ETC/SCP

European Environment Agency

Municipal waste management in Germany

Prepared by Christian Fischer
ETC/SCP

February 2013

EEA project manager
Almut Reichel

Author affiliation
Christian Fischer, Copenhagen Resource Institute, http://www.cri.dk/

Context
The Topic Centre has prepared this working paper for the European Environment Agency (EEA) under its 2012 work programme as a contribution to the EEA's work on waste implementation.

Contents

Highlights **4**

1 Introduction **5**

1.1 Objective 5

2 Germany's MSW management performance **5**

2.1 MSW Indicators 5

2.1.1 The recycling of MSW from 2001 to 2010 6

2.1.2 The yearly increase rate of recycling of MSW 8

2.1.3 Landfilling of biodegradable municipal waste 9

2.1.4 Regional differences of MSW recycling from 2001 to 2010 10

2.1.5 The relation between landfill tax level and recycling level of MSW 12

2.1.6 Environmental benefits of better MSW management 13

2.2 Uncertainties in the reporting 14

2.3 Important initiatives taken to improve MSW management 15

2.4 Future possible trends 16

References **17**

Highlights

- Recycling has increased from 48 % of MSW generated in 2001 to 62 % in 2010. The EU target for 50 % recycling by 2020 has therefore already been met;
- There was no increase in the recycling level of MSW between 2006 and 2010, whereas incineration has increased;
- The 2016 target for biodegradable municipal waste sent to landfill was met in 2006;
- There is a long tradition of national waste strategies and waste management plans in the federal states;
- A ban on landfilling un-pretreated MSW, producer responsibility and a focus on separate collection have proven to be important policy initiatives; and
- The latest initiative is the introduction of the so-called recycling bin that aims to increase recycling of plastics and metals from households, and mandatory separate collection of bio-waste by 2015.

1 Introduction

1.1 Objective

Based on historical MSW data for Germany and EU targets linked to MSW the analysis undertaken includes:

- The historical performance on MSW management based on a set of indicators;
- Uncertainties that might explain differences between the countries' performance which are more linked to differences of what the reporting includes than differences in management performance;
- Relation of the indicators to the most important initiatives taken to improve MSW management in the country; and
- Assessment of the future possible trends and achieving of the future EU targets on MSW by 2020.

2 Germany's MSW management performance

Germany is a Federal Republic consisting of sixteen Federal States (Bundesländer). Responsibility for waste management and environmental protection is shared between the national Government, the Federal States and local authorities. The National Ministry of Environment sets priorities, participates in the enactment of laws, oversees strategic planning, information and public relations and defines requirements for waste facilities. Each Federal State adopts its own waste management act containing supplementary regulations to the national law, e.g. concerning regional waste management concepts and rules on requirements for disposal. There is no national waste management planning in Germany. Instead, each Federal State develops a waste management plan for its area (EEA, 2009).

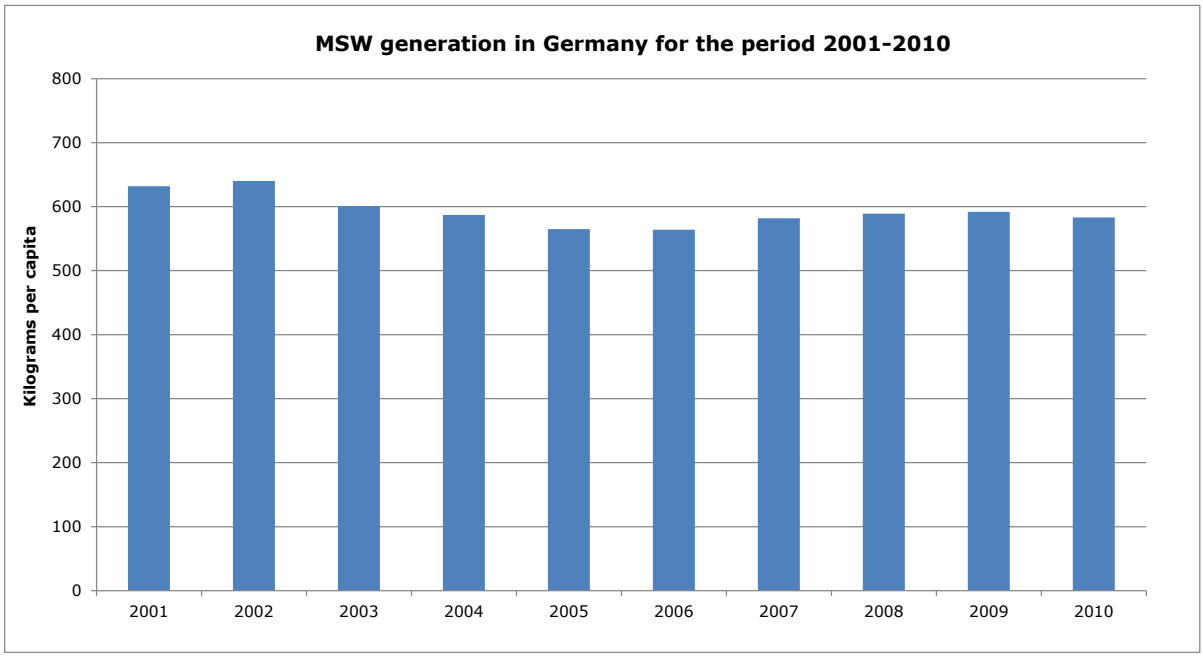
Germany was the first country in the EU to introduce producer responsibility with a packaging waste regulation in 1991. According to this principle, which is a core tenet of German waste legislation, the producer of a product is generally responsible for the product when it becomes waste. However, this principle has been implemented only for some product types such as packaging, waste electric and electronic equipment, vehicles, solvents, waste oil and batteries.

For waste generated by households, the Recycling Management and Waste Act assigns responsibility to the local public waste disposal authorities (in most Federal states these are districts and towns). Their responsibility covers collecting and transporting waste, measures to promote waste prevention and recovery, and planning, constructing and operating waste disposal facilities. Municipalities have more practical tasks such as providing sites for waste collection (EEA, 2009).

2.1 MSW Indicators

Figure 2.0 shows the development of MSW generation per capita in Germany from 2001 to 2010. There has been a decrease from 632 kilogram per capita in 2001 to 564 kilogram in 2006. From 2007 to 2009 there has been a minor increase, but the level seems to have been quite constant since 2006.

Figure 2.0 MSW generation per capita in Germany



Source: Eurostat, 2012.

The total German generation of MSW decreased from 52.1 million tonnes in 2001 to 46.4 million tonnes in 2006. The generation increased to 48.5 million tonnes in 2009 but then decreased from 2009 to 2010 to 47.7 million tonnes.

Germany was among the first European countries to introduce policies to limit landfilling in the 1990s. Measures included schemes for collecting packaging waste, biowaste and waste paper separately. The result of this was that by 2001 Germany already recycled about 48 % of municipal waste, whereas approximately 25 % was landfilled and 22 % was incinerated.

In 2010, the level of recycling had increased to 62 %, landfilling was almost 0 % and incineration had increased to 37 %.

Some indicators regarding the development of MSW management are shown below.

2.1.1 The recycling of MSW from 2001 to 2010

Figure 2.1 shows the development of recycling of MSW in Germany related to total recycling, material recycling (such as metal, glass, plastic, paper and cardboard) and organic recycling (compost and other biological treatment).

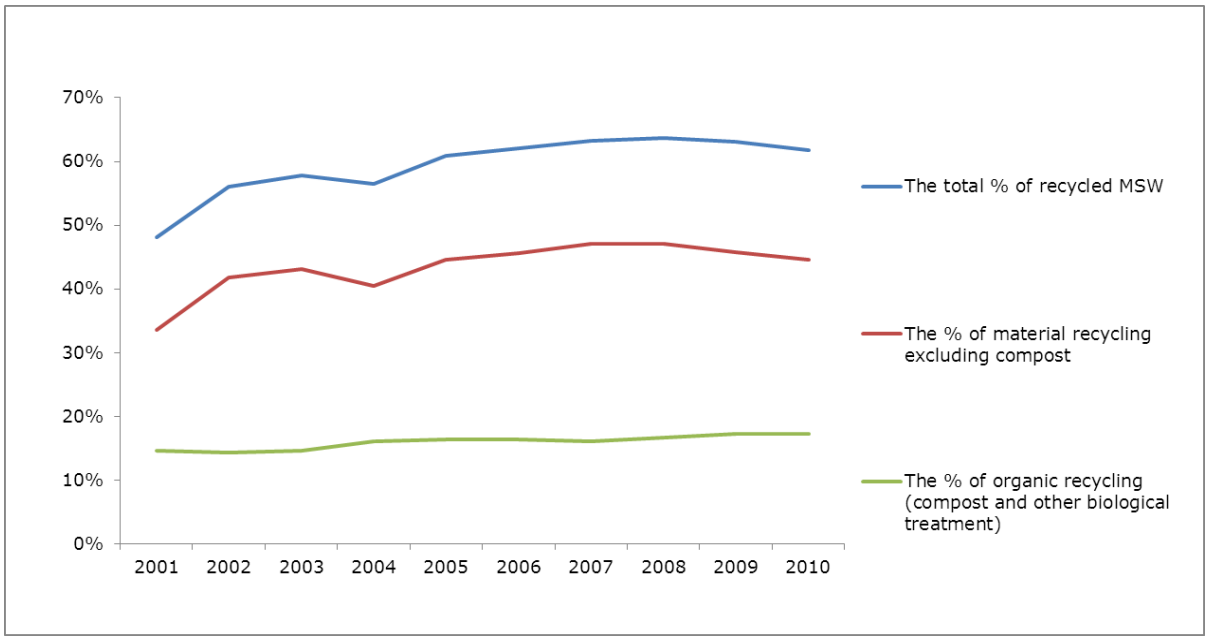
Germany had a high starting level of recycling of MSW in 2001, and the total recycling continued to increase steadily in the period from 2001 to 2008 from 48 % to 64 %.

However, in the last two years total recycling has decreased to 62 %. The reported German amounts of generated MSW decreased 11 % from 2002 to 2006, and therefore the percentage increase of recycling in the period from 2002 to 2006 is in fact not due to increase in the recycled amounts as such. It is rather due to the fact that the decrease of MSW generation in percentage is larger than the recycling.

Nevertheless, the total and consistent increase of MSW recycling covers different trends for material recycling and organic recycling. The amount of material recycling increased during the period from 17.5 million tonnes (34 %) in 2001 to 21.3 million tonnes (45 %) in 2010. However, this development

has been very uneven. There was a very steep jump from 17.5 million tonnes in 2001 to 22 million tonnes in 2002. This suggests that there must have been a shift in the reporting methodology from 2001 to 2002. The material recycling then decreased by 2.5 million tonnes from 2002 to 2004 but increased again in the period from 2005 to 2010. In the period from 2001 to 2010 organic recycling has increased very little from 15 % to 17 %. It is equivalent to an increase from 7.6 million tonnes to 8.2 million tonnes. The increase has taken place during the last three years in particular.

Figure 2.1 Recycling of MSW in Germany



Source: Eurostat, 2012. The percentages are calculated as % of generated MSW.

The composition of the recycling and its development from 2002 to 2010 is shown in Table 2.1. It has to be underlined that in order to get the longest possible timeline for the development, the figures stated in the table are the collected amounts and not the actual recycled amounts. The actual recycled amounts have only been found for the period 2006-2010. However, apart from 'light packaging' and 'metal, textile etc,' the differences do not appear to have a very large impact on the included amounts, although it should be expected this would be the case especially for green kitchen waste from households.

Table 2.1 Composition of recycled municipal waste in Germany from 2002 to 2010. Stated in 1000 tonnnes

1000 tonnes	2002	2003	2004	2005	2006	2007	2008	2009	2010
Glass*	3 106	3 289	3 100	3 572	1 929	2 233	2 480	2 442	2 523
Paper & cardboard	8 590	8 419	7 740	7 895	8 080	8 121	8 528	8 088	8 000
Light packaging	5 654	4 929	4 734	4 601	4 532	4 975	4 885	5 000	5 141
WEEE	105	104	263	291	409	396	469	605	586
Metal, textile etc.	1 313	1 204	1 333	1 274	1 570	1 685	1 842	1 607	1 730
Green kitchen waste from households	3 465	3 447	3 661	3 776	3 757	3 743	3 897	3 882	3 764
Organic food waste from canteens etc.	485	354	578	476	603	668	535	694	726
Garden and park waste	4 163	3 845	4 172	3 924	4 044	4 509	4 421	4 607	4 964

Source: (Statistics Germany, 2012 and Statistics Germany, 2012a).*The decrease of recycled glass is due to a change of the registration principles

Similarly to the total material recycling of MSW, Table 2.1 shows that for each of the individual waste streams, there have been some large fluctuations in the recycled amounts during the period.

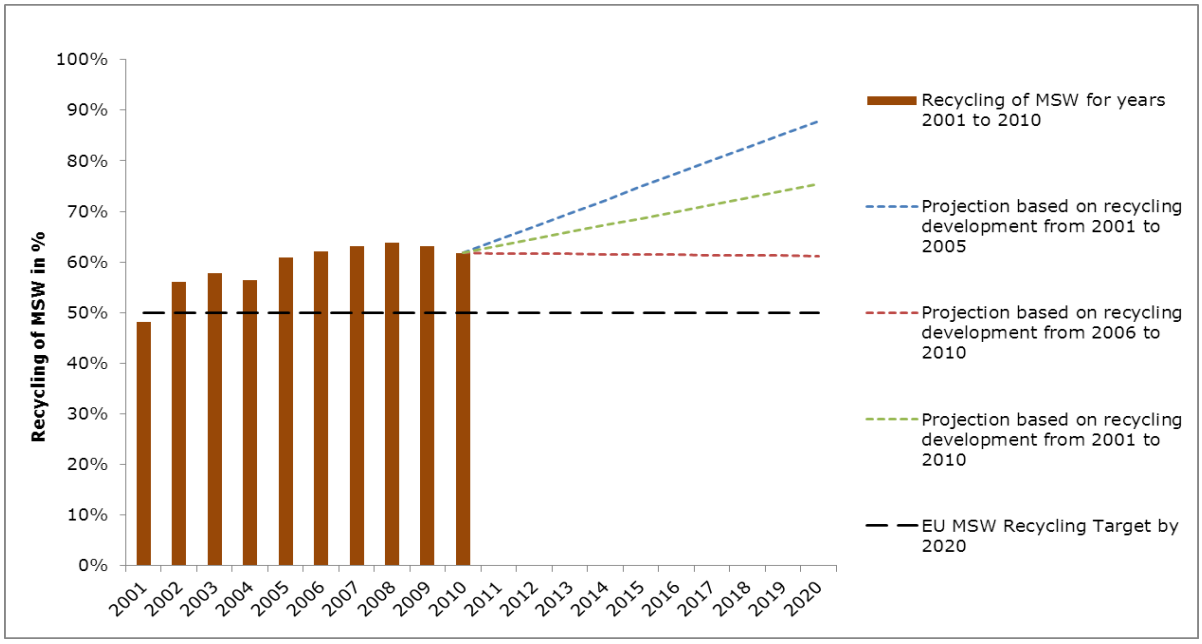
The recycled amounts for most of the waste fractions show a decrease in the collected amounts until 2006, cf. the explanation above regarding the decreasing amounts of generated MSW. WEEE and 'metal, textile etc. in particular have seen a more constant increase in the recycled amounts, while the waste fractions for organic recycling have constantly increased at least from 2005.

2.1.2 The yearly increase rate of recycling of MSW

In order to assess the prospects for Germany to meet the 50 % recycling target as set out in the Waste Framework Directive1, three scenarios have been calculated. The scenarios assume that recycling in the period 2010 to 2020 develops, based on a linear regression, with the increase rates of recycling in the periods 2001-2005, 2006-2010 and 2001-2010.

Figure 2.2 shows that Germany will fulfil the EU recycling target of 50 % by 2020, if the recycling trends continue from the years 2001-2006, 2006-2010 and 2001-2010 respectively. This is not surprising since Germany already has a MSW recycling level higher than 50 %. The projections also show that due to the slight decrease of recycling during the last two years, the projection based on recycling development from 2006 to 2010 would imply a decrease in recycling rate until 2020.

Figure 2.2 Future recycling of MSW in Germany



Source: Calculation by Copenhagen Resource Institute (CRI), based on Eurostat, 2012

Please note that these three scenarios are very simplistic and do not take into account any planned policy measures. In addition, they are based on one calculation methodology for recycling of municipal waste (MSW recycled/MSW generated, using data reported to Eurostat) whereas countries may choose to use another methodology to calculate compliance with the 50 % recycling target of the Waste Framework Directive. The scenarios in Figure 2.2 should therefore be interpreted only as to give some rough indications and assessment of the risk of missing the target.

[1] The EU's updated Waste Framework Directive from 2008 (EU, 2008) includes a new 50 % recycling target for waste from households, to be fulfilled by 2020. In 2011, the European Commission decided that countries can choose between four different calculation methods to report compliance with this target. One of these methods is to calculate the recycling rate of MSW as reported to Eurostat (EC, 2011).

2.1.3 Landfilling of biodegradable municipal waste

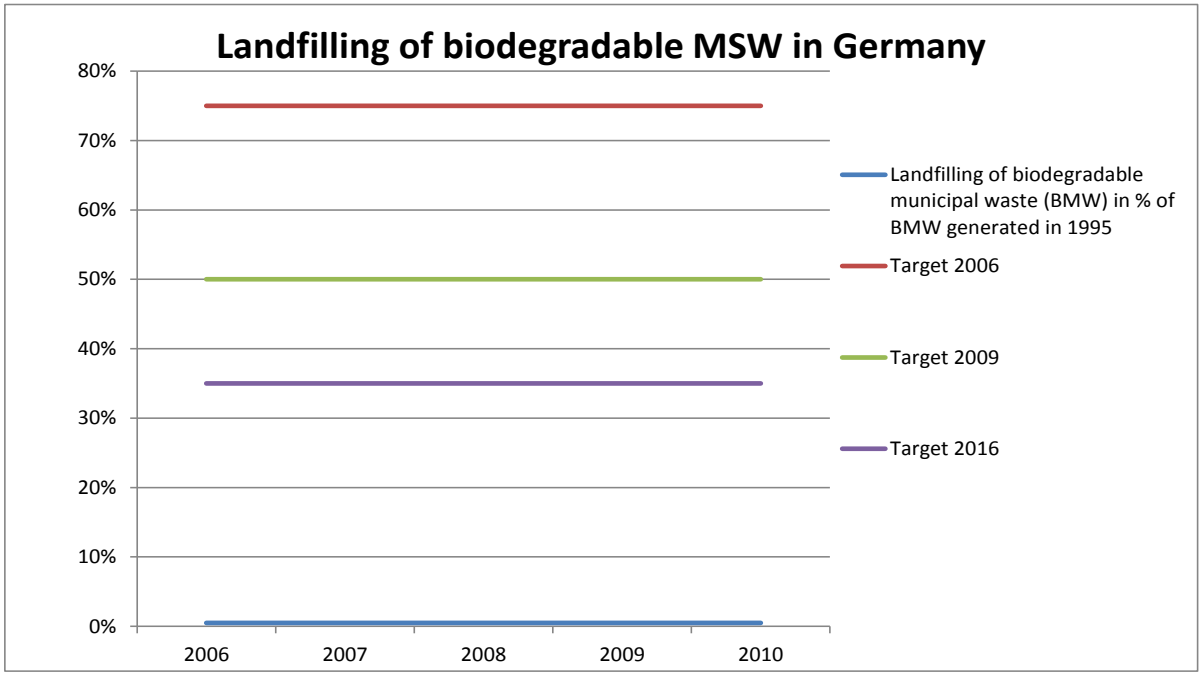
It is a general requirement of the EU Landfill Directive that all Member States have to reduce the amount of biodegradable municipal waste landfilled (BMW) by a certain percentage by 2006, 2009 and 2016. The targets are related to the generated German amount of BMW in 1995 (28.4 million tonnes).

Germany has reported to the Commission that zero tonnes of BMW were landfilled in 2006, 2007, 2008 and 2009. This is due to the fact that Germany introduced a ban on non-pretreated MSW. It was introduced in two steps using three pieces of legislation because the initial statute contained severe loopholes. The first step was an administrative regulation (TASi) in 1993, which limited the organic content in waste going to landfills to less than 3 % total organic carbon (TOC) supplemented by a transition period until 1 June 2005 (EEA, 2009). The second step was two ordinances in 2001 and 2002 that aimed at closing some of the loopholes within the 1993 administrative regulation (EEA, 2009) and setting the following two requirements (ETC/SCP, 2009):

- Municipal waste after 1 June 2005: max 5 % carbon content in waste direct landfilled;
- Municipal waste, which has been mechanically/biologically pre-treated: max 18 % carbon content and very low content of biodegradable organic carbon in waste landfilled measured with degradation tests.

With the implementation of the above mentioned initiatives of landfilled BMW and according to the Landfill Directive, Germany had already fulfilled the 75 % requirement in 2006, the 50 % requirement in 2009 and the 35 % requirement in 2013.

Figure 2.3 Landfilling of biodegradable MSW in Germany



Source: EU, 2012

2.1.4 Regional differences of MSW recycling from 2001 to 2010

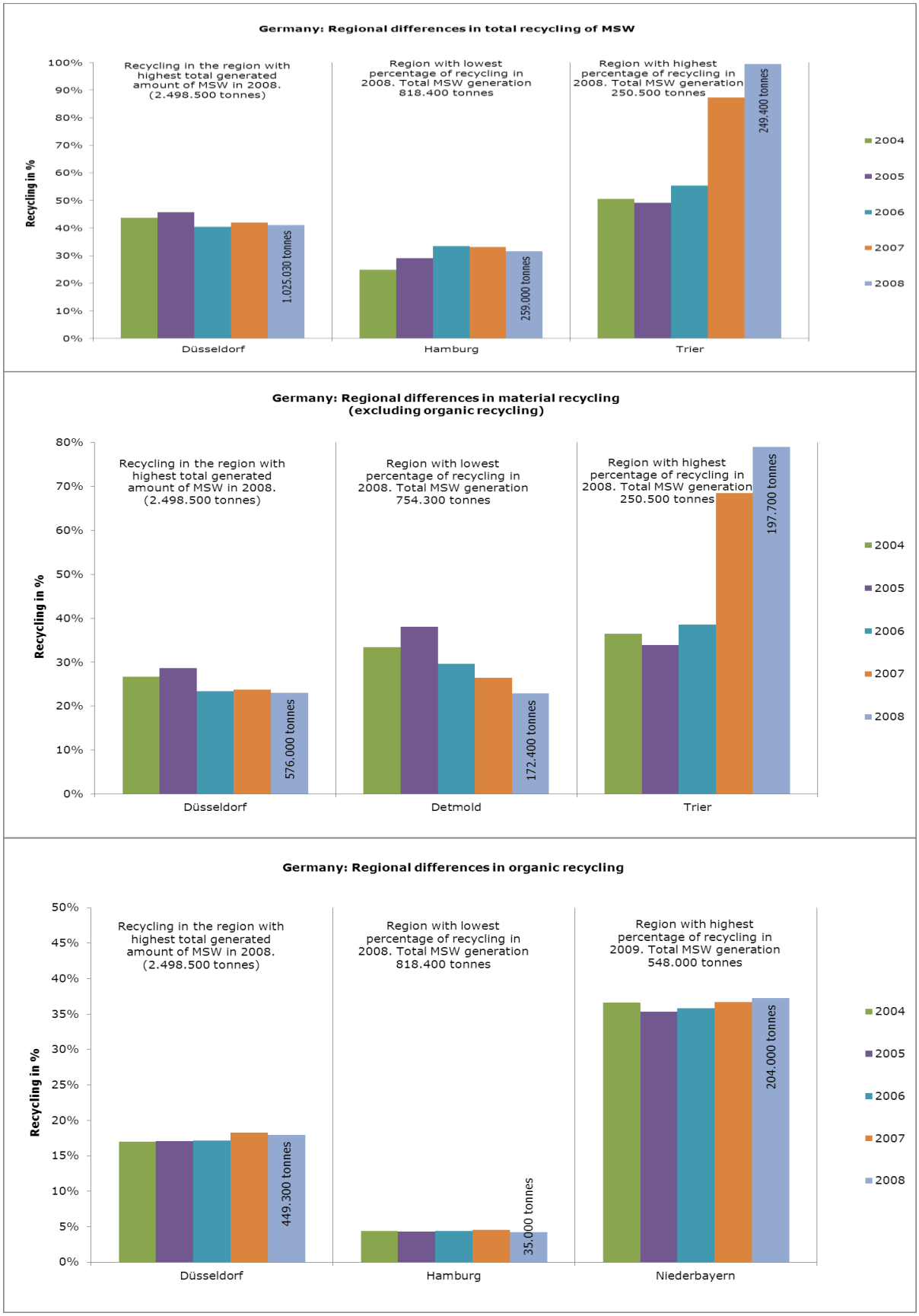
Germany has also reported regional recycling data of MSW to Eurostat. Figure 2.4 shows regional differences in the development of MSW recycling from 2004 to 2008 in relation to total recycling, material recycling and organic recycling. Three different regions have been chosen for each type of recycling: 1) Recycling in the region with the highest generated total amount of MSW in 2008; 2) Recycling in the region with the lowest percentage of recycling in 2008 and 3) Recycling in the region with the highest percentage of recycling in 2008.

This applies to the regions of Düsseldorf, Hamburg, Trier (situated in the south western part of Germany), the Detmold region (situated in North Rhine-Westphalia) and the Niederbayern region.

The graphs show huge differences in total recycling of MSW from 22 % to 26 % for 2004 to 2006, and about 60 % in 2007 and 2008. However, the incredible recycling level of almost 100 % for the Trier region is based on the fact that all waste sent to MBT is reported as recycled MSW.

First of all, these large differences for total recycling of MSW seem to be linked to differences in material recycling, especially for 2007 and 2008. However, the organic waste recycling also has large variations with Hamburg on a level of 4 % and Niederbayern with a level of 37 % of the total generated MSW.

Figure 2.4 Regional differences in recycling of MSW



Source: Eurostat regional data, 2012

Even in a country like Germany with a high level of recycling of MSW it is possible to find large regional differences. The graphs therefore give a clear indication of how regional and local policies in Germany have indirectly had a significant influence on the recycling levels of MSW.

2.1.5 The relation between landfill tax level and recycling level of MSW

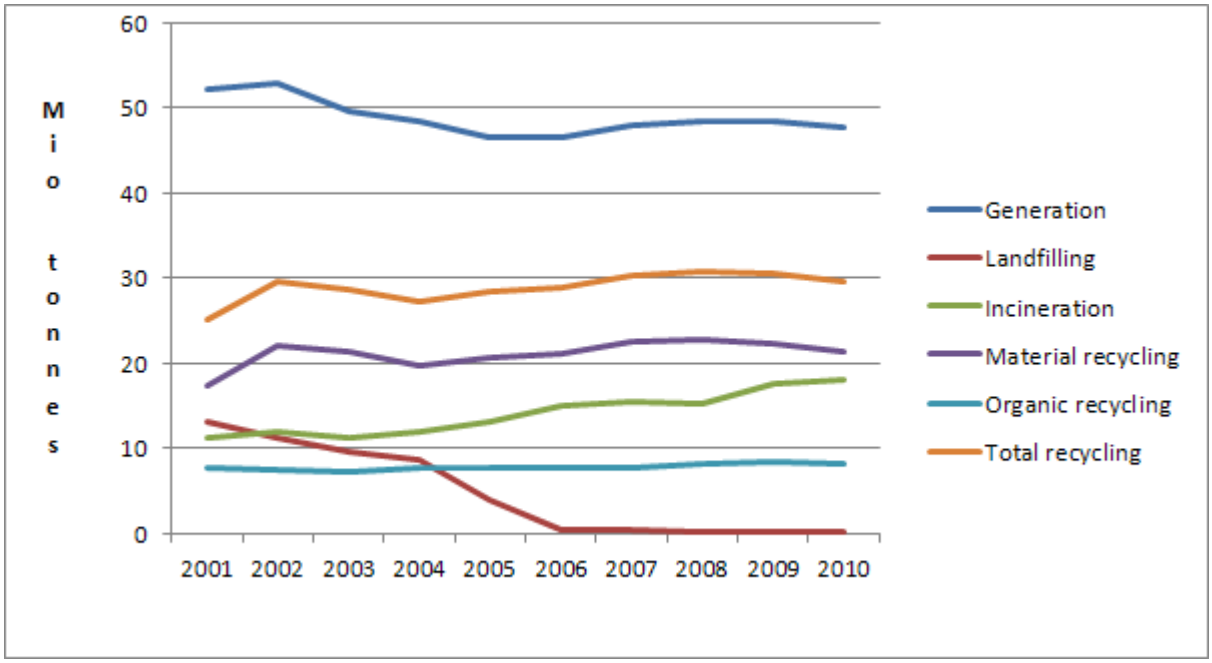
Twenty European countries are using a landfill tax but this does not include Germany. Germany has a very high level of recycling of MSW and it is interesting that Germany has achieved this without using a landfill tax. The requirement of pre-treatment of MSW before it can be landfilled combined with other management activities such as producer responsibility have been strong drivers in diverting MSW away from landfills and towards recycling.

Figure 2.5 shows that the ban on non-pretreated MSW in 2005 has had a huge impact on the amount of MSW landfilled.

The figure also shows that although the total amount of MSW for recycling has increased from 2005, it is first of all the amount of MSW sent to incineration, which has increased from 13.2 million tonnes in 2005 to 18.0 million in 2010. However, this increase of incineration does not necessarily reflect the real actual amount of MSW incinerated. According to the German reporting to Eurostat, 'incineration of MSW (without energy recovery) includes "treatment for disposal", mostly referring to mechanical biological treatment' (Eurostat, 2012).

Furthermore, the waste generated during the pre-treatment process such as sorting or mechanical biological treatment (MBT) will also include waste ending up partly in incinerators and in landfills and the latter part of this waste is not necessarily reported as landfilled but as incinerated (see above). According to a study of the flows from MBT in Germany, 22 % of the input of approximately 6.4 million tonnes into MBT plants ended up in landfills in 2007 (Thiel, Stephanie, and Thomé-Kozmiensky, Karl Joachim, 2011).

Figure 2.5 Development of landfilling, incineration and recycling of MSW in Germany (Stated in million tonnes).



Source:Eurostat, 2012

Germany has increased its incineration capacities substantially since the late 1990s. Therefore several studies forecast incineration overcapacities for Germany in different amounts. According to the German Federal Environment Agency, the studies overestimate the possible surplus because they include the incineration capacity which has already been or soon will be withdrawn. (Germany, 2012). Anyhow, an incineration overcapacity can potentially offer economic incentives for incinerating MSW instead of recycling, because the incineration plants may have to lower their prices in order to operate competitively.

2.1.6 Environmental benefits of better MSW management

Figure 2.7 shows the development of GHG emissions from MSW management, calculated using a life-cycle approach. The graph shows the direct emissions, the avoided emissions and the net emissions of the MSW management

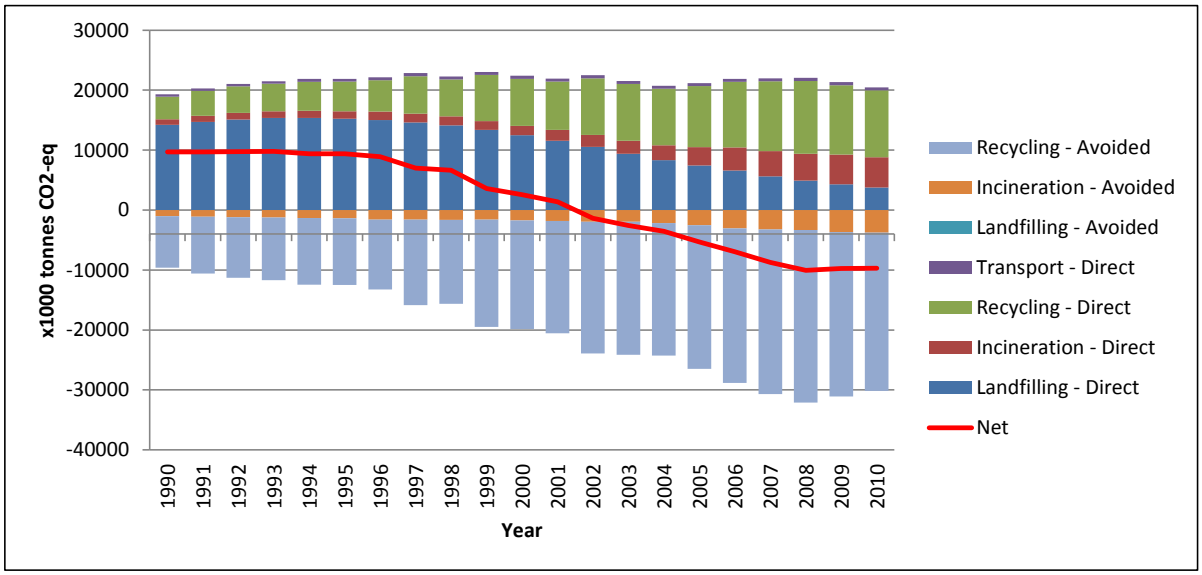
Figure 2.7 indicates a steady increase of direct emissions from landfilling from 1990 up until 1993. The direct emission levels have since been reduced due to less landfilling of BMW. Even though a ban on non-pretreated MSW was introduced in 2005, the direct emissions from landfilling will continue for several years due to the fact that recently landfilled BMW (e.g. seven to ten years ago) continues to emit considerable amounts of greenhouse gases. Direct greenhouse gas emissions from recycling have also increased due to increased recycling in the last 20 years. The same trend can be observed for incineration.

An immediate positive outcome is the fact that an increase in recycling of MSW has resulted in reduced greenhouse gas emissions. This is due to the fact that the recycling replaces the use of virgin materials and in that way avoids GHG emissions. In the same way, incineration of non-fossil based MSW generates energy which can replace energy based on fossil fuel. This positive impact can be recognised in Figure 2.7 in the whole period between 1990 and 2010.

From the year 2001, the avoided emissions from waste management activities were higher than the burden caused by direct emissions from landfill sites, incineration plants, recycling activities and the collection and transport of MSW. Therefore, the net greenhouse gas emissions shown by the red line indicate that a better management of MSW from 1990 has resulted in the reduction of greenhouse gas emissions from 9.4 million tonnes (1990) to around minus 21.6 million tonnes (2010) in terms of CO2-equivalent per year.

If avoided emissions are higher than direct emissions, one could conclude that it would be better for the environment to generate and recycle more waste. That is of course not the case. The reason is that the model only focuses on waste management and not the full production chain and its consequences in a life cycle perspective. Therefore, the increasing consumption of goods (and resulting generation of more municipal solid waste) is more harmful for the environment, if all life-cycle stages of materials were taken into account (ETC/SCP, 2011).

Figure 2.7 GHG emissions from MSW management in Germany[2]



Results presented in this figure should not be used for the compilation of GHG reporting (national inventory report of the IPCC) or compared with IPCC figures, as the methodology employed here relies on life-cycle thinking and, by definition, differs from the IPCC methodology.

2.2 Uncertainties in the reporting

Some uncertainties or differences in the reporting of MSW can result in different levels of recycling. One example of such a difference which might influence the recycling rate of MSW in Germany is the extent of which packaging waste from households and similar packaging from other sources is included in the reported recycling of MSW. Most Member States, including Germany, have producer responsibility schemes on packaging waste and therefore packaging waste is not always reported to Eurostat as MSW.

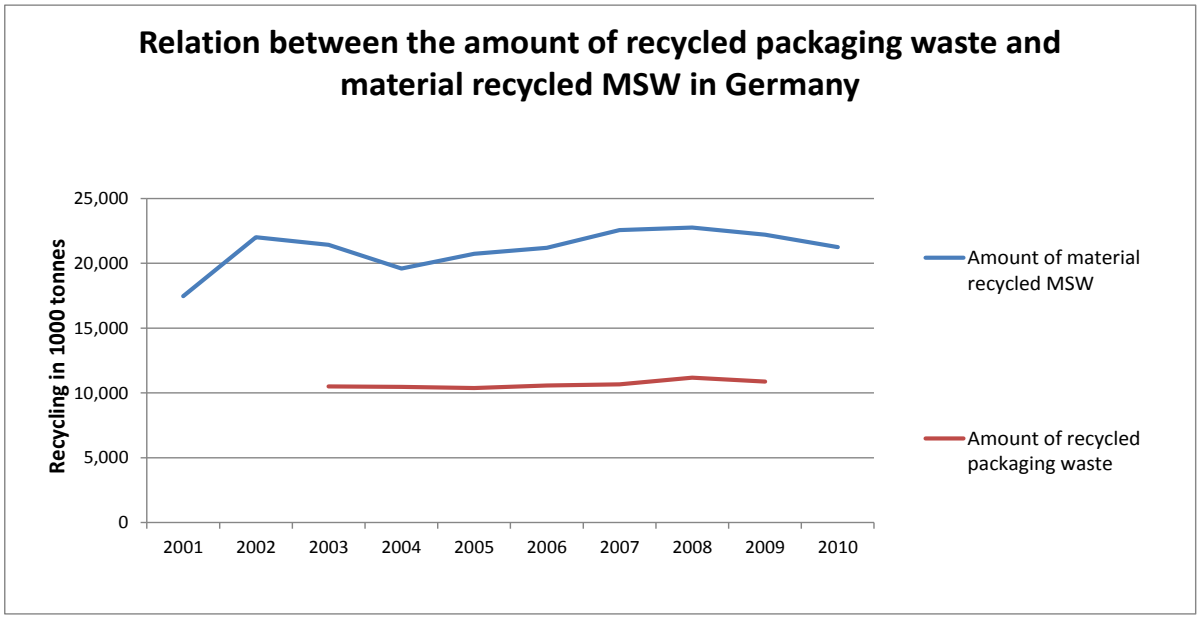
Figure 2.8 shows that the amount of recycled MSW in Germany was significantly higher than the amount of recycled packaging waste in the whole period from 2001 to 2009. In tonnes the development of recycled MSW has increased more in the period from 2004 to 2008 than the recycled amount of packaging waste. The figures indicate that Germany includes a reasonable amount of packaging waste from households and similar packaging from other sources in their reporting of recycling of MSW.

[2] All the GHG emissions (positive values) represent the direct operating emissions for each waste management option. These direct operating emissions have been calculated with the use of the IPCC (IPCC, 2006) methodology for landfills and life cycle modelling for the other technologies (incineration, recycling, biotreatment and transport). For the indirect avoided emissions (negative values), the calculations integrate the benefits associated with the recovery of energy (heat and electricity generated by incinerators, electricity generated by the combustion of landfill gas or methane from anaerobic digestion). Other avoided emissions include the benefits of recycling of food and garden waste, paper, glass, metals, plastics, textiles and wood in the municipal solid waste. Recycling is here assumed to include material recycling and biotreatment. Avoided emissions of biotreatment include fertilizer substitution. All processes generating electricity are assumed to substitute average electricity mix of Germany in 2002 (ILCD, 2008). Processes generating heat are assumed to substitute average heat mix for the EU-25 in 2002. The electricity mix and heat mix are assumed to remain constant throughout the whole time series. The complete methodology is available from (ETC/SCP, 2011). The compositions of the MSW disposed in landfills, incinerated or recycled respectively are also based on (ETC/SCP, 2011). In an Eionet consultation process, initiated by the EEA in 2012, Germany updated the compositions of the landfilled, incinerated and recycled MSW for 2008.

Another factor for uncertainty could be that in some countries the whole amount of MSW sent to Mechanical Biological Treatment (MBT), is allocated to recycling at the MBT plant. In other countries, it is in fact only the actual amount recycled after the MBT which is included, and not the amount subsequently sent to landfilling or incineration.

In Germany, a significant amount of MSW is treated in MBT plants as mentioned in section 2.1.5. According to the reporting to Eurostat, this amount is not registered as MSW recycled but as MSW incinerated (Eurostat, 2012). Therefore it seems that the recycling of MSW is not overestimated due to MBT. However, the real amount of incinerated MSW might be overestimated due to the fact that landfilled MBT outputs are not reported as landfilled MSW but as incinerated.

Figure 2.8 A comparison of packaging waste recycled and material MSW recycled



Source: Eurostat, 2012

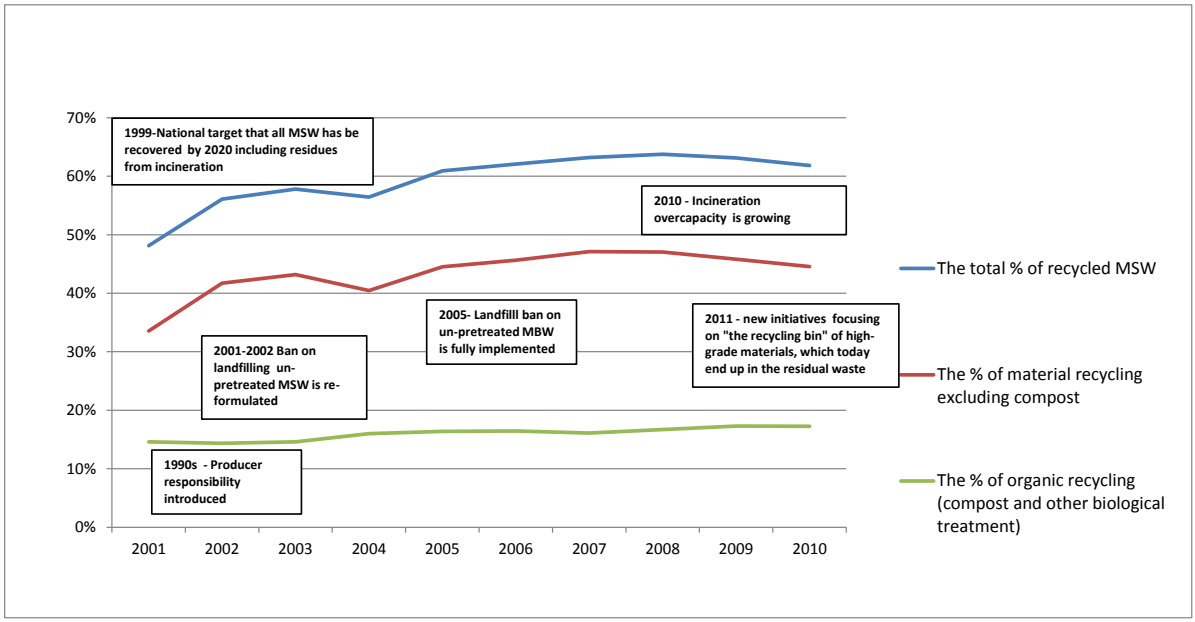
2.3 Important initiatives taken to improve MSW management

As mentioned earlier, Germany has for over 20 years had a strategy for diverting MSW away from landfills and increasing recycling. The most important initiatives taken in order to increase MSW recycling have been:

- A long tradition for developing waste strategies on the national level, and developing waste management plans in the federal states and in the municipalities;
- Introduction of producer responsibility for packaging waste already in 1991 (EEA,2009);
- In 1999, the German government committed itself to completely recover all municipal waste by 2020, so that landfilling of municipal waste and waste treatment residues would no longer be necessary. This is an ambitious objective and includes, for example, recovering waste incineration residues and further developing of treatment technologies such as sorting and MBT (EEA, 2009);
- A ban on landfilling un-pretreated MSW by defining requirements to the organic content of MSW direct landfilled (maximum 5 % carbon content) or maximum 18 % if the waste has been pre-treated. The first initiatives in relation to this ban were taken in 1993, followed up in 2001 and 2002 and fully implemented in 2005 (EEA, 2009 and ETC/SCP, 2009);

- Focus on separate collection and recycling of secondary raw materials (paper and biowaste), pre-treatment of mixed household waste in mechanical-biological treatment plants and dedicated incineration with energy recovery of mixed household waste (EEA, 2009);
- The latest initiative is the introduction of the so-called recycling bin where it is estimated that seven kilograms per capita per year of high-grade material of metal and plastic other than packaging can additionally be material recycled (UBA, 2011).

Figure 2.9 Recycling of MSW in Germany and important policy initiatives



2.4 Future possible trends

Germany has now had a MSW recycling level higher than 50 % for many years. As discussed in section 2.1.2 and shown in Figure 2.2, Germany will continue fulfilling the EU recycling target of 50 % by 2020, if the respective recycling trends from the years 2001-2006, 2006-2010 and 2001-2010 continue.

The question is more whether Germany will be in the position to further increase its recycling level and how much. Germany's own target from 1999 that all municipal waste including waste treatment residues will be completely recovered by 2020 is ambitious and it will increase the recycling percentage of MSW. However, Germany may experience a surplus of incineration capacity in the coming years. This will imply lower prices on incineration, which may well be the strongest challenge for increasing recycling of MSW. A first indication of this development is that in the last two years there has been a very slight decrease of recycling of MSW.

As of from 1 June 2012, the new "Kreislaufwirtschaftsgesetz[3] (KrWG)", which transposes the Waste Framework Directive into national law came into force in Germany. From the beginning of 2015, the new law makes the collection of bio-waste mandatory.

This will have an effect on the running of MBT plants because the biodegradable material will be redirected from MBTs into fermentation and composting plants for the production of bio-gas. In the mid and long term it may be possible that both MBT plants and composting plants will have to be closed (Germany, 2012).

[3] Recycling Management Act (RMA)

References

EC, 2011: Commission Decision of 18 November 2011 establishing rules and calculation methods for verifying compliance with the targets set in Article 11(2) of Directive 2008/98/EC of the European Parliament and the Council

EC, 2012: Member States' reporting to the Commission according to Council Directive 1999/31 of 26 April 1999 Landfill Directive and Commission Decision 2000/738/EC concerning a questionnaire for Member States reports on the implementation of Directive 1999/31/EC on the landfill of waste. E-mail from the Commission to the EEA on 16 February, 2012.

EEA, 2009: 'Diverting waste from landfill: effectiveness of waste management policies in the European Union'. EEA Report No 7/2009
http://www.eea.europa.eu/publications/diverting-waste-from-landfill-effectiveness-of-waste-management-policies-in-the-european-union

ETC/SCP, 2009: The ETC/SCP " Country fact sheets on waste policies – 2009 edition",
http://scp.eionet.europa.eu/facts/factsheets_waste/2009_edition/factsheet?country=DE

ETC/SCP, 2011: Bakas, I., Sieck, M., Hermann, T., Andersen, F. M., Larsen, H. and Reichel, A. (2011). 'Projections of Municipal Waste Management and Greenhouse Gases'. ETC/SCP working paper 4/2011. Copenhagen, Denmark, 89 pp.
http://scp.eionet.europa.eu/publications/2011WP4

Eurostat, 2012: 'Waste Statistics- Municipal Waste-Explanatory texts'
http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/Annexes/env_wasmun_esms_an1.pdf
Accessed on 25 June 2012

Eurostat, 2012a: MSW-workshop on 7-8 February 2012
http://circa.europa.eu/Public/irc/dsis/envirmeet/library?l=/municipal_luxembourg/presentations/questionnaireppt/_EN_1.0_&a=d#453,11,Results: Secondary waste/residues – example

Germany, 2012: Information received during the Eionet consultation of the paper. E-mail of 26 October 2012 from Joachim Wuttke, Federal Environment Agency, Germany.

Statistics Germany, 2012: 'Zeitreihe zum Abfallaufkommen 1996-2009'
https://www.destatis.de/DE/ZahlenFakten/GesamtwirtschaftUmwelt/Umwelt/UmweltstatistischeErhebungen/Abfallwirtschaft/Tabellen/ZeitreiheAbfallaufkommen19962009.pdf?__blob=publicationFile

https://www.destatis.de/DE/ZahlenFakten/GesamtwirtschaftUmwelt/Umwelt/UmweltstatistischeErhebungen/UmweltstatistischeErhebungen.html
Accessed on 22 June 2012

Statistics Germany, 2012a:'Umwelt – Abfallbilanz, 2010'
https://www.destatis.de/DE/ZahlenFakten/GesamtwirtschaftUmwelt/Umwelt/UmweltstatistischeErhebungen/Abfallwirtschaft/Tabellen/Abfallbilanz2010.pdf?__blob=publicationFile
Accessed on 22 June 2012

Statistics Germany, 2012b: ,Erläuterungen'
https://www.destatis.de/DE/ZahlenFakten/GesamtwirtschaftUmwelt/Umwelt/UmweltstatistischeErhebungen/Abfallwirtschaft/Tabellen/ErlaeuterungenAbfallbilanz.pdf;jsessionid=FE747956B70ACB8F8F8DADECA84F1738.cae2?__blob=publicationFile

Thiel, Stephanie, and Thomé-Kozmiensky, Karl Joachim, 2011: 'Mechanical-Biological Pre-Treatment of Waste – Hope and Reality'
http://www.iswa.org/uploads/tx_iswaknowledgebase/Thiel.pdf

UBA, 2011: Umweltbundesamt 'Yellow bin (*Gelbe Tonne*) to be upgraded to recycling bin'
http://www.umweltbundesamt.de/uba-info-presse-e/2011/pe11-043_recovering_more_metal_and_plastics_from_waste.htm
Accessed on 25 June 2012