

CLIMATE RELEVANCE OF THE WASTE MANAGEMENT SECTOR



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Introduction

Waste management measures make a major contribution to cost-effective reduction of greenhouse gases. The necessary steps for restructuring towards a “climate-friendly waste management sector” are known, and reliable recycling and waste treatment techniques are available. A phase-out of the landfill of untreated waste, accompanied by an increase in recycling rates and energy-efficient treatment of residual waste, immediately results in successes in greenhouse gas reduction.

In 1990, the German municipal waste management sector burdened the climate with nearly 38 million tonnes of climate-damaging gases. Today, it relieves the climate actively of 18 million tonnes – every year. The resultant savings of 56 million tonnes of CO₂ equivalents achieved by the sector compared to 1990 correspond to about one-quarter of the total reduction in greenhouse gas emissions achieved in Germany up to 2006.

Unlike Germany, which banned landfilling of municipal waste without pre-treatment in 2005, most other countries still landfill untreated waste in significant volumes. In 2007 the proportion of municipal waste going to landfill was 42 percent in EU 27 and even 54 percent in the USA. Since waste volumes are rising in developing and transition countries and the waste sector is still developing in those countries, huge potential for avoiding greenhouse gas emissions remains to be tapped in waste management worldwide.

How are greenhouse gases generated in the waste sector and how can they be prevented or reduced?

Methane emissions from landfills, formed by anaerobic breakdown of organic matter, are the main contributor to the sector’s greenhouse gases. The National Inventory Report [NIR 2010], in which Germany reports its greenhouse gas emissions to the United Nations Climate Secretariat, credits the German waste management sector with an emission reduction of about 28 million tonnes of carbon dioxide equivalents (for the period 1990 to 2008), thanks to the reduction of waste volumes sent to landfill and use of the landfill gas methane to produce energy. We project further savings in the area of landfill up to 2012, since landfill gas formation from older landfill storage layers tapers off and landfilling of waste with significant methane formation potential has not been permitted since 2005. To meet the criteria laid down in the Ordinance on Environmentally Compatible Storage of Waste from Human Settlements (Abfallablagungsverordnung), waste must be

treated by means of thermal or mechanical-biological methods. By 2012 landfill methane emissions in Germany will decrease by more than 90% compared to 1990 levels.

Further contributions to greenhouse gas reduction will result from waste streams shifting from landfill towards increased recycling and energy recovery from residual waste.

Ecological assessment

In 2005 a research project commissioned by us investigated the greenhouse gas reduction potential of the municipal waste management sector [Ökoinstitut/ifeu 2005]. The results clearly show that the sector’s contribution to climate protection is larger than what the assessments in the National Inventory Report lead one to assume. Based on the rules of the Intergovernmental Panel on Climate Change (IPCC), the NIR mainly reports landfill emissions for the waste sector whilst the credits for e.g. utilised electricity or heat from waste incineration plants are allocated to the energy sector. Other savings achieved by the waste sector, e.g. from recycling, are credited to the industry sector. This produces an incomplete picture which does not adequately reflect waste management’s contribution to climate protection.

Therefore, the accounting method chosen for the study “Climate Protection Potential in the Waste Management Sector”, published in January 2010 [Ökoinstitut/ifeu 2010], was life-cycle assessment according to ISO 14040 and 14044 as reduced to the environmental criteria “climate protection” and “fossil energy resources¹”. Waste management inputs, such as collection, transport, sorting, treatment, recovery and disposal, were inventoried starting from provision of the waste. Manufacture and use of the products, before they become waste, were not considered. The credits method applied uses “equivalence processes” to contrast the secondary products or energy made available by waste management with the primary products or conventionally generated energy they replace. The credits thus obtained were set off against the burdens resulting from waste management.

Results for Germany

The study comprises preparation of an inventory for 2006 and several scenarios for 2020 to identify the remaining reduction potential. The analysis is based in all cases on the same waste quantities in order to guarantee equivalence of the benefits and hence comparability of the scenarios. The influence of waste prevention measures cannot be depicted in this analysis as it only considers impacts arising from the moment waste is produced.

Table 1: Waste quantities according to waste balance 2006 (Federal Statistical Office (STBA) 2008)

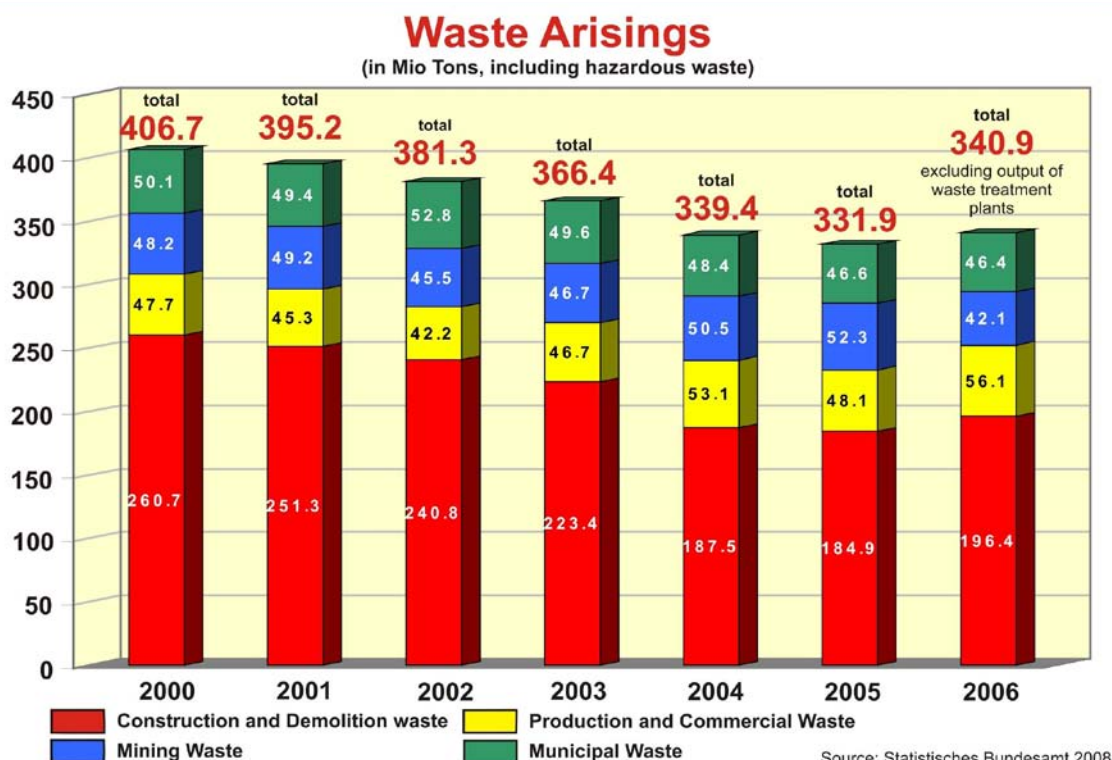
Waste	in 1,000 t
Municipal waste, total	46,246
Household waste	40,827
Household waste, household-type commercial waste, combined collection by public refuse collection	14.260
Bulky waste	2,247
Waste from bio bin	3,757
Garden and park waste, biodegradable	4,044
Glass	1,929
Paper, board, cartons	8,080
Lightweight packaging / Plastics	4,532
Household-type commercial waste, delivered or collected separately from household waste	3.821
Total²	42.670

In addition to household waste, the study published in January 2010 includes waste wood for the first time. In that area, it does not confine itself to households as a source, but covers waste wood from all sources (including waste wood in bulky waste, wooden packaging, and wood from construction and demolition). The reason that waste wood was not limited to the component in municipal waste is that it is a very homogeneous material which is used in similar ways regardless of its origin. Moreover, waste wood accounts for a particularly relevant portion of the waste management sector's overall contribution to reducing greenhouse gases. Having evaluated numerous sources, we assume the total quantity of waste wood to be 6.9 million t.

The volume of waste handled by the waste management sector as a whole is considerably larger than the quantities investigated in this study [STBA 2008]:

- Total volume of waste: 372.9 million t
- Municipal waste considered: 42.7 million t (11.4% of total quantity)
- Waste wood volume: 6.9 million t (1.9% of total quantity)

Construction and demolition waste accounts for slightly more than half of the total volume and the remainder largely consists of production and commercial waste and mining rubble.



Scenarios investigated

1. 2006

Ecological assessment of actual situation based on data from the Federal Statistical Office and supplementary calculations by the study team

2. 2020 T (Technology)

Improvements in the technical standards of treatment and recycling techniques, but with no change in waste volume streams, including improved energy efficiency

3. 2020 A (Waste Streams)

Describes major changes in waste management streams due to additional separate collection and recycling of an assumed additional 50% of the recyclable materials present in residual waste and household-type commercial waste in 2006, with no technological improvements.

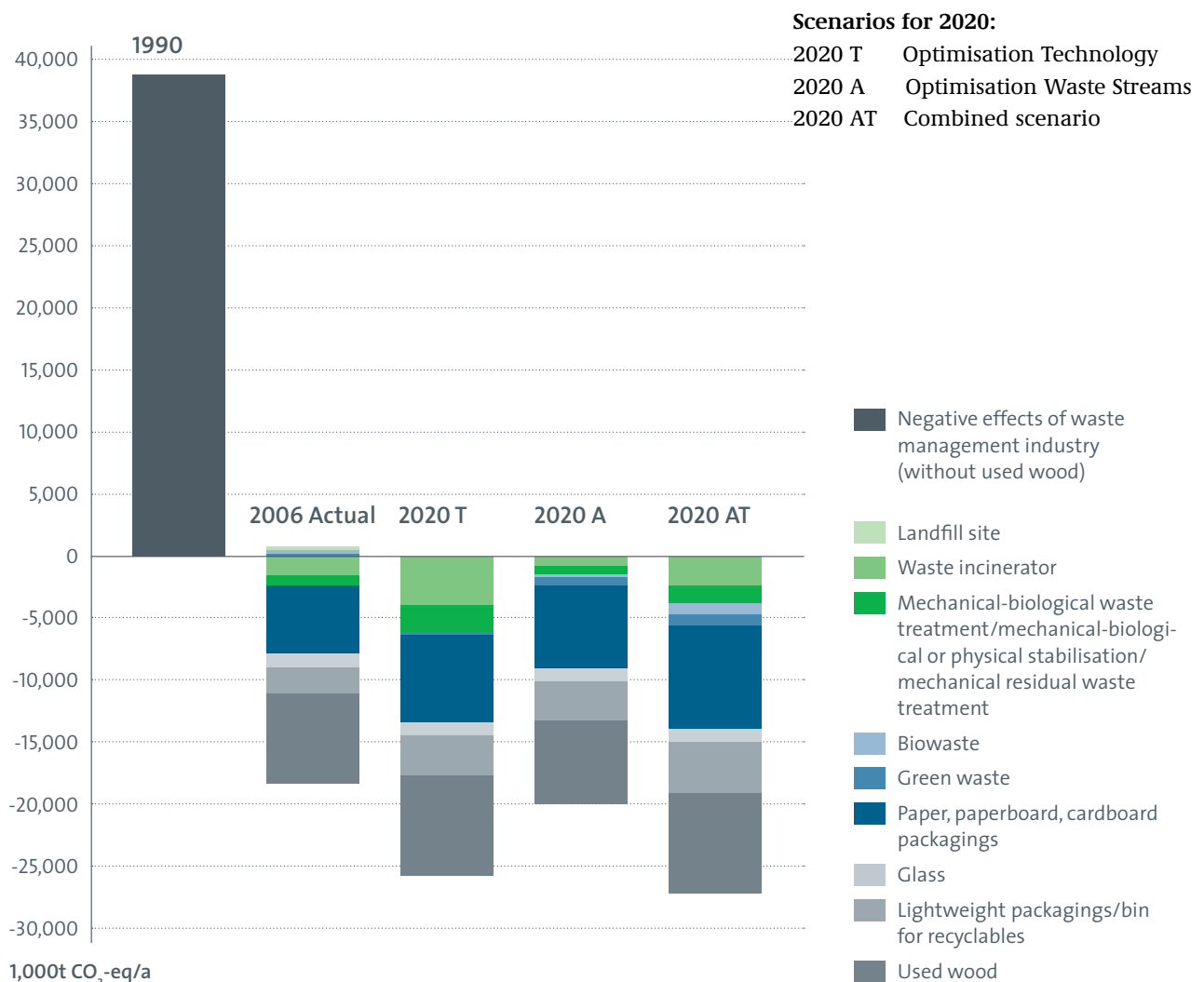
4. 2020 AT (Waste Streams and Technology)

A combination of scenarios 2020 T and 2020 A

Assuming that all optimisation options for the year 2020 are implemented, the contribution of municipal waste management in Germany to greenhouse gas reduction could be increased by a further 10 million tonnes CO₂-equ by that time. In particular, the largest savings are obtained by recycling of waste paper and waste wood, followed by recycling of lightweight packaging and energy recovery from residual waste in waste incineration plants (see Figure 1).

Germany is aiming to reduce its greenhouse gas emissions by a total of 40% by 2020 compared to 1990. This corresponds to a reduction of about 486 million tonnes CO₂-eq. The calculated contribution which waste management could make to this reduction amounts to about 13%.

Figure 1: Overall results of standard balance for greenhouse gases in Germany



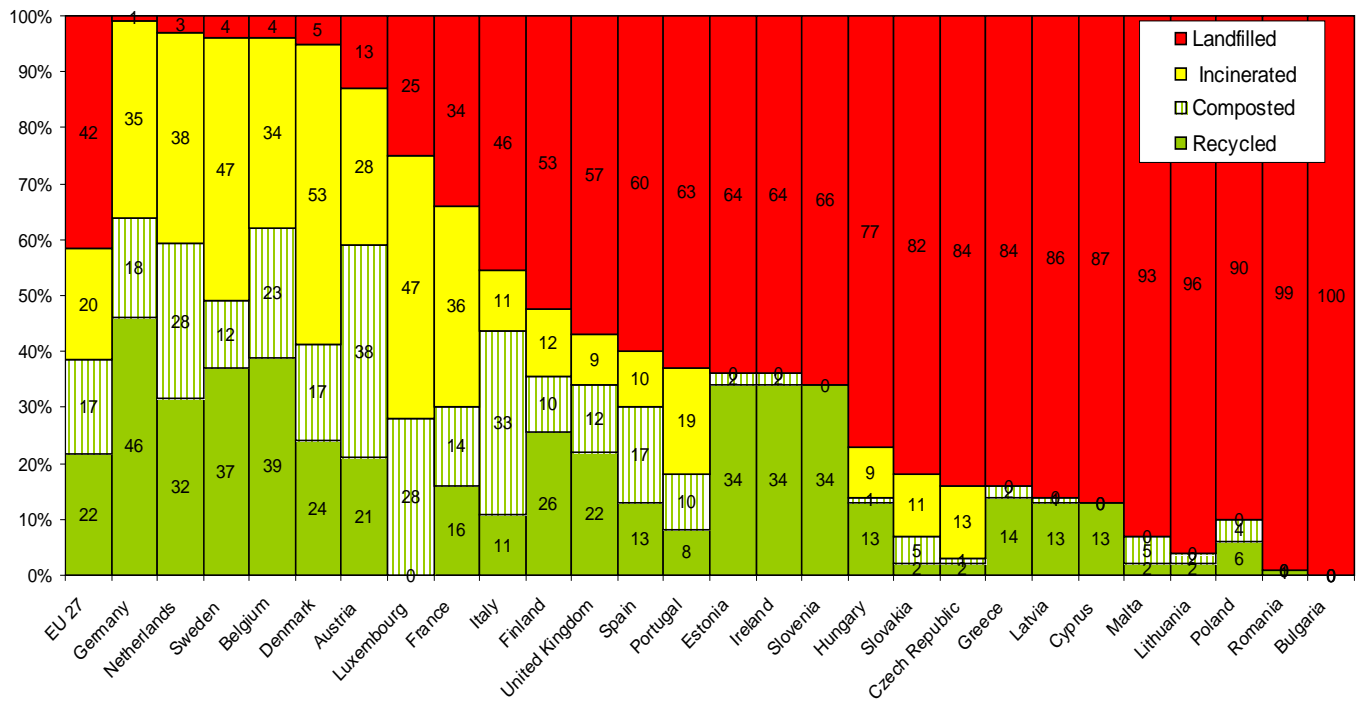


Figure 2: Disposal routes for municipal solid waste in EU 27 in 2007; Eurostat

Results for the European Union (EU 27)

Waste management in the 27 countries of the European Union is structured very differently and operates according to different technical standards. Unlike Germany, many EU countries still landfill significant volumes of untreated waste (Figure 2).

In 2007, the EU 27 generated about 250 million tonnes of municipal solid waste including waste wood. About 29% of this amount was collected separately and recycled, 21% was incinerated and over 42% was landfilled.

Unlike the situation in Germany, however, it may be assumed that only 40% of landfills are equipped with a gas capture system, which can capture at most 50% of landfill gases. This comes out to an effective gas capture rate of 20%. In order to take divergent information from a number of other Member States into account, the study also presents results for an effective gas capture rate of 40%. Based on these assumptions, a burden from landfill ranging from 83 to 110 million tonnes CO₂-eq. was calculated for EU 27 for 2007. Annual reductions of about 32 million tonnes CO₂-eq. are mainly due to recycling of separately-collected materials, waste wood recycling and incineration of residual waste.

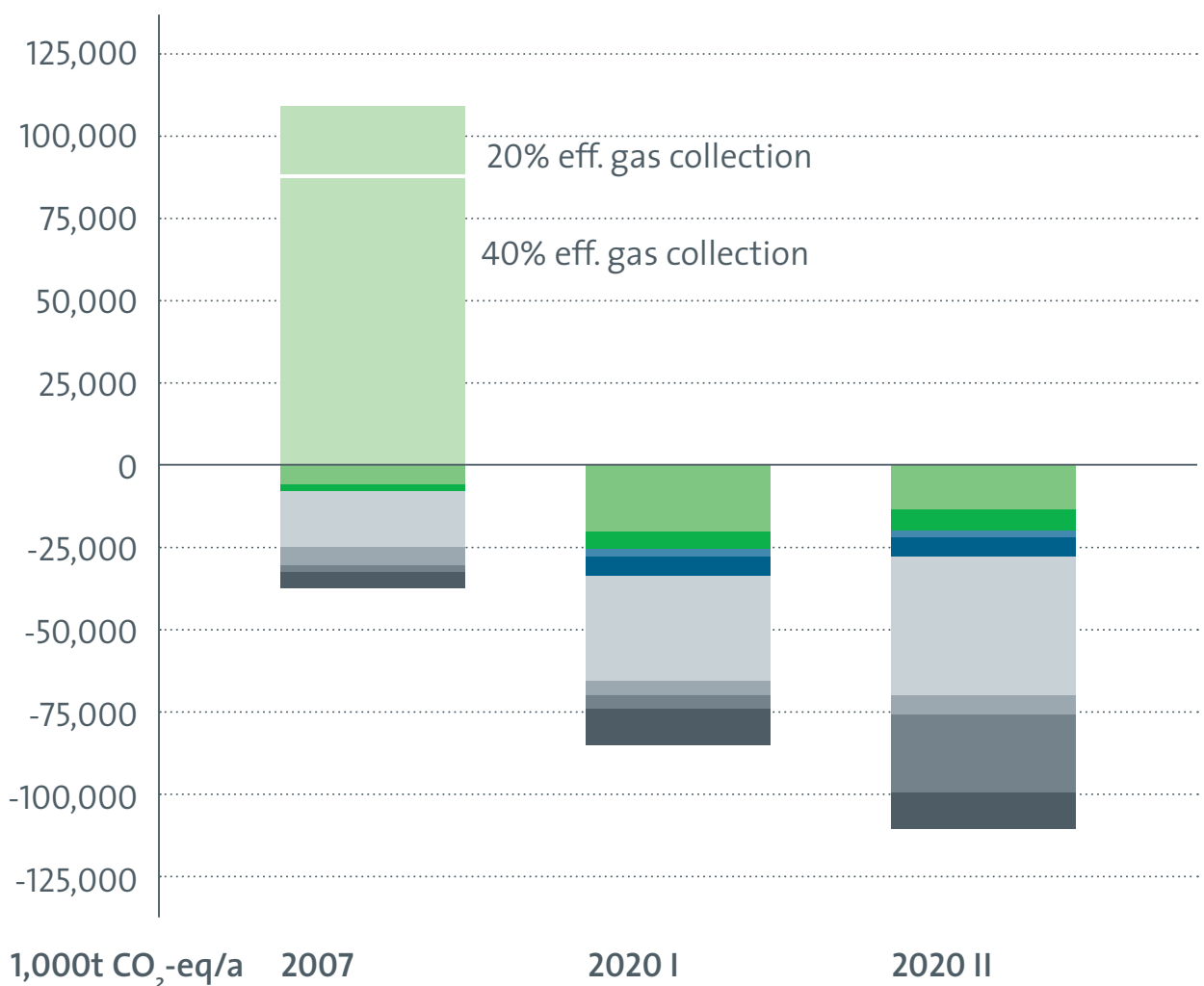
Possible reduction potentials for 2020, compared to 1990, for EU 27 vary between 142 and 192 million t CO₂-eq per year depending on the scenario and assumed effective gas capture rate.

The EU 27 does not have a common Kyoto target because the twelve newer Member States did not join the EU until the Kyoto Protocol was ratified. However, the Member States have agreed, in a “Climate Change Alliance”, to reduce their greenhouse gas emissions by 20% by 2020 compared to 1990 levels. To achieve this goal, a reduction of 600 million t CO₂-eq. has yet to be made. Waste management could contribute a share of 24 or 32% of this reduction (depending on the scenario).

A strict ban on landfill of untreated waste following the example set by Germany, Austria or Switzerland would make key contributions to improving the climate protection balance of the waste management sector and is also an essential precondition for significant optimisation in the EU 27. Landfill taxes as levied in e.g. the Netherlands could also take on a successful steering role. The minimum to be aimed for should be strict compliance with the EU Landfill Directive, which sets concrete targets for reduction of the quantity of biodegradable waste in landfills. By 2016 biodegradable waste going to landfills must be reduced by 65% compared to 1995. Some EU Member States have already achieved this target while others have yet to make crucial changes in the way they manage their waste.

- Landfill site
- Waste incinerator
- Mechanical-biological waste treatment/mechanical-biological or physical stabilisation/mechanical residual waste treatment
- Mixed waste composting
- Biowaste
- Green waste
- Paper, paperboard, cardboard packagings
- Glass
- Plastics/packagings
- Used wood

Figure 3: Overall results of balance for greenhouse gases for EU-27 ³



United States of America (USA)

In the USA 250 million t of municipal waste were generated in 2008. 135 million t of this quantity were landfilled (54%). This makes the USA the country with highest landfill methane emissions worldwide.

In the USA, landfill is traditionally the dominant waste disposal method. This is mainly because the country has large uninhabited areas where land for landfill sites is available at low cost and no residents are bothered by those sites. Although the situation has strongly improved compared to 2002, when 65% of waste was still landfilled, the remaining quantity that is sent to landfills without pre-treatment harbours huge potential for utilising the materials and energy it contains and, hence, for reducing greenhouse gases [Themelis 2004].

In recent years a debate has started which calls the current waste disposal practice into question [The New York Times]. The criticism concerns especially the long transport distances (mostly by truck) from the large cities to landfills in remote areas. However, the public also has strong reservations about other waste treatment facilities, especially waste incinerators. There are only 87 waste incineration plants in the USA. Most of them are at least 15 years old, but there are hardly any plans to build new ones for fear of public resistance [The New York Times]. Europe has about 400 waste incineration plants [CEWEP].

Requirements exist for the standard of landfills. For example, a federal act of 1996 requires the

capture and flaring of landfill gas. Voluntary programmes support the use of captured methane, for example the Landfill Methane Outreach Program (US EPA), and incentives are provided at federal and state level to promote renewable energies (e.g. tax cuts, low-interest loans, Renewable Portfolio Standards).

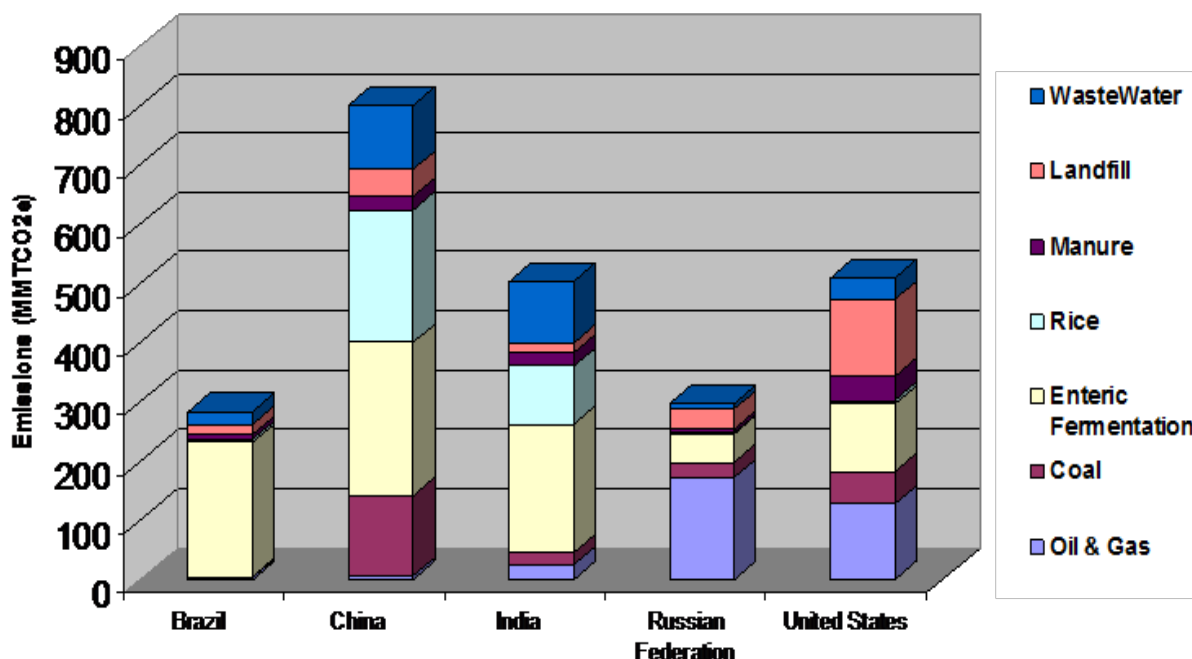
Despite the increase in waste volumes, methane emissions from landfills decreased by about 16% between 1990 and 2006. The emissions from the increased amounts landfilled have been more than compensated by the increase in landfill methane collection rates.

Nevertheless, the US Environmental Protection Agency (US EPA) has calculated huge greenhouse gas reduction potential for waste management changes in the US:

- Emissions amounting to 70 to 80 million t CO₂-eq. could be avoided if the recycling rate rose from 32.5% in 2008 to 50%.
- 35 to 60 million t CO₂-eq. could be saved if 50% of the amount of waste currently landfilled was combusted.
- 150 million t CO₂-eq. could be avoided if 100% of the methane emitted from landfills was captured and used for electricity generation [US EPA].

However, unlike Europe, the USA does not yet have legislation requiring the reduction of biogenic waste fractions going to landfills.

Figure 4: Methane emissions for Selected Countries (2005) Source: Paul Gunning, US EPA



Climate balance of municipal waste management in Turkey, Tunisia and Mexico

The study takes three countries as examples to show what impact waste management practices that are relatively low-tech and comprise extensive use of landfill, and, in part, uncontrolled disposal, have in terms of climate effects. The proportion of landfilled waste is very high (between 80 and 95%) in the three countries considered. There are, however, differences in landfill quality, i.e. in the shares of wide-area disposal, unauthorised tips and controlled landfill sites with or without gas capture. In the case of uncontrolled dumps, the key factor for gas formation is whether dumping occurs over a wide area and therefore without any substantial gas formation, or in stratified form. Recyclable fractions are often collected by the informal sector, and only a rough estimate can be made of the amounts collected.

Since the available data are less detailed than those for the EU, only an approximate balance could be drawn in the study. The current situation was determined and a scenario for 2020 was described. This scenario assumes that waste management in the three countries will develop in the same way as in EU 27 in Scenario 2020 I. This assumption represents a substantial simplification and may not reflect the possible development in any of these countries until 2020.

Assuming that landfilling of waste is abandoned and ambitious recycling is implemented, the potential total contribution of municipal waste management in the respective countries to greenhouse gas emissions reduction amounts to

- Turkey: between 26 million t and 47 million t CO₂-eq. per year,
- Tunisia: between 2.0 million t and 4.7 million t CO₂-eq. per year,
- Mexico: between 52 million t and 63 million t CO₂-eq. per year.

Conclusion

The waste management sector in Germany makes an important contribution to climate protection. Since 1990 until today it has contributed a quarter of the greenhouse gas reduction achieved in Germany during this period, due to waste recycling and energy recovery from waste. By increasing and optimising recycling and improving energy efficiency (electricity/heat) in waste treatment plants, an additional 10 million tonnes CO₂-eq. could be saved in Germany by 2020. The municipal waste management sector and waste wood recycling alone could contribute 13% towards meeting Germany's 40% reduction commitment by 2020. This would exhaust the largest potential of the waste sector available in Germany, however.

Ending the landfilling of untreated waste is the most important step for EU 27 to harness its significant available CO₂ reduction potential. A total of up to 192 million tonnes of CO₂-equivalents could be saved by 2020 through thermal or mechanical-biological waste treatment, increased recycling and technical optimisation. This corresponds to 32% of the reduction of 600 million tonnes of CO₂-equivalents which the EU 27 has yet to deliver to meet its voluntary commitment.

The USA so far has no legislation that requires a reduction of biogenic fractions in municipal waste going to landfills. The focus is on capture and subsequent partial use of landfill gas. This leaves much of the available greenhouse gas reduction potential untapped, because only a portion of methane emissions can be captured and further reductions that could be achieved through recycling and energy recovery from waste are not realised.

As shown by the examples of Mexico, Tunisia and Turkey, considerable potential for greenhouse gas reduction in the waste sector also exists in developing and transition countries, if the high landfilling rates of 80 to 95% are reduced in future and if this is accompanied by recycling measures – with inclusion of the informal sector – and an efficient treatment of the remaining waste using techniques adapted to local circumstances. Since waste volumes are rising in developing and transition countries, building a regulated waste management sector is particularly urgent to protect human health as well as soil, water and air. When planning waste management measures, climate protection aspects should be integrated right from the beginning.

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Opportunities to reduce Greenhouse Gas Emissions through Materials and Land Management Practices

¹ This contribution only deals with the greenhouse gas balance.

² The following fractions of total municipal waste are not considered: hazardous municipal waste, road sweepings, canteen waste, market waste, end-of-life electrical equipment, and quantities classified as “Miscellaneous”

³ Scenario 2020 I assumes that landfill and composting of residual waste will be abandoned completely and recycling rates increase.
Scenario 2020 II adopts the current distribution of waste streams in Germany and takes improved treatment and recycling standards into account.