Utilization of the CDM in Waste Management

Guide to Foreign Investment Projects

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Guide to Foreign Investment Projects

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INDEX OF CONTENTS

INDEX OF FIGURES

INDEX OF TABLES

1. Specification of tasks and objectives of the guide

Recycling and efficiency technologies – Made in Germany (RETech; www.retech-germany.net): In 2007 under this title the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety [in German: Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit (BMU)] began activities on the theme "Environment – Innovation – Employment" and on ecological industrial policy. The initiative aims at improving the development of waste management in cooperation with a network of business players, administration and universities in particular in emerging and developing nations and to promote the international export of German recycling and waste disposal engineering. In addition to the RETech Initiative, the CDM/JI Initiative (www.jiko-bmu.de, 2008) was also brought to life. The aim of both these initiatives of the BMU is to establish the existing market-based mechanisms for the reduction of greenhouse gas emissions as a reliable - instrument of finance through the execution of climate protection measures.

Of particular importance for the promotion of exports in the waste management sector were especially the project-based instruments of the **Kyoto Protocol – Clean Development Mechanism (CDM)** and **Joint Implementation (JI)**. Technical systems of waste management regarded as state of the art in industrial nations like Germany have for various reasons only been put to use to a very limited extent to date under the framework of CDM or JI projects.

These reasons include for example a lack of information in respect of the technical performance and potentials of modern waste treatment systems, or also the feasibility at a local site. Decision makers in countries suitable for CDM and JI are in most cases not able to appreciate the value, do not realise the potential of reducing greenhouse gases in a **mechanical biological waste treatment plant (MBT), a waste incineration plant** or a **managed landfill** compared with an unmanaged dumpsite. On the part of the providers of these technologies however, there is often a lack of knowledge of the financing contribution these flexible instruments can make in the implementation of modern waste management projects.

In order to show some of the ways for the increased use of modern waste handling systems, these guidelines provide information for potential project developers, system providers, and also for the decision makers in the administrative authorities – in particular in developing and transformation countries. Possibilities and options are described as to how the project-based instruments of the Kyoto-Protocol can be made more usable for modern waste handling systems. Technical possibilities and economic framework conditions are linked and divided in three main information sections:

- Brief description of the tools CDM and JI in the context of waste management
- Description and discussion of the **methodology** which forms the basis for implementation and acknowledgement of CDM/JI projects
- Presentation and description of the **refuse systems** which contribute to climate protection and displays of **potential for the reduction of greenhouse gases** in selected countries and regions

In addition, on the RETech platform (www.retech-germany.net) there is extensive information available (Country Sheets) for the countries listed in Table 1 that can be used to work out an initial approach to projects.

Table 1: Countries for which Waste Management Country Sheets have been compiled

Egypt	India	Russia	Tunisia
Brazil	Indonesia	Serbia	Ukraine
China	Kazakhstan	South Africa	

Further, in connection with the country data the guide also provides background information on social aspects which play a major role in project planning in the waste management sector.

2. Target groups of the guide

The guide is aimed at companies, non-profit oriented organisations and authorities who wish to make a contribution to the further development of waste management towards sustainability and climate protection.

First of all here, these are the project developers who already have the first experiences with CDM or JI projects and those who are not yet familiar with these.

The guide supports their efforts by a compilation of essential information on **waste handling systems** and **waste management**. Helpful are also the recommendations in dealing with refuse in general, for working out waste handling strategies and for the development of an efficient **waste management system**.

A further target group is formed by the decision-makers in the administration authorities of developing and transformation countries. The guide provides them with basic information for a professional assessment of project concepts in the waste management sector. Moreover, the officials responsible in the local communities or at regional or ministerial levels can take from the guide which procedures for the implementation of waste management projects are recommended using the project-base tools of the Kyoto Protocol.

The target group also includes installation companies and systems manufacturers from the field of environment technology such as producers of MBT and components for waste incineration plants, in particular also manufacturers of biogas plants and planning offices for waste management concepts. In connection with the **related country information**, the guide can help them to assess the chances and risks of waste management projects in selected target countries of the RETech Initiative. Possible competitive advantages through the integration of additional project financing aids as offered by the trade with emission rights can be used directly on purpose.

Finally, the guide is also a valuable help to organisations which offer international measures in the areas of education and further training (**Capacity Building**) for decision makers and other multiplicators. With an integrated approach – refuse technology, waste management and the use of project-based tools – the guide is a **reference work of practical applications**.

In compiling this guide, the preparation of concepts for the **execution of roadshows** for the exchange of information and knowledge in the target countries RETech Initiative was undertaken. The guide itself can form the essential core of such promotional export activities and in this way can greatly assist the speedy integration of the latest sustainable waste management tools in developing and transformation countries.

3. Basic functions of the project-based Kyoto mechanisms

Clean Development Mechanism (CDM) and Joint Implementation (JI) are project-based mechanisms anchored in 1997 under the terms of the Kyoto Protocol, international climate agreement (UNFCCC, United Nations Framework Convention on Climate Change: http://unfccc.int/2860.php). On the one hand, the idea aims at low-cost achievement of emission targets on the part of companies or states, on the other hand, at to offer incentives to invest in climate protection technology in development and transformation countries. The basic function procedures of the project-based Kyoto mechanisms are shown in illustration 1.

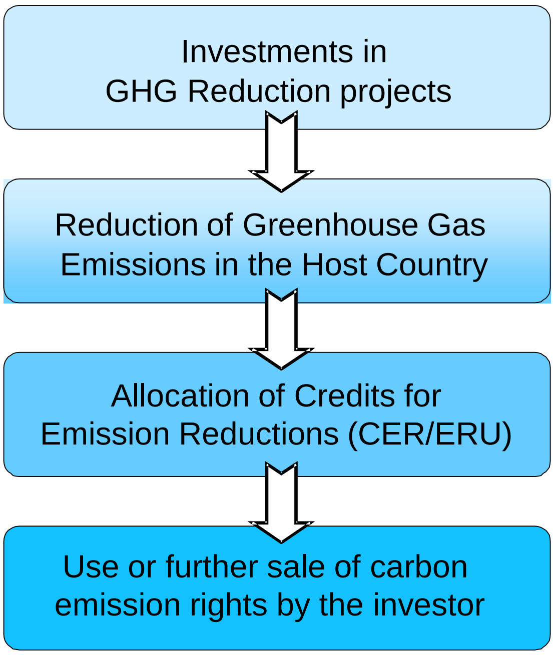

Figure1: Basic functions of the project- based Kyoto mechanisms CDM and JI

CDM projects are undertaken in developing and emerging countries; JI projects in industrial nations and states which are currently in transition to a market economy. Formal requirements and approval procedures of both mechanisms are different, as summarized in Table 2. CDM projects have generated certificates since 2000, JI projects only since 2008. The certificates from CDM or JI projects can be attributed to investors from the so-called Annex-I-States – e.g. public and private companies – in fulfilment of their obligation of reduction.

Table 2: Essential differences of JI 1st Track (simplified procedure) and JI 2nd Track (more sophisticated procedure) for CDM

	CDM	JI Track 1	JI Track 2
Duration	maximum 21 years	open, status as of 2013 not determined	
(Additionality)	restrictive criteria	Negotiable with the host country	restrictive criteria (as for CDM)
Validation	Yes	Not always necessary, national laws apply	Yes
Methodology	UNFCCC standard	Own methodology possible	UNFCCC-Standard or by approval of UNFCCC
Baseline determination	Prescribed by the methodology	National regulations of the host country or standard methodology	Prescribed by the methodology (as for CDM)
Project Design Document (PDD)	UNFCCC standard	Own format possible	UNFCCC-Standard
Verification	Verifier with UNFCCC accreditation	National regulations	Certification with UNFCCC accreditation
Granting of emission rights	by UNFCCC	Through national regulations	Through national government; in the case o no responsible office then UNFCCC
Designation of emission rights	Certified Emission Reduction (CER)	Emission Reduction Unit (ERU)	
Unilateral	Possible	Project development possible	Not possible

The various possibilities for putting projects into practice with the respective mechanisms are core elements of this guide. Fundamentals of climate-related emissions and technical systems to be used for the solution are now explained in the following:

4. Utilization of the tools Program of Activities (PoA) and project bundling

Further project-based tools with which waste management measures can be supported through the generation of tradable emission rights, are project bundling and in particular the Program of Activities (PoA; cf. Table 3). Under the framework of a PoA, several project activities ("CDM Project Activities" - CPA) can be registered as a single CDM project. According to the definition by the CDM Executive Board (CDM-EB) a PoA is a voluntary, coordinated activity of a person under private or public law who co-ordinates and carries out a program (a measure) which leads to emissions reductions or significant decrease in greenhouse gases.

In the creation of the tool PoA however, it was explicitly excluded that political specifications at national, regional or local level may generate credits under the terms of CDM. The reason for this is for example uncertainty as to whether the consequences of reduction arising from such measures can be measured with the necessary precision. Moreover, the "additionality" of such activities would be extraordinarily difficult to justify on the part of the legislative body.

A considerable advantage of a PoA for investors and project developers, in contrast to the registration of several project activities as individual CDM projects is that for the registration of a PoA Design Document (PoA-DD) various parameters can be left open. For registration, in particular the target region and the central managing entity, a co-ordination office for individual project activities, must be stipulated. The managing entity takes over the entire communication with the CDM-EB.

In the waste sector no registered PoAs are known at present. Conceivable applications for PoA under the framework of existing methodologies in the waste sector are for example

- Dump degasification plants with relatively low volume flow,
- Small fermentation plants which are provided with separately collected organic refuse,
- A network of surrogate fuel production systems which supply a joint clientele, or
- In principle, any replicable single project, the climate effect of which is relevant although alone it cannot effect enough reductions such that the registration procedure is economically viable.

We must wait and see how important PoAs become in future in the waste management field.

Table 3: Bundling in comparison to the Programme of Activities (Source: DEHSt, 2008)

	Programme of Activities	Bundling
Locations	The exact locations of the project activities are not known in advance in every case.	Prior specification of the exact locations required.
Project activities	The CDM project activity represents the sum of all individual activities under the program framework. On submission on the target activities are specified, the actual activities are then confirmed at the verification stage.	Each activity in the bundle represents a separate CDM project activity.
Project participants	Only the legal person who carries out the program represents the project activity as CDM project participant, but not all those persons involved in the project.	Each single activity is represented by a CDM project participant.
Methodology	All project activities combined in a PoA (CPAs) must be permitted on the basis of the same methodology.	The CDM project activity in the bundle can be permitted on the basis of different methodology.

A comprehensive description of the tools PoA and bundling can be found in a publication of the KfW (PoA BLUEPRINT BOOK: Guidebook for PoA coordinators under CDM/JI. Frankfurt a. M., 2009).

5. Greenhouse gas emissions from landfill refuse

Refuse from settlements in general contain a large amount of organic waste. If the refuse is collected at a landfill, methane is often created during the biological decomposition. In the course of time there can therefore be a considerable amount of methane build up at the landfill with high greenhouse gas potential. In the case of untreated refuse, the biological decomposition process in the body of the landfill can last for several decades. For reasons of climate protection therefore, it makes sense to treat the refuse before it is stored.

To reduce future emissions from waste a wide range of modern treatment systems are available. Landfill gas emissions from deposited waste can for example be collected and burnt off or converted to energy in block heat and power plants. At present the most economically attractive climate protection potential in the countries under review will continue to be achieved for a foreseeable time through the renovation of old landfills. The instructions for the execution of degasification and incineration plants for collected landfill gases for the purpose of achievable reductions are given in the construction specifications. Notes on the feasible potential for selected countries can be seen in Table 4, represented methane emissions from landfill dumps.

The additional avoidance potential calculated by the Eco-Institute is in part above that of the U. S. EPA estimated emissions from landfill. There are several reasons for this, for example, the use of different prognosis models for emission development of landfill sites. There are also often model calculations with diverse assumptions, both in respect of the quantities of dumped refuse and present level of recording and handling of landfill gases arising.

Table 4: Methane emissions from landfills in selected countries; Source: National communications of the countries to UNFCCC, U.S. EPA, Eco-Institute)

Region/country	Methane emissions from landfills in million tCO_2e /a			
	Emissions in 1994 (or other reference year) acc. to National Communications	2000 acc. to U.S. EPA	2010 acc. to U.S. EPA[2]	2020 acc. to U.S. EPA[2]
Egypt	5.5 in 1990/1991	4,9	6,0	7.1
Brazil	14	15	17 (24.00)	20 (35)
China	43	89	133 (74.00)	195 (103)
India	12	15	17.10 (55.00)	19 (84)
Indonesia	8.4[1]	9,1	10.20	11
Kazakhstan	4.1	3,2	3.1	3.1
Russia	37,80 (1990 acc. to U.S. EPA)	35	33 (38)	31 (39)
Serbia	n.s.	n.s.	n.s.	n.s.
South Africa	16	16	17	16
Tunisia	0.86	n.s.	n.s.	n.s.
Ukraine (1998)	4.7 in 1990	4.8 (in 2004 acc. to Nat. Com.)	15 (12.00)	18 (11)

The values in the table represent the methane gas emissions converted to CO_2 equivalents which are converted from the landfill sites (i.e., the CH_4 emission multiplied by the factor 21).

[1] The number also contains emissions from waste water, since according to the information from the Indonesian Government to UNFCCC; it is not possible to differentiate.

[2] In brackets as supplementary information are figures relating to the avoidance potential calculated by the Eco-Institute (2007) (compared with the status quo) through modern waste management including controlled landfill gas records and handling.

In order to be able to quantify more precisely by means of modern waste handling systems in the countries under review, the actual sources or the emissions thus avoided must be localized exactly. This applies primarily to the differentiation of emissions from landfill deposits already undertaken and those which would occur in the case of future landfill deposits. This differentiation would have for example the result that in the case of resolute implementation of modern waste management systems from the year 2010 the emissions forecast for the year 2020 would not be recorded to their full extent. Instead, the respective host country could announce the successful reduction to UNFCCC. (The framework conditions in the respective countries are still regarded as unchanged.)

The following illustration shows this connection: The last dump at the landfill site cited here as example will be in the year 2010. The landfill site will then be closed and future waste treated, recycled or disposed releasing CO_2, only. The CH_4 emissions from the landfill immediately begin to decrease, as there are no further dumpings which increase the emission potential of the landfill.

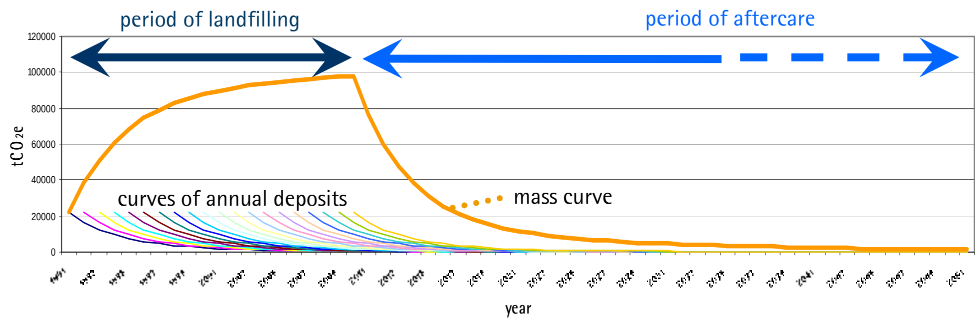

Figure 2: Course of methane emissions of the example up until the assumed end of the annual landfill deposits in 2010

Source: own representation based on Pfaff-Simoneit (2007)

The orange curve in **Fehler! Verweisquelle konnte nicht gefunden werden.** is formed by the sum of annual methane emissions. The CO_2 emissions arising from the incineration of methane are not taken into account because these are relatively small and of no significance for the course of the sum curve. Immediately after ending the dumping at the end of 2010, the annual emissions begin to sink rapidly.

On the basis of these connections the following conclusions for waste management projects in the target countries can be made:

- Landfill degasification projects can bring about rapid reduction of emissions from existing landfills.
- The less time taken between the end of dumping of quantities of refuse and the beginning of degasification and treatment (incineration) of landfill gas, the greater is the reduction of greenhouse gas emissions. The rate on emissions in the first few years is very high but diminishes with time until asymptotically reaching the zero baseline.

- Modern waste management represent an excellent possibility for the avoidance of methane emissions from refuse landfills as forecast for the years from 2010 to 2020. In such a case, the estimated values of Table 4 would not be applicable in the target countries.
- The estimated emissions from landfill sites represent the reference values for waste management treatment measures. They reflect the size of the so-called baseline emissions for CDM or JI projects.

6. Technology overview in the waste management sector

In principle there are two types of projects at present for the waste management sector:

a) The first project type prevents GHG emissions by collecting and treating methane from solid waste disposal sites or other uncontrolled landfills of organic waste from agriculture or industry.

b) The second project type avoids the production of methane at source; i.e. the uncontrolled anaerobic decomposition is prevented and the refuse subjected to alternative treatment.

The technical implementation possibilities for these project types are described in the guide on the basis of the available technical possibilities and possible balancing methodology according to UNFCCC.

Under the framework of CDM projects in the waste sector through treatment of waste emissions are avoided that would have occurred on the landfill otherwise. To account for the resulting amount of emission reductions the emissions caused by the treatment are usually being compared to the emissions the waste would have caused if disposed of on a landfill. The difference is expressed in tCO_2e and is credited to the project owner's account. In the following section, there is an overview of three eligible disposal methods.

6.1 Depositing waste at a landfill site

The aim of a landfill site is the proper and concentrated disposal of refuse from a region at one location. If the operation is carried out correctly and at the latest state of technology, then to a large extent the direct negative influences on the environment caused by the diffusion of the harmful substances concentrated on the landfill e.g. in ground water, can be avoided. Refuse which is to be dumped on a landfill site, should if possible be pre-treated mechanically, biologically or thermally, in order to reduce GHG emissions (see sections MBT and waste incineration plants). In addition, the pre-treatment minimizes volume and mass of the refuse and thus extends the scope of the landfills.

Deposits of refuse in landfills, in particular the build up of waste from settlements is at present the most usual form of waste disposal all over the world. In principle, in countries with developed waste management systems there are different types of landfills:

- concentration landfills (also known as dry landfills)
- rotting landfills, unmanaged and managed (reactor landfills)

- Inert substance landfills
- dry landfills as intermediate storage e.g. of surrogate fuels (RDF)

Whereas waste treatment procedures can fully eliminate the GHG potential of the waste treated, every variant of landfilling untreated wastes, listed before, still causes considerably high GHG emissions due to the technical limits of the landfill gas capturing.

Nevertheless legal restrictions to landfilling untreated wastes (e.g. as in use in the European Union) can foster the development of waste treatment structures by using minimal treatment quotes.

6.2 Mechanical-biological waste treatment plants (MBT)

The mechanical-biological waste treatment plants (MBT) together with thermal waste treatment serve to treat waste from residential areas and from industry prior to landfill dumping. This can also be implemented for example prior to thermal waste treatment.

In various mechanical treatment stages valuable substances or heat-value waste segments for example are separated from a further biological aerobic or anaerobic treatment of the remaining waste. Through biological treatment, there is stabilization with at the same time volume and mass reduction of the waste which is then deposited (cf. Table 5). In practice up to 25 % higher installation density can be achieved (Kuehle-Weidemeier und Langer, 2006). Biological treatment also anticipates mobilisation of harmful substances in the landfill body through the advance formation and further decomposition of organic acids. The term used for this therefore is "cold inertisation", although the material after the treatment still contains organics.

In the case of aerobic biologic procedures, mostly fresh air is fed actively or passively to the waste in a rotting process under controlled conditions. By process control, a dry stabilate or a surrogate fuel can be produced which can then be burned e.g. in a refuse conversion heating and power plant or industrial power plant (Waste to Energy Plant). In the case of an anaerobic biologic treatment stage, a waste product biogas plant – biogas is gained from the organic portion. From the biogas in combination with a block heating and power plant, electricity and heat can be produced for the operation of waste management plants. The fermentation residue should be dried and sanitized for further stabilization. This can for example take place with the help of biological drying – composting – or through the use of excess heat from the block heating and power plant.

6.3 Waste Incineration Plants

As well as the MBT the thermal waste treatment in a waste incineration plant also serves the pre-treatment of residential and industrial waste prior to landfill. The refuse is incinerated whereby essentially exhaust gases and incineration residues such as slag result. A waste incineration plant is operated 24 hours a day. Continuous operation means that a waste bunker must be provided for the refuse delivered.

For the incineration of residential waste, two systems have proven themselves: fluidized bed combustion and grate firing. Incineration is the basis of both methods.

On the whole, the incineration of waste is characterized by a relatively low level of pre-treatment. The process of controlled incineration, however, involves a high level of technology which on the one hand requires qualified personnel for the operation of the plant and on the other hand leads to high investment costs.

Despite the lost heat which occurs in waste incineration plant, it is nevertheless suitable for heating or cooling industrial or residential premises by means of remote heat (power-heat-coupling) or remote cooling networks (power-heat-cooling-coupling). The use of power-heat (-cooling) -coupling in combination with suitable storage systems can achieve a higher level of overall effectiveness.

An important factor for the utilisation of the energy from waste incineration is therefore the location of the waste incineration plant in proximity to users of heating or cooling systems. In this connection, consideration must be given to great deal of transport required which can only be mastered logistically by means of good connections to the transport routes (road, rail and/or water).

Table 5: Different characteristics of MBT and waste incineration plant

Technology	MBT	waste incineration plant
Type of operation	Sorting and batch feed to the plant as a rule takes place on work days. Also outside these times in the case of anaerobic wet fermentation plant.	Waste incineration plants are fed day continuously (day & night). Revision times must be scheduled every year when maintenance works can be carried out whereby only one incineration line at a time is stopped.
Specific investment costs	11 to 21 €/t	From 22 €/t
Full utilization of the plant	flexible	Operation at capacity is necessary because of the fixed costs
Size of plant	flexible	From 50.000 t/a profitable by German standards
Transport routes	Relatively low in the case of decentralized plants	Longer, because a larger area needs to be covered
Value creation	Recycling of resources (compost possible), for anaerobic processes also of energy	Energy (Bulk material for road construction)
Requirements on waste	low	Fuel value > 6,000 kJ/kg
Energy win from waste	Only possible for anaerobic processes	Steam power process with electricity production and heat extraction
Energy use from waste	low	High
Output product	Volume and mass reduction but no complete mineralization	Volume and mass reduction and mineralization to a great extent
Influence on the landfill	Increase in the covered distance of a landfill site	Increase in the coverage area of a landfill
Methane formation and reactivity of the waste	Methanogenic condition here more than 90 % reduced and reactivity reduced	No methanogenic condition; Reactivity low or dependent on pH value

7. Climate protection potential of different types of waste disposal

On the whole when there are high organic contents in the waste, through modern treatment methods such as MBT and waste incineration plant over periods of 50 years there is clearly higher GHG reduction potential than can be achieved with landfill technology. With an organic content of more than 5 % (MBT) or 25 % (waste incineration plant) the quantity of reducible tons CO_2e is higher, compared to a landfill and in the case of 50 % organic content, would be about double that of a landfill. With a waste incineration plant with organic contents of more than 50 % the highest reduction potential can be achieved. Similar potential can also be achieved with a combination of MBT and WtE plants. The interrelationships described are illustrated in figure 3.

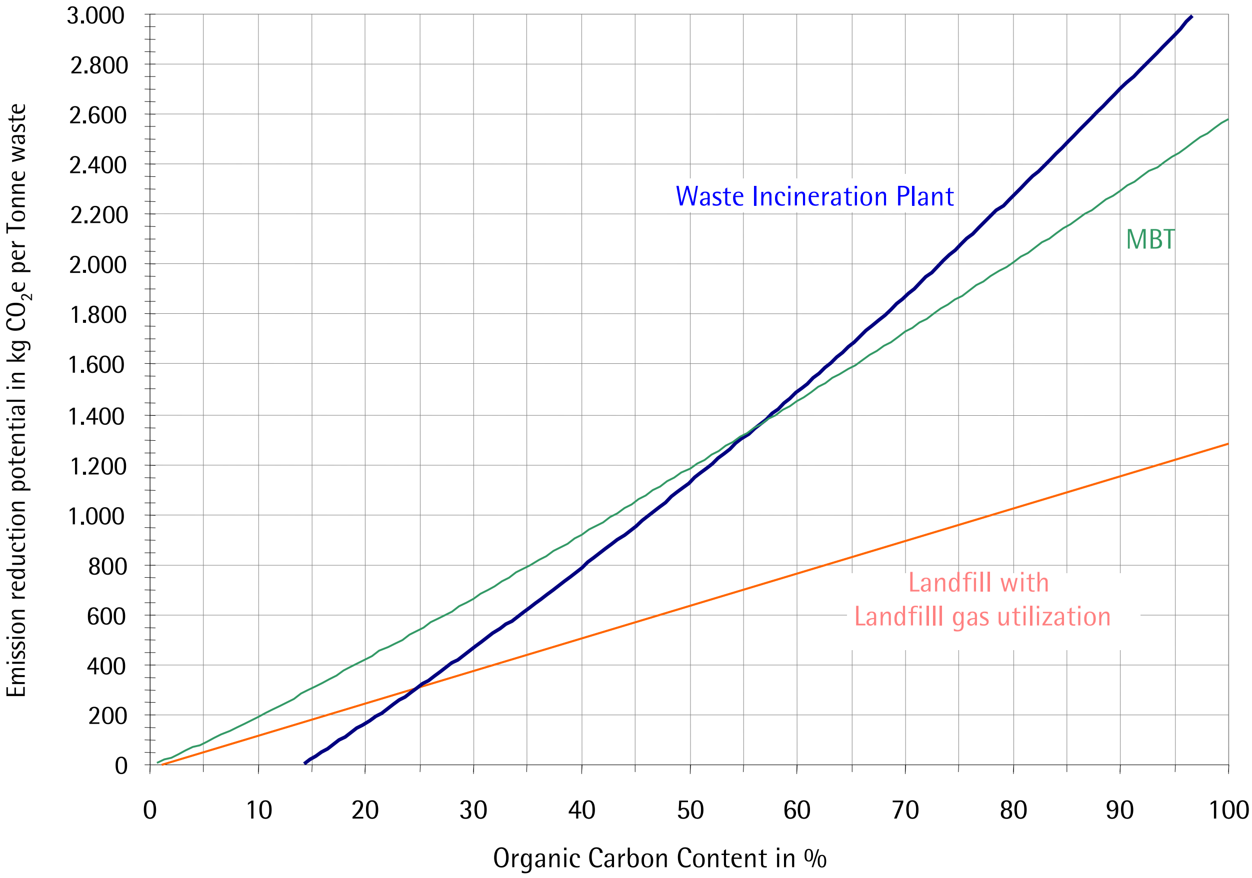

Figure 3: Benchmark GHG-reduction potential of a landfill with a landfill gas capturing, a waste incineration plant and a MBT depending on the organic content compared with an uncontrolled landfill

A further tool for the calculation of greenhouse gas emissions by waste management measures has been developed by the Kreditanstalt für Wiederaufbau (KfW) in cooperation with the Gesellschaft fuer technische Zusammenarbeit (GTZ). The so-called "climate calculator" needs information such as the climate of the country and the standard of technology and can represent actual projects in developing and emerging countries in detail and thus estimate the potential for emission reduction, similar to the system of figure 3.

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www.kfw.de

8. Benchmark estimate of CO_2e avoidance costs of waste handling systems

Depending on investment and operating costs, there are specific avoidance costs for each handling system or combinations of technical systems. By comparing the methane avoidance costs with the income achieved through the sale of the carbon emission rights generated through the project, benchmarks can be determine whether a project has a feasible economic foundation.

A detailed description of the technical systems and current investment costs can be found in the guide.

Since the operating costs depend primarily on conditions in the host country (wages, energy costs etc.), the investment costs are the most important influencing factors of the specific avoidance costs. Table 6 shows the benchmark values for avoidance costs, based on the investment costs of diverse variants. In industrial countries the actual costs tend to be somewhat higher than these values, in developing countries on the other hand, these could be lower.

Table 6: Specific avoidance costs of waste handling systems and refuse dumping dependent on the organic proportion and accreditation period (benchmark)

Variants *	Spec. avoidance costs in €/tCO_2e within the accreditation period (benchmark)			
Project running time in years	7	10	14	21
30% Organic				
Controlled landfill	90	75	63	51
MBT*	68	57	48	37
waste incineration plant*	181	151	126	98
50% Organic				
Controlled landfill	44	37	31	25
MBT*	38	32	27	21
waste incineration plant*	72	60	50	39
70% Organic				
Controlled landfill	30	25	21	17
MBT*	26	22	18	14
waste incineration plant*	45	38	31	25

*) Landfill costs for MBT and waste incineration plant residual materials were not taken into account

9. Financial accounting tools for waste related CDM projects

The financial accounting of the creditable CO_2 reductions in CDM projects is done on the basis of the so-called methodologies. Methodologies describe the procedure for the determination of project-related emissions, emission reductions and limit the observation framework. In addition here, the further obligations of the project operator, e.g. in respect of emissions monitoring are also stipulated.

In Table 7 the fields of application and the special features of the methodologies previously applied in the waste sector are summarized. An extensive presentation and description with the appropriate background information is contained in the guide. As the so-called FOD model forms the basis for all the methodologies shown in Table 7 this model is explained in the following.

Since only CO_2e quantities are given out as certificates that have actually been avoided it is necessary to determine emission quantities which do not occur because of the treatment (reference scenario or "What would be the case if the project were not carried out?"). These avoided GHG emissions are identified by the so-called "First Order Decay Model" (FOD Model) which calculates the relevant waste emissions from the composition of the waste treated, the local clime and the local landfill structure. From this calculation and the monitoring results, then the creditable amounts of CO_2e certificates are determined.

Table 7: Methodologies in CDM

Methodology	Potential	Challenges	Remarks and recommendations to project developers
ACM0001 (Collection/ Treatment/ Utilization landfill gas; major projects)	▪ Slim, robust methodical foundation ▪ For use in closed landfills and those still in operation ▪ Allows various options for the treatment of collected gas and the technical systems utilized ▪ Emission reductions arising from the replacement of fossil energy through energy from the biogenic fuel landfill gas are possible	▪ The prognosis of achievable emission reductions on the basis of First Order Decay Models in many cases does not lead to correct results ▪ The determination of the adjustment factors, whereby a necessary or plausible gas collection and treatment is taken into account in the reference case is often difficult ▪ Gas quantities must be recorded continuously by means of throughput measurement, as a rule at several reference points. In the event that such a continual measurement cannot be undertaken all the time, the corresponding gas quantities cannot be taken into account in the calculation of emission reductions. ▪ The question whether reliability of punctual measurements of the methane content and the frequency of measurements are acceptable, has in the past led to numerous examination requirements through to rejection of applications for the issue of CER. ▪ The determination of the torch effect level corresponding to the torch tool is very complicated. In principle a standard effect level of 90% can be used and which however, is very conservative.	▪ In the case of landfill gas projects the emission reductions which can be achieved can only be estimated with a high level of uncertainty; this must be taken into account by project developers right from the beginning at the planning stage. It can be that the reliability of the prognosis is increased through a respective conservative estimate and investigations on site. ▪ In the execution of projects, attention must be paid to the continuous recording of data, the planned calibration of the measuring instruments and the regular determination of the level of burn-off effects as otherwise this could lead to serious losses to the CER. Project developers must as appropriate declare measuring instruments to be redundant and to have emergency plans available for the event of measuring device malfunction. ▪ It is recommended that occasional methane content measurements are not undertaken, as these could be vulnerable.
AMS III.G (Collection/ Treatment/ Utilization landfill gas; minor projects)	▪ Slim, robust, methodological foundation ▪ For use in closed landfills and those still in operation ▪ Allows more options for the treatment of the collected gas together with the technical systems used than ACM0001	▪ The emission reductions in all other utilizations except for electricity and heat generation with the emission reductions from avoidance of landfill gas emissions must be below 60,000 tCO_2e per year. ▪ Selective measurements of the methane	▪ According to the information in ACM0001 ▪ This methodology has today only been applied once for landfill gas projects.

Methodology	Potential	Challenges	Remarks and recommendations to project developers
		content in the landfill gas must be undertaken with statistical certainty of 95 %. ▪ Further challenges as set forth in ACM0001	
AM0025 (Alternative treatment of fresh refuse in the place of a landfill)	▪ Covers a broad spectrum of alternative treatment possibilities for refuse, allows material current-related treatment concepts ▪ With the so-called multi-phase First Order Decay Models creates the first ordered foundation for consideration of various types of refuse, waste qualities and decomposition conditions ▪ Offers pragmatic calculation approaches for some emission sources from project activities	▪ The remaining substances from the treatment and as appropriate also the corresponding greenhouse gas emissions as project emissions must be monitored and taken into account. ▪ AM0025 requires the monitoring of a number of different parameters; all measuring devices should be calibrated at regular intervals, all measurement results must be statistically approved ▪ The tool to be used requires the determination of the waste composition with a maximum uncertainty of 20% with a statistical significance of 95% ▪ AM0025 requires taking into account the residual emissions from landfill treatment residues; the corresponding regulations however, are not really practicable in use	▪ The application of AM0025 for mixed residential waste is problematic because there are high requirements made for the statistical certainty of waste analyses. ▪ Landfill with residual materials cannot be properly taken into account in the current version of the AM0025 ▪ RDF production requires knowledge of the composition of the RDF ▪ Project developers must specify and document all the way for disposal and/or recycling of the treated products ▪ It appears to be a good idea that amendment applications are entered for some of the monitoring requirements ▪ Errors in the monitoring of mass flow in the treatment plant should be avoided. Attention should be paid in particular to loss of moisture. ▪ For the monitoring of transport distances and vehicles to be use, the operators should also draw up a practical concept.
AMS III.E (energy utilisation from organic wastes in small projects)	▪ AMS III.E allows certain simplifications in contrast to AM0025, including taking into account small project methodology in the project case only CO_2 emissions (methane and laughing gas emissions from the project activity not necessary) ▪ Recycling of previous landfill refuse is permissible	▪ Please refer to the information of AM0025 ▪ RDF bales and pellets should be recycled immediately as otherwise the reduction result is reduced by substitution of fossil energies by around 5 %. ▪ Insofar as in the baseline scenario there are occasional landfill fires or materials are taken away by other parties, these must be taken	▪ Please refer to the information given under AM0025 ▪ This methodology has to date been used primarily for energy recycling of biomass residuals (rice waste etc.). ▪ The matter of data acquisition in respect of installation possibilities in old landfills must definitely be checked out in advance.

Methodology	Potential	Challenges	Remarks and recommendations to project developers
		into account when calculating the base line emissions; there are however, no prescribed specifications for these values.	
AMS III.F	▪ In comparison to the corresponding fields of application for AM0025 contains additional project options and significant simplifications for monitoring project emissions.	▪ The simplifications can lead to very conservative estimates whereby the project emissions are estimated comparatively high. ▪ In the verification a great deal of effort is involved and an on-site examination is absolutely necessary. ▪ Financial accounting of burnt off refuse is on the basis of AMS II E but here too, the relevant specified values are missing. Fertilizer substitute products produced must be traceable and the absence of anaerobic conditions proved by random sampling.	▪ This methodology to date was used primarily for the treatment of biomass residual matter from the production of palm oil.

10. Emission reduction potential of waste management outside existing CDM methodologies

As can be seen in the above, (cf. Table 7), at present there are no methodologies which take into account possible reduction in emissions through recycling. Such emission reductions can be e.g. from a reduced energy consumption with the use of old glass or paper/ cardboard or from the substitution of synthetic fertilizer in agriculture.

This gap in the scope of validity of the existing methodologies can be filled in principle by working out and submitting a new methodology. A suggestion of this kind can be submitted by any of the parties involved, – project developers, investors, research institutes or public offices – to the Climate Secretary of State; in the case of a methodology for major projects, the proposal must be submitted via a DOE. With a view to recycling activities a methodology should be provided which really takes into account that the actual processing of the recycling resources or the utilization of the compost are monitored accordingly and that the corresponding emission balances can be determined with satisfactory accuracy. Only in this way can a new methodology be authorized by the UNFCCC.

Further possible waste management activities which lead to a reduction in emissions however, cannot at present be taken into account under CDM and include e.g.:

- Biological methane oxidation layers in the landfill
- In-situ-aeration and stabilization of landfill sites (two relevant methodology proposals are currently being examined by the commission)
- Deconstruction of landfill (one methodology proposal has already been turned down as the FOD model was not used)
- Recycling of resources and substitution or primary raw materials

11. Assessment of the CDM in waste management and sector approaches

Waste management activities are characterized by a number of material streams, treatment disposal or emission sources and reductions. Moreover, many of the emission sources and reductions are difficult to record with precision and must therefore be illustrated as models. This applies for example to emissions which would have arisen from organic refuse or diffuse emissions from open composing. This complex framework poses considerable challenges for the proper determination of greenhouse gas emission balances as also considered in the existing methodology inventory.

In principle the landfill gas projects are considerable easier to represent in their balance of values, than are those of treatment or recycling activities. In landfill gas projects the avoided emissions and the residual emissions from the project activity can be relatively simply determined through measuring the landfill gas/exhaust gas flows whereas emissions avoided in waste handling must take into account estimations and a variety of emission pathways within the project activity (emissions from the treatment plant, residual emissions and credits from the treatment educts). At the same time, refuse treatment as opposed to landfill and gas collection incurs higher costs anyway. From these circumstances it can be seen that landfill gas projects appear in the first instance to be considerably simpler and more cost-efficient than more sophisticated treatment methods.

The CDM can obviously not alleviate this imbalance: Whereas up until the end of November 2008 94 landfill gas projects were registered (89 large and five small projects), there were 42 project registrations for treatment of waste (six large and 36 small projects) as CDM projects. This distribution is in contrast to the efforts of the European Union according to which avoidance precedes recycling which precedes treatment in preference to disposal.

It is particularly serious that once a landfill gas project is implemented the realisation of more environmentally sound alternatives at the distinctive location is very unlike. This is due to the fact that the conversion of CDM projects with running times of ten to 21 years at such locations means that the landfill is determined to be the main disposal option for years. In the medium term, alternative treatment systems are therefore less likely in these locations (so-called "*Carbon Lock-in*").

The fact that this high contribution to climate protection of treatment/recycling technologies cannot be fully exploited at present under the CDM is especially by reason of the following circumstances:

- Part of the emission credits, e.g. from recycling, cannot yet be taken into account in the existing methodology inventory.
- The complex emission pathways in treatment/recycling methods require complex methodologies. An increased level of monitoring expenditure is the result of this complexity. The existing methodologies, in particular AM0025, in some parts present unrealistically high requirements or specify very unfavourable standard values. These method challenges make projects under AM0025 appear less attractive.

At the same time it must be stated that the existing landfill gas projects in the main were not able to fulfil expectations and achieved only approx. one third of the expected emission reductions. The reasons for this are a) the accuracy of the prognosis for gas potential at most of the landfills is only very limited (this problem can also be expected in future insofar as these are not controlled landfills) and b) the monitoring requirements in particular in the initial phase of the CDM are not given enough consideration.

Treatment projects on the other hand show a higher level of planning security in particular since the reference case emissions can be better estimated in advance. A change of waste management strategy – in other words, the resolute improvement of preconditions for treatment projects – could limit these problems. Existing and future waste management policies which provide aid on the part of public organizations e.g. the BMU, can play an essential role in supporting a suitable change of policy in the waste sector in the respective CDM host countries.

In order to better exploit all the ecological benefits of treatment/recycling methods, it is recommended at the specialist level,

- that the current method difficulties are remedied, that the appropriate methodologies are designed for implementation in practice
- and that the inventory of methodologies should be expanded.

In the case of successful integration of modern treatment systems in the host countries the existing disposal system structures cannot be ignored. A great many people in developing countries are directly dependent on the sale of resources to be found in refuse. By integrating these people in a long-term waste management policy, their livelihood can be retained and at the same time the full potential of manual sorting can still be used in order to win back resources.

In principle the use of the project-based tools of the Kyoto Protocol in waste management projects in developing and emerging countries generate important cash-flows which are essentially independent of the development of the household income of the respective host country and therefore also independent of waste charges.

On the basis of current negotiations on a follow-up Kyoto agreement, other climate protection tools have also been examined in addition to the CDM, in particular the tool **"Sectoral Approaches"**.

Sectoral approaches are based on country and region-related avoidance targets for defined economic sectors e.g. chemicals or waste management. They can also be specifically developed for countries which have made no stipulations on reduction targets according to the Kyoto Protocol. In contrast to the CDM, Sectoral approaches can provide for political or social changes and initiatives, for example through information campaigns on separation of refuse, as a contribution to the reduction of greenhouse gases.

On behalf of the BMU, the bifa Umweltinstitut is developing concepts for possible procedures for the implementation of sectoral approaches. These are intended as consolidation and promotion of modern waste management systems in developing and emerging countries beyond the year 2012 and much more intensively than ever using the tools of international climate protection and the emission trading.