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The implementation of the Municipal Waste Incineration Directives

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European Project IMPOL -
The Implementation of EU Environmental Policies: Efficiency Issues

Foreword

This report is an outcome of *The Implementation of EU Environmental Policies: Efficiency Issues* (IMPOL) project. The IMPOL project involved four research institutes (CERNA, Ecole des Mines de Paris, SPRU – Science and Technology Policy Research University of Sussex, CSTM, University of Twente, UFZ Leipzig-Halle) and was funded by the European Commission's DGXII under its Environment and Climate Programme (contract ENV4-CT97-0569) and national institutions (including ADEME, the French environmental agency). As its name suggests, the project concerned the implementation of EU environmental legislation. It sought to answer questions such as:

– Does implementation result in the attainment of the environmental goals set out in EU Directives?

– How does implementation affect the cost effectiveness of a particular environmental policy?

The core of the project consisted of the *ex post* evaluation of the implementation outcomes of selected pieces of EU legislation in four Member States (France, Germany, the Netherlands and the United Kingdom). Three cases studies were evaluated: Directive regulating emissions from existing domestic waste incinerators (89/429); the Directive on emissions of SO_2 and NO_x from Large Combustion Plants (88/609); and, the Council Regulation on the Eco-Management and Audit Scheme (1863/93) or EMAS.

IMPOL research reports are available at http://www.cerna.ensmp.fr/Progeuropeens/IMPOL.

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1. Introduction

End-of-pipe options are needed whenever recycling and source reduction can not cope with waste streams at acceptable costs. One of the disposal options is waste incineration. The incineration of waste was considered 'clean' for a long time. In the 1970s and 1980s it proved that the incineration of municipal waste was a significant source of air pollution. Notorious pollutants were hydrogen chloride, hydrogen florid, sulphur dioxide, oxides of nitrogen, fine particulate matter, 'heavy metals' and dioxins and furans. Most notorious and issue of public anxiety in some countries were emissions of dioxins and that might cause cancer and birth defects (Eberg 1997, EC 1997). Municipal waste is domestic waste from households and comparable waste from markets and companies. Consent is present that in the long history of waste incinerators, incineration in plants started in Europe around 1900, important steps to secure health and the environment have been taken and will be taken in the future. Debates are still going on the level of emissions that is negligible and acceptable.

Also in the European arena waste management is about knowledge, perceptions, uncertainties and negotiations (Weale 1992). Arguments are on the right level of ambition and the right level of fine-tuning where precautionary measures are discussed (EC 1997).

The European Union decided to issue two European Directives on the atmospheric emissions from municipal waste incineration in 1989. This chapter focuses on the implementation and effects of the 1989 Directives. In section 2 of this chapter we summarise the bargaining on the 1989 European Directives. Section 2 indicates that characteristics of municipal waste incineration and the level of pre-existing national regulation sectors in individual member states played decisive roles. When the 1989 Directives came into force, the requirements had to be integrated in the national legislation in European Member States. In section 3 Germany and the Netherlands will prove to have been most ambitious, the United Kingdom followed on a respectable distance and France integrated the European minimal requirements into French law. The restructuring of the municipal waste incineration sectors in the four IMPOL countries is also described in section 3. In section 4 the outcomes are evaluated. The evaluation criteria are the level of goal attainment and the contribution of the European Directives in section 4.1. In section 4.2 the efficiency of allocating abatement efforts and cost-effectiveness of abatement efforts at individual sources are assessed. In section 5 some conclusions are drawn and some observations are presented. *Summarising* some of the key-outcomes of the four case studies, keeping in mind that the dawn has broken for the implementation of a new and

more ambitious 'Directive Incineration of Waste' in the 00s of the 21st century: Although the four IMPOL countries are all north-west European countries, the outcomes of the national implementation processes of the 1989 Directives differ enormously. This chapter shows that implementation proves to be a highly interactive process that is strongly interrelated to the dynamics of contextual drivers and contextual policies in individual member states. In the period 1990-1996 the decrease of regulated emissions in IMPOL countries varied between roughly 25% and 90%. In some cases retrofitting costs were avoided by closing down incinerators, in one case retrofitting costs were avoided by lax enforcement towards non-complying plants. Technology packages for retrofitting varied according to the respective national ambition levels in the IMPOL countries. Roughly estimated retrofitting of incinerators increased incineration tariffs by 12 to over 75 Euro for every ton of waste incinerated. Countries with a high environmental performance with respect to the pollutants regulated by the Directives allocated the costs related to the abatement in a rather inefficient way. The European Directives had the highest impact on goal attainment in the countries that defined lower ambition levels. In those countries allocation of abatement costs was done more efficient. The presented analysis is predominately withdrawn from the national case studies by Bültman and Wätzold (2000), Eames (2000), Lulofs (1999) and Schucht (2000). The analysis on the plant level was focused on the approximately 400 existing incinerators for municipal waste in the four IMPOL countries. The research period covers the years 1989-1999 with a focus on the years 1989-1996.

2. Bargaining the European Directives

The European Directives 89/369/EEC of 8 June 1989 and 89/429/EEC of 21 June 1989 aimed at reducing air emissions from municipal waste incinerators. The European Directive 89/369/EEC sets standards for so-called *new* incinerators, being licensed after 1 December 1990. The Directive 89/429/EEC regulated the *existent* incinerators, being licensed before 1 December 1990. The directives came into force after a relative short period of negotiations and without major adjustments. *Previous studies* roughly indicated that, unlike the emission limits on large combustion plants in 88/609/EEC, the emission limits on municipal waste incineration plants were set almost effortlessly. The hazardous nature of the emissions from municipal waste incinerators was well documented and regulation was experienced as inevitable. There was no substantial opposition described from environmental groups or from industry (Brusco, Bertossi and Cottica, 1996).

Our study indicates supplementary that the negotiations in the European political arena were of some importance. Some national characteristics proved influential. The national waste policies, national waste markets and pre-existing national regulation of emissions are important key-explaining factors for both the European bargaining process and the follow-up events in the IMPOL countries. The European Directives implied high retrofitting costs on those countries that valued waste incineration and did not yet issue strict regulation towards municipal waste incinerators. However not all countries valued incineration equally. In the relevant period the United Kingdom was in the European waste incineration backfield (10% of waste incinerated). In increasing order Germany, France and the Netherlands where in the midfield. Denmark (60%), Luxembourg (60%) and Switzerland (80%) were frontrunners in the field (Hartenstein and Horvay, 1996). Seen from the alternative perspective of landfill Greece and Ireland were the frontrunners (100% landfill), the United Kingdom still showed 90 % landfill. The corresponding number for Germany is 70% and for France and the Netherlands 52% (Buclet and Godard, 2000).

These 'first glance' impressions have to be assessed in the context of the -dynamics in-national waste policies and resulting waste-markets. In Germany and the Netherlands the waste policy was developed relatively early prioritising re-use and recycling in the mid- and late 1980s. Within the category of disposal options, incineration is favoured over landfill. Although in Germany the share of incineration increased, there is still much more waste landfilled than incinerated (69.6% compared to 21.4% in 1993). The waste policy in France preferred cheap options until 1992. Between 1992 and 1998 the waste policy was not

always unambiguously. It first prioritised a reduction of landfill and an increase in material- and energy recycling. This change in waste hierarchy introduced uncertainty, regions had to redefine waste management. In the late 1990s this was readjusted in the sense that organic recycling and material recycling were to be increased and landfills had to be chosen as solution only where necessary. In the UK the waste policy also developed relatively late. The discretion space for de-central actors to choose the relatively cheap landfill option was large. In urban areas badly designed incinerators were present. Table 1 presents some key characteristics from national waste policies, waste markets and the incineration sector.

Table 1: Some characteristics of national waste policies, waste markets and waste incineration sectors

	France	Germany	Netherlands	United Kingdom
Waste policy	Prioritised cheap options until, 1992 equal status material and energy recycling, 1998 organic recycling and material recycling prioritised	Prioritised re-use and recycling in 1986	Prioritised organic recycling and material recycling in 1989	Poorly articulated until 1995. Since 1995 energy-from-waste was given an equivalent status to recycling and composting
Trend in incineration in landfill	Incineration favoured over landfill and of considerable importance, ban on landfill for combus-tibles from 2002	The share of incineration increases, but there is still more waste landfilled than incinerated	Incineration important and favoured starting 1989, ban on landfill for combustibles from 1996	Unrelenting emphasis cheap-landfill option, Non Fossil Fuel Obliga-tion has re-vitalised large scale incinera- tion since 1995
Number of incinerators	302 in 1989 297 in 1993	42 in 1980 48 in 1990 61 in 1999	13 in 1989 7 early 1990s 11 in 1999	40 in 1987 4 in 1996 10 in 1999
Capacity of Incinerators	1993 around 80 % < 6 t/h 20 % > 6t/h	around 1989 almost all > 6 t/h	around 1989 all but one > 6 t/h	Around 1990 all but 4 > 6 t/h
Market structure	Regional monopolies	Regional monopolies	Regional monopolies	Regional monopolies
Possibility to pass on retrofitting costs	Small due to budget constraints and local democracy	Large	Large	Small due to de-central budget constraints and competition from cheap landfill
National regulation compared to	Lax in general and moderate for new incinerators starting 1986	Strict	Strict	Lax

Table 1 illustrates that the impacts from the European Directives were likely to be marginal in Germany and the Netherlands. In Germany landfill was cheaper. However the regional monopolies made it possible to pass on retrofitting costs if incineration was chosen. Although landfill was also cheaper in the Netherlands, the chosen priorities in waste policy, the strict national regulation and the ability to pass on retrofitting costs made the European Directives a marginal issue in the Netherlands. For France and the United Kingdom the impacts of the draft Directives were likely to be substantial. For the United Kingdom this

was not a big threat because the national waste policy did not favour incineration over landfill. The substantial number of rather old-fashioned incinerators was regulated only very lax (Loader 1991). Closing down these incinerators would not cause a political debate of importance. In France the waste policy did favour incineration. This was combined with cheaper landfill, relatively lax regulation of incinerators and limited possibilities to pass on the costs (Bertossi et al. 1994, Buclet and Godard 2000:211). When the drafts of the 1989 Directives were discussed France perceived that the Directive would be a very ambitious project for the French incineration sector. It is not surprising that France participated in a coalition that tried to reduce the level of ambition of the Directives by objecting to standards for dioxin emissions that were already discussed at that time. Furthermore some countries including France tried to prolong the deadlines for bringing the plants into compliance and to differentiate the deadlines depending on the capacity of the plant. This in order to be able to spread investment costs, often to be incurred by de-central governments, over a longer period of time. The estimated costs turned out to be gigantic. With respect to the progressive deadlines the idea was to start bringing big incinerators into compliance and to leave the small plants time until 2000, so the municipalities could keep the small plants running, thus amortise their investment and then shut them down. France did not really fight for the very small plants of a capacity below 1 t/h but envisaged to - in the long term - close these plants. It seems that the French actors affected by the Directives were either well prepared - this holds true for industry - or did not see the problems that might arise for France. The later means at that time not fully considering the implications of the 1989 Directives. This holds true for the municipalities and the Ministry for the Environment. The municipalities, represented by AMORCE[2] and the AMF (Association of French Mayors) on the one hand were not yet organised with respect to environmental questions. The producers of incinerator equipment and private operators of waste incineration plants feared that municipalities could not invest enough, however they had an interest in sufficient environmental standards for the image of the sector (Schucht 2000)[3].

The bargaining led to *differentiated emission standards* according to capacity and age of the plant. These standards have a better potential for cost-efficiency compared to uniform emission limits. In 89/369/EEC the categories are plants smaller than 1 ton each hour ($^{t}/_{h}$), plants between 1 and 3 $^{t}/_{h}$ and plant larger than 3 $^{t}/_{h}$. According to 89/429/EEC the *existing* incinerators have to comply with predominantly the same emission standards as *new* incinerators *if* the incineration capacity of the plant is larger than 6 $^{t}/_{h}$ from 1 December 1996 onwards. For *existing* incinerators with a capacity of less than 6 $^{t}/_{h}$ there is a transitional arrangement until December 2000. The existing incinerators had to meet the transitional emission limits on 1 December 1995. As from December 2000 those incinerators have to meet the same requirements as new incinerators. The indirect

requirements to abate dioxins were also softened for existing incinerators.

Table 2: Emission requirements according to capacity of the incinerator, emission limits in mg/m3. Standardised conditions 273 degrees K, 101,3 Kpa, 11% Oxygen or 9% CO2

Plant / *Pollutant*	Emission limits for existent incinerators starting 1 December 1996 if the capacity > 6t/h, otherwise starting 1 December 2000 and for new incinerators starting 1 December 1990			Emission limits for existent plants < 6t/h between 1 December 1995 and 1 December 2000	
	< 1 t/h	1 t/h- 3 t/h	> 3 t/h	<1t/h	1-6t/h
Dust	200	100	30	600	100
Pb+Cr+Cu+Mn	-	5	5	-	-
Ni+As	-	1	1	-	-
Cd+Hg	-	0.2	0.2	-	-
HCl	250	100	50	-	-
HF	«divided»	4	2	-	-
SO2	-	300	300	-	-
CO	100	100	100	100	100
Organic Compounds	20	20	20	-	-

Meanwhile the European Commission decided to prepare a new 'Directive Incineration of Waste' that was publishes as a draft in 1994. This new Directive will probably dominate the 00s of the 21st century. The European Commission raised the ambition to roughly the level of the emission limits that are already in use in Germany and the Netherlands. In some MWI-related research Belgium, Italy and Spain are assessed largely comparable to France while Sweden and Austria are roughly assessed as comparable to Germany and the Netherlands. Finally the United Kingdom broadly represents countries having intermediate levels of ambition (EC 1997: v, 1.2).

3. Frontrunners and Laggards Analysed

In this section the story will be how Germany and the Netherlands as front-runners and France and the United Kingdom as relative laggards coped with the European Directives. Two perspectives are relevant. *Firstly* the EU-Directives 89/369/EEC and 89/429/EEC were not directly binding in the EU member States. They addressed national governments that were obliged to bring into force the laws, regulations and administrative provisions necessary to comply with the Directives no later than 1 December 1990. *Secondly* the national waste incineration sectors had to be restructured in order to comply with the national standards. A number of options were available for restructuring. The first choice was between compliance and non-compliance. A choice for compliance could be followed by three actions. The first one was to close plants, the second choice was to downgrade plants so that they would become smaller plants and the third choice was retrofitting plants. This section describes the choices made and clarifies the factors that influenced these choices, including national monitoring and enforcement efforts.

3.1. The frontrunners

The central issues and events that dominated the story-lines in Germany and the Netherlands are quite comparable. In section 3.1.1 the German case will be presented. It will be summarised in figure 1. Afterwards the Dutch case will be presented and some small aberrance's will turn out.

3.1.1. Integration and norm-realisation in Germany

Germany was the only IMPOL country that managed to integrate the European requirements in time. The special ordinance that integrated the European requirements was enacted on 23 November 1990. The German 'TA Luft 1986' was the relevant predeceasing air pollution regulation. The emission limit values set in the 'TA Luft' of 1986 are either equal or stricter compared to the requirements in the European Directives. The 1986 guideline, issued under the 'Federal Emmissions Control Act of 1974' did not yet set an emission limit for dioxins, but only demands plant operators to reduce dioxin emissions as far as possible. The mentioned general 'Federal Emissions Control Act of 1974' (Bundes-Immissionsschutzgesetz - BImSchG) proclaims that plants with high ecological risks require prior authorisation. One of the most important technical guidelines that amended the

'Federal Immission Control Act' was the 'Technical Guideline on the Prevention of Air Pollution' (Technische Anleitung zur Reinhaltung der Luft – TA Luft). This guideline was first enacted in 1974 and included emission limit values (in mg/m3). In 1986 the guideline was significantly tightened into the mentioned 'TA Luft 1986'. However action groups and environmental organisations were still not satisfied with it. Already in the 1980s, the German public was highly concerned about emissions from waste incinerators, particularly about dioxin emissions. While *ordinances* have the *same status* as acts, *technical guidelines* have the status of *administrative guidelines* and thus are binding only for the public administration. Therefore they are only binding within the public administration, but have no direct effect towards citizens and courts. Plants had to comply with the limits only after the limits were incorporated in the plants' individual license. Meanwhile, it is widely accepted (in legal theory and practice) that courts generally have to include the provisions of the 'TA Luft' in their decisions. Nevertheless, they may take differing decisions whenever there are compelling reasons to do so, for example when research produced new knowledge which was not yet adopted by the technical instructions (see Kahl/Voßkuhle 1995: 7-8 and 112-114).

Soon after the 'TA Luft 1986' was issued, the 'Federal Ministry of the Environment' (Bundesministerium für Umwelt - BMU) wanted to set even stricter emission limits. A key driver was found in responding to the public's high environmental concern regarding waste incinerators and an *ordinance* was prepared. The choice for an ordinance instead of a technical guideline is to a large extent the result of *blocking of authorisation processes by citizens' action groups and environmental organisations*. In many cases all the courts were used, it delayed the authorisation for up to 8 years. The blocking hindered the disposal of municipal waste and led to lengthy authorisation procedures that were very time-consuming for the licensing authorities. Therefore the BMU and the German federal states were interested in accelerating authorisation procedures. Unlike a technical guideline an ordinance is binding for courts. First drafts of the ordinance were prepared by the BMU over the year 1988. Operators of waste incineration plants, suppliers of incineration and emission abatement technologies and scientists were consulted on technical possible reductions. German engineers were frontrunners both on design of incinerators as on abatement technology. Regarding the discussion about the provisions of the ordinance one could observe the 'typical' picture. Federal and state Ministries of the Environment, environmental organisations and citizens' action groups were in favour of strict emission limits. Operators of waste incineration plant, their organisations, and the Ministry of Economics (Bundesministerium für Wirtschaft – BMWi) opposed tight limits. The German states, especially the Environmental Ministers' Conference (UMK), played a very active role. They demanded emission limits that were much stricter than those of the 'TA Luft 1986'. They also wanted to respond to the citizens' concerns and get their authorisation

and enforcement authorities out of the firing line. During the discussions the MWI operators adopted a rather cooperative strategy although they were not happy with the costs of the tighter emission limits. The markets, being regional monopolies, allowed the MWI to rather easily transfer the costs to their clients by charging higher fees. This mechanism occurs in interaction with the relatively high environmental awareness that contributed to the legitimacy of the costs to be incurred. As industry's 'spokesman' the BMWi also dropped their objections. The most problematic emission limit value discussed was that for dioxins and furans. The BMU strived for an emission limit value of 0.1 ng TEQ/$_m$3. The Ministry referred to promising results that were achieved in test operations. Although even the BMU had to admit that it was only very likely but not certain that the limit value of 0.1 ng. TEQ/$_m$3 could be met, it decided to set this value.

Textbox 1: Stricter German national limits

All municipal waste incinerators had to meet the same limits as new ones on 1 December, 1996, so there is no transitional arrangements for incinerators with a capacity of less than 6 tons/hour. Secondly there are no less strict limits for small incinerators. For all incinerators a 67% more ambitious limit on Dust and HCl was set, a 50% more ambitious limit on organic compounds, HF, Cd and Hg a 80% more ambitious limit was set on HCL and SO_2. Pb+Cr+Cu+Mn was regulated 90% stricter. Additional limits were set on NO_X and on dioxins (0.1ng TEQ/$_m$3).

Citizens' action groups and environmental organisations participated mainly in the context of the official hearing that took place around the end of 1988 and the beginning of 1989. They proclaimed that even stricter limits were technically feasible although some preferred to have no waste incinerators at all. Some minor points of the draft ordinance were changed.

The ordinance was incorporated in German Law as the 17th ordinance serving the implementation of the Federal Emissions Control Act (BImSchG) and therefore is called 17. BImSchV. The German Ordinance on waste incineration (17. BImSchV) is not restricted to the incineration of municipal waste and also covers combustion plants which were not solely built to burn waste, but uses waste as just one of a number of fuels (mostly from the energy sector and cement industry). Regarding the emission limits, scope, and most measuring procedures, the German ordinance was and still is a *lot stricter* than the European Directives. Since it would not have been possible to formulate the ordinance in this short period of time, preparations obviously began before the European directives were enacted.

Restructuring the municipal waste incineration sector in Germany

The empirical analysis on Germany focuses on the federal state North Rhine Westphalia (NRW). North Rhine Westphalia and Bavaria are the German states with the highest number of waste incineration plants[4]. Experts are of the opinion that the outcomes in other federal states are comparable. In August 1989 studies were done in NRW on the abatement of dioxins, available techniques and the costs incurred in their installation. It led to the result that there were four suppliers of active coal filters which had already tested their techniques in test plants and which could guarantee a limit of 0.1 ng TEQ/$_m$3. The techniques were ready to be applied in large-scale incinerators and could be installed without entailing excessive additional costs (4-6 Euro/ton of waste).

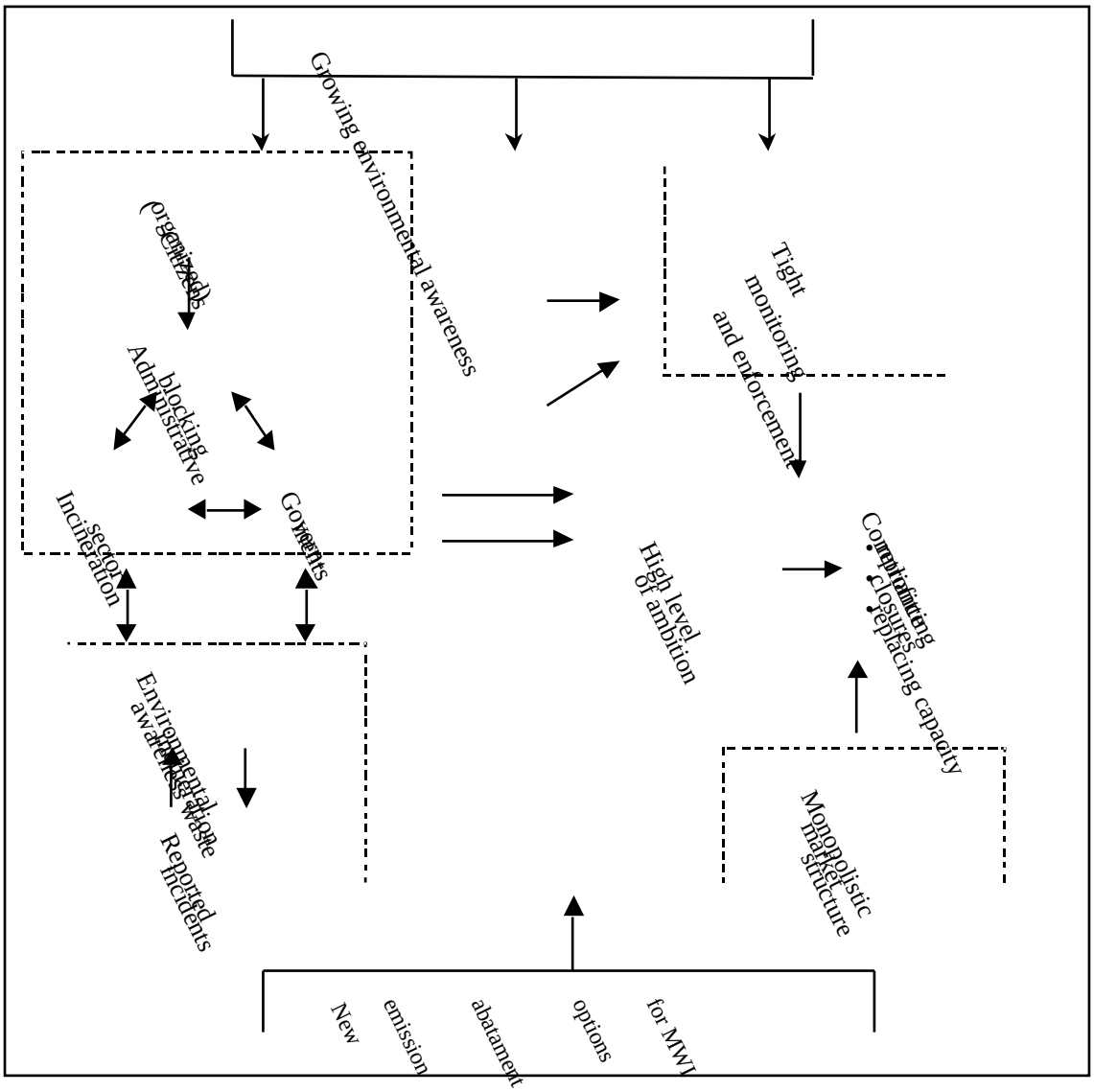
The government of North Rhine Westphalia negotiated a *voluntary agreement* with the North Rhine Westphalia waste incineration sector, the so-called Emission Reduction Plan for Dioxins from Waste Incineration Plants (Emissionsminderungsplan für Dioxine aus Abfallverbrennungsanlagen – EMDA). The previously described public's high concern about dioxin emissions from municipal waste incinerators and the practised administrative blocking were the *two decisive factors*. The agreement not only covered the incineration of municipal waste, but also integrated incinerators for hazardous and industrial waste. The deadline for retrofitting the incinerators was set on 1 December 1995. The covenant was agreed upon in February 1990, ten months before the 17. BImSchV was enacted. Although the covenant originally covered only dioxin emissions, it soon turned out that the equipment to abate dioxin emissions could not be separated from the abatement equipment for the other pollutants regulated in the meanwhile enacted 17. BImSchV. Therefore the EMDA's retrofitting deadline (indirectly) applied to the entire abatement technology necessary to comply with the 17. BImSchV.

The NRW government established a Coordination Committee (Koordierungsstelle) to work out (in writing) the official agreement, to observe the implementation of the covenant and to co-ordinate the retrofitting activities in a way that there was always enough capacity for waste incineration available. The co-ordination committee presented the final agreement in the beginning of 1991.The covenant included 14 municipal waste incineration plants. Only a very few small plants did not participate in the covenant. Approximately three incinerators got exemptions from the deadline because they had special site related problems. All incineration plants were given 6 months extra to optimise the abatement equipment after it had been installed.

In NRW 13 of the 14 municipal waste incinerators that participated in the EMDA were retrofitted. There was only one very small plant shut down and the 17. BImSchV was not even the decisive reason. The operators independently retrofitted their waste incineration

plants. They chose and installed flue gas purification techniques, which they regarded appropriate for their individual plants. When the 17. BImSchV was enacted German waste incinerators either already had or were just about to put in operation a de-dusting system (cyclones or electric filters) and some kind of scrubbers to 'wash' the flue gas from acid substances (dry, semi-dry, semi-wet or wet systems). Therefore the 17. BImSchV mainly required waste incinerators to additionally install deNOx-systems and devices for the abatement of dioxin and furan emissions. DeNOx-systems were already in use in other plants such as LCPs. Operators reported that from the whole bunch of criteria that influenced the decision on the specific abatement techniques, the question how they could be integrated in the existing combustion units and abatement equipment was the decisive one. The retrofitting mainly took place between 1994 and 1996.

Figure 2: Explaining the high level of ambition and outcomes in Germany



There is a strict monitoring and enforcement system in Germany. In general the plants are equipped with computers that automatically record and processed the emission data. Once the devices are installed, the whole system needs to be approved by the supervision authority. The 17. BImSchV requires MWI operators to have their measurement equipment once a year checked and calibrated every 3 years. At the end of each year a report on all emission values of the preceding year is submitted to the supervising authority. Simultaneously to the retrofitting with pollution abatement equipment, all MWI in especially NRW were connected to a system for telemetric transfer of emissions (Emissions-Fernüberwachung – EFÜ) by 1 December 1995. The processed and classified emission values are automatically transmitted to the supervising authority once a day. In addition to the emission data the authority has a message on its computer screen which says whether emission limit values have been exceeded during the last 24 hours. EFÜ makes it literally impossible to exceed emission limit values without the supervising authority noticing it. EFÜ even enables supervising authorities to log into the MWI's electronic emissions control system at all times and without prior notice to the operators. Moreover, supervising authorities are authorised to do on-site controls whenever they consider this is necessary. In most cases the limits are exceeded only for a few minutes. Shortly after the installation of the abatement equipment emission limit values were exceeded more often and for a longer period of time. This was repaired by process optimisation. MWI are still high on the supervision authorities' list of priorities. It seems to be almost impossible for waste incinerators to escape the control. In principle the means of coercion can range from fining to temporary closure of incineration units or revocation of the license.

3.1.2. Netherlands

The relevant story in the Netherlands starts in the mid-70s when the Seveso incident initiated in the Netherlands research on the issue of sources of dioxins. In 1979 questions were posed in Dutch parliament about waste incineration in relation to dioxins. Preparations to issue regulation started. A small research indicated serious emissions of heavy metals, mercury, cadmium and dioxins (Second chamber of parliament, 1983-1984, no. 18319). It was followed by a research on the possibilities of pollution abatement technology. The study concluded that stricter limits were viable. This led to the *Guideline Combustion 1985*. The level of ambition for new plants was more or less comparable to the European Directives, however the treatment of existing incinerators was left in the hand of the provinces, the licensing authorities. The government was afraid that the costs of living would rise too much if existing incinerators had to meet the same requirements (Wacque 1990). It has to be emphasised that in the late 1980s and early 1990s the growing environmental awareness changed the perception of these costs dramatically. Like in the Germany, these costs became legitimate.

When the Guideline Combustion 1985 was issued it soon became clear that it did not demand state-of -the art technology. Stricter limits were issued in Germany and Sweden in 1986. The preparation of a new Guideline started. In 1988 concepts were already presented that referred to the German limits in the 'TA Luft 1986' and to ongoing discussions in Germany. The Germans did however not yet have limits on dioxins. The Guideline Combustion 1989 was issued after an intensive consultation phase. The Association of Waste Incineration Plants (VEABRIN, nowadays VVAV) and the provinces participated in the consultation phase. There was no real discussion about the necessity of strict emission limits. In order to be able to raise the volume of waste to be incinerated, as required by the general waste policy, the emissions had to be reduced. The market structure, being it regional monopolies, implied an easy carry on of the costs. Of course these costs became acceptable in the context of some important developments: During the preparation period of the 'Guideline Combustion 1989', political and public general environmental awareness rose strongly and fast in The Netherlands. This awareness included the environmental effects of waste incineration and the endangerment of human health nearby incineration plants (Second Chamber of Parliament, 1988/1989, no. 18319). Raised concentrations of dioxins were found in the surface nearby incineration plants. Measurement of emissions at three other incinerators in the Netherlands proved in 1989 emissions that varied from 1.5 ng. TEQ/$_m$3 to 25 ng.TEQ/$_m$3 (Sein, Sluijmer and Verhagen, 1989). In 1989 it became public that traces of dioxins were found in dairy products made out of milk of cows that grazed in the Lickebaertpolder. Selling the milk and dairy products was forbidden immediately. Once German suppliers of pollution abatement equipment were willing to guarantee 0.1 ng. TEQ/$_m$3 on dioxins the *concept* 'Guideline Combustion 1989' was settled. The incineration sector was not amused by some of the aspects of the concept. The incineration sector started a publicity campaign communicating that they could not accomplish these limits. The limits on dioxins, dust, SO2, Heavy metals and NO_x were debated. Despite this opposition the Guideline Combustion 1989 was issued on 15 august 1989, only a month after the Lickebaertpolder affair had become public. The emission limits were comparable to those of the mentioned 'ordinance' issued in 1990 in Germany.

Textbox 2: Stricter Dutch national limits

There is no transitional arrangement for existing incinerators with a capacity of less than 6 tons/hour, they have to meet the same requirements as new ones on 1 January 1995. Secondly there are no less strict limits for smaller incinerators. For all incinerators at least 80% more ambitious limits are set on Dust, a group of heavy metals, HCl, SO2 set, a 50% more ambitious limit on organic compounds, HF, CO and Cd+Hg. Additional limits were set on NO_X and on dioxins. The spell of time for existing large incinerators to get into compliance was also shortened by one year in the Netherlands compared to the European requirements.

However the Dutch government faced huge problems to establish the formal integration of the European requirements of general rules into Dutch law in time. On 25 April 1991 the European Commission proved the Netherlands of default. The problem was that a Guideline like the Guideline Combustion 1989 leaves some discretion space for the provinces that have to integrate the requirements into the licenses of the incineration plants (compare the discussions on the status of 'Guidelines' in section 3.1.1). In order to meet the requirements of the European Directives the emission limits had to be issued in a so-called 'General Measure of Government' (Algemene Maatregel van Bestuur, AmvB). A Dutch AmvB can be compared to the German 'Ordinance'. The Combustion Guideline 1989 was based on the Dutch Waste Treatment and Waste Disposal law. The Dutch law on Waste Treatment and Waste Disposal did only provide the authority to the minister to issue 'Guidelines' not to issue AmvB's. So the Dutch Waste Treatment and Waste Disposal law had to be changed. Simultaneously the existing environmental sector laws in the Netherlands were integrated in a new single-law framework. Initially the political agenda was to integrate the Dutch law on waste treatment and waste disposal into this new framework and at the same time establish the necessary authority to issue an AmvB. Because of these technicalities the transformation process into a single-law framework was slow. On 17 October 1990, the Dutch Parliamentary Commission on European Affairs and the Dutch Parliamentary Commission on Environmental Affairs discussed the issue in a joint meeting with the Minister of Environmental Affairs. Several political parties insisted upon an increased tempo of settlement (Second Chamber of Parliament, TK 1990/1991, 21109, no. 29). Subsequently a proposal to change the old law on waste treatment and waste disposal was brought forward (Second Chamber of Parliament, TK 1991/1992, 22503, no. 1-2). This amendment of the existing law provided the Minister of Environmental Affairs with an authority to issue general rules by AmvB (article 53a, Stb. 1992, no.378). On 28 June 1991, the Dutch government explained to the European Commission that it would fulfil its obligations soon. The scope and strictness of the requirements in the AmvB are in line with the Dutch Combustion Guideline 1989. The Minister of Environmental Affairs perceived softening those requirements as not acceptable. The draft AmvB was pre-published on 3 April 1992. The proposed time schedule raised some discussions on the date the 'existing' waste-incineration had to comply with the same requirements as new incinerators. In the Guideline Combustion 1989 and the draft proposal the date was set on 30 November 1993. The date was replaced by 1 January 1995. This in order to prevent foreseeable and to be tolerated offences. For the incineration of domestic waste the old Guideline Combustion 1989 was finally withdrawn on 7 January 1993 and replaced by the Directive Air-pollution Waste Combustion (In Dutch: Besluit luchtemissies afvalverbranding). The issued limits, although identical to those in the Guideline Combustion 1989, go far beyond the standards in the European Directives 89/429/EEC and 89/369/EEC. The Dutch case is also illustrated and summarised by figure 2 that also explains the Dutch national ambition level and

outcomes. Compared with figure 2, the additional and deviant explaining factors was the firm choice within the Dutch national waste policy to favour incineration over landfill. This was partly driven by emerging large-scale contamination of soil near landfills also threatening quality of groundwater.

Restructuring the municipal waste incineration sector in the Netherlands

Very unlike the normal Dutch tradition of consultation, the final decisions on the Guideline Combustion 1989 were made very quick and not on a consensual basis. As an initiative to settle following conflicts a study and advisory group was formed: Representatives of the Ministry of Environmental affairs, the provinces and the incineration-sector jointly worked in a working group (Stuurgroep Uitvoering RV'89) in order to assess and co-ordinate the implementation of the Guideline Combustion 1989. In this study and advisory group the ministry, the provinces, the Veabrin (trade-association) and some advisors studied several aspects and consequences of the implementing the Guideline Combustion 1989. In its final report the 'Stuurgroup Uitvoering RV'89' disputed whether the limits for dioxins, mercury and for NO_x were achievable. The minister stuck to the Guideline Combustion 1989 with the exception of dioxins for existing incinerators. The 0.1 ng/$_m$3 limit should be considered not as an absolute standard but as a guideline for existing incinerators, but still 0.4 ng/$_m$3 was set as an absolute standard and this could not be done without obligations to reduce. In two cases the 0.4 limit was used with obligation to reduce to 0.25. For the NO_x-techniques a subsidy of 39 million guilders was granted. The NO_x limit itself should be achieved at 1 January 1995. The 'Stuurgroep Uitvoering RV'89' also assessed that four existing incinerators were too badly designed and old-fashioned to meet the requirements from the Combustion Guideline 1989. In total seven incinerators were closed including one small incinerator that was privately owned. In the period 1989-1996 four new incinerators for municipal waste were licensed, two of them were rebuilds of closed old incinerators. Six incinerators were retrofitted. The retrofitting-choices made reflect local circumstances and previous choices among which the resulting possibilities to connect to existing units and existing abatement equipment. In most cases the abatement line includes electric and/or canvas filters a two-step wet-washer or comparable technique, active coal injection or active coal filters to reduce emissions of dioxin and furans and NSCR or SCR techniques to reduce NO_x emissions.

Referring to figure 1, also for the Netherlands the strict system of monitoring and enforcement has to be emphasised. The incineration plants are equipped with measuring sensors and with computers that automatically record and process the data on emissions of a number of substances. The system is part of the licensing procedure and is checked by the authorities. Plants have to report to the authorities. The frequency of monitoring visits to

municipal waste incinerators is high. It is not unusual if the province visits the plant every month. A large comprehensive inventory for the Waste Board of the Ministry was done in 1995, monitoring the new standards for 'existing' incinerators. In a group of 212 measurements 206 were within the limits of the Dutch regulation. None were over the limits of the European regulation (Hesseling, Kuipers, Wormgoor, 1995). The authorities knew about these breaches and were working together with the involved plants to solve the issues. Some issues were solved because a plant was closed in 1995 and was replaced by a new one. There was however one exception made in Dutch practice: The Dutch authorities tolerated that one existing waste incinerator did not comply with the new Dutch regulations on 1 January 1995. They got postponement until 1 December 1996. For the limited number of breaches, the means for coercion are in principle comparable to the German case.

3.2. The laggards catching up activities

The central issues and events that dominated the story lines in France and the United Kingdom are quite different. In section 3.1.1 the French case will be presented. It will be summarised in figure 2. Afterwards the United Kingdoms case will be presented and will be summarised in figure 3. In the UK-case something that looks like a little 'quantum leap' emerged.

3.2.1. France

Prior to the integration of the European Directives into national law, an arrêté of 9 June 1986 regulated the atmospheric emissions. New plants and plants expanding their capacity were addressed by this regulation when authorised from 10 July 1986 onwards. Standards for these plants were set on dust, HCL, gaseous hydrocarbon, Cu, Pb, Zn, Ni, Cr, Su, Ag, Co, Ba, Hg+Cd, As and O. The 'arrêté' was slightly less strict than the European Directives of 1989 however addressed more and different atmospheric pollutants. In comparison with the European Directives there were no emission limits set on HF, SO_2 and CO, and on average the limits were 30-50% more lax. The limits set on a group of heavy metals was comparable to the European demands. Regulation on incinerators with a capacity of less than 1 ton/hour was marginal. The 'arrêté' takes an integrated approach, specifying as well standards for the prevention of water pollution from incineration residues, requirements for noise prevention and the treatment of remaining waste, such as slag (arrêté du 9 Juin 1986). However, only few incinerators where authorised between 1986 and 1991. For *existing* incinerators solely emission limits for dust existed before 1991.

At the time the European Directives were adopted France was a country where public

concern about environmental or health effects of waste incineration basically was absent. In the French public opinion waste incineration was believed to be 'clean' whereas landfill was believed to be more problematic. Concern about dioxin emissions from incineration plants and its effects on health started around 1997[5].

Textbox 3: French national standards

In the 'arrêté' of 25 January 1991 the *level of ambition* equals that of the European Directives. In some cases less frequent controls of emissions are required. Unlike the Directives, however, the French law takes an integrated approach. It defines requirements with respect to solid residues of waste incineration, such as slag, and residues of the flue gas treatment, in particular for their disposal (landfill), transport and elimination. The 'arrêté' furthermore defines requirements and standards for the prevention of water pollution and noise.

The Ministry of the Environment (MATE) and the Agency for Air Quality (Agence pour la qualité de l'air, former ADEME) perceived the fact that in France for existing plants there existed only emission limits for dust as not sufficient. At that time waste incineration had been identified as major source of pollution of HCL, mercury and other pollutants. France believed to be able to more or less comply with differentiated emission limits as decided upon in the European arena. Therefore the subsequent transposition of the Directives did not lead to noteworthy discussions or conflicts. France decided to integrate the minimal European requirements into national law and not to raise the level of ambition for air emission standards. An 'arrêté' of 25 January 1991 is the transposition of the 1989 European Directives into French law and currently this law specifies atmospheric emission limits for new and existing municipal waste incinerators.

Deviant from the European Directives, the 'arrêté' considered plants licensed after 8 March 1991 as 'new' plants. The integrated approach in the French law caused uncertainties and by that influenced the restructuring of the incineration sector in France. These issues concerned the possibilities and requirements of slag re-use and recycling and the disposal of off-gas cleaning residues of municipal waste incineration pertained between 1991 and 1994 and by that introduced uncertainty in the incineration sector.

Restructuring the municipal waste incineration sector in France

In the late eighties, most French municipal waste incineration plants were only equipped with off-gas de-dusting facilities (Milhau & Pernin 1994). Generally these were electro filters for big incinerators and mechanic de-dusters (such as cyclones) for small incinerators.

According to publications only about 25 plants installed technology to wash combustion gas by the end of the 1980s or where on their way to do so.

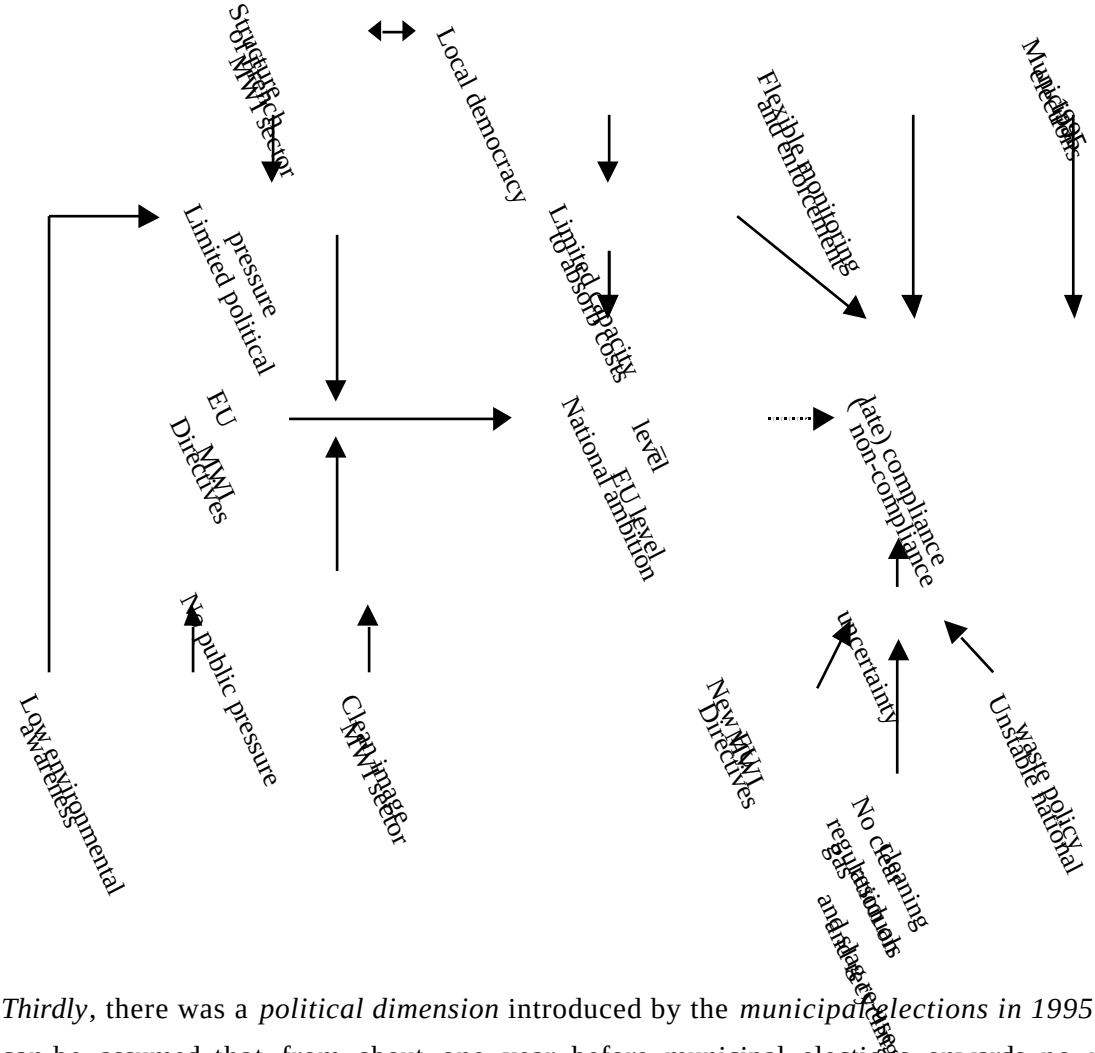
In France best information on compliance was available on individual ovens. Finally, in France about 134 ovens of plants with a capacity of more than 6 $^{t}/_{h}$ were retrofitted, although 61 of them were late compliant, being retrofitted between 1997 and 2000. Only two ovens remained non-compliant. In the category of ovens of plants with a capacity between 3 and 6 $^{t}/_{h}$, 19 ovens had been retrofitted in 1997 and 24 had not yet been retrofitted. The number of retrofitted ovens belonging to smaller plants is low, if there are any at all. So in general quite a number of large plants' ovens were brought into compliance too late and there is still a high share of non-compliance amongst ovens of smaller plants.

There is a number of factors that influenced norm-realisation in France. The *first* factor is the large number of -often small- plants, contrary to the situation in the other IMPOL countries. The *second factor* was *uncertainty* due to the still developing and unstable national waste policy. The market prospects for incineration were diffuse. A new waste law of 1992 changed the hierarchy of waste treatment modes and new requirements for packaging waste recycling which were also defined in 1992. Within regions debates were on how to develop the waste treatment in each region, and investment decisions were slowed down. Choosing between the options was further hampered by uncertainty about the requirements for the treatment of off-gas cleaning residues. This concerned the possibilities and requirements of slag re-use and recycling ('valorisation de mâchefers') and the disposal of off-gas cleaning residues of municipal waste incineration (so-called REFIOM, 'résidus d'épuration des fumées d'incinération des ordures ménagères'). With respect to the off-gas cleaning residues the discussions were about the level of quality of their treatment that was to be reached and which was not finally defined in the arrêté of 1991. Interaction with other law stopped this discussion: the publication of an arrêté (arrêté of 18 December 1992, published on 30 March 1993) dealing not specifically with REFIOM but with industrial hazardous waste landfills and defining requirements for waste to be disposed off in these landfills. Off-gas cleaning residues and slag belong to this group of waste. The arrêté demanded to 'pre-treat and solidify' ('stabiliser') the off-gas cleaning residues before disposing of them in landfills for hazardous waste (landfills of class I)[6]. The technical term 'stabiliser' means a chemical operation that consists in mixing the residues with a binding component so that leakage is avoided.

Uncertainty was increased when in 1993/1994 the discussions about the project of a new European Directive for municipal waste incinerators started. In this case, even the future requirements became unclear. First it was expected that the Directive would be adopted rapidly and again, investment decisions were postponed and the actors remained in a waiting position. Meanwhile, the adoption of the Directive was delayed. Finally, a new uncertainty

was added when the French Environmental Minister in April 1998 criticised the high share given to waste incineration in the waste plans and demanded a revision of the waste plans.

Figure 3: Explaining the national level of ambition and outcomes in France



Thirdly, there was a *political dimension* introduced by the *municipal elections in 1995*. It can be assumed that from about one year before municipal elections onwards no new investment projects are undertaken that might induce tax increases. And it takes about a further year after elections until projects are restarted. *Fourthly, public opinion* considered waste incineration as clean and landfills as problematic. Only recently this changed. Therefor contrary to the situation in Germany and the Netherlands public pressure was absent. The *fifth* factor was an *insufficient financing capacity*. The necessary high investments for compliance were difficult to finance for a lot of municipalities. The problem was deepened by the integrated approach of the 1991 'arrêté' including requirements for the treatment of solid and liquid residues and by the large number of small municipalities, owing to which an installation of large plants requires a co-operation between municipalities, which is difficult[6]. The *sixth* factor, *ignorance* might play a decisive role with respect to the very small incinerators. In several cases municipalities might not

even know that their very small incinerators belong to the 'installations classées' and/or believe that they comply with the law owing to their mechanic filters. These plants frequently are really small units, often of a capacity below $1^{t}/_{h}$ and often only used a few days a week.

We come to a *seventh* and possible important explaining factor for the low level of compliance in France: the *regulatory style. Imperfect enforcement* is a characteristic of the French regulatory style, including the emission measurement and reporting requirements. The application of the 1991 'arrêté' has not necessarily been the priority. The local French licensing and enforcement bodies (DRIRE) are in charge of a large area of activity: the application of the legal texts originating from the three respective Ministries: research, industry and the environment. The balance of power between local enforcers and politicians plays a further decisive role for low enforcement. The prefects find themselves opposite of strong elected representatives and some of them do not want to put pressure on implementation. Additionally, even if the prefects wish to enforce a law they cannot do much if the mayors are against it. The general picture is a flexible monitoring and enforcement focussing on large incinerators.

Quantitative analysis on compliance decisions

A *quantitative* analysis indicated a general positive link between the *size of plants* and the decision to comply (opposed to not comply) as well as for the decision to comply on time for big incinerators. This is in line with the existence of economies of scale in abatement effort, making compliance relatively less costly for bigger plants. There was a trend that ovens of big incinerators *with energy recovery* were rather brought into compliance on time while those without energy recovery rather complied late. Amongst ovens of incinerators of a capacity between 3 and $6\,^{t}/_{h}$ there is a comparable trend: The compliance rate amongst ovens with energy recovery is much higher than that of ovens without energy recovery. Unlike for big incinerators, for plants of small incinerators (plant capacity between 3 and 6 $^{t}/_{h}$) *age* seems to play a role for the compliance decision: the average year where the ovens where put into operation of compliant ovens is 1981 compared to the year 1976 of non-compliant ovens. A limited analysis showed a positive link between subsidies and compliance of plants. Subsidy could well be a result of a compliance decision, there is no comprehensive information on the allocation process. However France was the IMPOL country with the most substantial subsidy schemes for retrofitting incinerators. No significant differences were found between private or public character of ownership or operation. *Enforcement efforts* were only found in 28 cases out of the 75 non- or late complying ovens belonging to big plants. In 47 cases there were none taken. Furthermore, strict enforcement measures so far seem to have only been taken towards *big incinerators*. Furthermore, pressure from the side of the public authorities came late. Apart from one

case, the plants for which enforcement measures were taken already reached compliance or will soon reach compliance by investment, replacement or the closure of ovens[8]. There are about 5 to 6 big plants where the decision to shut down the plant was linked to the fact that they did not comply with the Directive's 1996 requirements. In some cases it was the local regulator (prefect) who enforced the closure. In some cases it was suggested that the municipality itself decided to stop operation because of local problems, such as dioxin pollution (example: plant Lille), and the fact that the plant was not in compliance. This has been true especially for the region Nord Pas-de-Calais. As a general fact, dioxin pollution has been a means of enforcing the Directive. We furthermore find that the strictest enforcement measures were rather taken against the - on average - older ovens. With respect to *small incinerators*, enforcement measures have been even less strict than towards big incinerators. The difference in strictness of enforcement (of measurement and emission standard compliance) between big and small plants may in parts explain the lower compliance rate of the small incinerators.

Recent enforcement efforts

Recently, the French Ministry for the environment exploited dioxin incidents in 1998 for enforcing the 'arrêté' of 1991. The fact that the dioxin topic got on the political agenda in France is partly explained by a Greenpeace campaign of 1996 and subsequent campaigns of CNIID (the National Centre of Independent Information on Waste). The Greenpeace campaign dealt with municipal waste incineration in general and with dioxin pollution in particular. In early 1997, France started its official policy towards dioxin pollution with the circular of 24 February 1997. The circular demanded new municipal waste incinerators to meet the emission standard of 0.1 ng TEQ/$_m$3. Secondly there was the circular of 30 May 1997, asking for dioxin emission measurement of big emitters, including the municipal waste incineration plants of a capacity of at least 6 $^t/_h$. It should be noted here, that a circular is not legally binding for the plants, but rather constitutes a recommendation to the prefect to include these requirements into the plant licenses and by this to anticipate the future Directive[9]. The measurement campaign following the circular and the generally rising concern about dioxin led to a media crisis: in January 1998 measurements had revealed a heavy contamination of cow milk with this pollutant in the vicinity of the Lille waste incineration plant.

The dioxin problem, which was discussed in the media, was thus a measure of persuasion for the enforcement of the Directives: The MATE clearly stressed that compliance with the Directives allowed a first reduction of dioxins. The MATE actually used this political leverage to enforce the 'arrêté' of 1991. These two debates were thus linked to each other. For the first time, the new left wing Environmental Minister took a stricter attitude towards the prefects and summoned the prefects of the regions which showed a delay in compliance

to ask them to take action. She asked them to bring the incinerators of a capacity above 6 t/h into compliance with the 1989 Directive, otherwise these plants would have to be closed down. This was written down in a 'circulaire' of 26 August 1998 (circulaire du 26 août 1998; cf. Desachy 1999).

3.2.2. United Kingdom

There was little regulation on municipal waste incineration prior to 1989. The plants were not subject to any system of prior authorisation, detailed emission limits or monitoring of emissions. The government was aware of the laxity of the existing regulation and proposed in 1986 to bring the municipal waste incineration plants under the control of her Majesties Inspectorate of Pollution (HMIP). This would have made them subject to prior authorisation and a requirement to use 'best practical means' for pollution abatement (House of Lords, 1989). This proposal was part of a consultation paper 'Air Pollution Control in Great Britain'. The initiator of the paper was the Department of the Environment, the paper aimed at changes to UK legislation to make it compatible with existing and prospective EC environmental Directives (DOE 1986). The proposal was not implemented for several years. Finally the 'stop-gap' Health and Safety (Emissions into the Atmosphere)(Amendment) Regulation 1989 brought all incineration processes, including municipal waste incineration plants with a capacity of more than 1 $^{t}/_{h}$ under HMIP (Loader, 1991). EC pressure for implementation played an important role[10]. When the 1989 MWI-Directives had to be integrated some local authorities associations were involved in the political process. One of them the Association of District Councils expressed some concern that the closure of plants would lead to the increased transport of waste to landfill in rural areas. The Association of Metropolitan Authorities lobbied unsuccessfully for the Department of Environment (DOE) to fund the necessary upgrading of existing MWI plants. The in politics influential environmental organisation National Society for Clean Air and Environmental Protection (NSCA) lobbied unsuccessfully for the DOE to build a state of the art plant using foreign designs and technology, to assist with implementation of the 1989-Directives (House of Lords, 1989). Both Friends of the Earth and Greenpeace UK have taken a much more hostile position with respect to waste incineration. However, there is little evidence to suggest that either Friends of the Earth and Greenpeace already played an influential role in the UK implementation of the 1989-MWI-Directives. Some ‘grass roots’ community organisations have campaigned against existing and proposed MWI, on human health and environmental grounds. Over 50 such organisations are currently active in the UK, although they became more active and more influential during the 1990s. Such organisations have frequently used the opportunities for public participation and objection presented by the UK’s planning system to successfully oppose or significantly delay construction of new incineration plants.

In a debate in the House of Commons it was concluded that the costs for up-grading the sector would also be broadly in line with costs incurred for domestic environmental reasons by the 1986 document (Haigh 1997). An important factor was the discussion about the implications of the tight fiscal control of local government expenditure that was maintained by the Department of Environment (DOE) during the relevant time-span as well of its own departmental expenditure. This basically implied limited finances to invest both by the ministry as well as by the municipalities that owned incineration plants.

Textbox 4: National standards in the UK

All municipal waste incinerators with a capacity of more than $1^{t}/_{h}$ had to meet the same limits as new ones at 1 December 1996. For all incinerators from 1-$3^{t}/_{h}$ a 70% more ambitious limit on Dust and HCl was set, an 80% more ambitious limit on PB+Cr+Cu+Mn was set and a 50% more ambitious limit on HF was set. For all incinerators with a capacity of more than $3^{t}/_{h}$ a 80% more ambitious limit was set on PB+Cr+Cu+Mn and a 40% stricter limit on HCl. On top of that there was also a limit set on dioxins of 1 ng TEQ/$_{m}$3 combined with an obligation to reduce. Finally there is an additional limit set on No_{X}.

The UK Government has consistently taken a more relaxed view of the risks associated with dioxins than the US EPA and a number of European governments did. A 1989 report by the DOE found no 'convincing evidence of a link between exposure to dioxins and cancer'. In 1989 the Department of Environment (on the basis of research commissioned with Warren Spring Laboratories) estimated that the MWI sector contributed up to 25% of UK dioxin and furan emissions. Since 1995 Her Majesties Inspectorate of Pollution had revised this estimate upwards, to suggest that the sector accounted for about 70% of total UK dioxin emissions.

The United Kingdom did not integrate the European Directives into national regulation by December 1990 as required. The Commission took formal infringement proceedings against the UK in May 1991. Formal transposition of the 1989 MWI-Directives into UK law was done in November 1991 and achieved by Directions (the Municipal waste Incineration Directives) issued under section 7 of the Environmental Protection Act 1990. The 1990 Act brought a more integrated and centralised approach. Incinerators with a capacity of more than $1^{t}/_{h}$ have to meet the Integral pollution Control regime (IPC). It includes prior authorisation and operating Best Available Techniques Not Entailing Excessive Cost (BATNEEC). Detailed advice on what constitutes BATNEEC for a particular process is set out in *process guidance notes*. The Municipal Waste Incineration Direction 1991 instructed

the relevant regulatory agencies to include conditions in IPC authorisations. It also stated that no derogation shall be granted for plants with a nominal capacity of less than 1 $^{t}/_{h}$ or that burns waste derived fuels. For municipal waste incinerators the process guidance notes were issued by the Chief Inspector of the HMIP. After technical reviews the Chief Inspector's *'Process Guidance Note IPR 5/3, Waste Disposal & Recycling Municipal Waste Incineration'* was published on the 1 June 1992.

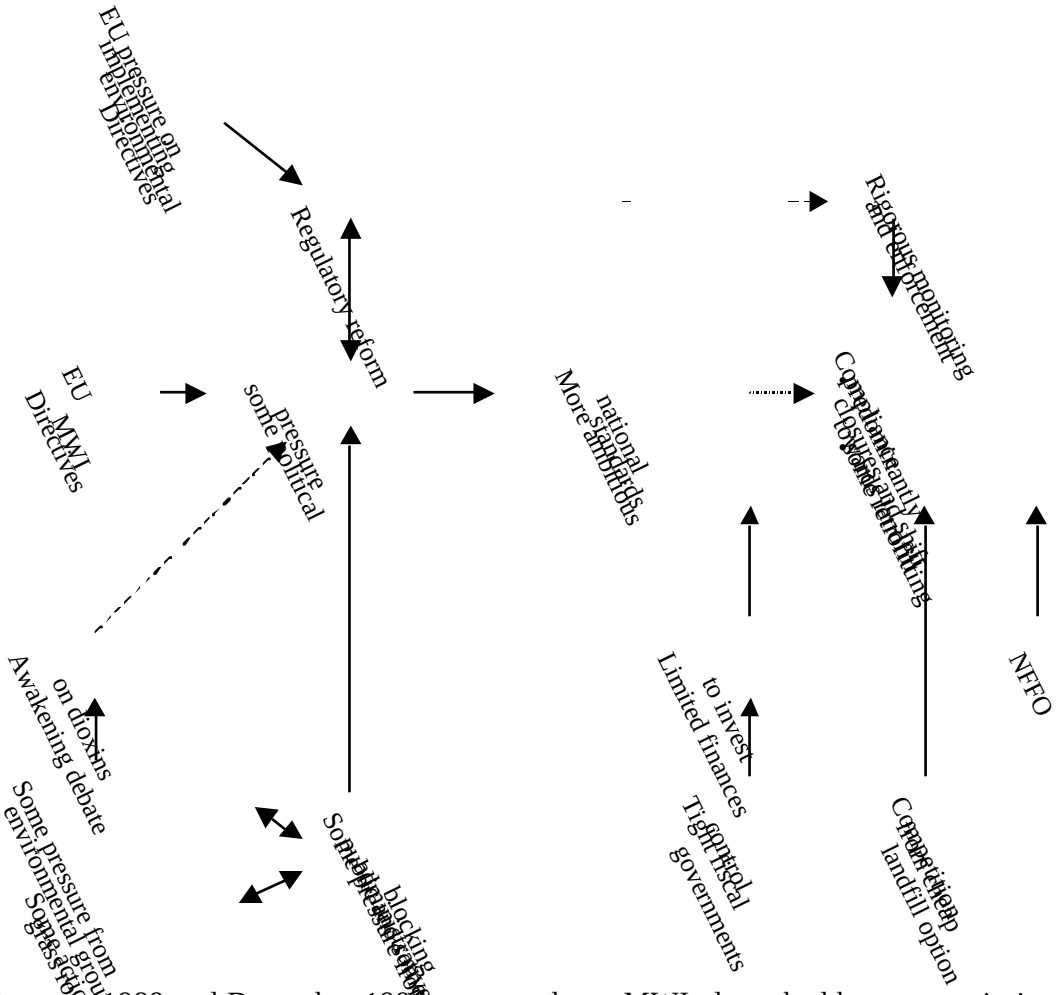
The European requirements were co-implemented with the Integrative Pollution Control regime that was introduced under the 1990 Environmental Protection Act. The issued stricter and more comprehensive UK *IPR 5/3 processes guidance* note standards are relevant, particularly the standard set for dioxin emissions. Still the requirements from European Directives were of importance to push forward these limits.

Restructuring the municipal waste incineration sector in the UK

The existing incineration plants were designed with the principal design criterion to reduce the volume at low costs. Heat recovery was absent and design was poor. It was also known that none of the existing UK MWI plants would by far meet the requirements of the MWI-Directives without significant upgrading. The impacts of the emission limits were huge. It led to the closing down of about 33 plants in the United Kingdom. The influential factors where the tight budget policy that prevented investments from municipalities, the availability of cheap landfill as an alternative for local governments and the reasonable tight monitoring and control that made closing down the non-complying plants inescapable.

By the beginning of 1996 only 18 existing plants remained in operation (Haigh 1997). After the 1 December deadline only three existing MWI plants remained in operation (Edmonton, Coventry and Nottingham). The Sheffield MWI, the fourth existing plant equipped with energy recovery, closed temporarily over the deadline whilst upgrading work was undertaken before subsequently reopening. The Edmonton plant stayed in operation through the 1 December 1996 deadline, but with a reduced throughput whilst up-grading work was undertaken. The one other remaining existing MWI plant equipped with energy recovery - the Sheffield plant – closed temporarily for several months over the deadline whilst up-grading work was undertaken before subsequently reopening[11]. A survey indicated that 12 existing MWI plants would close by 1994 irrespective of the stricter rules. The survey also identified a *number of factors* which would influence local authority's decisions on the up-grading or closure of the remaining plant. The cost of up grading to new plant standards, costs of closing plants and converting them into waste transfer facilities, availability and cost of landfill (including transport costs), availability and terms of loans for capital expenditure and energy prices[12].

Figure 4: Explaining the national ambition level and outcomes in the UK



Between 1989 and December 1996 two new large MWI plants had been commissioned in the UK. They obtained contracts under the Non Fossil Fuel Obligation (NFFO). The NFFO-subsidies significantly improved the financial viability of electricity generation from MWI plants and emphasises the economies of retrofitting present in large incinerators.

In the United Kingdom the Environment Agency stated that its annual inspection program for a typical incinerator consists of four to six planned visits and up to six additional visits to investigate complaints and operational problems. The number of visits could rise significantly where major problems arise, especially where '*public interest is generated*' (House of Lords, 1999).

Under IPC operators are required to report any breaches of their authorisation to the regulator. Breach of an authorisation condition renders an operator liable to prosecution under the 1990 Act: maximum penalty a £20,000 fine on summary conviction, or an unlimited fine and up to 2 years imprisonment on conviction in a higher court. Failure to comply with a court order could result in action for contempt of court, rendering the operator liable to sequestration of assets and an unlimited term of imprisonment. Corporate

liability applies under Section 157 of the Act. However, the regulator has considerable discretion in deciding whether to prosecute in any particular case.

Almost 500 breaches of emissions limits were reported to the EA between the 1 January 1996 and November 1998 by operators of incinerators (including MW, hazardous waste and sewage sludge incinerators) licensed under IPC. This figure is likely to be an underestimate as it is based upon self-reporting by plant operators. The majority of these breaches are thought to have occurred at MWI plants on HCl, Dust, NO_x and CO. It has to be emphasised that most breaches are believed to be only for a very short period of time. The exceedences have occurred both on 'new' plants and on 'existing' plants. The absence of waste separation prior to incineration might contribute to these problems. Substantial effort has been put in overcoming the problem. The Environmental Agency has used informal and formal sanctions to achieve changes and now believes that the problems have largely been solved.

The survival of the UK incineration sector

At the time of issuing the domestic UK-regulation it was already known that the outcome of the 'quantum leap' in the United Kingdom would be a structural shift towards the cheap landfill option. Until 1994 there was no recognised trade association representing the MWI sector as a whole. The Department of Trade and Industry (DTI) has played an important role in shaping the financial climate for MWI through the nineties. The DTI encouraged the formation of the Energy from Waste Association that was formed in 1994. It brought together local authorities with an interest in MWI with energy recovery, private sector waste management firms and incinerators equipment suppliers. And with the competition of cheap landfill, it was the promotion of energy recovery technology that was the life-insurance for a number of plants where the tight budget policy proclaimed the kiss of death for a lot of bad designed existing waste incinerators without energy recovery. The Electricity Act 1989 allowed the Secretary of State for Energy to require, by order, public electricity suppliers to purchase specified capacity generated from non-fossil fuel sources on long-term contracts, the so-called non-fossil fuel obligation (NFFO). The NFFO was designed to support the increased market penetration of renewable technologies and also to subsidise the UK's existing nuclear industry. The electricity supply companies must pay a premium price for electricity generated under the NFFO. The price being determined by a competitive bidding process involving potential generators (ENDS, 1994). As a result, the NFFO significantly improved the financial viability of electricity generation from MWI. This resulted in six 'new' plants additional to the four 'existing' plants. The total capacity of the sector has returned to approximately the same level as in the late 1980s although concentrated in a much smaller number of plants.

4. Environmental and Efficiency Outcomes

The stories of the implementation of the European Directives and the explaining factors have been told in the previous section. In this section the outcomes are summarised. In section 4.1 we present the environmental outcomes followed by the efficiency outcomes in section 4.2.

4.1. Environmental outcomes

The incineration of waste has some advantages. The directly intended result is the reduction of waste volume. It is also often argued that incineration reduces the toxicity of waste by inertization (Eberg, 1997: 72). If energy recovery systems are installed a third benefit appears: it might saves fossil fuels by for instance generating electricity or by providing city heating. Still about 30 % of municipal waste remains as slags and ashes. And even the most sophisticated abatement technologies do not abate perfectly. Finally some wastewater and gas cleaning residuals might be produced. Knowledge on the health and environmental effects from long-term exposures to low levels of the relevant pollutants is limited. Uncertainty is also present on the extent these pollutants enter food chains and by that accumulate and pose health risks (Eberg, 1997: 72-73; EC, 1997: 5.1 5.29).

In this section the focus is on the established reduction of the air-emissions from existing incineration plants. The assessment is linked to the goals of the 1989 European Directive 89/429. The emissions of a number of pollutants are relevant in this context. Just picking out one pollutant would not be a satisfactory approach. Therefore if data-availability enabled it, an index is calculated for 'existing' incinerators that expresses average compliance with the European emission limits on Dust, CO, HCl, SO_2, Cd + Hg and HF[13]. Detailed quantitative data on emissions from incinerators were available for Germany and the Netherlands.

A second relevant point of view is to what extent the European Directives contributed to the level of goal attainment and improvements in the IMPOL countries. Table 3 summarises the outcomes followed by some explanations.

Table 3: Environmental outcomes in the IMPOL countries

	France	Germany	Netherlands	United Kingdom
Average emissions as % of EU limits	> 150% estimated	3.2% calculated	15.4% calculated	< 100% estimated
Improvement **1990-1995/1996** **1994-1996**	25% estimated	> 90% estimated 57.6% calculated	91% calculated	> 90%
Contribution EU-Directives	High for large plants Low for small plants	None	None	High

The frontrunners: Germany and the Netherlands

In *Germany* the existing incinerators in North Rhine-Westphalia emitted on average 3.2% of the emissions allowed by the European requirements. Data of Bavarian MWI show that they reach comparably low levels of emissions. In Germany the available data on improvements for North Rhine-Westphalia covers the period 1994-1996. The average reduction of emissions in NRW over this period was 57.6%. The smaller improvement compared to the Dutch outcomes can be explained by the time-span of measurement (1994-1996). In 1994 the average level of retrofitting was already considerable. Over the period 1990-1996 the emission reduction would probably be equal or even better compared to the Dutch case. As has been analysed in the previous section the improvements in Germany and the Netherlands can not be attributed to the European Directives. In the *Netherlands* the existing incinerators emitted in 1995 on average 15.4% of the allowed emissions. The variance reached from 3.9% in the case of SO2 emissions up to 35% in the case of CO emissions. This performance of existing incinerators was only slightly worse than the performance of 'new' incinerators. These 'new' incinerators performed on average 9.8% in 1995, variance reached from 3.9% on SO_2 up to 22.5% on NO_2. In the *Netherlands* the relevant period was 1990-1995. The average decrease of regulated emissions over the research period was 91%. In *both* countries breaches on national limits are reported however minimal, breaches on the European limits have to be considered as negligible. It should be kept in mind that over-compliance on yearly averages is necessary to avoid breaches of emission limits for a smaller period of time.

France and the United Kingdom

For *France* data-availability was limited to whether ovens were in compliance or not and to which technology was applied. Estimates of the level of over-compliance are not available. Out of 136 cases of ovens belonging to plants with a capacity of more than $6^{t}/_{h}$, 61 (45%) were in compliance with the 1996 deadline, 75 (55%) were not. From the latter population 73 (97%) are late compliance cases, they reach out for compliance between 1997 and 2000.

Out of 43 ovens belonging to plants with a capacity between 3 and 6 $^{t}/_{h}$, 24 (56%) were non-compliant in 1997, 19 (44%) were in compliance with the deadline of 1 December 1995. When it comes to ovens smaller than 3 tons an hour the general impression is that all plants are non-compliant, if any, clean-up technology is limited to mechanic filters (such as cyclones). Estimates on the environmental outcomes can be made, however with substantial uncertainty involved. A substantial number of large plants are late compliant, in transitional years this could lead to, roughly estimated 60% more emissions than allowed (Schucht, 2000). It is plausible that regulated substances were decreased up to the 40-50% range in 1996, when emissions from large plants are taken into account. Estimates on the emissions of dust, HCl, Pb, Cd and Hg indicate that the share of the smaller non compliant plants in total emissions is on average 56% *if* all large incinerators are assumed to be in compliance (Schucht, 2000)[14]. Assuming a required, highly speculative, abatement level of 80%, it can be calculated that non-compliance of small plants brings about 45% more emissions than required on the aggregate level of France. If the emissions of the small plants are taken into the analysis the improvement in the research period might be something around 25% in 1996 compared to 1990. In *France* the European Directive was the key driver for the emission abatement at large plants. On the other hand the European Directives have not yet been influential towards all small incinerators in France.

In the *United Kingdom* 33 existent incinerators were found in compliance because they were closed in time. The status of the remaining four incinerators has to be discussed. A large number of reported breaches indicate that there are problems. However these can be very temporary and are reported as breaches on the stricter and more comprehensive UK regulation. When we take the level of retrofitting into account and the effects of the monitoring and enforcement efforts described, it is plausible that the existing incinerators on average are in compliance with the European requirements. Taken the retrofitting of the four remaining plants into account and the large number of closures it is likely that emission abatement in the United Kingdom is extremely large, if not the largest. In the United Kingdom about 80% of the incineration capacity was closed in the relevant time-span. However it was known that about one-third of the actually closed incinerators were going to be closed independently from the regulatory setting. Given the retrofitting and the large number of closures it is plausible to assume that emissions from the waste incineration were reduced by more than 90% in 1996 compared to 1989. The national British standards are causally linked to the implementation of the European Directives. The European Directives in interaction with nation legislation dominantly drove the retrofitting and the closures.

4.2. Outcomes on cost-efficiency

The kick-off question is why we should care about the allocation of retrofitting costs in the incineration sector. One argument is found in the large economies of scale when municipal waste incinerators are retrofitted. A second argument is related to the strongly rising marginal abatement costs when the level of ambition increases. In a study commissioned by the EC the *internal* costs were quantified by assessing costs and performances of six packages of technology taking into account eight capacities of plants reaching from 25 to 800 $^{kton}/_{year}$. Cost-effectiveness analysis was performed for 6 packages of technology for new plants. These packages represent three ambition levels and a basic distinction between dry gas washing and wet gas washing. Cost-effectiveness is interpreted as the fit between emission abatement costs and emission abatement at individual sources. The simple, less ambitious packages proved more cost effective than the complex ones. However only the simplest package appeared on the efficiency frontiers of all pollutants. These frontiers represent combinations of costs and benefits that cannot be improved upon unless more money is spend. However, all options occur on the efficiency frontier for some pollutant. Given the interactions between the abatement of different pollutants this does not surprise. Somewhere between the smallest level of ambition and the most ambitious level of ambition there is a breakpoint, beyond which benefits only can be reached at larger costs, normally two to ten times less cost-effective. However, the justification of a package of technology depends also on the relative emphasis on the involved pollutants. For instance strict limits on dioxins can imply that the most costly package that for other pollutants is not necessarily cost-effective, becomes cost-effective in general (EC 1998: 4.1- 4.12). Considerable economies of scale appeared. For retrofitting existing plants the numbers for total abatement costs varied between 16 $^{Euro}/_{ton\ waste\ incinerated}$ ($^{E}/_{t}$) for a 24 kton plant to 9 $^{E}/_{t}$ for a 200 kton plant. The most costly option, reaching for the German and Dutch limits was calculated at 31 $^{E}/_{t}$ and 14 $^{E}/_{t}$ for retrofitting existing plants that did not have any abatement technology before. Also for plants larger than 200 $^{kton}/_{year}$ economies of scale remain, however less substantial. Plants smaller than 25 $^{kton}/_{year}$ are confronted with very large economies of scale. The data presented are based on UK costs, French costs proved 15% higher and German costs proved 30% higher (EC 1998).

Secondly, it is important to assess whether these cost-characteristics are taken into consideration when allocating abatement patterns over individual sources in the waste incineration sector. The *policy instrument in use* might influence the allocation of abatement efforts over individual sources and by that cost-effectiveness. By theory, allocation is optimal when the abatement patterns over individual sources are allocated in a way that the marginal cost of the last unit of pollution abated is the same for every

emission-source. It is assumed that this theoretical position can most easily be approached if economic instruments are used. Abatement will continue until marginal costs of abatement are up to the cost of an unit of pollution. It is assumed that negotiated agreements, differentiated emission standards and finally uniform emission standards follow the economic instrument in efficiency. Legal regulations might lead to *allocative inefficiency* if they either impose different requirements on plants with equal -marginal-abatement costs or impose the same requirements on companies with different -marginal-abatement costs. Because the European Directives set plant related differentiated emission limits, a certain basis for inefficiency is created. National standards and the implementation process might have increased or decreased the level of allocative efficiency.

Thirdly economic theory assumes that the allocated abatement efforts are realised most cost-effective if the *better-informed agents* decide. It is often assumed that the individual firm has best knowledge on abatement options and involved cost characteristics, followed by industrial actors like sector trade organisations, local regulators and national regulators. The weight of the better-informed agent in the decision-making is therefor an important indicator. In all IMPOL countries the management of individual plants decided in freedom between alternative abatement packages. The operators chose and installed flue gas purification techniques that they regarded appropriate for their individual plants. Next to effectiveness in reducing emissions arguments were found in the possibility of integration into existing pollution abatement equipment, availability of absorber substances, the usability and markets for residuals, experiences, belief in robustness, stoppage time for transforming, the hinder on primary process, capital costs and running costs. The only restriction was often in the licensing process, the local regulator had to be convinced that the emission limits would not be exceeded. This does however not refer to the freedom of choice, it refers to the robustness of choice and underlying information. There are some signals that management of small incineration plants in France and old-fashioned incineration plants in the UK sometimes were ignorant to some level. It seems that the involvement of co-ordinating organisations on sector level can improve the quality of information and decision-making. There are no arguments found against the assumption that de-central decision-making in *combination* with high quality information lead to the most cost-effective decisions. Describing the decision-making as decentralised does not imply that other actors like national and local governments, trade associations and engineering firms were not involved in preparing and co-ordinating decisions.

The frontrunners: Germany and the Netherlands

For Germany and the Netherlands it was possible to collect data on cost-effectiveness. Some uncertainties are involved, the management of German plants had some difficulty to disentangle investment costs and some assumptions were made to be able to calculate and

compare[15]. However, table 4 presents in the third column comparable data on $^{\text{yearly total abatement costs}}/_{\text{ton waste capacity}}$. In the fourth column the individual abatement patterns are summarised while in the fifth column the fitness between pollution abatement differentiation and the total yearly abatement costs is expressed. It should be kept in mind that the European emission limits were set in $^{mg}/_{m}3$ combustion gas.

Table 4: Cost effectiveness retrofitting existing incinerators and fit between abatement patterns and costs (in Euro)

Characteristics incinerators (year of instalment and capacity expressed as $^{\text{kilotons}}/_{\text{year}}$)	**Total yearly abatement costs**	**Total yearly abatement costs/ ton waste capacity**	**Improvement average compli-ance 90-95 expres- sed as average % of EU-limits (% improvement)**	**Total yearly abatement costs/units improvement (each ton capacity)**
Dutch incinerators				
A-1973-945kt.	32636364	34.5	351 - 12 (96.6%)	0.1
B-1963-375kt.	10227273	27.3	313 - 14.5 (95.4%)	0.1
C-1973-158kt.	7500000	47.5	63 - 29 (49.3%)	1.4
D-1975-315kt.	5363636	17.0	36.5 - 21.5 (41.1%)	1.1
E-1986-69kt.	5318182	77.1	29.7 - 18.7 (37.0%)	7.0
German incinerators NRW			**Improvement average compliance 94-96**	
F- 1981-240kt.	8300000	34.6	4-2.1 (47.5%)	18.2
G- 1965-389kt.	5100000	13.1	5.7-4.1 (28%)	8.2
H- 1960-710 kt.	15100000	21.3	18.2-11.4 (37.4%)	3.1
I- 1966-115kt.	8300000	72.2	22.8-12.1 (46.9%)	6.7
J- 1982-261 kt.	7300000	28.0	8.8-4.9 (44.3%)	7.2
K- 1970-175 kt.	23400000	133.7	32.2-21.0 (34.8%)	11.9
L- 1972-450 kt.	36300000	80.7	17.9-5.8 (67.6%)	6.7
M-1969-84 kt.	3700000	44.0	25.9-11.0 (57.5%)	3.0

Globally the new 2000+ European Directive sets limits on air pollution that are comparable to the Dutch and German limits. Surprisingly the costs for Dutch and German existent incinerators are in a number of cases substantial higher than estimated by the above-mentioned research. At German cost level, for 25 kton plants 40 Euro was estimated and for a 200 kton plant 18 Euro (EC 1997). A possible explanation might be the considerable level of over-compliance to national standards in both Germany and the Netherlands. Still over-compliance on yearly averages is necessary to avoid breaches of emission limits for a smaller period of time. The even larger level of over-compliance in Germany might explain the substantial higher costs. If we include column 4 in the analyses it proofs that some incinerators with broadly comparable environmental performances also report somewhat comparable costs. Analyses of most of the fourth and the fifth column shows how large the

economies of scale really are and how expensive it gets when the abatement levels are getting very high like in the cases of some German incinerators. However it has to be acknowledged that the data on the German incinerators in the fifth column are probably overestimating the costs: The improvement on average compliance in the fourth column was expressed for the period 1994 - 1996. In Germany, improvements over the period 1990-1996 almost certainly were larger. We have to be furthermore careful because of the fact that the German estimates of costs might fail to disentangle the time horizon precisely, they might include all retrofitting costs for the period 1990-1996.

It is beyond doubt that it is more expensive to comply with more ambitious regulations. The assumption that unified emission limits, not taking into account cost characteristics of the individual source, are inefficient is supported by the outcomes. The smaller incinerators were faced with huge marginal costs because of the uniform emission standards in Germany and the Netherlands. One might also argue that given the high level of ambition in these countries the possibilities to reallocate emission abatement are limited due to technological constraints. Contra-arguments are found in the substantial variety on plant-capacity that reflects variety on marginal and average abatement costs. In the EC study it proved that a capacity of 200kton onwards the economies of scale are not that large anymore (1997). However there still remain economies of scale and there are also a number of smaller incinerators in Germany and the Netherlands.

A final argument has to do with the local character of some of the pollutants like dust and dioxins. Having no definitive information on the effects on the environment and health it is not possible to answer the question to what extent limits for the relatively smaller plants could be reduced. Just by the observation that the limits are in $^{mg}/_{m}3$, the absolute emissions are probably larger near larger plants. If these absolute emissions are found to be politically acceptable, from an ecologically point of view less ambitious limits could be used for relatively smaller plants. The conclusion therefor has to be that the efficiency of allocating abatement efforts and cost-effectiveness was *relatively low in Germany and the Netherlands*.

France and the United Kingdom

For *France*, quantitative analysis revealed a positive relation between compliance and the size of the plant, this is an efficient result in terms of costs because of the already indicated economies of scale. More recent and bigger ovens and ovens with energy recovery technology were often upgraded whereas older and smaller plants and plants without energy recovery technology where left in a waiting position, were replaced or closed down. That plants with energy recovery show a higher level of compliance can be considered as an outcome caused by a contextual French policy. The large number of non-complying smaller

plants will probably be closed in the end. Within the perspective of the large economies of scale while retrofitting this has to be considered as an efficient outcome. Some discussions might arise whether it is justified to assess situations of non-compliance as efficient. Cost-effectiveness and efficiency of allocating abatement efforts as economic concepts do not distinguish between legal and illegal situations. Seen from the viewpoint of the allocation of abatement efforts it was probably efficient to abate nothing at the small plants and allocate the abatement efforts over the larger plants that have lower marginal and average abatement costs. With the same money a lot more can be abated at the larger plants. The not formally taken decision, that in fact just resulted from 'French regulatory style' not to enforce small incinerators can be considered as efficient[16].

In the European Directives and in French national law equal *differentiated emission limits* are used. This can be efficient if the strata are chosen rightly. However it proofs by analysis that the abatement costs for very small incinerators are still enormous, certainly after the transitional period ends. The conclusion therefor has to be that the efficiency of allocating abatement efforts and cost-effectiveness was *relatively high in France*.

In the *United Kingdom* a large number of plants have been closed because of the tight budget policy and the competition of cheap landfill at about 9 $^{Euro}/_{ton}$. Without taking externalities from landfill into account, the closures are to be considered as cost-effective decisions. A few plants with energy recovery technology were retrofitted. This can be considered as an efficient outcome on allocating abatement efforts influenced by the contextual energy-policy making energy recovery profitable. The fact that also some big incinerators without energy recovery technology were closed down cannot be considered as efficient, however it is linked to other contextual national -tight budget- policy and the competition from landfill. The United Kingdom issued national limits that are stricter compared to the European limits, especially the fact that there was no transitional arrangement until 2000 incorporated for existing incinerators is important. In the case of the Germany and the Netherlands we had to discuss the issue that possibility to re-allocate emission abatement might be limited due to technological constraints. This issue could not be settled definitively. In the United Kingdom the possibilities to re-allocate abatement efforts were not limited to an extent that it influenced cost-effectiveness. Old incinerators could be closed easily when it was combined with a shift towards landfill. This option was open. The conclusion therefor has to be that the efficiency of allocating abatement efforts and cost-effectiveness was *relatively high in the United Kingdom*.

5. Conclusions and Observations

One of the striking outcomes seems to be the contrasting results on environmental and the efficiency outcomes. The frontrunners Germany and the Netherlands scored relatively well on the environmental outcomes and less well on efficiency outcomes. France scored not so well on the environmental outcomes and scored well on the efficiency outcomes. Finally the United Kingdom scored well on both aspects. The driving forces that led to these outcomes were described in section 3 and summarised in the figures 1 for Germany and the Netherlands, 2 for France and 3 for the United Kingdom. Decisive factors in Germany and the Netherlands seemed to be the relatively large environmental awareness both in the public sphere and in the private sphere. In between these two, the fact that governments were manoeuvred or manoeuvred themselves into a position of dependency is of importance. In both countries not only institutional credibility was at stake but also the possibility to implement incineration as the chosen waste disposal option. Public action, incidents, media coverage and administrative blocking made strict emission limits inescapable. This strategic task was performed without much attention to the allocation of abatement efforts over individual sources and without much attention on the cost-effectiveness in individual cases. The latter outcome can not be evaluated positively. The lack of attention for economic outcomes can be explained by the market structure, being regional monopolies established that made it easy to pass on the costs. Passing on the costs and by that raising the price of living was not welcomed however a legitimate outcome of the shared awareness for the environment both political and among the public in Germany and the Netherlands. It was the period in which environmental policy was rethought and strengthened. In France and the United Kingdom it was not easy to pass on retrofitting costs and the public environmental awareness was a lot smaller. In France the regulatory style kept a lot of incinerators open while in the UK the rather strict monitoring and enforcement culture led to a lot of closures and a shift towards landfill. It is however possible that small French plants will be closed related to the 1 December 2000 requirements' deadline.

The patterns as emerged and described have to be assessed as temporary balances. These balances were in some countries changed during the research period.

These -*dynamics in*- interactions between factors out of the 'political sphere' and out of the 'economic' sphere did not stop. For instance in France the incidents with dioxins from incinerators were reported in the late 90s. Environmental groups enforced environmental

awareness. Also a political shift -a new left wing minister took office- led to a situation in which the balance is changing. Forces developed that seem to overcome the French 'regulatory style' which can be analysed as a result of other factors. In the United Kingdom incineration capacity is raised under the influence of the incentives for energy recovery. New plants therefor are large and are equipped with energy recovery technology. In Germany and the Netherlands there are some weak signals that the opening up of markets might lead to an upward pressure on emissions. This is strongly observed in the case of the electricity plants as species of Large Combustion Plants, there are also some informal signals from the Dutch ministry of the environment as far as the municipal waste incinerators are at stake. In our research there was no proof that publicly owned incinerators scored better on environmental performances compared to privately owned or privately managed incinerators. It seems that the market structure in interaction with other described drivers is influential, not the ownership structure.

A new round of regulation arrives with the new European Directive on Waste Incineration. In this case it proved that the countries with a high level of ambition issued uniform emission limits expressed as concentration of a substance in a cubic meter combustion gas. It also proved that the capacity of the relevant incineration plants varied considerable. A number of pollutants are notorious for their local and regional impacts. Being aware of constraints found in packages of technology it still seems possible to take the capacity of the plants into account when issuing emission limits. Seen from an environmental and health point of view the nominal emissions are more important to assess local and regional effects. Nominal emissions are caused by the capacity in use by the plant multiplied by the emissions each cubic meter. From this point of view it seems logic to not only take environmental arguments into account but also the arguments that large economies of scale were found when incineration plants were retrofitted. More environmental improvement can be reached with the same amount of money. It limits the potential for efficiency considerable due to the fact that concentration limits on cubic meters combustion gas diminish the possibilities to transfer abatement from a source with higher marginal or average abatement costs to a source with lower costs. There are however justifications for this due to the fact that some emissions have local effects. Cost-benefit analysis indicates that the externalities of waste incineration are considerable. Definite conclusions can only be drawn on a case to case basis due to the fact that also the siting and population densities around an incinerator are of importance. It requires of course that the 'strata' are chosen rightly when differentiated emission limits are used. To rely on more decentralised instruments like covenants and economic instruments requires that the environmental and health arguments still have to be used as constraints when too large economies of scale lead to too little abatement at small incineration plants.

Another line of reasoning presented sometimes is that large incinerators cause too large nominal emissions of pollutants with regional or local impacts. In this line of reasoning the emission limits for such large plants should be even more ambitious. In this discussion next to the political and economic arguments the argument of technological development is introduced. There is no reason to assume that the kind of retrofitting done at the Dutch and German plants illustrates the end of technological development. There are new technologies in development that uses mainly techniques of gasification, pyrolysis, fluidized-bed processing and integrated processes that integrate pyrolysis with incineration or gasification[17]. Eberg concludes that it is hard to forecast whether the modern incineration plants with effective gas cleaning systems will be replaced by new technologies. Some of the new technologies perform better on air emissions. If this is going to be a decisive factor depends on some regulatory aspects. First it is going to be important whether even stricter limits on air emissions are going to be issued. Secondly regulation on the quality and usability of residues will be important, the new technologies are producing quite good results in these fields. For understanding the market mechanism it has to be stated that the new technologies seem to perform a bit inferior on energy recovery. Although some are sceptical about these technologies, they are in competition to replace the now usual technology with extensive emission abatement lines (1997: 66-69).

With regard to the broader European environmental strategy as expressed in the fifth Environmental Action Program (5EAP) the MWI case leads to some observations. 5EAP (CEC 1993) focuses on sectors and activities with an emphasis on changing current patterns of development by co-operation based on shared responsibility. The involvement of partners such as national governments, business and consumers is seen as crucial. In this respect '5EAP' speaks of *shared responsibilities* between governments, business and the general public. Out of the understanding that the ultimate goal of sustainable development can only be achieved by concerted action on the part of the relevant actors working together in partnership, 5EAP aims at a mixing of actors and instruments at the appropriate levels (CEC 1993: 113). So next to more traditional instruments 5EAP aims at building institutional capacity among industry and public groups. This includes the absorption of market incentives by customers. It can not be denied that in some fields German and Dutch customers are becoming a bit 'greener' consumers. If this penetration of ecological arguments into the 'economic sphere' appears to be lasting and expanding to other EU countries, this might well be causing a new balance between factors from the 'political sphere' and the 'economic sphere' in Member States. To anticipate and push these events, like 5EAP to a large extent does, and not to put effort only in the slow viscous bargaining between EU countries within the European arenas, could well be a sound strategy to move towards a more sustainable industry in EU countries. By that 5EAP might not push European decision-making forward directly, however at least it takes the decisive

importance of changing the national arena's into account. By this, public environmental groups and the consumers might play a decisive role. This might be considered as the 'modernisation' of the EU environmental policy towards industry. This lesson learned from previous decades is supported by the MWI-case and found -dynamics- in explaining patterns in the MWI case studies.

Notes

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[2] AMORCE represents the local municipalities and the private operators of waste incineration plants.

[3] An example of industry doing the minimum necessary to support a 'clean' image of waste incineration are discussions related to dioxin: industry was not pushing for stricter standards on an European or international level but they are pushing the municipalities to upgrade their plants as they do not want to be at the last end of the standards in Europe. Consequently, they have been asking for dioxin standards in France for years.

[4] For an analysis of the events in Bavaria see Eberg, 1997.

[5] With respect to dioxins, in a circular of 24th February 1997, France demands from all *new* municipal waste incinerators (licensed after that date) to meet the emission standard of 0.1 ng. TEQ/m3. This decision anticipates the future European emission standards. As this concerns new plants only, it does not affect the investigation undertaken in this case study.

[6] With this the juridical uncertainty was solved, however, it took two more years to solve the technical problems related to the 'stabilisation' of the residues.

[7] Costly investment (environmental upgrading) for small plants frequently is economically not feasible. Where there is no fast alternative to these incinerators, these plants cannot be easily closed down either. Alternatives, again, would require a development of the stated co-operation between municipalities, but these structural changes take time.

[8] The remaining big plants that were non-compliant in 1996 were progressively brought into compliance.

[9] Today, France does not regulate dioxin pollution in a binding law. A decision on dioxin

requirements to be defined had been suspended until the publication of a toxicology report on waste incineration and public health published by the "Société Française de la Santé Publique" (French Society of Public Health) recently, in November 1999 (cf. Société française de santé publique 1999). This report includes modelisation of emissions and their behavior in the food chain.

[10] ENDS Report, 1989, No. 170: 26.

[11] ENDS report: 262, November 1996.

[12] House of Lords Select Committee on the European Communities (1989), *Air pollution from municipal waste incinertation plants*, (HL Paper 17), London, HMSO, Memorandum by Warren Spring Laboratory, Minutes of Evidence, p. 52.

[13] The first step was to calculate the actual emissions for every substance separately, expressed as a percentage of the allowed emission. The second step was to add up the calculated percentages and to divide the outcome by the number of pollutants in the analysis. Detailed quantitative data on emissions from incinerators were available for Germany and the Netherlands.

[14] These estimates middle two scenarios: The *first* scenario assumes all plants of a capacity above 3 t/h to comply with the Directive's requirements for 1996 and 2000 respectively, while plants of a capacity below 3 t/h are assumed to not comply (not even with the requirements for 1995) but to only be equipped with mechanic filters. The *second* scenario assumes as the first scenario that the plants of a capacity above 6 t/h to comply with the Directive while those of a capacity below 3 t/h do not comply. Different to the first scenario we assume that amongst the group of plants of a capacity between 3 and 6 t/h only those plants comply with the Directive's requirements for 2000 that, in 1997, were complying with the Directive's 1995 requirements (equipped with fabric filters or electrostatic precipitators), while the plants not complying in 1997/98 are assumed to not comply in 2000 either (neither with the Directive's 1995 nor with it's 2000 requirements). The following calculations and estimated take into account the number of French plants in the distinguished capacities and the data on installed technology and data on ovens of plants in compliance or not in compliance. These are very rough estimation with high insecurity related to the assumptions involved and the results have to be interpreted with precaution.

[15] Assuming that write off is done in 15 years, annuity, full financed, 8% interest; capital cost on yearly basis can be estimated. The same holds for variable costs. Roughly estimated capital costs will be 65% of the added costs. Incinerators claim that about 5

% is spend on add-on by necessary materials. Maintenance takes about 25% of the costs of running the abatement equipment, 4% is claimed to be added for energy costs and 1 % for staff-costs.

[16] However, the quotient 'total yearly abatement costs/units improvement' cannot be calculated if no emission abatement has been performed.

[17] Gasification is partial oxidation of waste with air or pure oxygen, which produces gases to be burned or applied otherwise. Fluidised-bed processing is the incineration or gasification of homogenised waste in a turbulent air/sand mixture that acts like a fluid and provides for intensive contact burning of particulates. Pyrolysis is de-gassing of waste, without oxygen, at relatively low temperatures.

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