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Evaluation of waste policies related to the Landfill Directive

Germany

Draft paper

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Context
The Topic Centre has prepared this working paper for the European Environment Agency (EEA) under its 2007 work programme as a contribution to the EEA's work on policy analysis and assessment.

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Contents

1. Introduction to Germany

Germany is one of the largest countries in the EU, with a land area of around 357.000 km². It reaches from the North and Baltic Sea in the north to the Alps in the south. There are a large variety of geological formations and soil types. Due to the size of the country and the variety of soils there are sufficient landfill site locations.

Germany belongs to a moderate climate zone, lying in the transition between the maritime climate in the west and the continental climate in the east. Therefore, there are no extreme weather conditions to influence waste management.

With more than 82 million inhabitants, Germany is the most populous country in the EU and its population density of 231 inhabitants per km² is double the EU average of about 115 inhabitants per km². The 82 million inhabitants live in approximately 39 million households, resulting in an average of 2.1 persons per household. There is a large variety of settlement patterns across Germany, ranging from big cities like Berlin with 3 800 inhabitants per km² to rural areas like Mecklenburg-Vorpommern with around 75 inhabitants per km² (Statistisches Bundesamt 2006).

The German economy is dominated by service sectors, while the production sector contributes only 30% to the GDP. In 2006, the German GDP amounted to EUR 2 302.7 billion (= EUR 27 930 per capita); about 28% of the EU's total GDP (Statistisches Bundesamt 2007). Measured in Purchasing Power Standards, the German GDP per capita calculates to 109.4% of the EU average (Eurostat 2007c).

For historical reasons Germany has a strong federal character. In the field of waste management, the federal government sets priorities and develops a substantial part of the legislation. The federal government receives scientific and technical assistance in this process from the Federal Environment Agency (Umweltbundesamt).

The Bundesländer (provinces) can influence the development of national legislation through a co-decision making procedure and can also issue their own legislation in selected fields of waste management, where no national legislation exists. Furthermore, they are responsible for the implementation and enactment of national waste legislation. The practical task of collecting and treating municipal waste, including planning and management of waste treatment facilities, is the responsibility of the regional waste management associations.

2. Lessons learnt

The German instrument to divert waste from landfills – the limitation of organic waste to be landfilled - has proven to be effective. In the first half of 2005 only about 2 million tonnes of the biodegradable municipal waste (BMW) were landfilled (= 7% of BMW generated in 1993). This is far below the German target of the Landfill Directive, which requires that no more that 9.9 million tonnes of BMW goes to landfill in 2016 (=35%). Since 1st June 2005 (the implementation deadline of the *Waste landfilling Ordinance*) the landfilling of BMW is prohibited.

The restriction of organic waste going to landfills, however, requires the establishment of an appropriate waste management system, which requires significant financial investment. To induce these investments in waste treatment facilities it is necessary to have legally binding regulations which directly affect the municipal or private waste management companies.

Options for reducing the organic content in waste are either incineration or mechanical-biological treatment (MBT). It has to be ensured that both treatment methods cause as little pressure to the environment as possible. The tight emission threshold values for MBT can only be reached with advanced technical methods, incurring high costs. Under these conditions, the cost for MBT are in the same order of magnitude as the costs for waste incineration.

In order to reduce the waste quantities that require pre-treatment before landfilling, separate collection schemes and sufficient recovery capacities for paper (packaging paper as well as graphic paper) and biowaste must be established. Strong communication efforts are required to improve the environmental behaviour of the population.

The transition time between legislation and implementation should be kept short. Deadlines that are too far in the future tend to get out of sight and necessary activities are deferred as long as possible. If a full implementation is not possible in short time (e.g. for technical reasons) the implementation should be divided in a number of sub-deadlines, using a step-by-step approach. A good example for this approach is the series of deadlines in the Landfill Directive related to the strategy for BMW.

3. Understanding the overall strategy for diversion of waste from landfill

Modern waste management in Germany started in the mid 1960s. In October 1965, the federal government and the provinces founded the "Focal Point for Waste Disposal". The task of this organisation was to discuss aspects of waste disposal in expert groups and to distribute the result in leaflets among the municipalities, to whom the responsibility for the proper disposal of municipal waste had been assigned.

Due to a strong increase in industrial production and private consumption, waste generation grew rapidly at the beginning of the 1970s. At this time, there existed only about 130 landfills, 16 compost facilities and 30 incineration facilities for the proper management of household waste. This capacity was sufficient for only 37% of total generated household waste. The remaining waste was disposed off in 50,000 small and unprotected dumping sites.

The main objective of waste policy at that stage was the closure of the multitude of dumping sites and the building of appropriate waste management facilities. In order to reduce the environmental effects of waste management, the Waste Disposal Act was adopted in 1972. Based on this legislation, a considerable reduction of the number of landfills was achieved in the following years. In 1980 there existed 530 sanitary landfills with a highly improved technical standard.

Although the Waste Disposal Act met the objective to create a proper waste management system, it was not able to control the generation of waste. Therefore in 1986, there was a major amendment of the Waste Disposal Act, introducing the waste hierarchy with its priority for waste prevention. The latest main revision in German waste legislation took place in 1996, when the "Act on the encouragement of a closed loop recycling management and the environmentally sound disposal of waste" (KrW-/AbfG 1996) was adopted. This act, with its dedicated focus on waste prevention and closing of material loops, is still in force today (Bilitewski 2000a).

3.1. Objectives

3.1.1. General objectives

The main piece of German waste legislation is the "Act on the encouragement of a closed loop recycling management and the environmentally sound disposal of waste" (KrW-/AbfG 1996). The objectives of this act are to foster a closed loop waste management system for the purpose of saving the natural resources and to ensure an environmentally sound recovery and disposal of waste.
The main principle defined by this act is the waste hierarchy, formulated in Article 4. This states that;

1. waste must be primarily prevented, especially by reduction of their quantity and hazardousness
2. where prevention is not possible, waste must be;
   a) recovered as material,
   b) used for the production of energy.

Article 10 adds that wastes which are not recovered have to be excluded permanently from the closed loop recycling management and have to be disposed of to ensure the collective good.

3.1.2. Waste prevention

German waste act (KrW-/AbfG 1996) lists a number of potential waste prevention instruments that can be applied for specific waste streams. The instruments have to be implemented by an ordinance. Examples for ordinances with waste prevention aspects are the Packaging Ordinance and the Batteries Ordinance.

More specifically, the German provinces introduce waste prevention instruments as part of their responsibilities. The main instruments covered by provincial legislation, as well as provincial waste management plans, refer to the prevention of packaging waste and home composting.

The implementation of instruments to encourage home composting is the task of the municipalities. In a survey covering 240 municipalities, the following instruments have been identified (Fricke 2003):

- Public campaigns, including advice on home composting.
- Exemption from the obligatory collection of biowaste, mostly including reduction of waste collection fees.
- Subvention for composting devices.
- Cutting service for wood used for home composting.

Germany is currently developing a strategy to phase out landfilling of primary municipal waste by 2020. This strategy, however, focuses on technical methods to divert waste away from landfills. Waste prevention is only mentioned as a general obligation, but is not connected with specific activities.

3.1.3. Municipal waste

The legal instrument dealing with municipal waste is the Administrative Regulation: Technical Instructions on Municipal Waste (TASi 1993), which came in force in 1993. The objectives of this regulation are;

- to recover waste that can not be prevented,
- to keep the contamination of waste as low as possible and
- to ensure proper treatment and landfilling of waste which cannot be recovered.

To do so, it has to be ensured that sufficient treatment capacity is available and that the landfilling of waste does not pose threats on future generations.

3.1.4. Biodegradable Municipal Waste (BMW)

The German strategy for the reduction of biodegradable waste going to landfills, as reported to the European Commission, comprises the following elements:

1. Separate collection of biodegradable waste,
2. Composting or anaerobic biological treatment of biodegradable waste,
3. Limitation of the organic content in waste which is landfilled.

The two main biodegradable fractions in municipal waste are paper waste (either packaging paper or graphic paper) and biowaste coming from households (kitchen, garden) as well as from municipal services (garden and park waste).

Paper waste

The fourth amendment of the Packaging Ordinance (VerpackV 1991) implements the targets of the Packaging Directive 2004/12/EC. That means that by the end of 2008 the following targets have to be reached:

- Recovery of at least 65% of packaging waste
- Material recovery of at least 55% of packaging waste
- Material recovery of 60% of packaging paper and cardboard waste

As Germany meets all these targets already, the new provisions do not cause direct activities.

These legal obligations for packaging paper are supplemented by a voluntary agreement to increase the material recovery of graphic paper waste. The graphic paper industry committed itself in the year 2000 to maintain the rate of material recovery at a level of 80% ± 3% in the future.

Biowaste
Biowaste is mainly addressed by TASi. This expresses an expectation that the obligation for recovery of municipal waste will boost the separate collection and recovery of bio-waste. However, the TASi mentions no separate collection or recovery targets.

Limitation of the organic content in waste which is landfilled
The main legislation in this field is the Waste Landfilling Ordinance (AbfAblV 2001), which limits the organic content of waste going to landfills to less than 3% (measured as TOC). This limit value can only be reached with adequate pre-treatment and a well functioning waste management system. Therefore, this landfill ban is implicitly encouraging all previous steps of the waste management chain, such as prevention, separate collection, material and energy recovery and prevents landfilling of waste without pre-treatment. There exist no targets which are limiting the absolute quantity of waste going to landfills.

3.2. The package of measures for the waste streams presented above

The following section is limited to measures on national level. It should be mentioned that some initiatives on provincial level also play a certain role in diverting away BMW from landfills.

3.2.1. Limitation of the organic content in waste which is landfilled

The limitation of organic content of landfilled waste was introduced in two steps, but took three separate pieces of legislation, as the first piece of legislation contained severe loopholes that were being used to avoid compliance.

Technical instructions on municipal waste (TASi 1993)
To ensure that landfills are environmentally sound, pose no future danger and require as little as possible aftercare, TASi describes specific requirements for the landfill site, the landfill construction and the landfill management as well as for the character of the landfilled waste. The latter requires wastes with biodegradable content to be stabilised and inert. For this purpose, the regulation contains limit values for organic content (TOC < 3%) as well as for the eluate. The implementation of the regulation was inadequate for several reasons:

- An Administrative Regulation is targeted only towards the competent authorities and not towards persons outside the administration.
- The Regulation accepted exemptions from the landfill ban in exceptional cases. However, the competent authorities of the provinces made wide use of these exemptions.
- The Regulation had allowed exceptions for a long transition period. Using the exemption rule, the transition period was being extended by some competent authorities.

These loopholes meant that although the legislation was in place in principal, its practical implementation was not sufficient to deliver the expected improvements (BMU 2006).

Waste Landfilling Ordinance (AbfAblV 2001)

The Waste Landfilling Ordinance aims to ensure that only waste that does not pose a danger to soil, groundwater, air and climate, can be disposed of in landfills. In practice, this means that the landfilling of household and similar waste without pre-treatment is prohibited.

With this ordinance the difficulties of the above mentioned Administrative Regulation should be remedied, which means mainly that;

- the limit values for landfilling become legally binding,
- exemptions are no longer possible,
- the transition period has a fixed rumination date, i.e. 1st June 2005.

This means that, after the 1st June 2005, biodegradable waste has to be treated before landfilling. Pre-treatment can include both incineration and high quality mechanical-biological methods. Furthermore, the ordinance was used to implement requirements of the EU Landfill Directive in the field of municipal waste. (ifeu 2005)

Ordinance on Landfills and Long Term Storages (DepV 2002)

While the Waste Landfilling Ordinance deals mainly with the quality of the waste streams to be landfilled, the Ordinance on Landfills and Long Term Storages covers technical aspects of the landfill, the site and its management. In addition, this ordinance also contains specific landfill bans, e.g. the ban to dispose of tyres in landfills.

3.2.2. Separate collection of waste streams with biodegradable content and subsequent adequate treatment

Separate collection of packaging waste

In Germany, packaging waste is regulated by the Packaging Ordinance (VerpackV 1991) introduced in 1991. Major amendments were adopted in 1998 and came into force on 1st January 1999.

The objectives of the first Packaging Ordinance of 1991 were;

- Reduction of packaging waste generation,
- Reduction of burden for municipalities to manage high packaging waste quantities.

Main concept of the Packaging Ordinance is producer responsibility, which means in this case that the producer and retailer of packaged products are obliged to take back used packaging and contribute to their further management. The implementation of this ordinance led to the green-dot system.

Since its first introduction, this ordinance has seen some minor amendments. In 2005 an amendment was introduced that increases recovery quotas in line with the 2004 amendment of the EU Packaging Directive. In Germany, however, all new target values were already reached before the implementation of the new legislation.

Take-back and recycling of graphic paper

In order to avert a legal obligation by means of an ordinance, the graphic paper industry (represented by the association AGRAPA) committed itself to a voluntary agreement in 1994, the objective of which was to increase the material recovery of graphic paper until 2000. Due to its success, the voluntary agreement was extended and has no expiry date.

Separate collection and recovery of commercial waste

According to the Commercial Waste Ordinance (GewAbfV 2003), the following fractions of commercial waste, which is similar to municipal waste, have to be separated and recovered:

- Paper and cardboard
- Glass
- Plastic
- Metals
- Biodegradable kitchen and canteen waste, biodegradable park and garden waste, market waste.

The operator of a treatment facility for the above mentioned waste fractions is obliged to manage the process in a way that a recovery quota of 85% is reached. The objectives of these obligations were to ensure that as much commercial waste as possible is recovered and that the recovery process results in products of high quality.

Separate collection and recovery of biowaste
Rules on separate collection and recovery of biowaste are dealt with in the Technical instructions on municipal waste (TASi 1993). Article 5 deals with questions on separate collection, and states:

- The responsible waste disposal authorities have to set up separate collection schemes for secondary materials which are not targeted by other pieces of legislation, this includes biowaste from households. Furthermore, the authorities have to ensure a biological treatment of the separately collected biowaste (TASi 5.2.1.2).
- Waste from public gardens, parks and cemeteries shall be kept separate and shall be recovered preferably from the municipality itself. Waste which can not be recovered by the municipality has to be collected separately and must be recovered as far as possible by an external waste disposal company.

An Administrative Regulation, however, is targeted towards and implemented by the competent authorities. Natural and legal persons outside the administration, like household or private companies, do not have to comply with this regulation directly, but only in those cases where they are addressed by administrative decrees. This means, for example, that an operator of a landfill is not bound by the TASi, but the permitting authority has to enforce TASi provisions.

Tyres
According to the Ordinance on Landfills and Long Term Storages the landfilling of waste tyres is prohibited. This landfill ban means that other recovery and disposal paths have to be used.

Construction and demolition waste
The German instruments on separate collection and recovery of construction and demolition waste (C&D waste) consist of two elements:

- In a voluntary agreement, the construction and demolition industry committed itself to halve the quantity of recyclable waste going to landfills from 1996 until 2005. The objective of the measure is to minimise C&D waste disposal by separate collection and treatment and to ensure high recycling quota.
- The Commercial Waste Ordinance covers also C&D waste. Waste glass, plastics, metals as well as concrete, tiles and bricks generated during construction and demolition activities have to be kept separate and have to be recovered in appropriate facilities.

3.3. Stages of implementation

The most relevant measure of the above mentioned package is the landfill ban. Therefore the stages of implementation are listed for this measure.

Banning biodegradable waste from landfill is achieved by limiting the organic carbon content of the landfilled waste (TOC<3%). This limit value can only be reached using

incineration methods; mechanical-biological treatment (MBT) alone is insufficient. A lengthy political debate took place on whether MBT is an appropriate measure to pre-treat residual waste before landfilling. This discussion is presented in the following table. A detailed description of the development is presented in the chapter 6.

Table 3.1. Stages of implementation for landfill ban

September 1990	In its document "Sondergutachten Abfallwirtschaft", the German Council of Environmental Advisors demands that residual waste should only be landfilled in a quality which is comparable to soil or ore, and thus should be subject of prior incineration.
June 1993	Administrative Regulation "Technical instructions on municipal waste" (TASi) enters into force. The Federal Council of Germany (Bundesrat) asks the government to clarify, if residues from mechanical biological treatment (MBT) may be landfilled under TASi requirements.
1996	The Ministry for Environment recommends in its reply not to use MBT as pre-treatment option for residual waste before landfilling.
1995 – 1999	Research programme of the Ministry for Research on "Mechanical-biological treatment of residual waste before landfilling".
November 1998	German Conference of Environment Ministers asks the government to check the possibility for inclusion of MBT into TASi under certain circumstances.
July 1999	German Umweltbundesamt states that MBT is no option under the given circumstances.
August 1999	Decision of the Ministry for Environment that high quality MBT will be admitted for pre-treatment of residual waste.
1 March 2001	Waste Landfilling Ordinance comes into force: Limit values are confirmed (TOC<3%) and now legally binding, but general exemption rule for residues from MBT (TOC<18%) introduced. Abolishment of all individual exemptions, granted by provinces or permission authorities. Final transition period until 1 June 2005 for landfill ban.
June 2004	German Highest Administrative Court approves that permits of competent authorities that do not follow the Waste landfilling Ordinance are not longer valid under the new legislation.
April 2005	European Court of Justice dismisses objections of a German waste management association against the Waste landfilling Ordinance.

4. Understanding the associated package of measures

4.1. Relationships with a package of other policy interventions

Landfill ordinances
There are currently five ordinances and two administrative regulations that deal with landfilling of waste and the landfill itself. In addition to the two ordinances and the administrative regulation mentioned in the previous chapter, the following pieces of legislation exist:

- Technical instructions on waste (TA Abfall 1991).
  This regulation deals with hazardous waste, including landfilling of hazardous waste.
- Ordinance on the underground stowage of waste (VersatzV 2002).
  The ordinance regulates the recovery of residues and wastes in underground mines.
- Ordinance on the recovery of waste on landfills above ground (DepVerwV 2005).
  The ordinance regulates the use of waste as construction material in landfills.
- Ordinance for determination of criteria and procedures for the acceptance of waste in landfills (AbfAnnahmeV 2007).
  This ordinance which comes into force on 1 February 2007 implements the respective Commission Decision of 2002.

Waste Wood Ordinance
Full title of this ordinance is Ordinance on requirements for recovery and disposal of waste wood (AltholzV 2003); it was adopted on 15 August 2002 and entered into force on 1 March 2003.

The objective of the ordinance is the encouragement of an environmentally sound recycling of waste wood, for example in the flake board industry, and the elimination of hazardous substances from the economic cycle. For this purpose it clearly defines which types of waste wood can be used in which processes, thus creating a common standard of waste wood treatment. Waste wood which cannot be recycled due to pollutant content (e.g. painted or impregnated wood) has to be disposed of in authorised incineration facilities. Energy recovery in biomass power stations is the usual way of disposal for this kind of waste wood.

It has to be noted that this ordinance contains obligation neither for take-back or separate collection, nor for recovery quotas of waste wood (ifeu 2005).

Biowaste Ordinance
Biowaste is covered by the Ordinance on the Recovery of Biowaste on Soils which are used for Agriculture, Forestry and Market Gardening (BioAbfV 1998).

Objectives of the ordinance are;

- to regulate the quality of compost which is produced for further use, especially the content of pollutants and the sanitisation quality.
- to regulate the use of composts on soils.

The ordinance does not contain obligations for separate collection or recovery of this waste stream (ifeu 2005).

Implementation of Incineration Directive
The first piece of legislation for reducing the environmental impacts of waste incineration in Germany was the 17th Ordinance for the execution of the Federal Immission Act: Ordinance on Incineration Facilities for Waste and similar combustible Materials, which was adopted in1990 (17. BImSchV 1990).

The objective of this ordinance was the reduction of harmful emissions into the air during waste incineration by introducing strict standards for air pollution control. The main measure of the ordinance was the provision of limit values for the emission of hazardous substances and, for the first time, also for dioxins. Another important topic was the legalisation of co-incineration, including rules for the calculation of limit values.

In 2003, the amendment of the 17th BImSchV was adopted. With this amendment, the ordinance was adjusted in order to comply with the EU Incineration Directive, which came into force in 2000. The main revisions dealt with the co-incineration of waste in industrial facilities. It is interesting that, with only one exception, the limit values for air emission remained the same as in the 1990-version of the ordinance.

Quality standards for mechanical-biological treatment of waste (MBT)
In 1999, the German Ministry for Environment accepted MBT as pre-treatment method for residual waste before landfilling and implemented this decision in the Waste landfilling Ordinance. Prerequisite for this decision was that only facilities with a high technical standard should be allowed to operate. Therefore, a respective ordinance was adopted in 2001: Ordinance for the execution of the Federal Immission Act: Ordinance on Facilities for the Biological Treatment of Waste (29. BImSchV).

The objective of this ordinance is the reduction of environmental effects caused by mechanical-biological treatment of waste before landfilling. MBT must only take place in capsuled rooms and limit values are so strict that a thermal off-gas treatment must be applied.

5. Factors influencing the effectiveness of a policy of waste diversion from landfill

In this section we present a reference indicator related to the Landfill Directive target on BMW, and a number of factors related to the landfill, incineration and recycling of waste. This information serves as input to the proposed methodology presented in Mazzanti and Zoboli (2007) which will also be used in the comparative analysis of the five countries and one region in the study. The information is summarised in Tables 5.35 – 5.38.

The key idea of the proposed procedure is that the *causal relationship* between *specific* landfill policy *changes* and the *changes* of an indicator representing waste diversion from landfills is *'controlled'* by the state of other hindering/favouring factors *at the time of policy implementation*. This reflects a system-wide approach, and it should help us to identify the *specific role of policy change* in the framework of *co-causation* arising from the many factors at work in the waste system. The proposed methodology is a mixed quantitative/qualitative one, and it should be able to exploit the information on policy changes and other 'explaining factors' in a coherent model-like approach.

The time of policy implementation is the year where the Landfill Directive was transposed. In the study this is used to assess the trends before and after the policy implementation. The year 2001 has been chosen as the reference year for Germany; the year the Waste Landfilling Ordinance went into force.

5.1. Development in reference indicator, waste landfilled/waste generated in 1995

Data for recovery and disposal of all fractions of BMW are only available from 1999 until 2005.

Table 5.1. Landfilled quantities of all BMW fractions

Waste type \ 1,000 t	1999	2000	2001	2002	2003	2004	2005
Paper waste	8	2	2	12	10	15	47
Biowaste HH	0	4	1	6	0	5	2
Biowaste Municip	494	290	354	36	17	44	23
BMW in resid. waste	5,171	4,669	4,167	4,216	3,492	3,261	1,450
BMW in bulky waste	768	582	510	522	386	365	162
BMW in comm. waste	1,424	1,583	1,807	832	751	543	243
Total	**7,865**	**7,130**	**6,842**	**5,625**	**4,655**	**4,233**	**1,927**

Source: Destatis 1996-2005

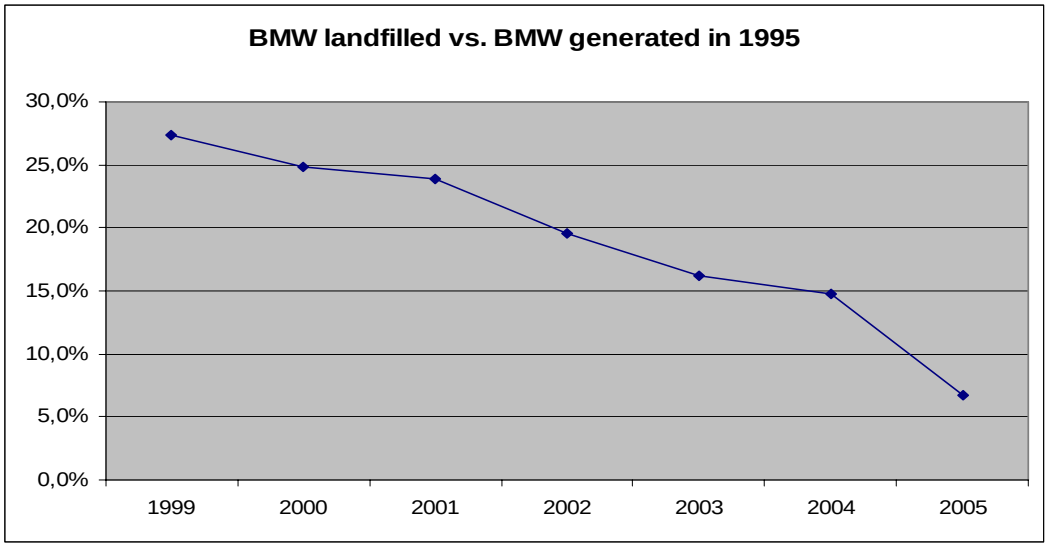
The official figure reported to the Commission for BMW generated in 1995 is 28,700 kt.

Table 5.2. BMW landfilled vs. BMW generated in 1995

Year	1999	2000	2001	2002	2003	2004	2005
BMW landfilled (in 1,000 t)	7,865	7,130	6,842	5,625	4,655	4,233	1,927
BMW landfilled / BMW generated in 1995	27.4%	24.8%	23.8%	19.6%	16.2%	14.8%	6.7%

Source for BMW generated in 1995: Eurostat

Figure 5.1. BMW landfilled vs. BMW generated in 1995



The limit values for landfilling organic waste were implemented in 3 steps:

- 1993: TASi
- 2001: Abfallablagerungsverordnung
- 2005: End of transition period

There are insufficient data for 1993 on which to produce a time series. Data for the year 2001, however, show a slight decrease in landfilled BMW which might be the effect of the Waste Landfilling Ordinance (AbfAblV) coming into force. A distinct decrease of landfilled BMW can be seen from 2004 to 2005, which is clearly the result of the implementation deadline of the Waste Landfilling Ordinance (AbfAblV).

5.2. Factors related to BMW landfill policy

5.2.1. Landfill Directive transposed

The political instruments related to the transposition of the Landfill Directive have been introduced in several steps.

First step was the introduction of TASi in 1993. This contained limits to the amount of organic waste to be landfilled as well as the technical requirements for the siting and construction of landfills. This means that main political instruments in landfill policy were already in force in Germany long before the Landfill Directive was adopted.

In order to solve difficulties with the implementation of TASi, and to introduce some changes necessary for the transposition of the Landfill Directive in Germany, two ordinances were put in force:

- Waste Landfilling Ordinance (AbfAblV) in 2001
- Landfill Ordinance (DepV) in 2002

As a last step, the transition period for landfilling of organic waste ended in mid 2005. Summing this development up, it can be stated that Germany transposed the Landfill Directive in time.

5.2.2. Landfill tariffs

There is no constant monitoring of prices in waste management. The following data were collected by surveys and provide only a limited indication of real prices nationwide.

Table 5.3. Landfill tariffs for commercial waste and municipal waste

	Commercial waste		Municipal waste	
Year	**1991**	**1992**	**2003**	**2004**
Minimum	9	22	28	30
Maximum	128	173	197	183
Average	47	73	93	89
Source	vanMark 1993		EUWID 2004	
Calculations	1 EUR = 1,9558 DM, VAT = 14%		VAT = 16%	

Note: in EUR/tonnes excl. VAT

The average price increased by about 90% between 1991 and 2004. This is much higher than the consumer price index, which increased by about 30% for the same period. The biggest increase, however, took place between 1991 and 1992 – when prices rose 50%. The price increase for landfilling of waste from 1992 – 2004 is only 22% and thus very close to the consumer price index of 23% (Source for consumer price index: Destatis 2007).

5.2.3. Landfill tax: Share of tax over tariff

German environmental policy, including waste policy, traditionally relies on rather strict regulatory instruments. As a supporting measure, the use of a landfill tax was discussed at the beginning of the 1990s. Due to strong opposition from other ministries and a number of provinces, this initiative was withdrawn. Therefore, there is no tax on landfilling of waste in Germany. Federal and provincial governments agree that regulatory instruments have already been successful in diverting waste from landfills and that there is no need to introduce additional economic instruments.

5.2.4. Pre-treatment

Under the TASi regulation, it is only permissible to landfill waste if it cannot be recovered and complies with the limit values dictated in the TASi annex. The latter is only achievable through the pre-treatment of waste. There is no direct obligation for pre-treatment before waste is landfilled but, implicitly, landfilling without pre-treatment is not possible. More accurately, the official explanation to TASi states that “Waste which cannot be recovered, has to be checked with regard to the landfilling criteria and has to be pre-treated before landfilling, if necessary”. The transition period for this rule ended in June 2005.

5.2.5. Selective bans

TASi also stipulates that TOC of waste for landfilling must meet a limit value of 3% (or 1% for technically lesser equipped landfills). Residues from MBT, however, can have a TOC of 18%. This effectively means that the landfilling of BMW is banned. The transition period for this rule ended in June 2005.

5.3. Factors related to waste generation and collection

5.3.1. Waste production

BMW

Generation of separately collected paper waste

For the purpose of this project, only paper waste collected from households and commercial activities, similar to households is considered. This waste stream consists of packag-

ing waste paper and graphic waste paper. The ratio of packaging against graphic paper changed from 1:2 in 1992 to 1: 4 in 2000.

Table 5.4. Paper waste generation (1 000 tonnes)

1990	1993	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2,150	3,946	5,486	5,719	6,513	6,944	7,263	7,550	8,590	8,419	7,740	7,895

Sources: Gallenkemper (1994) for 1990, Bilitewski (2003) for 1997, Destatis 1996-2005 for 1999 – 2005, all other years are interpolated.

Generation of separately collected biowaste from households

Separately collected biowaste from households comprises kitchen waste and garden waste.

Table 5.5. Generation of biowaste from households (1 000 tonnes)

1990	1993	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1,264	1,800	2,413	2,935	3,308	3,189	3,531	3,753	3,465	3,447	3,661	3,776

Sources: Estimation on basis of StBA (1990) for 1990, estimation on basis of StBA (1996) for 1993, Destatis (1996-2005) for 1996 – 2005

Generation of separately collected biowaste from municipalities

Biowaste from municipalities consists of green waste from public gardens and parks and also from green verges at the roadside.

Table 5.6. Generation of biowaste from municipalities (1 000 tonnes)

1990	1993	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
718	1923	3,069	3,216	3,137	4,223	4,380	4,239	4,163	3,845	4,172	3,924

Sources: Estimation on basis of StBA (1990) for 1990, estimation on basis of StBA (1996) for 1993, Destatis (1996-2005) for 1996 – 2005

BMW in residual waste

The quantity of residual waste is shown in Table 5.7.

Table 5.7. Generation of residual waste (1 000 tonnes)

1990	1993	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
33,807	24,728	19,875	18,476	17,313	17,173	18,030	16,466	17,090	15,824	15,558	13,912

Sources: StBA (1990) for 1990, StBA (1996) for 1993, Destatis 1996-2005 for 1996 – 2005

The share of BMW in residual waste is shown in Table 5.8. The figures for share of BMW are based on sorting analyses of residual waste. The biodegradable fractions, consisting of biowaste, paper and cardboard, wood, textiles and sanitary products, vary between 50% and 60% (see table 5.9).

Table 5.8. Share of BMW in residual waste

Year	1985	2002	2005
Biodegradable fractions	51 %	60 %	57 %
Source	Barghoorn (1986)	Fricke (2004)	Weigand (2005)

For the purpose of this assessment, the percentages of the latest available waste composition figures are used. This leads to the following results of BMW in residual waste.

Table 5.9. BMW in residual waste (1 000 tonnes)

Year	1990	1993	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Resid.	33,807	24,728	19,875	18,476	17,313	17,173	18,030	16,466	17,090	15,824	15,558	13,912
Share of BMW	51 %	51 %	60 %	60 %	60 %	60 %	60 %	60 %	60 %	57 %	57 %	57 %
BMW	17,242	12,611	11,925	11,086	10,388	10,304	10,818	9,880	10,254	9,020	8,868	7,930

BMW in bulky waste

The biodegradable fraction in bulky waste consists mainly of wood (furniture). For the share of BMW in bulky waste the arithmetic mean between the 45% of Kern (2005) and the 49% of Österreichisches Ökologieinstitut (2002) is taken, i.e. 47%.

Table 5.10. BMW in bulky waste (1 000 tonnes)

	1990	1993	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Bulky w.	3,427	3,818	3,003	3,170	3,174	3,021	2,568	2,676	2,933	2,608	2,589	2,167
BMW	1,611	1,794	1,411	1,490	1,492	1,420	1,207	1,258	1,379	1,226	1,217	1,018

Sources: StBA (1990) for 1990, StBA (1996) for 1993, Destatis 1996-2005 for 1996 – 2005

BMW in commercial waste that is similar to household waste

The main fractions in commercial waste are biowaste itself, paper and cardboard as well as wood. Three independent sources (Wuttke (1999), Wiemer (2002), Kern (2005)) all found that the share of BMW in commercial waste was around 41%.

Table 5.11. BMW in commercial waste (1 000 tonnes)

	1990	1993	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Comm. w.	15,239	7,839	5,317	5,305	5,079	8,337	7,335	8,109	5,092	4,718	4,143	4,161
BMW	6,248	3,214	2,180	2,175	2,082	3,418	3,007	3,325	2,088	1,934	1,699	1,706

Sources: StBA (1990) for 1990, StBA (1996) for 1993, Destatis 1996-2005 for 1996 – 2005

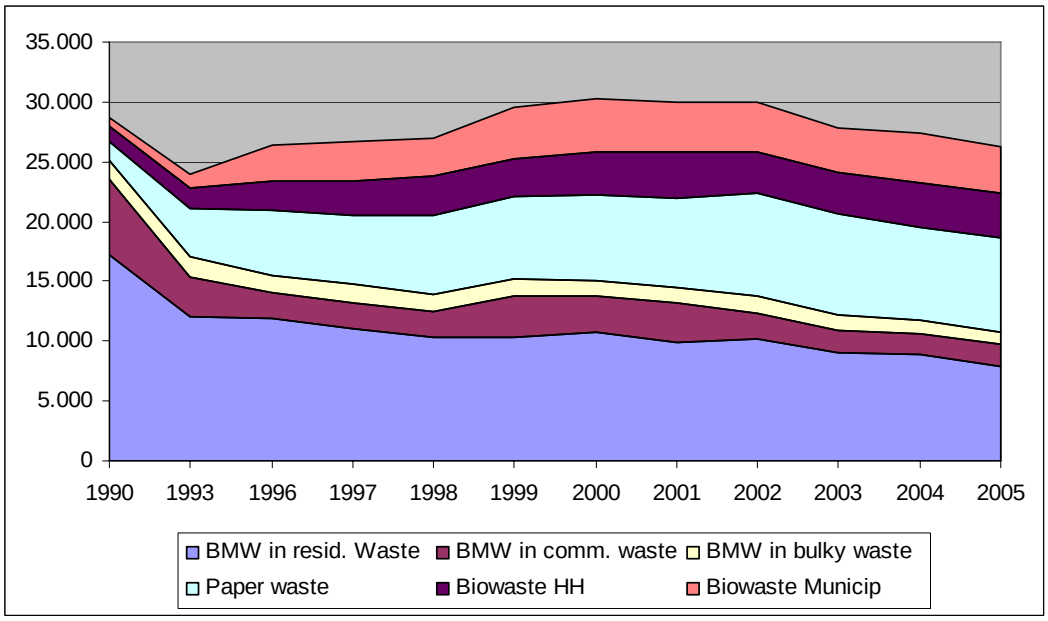
Total BMW

The total BMW generation is calculated by combining the figures for individual fractions.

Table 5.12. BMW generation (1 000 tonnes)

Year	1990	1993	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Paper waste	1.605	3.946	5.486	5.719	6.513	6.944	7.263	7.550	8.590	8.419	7.740	7.895
Biowaste HH	1.264	1.800	2.413	2.935	3.308	3.189	3.531	3.753	3.465	3.447	3.661	3.776
Biowaste municip	718	1.023	3.069	3.216	3.137	4.223	4.380	4.239	4.163	3.845	4.172	3.924
BMW in resid. waste	17.242	12.117	11.925	11.086	10.388	10.304	10.818	9.880	10.254	9.020	8.868	7.930
BMW in bulky waste	1.611	1.794	1.411	1.490	1.492	1.420	1.207	1.258	1.379	1.226	1.217	1.018
BMW in comm. waste	6.248	3.214	2.180	2.175	2.082	3.418	3.007	3.325	2.088	1.934	1.699	1.767
Total BMW	**28.687**	**23.894**	**26.494**	**26.621**	**26.920**	**29.498**	**30.206**	**30.004**	**29.938**	**27.891**	**27.357**	**26.310**

Figure 5.2. BMW generation, 1990-2005 (1 000 tonnes)



Germany's base year as assigned by the EU Landfill Directive is 1993, in which, according to officially reported data, 28.7 million tonnes of BMW were generated. For the purpose of this evaluation the figures for BMW generation are given here on a per capita basis.

Table 5.13. BMW generation per capita

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total BMW (in 1,000 t)	26,484	26,621	26,920	29,498	30,206	30,004	29,938	27,891	27,357	26,310
Inhabitants (in million)	81.8	82.0	82.1	82.0	82.2	82.3	82.4	82.5	82.5	82.5
BMW per capita (kg)	324	325	328	360	367	365	363	338	332	319

Source for inhabitants: Europa in Zahlen Eurostat Jahrbuch 2006 - 2007

5.3.2. Separate collection policy: Share of BMW production collected separately

BMW collected separately vs. municipal waste/BMW generated

The whole fractions of paper waste and generated biowaste are regarded as separately collected. The data are taken from the previous chapter on BMW generation.

Table 5.14. BMW collected separately (1 000 tonnes)

Year	1990	1993	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Separate BMW collection (total)	3.587	6.769	10.968	11.870	12.958	14.356	15.174	15.542	16.218	15.711	15.573	15.595
BMW generated	28.687	23.894	26.494	26.621	26.920	29.498	30.206	30.004	29.938	27.891	27.357	26.310
Separate BMW collection (% of BMW)	**13%**	**28%**	**41%**	**45%**	**48%**	**49%**	**50%**	**52%**	**54%**	**56%**	**57%**	**59%**
MSW generated	n/a	n/a	44.417	45.592	44.827	49.692	50.142	49.462	52.736	49.583	48.428	49.583
Separate BMW collection (% of MSW)			**25%**	**26%**	**29%**	**29%**	**30%**	**31%**	**31%**	**32%**	**32%**	**31%**

Specific collection rate for waste paper

The total quantity of waste paper is calculated by adding the separately collected share and the share which still remains in residual waste, bulky waste and commercial waste. Only waste paper that is collected by the green-dot system for packaging waste, and by

the AGRAPA system for graphic paper, is considered as separately collected. The data are taken from the previous chapter on BMW generation. The sources for the share of BMW in specific waste streams are:

- Residual waste: see previous chapter on BMW in residual waste,
- Bulky waste: Wiemer (2002), 2.9%,
- Commercial waste: arithmetical mean of Wuttke (1999) and Wiemer (2002), 9%.

Table 5.16. Paper waste collected separately (1 000 tonnes)

Year	1990	1993	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Separately collected waste paper	2150	3946	5486	5719	6513	6944	7263	7550	8590	8419	7740	7895
Waste paper in residual waste	5409	3956	3180	2956	2770	2748	2885	2635	2734	1266	1245	1113
Waste paper in bulky waste	99	111	87	92	92	88	74	78	85	76	75	63
Waste paper in commercial waste	1372	706	479	477	457	750	660	730	458	425	373	388
Total waste paper	9030	8718	9232	9245	9832	10530	10882	10992	11868	10185	9433	9459
Share of sep. collected waste paper	**24%**	**45%**	**59%**	**62%**	**66%**	**66%**	**67%**	**69%**	**72%**	**83%**	**82%**	**83%**

Specific collection rate for biowaste

The total quantity of biowaste is calculated by combining the figures for separately collected biowaste with the figures for the quantities of biowaste remaining in residual waste, bulky waste and commercial waste. Biowaste which is treated by the households and municipalities under the heading of home composting is not considered for this calculation due to lack of data. Only biowaste collected under a separate collection scheme by the municipalities is considered as separately collected.

Table 5.17. Separately collected biowaste (1 000 tonnes)

Year	1990	1993	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Separately collected biowaste	1982	2823	5482	6151	6445	7412	7911	7992	7628	7292	7833	7700
Biowaste in residual waste	11156	8160	6559	6097	5713	5667	5950	5434	5640	3640	3578	3200
Biowaste in bulky waste	103	115	90	95	95	91	77	80	88	78	78	65
Biowaste in commercial waste	991	510	346	345	330	542	477	527	331	307	269	280
Total biowaste	14232	11607	12476	12688	12584	13712	14415	14033	13687	11316	11758	11245
Share of sep collected biowaste	**14%**	**24%**	**44%**	**48%**	**51%**	**54%**	**55%**	**57%**	**56%**	**64%**	**67%**	**68%**

5.3.3. Full cost collection tariffs / charges: Share of management costs covered by tariffs

In Germany, the management of municipal waste is the task of public waste disposal authorities, which are defined in provincial legislation. Usually the function of the waste disposal authorities is allocated to the administrative districts (Landkreise und kreisfreie Städte). The waste disposal authorities are obliged to collect, transport and dispose of or recover the municipal waste in accordance with the German waste management acts. The costs from these activites are the responsibility of the authorities, who pass them on to private households by means of a tariff system. In contrast to a tax system, the tariff system offers a service from the state in return (Wonke 2006).

The usual rules for tariff calculation have to be applied (Rahmeyer 2006):

- Benefit principle: citizens who benefit from services of the municipalities have to pay for it and the tariff has to be in the right proportion to the value of the service.

- Cost recovery principle: the tariffs have to be set in such a way that the revenues do not fall short of, or exceed, the costs for the municipalities.

The one exemption to these principles is the use of increased tariffs for the purpose of initiating waste prevention.

This means that in practice each waste disposal authority has to calculate its tariffs based on its individual waste management situation. In a comparison of waste tariffs for 2003 and 2004, figures range between 40EUR/year and 340EUR/year for a four person household. The wide variations are a result of different collection schemes (kerbside collection of biowaste, collection system for bulky waste) and different waste treatment paths, including the quality of the facilities. (StMUGV 2006)

There is no general monitoring and verification of waste tariffs, which means that it is not possible to achieve an overview of information on the level of cost recovery of waste management services. It can be assumed, however, that according to the general rules mentioned above, the tariff covers around 100% of the waste management costs.

5.4. Factors related to landfill sector

Municipal waste landfilled of the total generation of municipal waste
The share of landfilled municipal waste is shown in Table 5.18.

Table 5.18. Landfill quota of municipal waste

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
MSW generated [kg/cap]	624	642	658	647	638	643	633	640	601	587	564
MSW landfilled [kg/cap]	245	225	216	199	180	165	160	137	115	104	48
Share	**39%**	**35%**	**33%**	**31%**	**28%**	**26.0%**	**25%**	**21%**	**19%**	**18%**	**9%**

Source: Eurostat Structural Indicators.

5.4.1. Landfill residual capacity

In the case of municipal waste, the landfill capacity for non-hazardous waste is relevant. There are no data on the temporal development of landfill residual capacity available, only for number of landfills for municipal waste.

Table 5.19. Number of landfills for municipal waste

1990	1993	1995	1998	2000	2005
8,273	562	472	421	333	160

The strong decrease in number of landfills from 1990 to 1993 can be explained by the situation in Eastern Germany. In all, 8 000 of the 8 273 landfills reported in 1990 existed in the former DDR, most of which were dumping sites without proper technical standard. They had to be closed down after the adoption of West German waste legislation in Eastern Germany in October 1990.

In a study on the future management of landfill space, a survey on municipal landfills and their residual capacity was carried out. At the close of 2000, 333 municipal landfills with a total residual capacity of 375 million m³ were identified (BMU 2006).

For the year 2000, the landfill residual capacity is related to diverse municipal waste streams (generation, landfill, landfill and incineration). In order to get an impression of the likely lifespan of the available landfill space, the density of household waste in landfills can be taken as 1 t/m³ as a rule of thumb.

Table 5.20. Residual landfill capacity related to different waste quantities

Waste stream	MSW generated	MSW landfilled	MSW LF + incin
Landfill residual capacity [in million m³]	375	375	375
Waste quantity [in million. t/year]	50.14	13.56	30.206
[in years m³/t] (first approximation: years)	7.5	27.6	12.4

5.4.2. Population density

Although the population density in Germany is about twice that of the EU-25, there is no scarcity of land for the purpose of landfill siting. The population density is presented in number of inhabitants per km².

Table 5.21. Population density

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005
Population density	229.8	229.7	230.0	230.2	230.6	231.0	231.2	231.1	230.9

Source: Eurostat (2007a)

For the purpose of the evaluation, the indicator is reversed to land per capita [in m²]:

Table 5.22. Land per capita

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005
Land per capita [m²]	4352	4354	4348	4344	4337	4329	4325	4327	4331

5.5. Factors related to incineration sector

5.5.1. Municipal waste incinerated of the total generation of municipal waste

The share of landfilled municipal waste is shown in Table 5.23.

Table 5.23. Incineration quota of municipal waste

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
MSW generated [kg/cap]	624	642	658	647	638	643	633	640	601	587	564
MSW incinerated [kg/cap]	97	106	111	112	125	133	135	143	137	144	160
Share	**16%**	**17%**	**17%**	**17%**	**20%**	**21%**	**21%**	**22%**	**23%**	**25%**	**28%**

Source: Eurostat Structural Indicators.

5.5.2. Incineration capacity

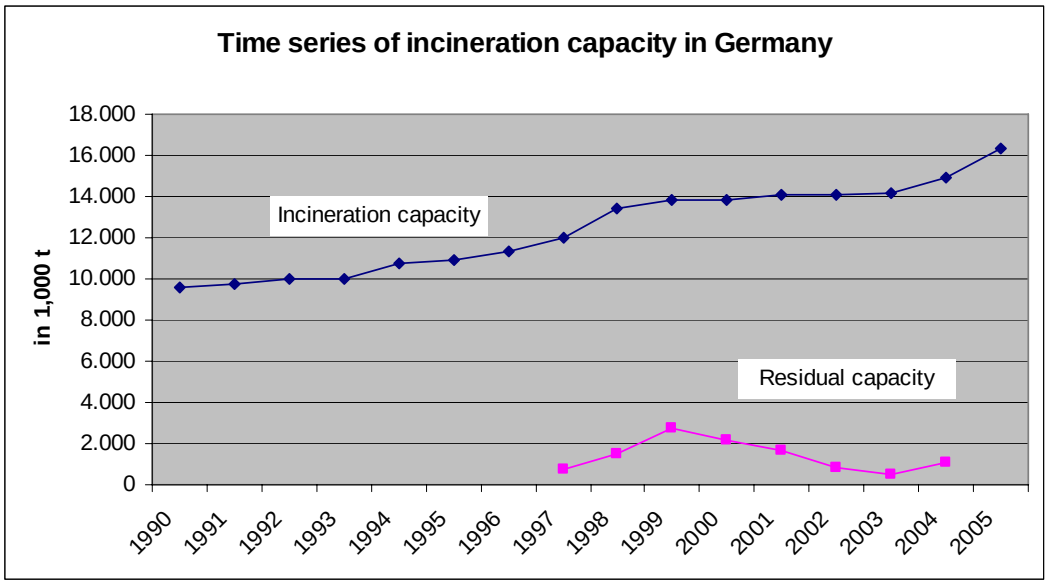
Based on data of the Interessengemeinschaft der thermischen Abfallbehandlungsanlagen in Deutschland (ITAD e.V.), the following time series for capacity of waste incineration facilities has been calculated. The figures are in 1000 tonnes.

Table 5.24. Incineration capacity (1 000 tonnes)

1990	1991	1992	1993	1994	1995	1996	1997
9.618	9.709	9.959	9.959	10.755	10.955	11.345	12.011

1998	1999	2000	2001	2002	2003	2004	2005
13.381	13.861	13.861	14.097	14.097	14.181	14.902	16.307

Figure 5.3. Incineration capacity



For the purpose of the evaluation, the incineration capacity is related to municipal waste generated / incinerated / landfilled + incinerated (Capacities and waste quantities in 1,000 tonnes).

Table 5.25. Incineration capacity for different waste streams (1 000 tonnes)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Incineration capacity	10955	11345	12011	13381	13861	13861	14097	14097	14181	14902	16307
MSW generated	43440	44417	45592	44827	49692	50142	49462	52736	49583	48428	49583
Percentage	0.25	0.26	0.26	0.30	0.28	0.28	0.29	0.27	0.29	0.31	0.33
MSW incinerated	7906	8671	9102	9195	10250	10933	11111	11783	11303	11880	12210
Percentage	1.39	1.31	1.32	1.46	1.35	1.27	1.27	1.20	1.25	1.25	1.34
MSW LF + incin	27873	27076	26814	25533	25010	24496	24279	23072	20790	20460	19553
Percentage	0.39	0.42	0.45	0.52	0.55	0.57	0.58	0.61	0.68	0.73	0.83

5.5.3. Incineration gate fees

As stated in the section on landfill gate fees above, there is no constant monitoring of prices in waste management. The following data were collected by surveys and provide only an indication of real prices.

Table 5.26. Incineration tariffs for commercial waste and municipal waste

	Commercial waste			Municipal waste
Year	**1990**	**1991**	**1992**	**2005**
Minimum	22	54	55	60
Maximum	96	202	161	271
Average	53	93	110	127
Source	vanMark 1993			EUWID 2005
Calculations	1 EUR = 1,9558 DM, VAT = 14%			VAT = 16%

Note: in EUR/tonnes excl. VAT

The increase of the average price from 1990 until 2004 is about 140%. This is much higher than the consumer price index, which is about 35% for the same time period. The biggest increase, however, took place between 1990 and 1992; in increase of nearly 110%. The price increase for incineration of waste from 1992 – 2005 is 15% and thus remarkably lower than the consumer price index of 25% (Source for consumer price index: Destatis 2007).

A reason for the low price increase is the development in waste incineration technology. The first facilities were specifically designed for each plant, but once the technology matured, facilities could be implemented using off-the-shelf technology .

5.5.4. National policies on RES (Renewable energy sources)

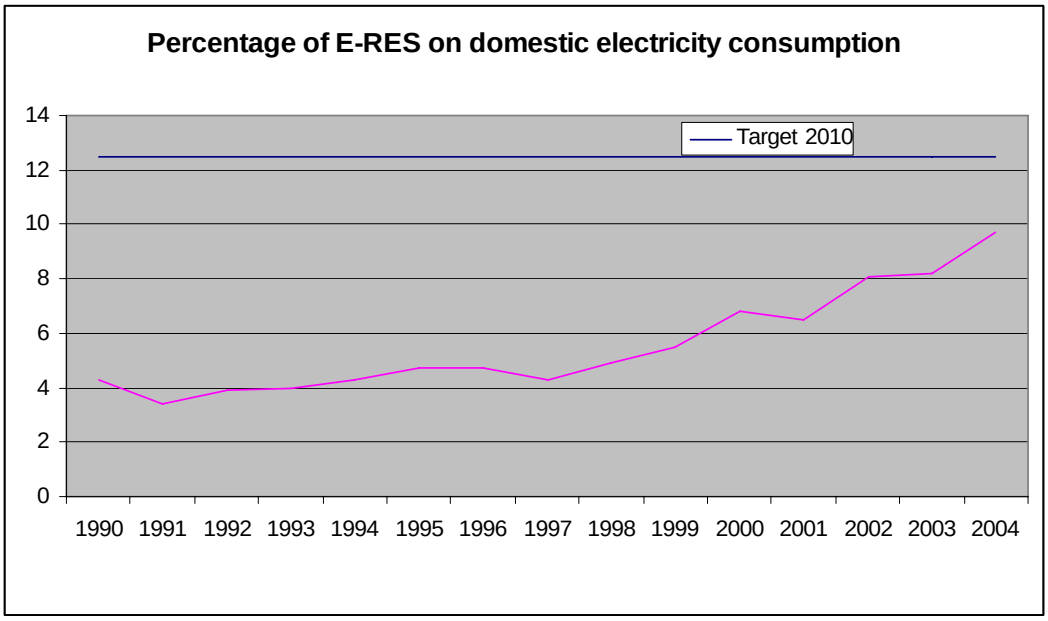
This indicator is the ratio between the electricity produced from renewable energy sources and the gross national electricity consumption for a given calendar year. It measures the contribution of electricity produced from renewable energy sources to the national electricity consumption (target for 2010 is 12,5%). Electricity produced from renewable energy sources comprises the electricity generation from hydro plants (excluding pumping), wind, solar, geothermal and electricity from biomass/wastes. Gross national electricity consumption comprises the total gross national electricity generation from all fuels (including autoproduction), plus electricity imports, minus exports.

Table 5.27. Electricity produced from RES (%)

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
4.3	3.4	3.9	4	4.3	4.7	4.7	4.3	4.9	5.5	6.8	6.5	8.1	8.2	9.7

Source: Eurostat (2007b)

Figure 5.4. Percentage of E-RES on domestic electricity consumption



The following table presents the progress towards the target in % of target value for 2010.

Table 5.28. Electricity produced from RES – % points of target

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
34%	27%	31%	32%	34%	38%	38%	34%	39%	44%	54%	52%	65%	66%	78%

5.6. Factors related to material recycling and recovery sector

5.6.1. Packaging policy in place

Data on packaging waste in Germany are provided by the Gesellschaft für Verpackung Marktforschung. A recycling rate for paper and cardboard is provided that relates recycling and consumption of packaging materials from private households.

Table 5.29. Recycling rate for paper and cardboard packaging from private households (%)

1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
28.0	41.2	52.8	n/a	61.1	70.9	76.3	74.7	75.5	77.4	77.2	81.0	78.0	77.2	79.3

Note: Data for 2005 are a preliminary estimation.
Source: GVM (2006)

5.6.2. MBT capacity available

In addition to the collection of individual data in selected publications, it is possible to estimate the MBT capacity by using information about existing MBT facilities on the ASA homepage. In a simplified method, the capacity of all existing MBT facilities is calculated, starting from the year of their construction. One fault in this method is that it ignores temporary or permanent closures over the time period, so these figures represent a maximum, rather than actual, capacity.

Table 5.30. MBT capacities

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Calculation based on data from Arbeitsgemeinschaft Stoffspezifische Abfallbehandlung (ASA 2007)											
Capacity [in 1,000 t]	75	118	527	666	860	1 513	1 738	1 898	2 038	2 322	4 843
Data from literature											
Capacity [in 1,000 t]						1 900				2 900	4 846
Sources						1)				2)	3)

Sources: 1) Fritsche 2004, 2) Prognos 2005, 3) Umweltbundesamt 2006

For the purpose of the evaluation, the incineration capacity is related to municipal waste generated / landfilled + incinerated. Capacities and waste quantities are in 1 000 tonnes.

Table 5.31. MBT capacities for different waste streams

Year	2000	2004	2005
MBT capacity [in 1000 t]	1,900	2,900	4,846
MSW generated [in 1000 t]	50,142	48,428	49,583
Percentage	0.04	0.06	0.10
MSW LF + incineration [in 1000 t]	24,496	20,460	19,553
Percentage	0.08	0.14	0.25
BMW generated	30,206	27,357	25,293
Percentage	0.06	0.11	0.19

5.6.3. Capacity for biological treatment

In addition to the capacity of composting facilities - the official indicator for biological treatment - data on facilities for anaerobic treatment of biowaste are also provided.

Table 5.32. Compost capacity

Year	1991	1993	1996	1998/99	2003	2005
No of facilities	73	100	380	544	880	
Capacity	n/a	1.15 Mio t.	5 Mio t	7.1 Mio t	11.1 Mio t	10 Mio t
Source	Turk 1992	Büker 1994	Müller-Langer 2006	Müller-Langer 2006	Kern 2006	BGK 2006

Table 5.33. Capacity for anaerobic treatment

Year	1996	1998/99	2003
No of facilities	22	42	85
Capacity	0.3 Mio t	1.2 Mio t	2.8 Mio t
Source	Müller-Langer 2006	Müller-Langer 2006	Kern 2006

Table 5.34. Capacity for total biological treatment

in million tonnes	1996	1999	2003
Capacity Compost	5	7.1	11.1
Capacity Digest	0.3	1.2	2.8
Total capacity biol. treatment	5.3	8.3	13.9
Biowaste collected	5.5	7.4	7.3
Percentage (total capacity bio. treatment vs. biowaste)	0.96	1.12	1.90
BMW generated	26.49	29.5	27.89
Percentage (capacity compost vs. BMW generated)	0.19	0.24	0.40

5.7. Tyres

Generation of waste tyres in 1000 t

Year	1995	2001	2003	2004
Waste tyres arisings	600	578	582	585

Source: Gesellschaft für Altgummi-Verwertungs-Systeme

5.8. Construction and demolition waste

Generation and management of construction and demolition waste in 1000 t

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Generation	231.480	229.338	230.997	252.377	253.700	243.660	240.812	223.389	187.478	184.919
Recovery		197.958	201.215	220.453	222.229	215.045	205.914	192.484	162.280	159.532
Incinerati-on		1	0	568	512	541	572	639	883	1.121
Landfill		31.363	29.771	31.488	30.958	28.073	30.741	26.878	25.415	23.220

Source: Destatis (1996-2005)

5.9. Factors influencing the effectiveness of a policy for diversion of BMW from landfill

Table 5.35. Factors influencing the effectiveness of a policy for diversion of BMW from landfills

Favour-ing/hindering factors	Influence on diver-sion	Justification of the +/- sign	Indicator	1990	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Reference indicator														
BMW landfilled vs. BMW gen-erated in 1995			BMW landfilled / BMW gen-erated in 1995 [in %]					27.4%	24.8%	23.8%	19.6%	16.2%	14.8%	6.7%
Factors related to BMW landfill policy														
Landfill Directive 1999/31/EC transposed	+	*Legal framework in place*	*Dummy (1/0) If implemented no later than 2003 =1*	0	0	0	0	0	0	1	1	1	1	1
Landfill tariffs / gate fees for BMW or MSW (excl. VAT and landfill tax)	+	*High cost of landfill*	*Average for country, or the highest gate fee and the lowest gate fee, in EUR / t*	47 (1991)	73 (1992)							93	89	
Landfill tax on BMW (or MSW)	+	*High cost of landfill*	*Average for country, or the highest and the lowest tax, % of gate fee*	0 (no landfill tax in Germany)										
Prohibition of untreated waste in landfill	+	*Discourage landfill*	*Dummy (1/0) If implemented no later than 2005 =1*											1
Selective ban on BMW	+	*Quantity limitation by law*	*Dummy (1/0) If implemented no later than 2005 =1*											1
Factors related to waste production and collection														
BMW genera-tion	-	High production requires many management options	BMW generation per capita, [in kg/y]		324	325	328	360	367	365	363	338	332	319
Separate col-lection for BMW	+	Basic require-ment for recycling	Share of generated BMW collected separately [in % of MSW gen.]		25%	26%	29%	29%	30%	31%	31%	32%	32%	31%

Favour-ing/hindering factors	Influence on diver-sion	Justification of the +/- sign	Indicator	1990	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
'Full cost' collection tariffs/charges (excl. VAT and taxes)	+	Higher capacity to invest in sepa-rate collection and recov-ery/recycling	Share of waste management cost covered by tariffs, %	concrete data for Germany not available according to legislation the collection charges should cover 100% of the costs										
Factors related to landfill sector														
MSW landfilled of total MSW generated	+	Pressure on capacity	Landfilled municipal waste over municipal waste genera-tion, %		35%	33%	31%	28%	26.0%	25%	21%	19%	18%	9%
Landfill residual capacity per MSW gener-ated	-	Discourage diversion	Landfill residual capacity for non-hazardous waste (years for landfilling of municipal waste)						7.5					
Land per capita	+	Land availability makes it a non-scarce resource	Land per capita in m2			4352	4354	4348	4344	4337	4329	4325	4327	4331
Factors related to incineration sector														
MSW incin-erated of total MSW gener-ated	-	Low incineration rate: makes diversion more difficult	Incinerated municipal waste over municipal waste genera-tion, %		17%	17%	17%	20%	21%	21%	22%	23%	25%	28%
Dedicated incineration capacity for MSW gener-ated	+	Makes diversion easier	Incineration capacity avail-able, % of generated munici-pal waste		26%	26%	30%	28%	28%	29%	27%	29%	31%	33%
Incineration gate fees for MSW (excl. VAT and incin-eration tax)	-	High fee, low incentive to diversion	Average for country, or the highest gate fee and the lowest gate fee, in EUR / t	53	110 (1992)									127
National poli-cies on RES: Target for DE 12,5% in 2010	+	Targets for RES policies stimulate energy from MSW	Distance-to-target for E-RES on domestic electricity con-sumption, % of target value	34%	38%	34%	39%	44%	54%	52%	65%	66%	78%	

Favour-ing/hindering factors	Influence on diver-sion	Justification of the +/- sign	Indicator	1990	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Factors related to material recycling and recovery sector														
Packaging and packaging waste policy	+	Stimulates diver-sion	Recycling rate (recycling over paper packaging placed on the market), %	28.0%(1991)	70.9%	76.3%	74.7%	75.5%	77.4%	77.2%	81.0%	78.0%	77.2%	79.3%
MBT capacity	+	Favours diversion	MBT capacity, % of gener-ated BMW					6%					11%	19%
Biological treatment capacity (i.e. input of bio-waste)	+	Favours diversion	Biological treatment capacity, % of generated BMW		19%			24%				40%		

We use 2001 as the reference year, because this was the year the Waste Landfilling Ordinance went into force and in this year the reference indicator shows a change.

Table 5.36. Evaluation of indicators for landfill policy in 2001

Landfill policy	Indicator	Strong	Weak
Landfill Directive 1999/31/EC transposed	*Dummy (1/0) If implemented no later than 2003 =1*	1	
Landfill tariffs/gate fees for BMW or MSW (excl. VAT and landfill tax)	*Average for country, or the highest gate fee and the lowest gate fee, % increase for available data*		22% from 1992 - 2004
Landfill tax on BMW or MSW	*Average for country, or the highest and the lowest tax, % of gate fee*		Tax is 0% of gate fee
Prohibition of untreated waste in landfills	*Dummy (1/0) If implemented no later than 2005 =1*	1*	
Selective ban on BMW	*Dummy (1/0) If implemented no later than 2005 =1*	1*	
Summary evaluation		**3**	**2**

* The German waste legislation (TASi) stipulates that TOC of waste for landfilling must be no higher than 3% (or 1% for technically less equipped landfills). This effectively bans the landfilling of BMW. In addition, the legal explanations to the TASi specify that "waste which cannot be recovered, has to be checked with regard to the landfilling criteria and has to be pre-treated before landfilling, if necessary". The transition period for these rules ended in June 2005.

⇨ **Landfill policy is globally strong.**

Table 5.37. Evaluation of favouring and hindering factors in 2001

	Favouring factors (+ sign)					Hindering factors (- sign)			
		Indicator	Strong if	Weak if			*Indicator*	Strong if	Weak if
	Related to waste production and collection								
1	Separate collection for BMW	*Share of BMW collected separately of generated MSW, %*	**DE 31%** (> 30%)	< 30%	1	BMW generation per capita	*BMW generation, per capita tonnes*	**DE 365** (>EU-25: 359)	< EU-25 average
2	'Full cost' collection tariffs/ charges	*Share waste management cost covered by tariffs/charges, %*	**DE n/a** (>90%)	< 90%					
	Related to landfill sector								
3	Landfilled MSW of MSW generation	*Landfill share in MSW waste generation, %*	>EU average	**DE 25%** (<EU-25 : 53%)	2	Landfill residual capacity (non-hazardous waste)	*Landfill capacity (non-hazardous), as % of MSW generated*	**DE 7.5 y** (>5 years)	< 5 years
					3	Land availability	*Land per capita in m2*	>5000	**DE 4337** (<5000)
	Related to incineration sector								
4	Dedicated incinera-	*Incineration capacity, as*	**DE 29%** (>20%)	<20%	4	Incineration gate	*Average for country,*	>30%	**DE 15%** from

	Favouring factors (+ sign)					Hindering factors (- sign)			
		Indicator	Strong if	Weak if			*Indicator*	Strong if	Weak if
	tion capacity for MSW (available)	*% of MSW generated*				fees for MSW	*or the highest gate fee and the lowest gate fee, EUR/tonne*		1992 – 2005 (<30%)
5	National policies on RES	*Distance-to-target for E-RES on domestic electricity consumption, %*	<50% of the 2010 target has been met	**DE 52%** (>50% of the 2010 target has been met)	5	Share of MSW incinerated	*Incinerated MSW over MSW generation, %*	**DE 21%** (>EU-25: 17%)	<EU-25 average
	Related to material recycling and recovery sector								
6	Packaging and packaging waste policy	*Recycling rate paper and paperboard, %*	**DE 77%** (>50%)	<50%					
7	MBT capacity	*MBT capacity vs. BMW gener.*	>20%	**DE 6%** (<20%)					
8	Compost capacity	*Compost capacity (input biowaste), vs. BMW gener. tonnes/year*	**DE 24%** (>20%)	<20%					
	Summary evaluation	***Globally strong: 4 out of 7***	**Globally strong: If at least 5 strong out of 8**	**Globally weak: If at least 5 weak out of 8**		**Summary evaluation**	***Globally strong: 3 out of 5***	**Globally strong: If at least 3 strong out of 5**	**Globally weak: If at least 3 weak out of 5**

Table 5.38. Policy evaluation according to methodology (Zoboli 2007)

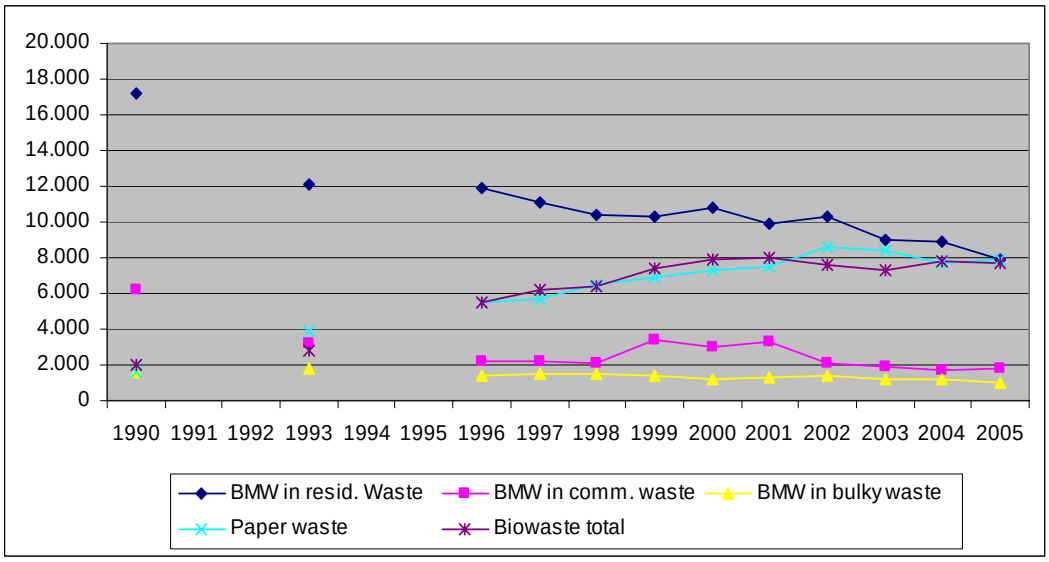
Combination	Landfill policy change	Favouring / hindering factors	Summary evaluation
5	Strong: The existing policy was far from the directive or was already in line, but its change went beyond the directive.	Combination 5: Strong favouring factors Strong hindering factors.	Effective: policy has been very active and it has exploited / reinforced strong favourable factors to counter strong hindering factors, leading to trend improvement.

6. Assessment and effectiveness evaluation of implemented policies

6.1. Overview of BMW

Composition of BMW
The following diagram shows the time series of all fractions which together constitute BMW.

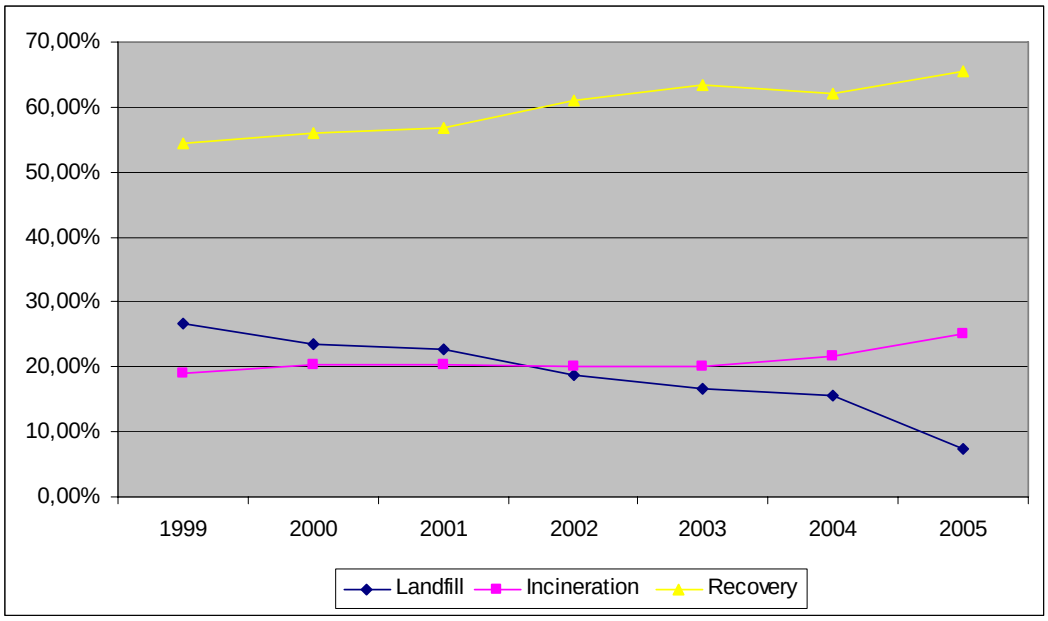
Figure 6.1. BMW fractions (in 1 000 tonnes)



At the beginning of the 1990s, the separate collection of paper and biowaste existed but was under-developed. At this time, the largest share of BMW (nearly 90%) consisted of the biodegradable content of residual and commercial waste. In the following years, separate collection schemes began to come into action, which transfered the BMW-content in municipal waste from residual waste to separately collected waste fractions. Although BMW in residual waste decreased by 50% between 1990 and 2005, it still remains the largest fraction of BWM in municipal waste. Separately collected paper waste and separately collected biowaste (as total of household and municipal sources) follow a near identical development: a quadrupling between 1990 to 2000, followed by relative stability in the years since. Each of the separately collected waste streams are nearly as large as the BMW fraction in residual waste. BMW is the smallest fraction in bulky waste, and has been almost stable of the whole investigated period.

Management of BMW
Unfortunately, detailed figures for management routes of BMW in municipal waste are only available from 1999 until 2005 (see following diagram).

Figure 6.2. Management routes of BMW



The predominant management route for BMW is recovery, i.e. recycling of paper waste and biological treatment of biowaste. The increase in recovery from 54% to 66% can be explained by the growth in separate collection, which enable almost complete recovery. The share of incinerated and landfilled BMW is dominated by the biodegradable part of residual waste. The steady decline of landfilling of BMW can be explained mainly by the decrease of residual waste itself due to separate collection schemes, but also by the shift from land landfilling to incineration and MBT. Consequently, incineration has a slightly increasing share of the total.

6.2. Development of waste paper management

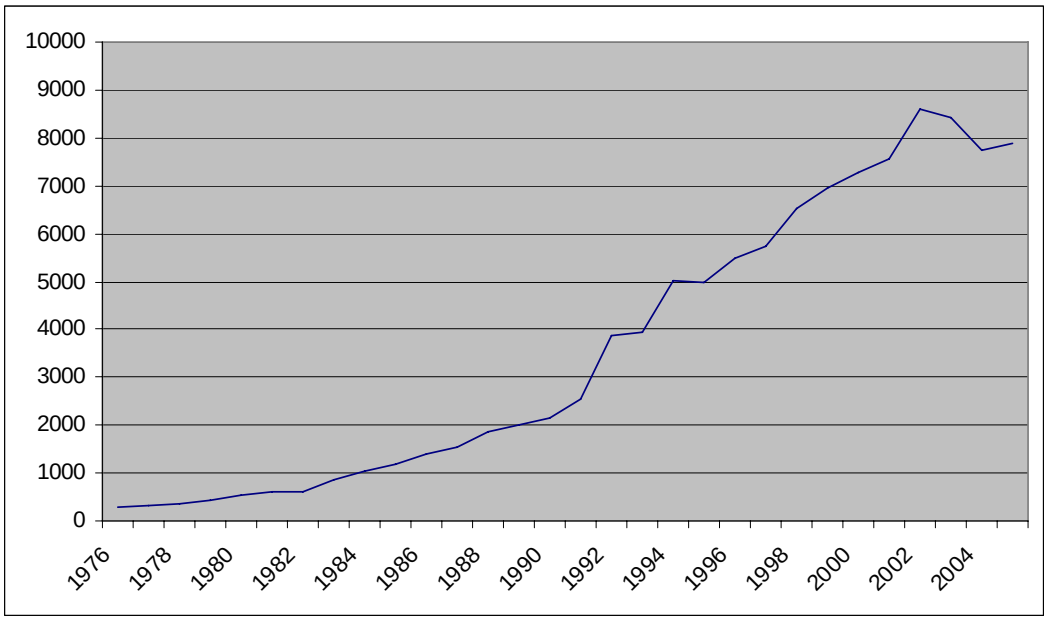
Historical development until policy intervention

Waste paper can be used as raw material for the production of new paper. Separate collection and recycling of paper waste has a long tradition in Germany. In 1907 in the Berlin region, for example, there was more than thousand sorting companies and traders of secondary raw material, including paper waste (Köstering 2003).

The most favourable source for waste paper is the paper processing industry itself, due to both the high quantity of paper waste per production site and the high quality of the paper waste. The use of these residues from paper processing meant that in the mid 1970s nearly 2.5 million tonnes of waste paper were recycled in the paper industry, which means a rate of waste paper in paper production of 46%. A further 300 000 tonnes were collected from households (Gallenkemper 1994). For the purpose of this study only paper waste collected from households and similar institutions are of relevance.

The following diagram is produced by using different sources and applying interpolations for about half the years between 1976 and 1998.

Figure 6.3. Waste paper collected from household (in 1 000 tonnes)



Sources: Gallenkemper (1994) for 1976, 1980, 1982, 1984, 1986, 1988, 1990, 1991
Bilitewski (2003) for 1992, 1994, 1997
Destatis (1996-2005) for 1999 – 2005
All other years are interpolated

Nevertheless, the time series shows a relatively stable increase in the amount of waste paper collected. Even before the first policy intervention in 1991, the developing waste management system, initiated by the first German waste act, caused a definite increase of waste paper collection.

Policy interventions

Policy interventions were twofold, targeting different fractions of paper waste:

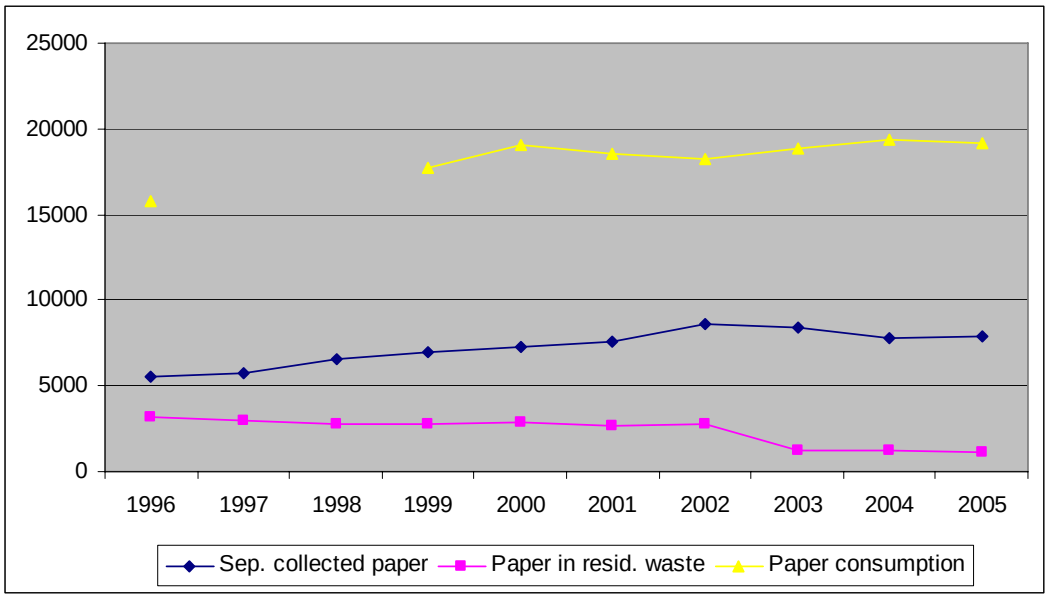
- Packaging paper: In 1991 the Packaging Ordinance came into force, leading to a separate collection scheme for paper packaging.
- Graphic paper: In 1994, an association of the paper production industry committed itself in a voluntary agreement on a recovery quota related to consumption levels. In order to reach this quota it was necessary to improve the collection system for paper waste.

The diagram shows that the increase in waste paper collection in the beginning of the 1990s becomes slightly steeper than in the decade before. It can be assumed that the policy interventions had some influence in that development. It has to be taken into consideration, however, that the data source changed between 1991 and 1992, which might be also the reason for a variation in trend.

Development after the policy interventions

The increase in separately collected paper waste continues until 2002. The following diagram shows the time series of separately collected paper waste in relation to paper consumption and in relation to the remaining paper waste in residual waste. This indicates that the increased quantities of separately collected waste paper originated from both an increase in paper consumption and the transfer of waste paper from residual waste.

Figure 6.4. Paper consumption and paper waste (in 1 000 tonnes)



Management of separately collected paper waste
Due to its material usefulness, ease of recycling and extensive separate collection efforts, nearly all separately collected paper waste (> 99%) was recycled.

6.3. The development of biowaste management

Biological waste treatment as an integrated part of a waste management concept can have the following objectives:

- Waste prevention by home composting,
- Waste recycling by producing high quality compost,
- Waste disposal by biological treatment of residual waste (Fricke 1993).

The first two bullet points concern biowaste as a separate waste stream. The third will be dealt with in the next chapter on BMW in residual waste.

Home composting
Home composting is defined as kitchen and garden waste that is composted by the waste generator; be it households, small businesses or municipal services. Because of this, these materials do not enter an official waste management system and are not subject to waste legislation. As the collection, transport and treatment of these biodegradable residues are not necessary, their environmental impacts are reduced. As home composting does not appear as part of the official waste management structure, data are scarce. The estimated quantities of home composted biowaste range from 3 to 7 million tonnes per year. (Fricke 1993)

Biowaste
The use of organic waste in agriculture is one of the oldest methods of waste recovery. However, from the beginnings of a regulated waste management system until the mid 1980s, composting played only a minor role in waste treatment. This is because composts based on residual waste were of insufficient quality as they contained non-organic materials (e.g. glass, metals, plastics) as well as heavy metals pollutants.

High quality compost can only be obtained if the input material consists of separately collected biowaste. In 1982, the province of Hesse and the University of Kassel started a pilot study for the implementation of a separate collection scheme for biowaste. After the green party entered the provincial government in Hesse, the projects for separate collec-

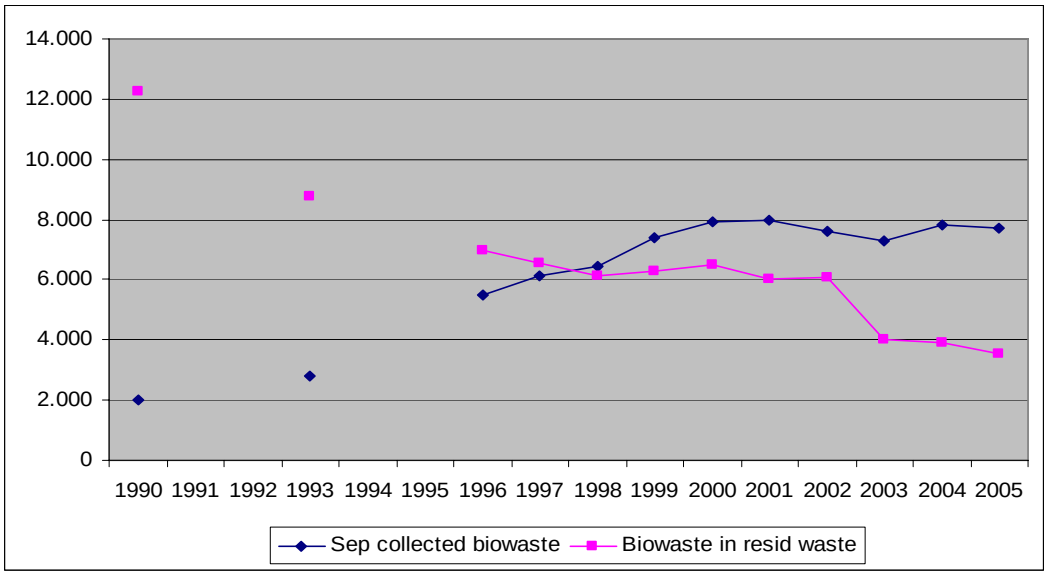
tion of biowaste were further intensified. When waste management companies realised the success of these pilot projects, separate collection of biowaste expanded to all of Germany. Between 1985 and 1993, the number of people which were connected to a biowaste collection system increased from 400,000 to 7.6 million. (Fricke 1994)

In addition, biowaste is generated by municipalities themselves through the maintenance of public gardens and parks as well as the green verges at roadsides.

Separate collection of biowaste
Up until 1995, there are only combined data for both sources of biowaste; households and municipal services. More detailed data in later years indicates that the quantity of biowaste generated by municipal services is approximately the same as the quantity of biowaste generated by households.

The following diagram show a time series for separately collected biowaste and the biowaste content of residual waste. The residual waste figure used here includes the biowaste in residual waste, bulky waste and commercial waste (see table 5.17). The main contribution comes from residual waste (around 90%), while biowaste from bulky waste is almost negligible.

Figure 6.5. Biowaste (in 1 000 tonnes)



The diagram illustrates that by the beginning of the 1990s the process of separate collection of biowaste had already gained momentum. In the decade from 1990 until 2000, separately collected biowaste quadrupled from 2 million tonnes to 8 million tonnes. It is likely that these 6 million tonnes originate from residual waste, as we can see a comparable reduction of this fraction in the same time period. The significant drop in reported biowaste in residual waste from 2002 to 2003 can be partly explained by the change in a reference definition for waste composition.

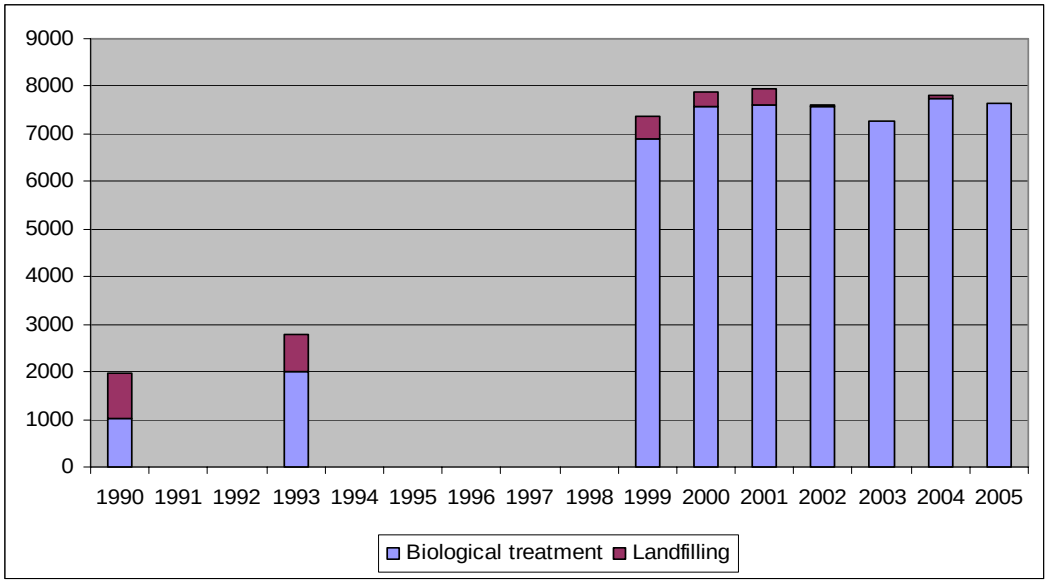
Policy interventions
The first policy intervention took place in the province of Hesse in 1983. In cooperation with a research institution, the possibilities of separate collection of biowaste and subsequent recovery were investigated. Once it had been shown that the new system was successful in diverting waste from landfills, other provinces followed the example. National policy intervention came a few years later, when in 1993 the Technical instructions on municipal waste (TASi) came into force. Although only binding for the administration, this legislation brought more impetus to the development of separate collection. It nevertheless took seven years before the separate collection of biowaste peaked. There has

been no significant change in the quantity of separately collected biowaste since the peak in 2000, from which we can presume that no further improvement will occur under existing regulations.

Management of separately collected biowaste

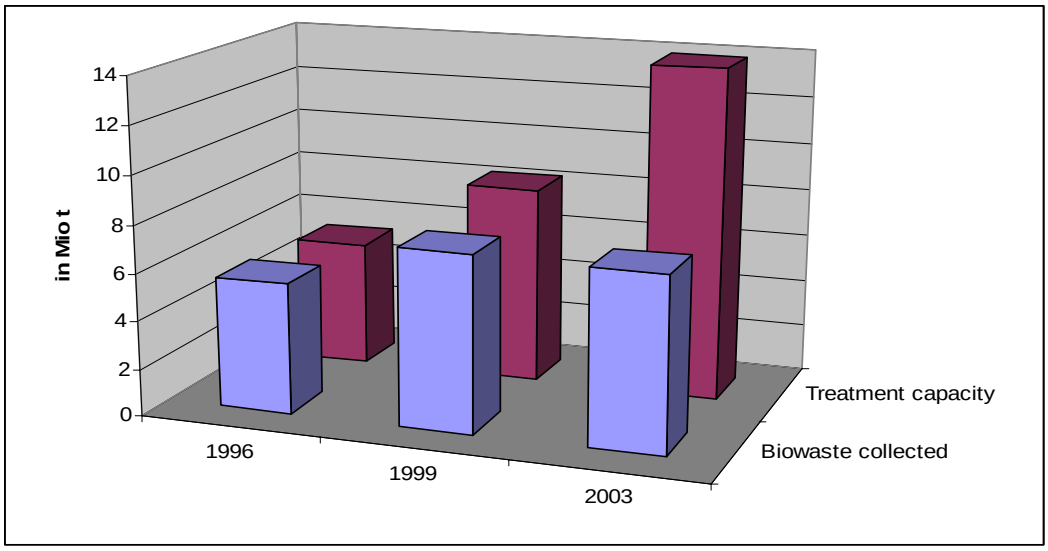
Although the objectives of the separate collection of biowaste are the diversion of biowaste from landfill, material recovery and reuse of the products, a share of separately collected biowaste was still landfilled. There is documentary evidence that the majority of this landfilled biowaste comes from municipal services.

Figure 6.6. Management of separately collected biowaste (in 1 000 tonnes)



Biological treatment includes composting and anaerobic treatment in digestion facilities. In the following diagram the total capacity for biological treatment is compared with the quantities of separately collected biowaste.

Figure 6.7. Comparison of total capacity for biological treatment with quantities of separately collected biowaste



In 1996 and 1999 the treatment capacity roughly matched the quantity of separately collected biowaste. Considering that a certain quantity of biowaste is landfilled (e.g. 7% in 1999), capacities and waste quantities were almost equivalent. After 1999, however, the

capacities of biological treatment facilities were significantly increased, especially in the eastern part of Germany, while the separate collection of biowaste stagnated. This means an increase of the residual capacity for biological treatment from 0.4 million tonnes up to 6.6 million tonnes.

Products from the treatment of biowaste
An association responsible for the quality of compost has been created (Bundesgütegemeinschaft Kompost e. V.). The membership is voluntary, but around 70% of the German compost producers belong to the quality association. The association publishes data on the quantities of compost produced by their members, and how these compost products are used. From 2002 to 2006 total compost production increased from 2.69 million tonnes to 2.95 million tonnes.

Up to 50% of the marketed compost is used in agriculture. Other main applications are landscaping, gardening and input to soil factories. The period 2002 to 2006 saw an increased share used in agriculture, while the share used in landscaping decreased by a similar amount.

Table 6.1. Use of compost products in %

	2002	2005	2006
Agriculture	44,3	47,7	47,8
Landscaping	16,6	12,8	12,4
Hobby gardening	11,4	11,9	11,7
Commercial gardening	3,7	3,9	4,0
Soil factories	12,5	13,6	13,9
Specialized crop	6,0	5,7	5,7
Municipalities	3,4	3,0	3,0
Others	2,0	1,3	1,5

Sources: BGK 2006, BGK 2007

6.4. Residual waste

Residual waste is defined as the waste from households and municipalities, as well as similar waste from commercial activities, that is not separately collected, either for recovery (secondary raw materials) or for special treatment (hazardous household waste). The more developed a separate collection system is, the less residual waste must be disposed of. Despite all separate collection efforts, residual waste will still contain some secondary raw materials and biodegradable waste.

In Germany, citizens are obliged to hand over their household waste to the communal waste disposal authorities. They are not allowed to search for alternative disposal paths.

6.4.1. Situation before first policy intervention

Driven by economic development, the quantity of waste disposed of by the public waste disposal system, especially household and similar commercial waste, increased by 75% between 1975 and 1990. In response, the local disposal authorities tried to increase the disposal capacity. (Walter 1996)

This was partially successful because the public had become aware of the impacts of waste management facilities on human health and the environment. The leakage of hazardous substances out of landfills and the emissions from waste incineration facilities, which were much higher compared with present limit values, attracted high public interest and lead to strong resistance against new facilities (NIMBY-syndrome).

The multibarrier concept for landfills was introduced in German waste policy as a means to reduce future environmental impacts of landfills. The multibarrier concept means that there should be multiple barriers preventing environmental impacts from landfilled waste. If possible, all following barriers should be in place (Stief 1986):

- appropriate location for the landfill,
- bottom sealing, including leachate management,
- quality of landfilled waste (as inert as possible),
- top sealing, including gas control,
- control of land use after closure of site,
- after-care (monitoring, maintenance).

In order to fulfil the requirements of the multibarrier concept three quality measures must be met. Waste management must ensure (BMU 2006):

- good containment system for landfills, incl. leachate and landfill gas management;
- diversion of relevant waste streams away from landfills as much as possible, especially packaging waste and biowaste;
- strict limitation of organic waste going to landfills. In expert's opinion from 1990, residual waste should only be landfilled in a quality which is comparable to soil or ore and thus should be subject of prior incineration.

Consequently, all administrative levels were involved in the introduction of separate collection schemes and enabling the construction of new waste management facilities, especially for recycling and for incineration. High technical standards for waste incineration facilities were set to convince citizens that all possible precaution had been taken, and thus overcome the NIMBY-syndrome. (BMU 2007)

6.4.2. First policy intervention

Technische Anleitung Siedlungsabfall (TASi)

The pieces of legislation to implement the multibarrier concept were;

- Separate collection of packaging waste: Packaging Ordinance
- Separate collection of biowaste: TASi
- Limitation of organic waste going to landfills: TASi
- Technical requirements for incineration facilities: 17. BImschV and Technical Regulations on Air Quality Control
- Technical requirements for landfills: TASi

Most relevant for the purpose of this project is the political instrument of limiting the organic content of waste going to landfills, which was implemented by TASi. The concrete wording in TASi is: "Waste may only be assigned to a landfill if it cannot be recovered and the assignment criteria of Annex B are complied with". Relevant assignment criteria in Annex B are ignition loss (5%) and total organic carbon (3%) for landfill type 2. For landfill type 1, which have lower requirements for containment, the limit values for ignition loss and total organic carbon are even lower. These limit values were set so tight that they were only achievable by using incineration technology. The intention was that only waste which was pre-treated by incineration could be landfilled.

The limitation of organic waste to be landfilled is a regulatory instrument and it was implemented by an administrative regulation.

Introduction as an regulatory instrument

All interviewed stakeholders agree that regulatory instruments are best choice in waste management legislation. Other instruments, like voluntary agreements or economic instruments are only seen as accompanying measures. Therefore, regulatory instruments have a long tradition in German waste management legislation. (BMU 2007, Länder 2007, UBA 2007)

Introduction as an administrative regulation
An administrative regulation is targeted towards the competent authorities who have to care for its implementation. Actors outside the administration, for example operators of waste management facilities, do not have to comply with this regulation directly, but only indirectly by complying with administrative decrees. Courts of justice are not bound by administrative regulations. Therefore, an administrative regulation is a comparably week instrument.

The big advantage of administrative regulations, however, is their flexibility. Competent authorities may, if they have well argued reasons, deviate from provisions set in such a regulation. This is relevant when setting technical standards in order to allow following technical developments. Flexibility is also one main reason that thermal treatment was not stipulated directly in legislation, but indirectly via the mechanism of a limit value for organic content. (BMU 2007)

A set of administrative regulations was planned as a means to introduce technical standards into waste management policy. The first administrative regulation adopted was on hazardous waste. This administrative regulation was successful and therefore served as a model for TASi, which followed a similar structure and approach. After the difficulties with the implementation of TASi, the approach of administrative regulations was not longer applied.

Political influences on TASi

- **Ministry for Environment / Umweltbundesamt (Federal Environment Agency)**

The Ministry for Environment is responsible for drafting federal waste legislation. For the development of the TASi, the Ministry asked for support of the Umweltbundesamt, which wrote the first draft. The final draft was elaborated in a working group, comprising of the Ministry for Environment, the Umweltbundesamt, selected representatives of Bundesländer (province) and selected representatives of private disposal companies. (BMU 2007)

- **Bundesländer (Province)**

The Bundesländer have a strong role in the development of legislation. In the case of TASi and Waste Landfilling Ordinance, it was clearly stipulated in the Waste Act, on which the ordinances are based, that the provinces must be involved in development of this type of legislation.

In total, the Bundesrat, the national representation of the Bundesländer, made 199 change requests to the draft version of TASi, most of which were editorial amendments. The main controversial issue was whether biological processes were also appropriate for pre-treatment of municipal waste before landfilling. It was consensus among the Bundesländer that waste should not be landfilled without pre-treatment. Although a number of Bundesländer favoured incineration as pre-treatment, others saw a health and environmental dangers in the emissions from incineration plants and therefore supported a biological treatment. (Radde 2005)

In the end, 10 out of 16 Bundesländer voted for the solution suggested by the Ministry for Environment; that incineration should be the only pre-treatment method. As a concession to the 6 remaining Bundesländer, the following amendments were accepted:

- Extension of transition period

The TASi drafted by the Ministry for Environment provided for a transition period of 8 years. The reason for this transition period was to give waste disposal authorities sufficient time to build up appropriate pre-treatment capacities. The new Bundesländer (i.e. the former DDR), with limited financial power, were concerned that they could not make sufficient funds available in time. In light of this, the transition period was extended to 12 years (until June 2005). (Länder 2007)

- Exemption

In order to allow for some flexibility in exceptional cases, the Bundesländer adopted the following exemption rule:
"The responsible authority may permit exemptions from the requirements of this Technical Instruction if, in individual cases, evidence can be provided that the interests of the public are not affected."

- Future of MBT

The Bundesrat asked the Ministry for Environment to define the criteria under which residues from mechanical biological treatment may be landfilled under environmental sound conditions.(Radde 2005)

- **Hearing procedure**

Other stakeholders get the chance to formally influence the draft legislation by presenting their opinions in a hearing procedure. The Waste Act stipulates that for each case the hearing procedure must include representatives from science, concerned persons and economic institution, the provinces, the municipalities and their associations.

- Private waste disposal organisations agreed to a pre-treatment of municipal waste before landfilling, but had no preferences for one of the pre-treatment options. (BDE 2007)
- Environmental NGOs had a strong opinion against incineration; they asked for increased efforts for waste prevention and recovery. This position, however, was almost totally missing from the final version of TASi. (BMU 2007)

Influence of the Landfilling Directive

When the Landfill Directive was under negotiation German already had a well developed landfill policy. Therefore, it is more likely that the German position influenced the Landfill Directive than vice versa. The German positions on the quality of the landfill containment were accepted, while a number of countries refused a very low limit value for TOC, because they considered it too strict.

Developments after TASi had come in force

- **Bundesländer**

The Bundesländer that agreed with the TASi approach built up sufficient incineration capacity, e.g. Bavaria or Baden Wuerttemberg. Consequently, there is a clear trend of increasing incineration capacity from 1993 on. Unfortunately there are no data available for this period that document the share of each treatment method for residual waste.

Other Bundesländer, especially those where the green party was part of the government, were against incineration for environmental reasons and had already concentrated on biological treatment as pre-treatment option.

Therefore, there was a strong opposition to the TASi and the legal validity of the instrument was challenged.

The main legal arguments against TASi were:

- The German Constitutional Court has ruled that decisions like the one between different waste disposal routes must be adopted by the parliament. An administrative regulation, however, is adopted by the government and not the parliament.
- An administrative regulation is not a law, but an internal instruction manual for the administration. In the even of a lawsuit, courts are not bound by an administrative regulation, but have the right to base a decision on thier own view of the respective law.
- The European Court of Justice asks the Member States to stipulate important decisions in binding pieces of legislation and not in administrative instructions.

(Kremer 1995)

- **Disposal authorities**

The construction of new incineration facilities is expensive. Therefore, those disposal authorities that had already opted for alternative disposal routes tried to circumvent the new system.

- Authorities who had already prioritised biological treatment tried to continue on this path. They furthermore tried to influence national legislators to allow MBT as treatment method before landfilling.
- Authorities that had spent resources upgrading and extending landfill capacities argued that the high technical quality of their landfills would allow to landfill higher levels of biodegradable content. They refused to build new pre-treatment plants due to additional investment costs.

Those authorities attempted to take legal action on the TASi or to ask the provincial governments for exemptions to the TASi. Some of the provinces supported these positions and made wide use of the exemption rule. Lower Saxonia, for example, permitted landfilling of only partially composted material until 2020 (UBA 2007)

- **Research programme on MBT**

Following the request of the Bundesrat, the Ministry for Research initiated a research programme to investigate the suitability of MBT as pre-treatment process before landfilling of municipal waste. The objective of the programme was to further investigate the performance of MBT and the behaviour of the MBT residues in landfills. If the results were positive, technical standards should be defined (Radde 2005).

The Umweltbundesamt summarised all results of the research programme and came to the conclusion that thermal pre-treatment is the favourite treatment option. Therefore, the authors recommended adopting a new ordinance for the landfilling of municipal waste containing the thermal treatment option as minimum requirement. MBT might be used as an alternative disposal route when fulfilling additional criteria (UBA 1999).
The results of this study could be used to argume for both disposal options, which meant that the political attitude towards thermal and MBT treatment options was important. In the 1998 elections there was a change of political colour of national government: the liberal conservative government was replaced by the red-green coalition. The green party favoured MBT as pre-treatment method and tried to water down the strict technical requirements on the quality of MBT-facilities suggested by Umweltbundesamt. The German Conference of Environmental Ministers, however, decided that MBT as a pre-treatment method has to follow equivalent environmental standard as incineration facilities, and that the deadline for the implementation of limit values for organic material on landfills (1. June 2005) must be kept (Radde 2005).

Based on the statement of the Bundesländer and the Umweltbundesamt report, the Ministry adopted five cornerstones for future disposal of municipal waste (20.8.1999) (Stief 1998):

- The landfilling of untreated municipal waste in municipal waste landfills shall be stopped as soon as possible. The existing pre-treatment capacities must be used and new capacities must be created.
- In addition to thermal treatment, high quality MBT processes will be accepted as legitimate pre-treatment of municipal waste. The requirements for these facilities and the arrangements that have to be observed shall be fixed in a supplement to the TASi and in an ordinance based on BImSchG.
- The waste fractions with a high calorific value resulting from MBT must be used as an energy source. That means that plastic and other energy-rich components of residual waste must be separated and incinerated in facilities with the strict off-gas limits of 17. BImSchV.
- Existing landfills that can not be easily upgraded to meet the technical requirements shall be closed down step by step. The construction of new landfills for municipal waste is not necessary. There is sufficient capacities in new and upgraded landfills as long as pre-treatment technologies are used and municipalities are cooperating.
- Treatment technologies shall be developed and extended further toward 2020, so that all municipal waste in Germany is recovered under environmental sound conditions.

6.4.3. Second policy intervention

Waste Landfilling Ordinance

As already noted, the objectives of the TASi were not fully implemented as planned. In order to remedy these shortcomings, national policy makers decided to adopt a new ordinance. The Waste Landfilling Ordinance, which came in force in 2001, brought the following improvements:

- limit values for landfilled waste became legally binding. They had to be applied not only by the administration, but also by waste owners and landfill operators;
- exemptions were no longer possible;
- The final transition period was fixed to end on 1st June 2005.

The legal procedure for the adoption of this ordinance required the same type of participation of provinces as for TASi. Political debate in the provinces indicated that the restriction of organic content on landfills was out of question (Länder 2007).
Furthermore, the national legislator reacted to the political pressure to accept biological treatment as pre-treatment method before landfilling. The Waste Landfilling Ordinance allows higher limit values for the landfilling of material coming from MBT. In order to improve the environmental performance of MBT facilities, the Ordinance on Facilities for the Biological Treatment of Waste (30. BImSchV) was adopted in 2001. As a result of the strict technical standards the treatment costs incurred by MBT are similar to those incurred by incineration. (UBA 2007)

As a supporting measure, the new Waste Act of 1996 simplified the licensing procedure for waste treatment facilities (with the exception of landfills). This made it easier and quicker to grant permission for the construction and operation of pre-treatment facilities.

Resistance against the Waste Landfilling Ordinance

A waste disposal authority in Rhineland-Palatinate that accepted only mechanical pre-treatment before landfilling filed a lawsuit against Waste Landfilling Ordinance. In this the authority argued that the German ordinance violates the Landfill Directive because it unacceptably tightens the existing provisions. During the lawsuit the German court asked the European Court of Justice for support. The ECJ decided that the German Waste Landfilling Ordinance is in compliance with the EU Landfill Directive and that stricter rules

can be applied. As a result the waste disposal authority was forced to comply with the content of the Waste Landfilling Ordinance. (Stief 2003)

Opposition to MBT facilities also came from the other political direction. The provinces of Baden Wuerttemberg and Bavaria did not want to accept MBT as pre-treatment option, because both had fully complied with the previous provision of TASi to rely only on thermal pre-treatment. (BMU 2007)

Results of the Waste Landfilling Ordinance

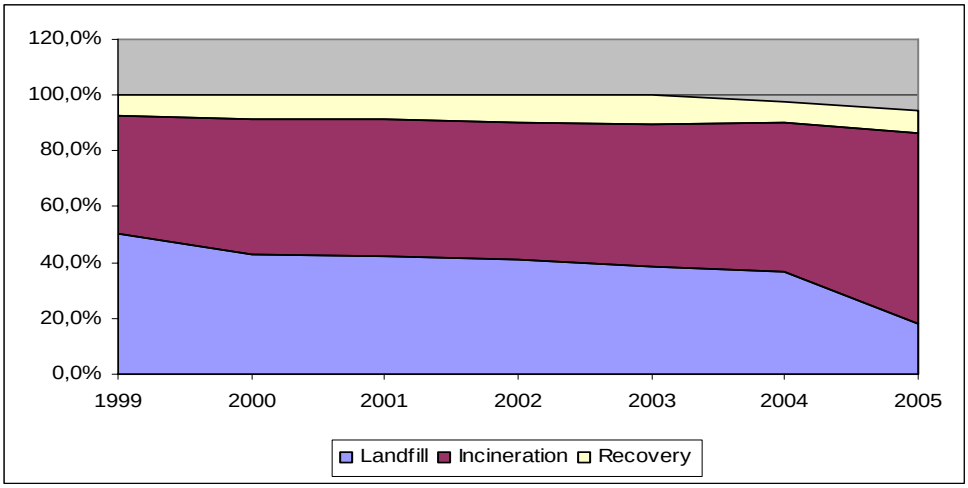
To fully evaluate the effects of the Waste Landfilling Ordinance, the development in landfilling after the transition deadline - 1st June 2005 - must be investigated. As only a short time has passed since then, no official data are available. Therefore, data of the previous years and estimations for the present situation have been used.

Table 5.24 (in the previous chapter) shows a further increase of the waste incineration capacity from 2003 onwards.

After MBT was accepted as a legitimate method of pre-treating waste before landfilling, the MBT capacity increased from below 2 million tonnes/y in 2000 up to nearly 5 million tonnes per year in 2005.

Between 1999 until 2005 the landfill quota of residual waste decreased from 50% to 18% of total residual municipal waste. This respective residual waste was rerouted to incineration facilities, which treated 68% of residual municipal waste in 2004. Despite an increase in MBT capacity, there has been a decrease in recovery rate from residual municipal waste. We have been unable to identify the cause of this decrease.

Figure 6.8. Time series for management routes of municipal waste



Source: Destatis 1996 – 2005

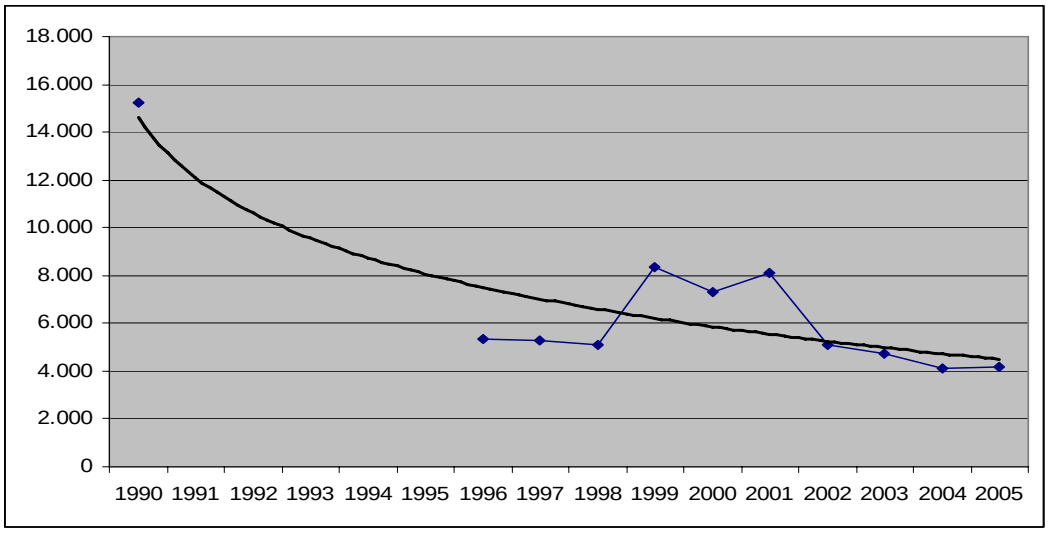
Incineration facilities and MBT plants are not only used to process residual waste, but also commercial waste and residues of waste treatment facilities (sorting plants, MBTs). After the Waste Landfilling Ordinance deadline (1st June 2005) all of these waste streams require proper pre-treatment. As a result, a bottleneck in waste treatment capacities was created. This was solved partly by the intermediate storage of waste; under this system, waste for disposal can be stored for a maximum of 1 year and waste for recovery for a maximum of 3 years. After this period the waste must be treated according to the legal requirements.

6.5. Commercial waste

6.5.1. Commercial waste arisings

The German Waste Act of 1996 (Kreislaufwirtschafts- und Abfallgesetz) brought an important change for commercial waste management. According to the producer principle, the responsibility for commercial waste destined for recovery was shifted to the commercial waste producers. The responsibility for commercial waste destined for disposal, however, remained with the public waste disposal authorities. Therefore, the following data on commercial waste generation only refer to is the fraction collected by public authorities. As no data are available between 1990 and 1996; a trend line is included to demonstrate the likely development.

Figure 6.9. Generation of commercial waste (in 1 000 tonnes)



Sources: StBA (1990) for 1990, StBA (1996) for 1993, Destatis 1996 – 2005

The data on development of commercial waste a cannot be explained. In addition to actual fluctuations in waste generation, changes might be caused by poor data quality.

Estimations for the generation of commercial waste destined for recovery, range from 5 million tonnes to 7 million tonnes. (BMU 2006)

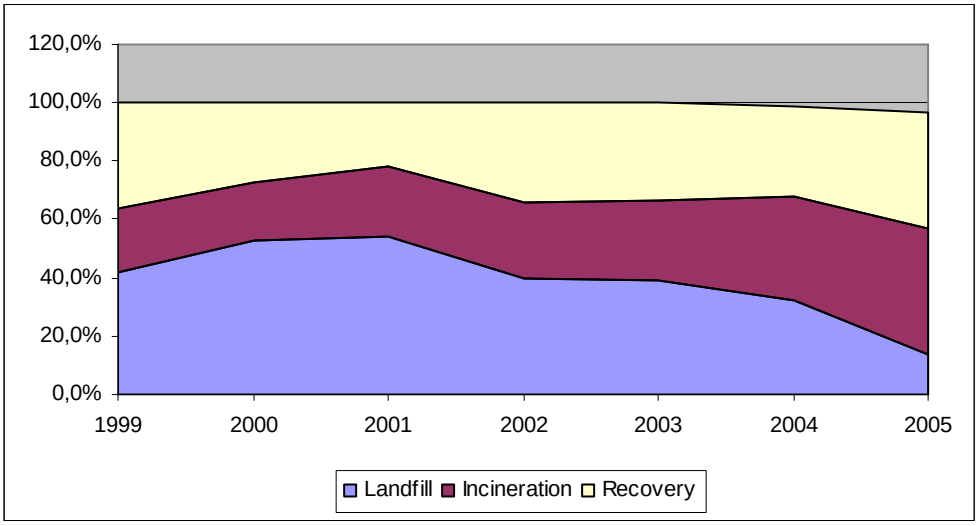
6.5.2. Policy interventions

The obligation for separate collection of certain materials in commercial waste was introduced in 2003 (Commercial Waste Ordinance). Although the data show a slight decrease in commercial waste from 2003 to 2005, the fluctuations and insufficient quality of the data mean that it is not possible to clearly attribute this drop to the ordinance.

The limit values for landfilling of biodegradable waste stipulated by TASi are also valid for commercial waste that is similar to household waste. The difficulties in the implementation of TASi have already been discussed in the previous chapter on residual waste.

The official data on the distribution of treatment methods for commercial waste destined for disposal show major fluctuations.

Figure 6.10. Time series for management routes of commercial waste



Source: Destatis 1996 - 2005

Since the Waste Landfilling Ordinance was adopted in 2001, there has been a shift from landfilling to incineration. In 2005, when the transition period for landfilling of organic waste ended, further strong decrease of landfilling of commercial waste took place.

7. Effectiveness of the implemented policy

Evaluating the effectiveness of a policy measure means judging whether or not the expected objectives and targets of the policy measure have been achieved. This requires comparing the effects of the measure with its intended objectives. (Vaz 2001)

The objectives of the German strategy for the reduction of biodegradable waste going to landfills can be summarized as:

1. Separate collection of biodegradable waste,
2. Composting or anaerobic biological treatment of biodegradable waste,
3. Limitation of the organic content in waste which is landfilled.

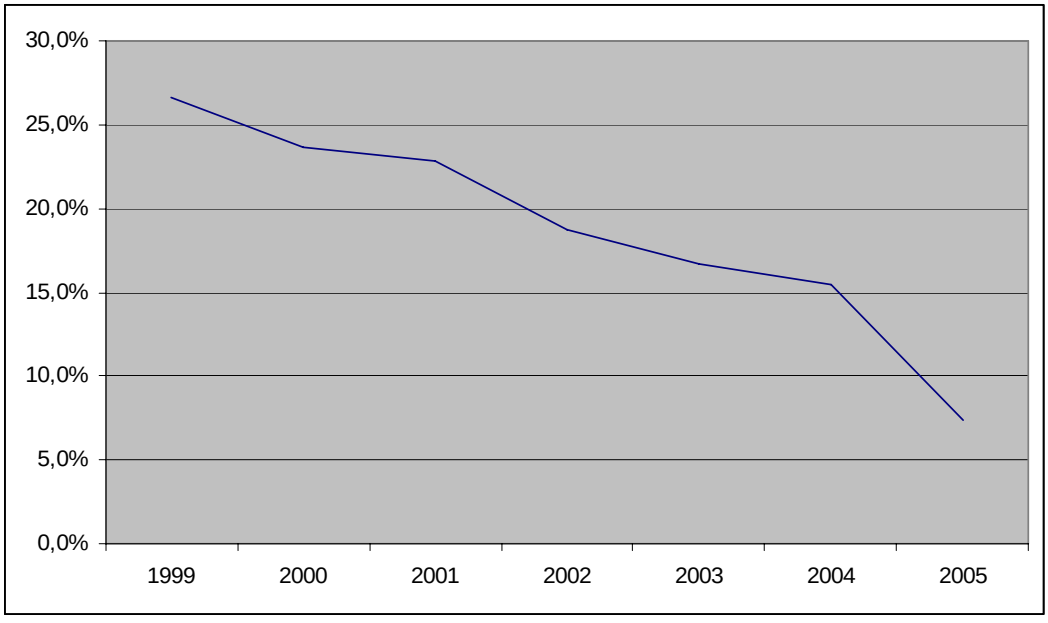
Concrete targets exist for the recovery of packaging waste paper as well as graphic waste paper. Furthermore, the organic content of waste going to landfills is restricted.

A more detailed description of the objectives and targets of the German strategy for the reduction of biodegradable waste going to landfills is presented in chapter 3.1.4.

7.1. Landfill ban

Main instrument of the German diversion policy is the limitation of the organic content in waste going to landfills. This policy instrument was introduced in three steps: adoption of TASi in the year 1993; adoption of Waste Landfilling Ordinance in 2001 and; the deadline for implementation on 1st June 2005.

Figure 7.1. BMW landfilled vs. BMW generated



The percentage of generated BMW going to landfill decreased slightly after 2001 and more sharply in 2005. In total, the percentage of generated BMW going to landfill falls from 27% in 1999 to 7% in 2005. From this, it is reasonable to infer these changes are the result of the implementation of the respective policy.

Although the strong decrease in the portion of generated BMW going to landfill between 1999 and 2005 can be seen as a big success, the objective of landfilling exclusively inert waste has not been fully realised. The main waste fraction of BMW that is still landfilled is the BMW in residual waste. Reasons for this development are that;

- the implementation deadline was in the middle of 2005, so that the landfilling of BMW was still possible until May 2005,
- not all pre-treatment facilities were fully operational in 2005.

It can be expected that the share of generated BMW going to landfill will further decrease.

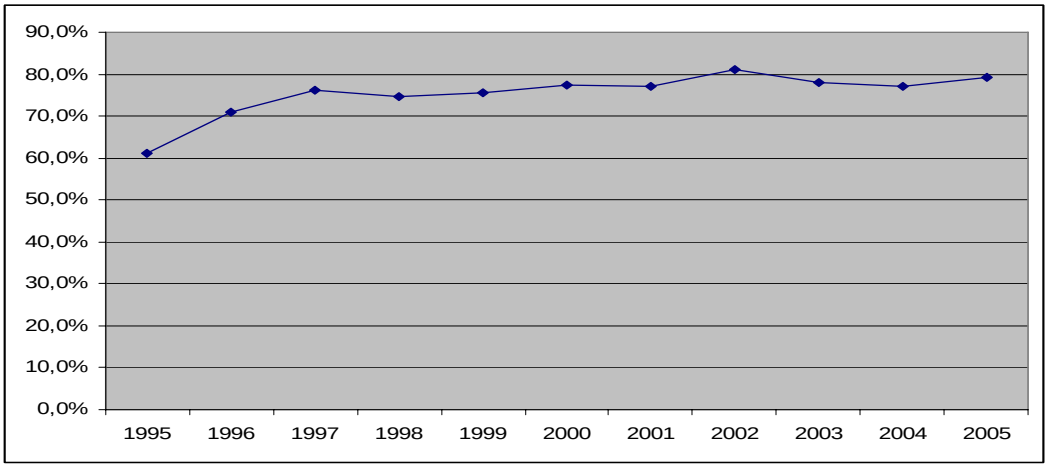
7.2. Separate collection and recovery of paper waste

This section examines German waste policy for the recovery of paper and cardboard waste, divided into packaging paper and graphic paper. For general information about the collection and recovery of separately collected waste paper and cardboard see chapter 6.2.

7.2.1. Packaging paper and cardboard waste

The fourth amendment of the Packaging Ordinance (VerpackV 1991), which came into force in 2005, implements the targets of the Packaging Directive 2004/12/EC. This requires that by the end of 2008, over 60% of packaging paper and cardboard waste must undergo material recovery. As Germany already meets these targets, the packaging waste policy for waste paper has been effective. (GVM 2006)

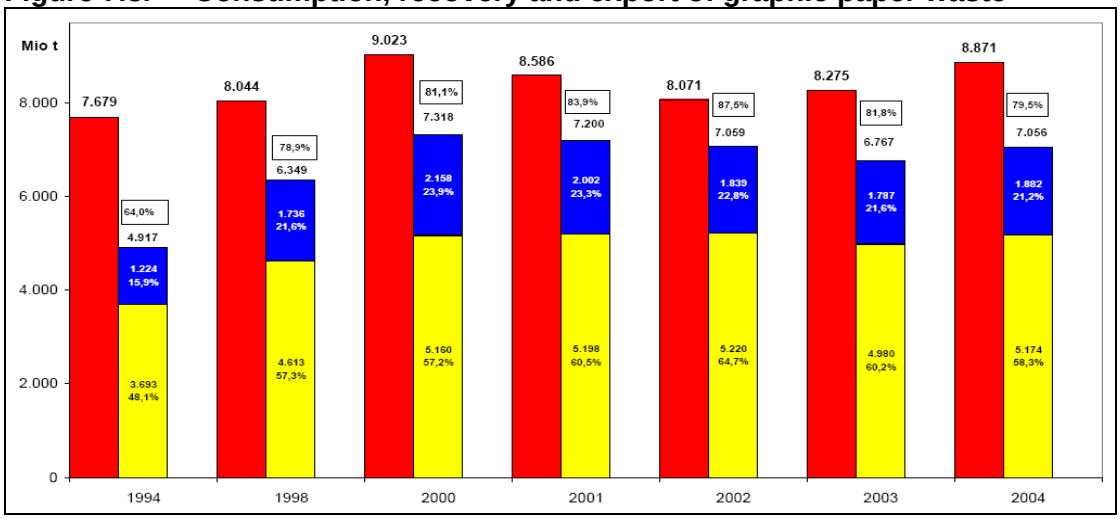
Figure 7.2. Recycling rate of packaging paper



7.2.2. Graphic paper waste

In 2000, the graphic paper industry committed itself to maintain the rate of material recovery at 80% ± 3% in the future. According to the progress reports of the graphic paper industry association (AGRAPA), this target has been met. (Agrapa 2006)

Figure 7.3. Consumption, recovery and export of graphic paper waste



Domestic consumption of graphic paper (according to AGRAPA definition)

Domestic recovery of graphic paper waste

Export of graphic paper

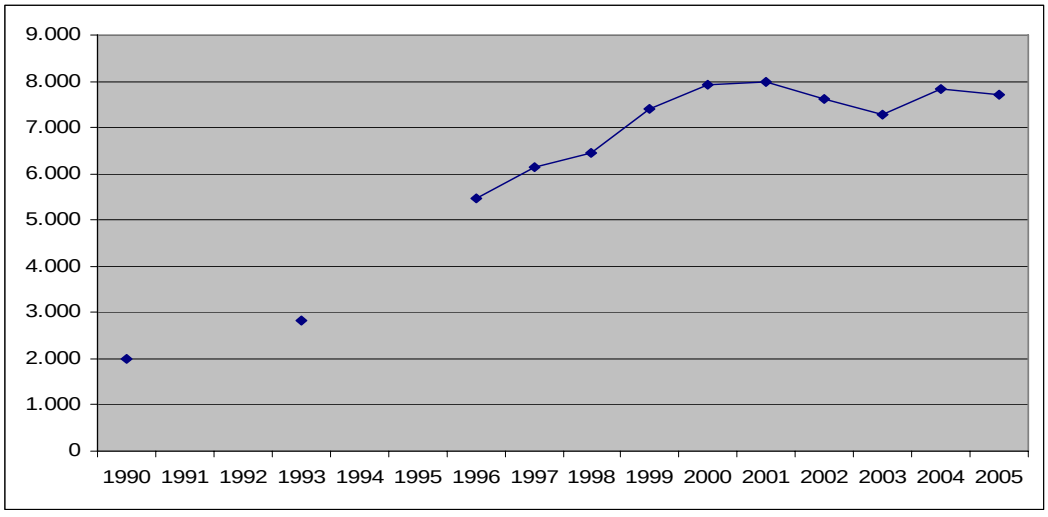
7.3. Separate collection and recovery of biowaste

Biowaste is regulated by TASi, which stipulates that;

- a separate collection system has to be established,
- biological treatment of those separately collected biowaste quantities has to be ensured.

Specific targets for separate collection and recovery of biowaste, however, are not mentioned.

Figure 7.4. Time series for separate collection of biowaste (in 1 000 tonnes)

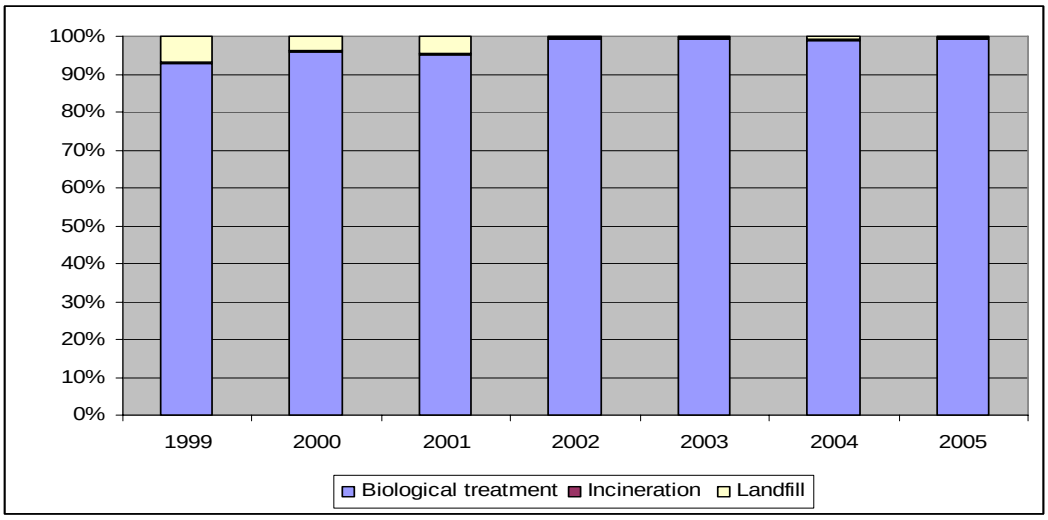


Following the provisions of TASi, Germany has build up a separate collection system for biowaste. The effectiveness of the system can be demonstrated by examining the development of separately collected biowaste quantities. From 1990 until 2001, these quantities quadrupled; after 2001, a stagnation can be observed. As a lot of biowaste is treated directly by home composting and does not, therefore, enter the waste management system, it is very difficult to calculate exactly how much biowaste is actually generated.

Therefore, it is not possible to judge whether there is more biowaste that should be accepted by the public collection system.

As of 2002, more than 99% of separately collected biowaste is recovered by biological treatment. This objective of TASi has clearly been fulfilled.

Figure 7.5. Management routes of biowaste, 1999-2005



8. Main findings

Modern waste management in Germany started in the mid 1960s; the first waste act went in force 1972. This early commitment to environmentally sound waste management and the political power Germany wields within Europe, means that Germany has played an important role in waste management policy of the EU. German rules on landfill technology have served as good example for technical aspects in the EU Landfill Directive. Germany also tried to establish its political instrument for the diversion of waste from landfills - the limitation of organic waste on landfills - at the EU-level. This, however, was not accepted by several Member States because of the high financial cost.

Generation of municipal waste as well as BMW in Germany is higher than the EU average, but is decreasing. After an increase until 2002, MSW generation has since slightly decreased ,despite of growing population and growing GDP. Total BMW generation increased until 2001, after which it decreased. This decrease after 2002 is mainly due to a recorded decrease in biowaste in residual waste over the same time period, which itself was partly due to a physical reduction in BMW generation, but was also influenced by a change in the reference definition for waste composition.

Germany uses a mix of policy instruments to control biodegradable municipal waste and divert it away from landfills;

- Separate collection and recovery of secondary raw materials (paper, biowaste),
- Ban on landfilling waste with organic content.

Based on a long tradition in German environmental policy, the main instruments used are regulatory. The German political instruments in the field of BMW rely more on general objectives than on quantitative targets.

In general, the policy instruments employed have proved to be effective.

- A separate collection scheme for waste paper and cardboard is in place. Recovery rates for packaging paper and graphic paper waste are around 80%, fulfilling the policy targets.
- A separate collection system for biowaste has been established. Almost all separately collected biowaste is recovered by biological treatment.
- The ban on landfilling organic was adopted in 1993, but several loopholes hindered its effective implementation. With the Waste Landfilling Ordinance, in force since 2001, these loopholes have been closed. Since the end of the implementation deadline in mid 2005, the landfill ban is working, although there is still room for improvement.

Due to these policy interventions, the share of both municipal waste and BMW going to landfill is continuously falling.

German policy making and implementation takes place within a the strong federal structure. The German provinces are responsible for the implementation of waste legislation and for creating local waste management plans; a national waste management plan does not exist. Although the provinces' responsibilities are limited, there is certain room for manoeuvre. This can lead to variations in the implementation of legislation between the provinces.

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I. Annex: List of interviewed stakeholders

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Bundesländer Working group on Waste (LAGA-ATA):
The LAGA working group has the task to harmonise the implementation of waste legislation among the Bundesländer on high administrational level. The chairmanship is rotating between the Bundesländer at regular intervals.

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