The Importance of Pollution Control for the Acceptance of Waste Treatment Facilities

Uwe Lahl and Barbara Zeschmar-Lahl

1. Introduction

In Germany, since the 1990s waste management experts as well as politicians have struggled extensively with the issue of incineration. In the early years the main aim was improving the standard of landfilling. The landfill was intended as a technical building, including a system of multiple protective barriers, working independently of each other. The focus was on turning waste itself into an effective barrier by pretreatment. Waste should be largely mineralized and it was expected, that it was no longer able to cause chemical reactions which resulted in problematic emissions in the environment.

Later on, the focus was expanded. After a phase of recovery of energy and/or raw materials – but in which the possible potentials were not sufficiently exhausted – climate protection after all became a political objective in the forefront of regulation. The formation of methane at landfills can be significantly reduced or brought to zero by waste treatment, such as waste incineration. Methane has a high greenhouse gas potential. Currently, the factor of 28 is assumed compared to CO_2 of fossil origin.

In general, waste disposal on landfills contributes to national greenhouse gas inventories in a range of 5 to 10 %, if no waste pre-treatment is required (and the technical standard of the landfills is low, e.g. no gas collection).

Figure 1 shows how waste treatment in Germany, particularly by the widespread installation of incinerators, has led to a decrease in greenhouse gas emissions from the waste sector since 1990, and will still fall further due to the termination of the deposition of untreated waste in mid-2005.

Incineration of waste, but recycling of waste, too, still have a second advantage. They save primary energy and primary raw materials. Both advantages can be converted to greenhouse gas reduction values (in CO_2 equivalents). Figure 2 shows the development in Germany and a forecast for the year 2020.

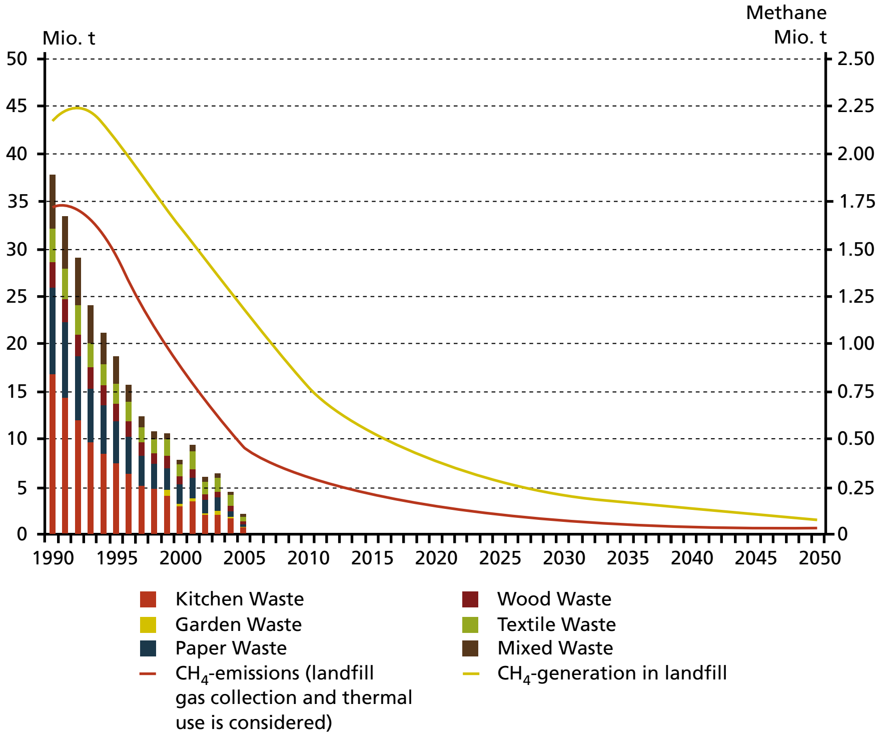


Figure 1: Development of disposal of organic waste on landfills, of methane formation on and emission of methane from landfills in the years 1990 to 2050, in million Mg CH_4

Source: Prognos AG & Öko-Institut e.V.: Modell Deutschland – Klimaschutz bis 2050. Berlin, Studie im Auftrag des WWF Deutschland, http://www.oeko.de/oekodoc/971/2009-003-de.pdf., 2010

Both effects, the reduction of methane emissions from landfill and raw material and energy recovery, together result in a relief of the national greenhouse gas inventory. Figure 3 shows this for Germany. Because of material recycling and incineration, waste management in Germany is by far the most significant single contribution to the national greenhouse gas balance. **Germany‘s success in reducing its greenhouse gas balance by more than 20 % is mainly associated with a reduction of greenhouse gas emissions in the waste sector: therefore Germany's sucess in climate protection is highly depending on the success of waste management**.

Nevertheless, waste incineration in Germany continues to be controversial. The main reason for this are the emissions resulting from waste combustion.

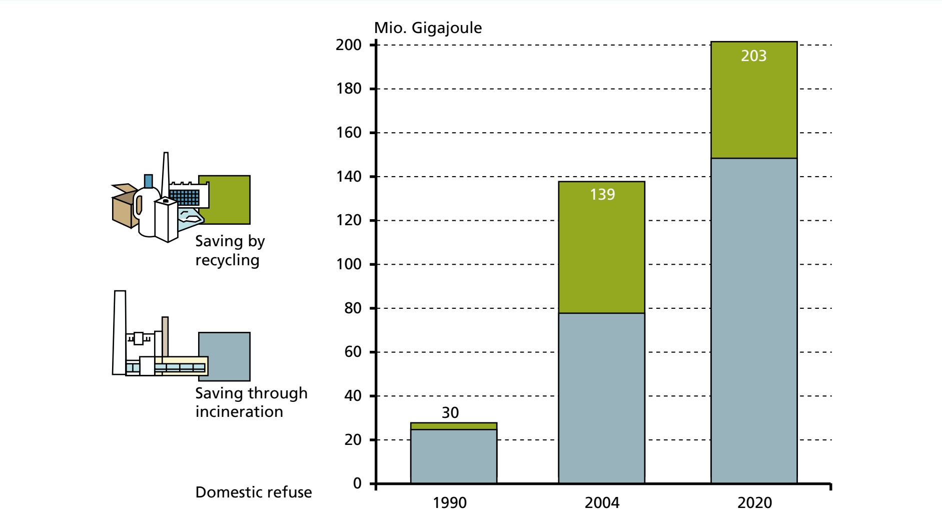


Figure 2: Recycling and incineration of waste saves about 1% of primary energy consumption in Germany

Source: BMU 2007

cited in: Fricke, K.; Bahr, T.: Chancen und Herausforderungen des Ressourcenmanagements als Baustein einer regionalen Null-Emissions-Strategie. In: Neue Wege in eine nachhaltige Industriegesellschaft. Auftaktveranstaltung zur Gründung eines Null-Emissions-Forschungsnetzwerks, 15. September 2008, Eberswalde, http://www.null-emissions-netzwerk.de/fileadmin/userdaten/bilder/ZEUN/10_Tobias_Bahr_-_Leitweiss_Institut_-_15.09.08.pdf

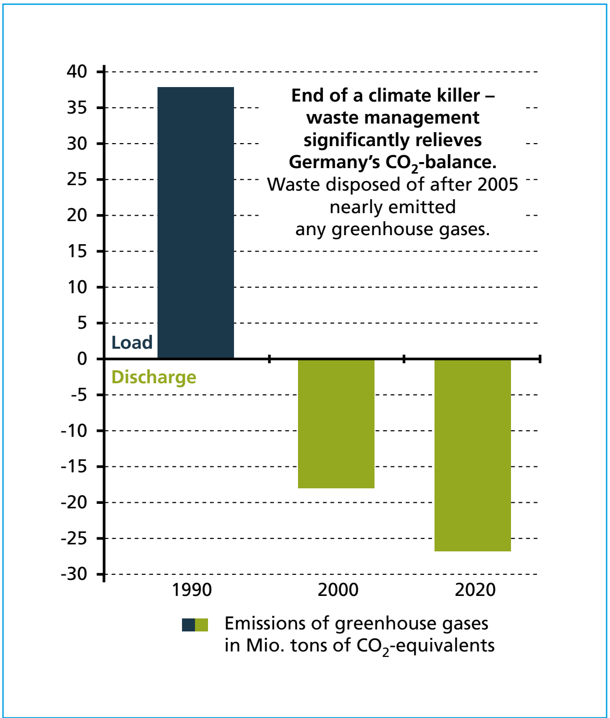


Figure 3:

Waste management in Germany relieves the national greenhouse gas balance

Source: BMU: Abfallwirtschaft in Deutschland 2011. Fakten, Daten, Grafiken. Januar 2011. http://www.bmu.de/files/pdfs/allgemein/application/pdf/broschuere_abfallwirtschaft_deutschland_bf.pdf

2. Requirements for waste incineration plants

2.1. Limit values and operating values for MSWI in Germany

In Germany the requirements for emission limits for waste incinerators are set in the 17th Ordinance under the Federal Immission Control Law (17th BImSchV). Table 1 shows that the limit values of the 17th BImSchV are very sharp, compared to the Large Combustion Plant Ordinance (13th BImSchV), which regulates the emissions of power plants, and the Clean Air Administration Provision (TA Luft), which sets the emission level for all other industrial plants.

Table 1: Comparison of emission limits of different regulations in Germany and real values in measured MSWI plants, in mg/Nm³, dioxins in ng TE/Nm³

Pollutant	**TA Luft**	**13th BImSchV Coal fired LCP** > 300 Megawatt	**17th BImSchV for MSWI**	**Values measured at MSWI plants**
Organic carbon ($C_{ges.}$)	50	–	10	**1**
Carbon monoxide (CO)	–	200	50	**10**
Hydrogen chloride (HCl)	30	not relevant	10	**1**
Hydrogen fluoride (HF)	3	not relevant	1	**0.1**
Sulphur dioxide (SO_2)	350	200	50	**1.5**
Nitrogene oxides (NO_x), measured as nitrogene dioxide	350	200	200	**60**
Dust	20	20	10	**1**
PCDD/PCDF	0.1 ng TE	–	0.1 ng TE	**0.005 ng TE**
PCDD/PCDF in metal processing plants	0.4 ng TE	–	–	–

Source: BMU: Müllverbrennung – ein Gefahrenherd? Abschied von der Dioxinschleuder. Stand Juli 2005, http://www.bmu.de/files/pdfs/allgemein/application/pdf/muellverbrennung_dioxin.pdf

In 2000, minimum requirements on immission protection and emission control for waste incinerators were introduced at the European level [5]. The 17th BImSchV became a model for the EU Directive on the Incineration of Waste for the emission limits for most of the relevant pollutants, but the limits for a few parameters were slightly weakened.

Table 1 also shows that the distance between limit values and operating values for waste incinerators is particularly wide. The flue gas cleaning technology is typically build on a very high level, so that the operating parameters can be maintained much lower than the law would require. This large gap reduces the real emissions significantly below what is required and it is therefore a guarantee, that cases of exceeding limits do not occur in practice.

Figure 4 illustrates this for the parameter dust using real measured values at the incinerators operated in Germany. Each bar represents one incinerator and represents the mean of all measured daily average values for one year. The emission limit in the 17th BImSchV is set to 10 mg/m³ (daily average). It can be seen that even the poorer incinerators lie in the range of 2 mg/m³, while a lot of plants are operated with a factor of 10 below the limit. On average, nearly no plant emits more than 2 mg/m³ during daily operation, that means nearly all plants emit less than 20 % of the limit value of 10 mg/m³. These values are reliable as the parameter dust is measured continuously at MSWI plants, and the results of the measurement are made available to the authorities *just in time* online via internet.

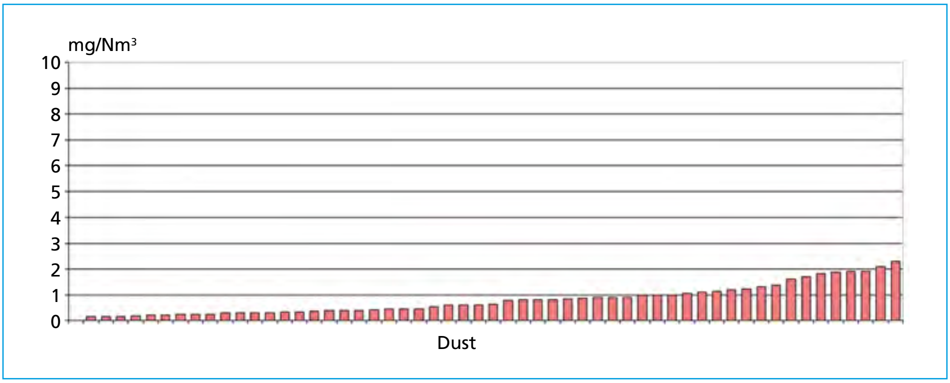


Figure 4: Range of operating values of German MSWI plants; here: dust

Source: IFEU: Beispielhafte Darstellung einer vollständigen, hochwertigen Verwertung in einer MVA unter besonderer Berücksichtigung der Klimarelevanz. UFOPLAN-Projekt FKZ 205 33 311, Heidelberg 2007, http://www.umweltdaten.de/publikationen/fpdf-l/3445.pdf

Such large distances between emission limit value and operating value can also be reported for the other pollutants regulated by law. Only for nitrogen oxides the distance is not so large, depending on the technology used.

2.2. Regulations case-by-case

Following immission proctection regulations, authorities have as part of the approval process to consider in each individual case, whether the operation according to the guidelines of the 17th BImSchV (general state of the art) is sufficient to ensure the protection

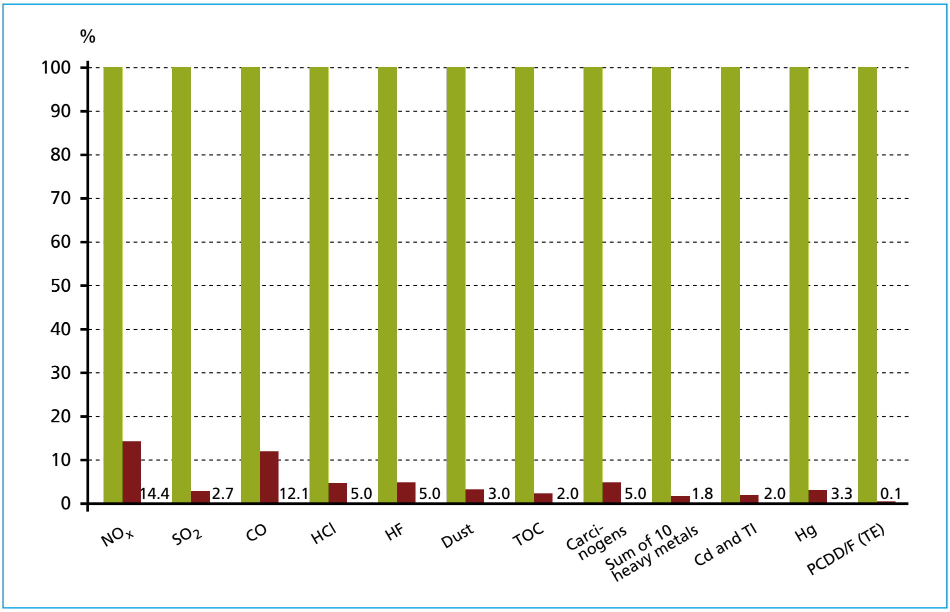


Figure 5: MSWI Bielefeld: Emission data 2007 (in per cent) compared to the limit values of the 17th BImSchV (set to 100 per cent)

of humans and the environment and the precautionary principle with respect to the local situation. Thus, the permit requirements for incinerators may in the practice of licensing authorities in some cases significantly lie above the requirements of the 17th BImSchV. Also, the operators themselves can apply for the establishment of stricter permit values – e.g. for something like acceptance reasons.

In the case of the MSWI Bielefeld, the permit value for NO_x was set to 100 instead of 200 mg/m³. Figure 5 shows the emission concentration values of the MSWI Bielefeld for 2007 compared to the permit values of the 17th BImSchV (including NO_x) [7].

Systems with such low emission levels are still within the upper third of the existing incinerators.

2.3. Loads on site

Since incinerators produce electricity, it is possible to calculate a *pollution backpack* of the produced electricity in gram or milligram pollutant per kWh electricity fed into the grid. These data can then be compared to conventionally produced electricity. In Germany, electricity from waste incineration has a smaller backpack than conventionally produced electricity. Based on such values, it is possible to determine regional balances. In a recent study on waste incineration in the German land of North Rhine-Westphalia for example, the authors come to the conclusion that waste incineration has improved the pollution balance of the land, for example SO_2-equivalents by 3,300 tons per year and for arsenic equivalents by 1.1 Mg/a [8].

But what about the vicinity of an incinerator? Can the operations of this plant lead to an additional pollution on site? The answer is yes. Incinerators are no zero polluters, despite the above mentioned strict regulation and inspections. And referring to other industrial plants that cause much higher emissions is no important argument for a specific approval procedure e.g. to build a new plant. Rather, it is to determine in each individual case, what will be the estimated additional burden of a planned facility and how this additional stress can affect the neighbourhood.

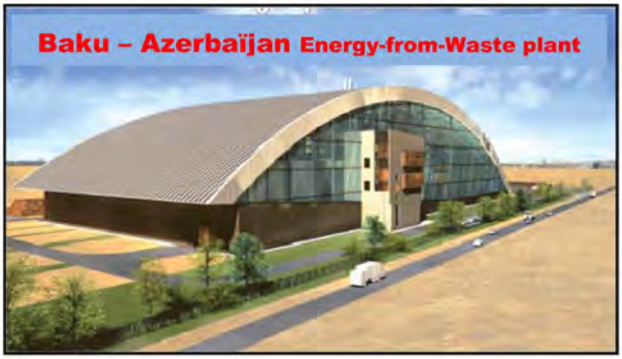
The total load in the neighbourhood of a site consists together of the already existing load (background level, preload) and the expected additional burden by the planned investment. The additional burden in Germany is calculated using a standardized procedure regulated by law (Clean Air Act, forecast model by Lagrange). The future total load is then the sum of the preload and the additional burden.

From a medical and environmental point of view the assessment of the overall impact is of most importance, because here not only the additional emissions from a planned (or realized) plant are considered, but the already existing emissions and loads, supplied from various other sources, too.

Using the example of the MSWI plant of Lauta in East Germany, which went into operation in 2005, table 2 shows the existing load and the additional burden for particularly relevant organic pollutants for this site.

The authors' comment [9, original text in German]: *For both the organic substances as well as the (dust-bound) metals it is clear that the measured preload is virtually unchanged by the calculated additional burden. For the organic substances, the proportion of the additional burden on the total load is between 0.32 % to 0.007 %. For the metals, the proportion in the suspended particulate matter is in a slightly higher range between 6.63 % and 0.04 %, but in the dust deposition, however, only between 0.31 % and 0.04 %.*

Environmentally friendly waste recovery



CNIM proposes to municipalities Waste-to-Energy plants that implement an integrated environmental approach. CNIM acts as an EPC contractor.

The whole process comply with the emission limit values of the European Directives and can easily be adapted to meet even more stringent limits

CNIM has more than 40 years of experience in the field of environmental technology and has installed more than 150 Waste-to-Energy plants throughout Europe.

Let’s talk about your projects

The CNIM Group is present in over 20 countries with 3,500 employees. The CNIM Group is structured along specialized product and service lines which are Environmental, Engineering, Complex Systems for Defence and Industry, Energy (thermal & solar) and Life Sciences.

CNIM

35 rue de Bassano, 75008 Paris, France tel : + 33 1 44 31 11 00 - www.cnim.com





Table 2: Preload and additional load for toxicologically relevant pollutants calculated for a planned MSWI

	PCDD/PCDF	Benzo-a-pyrene (BaP)	Benzene
Preload			
Suspended particulate matter	60 fg/m³	0.72 ng/m³	2 µg/m³
Dust deposition	3.7 pg/(m² • d)	–	–
Additional load			
Suspended particulate matter	0.14 fg/m³	0.0014 ng/m³	0.000143 µg/m³
Dust deposition	0.012 pg/(m² • d)	0.12 ng/(m² • d)	–
Total load			
Suspended particulate matter	60.14 fg/m³	0.7214 ng/m³	2.000143 µg/m³
Dust deposition	3.712 pg/(m² • d)	–	–
Share of additional load referring to total load			
Suspended particulate matter	0.23 %	0.19 %	0.007 %
Dust deposition	0.32 %	–	–

Source: Eikmann T., Eikmann S.: Humantoxikologische Bewertung von Abfallbehandlungsanlagen. September 2007. Published on the website of Interessengemeinschaft der Thermischen Abfallbehandlungsanlagen Deutschland e.V. (ITAD), http://www.itad.de/media/www.itad.de/org/med_90034/289_eikmann2007_humantoxikologischebewertung.pdf

It is apparent that in this example the additional load is significantly below 1 per cent. This order of magnitude may really be regarded as a typical value for such facilities.

The question remains, whether accumulation in e.g. the soil in the neighbourhood of plants can occur over a long period of time, despite the very low additional loads? In the 1980s and 1990s, the Environmental Agency of the federal state of Bavaria has made several studies in the vicinity of incinerators on the question, whether persistent pollutants accumulate in the vicinity of these plants. There were no accumulations found. Most of these measurement programs have therefore been adjusted again in the meantime [10].

Another issue of pollution control are individual pollutants, of which some may show a very high toxic effect. Especially the group of substances called *dioxins* (more precisely, polychlorinated dibenzodioxins and dibenzofurans) were in the focus of the public debate. The toxicologically relevant individual compounds can be calculated to a single unit by the use of conversion factors, to toxicity equivalents of 2,3,7,8-tetrachlorodibenzodioxin. 2,3,7,8-TCDD is the dioxin compound with the by far highest toxic potential and was e.g. responsible for the serious illnesses of exposed people during the accident at a chemical plant at Seveso in northern Italy.

High dioxin emissions have been in fact a characteristic of certain techniques, including incineration of waste, as is shown in Figure 6.

However, the hazards of dioxin emissions from today‘s plants are comparatively very low because of the legal requirements of multi-stage gas cleaning. And even today on the current very low level of overall emission other sources are far more important. Following today’s situation, dioxin emissions are no more characteristic for waste incineration. This is supported by clean gas measurements at MSWI plants.

As PCDD/PCDF cannot be measured continuously by technical reasons, MSWI operators in Germany are obliged to perform extensive single measurements several times a year. Figure 7 shows that even here the safety margin between the operating values and the limit value of 0.1 TE ng/Nm³ is high. In many systems, the margin is more than an order of magnitude (more than factor 10).

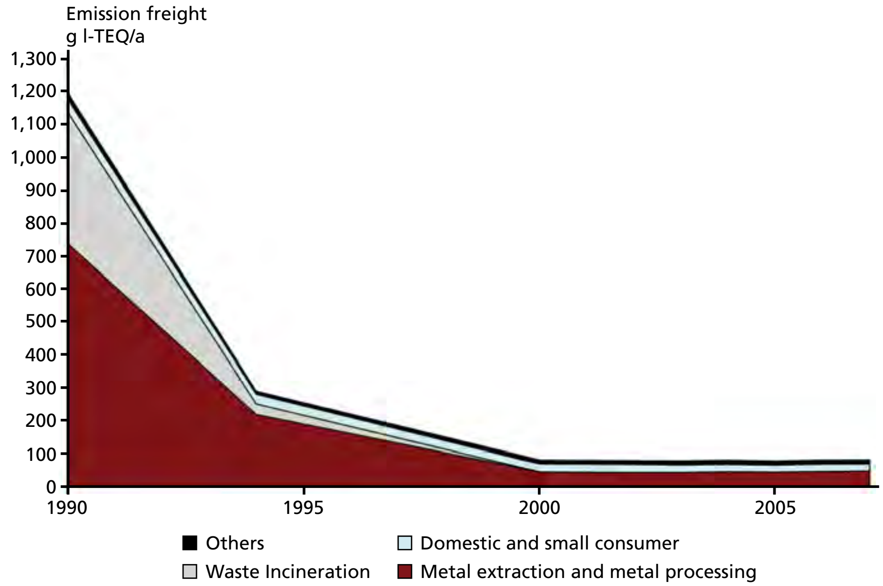


Figure 6: Dioxin emissions by source groups in Germany 1990 to 2007

Source: Löschau, M.: Beitrag der thermischen Abfallbehandlung zur gesamten Schadstoffemission in Deutschland. In: ReSource: Abfall – Rohstoff – Energie. Fachzeitschrift für nachhaltiges Wirtschaften 4/2009, Berlin, 2009: Quelle: Eigene Darstellung nach Umweltbundesamt (Hrsg.): Hintergrundinformation Dioxine: Chemikalienpolitik und Schadstoffe, REACH. Im Internet: http://www.umweltbundesamt.de, und Umweltbundesamt (Hrsg.): Nationale Trendtabellen für die deutsche Berichterstattung atmosphärischer Emissionen seit 1990, Emissionsentwicklung 1990-2007, persistente organische Stoffe. http://www.umweltbundesamt.de/emissionen/publikationen.htm

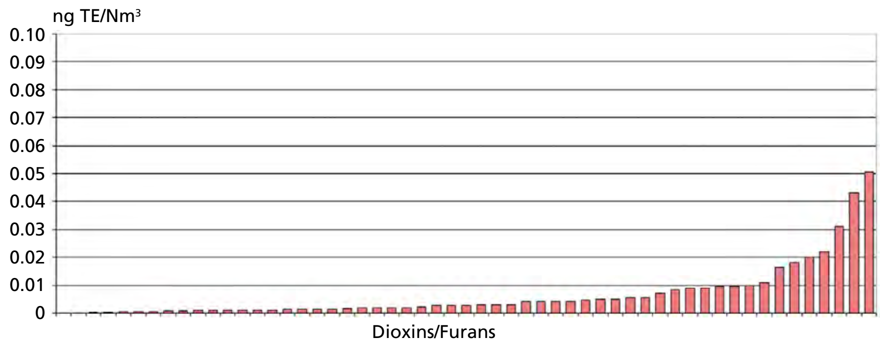


Figure 7 : Range of operating values of German MSWI plants; here: PCDD/PCDF

Source: IFEU: Beispielhafte Darstellung einer vollständigen, hochwertigen Verwertung in einer MVA unter besonderer Berücksichtigung der Klimarelevanz. UFOPLAN-Projekt FKZ 205 33 311, Heidelberg 2007, http://www.umweltdaten.de/publikationen/fpdf-l/3445.pdf

3. Requirements of pollution control at non-thermal waste treatment plants

Apart from thermal waste treatment, mechanical-biological treatment (MBT) was developed in the 1990s as an alternative to MSWI. Within the first phase of this development many environmental problems occurred. Therefore, in 2001 the legislator created a legal framework for MBT (30th BImSchV). One goal of this regulation was to reduce the emissions from MBT to the level of waste incineration. Table 3 shows the emission limits for the operation of MBTs.

Table 3: Emission limits for mechanical-biological treatment plants (MBT) in Germany following the 30th Ordinance of the Federal Immission Control Law (30th BImSchV)

Limit values for emission concentration	**Daily average values**	**Half hour average values**
Total dust	10 mg/m^3	30 mg/m^3
Organic substances (Total organic carbon)	20 mg/m^3	40 mg/m^3
	Single measures	
Odor	500 odor units/m^3	
PCDD/PCDF, sum (2,3,7,8-TCDD toxicity equivalents)	0.1 ng TE/m^3	
Limit values for emission freights	**Mean monthly values** for 1 Mg waste	
Nitrous oxide (N_2O)	100 g/Mg	
Organic substances (Total organic carbon)	55 g/Mg	

The main problem of MBT concerning pollution control is the emission of volatile organic compounds (VOC). Therefore, a limit value for the emission freight of organic substances has been introduced (as total organic carbon). To comply with this limit special thermal emission control techniques are used.

4. Acceptance of waste treatment facilities

Conflicts over techniques and locations for technical facilities have reached sometimes very large proportions, and not only in Germany and Europe. Current site conflicts over proposed incinerators as well as landfills e.g. in the People‘s Republic of China [12] show that the problem is not treated adequately by referring only to *German fear*.

These serious conflicts over incineration and sanitary landfills in policy and research over the last years have led to the question of whether these conflicts would not have been avoidable, if one had paid more attention to acceptance aspects within technology design. But these scientific approaches have failed because people's acceptance behaviour is highly complex and can hardly be predicted. Nevertheless, one has to deal with this difficult topic in practice in the context of waste management projects and has to find ways how to increase acceptance.

4.1. Immission control and acceptance

An incinerator or any other waste treatment facility must apply in Europe immission control requirements (see above). A system that does not meet this standard or violates it during operation is not acceptable also for the competent autorities

But will facilities that meet the legal requirements described above, or over-fulfill them, find acceptance in the neighbourhood among the population? This question cannot be answered in one sentence.

Experience shows that the expected or real emissions are a major point in the conflict over the construction of thermal waste treatment plants, but for the construction of other waste treatment facilities (e.g. MBT) and the planned construction of landfills, too. There are minimum legal requirements in Europe concerning emission control, and individual Member States have further additional requirements e.g. for flue gas cleaning, like the Netherlands, Austria and Germany.

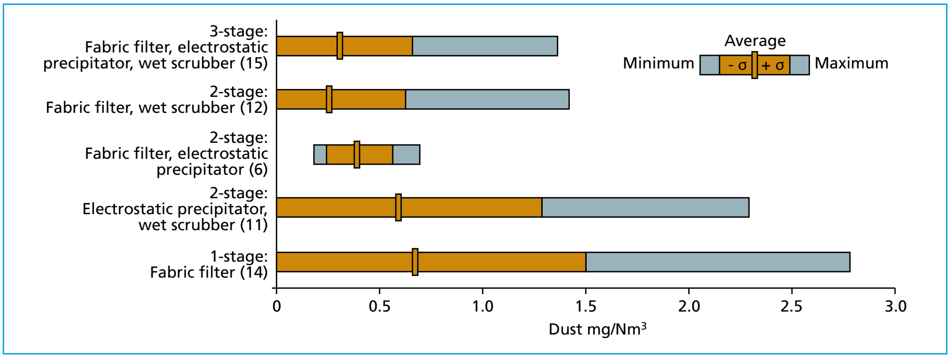


Figure 8: Comparison of different methods for dust removal

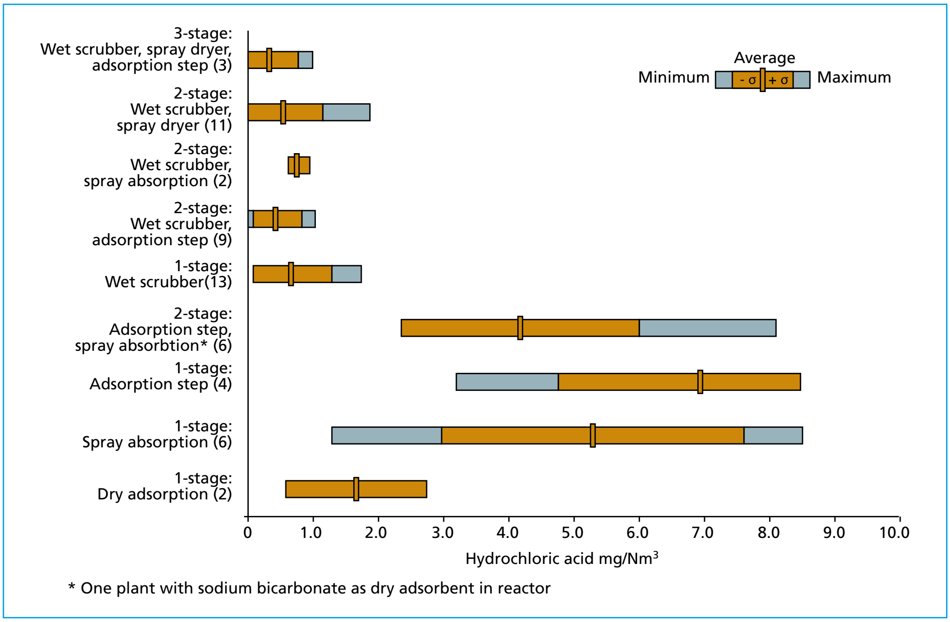


Figure 9: Comparison of different methods for HCl-deposition

Source (Figure 8 and 9): Quicker, P.; Noël, Y.; Daschner, R.; Faulstich, M.; Raesfeld, U.; Gleis, M.: Die Abgasreinigungsverfahren und deren Kombination weisen unterschiedliche Leistungsfähigkeit auf. ReSource 2, 50-54, 2011

Further, there is, as shown above, a considerable distance between everyday's emission values of incinerators in operation and the limits set in the 17th BImSchV. These coherences and corresponding data are meanwhile widely available. Therefore, in recent years in many conflicts concerning new facilities in Germany, the acceptance question shifted to a discussion about the performance of the emission control system. The opponents of a planned site use the known values of the best facilities and claime that the proposed facility should also reach these levels and should have such an equipment. The concerned citizens' part expects that the *better* or *best* systems for pollution control should be installed. Figure 8 and 9 show by example what the differences in cleaning performance between different systems are.

Generally it can be observed, that plants just operating below the legal limits for incinerators (17th BImSchV), have considerable acceptance problems. And many proposed sites and facilities have failed because of this very problem.

Will projects achieving a high level of pollution control find acceptance? In the public debate about a new location they certainly will have it easier and the resistance is smaller, as a rule. But pollution control is only one of several conflict fields.

4.2. Distribution of loads

Another relevant area of conflicts to be reflected, is the load distribution associated with location decisions. Just the economy of scale, but also the ecology sometimes forces to realize more centralised, that means bigger plants or systems. This centralization leads out of the case to the consequence that the load distribution is perceived as unfair by the affected population of the planned site.

The loads or *unreasonable demands* to be accepted at the site, include the above-described additional emissions. Now you can, as shown above, argue – particularly when the planned standard is ambitious –, that the emissions and risks are low for the neighbourhood compared to a lot of otherwise generally accepted activities, emissions or higher risks. You will be able to explain the benefits of technological progress of modern waste treatment plant compared to the current status quo.

But it would not be serious to negate the additional emissions at the site of a planned facility. Let us call these emissions as well as the delivery traffic, noise and other visual impression of a building as a disadvantage, as a burden or as an *imposition* in the literal sense, and allow ourselves even for a moment the question of whether this burden is high and significant. While activities with comparable or higher risks can be controlled individually by the individual decisions, this is not only difficult or even not possible for the burden posed by a technology site. The individual options to influence the loads combined with technological progress define very much the acceptance conditions [14]. While the people confronted with a new technical product, have the choice to buy it and use it and the burdens and risks related to this product is in their own sphere of influence, this is not the case at a site conflict. This option seems very much to influence the willingness of acceptance.

Is this feeling of helplessness combined now with the problem of load distribution, the conflict can be exacerbated. Especially for central waste treatment plants, it is the rule, that a small number of site-citizens carry the load from waste treatment of a large number of citizens having caused this waste. And the loads are present and even if they were only of psychological nature; such reservations can have grave consequences which affect the property prices.

From the acceptance research we know that people consciously or unconsciously do their own risk-benefit balance by themselves and do develop their own value judgments. This is one of the core issues of agricultural geno-technology to convince the consumers of agricultural products about the advantages of e.g. a genetically modified tomato. Are there any discernible benefits to the citizens through a planned installation? Usually not. Thus, the accounting would be clear for him. The case would change, if there were advantages and benefits that could be made available for themselves. This need not necessarily be a large financial transactions. In most site conflicts this subject is omitted. Even the obvious benefits such as new jobs, higher value-added on-site or local revenue were not be sufficiently scaled. Additionally, many benefits could also be developed.

The distribution of loads requires decisions. Decisions are taken in defined decision-making processes. Especially the process itself plays a special role to generate legitimacy. Democracy can not mean that it is compatible with the interests of all concerned. In democratic processes can come out winners and losers. It can be the result of a democratic process that to impose the loads to a local municipality is reasonable.

Legitimacy of a democratic process and the execution of a process without mistakes and violations should lead to acceptance, in many cases it does not. This is the nature of the matter of the above-described interest structure. It is crucial that the violation of procedural rules can **exacerbate** greatly problems of acceptance. Therefore, it is in practice a matter of taking the procedural issues very seriously, knowing that proper procedures can only gradually improve acceptance.

4.3. General technology scepticism

Another area of waste conflict to be reflected is the general technology scepticism in parts of the citizenry. This is reinforced by a widespread social psychological phenomenon: Although the products of our industrial society such as cars, cell phones, *Pampers* or computers are appreciated or even loved, but the way they are manufactured, filled us with shame, or even hate. And this contradiction is perhaps materialized in the observable doggedness, we quarrel in the waste sector. In nuce, the scepticism and rejection of technical projects relating to waste disposal is much more than just scepticism about the technology of waste incineration. The underlying conflict is a widespread ambivalent attitude of our daily consumption – in quantity and type.

5. Conclusions

The importance of pollution control for the acceptance of waste treatment facilities must be neither under- nor over-estimated.

Of course modern incinerators, designed, built and operated with state of the art, only contribute to a very small amount to the total load of pollutants on site. Nevertheless, such plants have the chance not to fail in the beginning of the process due to the inevitably emerging civil resistance only if they have a high emission standards. This means that the operating values have to show a clear distance to the legally fixed or individually set sharper limit values – by warranty of the system manufacturers.

On the other hand, a high pollution control standard will not automatically lead to acceptance of such a plant – as a lot of other motives such as fear of accidents, fugitive emissions, additional traffic, noise, loss of value of property and other more or idealistic motives, such as nature or landscape protection, play at least an equally important role.

Although the planning authorities can try with as early as possible and transparent information and public relations to achieve a high level of acceptance for his plan or to keep the resistance to a low threshold, but without a high pollution control standard of the proposed plant the chances for success are rather low.

6. References

[1] Prognos AG & Öko-Institut e.V.: Modell Deutschland – Klimaschutz bis 2050. Berlin, Studie im Auftrag des WWF Deutschland, http://www.oeko.de/oekodoc/971/2009-003-de.pdf., 2010

[2] Fricke, K.; Bahr, T.: Chancen und Herausforderungen des Ressourcenmanagements als Baustein einer regionalen Null-Emissions-Strategie. In: Neue Wege in eine nachhaltige Industriegesellschaft. Auftaktveranstaltung zur Gründung eines Null-Emissions-Forschungsnetzwerks, 15. September 2008, Eberswalde, http://www.null-emissions-netzwerk.de/fileadmin/userdaten/bilder/ZEUN/10_Tobias_Bahr_-_Leitweiss_Institut_-_15.09.08.pdf

[3] BMU: Abfallwirtschaft in Deutschland 2011. Fakten, Daten, Grafiken. Januar 2011, http://www.bmu.de/files/pdfs/allgemein/application/pdf/broschuere_abfallwirtschaft_deutschland_bf.pdf

[4] BMU: Müllverbrennung – ein Gefahrenherd? Abschied von der Dioxinschleuder. Stand Juli 2005, http://www.bmu.de/files/pdfs/allgemein/application/pdf/muellverbrennung_dioxin.pdf

[5] EU: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32000L0076:EN:NOT

[6] IFEU: Beispielhafte Darstellung einer vollständigen, hochwertigen Verwertung in einer MVA unter besonderer Berücksichtigung der Klimarelevanz. UFOPLAN-Projekt FKZ 205 33 311, Heidelberg 2007, http://www.umweltdaten.de/publikationen/fpdf-l/3445.pdf

[7] Daten der MVA Bielefeld-Herford, private Mitteilung 2008

[8] IFEU: Ökobilanz thermischer Entsorgungssysteme für brennbare Abfälle in Nordrhein-Westfalen. MUNLV 2007

[9] Eikmann, T.; Eikmann, S.: Humantoxikologische Bewertung von Abfallbehandlungsanlagen. September 2007. Veröffentlicht auf der Webseite der Interessengemeinschaft der Thermischen Abfallbehandlungsanlagen Deutschland e.V. (ITAD), http://www.itad.de/media/www.itad.de/org/med_90034/289_eikmann2007_humantoxikologischebewertung.pdf

[10] Mitteilung des LfU Bayern, 22.8.2008, zit. in Lahl, U.; Steven, W.: Gesamtemissionen deutlich verringert. Stand der Technik und Rechtsvorschriften gewährleisten ein hohes Umweltschutzniveau der thermischen Abfallbehandlung. Müllmagazin 4, 4-11, 2008, http://www.bzl-gmbh.de/de/sites/default/files/lahl_mm4-2008.pdf

[11] Löschau, M.: Beitrag der thermischen Abfallbehandlung zur gesamten Schadstoffemission in Deutschland. In: ReSource: Abfall – Rohstoff – Energie. Fachzeitschrift für nachhaltiges Wirtschaften 4/2009, Berlin, 2009: Quelle: Eigene Darstellung nach Umweltbundesamt (Hrsg.): Hintergrundinformation Dioxine: Chemikalienpolitik und Schadstoffe, REACH. Im Internet: http://www.umweltbundesamt.de, und Umweltbundesamt (Hrsg.): Nationale Trendtabellen für die deutsche Berichterstattung atmosphärischer Emissionen seit 1990, Emissionsentwicklung 1990-2007, persistente organische Stoffe. http://www.umweltbundesamt.de/emissionen/publikationen.htm

[12] Anon.: Einwohner protestieren gegen Müllverbrennungsprojekt. 25.11.2009, Webseite des China Internet Information Center (CIIC), http://german.china.org.cn/environment/txt/2009-11/25/content_18953044.htm

[13] Quicker, P.; Noël, Y.; Daschner, R.; Faulstich, M.; Raesfeld, U.; Gleis, M.: Die Abgasreinigungsverfahren und deren Kombination weisen unterschiedliche Leistungsfähigkeit auf. ReSource 2, 50-54, 2011

[14] Grunwald, A.: Zur Rolle von Akzeptanz und Akzeptabilität von Technik bei der Bewältigung von Technikkonflikten. Technikfolgenabschätzung – Theorie und Praxis Nr. 3, 54-60, 2005, http://www.itas.fzk.de/tatup/053/tatup053.pdf