Recycling stops greenhouse gases

The contribution of the recycling and water management industry to climate protection

BDE
FEDERATION OF THE GERMAN WASTE, WATER AND RAW MATERIALS MANAGEMENT INDUSTRY INDUSTRIAL AND EMPLOYERS' ASSOCIATION

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Umwelt Bundes Amt
For our Environment

Contents

"Let us do everything to ensure that we leave to the next generation, the children of today, a world that offers them not only the necessary space to live but also the environment that supports life and makes it worth living."

Richard von Weizsäcker, former German Federal President

We have made the change

A great deal has changed for the German waste management industry in recent decades. Purely waste disposal firms have become highly specialised suppliers and experts for efficient recycling and energy generation. In 1990, the German municipal waste management sector still burdened the climate with nearly 38m tonnes of climate-damaging gas. **It meanwhile relieves the climate actively of 18m tonnes – every year. That corresponds to the annual output of 7.7m vehicles or almost 20% of the cars registered in Germany.**

With a very favourable carbon footprint – much more CO_2 saved than emitted – the German waste management industry performs pioneering work for an economy without climate-damaging emissions. That is highlighted by the new study "Climate protection potentials in the waste management sector", jointly produced by the Federal Environment Ministry, Federal Environment Agency and Federation of the German Waste, Water and Raw Materials Management Industry. It analyses the potential usage of residual solid waste, paper, plastics, bio- and green wastes, glass and used wood for recycling and generating energy.

A supplementary BDE study has analysed the use of sewer gas and waste heat from waste water. The results document the significant contribution already made by the German waste and waste water management industry to reducing national greenhouse gas emissions. And they demonstrate that there are still many opportunities for further reducing emissions in Germany and particularly in the European Union, for example with the nationwide introduction of a bin for recyclables in Germany or the closure of all landfill sites in Europe.

With its enormous know-how and global leadership for technologies for waste recycling and waste water utilisation, the German waste disposal and recycling industry has a very favourable starting position for taking advantage of the available ecological and economic possibilities. Along with political and research initiatives, it is now vital to develop innovative technologies and solutions so that we can together achieve the national and European climate protection targets.

We do pioneering work for climate protection

"Climate change is not just an environmental issue, as too many people still believe. It is an all-encompassing threat. The warming of the earth must be given the same attention as wars, poverty and the spread of weapons of mass destruction. It is becoming increasingly clear that the reduction of emissions will be cheaper for us today than combating their consequences later."

Kofi Annan, former UN Secretary-General

Waste management industry in Germany

Despite the inclusion of greenhouse gas emissions in the national inventory report, there has so far been a lack of effective data for the German waste disposal and recycling industry, as the emissions and savings of the sector are not assessed together, but very often assigned to the industrial, energy and agricultural sectors. The present study has now compiled the CO_2 emissions of the entire German waste disposal and recycling industry with a systematic ecological assessment and defined the scope for savings up to 2020.

Over 40m tonnes of municipal waste and close on 7m tonnes of used wood are produced in Germany annually. Already today recyclable materials from a significant share of these volumes (about 62%) are collected separately and used for recycling or generating energy. The thermal use of the residual waste already makes a substantial contribution to climate protection. Moreover, recycling not only recovers valuable raw materials but also actively helps to lessen the burden on the climate, as the secondary raw materials thereby gained reduce energy requirements by up to 50% in glass, paper, plastic and metal production, according to manufacturers.

In 2006 the German waste management industry relieved the climate by close on 18m tonnes of CO_2 equivalents.

That means that the German municipal waste management industry and used wood utilisation already save more carbon dioxide than they emit. They work not only climate neutral, but also climate positive, actively helping other sectors to reduce their emissions. With innovative technologies, expanded collection and utilisation as well as an increased recycling rate, this contribution can be further expanded in the next few years.

An estimate for 2020 shows that with optimised recycling as well as the more efficient generation and usage of electricity and heat in the plants further harmful greenhouse gas emissions of up to 10m tonnes of CO_2 equivalents can be avoided compared with 2006.

Greenhouse gases = *Gases that make a considerable contribution to the greenhouse effect; carbon dioxide (CO_2), methane (CH_4), laughing gas (dinitrogen monoxide N_2O)*

Recycling = *Utilisation procedure involving treating wastes so they can be returned to the materials cycle*

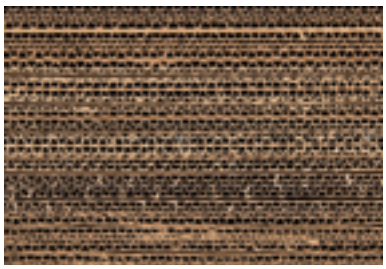
Ecological assessment = *Analysis of the effect on the environment; here: the exclusive consideration of the environmental impact "greenhouse effect" by presenting all variables and emissions resulting from waste utilisation*

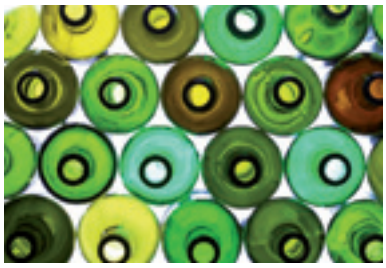
CO_2 equivalents = *Total of climate-relevant gases converted into CO_2; fossil carbon dioxide (factor 1), methane (factor 25, i.e. 25 times more harmful than carbon dioxide) and laughing gas (factor 298)*

Overall result of greenhouse gas standard assessment for Germany*

	2006 actual 1,000t CO_2-eq/a	2020 T 1,000t CO_2-eq/a	2020 A 1,000t CO_2-eq/a	2020 AT 1,000t CO_2-eq/a
Disposal of residual waste	-2,344	-6,009	-1,435	-3,861
Utilisation of separately collected recyclable materials	-8,926	-11,589	-11,356	-15,308
Used wood utilisation	-6,503	-7,897	-6,834	-8,299
Total	**-17,773**	**-25,496**	**-19,625**	**-27,468**

* 2020 T, 2020 A and 2020 AT present different future scenarios.
Details on the assumptions on which these are based are given on page 14.





World champion in recycling

Germany already has the world's highest recycling rates – precisely also for the relevant recyclable materials from the climatic point of view. The most significant CO_2 savings are achieved with the recycling of paper, paperboard and cardboard packagings as well as used wood, followed by the recycling of lightweight packagings and utilisation of residual waste for energy generation in waste incinerators. In Germany technical measures will thus have greater effects with the saving of greenhouse gas emissions than the sole change of waste flows with an expansion of recycling.

Paper, paperboard and cardboard packagings

Owing to their comparatively simple further processing, paper, paperboard and cardboard packagings have already for a long time been among the most recycled recyclable materials in Germany. Currently the recycling of used paper already reduces our greenhouse gas emissions by over 5.9m tonnes of CO_2 equivalents annually. However, the paper volume collected can be increased even more, as even today a part of the recyclable used paper is disposed of with the residual waste.
This share can be halved up to 2020. The wood saved by recycling is credited via use in efficient wood-fired combined heat and power stations. Overall this means that in 2020 the contribution of paper recycling to climate protection could increase by over 38% to nearly 8.2m tonnes of CO_2 equivalents annually.

Glass

Glass is also one of the classic recycling materials in Germany. The future potential of glass was not further analysed in the current study. However, it already relieves the climate today of 897,000 tonnes of CO_2 equivalents.

Lightweight packagings

Lightweight packagings are currently collected in the "yellow bin". The overall volume of recyclable materials regained could be considerably increased with the introduction of a bin for recyclables and the connected extension of collection to include material equivalent non packagings and if necessary also small electric appliances. Their quality can be increased by enhanced treatment technology so that these can replace higher-quality primary raw materials. Together, these measures would lead to a significant increase in saved emissions by over 92% from 2.3m today to more than 4.3m tonnes of CO_2 equivalents in 2020.

Used wood

Used wood plays a considerable part in the positive climate assessment of the waste management and recycling industry in Germany, although the recycling of used wood itself does not lead to any considerable saving of greenhouse gases. But as a high demand for usage of woods is currently to be assumed, the spared wood volume will probably be used as regenerative energy source in wood-fired combined heat and power stations for energy production on a climate neutral basis. By using plants with higher efficiencies for electricity generation and heat usage, CO_2 savings could be increased by over 27% from 6.5m tonnes today to 8.3m tonnes in 2020.

Bio- and green wastes

Bio- and green wastes are currently mainly composted – biowaste almost completely, green waste only seldom in closed plants. From the point of view of climate protection, there is scope for savings with the use of anaerobic digestion stages, increase in high-value compost application and establishment of closed composting plants. The biogases yielded by anaerobic digestion are used in combined heat and power stations for energy generation. The volume of bio- and green waste collected can be increased. Today, these wastes still emit gases harmful to the climate of 133,000 tonnes of CO_2 equivalents. They could relieve the climate by 1.9m tonnes in 2020.

Residual solid waste

Residual solid waste is usually thermally disposed of direct in waste incinerators or first treated mechanically in order to use the component with high calorific value efficiently for energy generation. Even today the disposal of residual solid waste with 2.3m tonnes of CO_2 equivalents contributes to relieving the climate. With more efficient plants, it could be 3.9m tonnes in 2020, although with more recycling the residual waste volume will decline. That corresponds to an almost 65% increase.

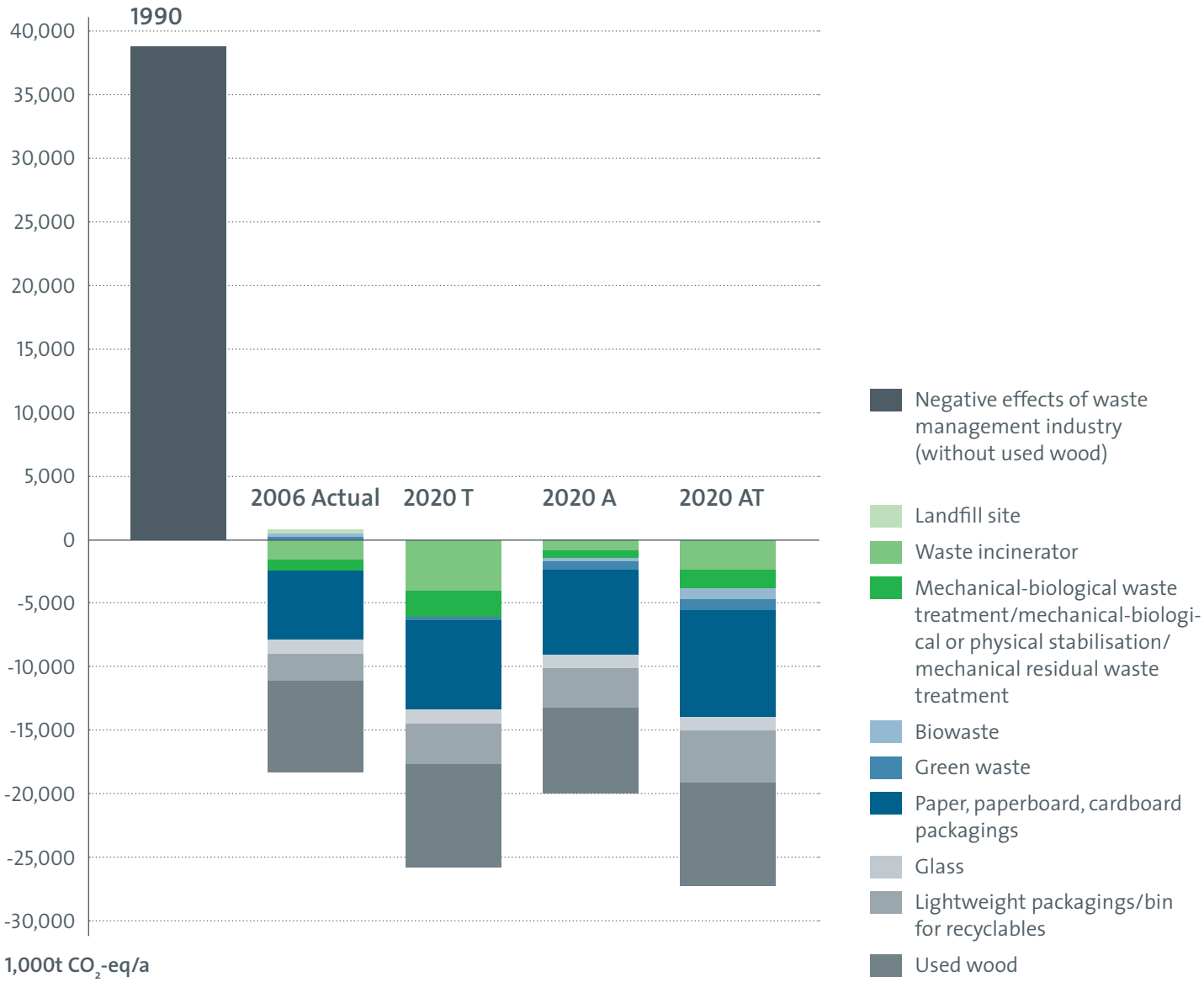
Altogether with all material flows an additional volume of nearly 10m tonnes of CO_2 equivalents could be saved in 2020.

Waste flows = *Waste that undergoes a specific utilisation or disposal method*

Material equivalent non packagings = *Metals, plastics and composite materials that are not packaging material, e.g. children's toys*

Anaerobic digestion = *Controlled biological decomposition of organic substances without oxygen (anaerobic). A combustible gas (biogas, fermentation gas or sewer gas), comprising mainly methane and carbon dioxide, is produced in the process*

Greenhouse gas emissions according to material flows



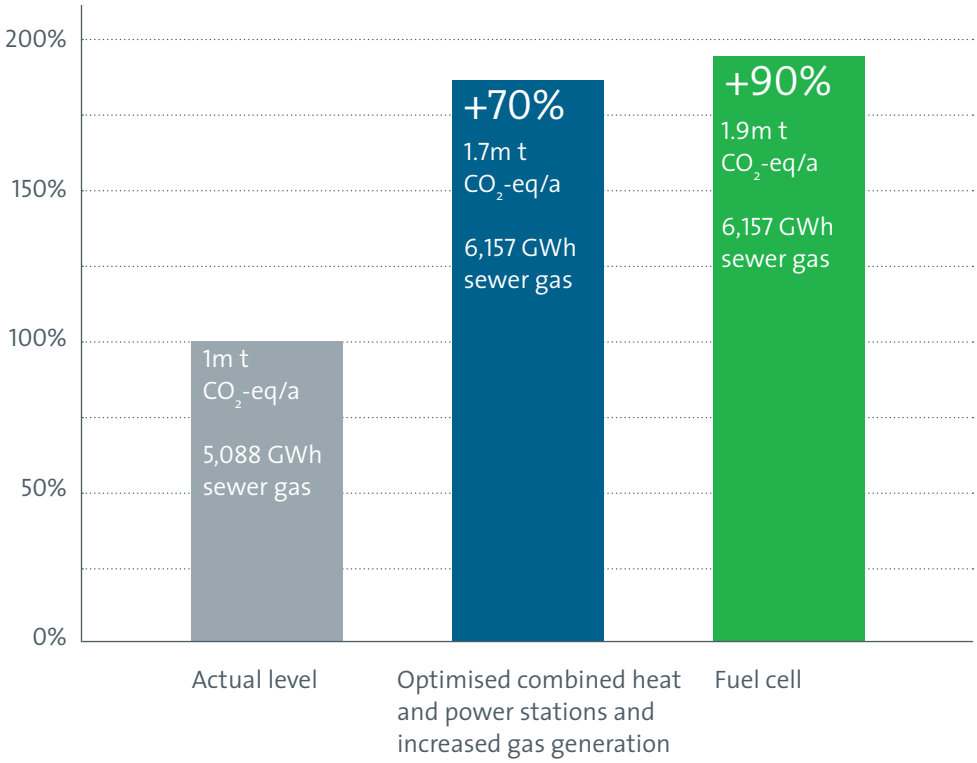
Waste water management industry in Germany

The waste water management industry offers numerous possibilities for making a contribution to climate protection. The new study by the Federation of the German Waste, Water and Raw Materials Management Industry has now for the first time identified and studied two particularly promising areas for Germany and Europe: use of waste heat from waste water and generation and utilisation of sewer gases from sewage sludges.

Sewer gases as energy supplier

The waste water management industry can make a particularly effective contribution to climate protection with the use of sewer gases for energy production. In 2008, 5,088 gigawatt hours of sewer gases were already generated and mainly converted into electricity. Today greenhouse gas emissions of a million tonnes of CO_2 equivalents are already saved annually. A switch from aerobic sludge treatment to anaerobic digestion would increase the gas yield by 21% to 6,157 gigawatt hours. With optimal usage in efficient combined heat and power plants up to 717,000 tonnes of CO_2 equivalents, i.e. over 71%, can thus be additionally saved. The today still hypothetical use of fuel cells would boost emission savings by as much as 90% to 1.9m tonnes.

Emission savings with the use of sewer gas



Waste heat from waste water

Apart from the use of sewer gases for energy generation, use of waste heat from waste water can also reduce greenhouse gas emissions. Germany accounts for 6.3 billion m^3 of waste water for heat removal every year, corresponding to a flow of 200,000 litres per second. Assuming that merely 0.5°C heat is withdrawn from this flow on average in Germany, there is a theoretical potential of 418 MW of heat output. It would thus be possible purely theoretically to cover the annual space heating requirement of approx. 270,000 households, corresponding to a city the size of Cologne.

Ideal locations for smaller heat pump plants are public buildings such as schools, sports halls and swimming pools. Industrial and commercial locations are suitable for larger projects. With only 25 projects per major city, the entire potential could be used and thus annual greenhouse gas emissions of up to 1.3m tonnes saved, corresponding to the annual emissions of 111,000 inhabitants.

Summary: Our contribution to national climate protection

The Federal Republic of Germany has undertaken to reduce its greenhouse gas emissions by 40% up to 2020 compared with 1990. Even today the contribution to this reduction just of the waste industry including used wood utilisation totals approx. 55.6m tonnes. This corresponds to about a quarter of the decline in greenhouse gas emissions in Germany of 235m tonnes of CO_2 equivalents achieved up to 2006. This level could increase to 65.3m tonnes up to 2020.

The waste water management industry relieves the climate with the use of sewer gases for energy production of a million tonnes of CO_2 equivalents every year. This could increase to 1.9m tonnes with improved plants and a more efficient use of the gas. Moreover, up to 1.3m tonnes can be saved with the use of waste heat from waste water. The entire potential of the waste water industry is, of course, far from exhausted with these two partial areas.

If all studied potentials of the waste management and recycling industry were used up to 2020, over 11.9m tonnes could be additionally saved. With overall 68.5m tonnes of CO_2 equivalents – the annual emissions of 29.3m cars – that comes to 14% of the savings target for Germany.

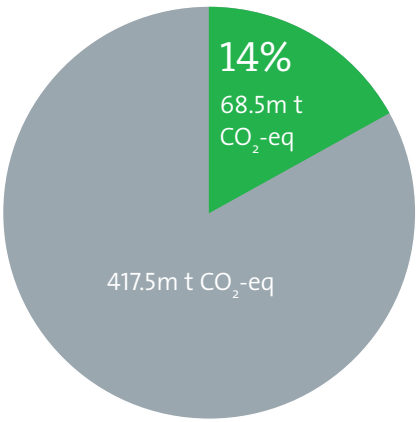
That corresponds to every 7th tonne of CO_2 that has to be saved throughout Germany.

Sewer gases (also bio or fermentation gases) = *Gases that result with digestion and fermentation processes in sewer plants, the main components being methane and carbon dioxide*

Fuel cell = *Plant converting energy into electricity without combustion via a chemical reaction*

Contribution of the recycling industry and the use of sewer gas and waste heat up to 2020

The Federal Republic has undertaken to reduce its greenhouse gas emissions by 486m tonnes of CO_2 equivalents up to 2020. 14% can be contributed just by the waste disposal management and recycling industry.



Sustainable technologies, sustainable economic development

"Today no one can afford to believe any more that the world will somehow solve the environmental problems."

Albert A. Gore Jr., Nobel Peace prize winner and former US vice-president

Waste management industry in the European Union

The EU comprises 27 economically and technologically heterogeneous economies. The waste management industry also works in these countries today at many different technological levels, which means that the enormous potential of the European waste disposal and recycling industry for climate protection has so far been scarcely used systematically. With the current study, the Federal Environment Ministry, Federal Environment Agency and Federation of the German Waste, Water and Raw Materials Management Industry seek to contribute to ensure that this potential is better used in future.

There are currently still significant differences in the treatment and processing of European and German waste. Unlike in Germany, the landfilling of untreated wastes still plays a considerable role in many EU states.

In 2007 in the EU27 over 42% of the overall waste volume was landfilled, almost 29% separately collected and used as recyclable materials, nearly 21% incinerated and 8% treated in different ways. Overall, European wastes depending on gas collection on the landfill sites burden the climate with greenhouse gas emissions of up to 78m tonnes of CO_2 equivalents every year.

A strict landfill ban for untreated wastes based on the practice in Germany, Austria or Switzerland would make a decisive contribution to improving the climate protection assessment of the waste management industry. Along with a substantial increase in the recycling rate as well as technical measures and efficiency increases, greenhouse gas emissions of over 114m tonnes of CO_2 equivalents could be saved, as much as is emitted by Sweden and Switzerland together in a year.

Landfilling = *Proper waste disposal*

Gas collection = *System for collection of gas, with effective gas collection indicating the gas volume in percent that is actually collected for use*

Overall result of greenhouse gas standard assessment in the European Union*

	2007 1,000t CO_2-eq/a	2020 I 1,000t CO_2-eq/a	2020 II 1,000t CO_2-eq/a
Landfill 20% effective gas collection	109,930	0	0
Landfill 40% effective gas collection	83,112	0	0
Disposal of residual waste	-6,672	-28,454	-24,823
Utilisation of separately collected recyclable materials	-18,623	-50,332	-77,986
Used wood utilisation	-6,665	-11,608	-11,608
Total (landfill 20%)	**77,970**	**-90,395**	**-114,418**
Total (landfill 40%)	**51,152**	**-90,395**	**-114,418**

* 2020 I and 2020 II present different future scenarios. Details on the assumptions involved are given on page 14.

- 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

Landfilling

In 2007, 106m tonnes of municipal wastes were disposed of in landfills in the European Union and thus withdrawn from possible utilisation for recycling and energy generation. Up to 2020, this practice can be completely discontinued throughout Europe – as has already been the case in Germany since 2005. Just this measure would avoid emissions of up to 110m tonnes of CO_2 equivalents annually.

Residual waste

There is still mixed waste composting in some countries. This results in a net burdening for the climate of 204,000 tonnes of CO_2 equivalents per year. From 2020, the residual waste produced could be used in waste incinerators and refuse derived fuel power stations for energy generation. Relevant plants already relieve the climate by 6.9 m tonnes of CO_2 equivalents. With more efficient technology, utilisation of the residual waste for energy generation could save up to 24.8m tonnes of CO_2 equivalents in 2020. That corresponds to almost a quadrupling of the previous volume.

Plastics and packagings

In Europe, plastics and packagings are collected mainly via bring systems. This has the advantage that the collected plastics are clearly separated and scarcely have to be subsequently sorted. However, overall less waste is collected via such a system than with a dual system. In 2007, 5.4m tonnes of plastics and packagings were collected, thereby saving 2.2m tonnes of CO_2 equivalents. Up to 2020, the waste volume collected for example via a bin for recyclables could be five times as large and with additional technical measures the emission savings increased by more than ten times to as much as 24.6m tonnes.

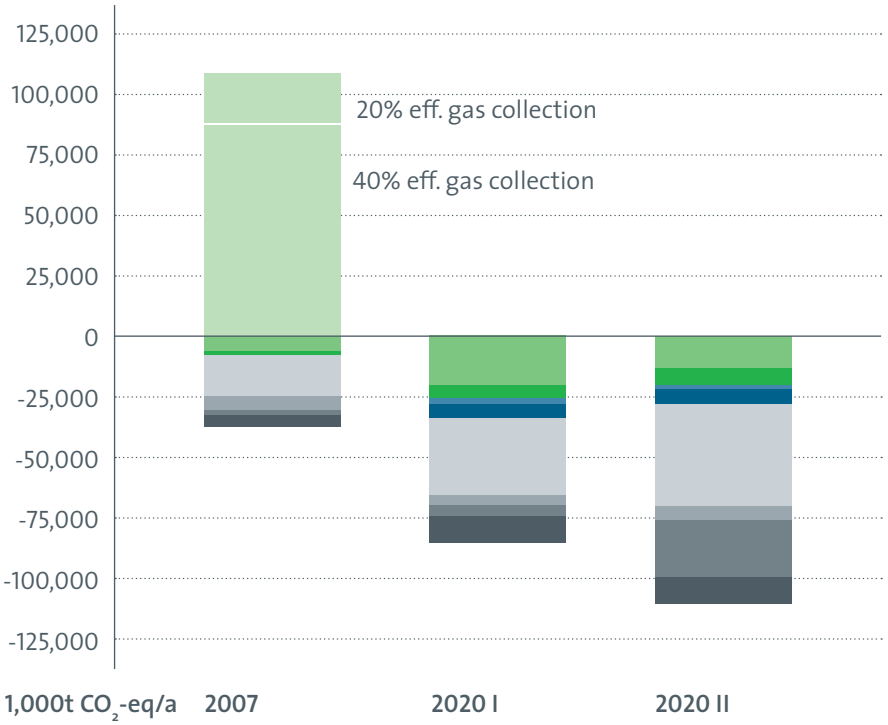
Bio- and green waste

A major part of the bio- and green wastes is currently openly composted and seldom used for energy generation. A consistent treatment of exclusively separately collected bio- and green wastes in closed plants as well as the use of a supplementary anaerobic digestion stage could considerably increase the biogas yield. The gases should then be used for energy generation in efficient combined heat and power stations. A total of 6.1m tonnes of CO_2 equivalents could thus be saved in 2020.

Used paper and used wood

Used paper and used wood already today contribute to effectively relieving the climate, together saving 20.7m tonnes of CO_2 equivalents annually. With an expansion of the collected volume as well as optimised technical plants, their contribution could be increased by the factor 2.5 to 53.6m tonnes by 2020.

Greenhouse gas emissions according to material flows



Waste water management industry in the European Union

There are also many possibilities in the EU for the waste water industry to make a profound contribution to climate protection. However, these are not systematically used or completely researched. The current study thus focuses mainly on the waste heat potentials of waste water and on sewer gases, as they can be relatively simply exploited and used profitably for the European waste water industry.

Energy from sewer gases

The potential of sewer gases can be only approximately determined because of the lack of uniform data. Currently emissions of 1.7m tonnes of CO_2 equivalents are saved. With an expansion of sewage sludge digestion as well as the complete and efficient utilisation of the gas in combined heat and power stations, savings could be more than tripled to approx. 5.2m tonnes. The additional savings correspond to the average annual emissions of 350,000 Europeans.

Heat potential from waste water

Approx. 26 billion m^3 of waste water for heat usage is available annually in the European Union. With a heat gain of 0.5°C, this corresponds to a theoretical potential of 1,693 MW. In relation to Germany, that corresponds to the space heating requirement of more than a million households, as much as in the cities of Cologne and Berlin together. According to conservative estimates, up to 5.1m tonnes of CO_2 equivalents could be saved annually with the use of this energy source.

Summary: Our contribution to European climate protection

The EU member countries have undertaken in a Climate Alliance to reduce greenhouse gas emissions by 20% up to 2020 compared with 1990. Assuming the level of 2007, the EU states would have to reduce their emissions by 600m tonnes of CO_2 equivalents by 2020 to achieve their target. The European municipal waste sector could save up to 114m tonnes of CO_2 equivalents by 2020. Taking into consideration the 78m tonnes still emitted today, this would result in an absolute saving of 192m tonnes. The waste water sector could save a further 10.3m tonnes just with the measures analysed.

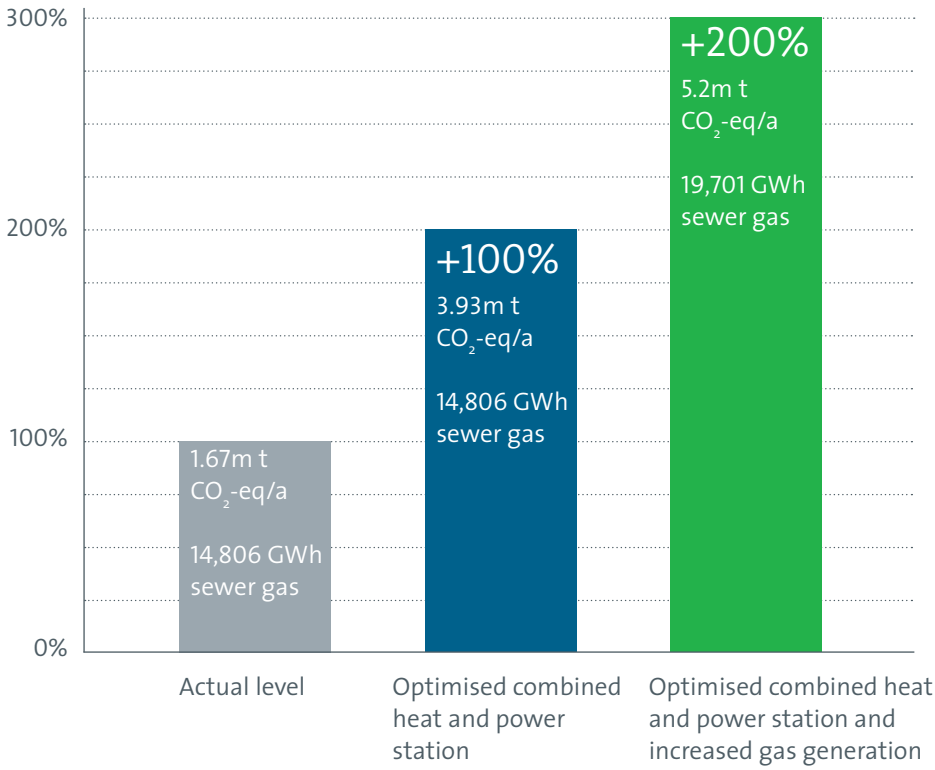
The identified savings potential of the European waste disposal management and recycling industry thus amounts to over 200m tonnes, corresponding to 34% of the necessary overall savings.

Composting = *Controlled biological decomposition of organic substances in the presence of oxygen (aerobic)*

Refuse derived fuel power station (RDF power station) = *Plant for generating electricity and heat from substitute fuels*

Bring system = *Waste is taken to central collecting points, e.g. glass and paper depot containers*

Emission savings via use of sewer gas



Comments on methodology

The results for the waste management industry presented in this brochure derive from the joint study "Climate protection potentials in the waste management sector" produced by the Federal Environment Ministry, Federal Environment Agency and Federation of the German Waste, Water and Raw Materials Management Industry. They were supplemented by figures on the waste water industry based on the study "Selected climate protection potentials of the waste water management industry" of the Federation of the German Waste, Water and Raw Materials Management Industry.

Waste management industry

To be able to estimate the climate protection potentials of the German waste management industry for 2020, the following assumptions were made:

Scenario 2020 T envisages an improvement in the technical standards of the individual treatment and recycling techniques with unchanged waste flows. It is assumed that net efficiencies of plants can be improved, the gas yields of anaerobic digestion plants increased and higher-value secondary products produced.

Scenario 2020 A envisages a change in the waste flows with increased collection and more recycling. It is assumed that 50% of the recyclable materials still in the mixed residual waste in 2006 are additionally collected and utilised.

Scenario 2020 AT is the combination of the scenarios.

Two other scenarios were applied for Europe:

Scenario 2020 I forecasts that landfilling and mixed waste composting are completely discontinued and the recycling rate rises to 47%, for used wood to 90%. Technical improvements similar to the scenario 2020 T for Germany are also predicted.

Scenario 2020 II assumes the current distribution of the waste flows in Germany and in turn the assumptions of the scenario 2020 T, i.e. improved technical standards of treatment and recycling methods.

Waste water management industry

Use of waste heat from waste water is effective only from a volume flow (dry weather flow) of at least 15 litres per second. It was assumed that the heat potential of heat pump plants with an average output of 500kW is exhausted with electric or gas heat pumps. It also presupposes that the waste heat can be used only at locations at which there are relevant heat consumers or an existing district or local heating network.

A complete use in combined heat and power stations as well as the expansion of the sludge digestion at 95% is assumed for the sewer gases. Various efficiency increases up to the complete use in fuel cells are also studied.

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"Let there be no doubt about the conclusions of the scientific community. The threat of global warming is very real and action is needed immediately. It is a grave error to believe that we can continue to procrastinate. Scientists do not believe this and no one else should either."

Henry Kendall, Nobel prize winner in physics

BMU
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Robert-Schuman-Platz 3
53175 Bonn
Tel: +49 228 99 305-0
Fax: +49 228 99 305-3225
www.bmu.de

UBA
Federal Environment Agency

Wörlitzer Platz 1
06844 Dessau-Roßlau
Tel: +49 340 2103-0
Fax: +49 340 2103-2285
www.uba.de

BDE
Federation of the German Waste, Water and Raw Materials Management Industry Industrial and Employers' Association

Behrenstraße 29
10117 Berlin
Tel: +49 30 5900335-0
Fax: +49 30 5900335-99
info@bde-berlin.de
www.bde-berlin.de