rates of 2.5 – 12 l CH4/m2*h. Compost and stabilized biomass from biological waste treatment succeed 12 – 30 l CH4/m2*h. The methane oxidation layer is suitable as landfill cover, in case the methane generation has already passed its peak level and dropped down into the weak gas range indicated by methane concentrations less than 15 %. It can not entirely substitute gas extraction systems or biological treatment measures for fresh waste. However, it is a feasible concept for covering old landfill sites. Figure 2 and 3 illustrate how methane oxidation layer material is segregated from MBT output and placed on a landfill.

FIGURE 2 Segregation of methane oxidation material

FIGURE 3 Placement on top of a landfill

3.3 NEW METHODOLOGY

The baseline calculations for covering old landfills are similar to new landfills. The methodology AMS III.F (Avoidance of methane production from decay of biomass through composting) serves as the base of the baseline study and the monitoring concept for Methane Oxidation Layer (MOL) project. For calculations an appropriate separate tool is available, the „ Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site". The baseline emissions BE are calculated with the formula below.

$$BE_{CH4,SWDS,y} = \varphi \cdot (1-f) \cdot GWP_{CH4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-k_j \cdot (x-y)} \cdot (1-e^{-k_j})$$

as provided in the tool. Further explanations can be found there.

The formula contains one term modelling oxidation effects of landfill covers (1 – OX). A default value for landfills covered by soil is OX = 0.1. For the new methodology it is proposed to calculate the project emissions (remaining emissions after implementation) by using the same formula. All other variables in the formula are not subject to changes due to project activities (such as waste composition inside the landfill, decay rates etc.). The project activity simply targets the oxidation factor. However, one problem still remains: How can the change of the oxidation factor be validated in the monitoring program? It appears most feasible, to simply compare methane concentrations below and on top of the MOL. In general, the concentrations do not say much about the total gas emissions, however, the shift in concentrations reflect the reduction of the baseline emissions. Hence, it is essential to once determine the gas flow (baseline measurements) and to check, how it corresponds with the first order decay model.

4 NEW CONCEPT FOR MODELLING BASELINE EMISSIONS

As mentioned in chapter 3 the baseline emissions are commonly calculated according to the „ Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site". The certifiable emission reductions of a waste management project strongly depend on the amount of modelled, "virtual" emissions in the baseline scenario. Unfortunately, the first order decay model, which is generally used in UNFCCC issues (baseline modelling, national GHG inventories), is a very simple model and reflect a conservative scenario. Real gas generation can happen much quicker, particularly under tropical climate conditions. Since the crediting period is limited to a certain time (10 years or 3 x 7 years) the velocity of gas generation is of particular interest, because it effects the emission reductions. To make this point clear: 1 ton of municipal solid waste generates up to 1700 kg CO_2-equivalents during the entire time of decay, which may last 50 years. The gas generation can be avoided by waste treatment, for instance by biological treatment (95 %) or combustion (100 %). However, only the avoided gas generation during the crediting period can be certified as

CER (Certified Emission Reduction). At this point, the velocity of decay makes the difference. For example: If half of the organic matter in a uncontrolled landfill (baseline scenario) is being decomposed in the first ten years, the CERs would amount to 850 kg CO_2-equivalents per ton waste. If the decay process runs slowly and only 25 % of the organic matter is decomposed, the CER output drops to 425 kg CO_2-equivalents. Hence, the profitability of a MBT or combustion project strongly depends on the decay model, which is given and not subject to monitoring. Landfill gas projects, only, are not concerned, because in those projects the extracted gas volume is measured (and not modelled). In the opposite, particularly sustainable projects, which totally avoid methane generation, are disadvantaged by the conservative modelling.
With the aim to more exact determine the emission reduction a research project has been started to develop a technical simulation of decay processes. The method shall replace the first order decay. During the 90ies, a number of investigations on technical simulation of landfill processes have been carried out in Germany. As a first step, the results of the tests have been confronted to the first order decay model.

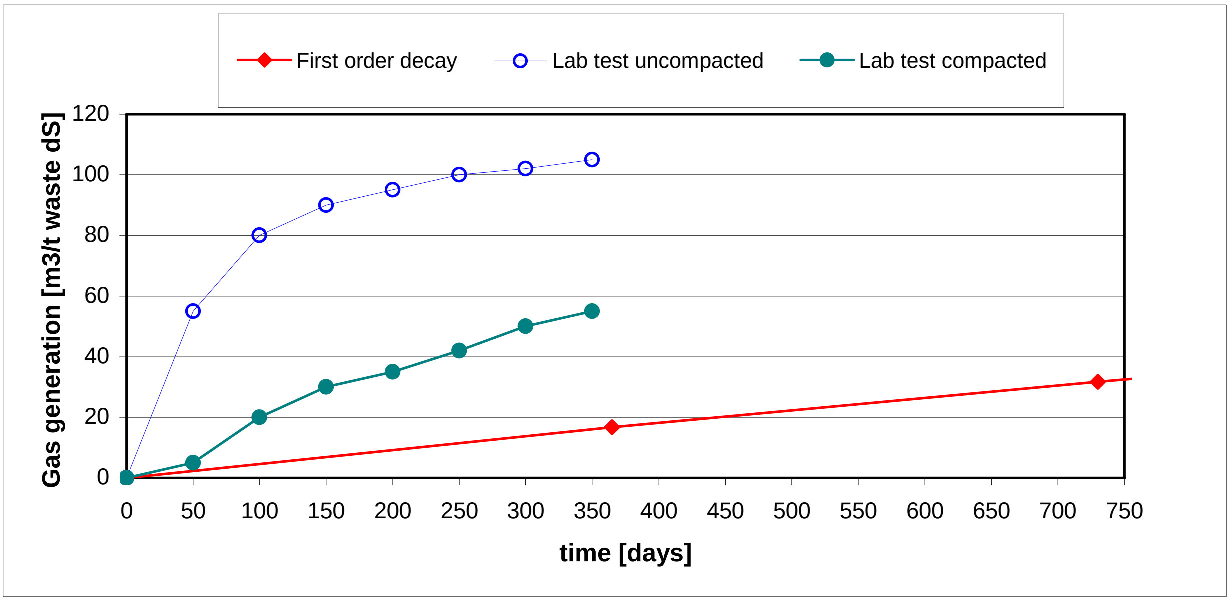

FIGURE 4 Comparison of laboratory testing and first order decay modell

Figure 4 proves that the laboratory test generate landfill gas much quicker than the first order decay model indicates. The results are published by Scheelhaase (1999). However, the laboratory test does not necessarily reflect landfill conditions, since the research objectives at that time were different. Therefore, a new laboratory testing project has been started at Technical University Braunschweig funded by German Federal Ministry of Environment. Figure 5 illustrates the laboratory testing equipment. More results are expected by 2010.

Inside the simulation box

Feeding

Simulation box

FIGURE 5 Laboratory testing equipment

5 PROGRAM OF ACTIVITIES

A program of activities allows establishing an umbrella framework with many individual projects under one/more approved methodologies. The PoA is a strong new concept under the CDM with the potential to literally bring the benefits of the CDM into the houses of people in developing and Least Developed Countries (LDC). PoA facilitates programs in numerous small applications to be developed and implemented over a longer period of 28 years. Contrary to bundled CDM projects, PoA allows adding units to the project after its registration. Thus, no registration fee is payable on CPAs which are added subsequently to validation.

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A potential PoA has been identified for the region of New Dehli (India). Delhi is the most densely populated and urbanized city of India. The annual growth rate in population during the last decade (1991–2001) was 3.85%, almost double the national average. Delhi is also a commercial hub, providing employment opportunities and accelerating the pace of urbanization, resulting in a corresponding increase in municipal solid waste (MSW) generation. Presently the inhabitants of Delhi generate about 7000 tons/day of MSW, which is projected to rise to 17,000–25,000 tons/day by the year 2021. MSW management has remained one of the most neglected areas of the municipal system in Delhi. About 70–80% of generated MSW is collected and the rest remains unattended on streets or in small open dumps. Only 9% of the collected MSW is treated through composting, the only treatment option, and rest is disposed in uncontrolled open landfills at the outskirts of the city. The existing composting plants are unable to operate to their intended treatment capacity due to several operational problems. Therefore, along with residue from the composting process, the majority of MSW is disposed in landfills. In absence of leachate and landfill gas collection systems, these landfills are a major source of groundwater contamination and air pollution. On the same side Delhi is currently facing the problem of energy deficit, which is met by the combination of dynamic power shedding and power purchase from various independent power plants (IPP). Significant improvements of solid waste management definitely require carbon trade funding.

In order to avoid simple LFG projects, but to promote sustainable projects, the PoA was designed to cover all waste projects in the region, which can generate CERs. The PoA management unit will receive the CER revenues and direct it to the projects according to their own funding scheme.

6 CONCLUSIONS

A number of initiatives are on the way aiming on improvements for crediting sustainable waste management methods. The experts are currently looking forward to the negotiations in Copenhagen in December about the follow up for the Kyoto protocol, which will most likely affect the activities in waste management.

7 ACKNOWLEDGEMENTS

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