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Germany:
Self-Commitment on the Collection and Recovery of Spent Batteries and the Reduction of Mercury Content in Batteries

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Introduction

Almost 870 million of batteries and accumulators are sold annually in Germany with a total weight of 27.000 tons. The amount is increasing and most of the batteries still are disposed of with household waste. While the largest part (83 per cent of items) today are batteries containing a low level of harmful substances, the greatest environmental threat is posed by the remaining 17 per cent of batteries and accumulators containing high levels of harmful substances, especially mercury, cadmium and lead.

In 1988 a voluntary agreement was concluded which committed producers and importers to avoid harmful substances in batteries by means of development and production of alternative and environmentally friendlier products. Furthermore, certain types of batteries containing harmful substances were to be labelled, taken back by retailers and recycled and/or disposed of separately in order to reach the overall goal of the voluntary agreement: the reduction of harmful batteries disposed of with household waste.

This voluntary agreement led to some relevant success in the substitution of lead, mercury and cadmium in batteries. However, the scheme for take back and separate recycling and disposal was less successful and a large amount of batteries containing harmful substances was still disposed of with household waste.

Since 1989 the German *Ministry for the environment* presented various drafts for a federal ordinance on recycling and disposal of used batteries and accumulators, which had been necessary in order to transpose the EC Council Directive 91/157 on batteries and accumulators containing harmful substances and its amendment through the Commission Directive 93/86 into national law. The ordinance on batteries and accumulators was passed in Parliament in March 1998 and came in force in October 1998. Its prescriptions were designed by taking into account the failure of the recycling and collection scheme implemented in 1988 in order to overcome the shortcomings of this voluntary agreement and reveal a certain learning process by the different actors.

Context

The Environmental Problem

In general, batteries can be differentiated in non-rechargeable primary batteries and rechargeable accumulators or secondary batteries. Within these two basic categories a variety of battery types exists which differ according to their size and materials as well as to their environmental impacts.

The largest part (83 per cent of items) today are primary batteries containing a low level of harmful substances. The greatest environmental threat is posed by the remaining 17 per cent of batteries and accumulators containing high levels of harmful substances, especially mercury, cadmium and lead (see table 1).

The overall number of batteries, which were sold in Germany, increased about 92 per cent since 1986. In this year 450 million batteries were put into circulation with a total weight of 15.500 tons. They contained approximately 198 tons of cadmium and 19 tons of mercury (UBA, 1992: 125). In 1997 approximately 867,5 million batteries and accumulators for electronic appliances were sold in Germany (see table 1) with a total weight of near 27,700 tons and containing around 440 tons of cadmium and 3,4 tons of mercury (UBA, 1999: 3; ZVEI, 1998b).

Table 1: Batteries Put in Circulation in Germany by Type in 1997 [1)]

Battery	Form	Type	Dry Batteries in Germany	Percentage of Total
Primary batteries	Cylinder	Alkali-manganese	364,9 million	Together 42,1%
		Zinc-carbon	299,8 million	
	Button	Zinc-mercury	Together 95,5 million	Together 45,5 %
		Silver oxide		
		Alkali-manganese		
		Zinc-oxygen		
		Lithium		
Total of primary batteries			**760,2 million**	**87,6 %**
Accumulators	Cylinder	Nickel-cadmium	50 million	5,8 %
		Nickel-hydride	50 million	5,8 %
	Button	Nickel-cadmium	Together 7,3 million	Together 0,8 %
		Nickel-hydride		
Total of accumulators			**107,3 million**	**12,4 %**
Total of primary batteries and accumulators			**867,5 million**	**100 %**

Source: ZVEI, 1998b

1) Additionally 52 million lithium batteries and 6-8 million built-in rechargeable NiCd and NiMH batteries are brought into circulation with appliances sold. Also, not included in these numbers are accumulators, which are built-in and imported in consumer applications with a total share of approximately 10 per cent of the batteries market (Nathanie and Reger, 1998: 312).

The main environmental problems related to the production, use and disposal of batteries and accumulators are:

? the release of heavy metals, especially cadmium, mercury and lead, into the environment after disposal of batteries with the household waste; and

? the relatively low energy output: energy input for batteries is up to 50 times higher than energy output (Scholl, 1995: 11).

Whereas the latter aspect has not yet received much political attention and has not led to the formulation of political programmes, the environmental problems related to the disposal of batteries were set on the political agenda in the beginning of the eighties. At this time, especially the mercury content of batteries was perceived as the most severe environmental problem. Today, after a far-reaching elimination of mercury in the production of batteries, the use of nickel-cadmium accumulators impose the most significant threat to the environment. The quickly expanding market of mobile telephones and other mobile appliances during the 1990s has contributed to the increased use of accumulators containing cadmium. Besides mercury and cadmium, batteries contain a great number of other chemicals the ecological effects of which have not yet been adequately assessed. A study revealed that more than 270 different chemicals were used in the production of batteries (UBA, 1993a: 256).

The disposal of used batteries can follow three different paths: landfill, incineration and recycling. From an environmental point of view the batteries landfilled with household waste gain importance because the landfill conditions may lead to the leaching out of the chemical substances contained in batteries and contaminate the environment, especially the ground and the water (Scholl, 1995: 33). About two thirds of all batteries are disposed of together with household waste (Hiller, 1998b: 9; Jülich, 1998: 271). Batteries are responsible for about 85 per cent of all cadmium and 11 per cent for mercury in household waste. Lead pollution from batteries, on the other hand, is very small (Jülich, 1998: 272).

Although only 30 per cent of all batteries are incinerated, this way of disposal has received attention due to generation of hazardous residues which have to be disposed of properly in order to prevent any negative impact on the environment (Hiller, 1998b: 9; Jülich, 1998: 271). Depending on the assumptions about the recycling quotas the contribution of batteries to the overall heavy metal load of waste scheduled for incineration differ widely. Assuming that no batteries are recycled, cadmium contributes to the heavy metal content in incinerated waste with 38 tons and mercury with 3,6 tons (see table 2).

Table 2: Estimated contribution from batteries
to the heavy metal load from incinerated domestic waste

Metal	**Metal content in waste in tons**	**Input in tons (recycling quota = 0)**	**Input in tons (recycling quota assumes a life span of 5 years)**	**Input in tons (recycling quota assumes a life span of 7 years)**
Cadmium	171,5	38,3	13,2	29,0
Mercury	32,1	3,6	1,36	2,42
Nickel	865	38,5	13,3	29,3

Source: UBA, 1993b

When burned in a household waste incineration plant, the mercury contained in batteries evaporates. In the past about 50 to 70 per cent of the mercury content were emitted into the air, the rest was bound in the slag and the residue by electronic filters. In 1990, 0,3 tons of mercury and 2 tons of cadmium were emitted into the air by incineration plants, which burned small batteries (see table 3).

Table 3: Material flows of small batteries in incineration plants (1990)

Metal	**Cadmium**	**Nickel**	**Lead**	**Mercury**
Metal content in waste (ton)	98	120	20	2,7
Slag, cleaned (ton)	9,8	112	12	0,1
Filter dust (ton)	83	6	5,8	0,1
Waste water (ton)	3	2,4	<1	2,2
Slag water (ton)	< 1	< 1	< 1	< 1
Emission (ton)	2,0	< 1,4	< 0,2	0,3

Source: UBA, 1992

Today, wet filters reduce the emitted mercury to 5 per cent of the mercury content and carbon filters even bind completely the mercury content (Hiller, 1998a: 10). Cadmium is released with ash particles requiring additional filtering efforts and leading to increased amounts of hazardous waste (UBA, 1993a: 256).

Alternative to the landfill and incineration batteries can be recycled. The possible recycling paths for the sorted battery fractions concentrate on recovering materials such as cadmium, lead, mercury, silver, iron, nickel and copper. Before recycling, the used batteries must be collected separately. However, battery mixes, as can be found usually in collection boxes, are difficult to recycle, because they require several preparatory processes to separate the different metals and other contents of the batteries (UBA, 1992: 156-157). Attempts to recycle a mix of different battery types have proven too expensive and highly energy and waste intensive. In general, the necessary sorting of used batteries is the most relevant cost factor emerging during recycling efforts (Nathanie, 1998: 306). Additionally, the recycling of mercury, cadmium and some other heavy metals is seldom efficient. In most cases e.g. for mercury, depending on its market price, the costs of recycling exceed the value of the reusable mercury (Kiehne, 1998a: 18; Hiller, 1998d: 46-48). Furthermore as a result of the recycling process hazardous waste is generated. Its disposal leads to additional costs.

Box 1: Waste Policy in Germany

Jänicke and Weidner (1997: 140) describe the general German environmental policy as being "based largely on an inflexible approach and conventional attitudes toward regulation, rooted in old-fashioned policing law (danger avoidance) and 'statist' ideology". Similarly, Weidner (1995: 67) identifies "a bureaucratic, highly legalistic policy style with limited participation, based primarily on conventional regulatory instruments".

However, the German government has argued that traditional regulatory instruments would not be an efficient solution as they would rather stifle the development of innovative techniques and has given priority to voluntary agreements as an integrated approach (Bundesregierung, 1996). The new government, which came into power in October 1998, has maintained in principle this preference for voluntary solutions (Coalition Agreement between the SPD and Alliance 90/The Greens signed in Bonn on 20 October 1998).

Contrary to other European countries like Denmark or the Netherlands, the co-operative instrument of voluntary agreements in Germany are "unilateral, legally not binding, declarations by industrial associations or companies (...) to take up certain environmental measures". These declarations are "informally" accepted by government "without entailing any legal obligation for the state" (Merkel, 1997: 92). Public authorities are not formally involved in these commitments. However, these voluntary agreements are usually the result of lengthy intensive discussions and negotiations with the competent ministries. The declarations are addressed to the public bodies, who recognise them in an informal way, e.g. by a press release.

The development of waste policy in Germany seems to confirm Jänicke's and Weidner's general characterisation of the German environmental policy. Since the early 1970s a broad network of laws and ordinances has been established to regulate this area of environmental protection. The first comprehensive federal waste law (*Waste Disposal Act*) was enacted in 1972. Its main aim was to ensure the environmentally sound waste disposal. At least until the middle or late 1980s the dominant regulatory approach has been one of traditional command-and-control with all stages of waste processing - ranging from its generation through storage, treatment, collection and transport all the way to its final disposal - being subject to direct administrative control. Economic instruments, on the other hand, are relatively underdeveloped (SRU, 1991: 54-55; Jörgens and Jörgensen, 1998).

However, co-operative instruments of indirect regulation have also found their way into German waste policy since the adoption of the *Waste Avoidance and Management Act* in 1986. This act placed more weight on waste minimisation and recycling and for the first time laid down a preference of waste avoidance over recycling and disposal (BMU, 1998: 117). The general idea behind this co-operative approach is that the government sets concrete goals for the avoidance, reduction or reuse of waste in specific areas, but leaves it up to the target groups to reach these goals within a reasonable time frame. In the case that the goals are not reached or sincere efforts are not made within a given time, the minister of the environment is entitled to rule this area by means of an ordinance (SRU, 1991: 56-57).

In 1994 a new legal framework for waste policy – the *Closed Substance Cycle and Waste Management Act* (Krw-/AbfG) – was adopted by parliament and came into force two years later on 7 October 1996. The new law brought with it an extension of the definition of waste to include not only waste for disposal, but also waste for recovery in order to bring German law in line with European practice (Jörgens, 1998b). Furthermore, it introduced a general duty to avoid the generation of waste, which covers production processes as well as products (BMU, 1998: 117). The concept of extended producer responsibility is an essential element of this waste minimisation strategy.[1] It depicts the legal basis for product regulations concerning for example end-of-life-vehicles, packaging, or batteries. On this legal basis, government is entitled to regulate in detail and is enabled to develop and pass ordinances concerning specific requirements for products including:

? restrictions regarding the composition/characteristics or destined uses of certain products in order to facilitate reuse or proper recovery or disposal:

? product bans if "during management of their waste, the release of noxious substances cannot be avoided, or can be avoided only at disproportionately high expenditure";

? labelling obligations, which point out "the necessity of return to the manufacturer, distributor or specified third parties"; and

? return or take-back obligations. [2]

1 The idea of extended producer responsibility described in detail in chapter four of the new act, however, is not altogether new to German waste policy. Problems related to one-way-packaging had already been debated during the formulation of the first German Waste Disposal Act in 1972 (Thomsen, 1998: 27) and to some extent provisions entitling government to develop product related ordinances have been included in this act (for packaging and containers) and to a greater extent in the Waste Management Act of 1986 (for products of all kinds, Art. 14 AbfG; c.f. Spangenberg and Verheyen, 1996: 63). Furthermore, Art. 14 of the old Waste Management Act enabled government to set national targets for avoidance, minimisation and recovery of individual products.

2 Regulations in the area of extended producer responsibility have first been developed in the area of packaging waste. The most prominent result has been the adoption of the *German Packaging Ordinance* in 1991 – still under Article 14 of the old 1986 *Waste Management Act* – which since has served as one of the main examples and models of EPR schemes within the OECD (OECD, 1998).

Process

Structure of The Economic Actors Involved: The Batteries Industry and the Retail

Concrete numbers about the structure of battery producers and importers are hardly available. In 1998 the whole batteries industry, which is one of the smallest industrial sectors in Germany, employed 8.634 people. In 1997, the total turnover amounted to 1,9 billion DM (ZVEI, 1998b: 2). All large international battery producers *Duracell*, *Ralston*, *Rayovac*, *Philipps* and *Panasonic* have affiliated companies in Germany (Scholl, 1995: 21). The only domestic producer is *VARTA AG*. The government counts 13 market leaders on the batteries market that together have a market share of 90 to 92 per cent in the field of primary batteries and 78 per cent in the field of accumulators. About 85 per cent of primary batteries are produced by only four companies: *VARTA*, *Duracell*, *Philipps* and *Ralston* (Bundesregierung, 1997).

Most of the batteries are imported. The government estimates the share of imported primary batteries in Germany in 1997 at about 70 per cent and of accumulators at about 84 per cent (Bundesregierung, 1997). Additionally, the share of grey imports and plagiarism seems to be significant on the batteries market. However, no concrete numbers are available.

Furthermore, the producers of consumer applications play an important role on the accumulator market (e.g. laptops, personal computers, mobile telephones) in the so-called OEM-market (Original Equipment Manufacturing). These companies buy about 65 per cent of the accumulators sold by the producers. Only 25 per cent are put on the open consumer market (Nathanie and Reger, 1998: 312). According to Nathanie and Reger the influence of the OEM-companies cannot be underestimated, especially if one considers possible innovation incentives resulting from their economic or environmental goals (Nathanie and Reger, 1998: 342).

The retail sector, the third largest sector in Germany, employs about 3.3 million people and its turnover amounts to DM 964 billion (HDE, 1999). Its structure is very heterogeneous, ranging from internationally operating companies to little family owned retail shops. 25 different retail trade associations representing about 470.000 enterprises are organised at the federal level in the umbrella organisation HDE.

The Development of the Voluntary Agreement

Environmental problems related to the disposal of batteries first came onto the public and political agenda in the late 1970s. At that time it became known to a greater public that mercury oxide button cells were landfilled together with normal household waste so that significant amounts of mercury were released into the environment (Jülich, 1998: 290). The public concern quickly led to first voluntary measures by the batteries industry including the installation of boxes in 1977 for the separate collection of mercury oxide button cells used in hearing aids or watches (Kiehne, 1998a: 15).

In 1980 a first voluntary agreement between the *Federal Ministry of the Interior* and the batteries industry was signed. The batteries industry agreed to separately collect mercury oxide batteries and recover the mercury. As a supplementary measure, zinc-oxygen cells which contained significantly less mercury (one per cent by weight) were awarded the German eco-label by the *Federal Environmental Agency* (Umweltbundesamt – UBA) under the condition that these batteries were collected separately (UBA, 1981:

108-109). In 1985 the batteries industry additionally started a program for the reduction of mercury in household batteries (Kiehne, 1998a: 15).

However, the agreement of 1980 did not succeed in taking the batteries issue off the political agenda. On the one hand, only a small fraction of all batteries had been covered by this agreement. On the other hand, the separate collection of mercury oxide batteries had not been sufficiently successful.[3]

With the adoption of the *Waste Management Act* in 1986, government's competencies for passing product-related regulations were significantly enlarged. This was perceived as a serious threat by the batteries industry as batteries together with packaging and end-of-life-vehicles were priority issues within the area of product oriented waste policy. The Ministry had signalled to the responsible sector that batteries was one of the areas where regulation could be expected, especially in order to reduce the use of harmful substances, which the Ministry considered as the most significant environmental problem related with batteries. Among the regulatory options brought into the debate by various actors were (Jülich, 1998: 278):

? a mandatory deposit on batteries containing harmful substances (*Council of Environmental Experts*);

? prohibition of appliances with permanently built-in batteries;

? collection of all batteries regardless of their harmfulness (*Federal Environment Agency* and *Federal Ministry for the Environment*);

? the introduction of a legal take-back and return obligation for industry and consumers respectively; and

? the introduction of take back and recycling quotas.

At the same time, environmental and consumer organisations had intensified their information work, which led to increasing sensitivity of the public towards waste problems caused by batteries (Jülich, 1998: 268). The perception of the problem focused on the content of harmful substances in batteries. Considering the environmental problems related to batteries in general, the *Federal Association of Environmental Consulting (*Bundesverband für Umweltberatung - BfUB) has demanded a prohibition of devices with permanently built-in batteries, the separate collection of all batteries and a take back obligation and an obligatory deposit for environmentally harmful batteries. The *Consumer Center* (Verbraucherzentrale), a German consumer organisation, recommends avoiding and reducing the use of batteries as far as possible, recollecting all batteries and preferring mercury free battery systems (Scholl, 1995: 57).

On 9 September 1988, as a reaction to the modified legal framework and after negotiations with government the producers and importers of batteries organised in the *German Association of Electrical Appliances Producers* (Zentralverband der Elektroindustrie - ZVEI) together with the *Federal Association of German Retail Trade* (Hauptverband des Deutschen Einzelhandels - HDE) presented the "Self-Commitment on the Collection and Recovery of Spent Batteries and the Reduction of Mercury Content in

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3 Heinz-Albert Kiehne, president of the *Trade Association Batteries within the German Association of Electric Appliances Producers* (ZVEI), argues that collection quotas of up to 50 per cent of all mercury-oxide button cells had been reached (Kiehne, 1998: 15). However, a study commissioned by the *Federal Environmental Agency* showed that in the early 1990s only 42 per cent of all mercury-oxide batteries were collected – indicating even lower collection results in the 1980s (UBA, 1993: 256).

Batteries" to the Federal Minister of the Environment. According to the *Ministry for the Environment*, the preceding negotiations concentrated on the reduction of harmful substances in batteries, whereas the recollection of batteries only played an inferior role.

Scholl concludes that two factors led the batteries industry to offer a voluntary agreement in 1988. Their initiative „has certainly been influenced on the one hand by the changed priorities and new regulatory possibilities which had been offered by the modified waste legislation and on the other hand by the increased sensitivity of the public towards the waste problems, not least because of the intensive information work of environmental and consumer organisations." (Scholl, 1995: 50-51) By proposing a voluntary agreement, the batteries industry intended to anticipate eventual regulatory measures by government.[4] They feared a prohibition of batteries containing harmful substances, the introduction of a deposit-refund system and/or the recollection of all, harmful and non-harmful, batteries which was and still is rejected by the batteries industry. For two reasons, the batteries industry considered regulatory measures as highly probable. First, in their perception the seriousness of the former Minister for the Environment Klaus Töpfer in pursuing an environmental policy based especially on the concept of extended producer responsibility was very strong. Second, from their point of view the changes in the legal framework, especially the *Waste Avoidance and Management Act*, increased the probability of new regulatory measures. The voluntary agreement thus was mainly an attempt to prevent direct regulation by proposing voluntary measures as the lesser evil (Scholl, 1995: 98).

Another factor which influenced the offer of the voluntary agreement, was a previous decision of the European, North American and Japanese battery producers to gradually eliminate the mercury content in alkali-manganese batteries (Scholl, 1995: 51). The underlying motives for this decision were, among environmental, also purely economic considerations. In Germany, the use of mercury in the battery production led to continually rising costs because the battery producers had to fulfil expensive safety and environmental standards due to the classification of mercury as hazardous substance in 1990 (Nathanie and Reger, 1998: 308).

The main goal of the HDE and the participating large retail companies during the negotiations and also during the later developments was to prevent a take back obligation exclusively for retailers. The HDE considered the continuation of collection by municipal authorities as essential in order not to confuse the consumer. Retailers saw no reasons to take back the batteries exclusively because product responsibility did not lie with them. They considered the offer to take back used batteries as an additional service for their consumers and not as their environmental responsibility.

Although the state did not assume any formal obligations, the Federal Minister for the Environment accepted the self-commitment and announced that he would refrain from any legal regulation on the issue if the goals were met. The *Ministry for the Environment* had no explicit preference neither for an ordinance nor for a voluntary agreement. At the time the agreement was concluded, the Ministry considered the targets as sufficient and informally accepted the voluntary agreement of 1988 (Jülich, 1998: 293), although it

4 In general, the batteries industry's acceptance of voluntary agreements as environmental policy instruments is relatively high, whereas the acceptance of regulatory or command and control instruments is rather low (Scholl, 1995: 79-80).

would have preferred the inclusion of concrete reduction targets for additional harmful substances into the voluntary agreement. Because of the lack of quantified targets with respect to the recycling and take back quotas (see below) it remained unclear at which level the Minister for the Environment would consider the goal attainment as sufficient and renounce from any further regulatory measures. However, an additional reason for not enacting a German regulation was the beginning debate on a European directive (Jülich, 1998: 270).

Content

The voluntary agreement introduced obligations for the reduction and avoidance of hazardous substances in batteries, labelling of batteries containing hazardous materials, the collection of these batteries and their recovery. The self-commitment came into force on 1 April 1989. Beside the overall goal of reducing batteries disposed of with household waste, the main goals formulated in the voluntary agreement were (see also UBA, 1988: 132; SRU, 1991: 232-233):

? to give preference to the development and production of battery systems without or with only a reduced content of hazardous substances, and the commitment to develop battery systems which are apt to substitute batteries containing hazardous substances;

? to reduce the mercury content of alkali-manganese batteries in three steps from approximately 0.2 per cent to less than 0.1 per cent by weight; by the end of 1988 mercury content was to be reduced to 0.15 per cent, by the end of 1990 to 0.1 per cent and by the end of 1993 to less than 0.1 per cent;

? for retailers selling new batteries to take back from the second quarter of 1989 small accumulators, nickel-cadmium accumulators, car batteries, button cells containing mercury, and alkali-manganese batteries with a mercury content of 0.1 per cent or more; these batteries are to be labelled with the recycling symbol (ISO: 7000-Reg.No. 1135) by the producers or in case of imported batteries by the retail; the label shall be explained to the consumer on the package; and

? for producers to accept all labelled batteries from retailers (non-hazardous batteries which are not labelled shall be taken back only for an interim period until the end of 1989) and to recover hazardous substances, especially heavy metals, from the returned batteries according to the recycling principle of the *Waste Management Act*.

The reduction of harmful substances in batteries concentrated on mercury, cadmium and lead. Of those three metals, only with regard to mercury did the agreement formulate concrete and quantified reduction targets. Other heavy metals were considered as less environmentally harmful (Jülich, 1998: 269).

In order to guarantee the functioning of the collection system, which is based beside the logistic connections between battery producers and retail, on the participation and information of the consumers, the agreement included provisions concerning consumer information about the difference between low-emission and environmental harmful batteries and the possibilities to return harmful batteries.

Analysis

Performance

Target Relevance

The reduction targets for mercury in the 1988 self-commitment were not very far-reaching taking into account the technical potential already in place at that time. It can be assumed that targets would have been reached as well without the voluntary agreement (Scholl, 1995: 77).[5] On the one hand, targets did not go beyond the announcement made in 1984 by leading international battery producers to reduce the mercury content of alkali-manganese batteries by at least 85 per cent by the year 1989. On the other hand, already in 1987 mercury content of 0.025 per cent was reached and 0.015 per cent were seen as technically feasible (SRU, 1991: 233). Jülich states, that it is rather questionable, whether the technological developments caused by the voluntary agreement exceeded the 'business-as-usual'-development (Jülich, 1998: 284).

Beside environmental considerations, the reductions of mercury, cadmium and lead in existing battery systems and the substitution of harmful substances through the development of new battery types may also have been motivated by economic considerations (e.g. the above mentioned high costs caused by the use of mercury in the battery production) and/or competitive advantages (Jülich, 1998: 288). A survey carried out by the German *Institute for Ecological Economy Research* partly confirms this assumption: different actors attached a minor importance to the voluntary agreement with respect to its incentive function (Scholl, 1995: 78). Concerning the goal to develop innovative battery systems two battery manufacturers stated that competition with other manufacturers and a change in the areas of application had been the most significant motives to develop innovative battery systems (Scholl, 1995: 78). In general, according to interviews with battery producers in Germany, environmental motives to develop new accumulators played an inferior role in their considerations, whereas the actors attributed superior relevance to economic considerations. Nathanie and Reger confirm this argument. Using the example of the substitution of nickel-cadmium accumulators by nickel-hydride and lithium-ion accumulators, they point out that the major incentive for the battery producers to develop new battery systems, especially new accumulators, was set by market developments. Concentration processes and hard competition on the batteries market intensified the pressure on the battery producers to develop new battery systems. The producers of consumer applications on the OEM-market, who strongly demanded innovations, especially forced the development of new accumulators. The increased use of mobile consumer appliances had been the major cause for the demand for technical innovations and led to the development of improved accumulators with respect to their size, durability or stand-by times and power. The nickel-hydride and the lithium-ion accumulators fulfil these new requirements better than the nickel-cadmium accumulators (Nathanie and Reger, 1998: 323-325).[6] The rising costs of the disposal of cadmium led

5 In retrospective, the Ministry for the Environment confirms this assumption.

6 For example the development of the lithium-ion accumulator by Sony was not intended to reduce environmental impacts. Rather, Sony aimed at reducing the weight and the size of its accumulators, and at the same time increasing their power (Nathanie and Reger, 1998: 327).

to a further incentive for the battery producers to substitute the nickel-cadmium accumulators.

In sum, it can be seen as the merit of the voluntary agreement to give a clear signal that these reduction potentials should be realised by all German producers and importers. However, the voluntary agreement and environmental considerations by the batteries industry are only one of several factors contributing to the efforts in reducing the harmful substances in batteries.

On a more general basis it can be argued that concrete targets were set only for the most easily solvable problem. On the one hand, while targets for the reduction of mercury were set, this did not happen with regard to the other environmentally harmful heavy metals (cadmium and lead). On the other hand, the existing mercury reduction targets only referred to alkali-manganese batteries, not to the environmentally relevant group of button cells containing mercury. Although in both cases the lack of concrete goals was mainly due to the fact that substitution within the existing battery systems was considered not to be feasible, an overall goal on the reduction of cadmium and lead in accumulators and mercury in button cells could have served as an incentive for producers to develop altogether different battery systems (Jülich, 1998: 277-278).

With regard to the take back of spent batteries, no concrete quotas for collection and recycling of batteries have been set. However, the existence of such quotas has been an important element for the relative success of the German Packaging Ordinance of 1991 (Jörgens, 1998). It could be argued that also in the area of batteries the formulation of concrete quotas could have been an important element in order to increase the relevance of the targets and subsequently reduce the disposal of spent batteries together with the household waste. Finally, those batteries which were directly built into consumer appliances, were not at all included in the voluntary agreement.

Goal Attainment

Since the voluntary agreement contains few quantifiable targets, it is difficult to precisely evaluate the goal attainment. However, different studies and evaluations of the voluntary agreement show that while the quantified targets for the reduction of harmful substances in batteries have been reached quickly and have generally been exceeded, there is an astonishingly clear failure in setting up a functioning take back system for labelled batteries. Although concrete quotas were missing, it is clear that the collection quotas, which were actually attained, could not be interpreted as a success and led to a failure with respect to the goal of reducing the contents of heavy metals (mainly cadmium and nickel) from batteries in household waste.

Reduction of harmful substances in batteries

Chemical analysis of different types of batteries showed that the goals concerning the reduction of heavy metals, especially mercury, were reached and even exceeded. Alkali-manganese batteries with reduced mercury content contained less than 0.025 per cent of mercury. Lead and cadmium contents were below measurability. With zinc-carbon batteries mercury as well as lead and cadmium contents were below measurability (e.g. Hg<0.005%, Cd< 0.001%, Pb<0.01%) (UBA, 1991: 258-259). Already in 1993 most alkali-manganese and zinc-carbon cylinder batteries were free of cadmium and mercury. Taking into account that these two types of batteries account for about 80 per cent of all batteries, this has clearly been an environmental success (UBA, 1993a: 256; Jülich, 1998: 280).

In sum the mercury content of batteries decreased from 19,8 tons in 1986 to 4,2 ton in 1997 (see table 4). In contrast to this reduction the cadmium content of batteries increased from 198,3 tons in 1986 to 442,8 tons in 1997 (see table 4).

Table 4: Total amounts of selected metals in batteries in 1986 to 1997

	Amount of metals in batteries (tons)						
	1986	**1991**	**1993**	**1994**	**1995**	**1996**	**1997**
Nickel	198,5	604,2	647,9	642,7	921	1105,3	1334,2
Cadmium	198,3	604	647	619	528,4	466,8	442,8
Mercury	19,8	16,1	16,2	6,8	5,3	5,5	4,2

Source: UBA, 1999

The development of new battery systems can be observed in areas where harmful substances cannot be substituted in existing battery types. Mercury-oxide button cells, for example, have been substituted to some extent by the less harmful zinc-air cells. Between 1988 and 1997 the amount of sold zinc-air cells has risen from 6,6 to 33 tons while the number of mercury oxide cells decreased from 55,9 to 11 tons (see table 5). As mentioned above, the nickel-cadmium accumulators impose today the most serious environmental problem. Their cadmium content cannot be reduced for technical reasons. Therefore, the only way to cope with the environmental problems, resulting from their use, is their substitution by new battery systems. Low emission lithium cells and nickel-hydride accumulators have increasingly substituted nickel-cadmium accumulators since they were developed and put on the market.[7] In 1991 only 10 tons of lithium batteries were sold, but in 1997 this amount increased to 344 tons. In 1995, when the nickel-hydride accumulators came on the market, 1.617 tons were sold, by 1997 this amount had increased to 2.259 tons (see table 5). However, in spite of the increasing use of lithium-ion and nickel-hydride accumulators, nickel-cadmium batteries are still sold in great quantity. Their amount decreased from 3.020 tons in 1991 to 2.214 tons in 1997 (see table 5).

Table 5: Tons of sold batteries and market share

			1988*		**1991**		**1993**		**1995**		**1997**	
			Tons	**% of total**	**Tons**	**% of total**	**Tons**	**% of total**	**Tons**	**% of total**	**Tons**	**% of total**
Primary batteries	*Cylinder*	Alkali-mangan	6.229,5	31,67	8.815	35,07	10.700	39,1	10.740	39,56	10.946	39,79
		Zinc-carbon	12.331,8	62,69	13.185	52,46	13.300	48,6	12.457	45,88	11.636	42,3
	Button-cells	Mercury-oxide	55,9	0,28	43,8	0,17	46	0,17	15	0,06	11	0,04
		Silver-oxide	52,1	0,26	41,1	0,16	45	0,16	45	0,17	45	0,16
		Alkali-mangan	n.a.	n.a.	11,8	0,05	14	0,05	23	0,08	23	0,08
		Zinc-air	6,6	0,03	6,8	0,03	14	0,05	18	0,07	33	0,12

7 Lithium accumulators were presented the first time in 1988 on Electronica.

			1988*		1991		1993		1995		1997	
			Tons	**% of total**	**Tons**	**% of total**	**Tons**	**% of total**	**Tons**	**% of total**	**Tons**	**% of total**
Primary batteries		**Total of primary batteries**	**18.676**	**94,93**	**22.103,5**	**87,94**	**24.119**	**88,13**	**23.298**	**85,82**	**22.694**	**82,49**
Lithium-batteries	*Cylinder*		n.a.	n.a.	0	0	14	0,05	200	0,74	300	1,09
	Button-cells		3,8	0,02	10	0,04	0	0	20	0,07	44	0,16
		Total of lithium-batteries	**3,8**	**0,02**	**10**	**0,04**	**14**	**0,05**	**220**	**0,81**	**344**	**1,25**
Accumulators	*Cylinder*	Nickel-cadmium	921,7	4,69	2.925	11,64	3.135	11,45	2.590	9,54	2.205	8,01
		Nickel-hydride	n.a.	n.a.	0	0	0	0	950	3,5	2.210	8,03
	Button-cells	Nickel-cadmium	69,9	0,36	95	0,38	100	0,37	52	0,19	9	0,03
		Nickel-hydride	n.a.	n.a.	0	0	0	0	40	0,15	49	0,18
		Total of accumulators	**991,6**	**5,05**	**3.020**	**12,02**	**3.235**	**11,82**	**3.632**	**13,38**	**4.473**	**16,25**
		Total	**19671,3**		**25.133**	**100**	**27.386**	**100**	**27.150**	**100**	**27.511**	**100**

* estimated numbers for 82 million inhabitants based on the number of inhabitants in the Old Länder

Source: ZVEI, 1998b

Recollection and Recycling

Several studies analysed the collection and recycling scheme and revealed that especially the take back scheme did not work successfully. According to a study of the *Bavarian Trade Agency* (Landesgewerbeanstalt Bayern – LGA) – which had been commissioned by the *Federal Environmental Agency* – only 60 per cent of the retailers were informed about the take-back obligation, although 88 per cent had generally been in favour of the goal to take back used batteries and treat them in an environmentally sound way (UBA, 1992: 163). Additionally, maybe as a result of the insufficient information of retailers, an inquiry found out that 83 per cent of the retailers participating in the collection took back all types of batteries and did not distinguish between labelled and non-labelled batteries (Jülich, 1998: 292). Some parcels contained up to 90 per cent of non-labelled batteries, which were to be collected only in the interim phase until 1989 (Baumann and Muth, 1997: 93).

Estimates on the number of returned batteries differ from source to source.[8] In a study commissioned by the *Federal Environmental Agency*, the *Institute for Environmental Protection at the University of Dortmund* found in 1992 that only 42 per cent of all button cells containing mercury and only 22 to 36 per cent of nickel-cadmium accumulators were returned. The rest continued to be disposed of mainly with household waste. Similarly, Jülich (1998: 281-282) estimates a collection quota for nickel-cadmium accumulators of 17 per cent to a maximum of one third. In 1996 a study carried out by the *Technical University of Berlin* confirmed these results (Bundesregierung, 1997). These numbers differed enormously from those given by the batteries industry: 82 per cent button cells and 50 per cent for accumulators (UBA, 1993a: 256) and thereby showed that monitoring was not taken seriously by the parties who signed the voluntary agreement. The retail trade estimated that only 25 per cent of all batteries sold were returned and the *Federal Environmental Agency* estimated the actual return to be even lower (UBA, 1991: 258-259). Similarly, the *Council of Environmental Experts* estimated take back quotas, dependent on the type of battery, to be less than one third.[9] The failure of the recollection system led to a failure with respect to the goal of reducing the contents of heavy metals (mainly Cadmium and Nickel) from batteries in the household waste.

The main reasons for the failure were assumed in

? the reluctant behaviour of the retail sector (in around 63 per cent of the retail shops the information was given only if requested and remained passive; only in 37 per cent of the retail shops the information was actively given (Jülich, 1998: 292);

? the lack of information for the consumers about the existence of collection boxes in specialised retail shops and supermarkets (the HDE renounced from starting a broad information campaign because such a campaign would have caused additional costs); and

? the lack of participation on the side of consumers who had obviously difficulties in distinguishing batteries containing harmful substances from those that could be disposed of with household waste.

In sum, Scholl concludes „that the trade is one of the major bottlenecks within the recollection chain“ (Scholl, 1995: 89). The *Ministry for Environment* points out, that one reason for this failure might have been the HDE‘s lacking potential of sanctions in order to

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8 One of the major reason for these differences are diverging assumptions about the life span of batteries which lead to diverging reference years. In general, the return quotas are calculated on the basis of the returned batteries as well as the batteries sold in the reference year and depending on the assumed life span of batteries. The ZVEI assumes a life span for nickel-cadmium accumulators of seven years, whereas the University of Dortmund calculates the return quotas assuming a life span of 5 years for the same battery type pointing out that the life span of seven years is a very optimistic assumption. According to the Federal Environment Agency, rather a life span of less than five years seems to be realistic (UBA, 1993b: 84).

9 Interestingly, in practice the major responsibility to dispose of the collected batteries remained with the public authorities and not as intended with the battery producers or private recycling companies. In 1990 an inquiry commissioned by the Federal Agency for the Environment revealed that 65 per cent of the retailers returned the batteries to public waste management companies, containers or other public collection facilities. Only 11 per cent of the retailers returned the used batteries to the battery producers (UBA, 1992: 164).

implement the obligations resulting from the voluntary agreement in every single retail shop.

In regarding the recycling quotas, the problem of diverging quotas occurs again (see above). To calculate the recycling quotas, one has to put the recycling potential (the total amount of sold batteries and their life span) in relation to the amount of collected and recycled batteries. Two diverging recycling quotas of nickel-cadmium accumulators with different assumptions about the life span of batteries and thus of the recycling potential range from 24 to 51 per cent in 1993 and from 17 to 33 per cent in 1996 (see table 6).

Table 6: Development of recycling rates of nickel-cadmium accumulators

Year	**Recycling Rate**	
	Life span 5 years	Life span 7 years
1991	24	36
1992	23	46
1993	24	51
1994	26	34
1995	29	32
1996	17	33

Source: Jülich, 1998; Baumann and Muth, 1997

For mercury button cells the *Institute for Environmental Research* (Institut für Umweltforschung) estimated a recycling quota of 35,7 per cent in 1994 (Baumann and Muth, 1997: 101). The nickel-cadmium accumulators were exported to France in order to recycle them and the mercury button cells were destillated.

The *State Agency for Environment* (Landesanstalt für Umwelt) examined in a study the percentages of the different alternatives of disposal. Due to its basis on several more or less robust assumptions the results of this study cannot be more than a rough estimate. However, the study reveals that the proper after-use-management of batteries did not work (Scholl, 1995: 91). The majority even of labelled batteries containing harmful substances were disposed of (56 per cent) and only 44 per cent have been recycled (see table 7).

Table 7: Batteries and their disposal in 1994

Used equipment batteries	**Disposal alternatives**		
	Disposal as domestic waste (%)	Disposal as hazardous waste (%)	Recycled (%)
Labelled	36	20	44
Nonlabelled	82,2	17,8	0
Labelled and nonlabelled	80,8	17,8	1,4

Source: Scholl, 1995

In sum these numbers show, that the overall goal of reducing disposal of batteries with household waste was missed.

Concerning the innovative impact of the voluntary agreement in the area of batteries recycling no significant technological developments occurred. According to the *Federal*

Agency for the Environment, little progress was made in the recycling of nickel-cadmium- accumulators.

Cost Efficiency

The producers established the collection scheme and bear the entire costs for the collection, the disposal and the recovery or recycling. Therefore a *Consortium Battery* (Arbeitsgemeinschaft Batterien - ARGE Bat) with three employees was founded, of which 29 battery producers were members. The turnover of the *ARGE Bat* increased from DM 480.000 in 1990 to 4,1 million in 1998 (see table 8).

Table 8: Costs of collection and recycling/ disposal of the batteries industry

Year	Costs
1990	479.815 DM
1991	665.702 DM
1992	1.302.592 DM
1993	2.849.242 DM
1994	2.022.464 DM
1995	2.062.605 DM
1996	3.235.160 DM
1997	4.508.054 DM
1998	4.125.000 DM*

*only for nine months

Source: ZVEI, 1998b

The distribution of the costs was based on the estimation of every producer's market share (Benzler, 1998: 93). The participating battery producers informally negotiated at a round table their estimated market share without using concrete numbers about their production or turnover. This procedure rather resembled a gentlemen's agreement than a cost efficient procedure.

Costs arose in developing new battery systems with reduced or substituted harmful substances. About these costs no information was available. Costs concerning the labelling of batteries were only marginal according to information from the batteries industry (Jülich, 1998: 285). The major cost factors for the batteries industry were the fees for the parcels sent from retail shops without postage, the provision of the logistic material for collection (cartons for the retail, which had to fulfil certain technical standards) and the storage of the collected materials (Jülich, 1998: 285). Additionally, the insufficient differentiation between less harmful, non-labelled and environmentally harmful, labelled, batteries during collection and take back, from both the consumers and the retail, led to rising and unexpected costs for the batteries industry. The *ARGE Bat* bear the costs for the sorting of the batteries and the disposal of the less harmful batteries, although they were not obliged to by the voluntary agreement. In general, the batteries industry raised the prices of batteries in order to compensate their additional costs. Depending on their competitive situation the retailers passed it on to the consumer.

According to the batteries industry and the *Federal Agency for the Environment* one significant problem, a collection and recycle scheme of batteries has to cope with, constitutes the plagiarism of batteries and grey imports. Because of these practices the problem of free rider becomes evident and increases the costs for those battery producers and importers who participate in the collection and recycling scheme. Compared to the estimated number of about 500 battery producers and importers operating in Germany, the 29 members participating in *ARGE Bat* do represent only a small share of the total amount of battery companies. Taking into account this share, one could assume that the problem of free riders might have been evident during the implementation of the voluntary agreement. However, the participating companies are those with the largest market share. Concrete numbers for assessing the free rider problem, which usually leads to rising costs for the participating firms, are not available. The batteries industry estimated the share of overall collected nickel-cadmium accumulators from not participating battery importers at about 25 per cent (Kiehne, 1997: 7). The *Ministry for Environment* recognised the free-riding but only to a small extent, which did not make necessary any measures.

Competition

The *Federal Cartel Agency* criticised the fact that almost all batteries were collected by the retail and thus the battery producers and importers controlled the disposal or recycling. It feared an emerging monopoly on the disposal and recycling market due to this fact. If the separate collection of harmful and less harmful batteries had worked, the responsibility and thus the possible control of the disposal and recycling would have only concerned a little share of the whole batteries market.

Monitoring, Participation and Transparency

Neither environmental nor consumer organisations participated in the negotiations leading to the voluntary agreement or were consulted (Jülich, 1998: 290). Third party participation therefore was very low.

In order to asses the performance of the voluntary agreement, yearly reports by the producers' and retailers' associations were to be submitted to the *Federal Ministry for the Environment*. However, the voluntary agreement did not foresee any sanctions in the case that the formulated goals were not reached. Rather, it stated that if take back of labelled batteries proved not to be practicable, the respective provisions in the voluntary agreement would be reformulated (Jülich, 1998: 270).

The required data for the monitoring originates from the battery producers and they are also responsible for the monitoring. An independent monitoring was not foreseen in the voluntary agreement. Additionally, no numbers were available from other actors, which could have been compared to the provided data of the battery producers. However, as has been shown above, the *Federal Agency for the Environment* commissioned several studies in order to assess goal attainment. The amount of batteries, which were built-in in consumer applications, has not been taking into account by the battery producers or other organisations or institutions.

Further development: General Regulation on Batteries

In 1992 and in 1994 the *Ministry for the environment* presented further proposals for a federal ordinance on recycling and disposal of used batteries and accumulators which were designed to overcome the already visible shortcomings of the voluntary agreement and to transpose the EC Council Directive 91/157 on batteries and accumulators containing harmful substances and its amendment through the Commission Directive 93/86 into national law.

As a reaction, producers, importers and retailers presented in 1995 a proposal for a second voluntary agreement which took into account the provisions of the EC Directive. Among other elements it included the take back and recycling/disposal of all batteries for electronic appliances (including batteries without harmful substances) by their producers and importers and via the retail sector. Furthermore, the sale of batteries containing mercury-oxide would be phased out by the end of 1997, labelling would be improved, producers and importers commit themselves to participate in the creation of technologies for sorting and recycling of batteries until 1999, and regular reports on the implementation of the voluntary agreement shall be provided to the *Ministry for the environment*. The underlying motives, which led to the offer of a voluntary agreement by the batteries industry, were in general the same as in 1988. The batteries industry perceived the EC directive, the drafts of a battery ordinance and the *Closed Substance Cycle and Waste Management Act* (Krw-/AbfG) as serious threats and tried again to anticipate these measures. Additionally, the experiences with the voluntary agreement of 1988 played an important role in their considerations.

In spite of this proposal for a second voluntary agreement, an ordinance on batteries and accumulators was passed in March 1998 and came in force in October 1998. Since a self-commitment by the batteries industry would not have been sufficient to transpose the EC Directive into national law, this ordinance had become necessary. It was drafted in informal co-operation with the HDE and the ZVEI. The ordinance generally follows the proposal of the voluntary agreement of 1995, adding an obligation for consumers to bring back all used batteries to the selling point or to special municipal collection posts. The main elements of the ordinance are:

? a general obligation for retailers to take back all spent batteries and leave them to the producers for recycling or disposal;

? an obligation for retailers to inform customers about the possibilities of returning spent batteries free of charge;

? an obligation for customers to bring back spent batteries to retailers or special return stations;

? a prohibition to bring into circulation alkali-manganese batteries containing more than 0.025 per cent of mercury or appliances with built-in batteries containing hazardous substances which cannot be removed by the customer after use; and

? a deposit of 15 DM for car batteries.

According to the *Ministry for the Environment* the ordinance was designed to overcome the shortcomings of the voluntary take back scheme. The *Ministry for Environment* judged the agreement only as partly successful, because the collection system did not work the way it would have been desirable. However, it refrained from introducing a deposit-refund system, except for car batteries, which was considered as effective instrument but politically not feasible against the opposition of the *Ministry for Economy*.

Although, the first draft of the batteries ordinance limited the take back and return obligation to batteries containing harmful substances (Abfallwirtschaftlicher Informationsdienst, 1997a: 2) the *Ministry for the Environment* later decided to expand the take back and return obligation on all batteries. As mentioned above, the experiences with the voluntary agreement revealed greater difficulties for consumers in separating labelled and non-labelled batteries. To keep consumers from throwing batteries containing a large percentage of harmful substances into the domestic waste the government considered a general take back obligation as necessary without differentiating between less harmful and harmful batteries (Scholl, 1995: 54). This position was supported by the retail, who disposed of a serious threatening potential against the batteries industry, because the retailers could refuse to sell batteries of those producers which did not accept the take back obligation for all batteries. During the informal negotiations the batteries industry first opposed to the general take back obligation. They favoured a separate collection of harmful and less harmful batteries in order to reduce their own disposal costs. Finally, however, taking into account the failure of the former collection system and after informal discussions with the government and HDE, the batteries industry agreed. Additionally, if the new collection and recycling scheme failed again, the batteries industry feared the introduction of obligatory return and recycle quotas which they intended to avoid. Also the HDE, taking into account the failure of the former collection scheme, supports the general take back obligation for all batteries.

Conclusions

General Assessment

Considering the reduction or substitution of heavy metals in batteries the voluntary agreement of 1988 was only partly successful. Only for mercury did the voluntary agreement contain well specified and quantified targets. Subsequently, the mercury content of batteries was reduced successfully. However, the same could not be observed with regard to other heavy metals, especially the equally hazardous cadmium. While the total mercury content in batteries steadily decreased (from nearly 20 tons in 1986 to little more than four tons in 1997), the overall use of cadmium more than doubled in the same period (from nearly 200 tons in 1986 to 440 tons in 1997). So, in spite of the significant success in banning mercury from the production of batteries, other heavy metals, especially cadmium, continue to impose an environmental threat. The development of new battery systems has alleviated the trend, but not yet solved the problem. Furthermore, an evaluation of the VA has to take into account that the observable reductions in heavy metal content of batteries has not exclusively been the result of the voluntary agreement. Rather, market developments and economic considerations of the battery producers contributed to the significant reduction of mercury and the more recent reduction of cadmium.

With regard to the overall environmental goal of reducing or eliminating heavy metal contamination of household waste resulting from the disposal of batteries, which was neither well specified nor quantified, the voluntary agreement has not been successful. Besides the failure in reducing the cadmium content of batteries, this is due to the failure of the collection scheme. Especially the retail has been the bottleneck of the collection scheme. The efforts and acceptance in participating in the collection of used batteries differed widely between the single retailers. Additionally, and in spite of the public sensitivity towards the problem, consumers have been reluctant to bring back spent batteries to the dealers and did not differentiate between harmful and less harmful batteries. Furthermore, it can be assumed that at least part of the failure of the agreement can be seen in the structure of the underlying problem. The type of product to be regulated explains to some degree the various failed attempts to implement some form of producer responsibility on a voluntary basis. While for example cars are large, long-lived and individually registered items which theoretically makes it more easy to monitor and control their movements, batteries are the exact opposite. They are small, short-lived items over which producers or public authorities have little control after they are sold.

For the reasons mentioned above, it is unclear whether alternative measures would have been significantly more successful. It can be assumed that the introduction of a general take back and return obligation for *all* types of batteries would have reduced uncertainties on the part of the consumers as to which types of batteries were to be returned and therefore might have led to increased collection quotas for those batteries containing harmful substances. But – as first evaluations of the new Batteries Ordinance show – even in this case, a significant amount of batteries would probably have continued to be disposed of with household waste. From a purely environmental point of view the introduction of a mandatory deposit for harmful batteries would have been a promising alternative. However, this option has always been criticised, among other reasons, for its lack of economic feasibility.

In general, the voluntary agreement and especially its further development reveals a learning process by the different actors. Taking into account the failure of the voluntary agreement in collecting harmful batteries, the batteries industry finally agreed on an ordinance, which was mainly designed to cope with the problems related with the former collection scheme, and abandoned its opposition to the collection of all batteries, irrespective of their harmfulness. Similarly the *Ministry for the Environment*, considering the failure of the collection scheme, rejected the differentiation between harmful and less harmful batteries and introduced an ordinance, which obliged the consumer to return and the retail and batteries industry to take back all batteries. Whether this ordinance succeeds in reducing the amount of batteries disposed of with the household waste remains to be seen.

Policy Hypothesis

The German environmental policy was neither characterised by a general tradition of consensus seeking nor by a complete lack of co-operative mechanisms. Though, at the time the voluntary agreement was negotiated and concluded, the German environmental policy did not evolve in a general tradition of joint problem solving, first co-operative approaches had found already their way in German environmental policy. Especially traditional economic and social actors (industry associations, trade unions) co-operated with the government or participated in the governmental decision-making processes by more or less informal mechanisms.

In the case of the voluntary agreement, its conclusion can be judged as the first step to a closer co-operation of the different actors and the beginning of joint problem solving efforts in this issue area of environmental policy. Already at the beginning of the eighties, the batteries industry showed an obvious willingness to cope with the battery-related environmental problems as they installed voluntarily the first collection boxes and concluded a voluntary agreement with the *Ministry of the Interior*. At the same time, with the adoption of the *Waste Management Act*, the government signalled to the private sector that voluntary and cooperative approaches in waste policy could be one important instrumental option to deal with environmental problems. These two factors may have led to a greater willingness of both actors to conclude a voluntary agreement in order to cope with the environmental problem of batteries.

The case study, therefore, to some extent supports the policy hypothesis: the overall failure of the voluntary agreement coincides with a political dominance of traditional command-and-control regulation. However, the self-commitment on batteries clearly marks a turning-point in the area of waste policy as it has been followed by a great number of other more or less voluntary and consensus-oriented measures.

Instrumental Hypothesis

The disposal of batteries containing significant amounts of heavy metals was early subject to discussions of regulatory measures. With the adoption of the *Waste Management Act* in 1986, government's competencies for passing product-related regulations were significantly enlarged. The Ministry had signalled to the responsible sector that batteries were priority issues and that this was one of the areas where regulation could be expected. The Ministry developed first drafts for an ordinance dealing with the disposal of batteries, which would have had severe consequences for the batteries industry. This was perceived as a serious threat by the batteries industry and has led to the offer of a voluntary agreement.

But at the same time the discussion of a battery-directive at the European level might have weakened the threat by the German government to use an alternative instrument. In the expectation of a EC-directive the *Ministry for the Environment* could have refrained from introducing a national regulation, which later would have to be adapted to the provisions of the EC-directive. Maybe the weakening influence of the European initiative contributed to the formulation of less ambitious targets, which did not significantly exceed the business-as-usual scenario.

However, the debate about the directive, suggesting quantified targets for the reduction of harmful substances in batteries, might have prompted the battery producers to increase their efforts in substituting harmful substances. They could expect to be obliged to reach certain reduction targets by the time the directive would have been adopted. Thus the directive might have been an additional incentive for the battery producers to reach the reduction targets set out in the voluntary agreement.

Considering the retail and its clear failure in establishing a successful collection scheme, there was no disposable ‘stick behind the door’ or incentive, which might have prompted the retailers to increase their efforts, neither at the national nor at the European level. The implementation of the only imaginable measure with a threatening potential, the introduction of a deposit-refund-system, which might have led to rising costs also for the retailers, was highly improbable, because the German *Ministry of Economy* opposed to this solution and this measure was considered as economically not feasible.

In sum, a stick behind the door – if it existed at all – was only effective at the time of the *formulation* of the voluntary agreement. In the course of its *implementation*, the prospect of a European directive on batteries made it highly improbable that government would come up with a regulatory measure at the national level.

Sectoral Hypothesis

On the one hand, concerning the homogeneous battery sector, a small number of players with large market shares and their industry association dominated with their interests the negotiations with the *Ministry for the Environment* and implemented the voluntary agreement. The batteries industry succeeded in fulfilling their only quantified obligation to reduce mercury. However, where reductions had not been quantified (e.g. cadmium), success was less visible. Contrary to the retail, the battery sector had to cope with free-riders, but the significance of this problem can hardly be assessed, because concrete numbers are not available. However, the fact that the participating firms are those with the largest market share leads to the assumption that the free-rider problem should not be overestimated.

On the other hand, concerning the retail sector, a weak industry association without sanction potential, which hardly could represent the diverging interests in this sector characterised by heterogeneous structure ranging from one-man-business to large retail companies with thousands of employees, led the negotiations and implemented the voluntary agreement. The retail sector failed in implementing a functioning collection scheme as presupposition to succeed in reducing the harmful substances of batteries in household waste.

Both results support – to some extent – the sectoral hypothesis.

Competition Hypothesis

According to the competition hypothesis the great public awareness and the high consumer pressure in this issue area should have contributed to a successful performance of the voluntary agreement and adequate efforts of the responsible actors.

However, the responsible actors did not succeed in organising a functioning collection scheme in order to prevent the disposal of batteries with household waste. The incomplete information provided by the retail is one of the main reasons to this failure, because the consumers were only partly informed about the possibility to bring back the used batteries. Surprisingly and despite their environmental awareness, a majority of the consumers were obviously not willing to differentiate harmful and less harmful batteries and to bring back used batteries. Both factors led to the failure of the agreement concerning the goal of the reduction of harmful substances in household waste.

These findings clearly do not support the competition hypothesis.

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