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The impact of policy interactions on the recycling of plastic packaging waste in Germany

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Abstract

Due to the environmental challenges associated with the strong growth of plastic waste worldwide, the EU Commission recently published a green paper on a European Strategy on Plastic Waste in the Environment (COM (2013), 123 final), which highlights the challenges and opportunities that arise from improving the management of plastic waste in the EU. The European Waste Directive (2008/98/EC) which was transposed into German law through the Kreislaufwirtschaftsgesetz (KrWG) established the so-called 5-step waste hierarchy, which gives a clear preference to recycling over energy recovery and disposal of waste in landfills.

Although waste avoidance and recycling are stated objectives of German waste policy, effectiveness and efficiency of the respective regulations seems to be influenced negatively by interactions with other policy instruments. Both, the internal interaction between different waste management policies as well as the external interaction between waste management policy and climate policy, seem to have a negative impact on the recycling of plastic packaging material.

In order to gain insights regarding the impacts of different policy instruments on the recycling of plastic packaging waste, we conducted a case study analysis based on data gained from an online survey among German experts in the field of plastic packaging waste management and from the literature on waste management.

Apparently, negative policy interactions originate from conflicting interests between the stakeholders of the different waste treatment options, i. e. recycling, thermal recovery and incineration. In the policy design stage, these conflicting interests have resulted in a regulatory flexibility that has made the recycling objective susceptible to the potentially negative effects of policy interactions. Apart from the requirement to achieve the minimum recycling quota for plastic packaging waste of 36 %, the waste management actors are flexible to choose their preferred waste treatment option once this threshold level has been achieved. In particular with regard to the recovery of low and medium grade plastic waste, economic incentives for thermal recovery and incineration seem to be much stronger than for recycling. This situation can partly be explained by the demand of energy intensive industries for plastic waste as a substitute for conventional energy sources. This trend has resulted in a considerable increase of the thermal recovery of plastic packaging waste between 2003 (2.3%) and 2010 (25.6%). With regard to waste incineration, the effect of the TA Siedlungsabfall (TaSi) on the build-up of incineration capacity and the economic imperative to utilize these capacities materialized in low costs for waste incineration. The massive build-up of capacities for waste incineration and RDF power plants decreased the costs for thermal recovery and made recycling less competitive. Structural changes of the packaging waste stream

have also had a negative influence in recycling because the use of composite materials can render recycling technologically and economically infeasible.

The case study was conducted for the EU 7th Framework Programme project *APRAISE – Assessment of Policy Interrelationships and Impacts on Sustainability in Europe* (ENV.2011.4.2.1-1: Efficiency assessment of environmental policy tools related to sustainability, Grant agreement No.: 283121).

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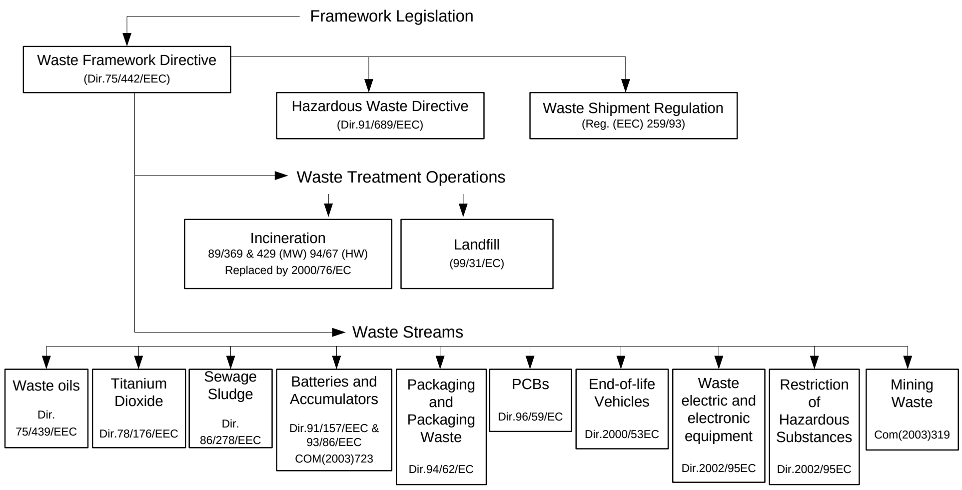
1 Introduction

1.1 Background

The substantial reduction of the use of natural resources is a priority of the EU's 6th Environmental Action Programme. One of the EU's most important political strategies to address this issue is its Thematic Strategy on the prevention and recycling of waste. This strategy is supported by a number of EU waste regulations. A general overview of the EU regulations on waste is provided in Figure 1. The EU waste directive establishes the legal framework for the treatment of waste in Europe as well as overriding principles for regulations pertaining to specific waste streams, treatment options and waste shipments.

Figure 1: Overview EU Waste Regulation



The topical EU framework directive on waste (2008/98/EC) establishes the so-called 'waste hierarchy': prevention, preparing for reuse, recycling, other recovery, and disposal. As of 2008, the total generation of post-consumer plastic waste in the EU-27, Norway and Switzerland was 24.9 Mt. Thereof, 51.3% (12.8 Mt) was recovered and the remaining amount (12.1 Mt) was disposed of, either in landfills (12.1 Mt) or in incinerators without energy recovery (just 0.046 Mt). The plastic waste recovered went either to energy recovery (7.4 Mt, or 30%) or recycling (5.3 Mt, or 21.3%) (BioIntelligence Service 2011).

There are several options to manage plastic waste, including recycling, thermal recovery, incineration with or without energy recovery, and disposal. The waste hierarchy gives a clear preference to recycling over energy recovery and disposal of waste in landfills. According to the definition provided in the EU waste directive (2008/98/EC, Article 3, § 17), "recycling means any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic materials but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations."

Due to the environmental challenges associated with the strong growth of plastic waste worldwide, the EU Commission recently published a green paper on a "European Strategy on Plastic Waste in the Environment", which highlights the challenges and opportunities that arise from improving the management of plastic waste in the EU.[1]

Major environmental and health problems are associated with the landfilling of plastic waste and marine litter:

- According to data from 2008, 48.6% of plastic waste generated in Europe is landfilled. Landfilling of plastic waste is a highly resource inefficient practice because the material and the energy contained in plastic waste is not recovered. In contrast, recycling as well as thermal recovery can reduce ecological risks associated with extraction of crude oil and the processing of crude oil to plastic products.[2] Approximately 8% of global oil production is used for the production of plastic products: 4% as raw material and 3-4% as a source of energy (Hopewell et al. 2009). Furthermore, landfills – depending on the standards for their construction and management – can lead to methane emissions as well as the contamination of soil, groundwater and surface water.
- Marine litter is an emerging environmental issue on a global scale, which is especially emphasized by the EU Commission's Green Paper on plastic waste (COM 2013, 123 final): "Dozens of millions of tonnes of plastic debris end up floating in world oceans broken into microplastic, the so-called plastic soup. Microplastics are found in the most remote parts of our oceans. Entanglement of turtles by floating plastic bags, sea mammals and birds that die from eating plastic debris and ghost fishing through derelict fishing gear produce shocking pictures. Moreover, plastic is not inert and chemical additives, some of them endocrine disruptors, can migrate into body tissue and enter the food chain."

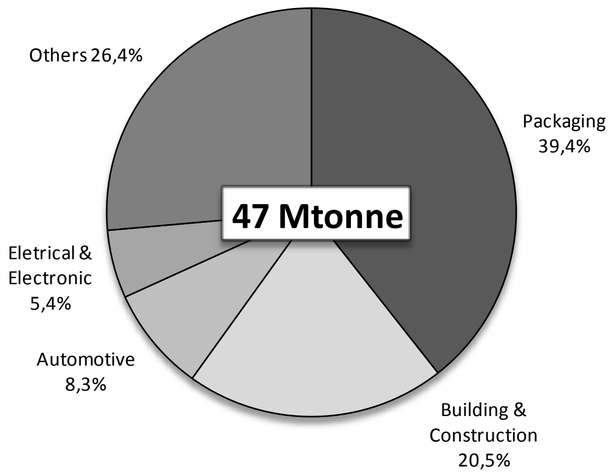
With respect to the economic and the social dimension of sustainability, the reduction of the use of primary raw materials that is achieved by increasing the use of secondary raw materials can result in reduced import dependency, cost reductions and increased competitiveness of EU businesses. As the collection and sorting of waste are relatively labour intensive activities, waste policies also have the ability to stimulate the labour market.

1 COM (2013), 123 final.

2 For the sake of clarity and taking into account the fact that bio-based plastics are still a niche application, this case study is focused on petroleum-based plastics only.

Taking into account the overall objectives of the Apraise project and the case study, it is necessary to narrow down the scope of the analysis to a specific waste stream and to focus on one Member State. Therefore, in what follows, we will address the management of plastic packaging waste in Germany. Plastic packaging has a share of 39.4% of plastic demand in Europe and is by far the largest contributor to plastic waste (Figure 2).

Figure 2: Plastics demand in Europe by segment



Source: Plastics Europe (2012)

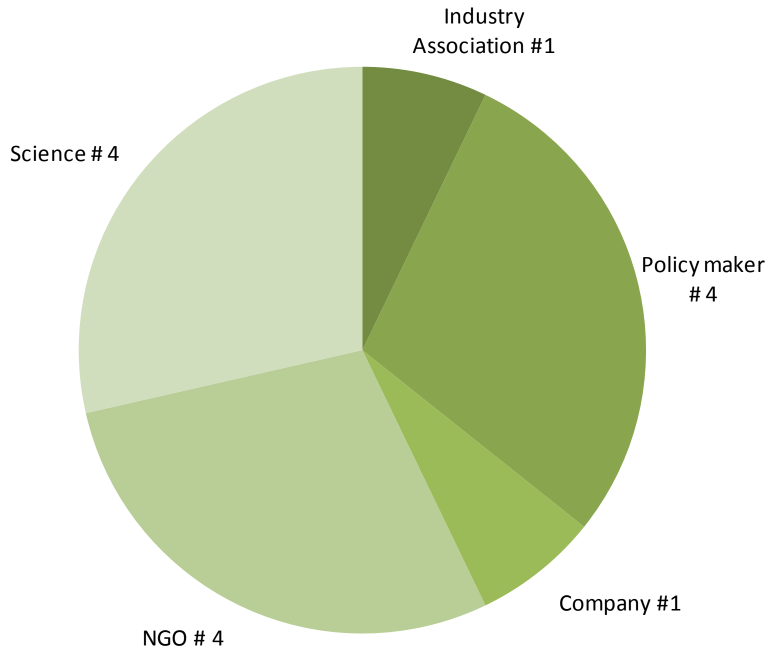
The management options for plastic packaging waste in Germany include recycling, thermal recovery and incineration. In 2010, 45.1% of plastic packaging waste was recycled (GVM 2011). In trying to increase this percentage, it is important to keep in mind that policy instruments that aim to increase the share of recycling will also have implications for other activities within and outside the waste management chain, which could be either positive or negative from an environmental, economic or social perspective. For example, increased recycling of plastics will reduce the amount of plastic waste available for co-incineration in the cement sector, where plastic waste is considered a climate friendly energy source.

1.2 Methodology

Policies on waste management have a strong impact on a wide range of stakeholders, e.g. producers of plastic packaging, retailers, private households, waste management authorities, waste management companies as well as operators of co-incineration and incineration plants. In order to gain new insights regarding the impacts of different policies on these stakeholders and to validate insights gained from other sources, we conducted an online survey among 71 experts in the field of plastic packaging waste management. The respondents were assigned to five different stakeholder categories:

policy makers, industry associations, companies, NGOs and research institutes. 14 experts responded to the survey which equals a total completion rate of 19.7%. The distribution of the experts that completed the survey is illustrated in Figure 3.

Figure 3: Distribution of the experts that completed the online survey



In addition to the online survey, data was also collected through phone interviews and Email correspondence with waste management experts, as well as the use of industry information services and scientific literature on waste management.

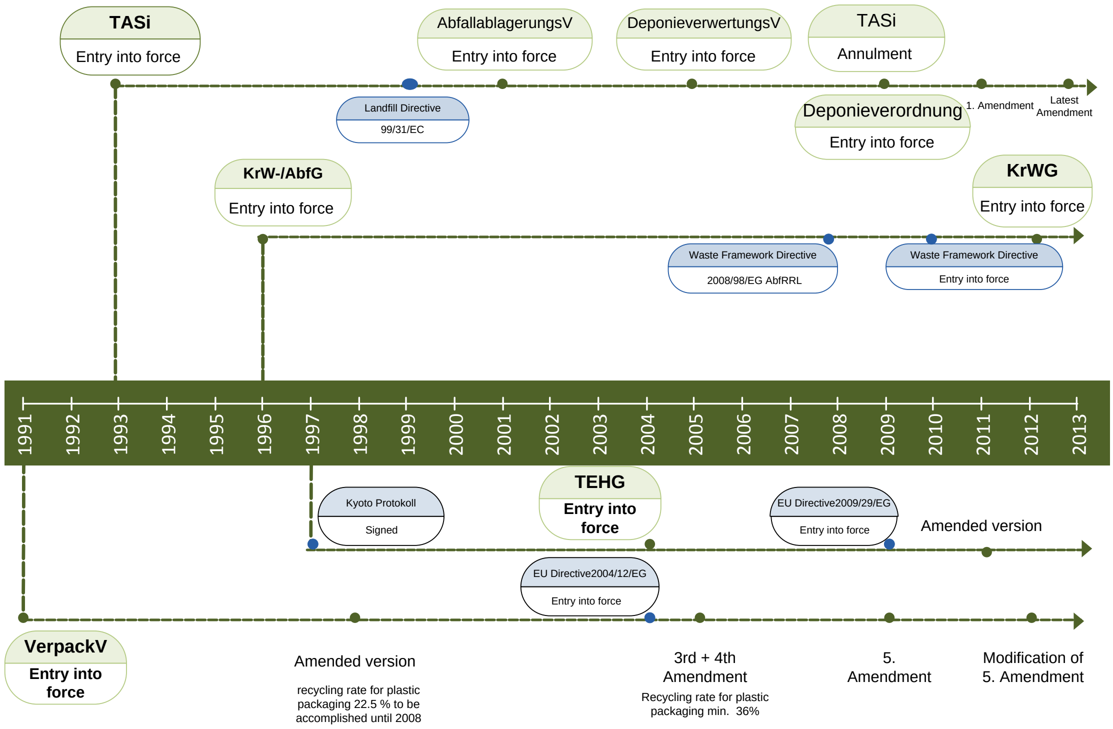
2 From EU directives to national policy instruments

2.1 EU directives and corresponding national policy instruments

In order to assess the impact of policy instruments on the management of plastic packaging waste in Germany and to illuminate the relationship between regulations on the European and the national level, it is necessary to narrow down the number of policy instruments analysed in this case study. The national policy instruments that will be discussed in greater detail are the Closed Substance Cycle and Waste Management Act (KrWG), the Packaging Ordinance (VerpackV), German Greenhouse Gas Emission Allowance Trading Act (TEHG), and the Technical Ordinance on Waste from Human Settlements (TaSi). These four policy instruments will be discussed in greater detail in chapter 2.2. This chapter will also provide arguments as to why these policy instruments have been selected as well as a validation of this selection by the stakeholders.

Figure 4 highlights the relationship between the selected national policy instruments and the corresponding European regulations and their development over time.

Figure 4: Timeline of German and corresponding European policy instruments that are relevant for the management of plastic packaging waste in Germany



Besides the policy instruments mentioned thus far, further European and national regulations exist that are relevant for the recycling of plastic packaging waste, but will not be discussed in greater detail in this case study:

- 282/2008/EC as well as 10/2011/EC stipulates that if recycled plastic materials are intended to come into contact with food, it must be proven that the recycling process can efficiently reduce potential contamination to a level that does not pose a risk to human health. The safety of the recycled plastic has to be ensured, which can constitute a considerable technological and administrative burden for recycling companies.
- The flagship initiative 'Resource Efficient Europe' is one of seven flagship initiatives of the Europe 2020 strategy. The aim of this flagship initiative is to provide a common framework for actions to increase resource efficiency in different policy areas, e.g. energy, climate change, innovation, industry, transport, and environment. Of particular relevance for the case study at hand are measures envisioned to promote recycling and the use of waste as a resource.
- The German Resource Efficiency Programme (ProgRess) is focused on the efficient use of abiotic, non-energy resources. The German government is striving to decou-

ple economic growth as much as possible from the consumption of such resources in order to reduce the burden on the environment and to strengthen the sustainability and competitiveness of the German economy. The emphasis is particularly on the use of persuasive instruments, e.g. information campaigns, networks and consulting on resource efficiency.

- The Energy Taxation Directive (2003/96/EC) has widened the scope of the EU's minimum tax rate system for energy products, which was previously limited to mineral oils, to all energy products including coal, natural gas and electricity. According to the planned overhaul of the Energy Taxation Directive (COM 2011/169), minimum tax rates for different energy sources will be based on the energy content of the product and the amount of CO_2 emitted. Products that pollute more are taxed more heavily. The Energy Taxation Directive is theoretically relevant for the case study, because refuse-derived fuels that contain high calorific fractions of municipal waste, e. g. packaging waste, could now be taxed by national governments. However, due to the fact that refuse-derived fuels could be classified either as energy products or waste, the legal situation in Germany is still ambiguous and therefore this directive is not included here.

2.2 Selection of key national policy instruments

Policy Instrument 1: Kreislaufwirtschaftsgesetz (KrWG)

The EU Waste Directive (2008/98/EC) establishes the legal framework for the treatment of waste in Europe as well as overriding principles for regulations pertaining to specific waste streams, treatment options and waste shipments (Figure 1). Directive 2008/98/EC was transposed into German law through the Kreislaufwirtschaftsgesetz (KrWG) (Closed Substance Cycle and Waste Management Act), which came into force on June 1st, 2012. The KrWG is the successor of the Kreislaufwirtschafts- und Abfallgesetz (KrW-/AbfG), which came into force in 1996.

The KrWG aims to protect the environment and human health through the prevention of harmful effects from waste generation and poor waste management. According to this act, those who generate waste are responsible for its avoidance, recovery, and disposal (extended producer responsibility). The following targets have been set (§ 14 KrWG): (1) separate collection and recycling of paper, metal, plastic and glass waste until January 1st, 2015, (2) reuse and recycling rates of at least 65% by weight for municipal solid waste and (3) at least 70% by weight for construction and demolition waste as of January 1st, 2010.

Anyone who produces or holds waste has to adhere to the so-called 5-step 'waste hierarchy': (1) prevention, (2) preparation for reuse, (3) recycling, (4) other recovery (in particular energy recovery) and (5) disposal.[3] Adherence to the waste hierarchy takes

3 The KrW-/AbfG from 1996 stipulated the 3-step waste hierarchy (reduce, reuse, recycle).

into account technological capabilities as well as economic and social impacts. Of particular relevance for the management of plastic waste is the provision that, if the calorific value of the waste exceeds 11,000 KJ/kg, energy recovery is considered to be equivalent to recycling; if not, it is given lower priority. The provision that private households are obligated to make their waste available to public waste management companies provoked a lot of controversy in the public debate, because it gives public waste management companies an advantage over private companies. Before the latter can acquire munipical waste, they have to prove to public authorities that their collection and treatment of waste is superior to that of public waste management companies.

Policy Instrument 2: Verpackungsverordnung (VerpackV)

The EU Packaging and Packaging Waste Directive (2004/12/EC) introduces specific recycling and recovery targets for the materials contained in packaging waste. In 2005, the 4th amendment of the Verpackungsverordnung (VerpackV) (Packaging Ordinance) transposed Directive 2004/12/EC into German law. However, the German VerpackV has a much longer history that goes back to 1991. It formulates recovery and recycling quotas for specific packaging waste streams. As of 1999, at least 60% of plastic packaging materials have had to be recovered, of which 60% have to be recycled. That means that 36% is the minimum recycling quota for plastic packaging waste in Germany. The VerpackV puts the extended producer responsibility principle into practice: producers and distributers of packaging materials are required to take back and recover packaging waste (e.g. glass, plastic, cardboard, etc.) and to provide a return, collection and recovery system. In order to release industry from this take-back and recovery obligation, the Duales System Deutschland (DSD) was founded by the industry, which operates parallel to the public waste management services. The DSD covers all of Germany. From 1990 until 2003, the DSD was the only operator of a country-wide take-back and recovery scheme. After enforcing competition laws in this sector, there are now 10 such operators of 'dual systems' in Germany.

The collection, sorting and recovery of used sales packages is financed by licensing fees paid by the manufacturers or importers who put sales packages into circulation. The licensing fee is charged by the DSD, based on the packaging material (glass, paper, plastic) and weight. Packaging material, which is recycled by the DSD, is marked with a green dot and collected separately at the household level. In addition to that, the VerpackV introduced a compulsory deposit (0.25 Euro) on non-refillable beverage containers. As a result, non-refillable beverage containers are not recylced by the DSD.

Policy Instrument 3: TA Siedlungsabfall (TaSi)

The TA Siedlungsabfall (TaSi) (Technical Ordinance on Waste from Human Settlements) came into force in 1993 and is relevant for the case study because it had important implications for the development of waste management infrastructure in Germany. The TaSi required thermal treatment of waste and inertisation prior to final disposal and, consequently, prevented the direct disposal of biodegradable waste in landfills. The provisions of the TaSi had to be met until 2005 and stimulated considerable investments in the build-up of incineration plants. The ordinance was suspended in 1999 and was followed by the Deponieverordnung which transposed the EU Landfill Directive (1999/31/EC) into German law.

Policy Instrument 4: Treibhausgasemissionshandelsgesetz (TEHG)

The Treibhausgasemissionshandelsgesetz (TEHG) (German Greenhouse Gas Emission Allowance Trading Act) came into force in 2004. The overall objective of this act is to reduce greenhouse gas (GHG) emissions from the energy sector and energy intensive industries. The TEHG is a national policy instrument that is closely linked to the commitments that stem from the ratification of the UNFCCC (1994) and the Kyoto Protocol (2002) by the EU. Based on the provisions of the Kyoto Protocol, Germany was obligated to reduce greenhouse gas emissions by 21% in the period from 2008 to 2012 as compared to the 1990 levels. The TEHG transposed the EU Emissions Trading Directive (2003/87/EC) into German law. In connection with further legislation in 2004, it laid out the foundation for the trade in emission allowances (certificates) in Germany. The latest revision of the TEHG, which transposed EU Directive 2009/29/EC into national law, came into force in 2011. Companies that operate facilities with high GHG emissions are required to hold enough certificates. The National Allocation Plan sets out the total number of certificates to be allocated for the relevant trading period. The certificates can be traded nationally and internationally between companies and states. The TEHG regulates the monitoring, allocation, management and trading of certificates. An Emissions Trading Authority at the Federal Environmental Agency dispenses and deletes certificates according to the amount of GHG that has been emitted. The relevance of the TEHG for the case study results from the fact that energy intensive industries can reduce their GHG emissions by substituting fossil fuels with high calorific waste, e. g. plastic waste. Since §2, para. 5, sentence 3 of the TEHG specifies that plants for incineration or thermal recovery of municipal waste are not covered by the TEHG, this might result in higher incentives for thermal recovery of waste, e.g. in RDF power plants.

In order to validate this selection of policy instruments, the stakeholders that participated in our survey were asked to assess the positive or negative relevance of the impact of these instruments on the recycling of plastic packaging waste in Germany. An overview of the results is provided in Table 1.

Table 1: Relevance of the selected policy instruments (number of respondents assigning the respective relevance)

Q 2: Please assess the relevance of the (positive or negative) impact of the following policy instruments on the recycling of plastic packaging waste. Scale 1-5 (1 = not relevant, 5= very relevant)					
	1	2	3	4	5
KrWG	0	0	2	2	10
VerpackV	1	0	1	2	9
TaSi	2	3	1	3	4
TEHG	5	2	2	2	1

The feedback provided by the stakeholders clearly supports the selection of the KrWG and the VerpackV, whereas the responses for TaSi are quite varied. The stakeholders saw the TEHG as less relevant, perhaps because, the connection between the TEHG and plastic recycling is less obvious compared with the other policy instruments.

2.3 Effectiveness of policy instruments

Based on the discussion in the first chapter, it becomes clear that policies on waste management aim to achieve multiple environmental, social and economic objectives. Although analysing the policy impact on the recycling of plastic packaging waste is the overriding concern of this case study, it is important to bear in mind other objectives of European and German policies towards waste management, such as the reduction of the amount of waste generated by society or the prevention of negative impacts of waste on human health and the environment. The environmental and social problems associated with landfilling have already been briefly discussed in the first chapter. Against this background, the effectiveness assessment performed in this chapter does not only take into account the effectiveness with regard to recycling and the reduction of plastic packaging waste, but also with regard to the recovery of plastic packaging waste. Next to recycling, recovery also encompasses the options thermal recovery and incineration. According to the waste management hierarchy, recovery of waste is regarded to be more environmentally friendly than waste disposal (landfilling).

Based on this reasoning and backed by the priorities formulated by the waste hierarchy, the effectiveness of the policy instruments identified in chapter 1.3 shall be evaluated with regard to the following policy objectives:

1. Reduction of plastic packaging waste generation
2. Increase in the recycling of plastic packaging waste
3. Increase in the plastic plastic packaging waste recovery rate

Some of the comments made by the participants of our survey point to the fact that the KrWG and the VerpackV have to be analysed in close combination to each other, because the KrWG establishes the framework for the more specific provisions of the VerpackV. Both regulations address all three of the objectives. The TaSi is relevant for the case study because of the restrictions imposed on landfilling and the resulting changes in the German waste management infrastructure, which are argued to influence the achievement of objective No. 3 directly and of No. 2 indirectly. In contrast to the other policy instruments discussed here, the TEHG is a climate policy instrument, not a waste policy instrument. Although we suspect that the TEHG influences the attainment of objectives No. 2 and No. 3 indirectly, the overall effectiveness and efficiency of this law need to be evaluated in a more climate-specific policy context. As a result, the TEHG is only included in this study whenever interactions between the TEHG and waste management laws occur, but its effectiveness and efficiency are not analysed in detail as a policy instrument, since this would be beyond the scope of this case study.

Effectiveness of policy instruments with respect to objective No. 1 (reduction of plastic packaging waste)

On a more general level, § 6 of the KrWG establishes the waste hierarchy for Germany, which gives first priority to the avoidance of waste. Furthermore, § 23, para. 1, of the KrWG introduces the extended producer responsibility principle giving those actors that produce or circulate a product the responsibility to minimize waste and to ensure environmentally friendly disposal or recovery after use. Based on these basic principles of German waste management policy, § 12, para. 1, of the VerpackV specifies that packaging has to be reduced to such an extent that security and hygiene of the product can be ensured. § 12, para. 2, of the VerpackV states that packaging material should be designed in such a way that re-use und recovery is possible and that negative environmental impacts are minimized. In addition to that, § 6 of the VerpackV formulates the obligation to operate a country-wide collection system for packaging waste at the household level. Annex 1 to § 6 specifies the obligation to recover 60% of the collected plastic packaging material, of which 60% has to be recycled, which yields an end-of-life recycling quota of 36%.

The operation of the Duales System Deutschland (DSD), the country-wide collection and recovery system for packaging materials, is financed by compulsory licensing fees which are paid by the producers and importers of packaged consumer goods. The licensing fee varies and is based on the weight and type of the packaging material.

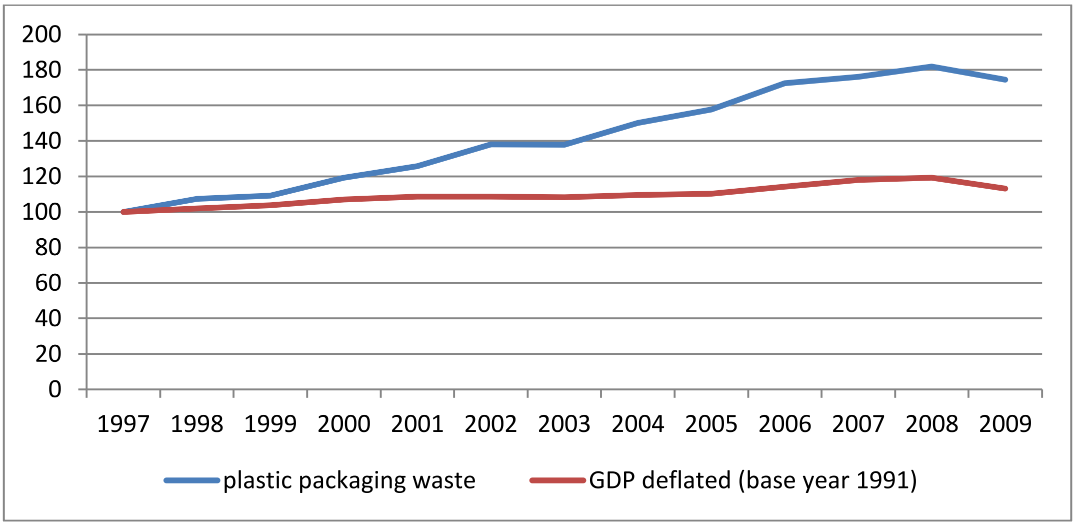
The development of plastic packaging waste in Germany in relation to GDP is displayed in Figure 5. During the period from 1997 until 2009 the amount of plastic packaging waste increased by 74%, whereas real GDP grew by 13%. However, it is not perfectly clear whether the increasing amount of plastic packaging waste can be attributed to a rise in consumption or improved collection of plastic packaging waste. One study suggests that collection of plastic packaging waste has been constantly improving over the years, in particular with regard to the years following the introduction of the collection scheme (Bundeskartellamt 2012, p. 30-31). However, the parallel decrease of plastic packaging waste and GDP in times of economic crisis, 2003 and 2009, somewhat supports the hypothesis that the figures for the generation of plastic packaging waste are connected to the development of GDP and consumption, whereas the effects of improved waste collection should become more and more negligible over time.

Plastic packaging is perceived to satisfy some of the needs stemming from changes in consumer behaviour, e. g. towards smaller packaged units, convenience products, PET bottles and plastic screw caps (gvm/UBA 2012 and 2006).

The producers of packaged goods are probably able to pass on the licensing costs, at least in parts, to the consumers, as the price elasticity of demand is expected to be rather low for many low-price and short-lived consumer goods, e. g. food products or personal care products.

Based on these arguments, the effectiveness of the KrWG and the VerpackV with regard to the objective to reduce the amount of plastic packaging waste appears to be rather low. Although the costs for collection and recovery of plastic packaging waste by the DSD are – partly – internalized through the licensing fee, they do not give producers sufficiently high incentives to use less plastic packaging material or use different packaging materials. To effectively discourage the generation of waste would require a more integrated and fundamental policy approach that addresses fundamental aspects of production and consumption (Angrick 2013).

Figure 5: Generation of plastic packaging waste in Germany in relation to GDP (1997 = 100)



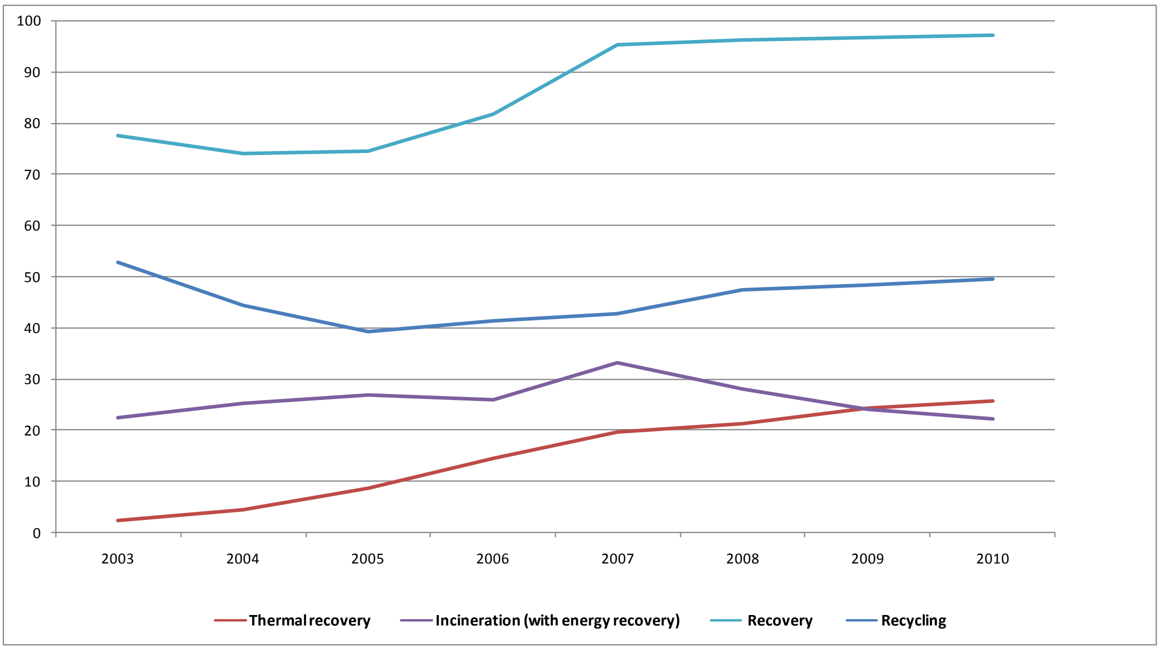
Source: gvm/UBA (2003, 2009)

Effectiveness of policy instruments with respect to objective No. 2 (recycling of plastic packaging waste)

With regard to the recycling of plastic packaging waste, the minimum recycling rate formulated by the VerpackV is of crucial importance. As Figure 6 shows, between 2003 and 2010 the recycling rate has been considerably higher than the 36% specified by the 4th revision of the VerpackV. However, the fact that in 2003 recycling had already reached 52.8% and dropped to 49.4% in the year 2010 suggests that the requirements put forward by the 4th revision of the VerpackV in 2005 were not very ambitious. This argument is supported by the results of our survey, where 75% of the experts stated that recycling targets for plastic packaging waste could have been more ambitious in the past (Question No. 12).

Figure 6: Different waste management options for plastic packaging waste in Germany - given in % of plastic packaging waste (table and graph)

in % of plastic packaging waste	2003	2004	2005	2006	2007	2008	2009	2010	2010 to 2003 in % -Points
Recycling	n.a.	n.a.	n.a.	38,1	40,7	44,7	46,5	45,1	
Feedstock recycling	n.a.	n.a.	n.a.	3,2	2	2,6	1,9	4,3	
Recycling total	**52,8**	**44,4**	**39,1**	**41,3**	**42,7**	**47,3**	**48,4**	**49,4**	-3,4
Thermal recovery	2,3	4,4	8,5	14,4	19,5	21,1	24,3	25,6	23,3
Recycling and thermal recovery	**55**	**48,8**	**47,6**	**55,7**	**62,2**	**68,4**	**72,7**	**75**	20
Incineration (with energy recovery)	22,5	25,3	26,9	26	33,1	27,9	24,1	22,2	-0,3
Recovery (recycling + thermal recovery + inceration)	**77,5**	**74,1**	**74,5**	**81,7**	**95,3**	**96,3**	**96,8**	**97,2**	19,7



Source: gvm/UBA (2012, 2009)

In order to evaluate the effect of the KrWG and the VerpackV on the recycling of plastic packaging waste in relation to the more indirect influences emanating from the TaSi and the TEHG, Table 2 displays the results of question No. 8 of the survey.

Table 2: Impact of policy instruments on recycling of plastic packaging waste

Q 8: Impact of policy instruments on recycling of plastic packaging waste (Scale -2 to 2 with -2 = strong negative impact and 2 = strong positive impact							
	-2	-1	0	1	2	n	Weighted average
KrWG	1	4	6	3	0	14	-0,25
VerpackV	2	1	3	5	1	12	0,2
TaSi	2	2	5	1	1	11	-0,3
TEHG	4	1	2	0	0	7	-1,5

On the surface, the effectiveness assessment could be based on the fact that the minimum recycling targets of the VerpackV have been constantly met during the 2003 and 2010 period. The recycling rate displayed in Figure 6 shows a considerable decline in the recycling performance between 2003 and 2005, but from 2005 onwards the recycling rate constantly increased. However, it is not clear to what extent this increase can be attributed to waste management policy. Based on the views expressed in the expert survey (question No. 8), the effectiveness of the VerpackV on the recycling of plastic packaging is only weakly positive, the KrWG and the TaSi are almost neutral, and the TEHG has a strongly negative influence.

The minimum recycling quota, which was specified by the 4th revision of the VerpackV in 2005, cannot explain the increases in the recycling performance in the period from 2005-2010. Rather, this development seems to have been triggered by a combination of different system context factors, such as advances in sorting technologies, increased competition within the DSD and the development of the oil price (see chapter 3).

Effectiveness of policy instruments with respect to objective No. 3 (recovery of plastic packaging waste)

The provisions of the VerpackV specified a minimum recovery rate for plastic packaging waste of 60%. The effectiveness assessment with regard to the recovery of plastic packaging waste can be based on the fact that the amount of plastic packaging waste increased by 26.6% between 2003 and 2009. In spite of that increase, the recovery rate was raised from 75% to 97.2% in the same period. This development can mainly be attributed to the increase in thermal recovery (cf. Figure 6).

In conclusion, the effectiveness assessment yields ambiguous results that have to be interpreted with caution. With a recovery rate of slightly over 97%, German waste policies can be assessed to be highly effective with regard to the recovery of plastic packaging waste. This statement holds true in particular if this figure is compared to the performance of most other European countries.[4]

Although the 36% recycling target put forth by the 4th revision of the VerpackV was constantly met throughout the last years, our effectiveness evaluation has to take into account the view expressed by most of the participants of our survey that this target was not very ambitious. Although the impact of the minimum recycling quota seems to be very weak, it can be argued that the existence of collection and sorting structures, which can be directly attributed to the command-and-control regulations of the VerpackV, was a prerequisite for the increase of the recycling rate that can be observed since 2005.

Taking into account data uncertainties, the considerable increase of plastic packaging waste that could be observed throughout the last years seems to support the argument that policies addressing the avoidance of plastic packaging waste were not effective.

2.4 Efficiency of policy instruments

2.4.1 Cost-benefit assessment

A thorough economic analysis of the efficiency of German waste policies with regard to the management of plastic packaging waste would imply that the social benefits of increased recovery and recycling will be put in relation to the social costs arising from these activities. Furthermore, benefits and costs would have to be translated into economic terms (Schulze 2013). Given the methodological difficulties of these tasks and the limited scope of this case study, we have to take a much simpler and general approach for the efficiency assessment.

The VerpackV assigns the responsibility for collection, sorting and recovery of packaging waste to the different 'dual systems' in Germany. The licensing fees generated by these systems can be used as a proxy for the external environmental costs of plastic packaging. A break down of these costs to the individual level yields annual costs of 11.50 Euros per capita. It becomes clear that this complex structure of contractual agreements involves a significant amount of information and documentation obligations for the parties involved in this system. These obligations represent a large amount of the transaction costs, which have been estimated by the German Federal Statistical Office to reach 69 Million Euros per year (Schulze 2013).

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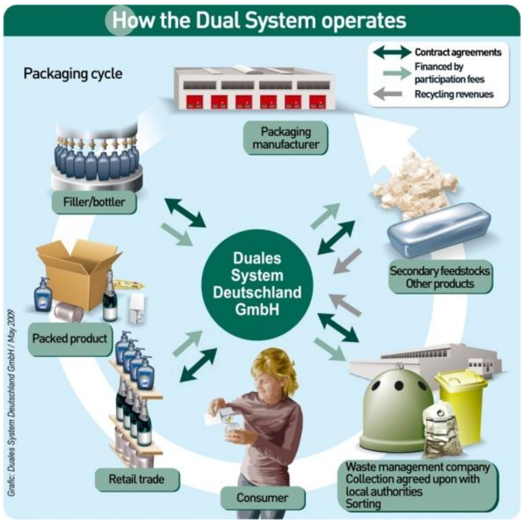
4 Based on figures from 2010 only Denmark, Belgium and the Netherlands have a higher recovery rate then Germany.

Figure 7 illustrates the structure of the contractual agreements of the DSD and the flow of revenues from licensing fees and recycling.

Figure 7: Structure of contractual agreements of the DSD and flow of revenues



Source: Duales System Holding (www.dsd-holding.de)

As the dual systems are not only responsible for plastic packaging waste but for all kinds of packaging materials, the figures that come as close as possible to the licensing fees generated from plastic packaging are the ones for lightweight packaging materials (see Table 3). Lightweight packaging (LWP) includes plastics, tin plate, aluminum, and composites. Approximately 80% of the costs and licensing revenues of the dual systems in Germany can be attributed to lightweight packaging materials.

Table 3: Costs and Revenues of the DSD attributed to lightweight packaging materials

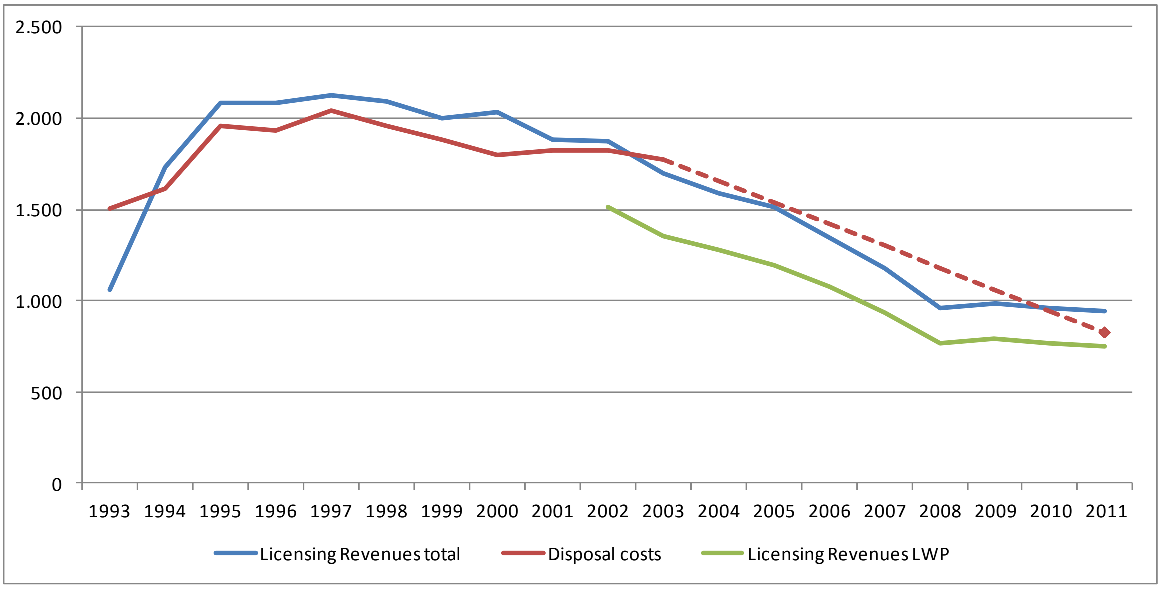
2011	Costs / Revenues in Mill. €	Costs / Revenues per licensed LWP in €/t	Costs / Revenues per collected LWP in €/t
Collection costs	328	274	139
Sorting / recovery costs	229	191	97
Side-payments	105	88	45
Total costs	663	553	281
Licensing-fees revenues	749	625	317
Gross margin	86	72	36

Source: Bundeskartellamt (2012), p. 61

Figure 8 shows that the total costs of the dual systems have decreased from approximately two billion Euros per year in the period from 1995 to 2000 to approximately one billion Euros per year since 2008. The decrease in licensing revenues and disposal costs can mainly be attributed to increased competition and advances in sorting technologies, which have taken place after the year 2000 (Bundeskartellamt 2012).

Although this development can be interpreted as a sign of increasing efficiency in the DSD, the high cost differential between licensed LWP (553 Euros/t) and total collected LWP (281 Euros/t) at least partly points to institutional deficits. The weight of the LWP material collected at the household level is almost double the weight of the licensed LWP. The difference can be ascribed to residual waste that is accidentally or intentionally thrown away, leftovers attached to packaging material, and non-licensed packaging material (free-riding) (Bundeskartellamt 2012). Even though some studies argue, that the negative effect of free-riding on the efficiency of the dual system should not be overestimated (Bundeskartellamt 2012, Schulze 2013), the problem of free-riding is currently object of intense public debate about the economic viability of the dual system.

Figure 8: Licensing revenues and disposal costs of the DSD[5] (in millions of Euros)



Source: Bundeskartellamt (2012)

2.4.2 Impacts of co-effects on efficiency

The intended effect of legal initiatives to avoid plastic packaging waste and to increase recycling is to reduce the consumption of raw materials, in particular crude oil, energy and GHG emissions associated with the production of primary plastics. In addition, improved recovery of plastic packaging waste contributes to a useful utilization of the energy contained in plastic waste. Furthermore, improved recovery reduces the space

5 The red dashed line is an extrapolation for missing data for disposal costs in the years 2004-2010. Data for 2011 was available.

needed for the construction of landfills for municipal waste. Apart from these intended positive effects on the environment, the regulations of the VerpackV and the KrWG have positive as well as negative co-effects on the economic and social dimensions of sustainability. As indicated above, the efficiency of the VerpackV is influenced negatively due to costs that arise from the operation and administration of the DSD. Furthermore, opportunity costs that arise due to the underutilization of the municipal waste management infrastructure have to be taken into account. However, these negative effects are compensated for by the positive economic impacts that arise from the increased investment and employment in the waste management sector. Furthermore, postive co-effects on technological innovation in the recycling sector have to be taken into account (Schulze 2013).

3 Expected and ovserved system context

3.1 Defining the system context and identification of context factors

The political objective of increasing the recycling of plastic packaging waste is embedded in a wider system context that takes into account fundamental political, economic, environmental and social developments on a national and global level, as well as the public debates reflecting upon strategies as to how to deal with these developments. Expected or unexpected changes in the system context can influence the legitimacy of policy instruments over time and their ability to achieve the stated objectives. Based on this reasoning, this chapter will briefly lay out some fundamental developments and debates that seem to be of relevance for the recycling of plastic packaging waste and the corresponding policy instruments:

1. Traditional waste management perspective

   From the first beginnings of systematic municipal waste management activities in Germany in the late 19th century, waste management was mainly concerned with the protection of human health (the avoidance of epidemics, in particular) and the environment. Disposal of waste had to be carried out in an environmentally safe and sustainable manner. These objectives were developed primarily as a result of the fact that there was not enough landfill capacity to absorb the rising amount of waste produced by a highly industrialized country. Furthermore, the operation of these landfills was associated with severe environmental and social problems (Kranert/Cord-Landwehr 2010). From the traditional waste management perspective the following context factors are most important:

- Volume of plastic packaging waste
- Public awareness for recycling of plastic packaging
- Capacities for different alternative waste treatment options:
  - Landfilling
  - Thermal recovery
  - Incineration
  - Recycling
- Availability of environmentally safe technologies, in particular for incineration plants and landfill management
- Social acceptance of waste management operations

2. Resource efficiency perspective

   Increasing global demand for mineral resources and surging commodity prices have drawn much political attention to resource efficiency (since approximately 2005). From a resource efficiency perspective, waste is considered a 'secondary' resource for industrial processes. In this context, the vision of a 100% recycling society has been formulated. Resource efficiency cannot only be promoted through the development of recycling-friendly products, resource-efficient production processes and recycling technologies, but also through a shift towards more sustainable consumption patterns. From the resource efficiency perspective, the following fundamental context factors are relevant:

   - Prices for crude oil
   - Technological progress of recycling technologies
   - Quality standards for secondary plastics
   - International trade with plastic waste
   - Public awareness for sustainable packaging
   - Willingness of private households to separate different types of waste

3. Climate change perspective

   The fight against climate change has been a political priority in German environmental policy during the last years. Based on the ratification of the UNFCCC (1994) and the Kyoto Protocol (2002) by the EU, Germany is obligated to reduce greenhouse gas emissions by 21% in the period from 2008 to 2012, as compared to 1990. The mitigation of climate change has two major implications for the management of plastic packaging waste. First, plastic packaging waste is a high calorific waste stream that can be used to substitute fossil fuels in the energy sector or in energy intensive industries. Second, in contrast to the primary production of plastic packaging, recycling can contribute to the reduction of greenhouse gases (GHG) emissions. From the resource efficiency perspective, the following fundamental context factors are key:

- GDP development
- GHG emissions from production of plastic packaging
- Demand for plastic waste as a climate friendly energy source

3.2 Impact of expected and observed context factors on the effectiveness and efficiency of policy instruments

In line with the argument put forth in chapter 3.1, the system context for the recycling of plastic packaging waste is shaped by general debates about waste management, resource efficiency and climate change. 33% of the survey participants expressed the opinion that the system context ended up developing differently than had been expected in 1998, when the VerpackV was first revised. 50% said that the system context developed partly differently and 17% said that the system context did not develop differently than had been expected in 1998. In the context of the online survey, the experts evaluated the strength and direction of different context factors on the recycling of plastic packaging waste.

Table 4 is based on the results gathered from the online survey (observed impacts) as well as our own assessments. Important changes of context factors that have influenced the recycling of plastic packaging waste positively are the technological progress of sorting technologies and the rise of the oil price, because both developments improved the economic viability of plastic recycling compared with primary production. Furthermore, the development of reliable quality standards for recycled plastic was important in order to improve market acceptance of recyclates. The general willingness of private households to separate waste and to finance the DSD with higher prices for packaged goods had a sightly positive impact on effectiveness and efficiency of the VerpackV.

Negative influences on the recycling of plastic packaging waste arise from the increased export of plastic packing waste to other countries, in particular to China. Furthermore, the debate about climate change increased the demand for the thermal recovery of plastic packaging waste which competes with recycling activities, provided that the quality of the waste is high enough to allow for recycling. The increasing use of plastic waste in RDF power plants is of particular relevance in this context. According to the view expressed by some of the stakeholders, the massive build-up of capacities for waste incineration and RDF power plants decreased the costs of thermal recovery and made recycling less competitive. Structural changes in the packaging waste stream have had a negative influence on recycling as well: the use of composite packaging materials can render recycling technologically and economically infeasible.

Table 4: Impact of expected and observed context factors on effectiveness and efficiency of the VerpackV

System context factor	Expected “impact” (-2 to +2)	Observed “impact” (-2 to +2)	Explanation	Impact on effectiveness/ efficiency
Techological progress	0,5	1,5	Technological advances, e.g. more efficient sorting technologies, can substantially reduce the costs of recycling	Highly positive
Oil price	0	1	With rising oil prices, recycled plastic becomes more competitive as compared to primary plastic.	Highly positive
Quality standards for recycled plastic	0	1	On the one hand, quality standards can increase market acceptance of recycled materials. On the other hand, quality standards can act as an impediment for recycled materials if the requirements are too high.	Highly positive
Public awareness and acceptance of plastic recycling	0,5	0,5	Public awareness and acceptance of plastic recycling can have a positive impact on the performance of recycling, the demand for products made of recycled materials and the willingness to finance the DSD.	Slightly positive
Amount of plastic waste generated	0	0,5	A lower than expected amount of plastic packaging waste could threaten the financial viability of recycling and recovery facilities due to fixed costs.	Slightly positive
Demand for plastic waste as energy source	0	-0,5	One the one hand, substituting plastic waste for fossil fuels can be economically efficient and improve the environmental performance of energy intensive industries. On the other hand, the plastic waste is no longer availbale for recycling, provided that the quality of the waste is such that recycling is a feasible option.	Sightly negative
Free-riding	0	-0,5	Free-riding refers to producers or importers of packaged goods that do not pay the DSD licensing fee. As non-licensed packaging materials are collected and recovered by the DSD, financing might be inadequate.	Sightly negative
Use of composite packaging materials	0	-0,5	Recycling of composite packaging materials is technologically very challenging due to the need for separation. Increasing use of composite materials can render recycling impossible.	Sightly negative
Export of plastic waste	0	-1	Export of plastic waste could threaten the financial viability of recycling and recovery facilities in Germany.	Strongly negative

4 Expected and observed policy transposition and implementation

Prior to the discussion about policy design and implementation, Table 5 and Table 6 are presented here in order to show the differences between expected and observed implementation of these policy instruments from the perception of the stakeholders.

Essentially, the comparison highlights that the positive stakeholder expectations with regard to the impacts of the KrWG and the VerpackV have hardly been met, which is rather surprising given that the recovery rate increased considerably throughout the last 10 years and that the recycling quotas specified by the VerpackV have been constantly met (cf. chapter 2.4). Summarizing the results presented in Table 5 and Table 6, it becomes clear that the observed impact of the VerpackV was assessed to be only slightly positive and that of the KrWG and the TaSi to be slightly negative. The observed negative impact of the TEHG was stronger than expected. The gap between expected and observed impact was smallest for the TaSi. With regard to the KrWG, the VerpackV and the TaSi, observed impacts were less positive than expected. With regard to the TEHG, the impacts were even more negative than expected.

Table 5: Expected impact of policy instruments on recycling

Q 7: <u>Expected</u> impact of policy instruments on recycling of plastic packaging waste (Scale -2 to 2 with -2 = strong negative impact and 2 = strong positive impact							
	-2	-1	0	1	2	n	Weighted average
KrWG	1	0	5	6	2	14	0,7
Verpackv	1	1	3	0	7	12	1,1
TaSi	1	0	7	1	2	11	0,3
TEHG	1	2	3	1	0	7	-0,5

Table 6: Observed impact of policy instruments on recycling

Q 8: Observed impact of policy instruments on recycling of plastic packaging waste (Scale -2 to 2 with -2 = strong negative impact and 2 = strong positive impact							
	-2	-1	0	1	2	n	Weighted average
KrWG	1	4	6	3	0	14	-0,25
VerpackV	2	1	3	5	1	12	0,2
TaSi	2	2	5	1	1	11	-0,3
TEHG	4	1	2	0	0	7	-1,5

Expected policy instrument design and implementation

Provided that policy makers were equipped with perfect rationality and that there was a clear social preference for the recycling of plastic packaging waste, we would expect that the design and implementation of the policy instruments would take into account the following aspects, which summarize the feedback that was gained from stakeholder responses to our survey (questions Nos. 13 and 15).

The recycling targets specified by the VerpackV should be much more ambitious and give actors (dynamic) incentives to constantly increase recycling performance. In order to avoid downcycling, such a regulation would have to be supplemented with further changes of existing regulations that would improve market acceptance of recycled materials.

The principle of extended producer responsibility which is formulated by the VerpackV and the KrWG is manifested in the obligation to collect and recover packaging waste. This principle should be expanded further by making product-specific requirements with regard to packaging design that include aspects such as recycling friendliness or a minimum input quota for recycled materials.

The preference for recycling over thermal recovery and incineration stated in the waste hierarchy of the KrWG should be expressed more clearly and give the waste management actors less flexibility with regard to the choice between recycling and thermal recovery. Such a policy could be supported by regulations that give economic disincentives (e.g. incineration tax) for thermal recovery and incineration of plastic packaging waste.

§ 2, para. 5, sentence 3 of the TEHG specifies that emissions from the burning of municipal waste are not subject to the provisions of the act. This exemption was expected to provide economic incentives for thermal recovery of plastic packaging waste as compared to conventional power generation.

Observed policy instrument design and implementation

In the following, we will discuss some of the reasons why observed policy design and implementation deviated from what was expected.

Throughout the design stage of the policy cycle, there was no clear political preference for the recycling of plastic packaging waste as compared to the use of plastic waste as an energy source. These uncertainties resulted in the provision of the KrWG that, if the calorific value of the waste exceeds 11,000 KJ/kg, energy recovery is considered to be equivalent to recycling. Combined with the relatively low minimum recycling rates specified by the VerpackV and the economic incentives for thermal recovery and incineration, this decision has had a negative impact on recycling.

Furthermore, support for recycling from special interest groups was low compared to the combined influence of the plastics industry and operators of incineration plants or RDF power plants.

Other reasons for the gap between expected and observed policy design are that recycling technologies were not advanced enough to make sure that ambitious recycling targets could be achieved. Furthermore, market acceptance for recycled products was very low, in particular in the food and personal care sector, where legal requirements restrict the use of recycled plastic as packaging material.

Observed economic incentives for thermal recovery of plastic packaging waste stemming from the provisions of the TEHG were probably lower and less stable than expected. The implementation of the TEHG was characterized by an overallocation of certificates in order to avoid negative economic impacts on energy intensive industries in Germany and offshoring. After the global financial crisis hit Europe in 2008, certificate prices fell sharply. Apart from this, positive expectations with regard to the use of plastic packaging waste as an energy source have induced considerable investments in RDF power plants and coincineration plants (Alwast/Birnstengel 2010).

5 Explore policy instrument interaction including an analysis of stakeholder behaviour within the application system

5.1 Overview of the stakeholder system

The basic stakeholder system is connected through the material flows of plastic packaging, packaged goods and plastic packaging waste in the economy. A simple description of the stakeholder system starts from the production of plastic packaging from primary or secondary sources. The producers of plastic packaging material supply their customers, the manufacturers of consumer goods, with packaging material for their products. Based on the weigth of the plastic packaging, the producers or importers of the consumer good are required to pay a license fee to the DSD. The packaged goods are distributed through retailers to the final consumers. At the household level, packaging waste is disposed of separately and collected and shipped to a sorting plant, where the plastic is separated from other packaging materials (e. g. paper, glass, metals). Different kinds of plastic are sorted (e. g. PET, PE, PP), as far as separation is technologically and economically feasible. Both, collection and sorting of packaging waste, are organized but not necessarily performed by one of the DSDs. Depending on the quality of the sorted plastic packaging waste and the respective market demand, there are three different waste treatment options available: recycling, thermal recovery and incineration.[6]

These different options are performed by different groups of stakeholders. For the recycling path, sorted thermoplastics are sold to recycling companies, where - after grinding, washing, elimination of impurities, drying and melting - plastic granulates are produced. These granulates are sold to customers in other value chains. Depending on the end products of these value chains, the whole process can be described as recycling, upcycling (e. g. clothing) or downcycling (e. g. paint buckets). For the thermal recovery path, plastic packaging waste can be used, together with fossil fuels, for coincineration in energy intensive industries, e. g. in the steel, cement or energy sectors, or as a fuel for RDF power plants. The third waste treatment option, incineration, is chosen for mixed and highly impure plastic materials, where the costs for achieving the quality standards necessary for recycling or thermal recovery would exceed the costs for incineration.

6 Because of its decreasing importance in Germany, feedstock recycling is not explicitly considered here.

Besides these operational stakeholders, there are other important groups that have a stake in the recycling of plastic packaging waste:

- Waste management authorities on the local, state or federal level, implementing, monitoring and enforcing the policy goal of plastic recycling
- Competition authorities (in particular monitoring of DSD)
- Environmental NGOs
- Suppliers of recycling technologies

5.2 Expected impact of single policy instruments on direct stakeholders' behaviour

The following discussion of the impact of single policy instruments on direct stakeholders is organized by policy instrument. The results are shown in the respective figures that provide a graphical display of the direct influence of the policy instrument on the different stakeholder groups (arrows). The graphical display is based on results gained from the online survey of stakeholders.

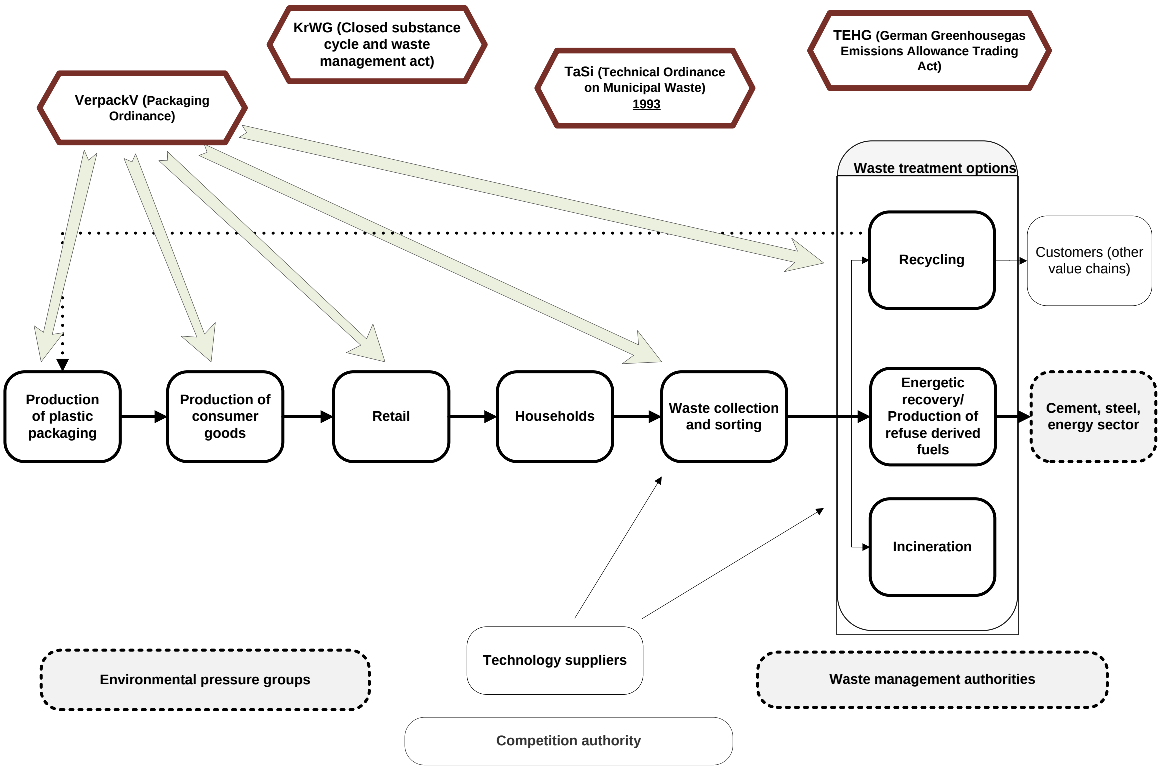
Impact of the VerpackV on direct stakeholders

Figure 9 shows that the direct impact of the VerpackV streches over the whole value chain. Buidling on the principle of extended producer responsibility, the regulation has resulted in the build-up of the DSD which is financed by licensing fees that are paid by the producers or importers of packaged consumer goods. However, due to the fact that the licensing fee can be passed on to the final consumer, it can be assumed that the DSD is financed to a large part by the consumers of packaged goods. The impact of the VerpackV on the changes towards a more environmentally friendly packaging design can be assumed to be small, because the incentives arising from the licensing fee of using less plastic packaging are rather small in relation to the total price of most consumer products. The introduction of a compulsory deposit for non-refillable beverage containers had a major impact on retailers because of the obligation to set up a separate collection system in every store.

The physical and organisational separation of the packaging waste from the other municipal waste streams has the effect, that public waste management companies have no direct access to packaging waste. With regard to long-lived capital goods, such as incineration plants, this decision might have had a negative impact on the degree of capacity utilization. Underutilization of existing incineration capacities could have resulted in higher charges for waste disposal for private households.

The recovery and recycling rates specified by the VerpackV formulates minimum requirements with regard to the treatment of plastic packaging waste. The minimum recycling rate for plastic packaging (36%) makes sure that recycling will take place up to this threshold and provides some financial security for investments in recycling (i.e. sorting) plants and technologies, because in a situation where revenues from recycling are lower than costs, the difference will be covered by the DSD.

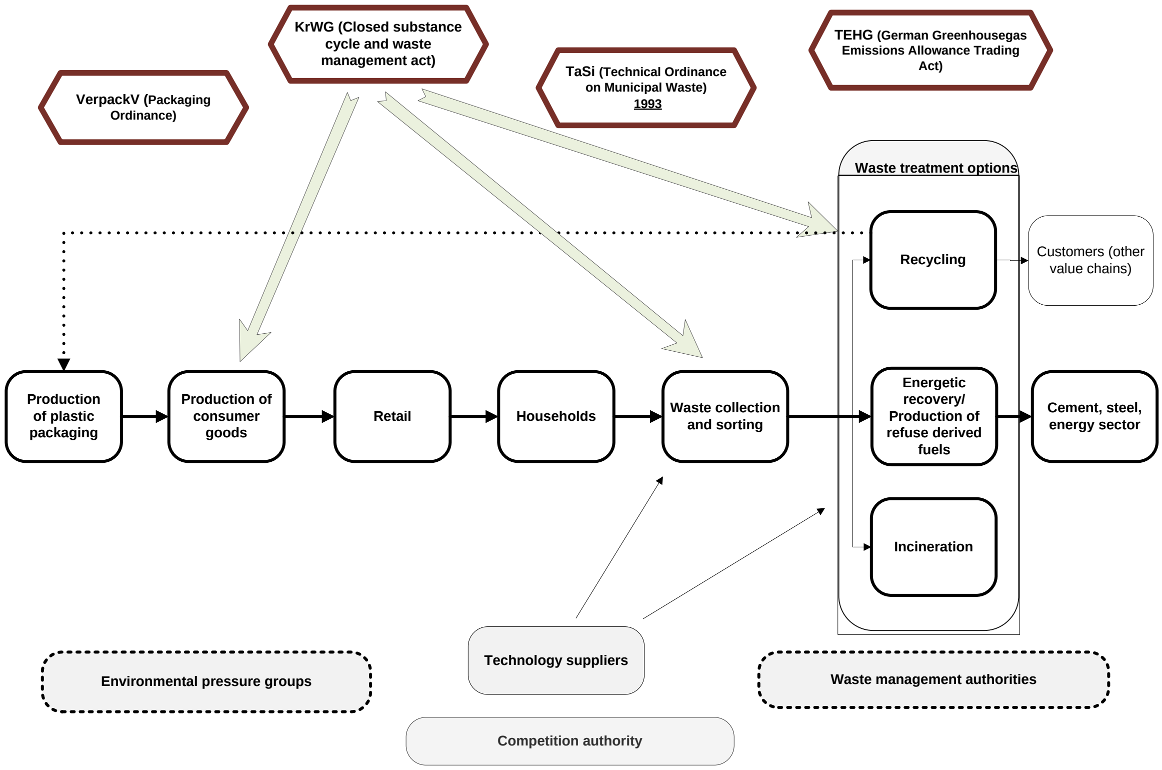
Figure 9: Direct influence of the VerpackV on stakeholder system



Impact of the KrWG on direct stakeholders

The direct impacts stemming from the KrWG are similar to the impacts of the VerpackV, although the KrWG is more concerned with the regulation of waste management activities in general. The flexibility that was introduced in the 5-step waste hierarchy had important consequences for those stakeholders that have an interest in using plastic packaging waste as a feedstock for energy production, because thermal recovery of high calorific waste is considered to be equivalent to recycling, despite the general preference of the KrWG for recycling.

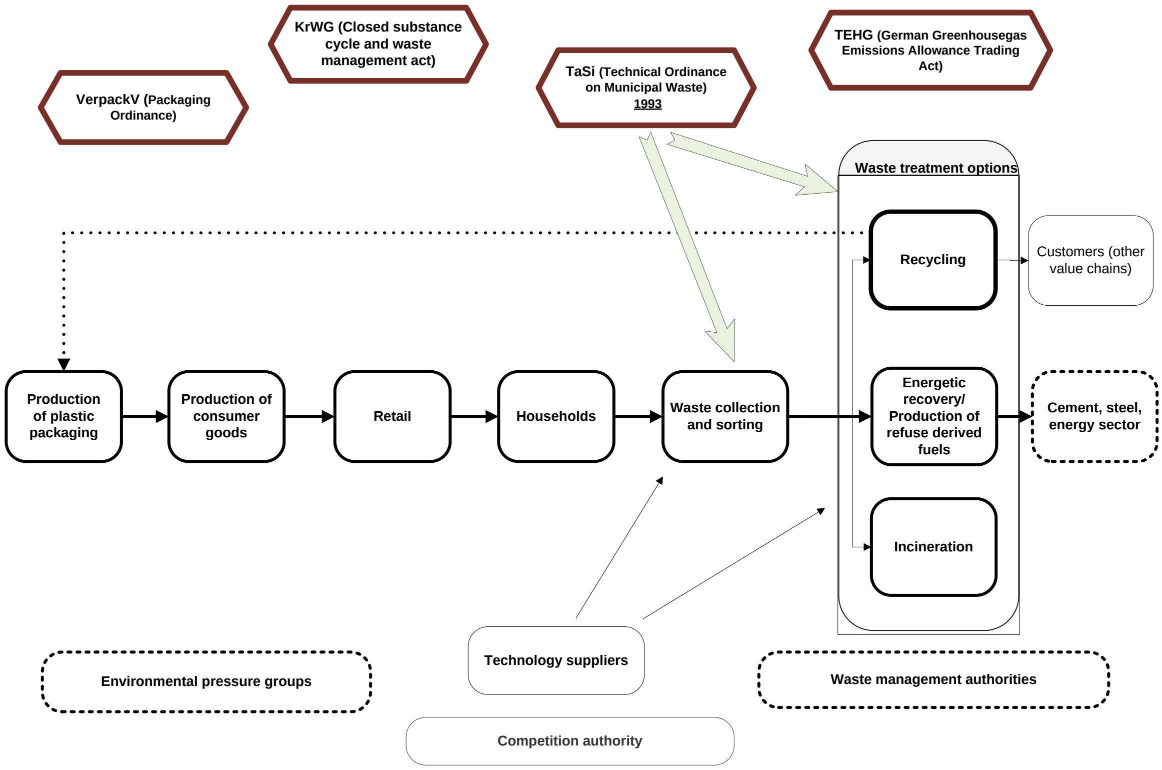
Figure 10: Direct influence of the KrWG on stakeholder system



Impact of the TaSi on direct stakeholders

The impact of the TASi was very focused on the waste management part of the value chain. In contrast to the other policy instruments, the TaSi is not in force anymore and the impact has probably been strongest in the years before 2005, the year until the requirements of the TaSi, thermal treatment of waste and inertisation prior to final disposal, had to be met. One of the reasons why the impact of the TaSi is of relevance for the situation today is that the TaSi has resulted in considerable investments in long-lived incineration plants. Overcapacities for incineration of municipal waste and the desire of public or private waste management companies to utilize the available incineration capacity at an optimal level have resulted in decreasing costs for incineration. This situation is particularly relevant with regard to recycling or thermal recovery of low grade plastic packaging waste (e. g. composite materials), because decreasing incineration costs render further separation steps economically less attractive.

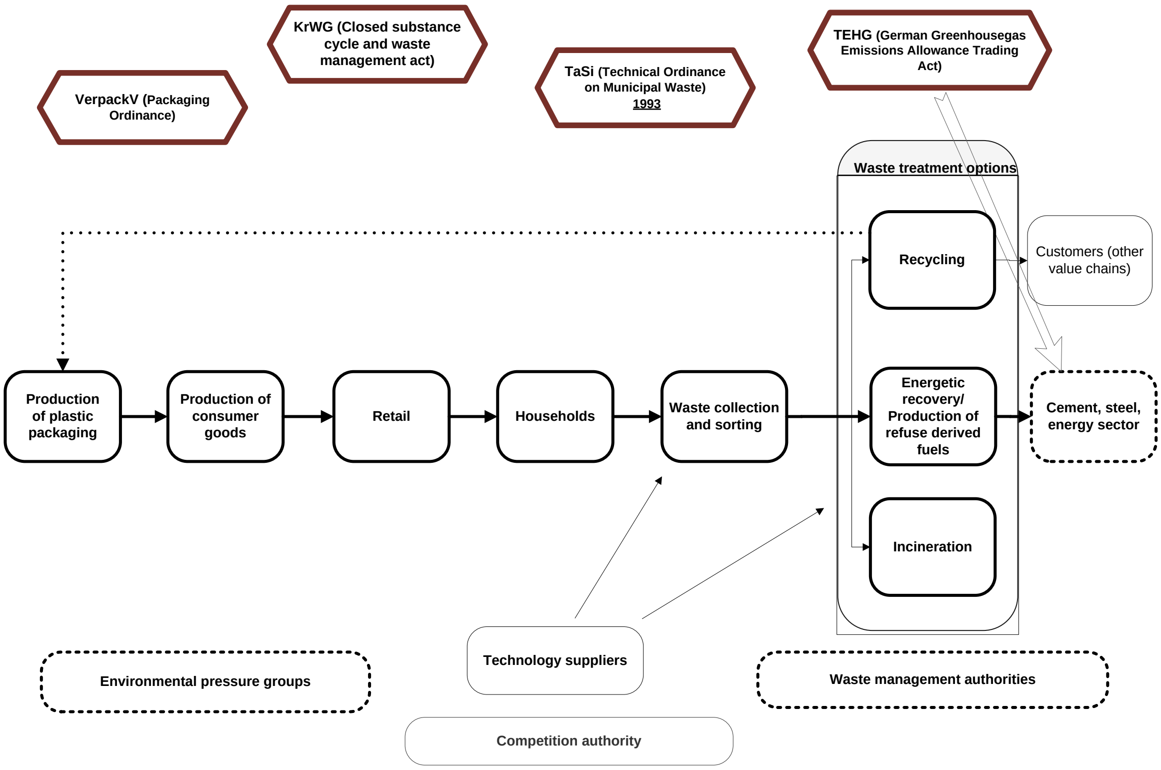
Figure 11: Direct influence of the TaSi on stakeholder system



Impact of the TEHG on direct stakeholders

The TEHG regulates the trade with emission certificates in the energy sector and energy intensive industries. The act is therefore directly relevant for those stakeholders that can use plastic waste for the generation of energy. By switching from fossil fuels to plastic waste, these actors are able to reduce the amount of emission certificates needed for their operations.

Figure 12: Direct influence of the TEHG on stakeholder system



5.3 Expected impact of combined policy instruments on direct stakeholders' behaviour

Figure 13 illustrates the influences of multiple PIs on the stakeholder system. Stakeholders coloured in blue face the strongest direct influences from multiple policy instruments. The assessment is based on data gained from the online survey which is summarized in Table 7.

Based on the number of respondents who indicated a direct impact of the policy instrument on the stakeholder group, the degree of interaction can be calculated based on the deviation of the observed distribution from the theoretically assumed equal distribution. This would assume that all responses are equally distributed among the four policy instruments. The deviation between observed and the theoretically assumed equal distribution can be measure on the basis of chi-square values.

High chi-square values indicate a strong deviation of observed results from the theoretically assumed equal distribution. The deviation between observed and assumed results would be greatest where one policy instrument has a very strong impact, whereas the impact from all other policy instruments is weak. To give an example: According to the survey results, the producers of plastic packaging were directly affected by the VerpackV (9), the KrWG (5), the TaSi (1), but not by the TEHG (0). If the stakeholder group was equally affected by all four policy instruments, we would expect an equal distribution of the 15 results, which would give us a value of 3.75 for each policy instrument. In fact, the chi-square value for the producers of plastic packaging is 13.53, which is the highest value among the different stakeholder groups. Chi-square values near 0 indicate that the difference between observed and the theoretically assumed equal distribution is very small, which is the case when the impacts of all four policy instruments on the stakeholder are equal. Therefore, in our context, low chi-square values can be interpreted as an indication for a high degree of policy interaction on the stakeholder level.

Based on the survey results, the following stakeholder groups are faced with a high degree of interaction between policy instruments (chi-square value < 5). In Figure 13 these stakeholders are coloured in blue:

- Energetic recovery / Production of RDF
- Cement, steel and energy sector
- Private housholds
- Waste management authorities
- NGO

These results can be interpreted such that the producers of RDF, the energy sector and the energy intensive industries all take an interest in using plastic packaging waste as an energy source. The trade of plastic packaging waste between waste management companies and these stakeholder estabishes an "external trading interaction" between stakeholders and regulations in the waste and the energy sector. The increasing interaction has had the effect that the thermal recovery of plastic waste has grown significantly during the last years. One of the drivers for this development is the energy sector's demand for alternative fuels. It is difficult to assess the real impact of the TEHG on the energy sector's demand for plastic packaging waste. The fact that RDF power plants are not subject to this regulation combined with the expectations of stakeholders regarding rising prices for fossil energy might have stimulated investments in RDF power plants. However, it is not only the energy sector's strong demand for plastic packaging waste that has established this "trading interaction". Equally important is the flexibility that was introduced into the waste hierarchy specified by the KrWG, because this flexibility facilitated the thermal recovery of plastic waste in the first place.

The private housholds, the waste management authorities and the NGO have an interest in the overall economic, social and ecological performance of the waste management system. Therefore, it can be argued that these stakeholders are more likely to be influenced by multiple policy instruments than stakeholders with a stronger focus on parts of the system, e.g. special interest groups. On the one hand, private households finance the DSD as well as the municipal waste management companies.

Therefore they have an interest in reducing the total costs of waste management and will reflect upon all policy instruments that influence these costs. On the other hand, most of the private households - to a greater or lesser extent - have a preference for environmental protection and will also take into account environmental benefits and disadvantages of different policies. Such a holistic perspective can be assumed for environmental NGOs and waste management authorities as well.

Figure 13: Direct and indirect impacts of multiple PI on stakeholder system

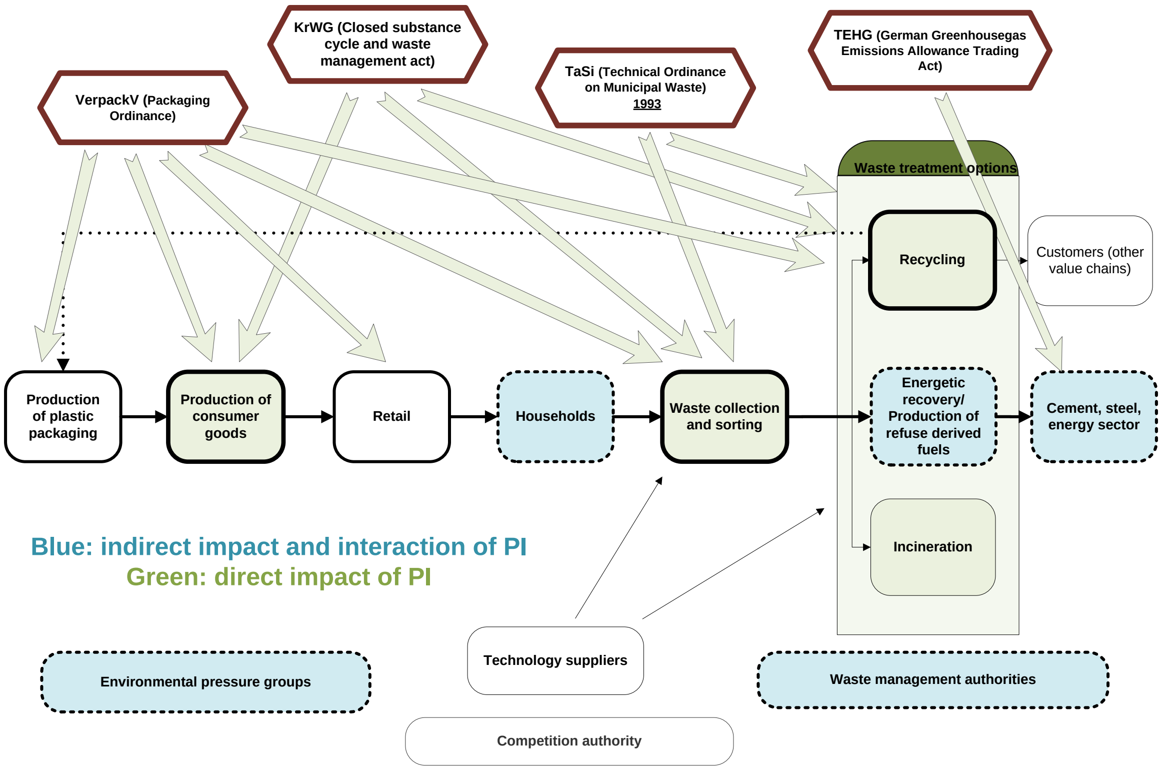


Table 7: Impacts from multiple policy instruments on stakeholders

	not specified	not affected	directly affected	expected distribution high interaction	not specified	not affected	directly affected	expected distribution high interaction
	Production of plastic packaging				Production of consumer goods			
KrWG	3	0	5	3,75	3	0	7	3,75
VerpackV	0	0	9	3,75	1	1	7	3,75
TaSi	2	2	1	3,75	4	4	1	3,75
TEHG	1	1	0	3,75	2	1	0	3,75
Total			15				15	
Chi-Square (directly affected)				13,53				11,40

	not specified	not affected	directly affected	expected distribution high interaction	not specified	not affected	directly affected	expected distribution high interaction
	Retail				Households			
KrWG	3	0	6	3,5	4	1	2	1,5
VerpackV	1	0	7	3,5	1	1	3	1,5
TaSi	4	4	1	3,5	4	2	1	1,5
TEHG	2	2	0	3,5	2	2	0	1,5
Total			14				6	
Chi-Square (directly affected)				10,57				3,33

	not specified	not affected	directly affected	expected distribution high interaction	not specified	not affected	directly affected	expected distribution high interaction
	Waste collection				Waste processing			
KrWG	1	0	9	5,75	1	0	9	5,75
VerpackV	0	0	9	5,75	1	0	8	5,75
TaSi	2	0	5	5,75	2	0	5	5,75
TEHG	1	2	0	5,75	2	0	1	5,75
Total			23				23	
Chi-Square (directly affected)				9,52				6,74

	not specified	not affected	directly affected	expected distribution high interaction	not specified	not affected	directly affected	expected distribution high interaction
	Production of secondary plastics				Energy sector companies			
KrWG	2	0	8	5,25	1	1	3	3
VerpackV	0	0	8	5,25	0	1	2	3
TaSi	2	1	4	5,25	2	0	4	3
TEHG	1	1	1	5,25	1	0	3	3
Total			21				12	
Chi-Square (directly affected)				6,62				0,67

	not specified	not affected	directly affected	expected distribution high interaction	not specified	not affected	directly affected	expected distribution high interaction
	Energy intensive industries				Environmental pressure groups			
KrWG	1	1	4	3	2	1	2	1
VerpackV	0	2	2	3	0	1	2	1
TaSi	2	0	3	3	2	2	0	1
TEHG	1	0	3	3	1	2	0	1
Total			12				4	
Chi-Square (directly affected)				0,67				4,00

	not specified	not affected	directly affected	expected distribution high interaction	not specified	not affected	directly affected	expected distribution high interaction
	Waste management authorities				Production of refuse derived fuels			
KrWG	2	0	6	4,25	1	0	6	3
VerpackV	0	0	6	4,25	0	0	2	3
TaSi	2	0	4	4,25	2	0	3	3
TEHG	1	2	1	4,25	0	0	1	3
Total			17				12	
Chi-Square (directly affected)				3,94				4,67

5.4 Overall assessment: Expected impact of stakeholder interaction in a multi policy instrument environment on the ability to achieve policy objectives

Although waste avoidance and recycling are stated objectives of German waste policy, effectiveness and efficiency of the respective regulations seems to be influenced negatively by interactions with other policy instruments. Both, the internal interaction between different waste management policies as well as the external interaction between waste management policy and climate policy, have a negative impact on the recycling performance. Table 8 and Table 9 summarize the interaction analysis and the effect of policy interaction on effectiveness and efficiency of the VerpackV and the KrWG. Apparently, these negative interactions originate from conflicting interests between the stakeholders of different waste treatment options, i. e. recycling, thermal recovery and incineration. In the policy design stage, these conflicting interests have resulted in the fact that, apart from the requirement to achieve the minimum recycling quota, the actors are flexible to choose the optimal waste treatment option - taking into account economic and ecological considerations - once this threshold level has been achieved. This regulatory flexibility has made the recycling objective susceptible to the potentially negative effects of policy interactions.

In particular with regard to the recovery of low grade plastic waste, economic incentives for thermal recovery and incineration seem to be much stronger than for recycling. This situation can partly be explained by the negative impact of the TEHG and other climate policy instruments on the use of fossil energy and the political will to use alternative energy sources (external interaction). In the previous chapter, the interaction between waste management policies (VerpackV, KrWG) and the TEHG, a climate policy instrument, was characterized as an external trading interaction. The trend to use plastic packaging waste as an energy source has resulted in a considerable increase of the thermal recovery rate between 2003 (2.3%) and 2010 (25.6%). Although this development had a positive effect on the useful utilization of plastic packaging waste, it can be assumed that the effect of the increase of thermal recovery on recycling was negative.

With regard to incineration, the effect of the TaSi on the build-up of incineration capacity and the economic imperative to utilize these capacities materialized in low costs for waste incineration (internal interaction). Both thermal recovery in RDF power plants and incineration imply high investments in technological equipment with an average life span of about 20 years. Hence, the sunk costs argument put forth by the respective stakeholders is politically very powerful.

The recycling quota specified by the VerpackV makes sure that high and medium grade plastic packaging waste is recycled. Due to the lack of dynamic incentives, the VerpackV itself was not successful in increasig the recycling performance beyond the

36% threshold level. Rather it seems to be the case that the observed increase of recycling between 2005 (39.1%) and 2010 (49.4%) was induced by a positive development of the system context, in particular the technological progess of recycling technologies and the increase in the oil price. However, it must be stated that such a development could only take place with the basic recycling infrastructure being in place, which can be clearly ascribed to the provisions of the VerpackV.

Table 8: Detailed comparison of policy instrument's design features and preliminary policy instrument interaction analysis

	Tier 1 Analysis: Comparison of individual policy instruments				Tier 2 Analysis Policy instrument interaction analysis (Policy compatibility + /0 / -)	Tier 2 Analysis Policy instrument interaction analysis (Policy compatibility +/-/o)
Parameters	PI 1: KrWG	PI 2: VerpackV	PI 3: TaSi	PI 4: TEHG	PI 1/ PI 2 and PI 3	PI1/ PI2/(PI3) and PI 4
1. Timeframe	since 1996 in force, latest revision in force since 2012	Since 1991 in force, latest revision in force since 2009	Came into force in 1993, out of force 2009	Came into force in 2004, latest revision in force since 2011	Time overlap 1993-2009	Time overlap since 2004
2. Context indicators	See figure 10	See figure 10	Amount of municipal waste generated, capacities and costs for treatment of municipal waste, investments in waste treatment, social legitimacy	GDP development and structure, development of energy demand, technological advances of energy efficient technologies and renewable energies, effectiveness of national allocation plan and regulatory oversight		
3. Policy objectives	Waste hierarchy, circular economy, producer responsibility, regulation of waste management activities	Reduce packaging waste, improve recovery of packaging waste, improve recycling, accountability of producers for collection, sorting and recovery	Establish thermal treatment of municipal waste and inertisation prior to final disposal until 2005	Cost efficient reduction of GHG emissions	(-) Neg. impact on recycling because of low costs for incineration (due to overcapacities) and flexibility introduced into waste hierachy (-) Neg. impact on the objective to reduce plastic packaging waste	(-) Neg. impact on recycling because of investments in RDF power plants and increasing demand for plastic waste as a feedstock (-) Neg. impact on the objective to reduce plastic packaging waste
4. Type	Command-and-control	Command-and-control	Command-and-control	Market based		
5. Activity coverage	Waste management	Production and retail of packaged consumer goods, waste management	Construction and operation of landfills	Energy production. Energy production from municipal waste is exempted from the TEHG		
6. Directly targeted stakeholders	Producers of plastic packaging, producers of consumer goods, retailers, waste collection, waste management companies, recycling industry, RDF producers, waste authorities	Producers of plastic packaging, producers of consumer goods, retailer, waste collection, waste management companies, recycling industry, waste authorities	Landfill operators	Energy sector, iron and steel, glass, cement, pottery and bricks, airlines	Municipalities, waste management companies, recycling industry, waste authorities, households, NGO	Municipalities, waste management companies, recycling industry, production of refuse derived fuels, energy sector, energy intensive industries, private households, waste authorities, NGO
7. Market flexibility	partly (choice between recycling, thermal recovery and incineration based on economic considerations)	partly (choice between recycling, thermal recovery and incineration based on economic considerations)	No	Yes		
8. Overall Compatibility of PIs					medium /low	medium
	Policy instrument interaction categorisation					
9.. Expected type of interaction					internal	external

Table 9: Impact of interactions on effectiveness and efficiency of policies to increase recycling of plastic packaging waste (VerpackV/KrWG)

Policy intercations	Impact	Impact on effectiveness/ efficiency of key PIs
PI 1/ PI 2 and PI 3 (internal)	(-) Neg. impacts on recycling because of low costs for incineration as a competing option for waste treatment (-) Neg. impacts on the objective to reduce plastic packaging	Slightly negative
PI1/ PI2/(PI3) and PI 4 (externa	(-) Neg. impacts on recycling because of increasing demand for plastic waste from RDF power plants and economic incentives for thermal recovery (-) Neg. impacts on the objective to reduce plastic packaging	Slightly negative

6 Synthesis and Conclusion

6.1 Conclusions on effectiveness

Analysing the effectiveness of policy instruments with regard to the recycling of plastic packaging waste was the overriding concern of this case study. However, it is important to keep in mind that there are other objectives of German waste management policy, such as the overall reduction of waste or the increase of recovery and useful utilization of waste. Next to recycling, recovery encompasses thermal recovery and incineration. Against this background, the effectiveness assessment is based on the following objectives:

1. Reduction of plastic packaging waste
2. Increase in recycling of plastic packaging waste
3. Increase of plastic packaging waste recovery

The effectiveness of the analysed policy instruments with regard to objective No. 1 appears to be rather low. Although data uncertainties have to be taken into account, the considerable increase in plastic packaging waste that occured throughout the last years seems to support the argument that policies addressing the avoidance of plastic packaging waste have largely been ineffective. Even though the costs for collection and recovery of plastic packaging waste are - partly - internalized through the licensing fees paid to the DSD, they do not give producers sufficiently high incentives to use less plastic packaging material or to use different packaging materials. To effectively discourage the generation of plastic packaging waste would require a much more integrated and fundamental policy approach.

The effectiveness assessment with regard to objective No. 2 starts off with the fact that the minimum recycling targets of the VerpackV have been constantly met during the 2003 and 2010 period. From the year 2005 onwards, the recycling rate has constantly increased. However, it is not clear to what extent this increase can be attributed to waste policies. Based on the views expressed in the expert survey, the effectiveness of the VerpackV on the recycling of plastic packaging is only sligthly positive. One of the reasons for this assessement is that the minimum recycling quota of 36% specified by the 4th revision of the VerpackV in 2005 is considered to be underambitious and, due to the fact that in the following years the recycling performance was much higher than the minimum quota, did not offer actors high enough incentives. Rather it seems to be the case that the positive development of the recycling performance was triggered by a combination of different system context factors, such as advances in sorting technologies, the rise in oil prices and the development of quality standards for secondary plastics. However, it can be argued that these context factors could only effect the recycling of plastic positively on the basis of existing country-wide collection and sorting structures for packaging waste. The formation of these structures has been mandated by the VerpackV.

The effectiveness of policy instruments with respect to objective No. 3 can be based on the fact that between 2003 and 2009 the amount of plastic packaging waste increased by 26.6% and, in spite of that increase, the recovery rate was raised from 75% to 97.2%. According to the offical statistics, this development can mainly be attributed to the increase in thermal recovery. Based on these figures, the effectiveness of policy instruments that have promoted the necessary public and private investments in thermal recovery plants seems to be very high.

In conclusion, the effectiveness assessment yielded ambiguous results that have to be interpreted with caution. The findings seem to support the argument that the strong increase in thermal recovery and a lack of political support for recycling impeded a stronger increase in recycling. The following chapter will summarize the hypothesized effects that different categories of influence have had on waste management actors and their choice between thermal recovery and recycling.

6.2 Conclusions on the impacts of contextual factors, implementation factors and policy interaction

So far, influences stemming from contextual factors, implementation and interaction have been treated separately in this case study. The objective of this chapter is to relate these different categories of influence to each other and to provide a more holistic perspective on the factors that have shaped the effectiveness the VerpackV and the KrWG.

Against this background, Table 10 compares the impacts of factors from different influence categories to each other. The main argument that is put forth here is that the policy design and implementation factors have been of crucial importance for the other categories of influence to become effective.

Throughout the design stage of the VerpackV and the KrWG, there was no clear political preference for the recycling of plastic packaging waste as compared to the use of plastic waste as an energy source. These uncertainties resulted in the provision of the KrWG that, if the calorific value of the waste exceeds 11,000 KJ/kg, energy recovery is considered to be equivalent to recycling. Combined with the relatively low minimum recycling rates specified by the VerpackV and the economic incentives for thermal recovery and incineration, this flexibility can be interpreted as a prerequisite for policy interactions to come into effect.

However, observed economic incentives for thermal recovery of plastic packaging waste stemming from the provisions of the TEHG were probably much lower and less stable than expected. The implementation of the TEHG was characterized by an overallocation of certificates in order to avoid negative economic impacts on energy intensive industries in Germany and offshoring. After the global financial crisis hit Europe in 2008, certificates prices fell sharply. Rather it seems to be the case that political support and positive expectations of investors with regard to the use of plastic packaging waste as an energy source have induced investments in RDF power plants and coincineration plants. With regard to incineration, the effect of the TaSi on the build-up of incineration capacity and the economic imperative to utilize these capacities manifested itself in low costs for waste incineration. Both thermal recovery in RDF power plants and incineration imply high investments in technological equipment with long average life spans.

The discussion of comparative impacts stemming from implementation and interaction factors suggests that expectations about future developments play a crucial role for decisions to invest in recycling, thermal recovery or incineration plants. It is argued here that these expectations have chiefly been influenced by the development of the system context, whereas implementation and interaction factors have a mediating function in this case study. Without the influences stemming from changes in the system context, these factors would probably not be sufficient to explain the strong increase of thermal recovery and co-incineration that was observed throughout the last years. Due to their mediating role, the impact of implementation and interaction factors was labelled as "slightly negative" in Table 10, whereas some of the context factors have a "highly negative" or "highly positive impact" on the effectiveness of the VerpackV and the KrWG.

Going into more detail here, important changes of context factors that have influenced the recycling of plastic packaging waste positively are the technological progress of sorting technologies and the rise in oil prices, because both developments improved the economic viability of plastic recycling compared with primary production. Furthermore, the development of reliable quality standards for recycled plastic was important in order to improve market acceptance of recyclates. The general willingness of private households to separate waste and to finance the DSD by higher prices for packaged goods had a sightly positive impact on effectiveness of the VerpackV. Negative influence on the recycling of plastic packaging waste arises from the increased export of plastic packing waste to other countries, in particular to China. Furthermore, the fight against climate change increased the demand for the thermal recovery of plastic packaging waste, which competes with recycling activities, provided that the quality of the waste is high enough to allow for recycling. The increasing use of plastic waste in RDF power plants is of particular relevance in this context. According to the view expressed by some of the stakeholders, the massive build-up of capacities for waste incineration and RDF power plants decreased the costs for thermal recovery and made recycling less competitive. Structural changes of the packaging waste stream have had a negative influence on recycling as well, because the use of composite packaging materials can render recycling technologically and economically infeasible.

Table 10: Impact of system context, implementation and interaction with other policy instruments on the effectiveness of VerpackV/KrWG

	Factor	Impact on effectiveness of VerpackV/KrWG
System Context	Techological progress	Highly positive
	Increase of oil price	Highly positive
	Quality standards for recycled plastic	Highly positive
	Public awareness and acceptance of plastic recycling	Slightly positive
	Demand for plastic waste as energy source	Sightly negative
	Use of composite packaging materials	Strongly negative
	Export of plastic waste	Strongly negative
Implementation	"Flexibility" of waste hierarchy	Sightly negative
Interaction	Interaction with the TASi	Slighly negative
	Interaction with the TEHG	Slighly negative

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