Impulses for a Sustainable Waste Management

Strategy Paper Baltic States

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Greeting

Florian Schröder
CEO of German-Baltic Chamber of Commerce in Estonia, Latvia, Lithuania

Dear Ladies and Gentlemen

With the European Green Deal, the EU Commission provides an action plan to boost the efficient use of resources by moving to a clean and circular economy, restoring biodiversity, and cutting pollution. While the Baltic States, together with Romania, emit the fewest greenhouse gases in the EU, there is still plenty of room for improvement in other fields. These include the recycling rate of municipal waste, with values of 30.8% (Estonia), 41% (Latvia) and 49.7% (Lithuania) compared to Germany with 66.7% (Eurostat, 2019). In Latvia, a deposit system for beverage bottles was introduced only recently. The European Commission is willing to turn the "idea" into reality and a number of further legislative initiatives will be taken. My impression is that many companies are not yet aware of what they will have to face in the near future.

As the German-Baltic Chamber of Commerce in Estonia, Latvia, Lithuania we would like to contribute our part to make people and companies aware of the importance of a clean and circular economy. The project "Export Initiative Environmental Technologies", which is supported by the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV), offers the opportunity to analyze the circular economy in the Baltic States, to discuss the problems together with experts from the Baltic States and Germany and to build bridges between the companies. The German companies provide their know-how and technologies, which have proven their quality in Germany and abroad over the past decades.

The Environmental Technologies Export Initiative will thus make an important contribution to further improve the situation in the Baltic States!

Florian Schröder

1 Initial Situation - Today's Situation in the Baltic States

1.1 Approach in the Baltic States Strategy Paper

Due to the EU Waste Framework Directive, the Baltic States are confronted with the priority demand to increase recycling rates. The needs assessment of the German-Baltic Chamber of Commerce in Estonia, Latvia, Lithuania (AHK), elaborates the background information in detail and consistently places the thematic focus of the project "on the prevention, reuse[1] and recycling of waste ... as all three countries have considerable gaps in this area."

The task of this strategy paper, financed by the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV), is to promote the exchange of knowledge between the Baltic States and Germany as well as to bring about the networking of local stakeholders with experts of recognized practice. This strategy paper is committed to the overall goal of the export initiative to "strengthen sustainable (environmental) infrastructure[2] ... and make a real contribution to sustainable development and better living conditions" in capacity building in the Baltic countries.

In the course of this strategy paper, with reference to the general experience in Germany, the initial focus on recycling will be intentionally supplemented and reassessed with regard to prioritization in terms of time of implementation.

1.2 The Needs Analysis 2021 of the AHK Baltic States

As a consequence of the EU Directive 2018/851 and the objectives of the project, the needs analysis of AHK Baltic focuses on the recycling rates of the three Baltic countries. In the summary of the analysis, the recycling rates of municipal waste recorded in 2019 are

- - In Estonia, of 30.8 %,
- - in Latvia of 41.0 % and
- - in Lithuania of 49.7%

compared to the rate in Germany of 66.7 %.

Due to the EU Directive 2018/851, the Baltic States face the challenge to correct this situation over the next years. As a first milestone, the directive requires, for example, an increase in the recycling rate to at least 55% by weight by 2025.

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[1] Demand analysis of the AHK Baltic States

[2] Ibid

In order to strengthen the Baltic waste management and to promote the development of a sustainable circular economy, the AHK emphasizes that this project is based on the Sustainable Development Goals 2030 (SDGs) of the United Nations. The 17 political objectives are intended to ensure sustainable development worldwide, whereby the economic, social and ecological levels are of great relevance. The Baltic States regard the implementation of the 2030 Agenda as extremely important, both at the national and international levels. Lithuania, through an analysis of the compatibility of the 2030 Agenda, found that most of the SDGs are already reflected in Lithuania's strategic planning documents.

The needs analysis shows that this pan-Baltic project focuses in particular on the following sustainable development goals:

- ***Goal 9:*** *Develop a resilient infrastructure, promote broad-based and sustainable industrialization, and support innovation.*
- ***Goal 11:*** *Resilient and sustainable design of cities and settlements*
- ***Goal 12:*** *Ensure sustainable consumption and production patterns*
- ***Goal 17:*** *Strengthen means of implementation and revitalize global partnerships for sustainable development.*

Figure 1: The 17 Sustainable Development Goals of the United Nations

1.3 Global Climate Crisis

From the perspective of the strategy paper and with knowledge of the enormous importance, these important goals are being supplemented by the following goal:

- ***Goal 13:*** *Take action on climate change*

Under this chapter, the United Nations community emphasizes, "Measures to combat climate change and its impacts must be taken immediately."

In the following, the importance of climate protection will be emphasized, and it will be explained why waste management geared towards sustainability can make a considerable contribution:

At the end of 2022, the Intergovernmental Panel on Climate Change (IPCC)[3] will conclude its sixth major world climate report with the third part. The first part of the world climate report, dated August 9, 2021, supplements the scientific basis with disturbing results: According to it, only a rapid, comprehensive, and sustainable reduction of greenhouse gases would still make it possible for humanity to limit global warming to 1.5 or at least two degrees Celsius compared to the pre-industrial era.

The second part of the Sixth World Climate Report[4], released on February 28, 2022, emphasizes the consequences and vulnerability of humanity to climate change. Here are excerpts:

- "B.2 The vulnerability of ecosystems and people to climate change varies significantly across and within regions (very high confidence), due to overlapping socio-economic development patterns, unsustainable ocean and land use, inequality, exclusion, historical and persistent patterns of inequality such as colonialism and governance (high confidence). Approximately 3.3 to 3.6 billion people live in conditions that are highly vulnerable to climate change (high confidence). A large proportion of species are vulnerable to climate change (high confidence).
- ▪ B.5 The consequences and risks of climate change are becoming increasingly complex and difficult to manage. Multiple climate hazards will occur simultaneously, and multiple climatic and non-climatic risks will interact, leading to compounded overall risks and risk cascades across sectors and regions."

In the report, the Intergovernmental Panel on Climate Change (IPCC) calls for "political determination and consistent implementation with clear targets and priorities ..." and identifies the right time for adaptation as "now" rather than someday!

"The EU 27 does not have a common Kyoto target because the 12 newer member states joined the EU only after the ratification of the Kyoto Protocol. However, the member states have agreed

[3] German IPCC Coordination Office: https://www.de-ipcc.de/

[4] Main messages from the summary for policy making (SPM); https://www.de-ipcc.de/media/content/Hauptaussagen_AR6-WGII.pdf

in a "Climate Action Alliance" to reduce their greenhouse gas emissions by 20% by 2020 compared to 1990 (EEA 2009).

1.4 War in Ukraine

From the point of view of the German authors of this strategy paper, the psychological and economic effects of the war in the neighboring country cannot even be approximately conceived. The many dead and the war-related destruction in close proximity caused by the immediate neighbor Russia as well as the many Ukrainian and Russian refugees must deeply disturb the citizens of the Baltic States, who had regained their sovereignty only in 1991.

It is understandable that these emotions, to return to the context of this study, must be accompanied by a high level of self-sufficiency in terms of energy and raw materials supply.

Since the beginning of April 2022, Lithuania no longer receives gas[5] from Russia. The appeal of the Lithuanian President Gitanas Nausėda to the other EU countries to imitate Lithuania is only too understandable. It has been decided that Latvia and Estonia will join this import ban on Russian gas. Estonia has announced together with Finland that it will also start operating a liquefied natural gas terminal.

2 Objectives and Priorities in the Analysis

Even though Lithuania and the two other Baltic states have succeeded in breaking away from their former energy dependence on Russia, they remain highly dependent on gas imports via ship deliveries from abroad. In view of this fact, the strategic prioritization in this study is emphasized on searching and using all possible energy-saving or energy-generating possibilities of waste management. There are enormous potentials in the field of material recycling and even more so in the field of thermal recycling, which will be pointed out in detail in this study.

It is not necessary to refer to point 1.3 again in order to know that consistent measures for climate protection are required now. To achieve the known climate targets, a reduction of 600 million t CO_2 eq is still necessary by 2020[6].

In simple terms, the goal is to reduce greenhouse gas emissions, which scientists agree cause atmospheric warming, which is the basis for the increase in aridity, drought, storm surges and ultimately crop failures.

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[5] Communicaton from Lithuania's Ministry of Energy in the ARD News; https://www.tagesschau.de/wirtschaft/weltwirtschaft/gas-baltikum-101.html

[6] Climate relevance of waste management, UBA January 2011

Even if not necessarily common knowledge, the scientific findings regarding the enormous contributions of waste management to climate protection are now clear.

The website of the German Federal Environment Agency, for example, states:

"Waste management makes an important contribution to climate protection[7]. Recycling, the use of residual waste as an energy source, and the collection and use of landfill gas contribute significantly to the reduction of greenhouse gases. The ban on landfilling non-pretreated municipal waste has given a decisive impetus to this development in Germany. ... The use of the remaining residual waste for energy generation also contributes to climate protection. This is because it replaces fossil fuels for energy generation. However, the greatest contribution is made by avoiding the formation of methane in landfills.

On the previously mentioned target of a reduction of 600 Mt CO_2 eq in the EU as soon as possible, "waste management[8] can contribute **24 or 32%** (depending on the scenario). A strict landfill ban for untreated waste following the example of Germany, Austria or Switzerland would provide decisive contributions to improve the climate protection balance of the waste management and is a necessary prerequisite for a significant optimization in the EU 27. An equally successful steering element is achieved by landfill taxes as e.g., in the Netherlands. A minimum goal should be strict compliance with the EU Landfill Directive, which sets concrete targets to reduce the amount of biodegradable waste in landfills."

As early as 2005, the climate protection potential[9] of municipal waste management was examined in a research project [Ökoinstitut /ifeu 2005]. "The results clearly show that the contribution of waste management to climate protection is greater than the accounting in the National Inventory Report would suggest. In the NIR, according to the rules of the Intergovernmental Panel on Climate Change (IPCC), emissions from landfills are primarily reported for the waste sector. Credits from e.g. electricity used or heat from waste incineration plants (MVA) are accounted for in the energy sector. Other waste management services, e.g., from material recovery, are credited to the industry sector."

In summary, these arguments signify that the contribution of waste management to the reduction of climate gases in the EU has been significantly underestimated so far. Equally underestimated is energy recovery, without which closure of landfills for organic waste has not been achieved anywhere in Europe.

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[7] https://www.umweltbundesamt.de/themen/abfall-ressourcen/abfallwirtschaft/klimaschutz-in-der-abfallwirtschaft

[8] Climate relevance of waste management, UBA January 2011

[9] Ibid

The following graph with values from 2017 shows that the countries (Netherlands, Belgium, Germany, Finland, Denmark, Sweden, and Austria), which have only a small Landfill rate of 1 - 2 % have achieved this through on average a 50/50 split, between:

- composting and mechanical recycling and
- thermal recycling

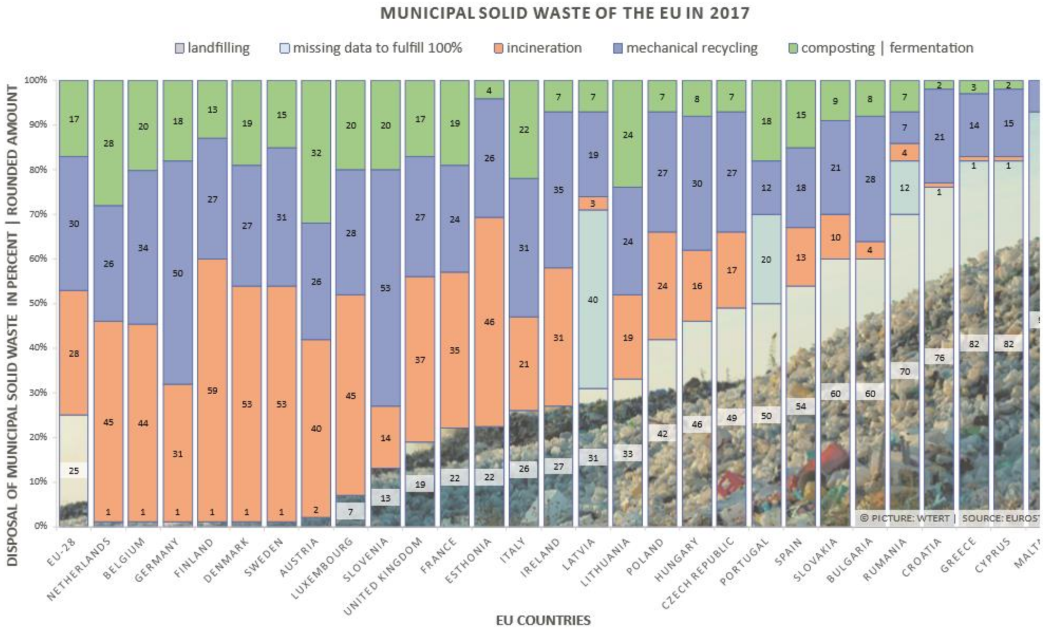

Figure 2: Treatment of urban waste in the EU 2017

The target for the Baltic States in terms of climate protection should therefore be as follows:

- approx. 50%: composting and recycling and
- approx. 50%: thermal recycling

Accordingly, the strategic considerations in Estonia with a high share (45% Waste to Energy in 2019) of energy recovery will vary from those in countries with only small amounts for thermal recovery. This is the only way to achieve the overall goal of ending the landfilling of waste with organic content. As the further explanations show, besides reducing the quantities that are still being landfilled today, the technical measures in the landfill operation (covering, leachate and gas collection, etc.) can be tackled at the same time.

It is anticipated that this prioritization should be seen complementary to the efforts to expand recycling and waste prevention that are already underway in the country. In any case, only initial impulses for sustainable waste management can be given in this short period of time. The "Baltic States Strategy Paper" concentrates on measures which, after considering the facts, have so far been underweighted or overlooked.

In terms of communication, the "Baltic States Strategy Paper" pursues the goal of presenting real case studies and, if these are perceived as ideas for concrete solutions in the Baltic States, to establish contact with the protagonists of these case studies, who have already implemented these solutions

Moreover, even though the authors usually refer to the Baltic States as a whole, they are well aware of the cultural and historical differences between the three Baltic States.

3 The Waste Management Hierarchy of the EU

Since the ratification of Directive 98/2008/EC, the order of priorities defined in the waste hierarchy has been the subject of controversy in Europe:

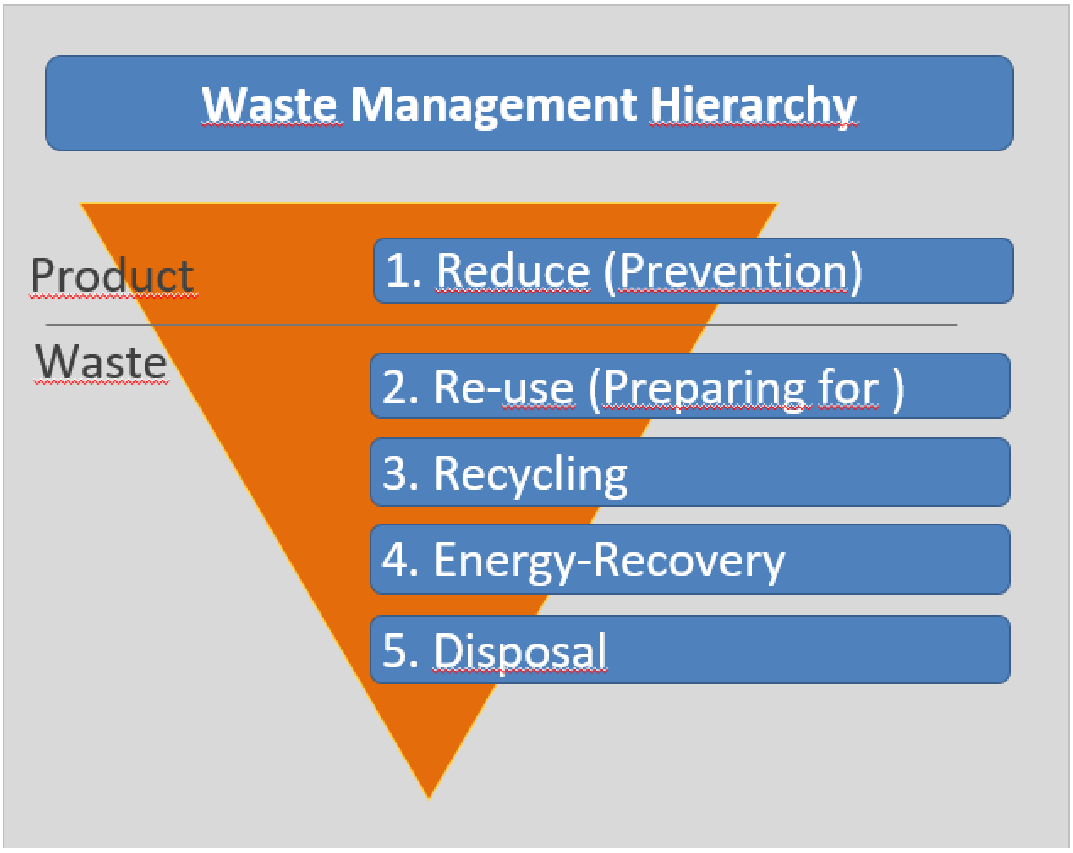

Figure 3: EU waste hierarchy

At first glance, "this five-level ranking"[10] provides a simple and quick decision-making aid as to which types of waste treatment should be preferred or avoided.

In practice, however, it is evident that the preferred options in the waste hierarchy, avoidance, and reuse, are not implemented enough and the amount of waste continues to increase. Recycling has gained importance in recent years; however economic and technical constraints limit further increases in recycling rates." In his detailed examination of four selected cases, Bartl shows that bypassing the waste hierarchy can make sense where appropriate, which is why it is essential in practice to conduct an in-depth investigation of all options in order to find an optimal solution in terms of energy consumption, resource requirements and environmental impact.

Nevertheless, it has become the guiding principle for waste management measures in Europe.

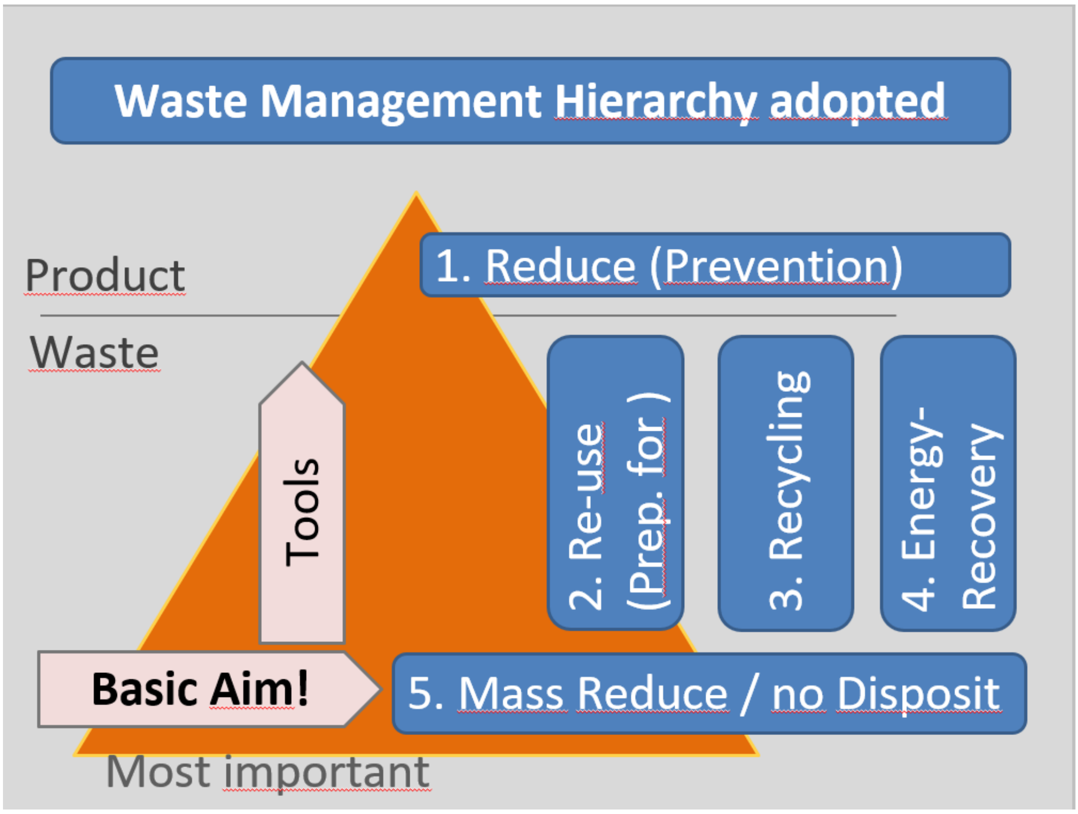

Figure 4: EU waste hierarchy – adapted

If one takes the overriding priority of climate protection into account, it makes sense to reorganize the waste hierarchy in a slightly different way. First of all, the essential goal of overcoming the landfill (for organic waste) is expressed and the tools required for this are stated. Where no more wastes with organic contents are to be deposited, the waste masses must be reduced. Here, the

[10] Bartl, A. (2014) Muss die Abfallhierarchie entsorgt werden?, in Depotech 2014, Universität Leoben (November 2014)

use of waste in waste-to-energy plants is the biggest tool. Trans-regional plants of thermal utilization should be started **parallel** to the measures of preparation for reuse and recycling.

Regardless of these fine details in the strategic prioritization of individual steps, waste prevention is indisputably the first step in the waste hierarchy.

4 Waste Prevention - Responsibility of Manufacturers

4.1 Responsibility and Possibilities of Waste Prevention

The prioritization of waste prevention must not be understood to mean that citizens alone are responsible for its implementation. Even though a broad section of the population is becoming more and more aware of the sometimes absurd excesses of our consumer society, growing prosperity is reflected in increasing amounts of waste. For many, a new mobile phone every year seems to be just as important as the bigger and bigger television set.

Figure 5: TV sets in a German retail store

The producers and distributors stimulate this consumption with advertising. More still: the example of washing machines shows that appliances that used to last for more than 20 years are "produced" cheaper and cheaper and "deliberately" (obsolescence) break down after a few years. Without legislative measures that implement the responsibility of industry (producer responsibility) in organizational terms, the goal of waste avoidance is meaningless. Fiscal options via taxes and levies also come into play here.

In order to implement the goal of waste avoidance, the actions of citizens should not be relied upon. Sufficiency and purchasing restraint are desirable, but they are no guarantee of a waste management strategy. Primarily the legislator is called upon to act:

4.2 Producer Responsibility

Product responsibility in waste management still holds producers accountable even when their products become waste. This applies in particular to take-back and recycling. It is intended to create an incentive to design sensible products and avoid waste as early as in the product manufacturing stage. Environmentally compatible recycling and disposal after use are also to be ensured.

The legal basis for product responsibility in waste management in Germany is the Recycling Management Act. This includes, in particular, requirements for the development of long-life products, the use of secondary raw materials in production, and the take-back and environmentally sound disposal after use. The ban on substances, labeling obligations and take-back obligations for manufacturers and retailers support these goals.

Specific requirements for certain products can be laid down in laws[11] or ordinances (for example, for the deposit regulation for packaging).

Some laws or ordinances specify the scope of waste management product responsibility for packaging, vehicles, batteries, electrical and electronic equipment and (mineral) oils:

- Packaging Act,
- End-of-Life Vehicles Ordinance,
- Battery Act,
- Electrical and Electronic Equipment Act,
- Waste Oil Ordinance.

As an example, the Battery Act regulates the return and disposal of used batteries. The responsibility of the consumer is to take the old batteries to a separate collection. The retailer is obliged to take back used batteries free of charge and to set up suitable collection boxes for this purpose. The manufacturers of batteries are responsible for the environmentally sound recycling of the separately collected used batteries.

Since more than 50% of plastic is produced exclusively for single use[12], it usually ends up in a landfill, in the landscape or even in the ocean. For this reason, a ban on single-use plastics is being discussed in many countries. In Germany, under the requirements of the Single-Use Plastic Ban Ordinance, the marketing of certain single-use plastic products has been banned since July 3, 2021.

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[11] Freely adapted from the Federal Environment Agency's web pages on producer responsibility

[12] UNEP, 2018. Beat Plastic Pollution. Recovered from: https://www.unep.org/interactive/beat-plastic-pollution/

Instead of a ban, the plastic packaging tax[13] (PPT) will apply in the United Kingdom as of April 2022. The aim of this tax, which has been announced since 2018, is to encourage the use of recycled plastics. The newly introduced tax will provide an incentive to manufacturers to recycle at least 30% of all plastic packaging produced in or imported into the UK. Those that do not reach the minimum 30% of recycled plastic will have to pay a tax of approx. 200 pounds per ton of plastic packaging material.

In any case, it is desirable that the countries in the Baltic States at least take up the rules of the European Union and implement them quickly. If bans or trade restrictions through taxes are announced long enough in advance, the affected countries can adjust to them, which often leads to product and service innovations and thus ultimately to growth.

5 Bans - Taxes - Duties

Bans and taxes are also the most effective means of environmental protection within the scope of waste management.

5.1 The Landfill Ban

The greatest contribution to climate protection is " ... the prevention of methane formation in landfills. This has been achieved in Germany through the landfill ban[14] for non-pretreated municipal waste, which has been in force since June 2005. The criteria of the Waste Disposal Ordinance (now integrated into the Landfill Ordinance), which came into effect in 2001, have had to be complied with without exception since June 2005."

With reference to the overriding goals of waste management, it is recommended that the countries of the Baltic States implement the ban on the landfilling of organic waste, which has already been imposed by the EU, as far as possible well in advance of the deadline.

[13] UK Government, 2022. Introduction of Plastic Packaging Tax from April 2022. Recovered from: https://www.gov.uk/government/publications/introduction-of-a-new-plastic-packaging-tax/introduction-of-a-new-plastic-packaging-tax

[14] UBA; https://www.umweltbundesamt.de/themen/abfall-ressourcen/abfallwirtschaft/klimaschutz-in-der-abfallwirtschaft

5.2 The Landfill Directive

On 30.05.2018, the EU Directive 2018/850 amending Directive 1999/31/EC on the landfill of waste (Landfill Directive) entered into force and brought some significant changes[15].

For example, Article 5(5) was added to Directive 1999/31/EC, stating:

"Member states shall take all necessary measures to ensure that by 2035 the amount of municipal waste going to landfills is reduced to a maximum of 10 (weight) percent of the total municipal waste generated is reduced." (§ 5(5) of Directive 1999/31/EC).

In addition, a derogation for member states has been created:

A member state may extend the deadline for achieving the target set out in paragraph 5 by up to five years, provided that that member state (a) according to data provided in the joint OECD/Eurostat questionnaire, landfilled more than 60% of its municipal waste in 2013" (Article 5(6) of Directive 1999/31/EC).

But what is included in the calculation of the "10%" target is partly noteworthy and explained by the newly added Article 5a(1) of the Landfill Directive.

"(1) For the purposes of calculating whether the targets in Article 5(5) and (6) have been achieved, the following shall be considered

(a) the weight of municipal waste generated and landfilled in a given calendar year,

(b) the weight of waste generated in treatment operations prior to recycling or other recovery of municipal waste, such as sorting or mechanical-biological treatment, and subsequently landfilled shall be considered when calculating the weight of municipal waste reported as landfilled,

c) the weight of municipal waste incinerated for disposal and the weight of waste resulting from the stabilization of the biodegradable fraction of municipal waste to be subsequently deposited in a landfill shall be reported as deposited in a landfill,

(d) the weight of waste generated from recycling or other recovery of municipal waste and subsequently deposited in a landfill shall not be considered for the weight of municipal waste reported as deposited in a landfill.

Particular consideration should be given to subparagraph (c). If municipal waste is incinerated at a waste-to-energy facility that is declared as a disposal facility, nonsensically, the output of the facility, most of which is actually deposited, is not used in the calculation, but rather the input of the

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[15] Bachmann, A. (2022), UBA, Entwicklungen im europäischen und nationalen Deponierecht, Kasseler Abfallforum 2022, Witzenhausen Institut

facility. Thus, an amount of municipal waste is included in the target that does not reach the landfill in this way. Furthermore, waste incineration ash is not municipal waste, but belongs to chapter 19 according to AVV, as is comprehensibly recognized under letter d) for other treatment processes. It seems waste incineration is deliberately to be discredited. Also it is ignored that even if the R1 criterion is not met, incineration of the waste destroys the content of organic pollutants, greatly reduces the volume of waste, prevents the formation of gas after landfilling, and ultimately recovers energy in some quantity. "

The "Baltic States Strategy Paper" deliberately quotes in the original the speaker A. Bachmann from the German Federal Environmental Agency. It seems that the hazards of methane emissions from open dumps were not considered in the script of the Landfill Ordinance to the extent known today. This is regrettable. Ultimately, it is up to the actors involved in the countries affected by the EU Directive to be at liberty to make their own rules in the interests of environmental protection or to formulate their own considerations at the local/regional level (see point 5.4).

5.3 Landfill Tax

The goal of reducing the quantities to be deposited as quickly and extensively as possible is served in particular by the landfill tax. It is understandable that the effect of this tax has a relation to the amount of the sum to be paid. In the following, the amounts of the landfill tax in European countries are shown:

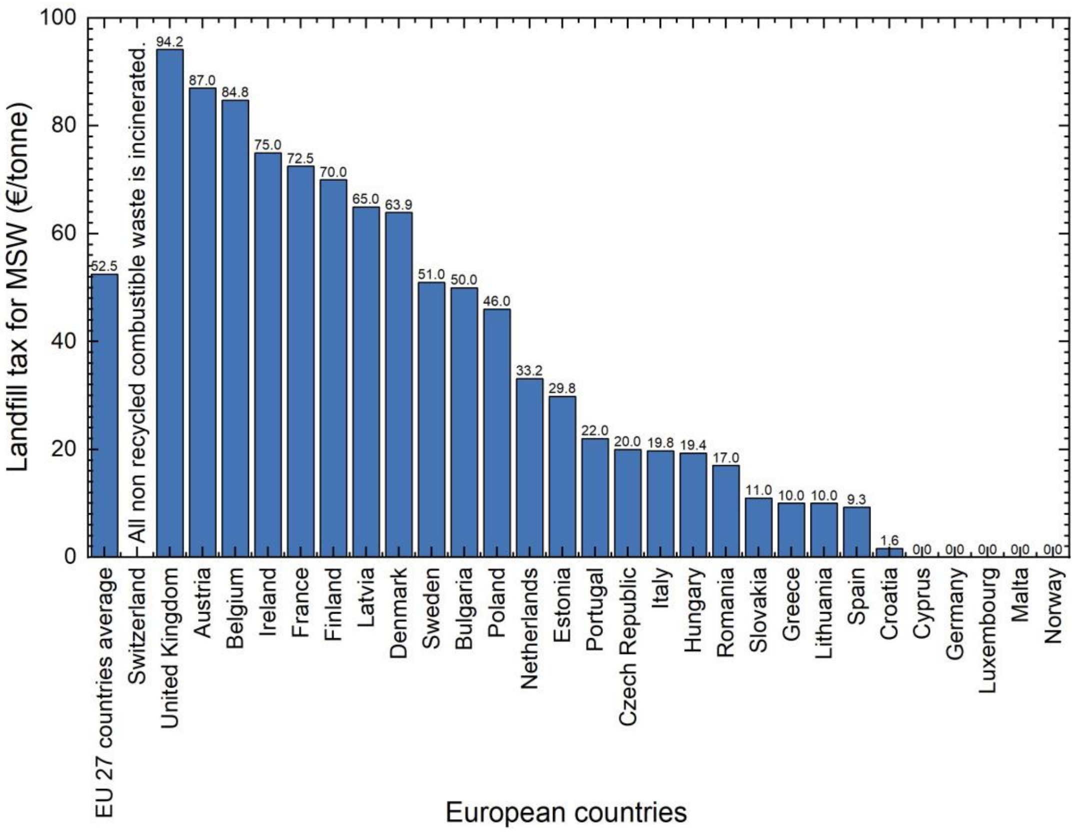

Figure 6: Landfill tax in the EU

Latvia has a high landfill tax at the time of the survey, while Estonia and Lithuania are below the average. There is still room for improvement here. The landfill tax has a strong incentive effect and creates a budget from which measures for recycling, etc. can be financed.

Support for this can be provided by the member companies of ReTech, which can be reached via the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV).

5.4 Municipal Activity - Responsible Action

In view of the importance of methane emissions from landfills mentioned at the beginning, the legal possibility to operate a landfill until 2040 is in the opinion of the author no longer responsible.

The example of the Schwandorf special-purpose association, which converted a lignite-fired power plant to operate with waste as early as 1982, shows that it is possible to say farewell to landfills much more quickly than is legally required and thus, with a high level of local value creation, made it possible to gradually close all local landfills well before the German ban on landfills in 2005.

Using the example of the Schwandorf municipal special-purpose association (ZMS), it was possible to show that the ZMS and its facilities have saved **around 8.3 million tons of CO_2** over the last 40 years. The main reason for this is the conversion of the former coal-fired power plant into a combined heat and power plant powered by waste and the subsequent measures taken by the association members to immediately reduce landfilling and successively close the landfills.

On the occasion of the 40th anniversary of the Schwandorf special-purpose association, a brochure[16] was developed in which the emissions associated with this decision were compared with the emissions that would have arisen if this decision had not been made over 40 years ago and the districts and cities in eastern Bavaria had continued to landfill waste, each on its own, until the statutory deadline of June 1, 2005, set by the Technical Guidelines for the Disposal of Municipal Solid Waste (TASi).

The case study ZMS[17]:

5.5 Adequate Fees - Basis for Proper Waste

Waste fees are intended to cover the costs incurred by municipalities in managing waste.

Polluter-pays waste fee systems such as "pay-as-you-throw" (PAYT) systems are an economic instrument for applying the polluter-pays principle, whereby the amount of the disposal fee for citizens is based on the volume of residual waste, bio-waste and bulky waste handed over for disposal. In the presence of a well-developed infrastructure for separate collection and in conjunction with a high level of public awareness, high recyclables collection rates can be realized.
However, the municipality must make considerable advance payments for the installation and operation of PAYT systems. Last but not least, the introduction of the identification system, an electronic system for the recognition and management of waste containers, makes it possible to direct material flows and actively bring about positive changes for the environment and the people.

[16] 40 Jahre Zweckverband Schwandorf, 2019; ZMS Körperschaft des öffentlichen Rechts, Alustraße 7, D- 92421 Schwandorf; https://www.z-m-s.de/index.php

[17] https://www.wtert.net/bestpractice/289/Conversion-of-a-lignite-fired-power-plant-into-a-waste-to-energy-plant-using-the-example-of-the-ZMS-Schwandorf-Germany

These are examples of the goals that can be achieved with the introduction of the new Waste Management System and specifically through the design of the fee.

See the case study of the district of Aschaffenburg[18]:

6 Municipalities - Responsible Waste Management Actors

6.1 Basic principles - Presentation by G. Langer, former AWM (Online)

European law limits the scope of action of the actors in the waste management sector. However, it is not decisive for the question of whether the tasks are performed privately or by public-law institutions. If monopolies or quasi-monopolies of individual companies exist in competition, municipal waste management is a regulatory factor. In Germany, municipal waste management is also represented via special-purpose associations in larger units.

Using the example of the municipal waste management of the city of Munich, it is shown to which extent the Abfallwirtschaftsbetrieb München (AWM) - Waste Management Cooperation Munich takes over tasks and which services it usually awards to private companies following European-wide invitations to tender.

"The AWM is a municipal undertaking of the City of Munich. It is managed as an organizationally, administratively and financially separate economic enterprise[19] without its own legal personality". The AWM assumes the tasks of the public waste management authority (örE) of the state capital Munich and is oriented to the requirements of the city's policy. The Municipal Officer as First Plant Manager represents the AWM in the City Council. The second plant manager is responsible for the operational and administrative management of AWM and manages the day-to-day business. All important decisions concerning the AWM and waste disposal in Munich are made by the plenary session of the Munich City Council or the Works Committee (Municipal Committee). The tasks of

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[18] https://www.wtert.net/bestpractice/44/Pay-As-You-Throw-Municipal-Solid-Waste-Management-in-a-German-County

[19] Resolution of the plenary session of the city council of the state capital Munich dated 04.10.2001

the AWM are the enforcement of the Closed Substance Cycle Waste Management Act, the Bavarian Waste Management Act, the Munich Waste Local Law, in particular the collection, transport and disposal of waste and the economic operation of the disposal facilities and the recycling centers.

AWM finances these sovereign services through fees. The fees are currently calculated for a three-year period. According to the Bavarian Municipal Tax Act, cost surpluses and shortfalls must be balanced out in the next calculation period. Other commercial business areas have a financial and procedural supporting function within the AWM.

The strategy follows the overriding claim and guiding principle that AWM, as a municipal model company for the growing metropolis of Munich, is a guarantor of reliable service provision, sustainable treatment and disposal. This is based on the two central pillars of customer orientation in services and the contribution to a good quality of life for the people of Munich at reasonable fees. Further components of the strategy are the fulfillment of ecological responsibility for future generations and social responsibility for the company's own employees. In the opinion of AWM, commitment to social and ecological issues is also of central importance for the sustainable achievement of economic goals (see also Hall 2 in item 7.2). AWM's sustainable management pursues the goal of not only assessing the effects of operational activities from an economic point of view, but also of including social and ecological components in the decision-making process.

In line with its core processes, AWM's organization is divided into the operational units Waste Management Services (waste collection and transport, including fleet management and the Innovations and Projects business unit), Recyclables and Problem Materials Service (recycling centers and problem materials collection). These areas are supported by the service units Human Resources, Organization and IT, Administration and Legal Affairs, Marketing and Sales, Finance and Accounting with Controlling, and Technical Services. The impact of business activities on fees is the yardstick for AWM's corporate decisions.

7 Preparation for Reuse

7.1 Potentials of VzW

At the beginning of 2020, the Bavarian Ministry of the Environment published the "Guideline for Preparation for Reuse". Following extensive research at more than 60 recycling centers in Bavaria, the potentials of VzW were determined. According to this, a realizable potential P III could be estimated, according to which, measured for Bavaria and under appropriate conditions, 415 302 tons (39.2%) of used furniture could be supplied to the preparation for reuse. If the assumptions are interpreted more restrictively (cf. chart), the realizable potential is reduced to 76,467 tons (7.2%), which would still mean a tripling of the current quantities in the preparation for reuse.

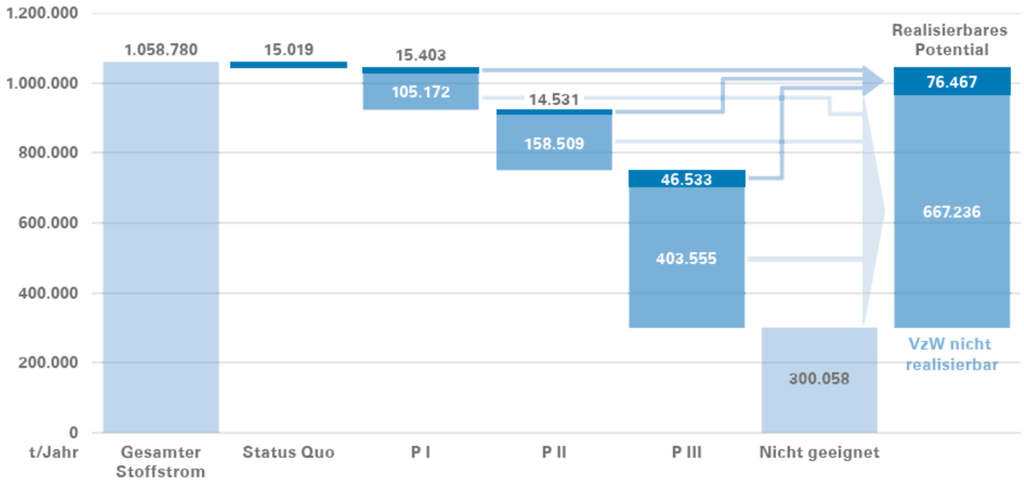

Figure 7: Potentials of preparation for reuse using the example of the used furniture goods stream

"According to the study, even comparatively conservative measures[20], such as a moderate level of reuse or the implementation of a sharing economy, could achieve high savings in certain areas.

For example, increasing the reuse rate of electrical and electronic equipment from the current 2% to 30% would reduce the greenhouse gas emissions associated with production by a good 50%.

An increase in the current average use of recycled materials to nearly 100% would reduce GHG emissions associated with manufacturing by just over 40%."

As noted in the GACC's needs assessment, promoting preparation for reuse requires establishing

- an infrastructure for the collection and preparation of goods, and
- an organized system for the circulation and sale or transfer of second-hand goods.

It would be extremely useful to launch a pilot project to obtain information on the number, type, and participation rate of the population.

[20] Deloitte 2016

Figure 8: Acceptance of old electrical appliances at AWM separated into defective and still functional

Old electrical equipment, which is brought to the recycling centers in Munich as shown in the picture above and is "saved" from the containers, is inspected, processed and sold in "Hall 2".

7.2 The AWM Case Study "Hall 2"

A rummage paradise in Munich-Pasing is the second-hand store "Hall 2" of the city of Munich. The Abfallwirtschaftsbetrieb München (AWM) - Waste Management Cooperation Munich offers a sales area of almost 800 m², weekly auctions and long opening hours for the purchase of second-hand goods. In addition, space is provided for the acceptance and technical inspection of the goods. All of the goods being offered at the City of Munich's second-hand store come from Munich's recycling centers, are in good condition and can be purchased at low prices. These include books, records, televisions, consoles, furniture, lamps, household appliances, bicycles, skis, sporting goods, toys, children's articles, lamps, radios, computers and odd individual items.

Case study AWM[21]

[21] https://www.wtert.net/bestpractice/78/Halle-2-Munichs-second-hand-store-as-nucleus-of-Reuse

8 Recycling

The promotion of recycling is based on a detailed knowledge of the materials and material flows and a precise planning of how they are to be collected and in which dimension they are to be combined. Processing plants for compost or secondary raw materials must be well planned.

8.1 Data – Facts

8.1.1 Data - Basis for Waste Management Concepts

Municipal waste analyses provide information on the material composition of waste and are indispensable when it comes to describing the technological, chemical or physical properties.

The quantity and composition of mixed municipal waste in a disposal area are determined by a representative sample and a sorting analysis based on statistical survey and analysis methods. Since national or international regulations do not yet exist, data are often not comparable. Existing methods for sampling granular bulk materials such as ores, coal or gravel are not applicable to the heterogeneous material mixtures in waste management.

When sampling waste and waste mixtures, the structure and properties of the material mixtures are of essential importance. Structure and properties are determined by the degree of heterogeneity. According to the heterogeneity of a mixture of substances, a detailed sampling plan is required for representative sampling.

Knowledge of the chemical/physical properties of waste is a crucial factor in the design and/or optimization of waste treatment and disposal processes.

8.1.2 Case Study - ARGUS GmbH

Since the representative sampling of heterogeneous waste and waste mixtures for the evaluation of physical, chemical and technological properties has not yet been solved satisfactorily in waste management, the adjacent case study shows how an optimal approach can be taken and which aspects must be taken into account.

Case study ARGUS-statistics[22]

[22] [22]https://www.wtert.net/bestpractice/218/Methodology-Design-and-Implementation-of-Solid-Waste-Analysis-(SWA)-Germany

8.2 Waste Management Concepts

Waste management concepts (AWC) are an indispensable basis for the entire decision-making, planning and construction process[23] in municipal and company waste management. The waste management concepts record the type, quantity and source of the waste currently produced (waste analyses and waste balances) and calculate the quantities of waste to be expected in the future (waste forecasts). Measures for the avoidance, recycling and treatment of non-recyclable waste are derived from the targets for avoidance and recycling and the quantity structure, - and a proposed resolution is prepared. For municipal waste management concepts, the security of disposal and the environmental compatibility of the facilities operated play an essential role.

The implementation of waste management concepts takes place in three steps:

- 1. Step, the actual situation is recorded. This includes the legal framework, the type, quantity, composition and origin of the waste, the disposal logistics, the settlement and economic structure of the disposal area.
- 2. Step: the waste volume development is determined in a waste forecast.
- 3: Step of the AWC is the conceptual part, in which the desired waste management target status is designed and different variants for achieving the target status are discussed. Based on this, the decision for the optimal variant is finally made.

8.2.1 Separate Collection - Optimization of Material Flows

In particular, the separate collection of different waste fractions such as paper and cardboard, plastics and, above all, biogenic waste is a key prerequisite for a functioning circular economy. The purity and quality of the separately collected fractions are challenges that must be addressed worldwide.

The separate collection of waste fractions in several containers forms the basis for high-quality sorting and for sophisticated material recycling. Depending on the fraction and settlement structure, collection or bring systems can be used. Today, in many cases, high-performance waste collection vehicles with compacting equipment are used.

Public relations activities to improve and guarantee good quality in collection is, like the logistical organization of new collection systems, a task that must be adapted to the respective conditions in the individual countries and regions.

When introducing or expanding collection systems for the separate collection of waste fractions, step-by-step concepts serve as an elementary procedure for efficient and economical action. Pilot projects of representative size can provide experience that allows for targeted adjustments in the expansion of systems in the area.

[23] Argus-statstik.de

The German waste and recycling industry offers good solutions for this.

As an example, here is a case study[24] of

a consultancy in Greece
of the company
<< Ressource Abfall GmbH

as well as a case study[25] of the company Stadler Anlagenbau GmbH >> on the realization of a sorting plant in Grenada, which is shown as just one of more than 100 plants operated by the company for sorting a wide variety of material streams.

8.3 Composting

8.3.1 Basic Information on Organic Waste

In landfills, it is the organic waste that is responsible for methane emissions and the formation of leachate.

One of the first possibilities to overcome this is to compost these organic materials in a separate plant process. Ideally, this is done with clean separated organic waste (e.g. garden waste) with the aim of obtaining clean compost. If the goal is only to reduce emissions from a landfill, it is also possible to "treat" residual waste directly at the landfill using the same equipment.

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[24] https://www.wtert.net/bestpractice/496/Guide-on-Separate-Collection-of-Municipal-Waste-in-Greece

[25] https://www.wtert.net/bestpractice/194/Mechanical-biological-treatment-plant-(MBT)-in-Granada-Spain

A simple solution for composting is offered by the company UTV AG, which is shown by the following case study.

The Tallinna Jäätmete Taaskasutuskeskus AS plant in Tallinn uses the GORE® Cover System Technology in order to compost bio-waste and chicken manure whilst reducing odors and emissions.

Case Study: Tallinn of the company UTV AG[26]

8.4 Fermentation

8.4.1 Basic Information on Energy Production during Fermentation

Organic and green waste should not only be utilized as material, but also as energy. The brown bio garbage can is an integral part of sustainable waste management. The three bi-organic processes (fermentation, tunnel composting, CONVAERO drying) are presented as well as the project of BEKON in Daibe, Latvia, (the project is currently in the implementation planning stage and is scheduled for completion in Sept 2023).

8.4.2 The Case Study - Bekon

Dry fermentation is designed for the recovery of biogas from dry waste and contaminated wastes. Following the fermentation process the material is processed into compost.

Case Study – Steinfurt of the company BEKON GmbH[27]

[26] https://www.wtert.net/bestpractice/490/Composting-of-Bio-waste-in-Tallinn-Estonia

[27] https://www.wtert.net/bestpractice/43/Batch-Dry-Fermentation-Steinfurt-Germany

8.4.3 The Case Study – Input

Biogas can also be obtained from recovered organic material via wet fermentation.

For this purpose, more moist waste with less amounts from garden waste is taken. Here, too, after the fermentation process, the material is processed into compost.

Case Study –Westheim Plant of the company Input GmbH[28]

9 Possibilities of Thermal Recycling

9.1 Basic Information regarding the Confidence of the Population The Preface to the Topic "Waste Incineration"

Unfortunately, the possibilities of thermal recycling are still underestimated, as the resulting emissions are difficult for citizens to assess. For this reason, it is urgently necessary to operate existing waste-to-energy plants optimally and to ensure that the emissions are always within the range of the required values of the approval notice or are undercut.

If there is any uncertainty in this respect, it is advisable to review or refurbish the current operating status.

The efficiency of energy generation is also decisive for the environmental impact of the plant.

Open landfills produce a lot of greenhouse gas, especially carbon dioxide (CO_2) and methane (CH_4). Methane emissions are a particular focus of attention with regard to climate protection, because the greenhouse gas effect of methane is 25 times higher than that of CO_2. Landfills rank third among methane emitting climate offenders.

[28] https://www.wtert.net/bestpractice/495/Biowaste-Fermentation-Plant-Westheim-Germany

Not all waste can be recycled or may not be recycled due to its contamination. This is where waste management needs a solution. For this purpose there are two options:

- *Landfilling*
- *Waste to Energy (WtE)*

Landfilling pollutes air, water and soil. In addition, it requires a lot of space and requires extremely long follow-up care.

Waste to Energy plants sterilize the waste in a safe way. All organic materials are destroyed and the inorganic pollutants are concentrated. The volume and mass of the waste are reduced and recovery of metals and energy is made possible.

A statement that WtE hinders recycling cannot really be agreed to. Due to the high cost of WtE, the similarly expensive recycling processes can be competitive, but this is not the case when the waste is landfilled.

Final Sink

Waste management needs an option for final treatment of waste that cannot (and in some cases should not) be recycled. For this purpose only two options exist: Landfilling and waste-to-energy.

by Prof. Dr.-Ing. Peter Quicker

The best way to treat waste that cannot be prevented, is recycling. But unfortunately not all wastes can be recycled: The residual waste in the dustbin in front of the house for example, has not the quality for a high grade recycling. Other examples are contaminated waste streams. These fractions shouldn't be recycled. Otherwise all the pollutants are a brought back to the product cycle and will poison the society over the years. Even during the recycling process relevant waste fractions remain, which cannot be used as a material anymore, because of impurities and contaminants.

These clearly underlines: waste management needs an option for final treatment of waste that cannot (and in some cases should not) be recycled. For this purpose only two options exist: Landfilling and waste-to-energy.
Landfilling pollutes air, water and soil, needs a lot of space, requires extremely long follow-up care and has no benefit.Waste-to-energy safely sterilizes the waste, destroys all organic and concentrates the inorganic pollutants, reduces the volume and mass of the waste and allows the recovery of metals and energy.
There is no other reasonable way to treat residual waste.

And it is not true that waste-to-energy hampers recycling. The opposite is the case!Due to the high costs of waste-to-energy, the similar expensive recycling processes can be competitive, what is not the case if landfilling is applied for residual waste "treatment".
This is also approved by the European statistics: In all countries with high recycling quotas (and low landfill share) waste-to-energy is the second and an important pillar of waste management.

An efficient waste management system with high recycling shares cannot exist without a waste-to-energy plant as a final sink!

published: , 10|2017

In all countries where recycling rates are high and a small share of landfills exist, WtE is the second pillar of waste management, which is also considered important.

Efficient waste management with a high percentage of recycling cannot exist without a waste incineration plant as the final stage.[29]

Emissions are released from waste incineration - yes! However, this takes place under controlled conditions and the strictest emission requirements must be met.

[29] Quicker P. https://www.wtert.net/paper/3991/Final-Sink.html

Residues

After combustion, some residues remain. For example, grate ash used in road and industrial construction. Ferrous and non-ferrous metals are recovered from the bottom ash and recycled. The residual materials that can no longer be recycled, such as filter dust, are stored underground in former salt domes in Germany.

Current developments indicate that some research projects are investigating the utilization of all incineration residues including filter dusts

The very efficient and quantitative separation of mercury (Hg) in the exhaust gas cleaning system implements and ensures the requirements of the *Minamata Convention*[30], agreed in 2013 to remove Hg from the material cycle.

9.2 Emission Requirements for Waste Incineration

Emission requirements of a waste incineration plant in Germany are determined according to the 17th BImSchV. Compared to other industrial activities, such as the energy industry, the requirements for waste incineration determined in the 17th BImSchV are one of the most stringent emission-limiting requirements.

The minimum requirements of the specifications described in the 17th BImSchV are defined by European law. On December 14, 2018, the Final Draft of the WI BREF (Best Available Techniques Reference Document) was published by the EIPPCB, Seville for waste incineration. Compliance with the new requirements must be ensured by the end of 2023.

The comparison in Table 1 of the current emission limits according to the 17th BImSchV and those in the BREF document shows a tightening for some parameters (cf. values marked in orange).

[30] https://www.mercuryconvention.org/en

Table 1: Comparison of requirements according to 17. BImSchV and BREF-document

Parameter	Einheit	Grenzwerte 17. BImSchV			BAT für Abfallverbrennung		
					Bestehende Anlagen	Neue Anlagen	Überwachungsfrequenz
		TMW	HMW	JMW	TMW	TMW	
Staub	mg/m^3 i.N.tr.	5	20	-	<2-5		kontinuierlich
HCl	mg/m^3 i.N.tr.	10	60	-	<2-8	<2-6	kontinuierlich
HF	mg/m^3 i.N.tr.	1	4	-	<1	< 1	kontinuierlich
NO_x (SCR)	mg/m^3 i.N.tr.	150	400	100	50-150 (2)	50-120	kontinuierlich
SO_x als SO_2	mg/m^3 i.N.tr.	50	200	-	5-40	5-30	kontinuierlich
Hg	mg/m^3 i.N.tr.	0,03	0,05	0,01	<0,005-0,02		kontinuierlich
					0,001-0,01		Langzeitüberwachung
NH_3	mg/m^3 i.N.tr.	10	15	-	2-10 (4)	2-10	kontinuierlich
N_2O	mg/m^3 i.N.tr.				Wird nicht angegeben		jährlich
CO	mg/m^3 i.N.tr.	50	100	-	10-50		kontinuierlich
Cd + Tl	mg/m^3 i.N.tr.	0,05			0,005-0,02		alle 6 Monate
∑Sb+As+Pb+Cr+Co+Cu+Mn+Ni+V+(Sn)	mg/m^3 i.N.tr.	0,5			0,01-0,3		
∑As+Benzo(a)pyren+Cd+Co+Cr	mg/m^3 i.N.tr.	0,05			-		jährlich
PCDD/F	ng I-TEQ /m^3 i.N.tr.	-			< 0,01-0,06	< 0,01-0,04	alle 6 Monate
					< 0,01-0,08	< 0,01-0,06	monatlich
PCDD/F + Dioxin-like PCBs	ng WHO-TEQ /m^3 i.N.tr.	0,1			< 0,01-0,08	< 0,01-0,06	alle 6 Monate
					< 0,01-0,1	< 0,01-0,08	monatlich
TVOC / $C_{ges.}$	mg/m^3 i.N.tr.	10	20	-	< 3-10		kontinuierlich

The explanations to the table as well as the whole document "Best Available Techniques (BAT) Reference Document for Waste Incineration" can be taken directly from the document[31].

9.3 Reducing CO2 Emissions and Increasing Energy Efficiency

Optimization of the use of operating resources and utilization of recuperative exhaust gas cooling and condensation energy are some examples of how the overall energy efficiency can be optimized within the exhaust gas cleaning processes.

Chapter 9.3.1.1 shows an example of an efficient new plant, while the optimization possibilities at an existing plant are described in Chapter 9.3.1.2.

[31] https://eippcb.jrc.ec.europa.eu/sites/default/files/2020-01/JRC118637_WI_Bref_2019_published_0.pdf

9.3.1 Examples of Optimization

9.3.1.1 New Plant - EEW Energy from Waste Delfzijl B.V. (NL)[32]

9.3.1.2 Optimization of an Existing Plant - MHKW Rothensee[33]

[32] https://www.wtert.net/bestpractice/494/Optimization-of-an-existing-plant-WtE-Rothensee.html

[33] https://www.wtert.net/bestpractice/494/Optimization-of-an-existing-plant-WtE-Rothensee.html

9.4 Optimized exhaust gas cleaning in the future

Future exhaust gas cleaning concepts should take into account the following in adaptation to the future energy market:

- Short transport distances
- Direct use of energy (high energy efficiency)
- Minimal CO_2 emissions
- Optimal energy use and energy efficiency increase

It is not a matter of developing completely new systems or processes, but rather of intelligently combining existing processes and use of synergies.

In this sense, a symbiosis can be created in the provision of the CO_2 (valuable material) from the exhaust gas to the surplus volatile regeneratively produced electrical energy, e.g. for methanol synthesis.

Another approach for using the CO_2 present in the exhaust gas has already been successfully tested in a pilot plant in Twence, the Netherlands, through the on-site production of sodium bicarbonate from CO_2 and soda ash as an additive for exhaust gas purification.

In the comparable ReNaBi process, CO_2 from the flue gas is also used for sodium bicarbonate production as part of a closed-loop process by reprocessing the residual materials produced in dry flue gas cleaning.[34]

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In this respect, thermal waste utilization, with 90% CO_2 capture, offers the possibility of showing a negative CO_2 balance and thus removing CO_2 from the atmosphere. This is possible because an extensive study[35] in France has proven that approx. 50% of the residual municipal waste is of biogenic origin and thus climate-neutral.

9.5 Energy Production in the Cement Industry

As one of the most energy-intensive industries, the cement industry contributes approx. 6% to global CO_2 emissions. This is due, on the one hand, to the CO_2-containing limestone in the raw material, which accounts for approx. 90% of the total mass flow, and, on the other hand, to the use of fossil fuels, which account for approx. 10% in the rotary kiln.

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[34] Karpf Rudi, Drukmane Linda. Warum müssen in Deutschland Abgasreinigungsanlagen hinter MVA abwasserfrei sein? – Ein Widerspruch zum Rest von Europa und dem Energienutzungsgebot. Energie aus Abfall, Band 17. 2020

[35] DÉTERMINATION DES CONTENUS BIOGÈNE ET FOSSILE DES ORDURES MÉNAGÈRES RÉSIDUELLES ET D'UN CSR, A PARTIR D'UNE ANALYSE 14C DU CO_2 DES GAZ DE POST-COMBUSTION, Nov. 2020

These fuels are used to deacidify the raw meal and form the clinker minerals. This burnt clinker is ground into a standardized cement with the addition of gypsum, fly ash, slag or other admixtures. It is then packaged and transported to the concrete plant, from where the building material is shipped out.

To minimize CO_2 emissions, the cement industry has committed to reduce about 38% of its total emissions by 2050. The measures identified are based on the following key pillars

- Operation of high-efficiency and energy-saving equipment,
- Substitution of raw materials with CO_2-free raw materials and
- Co-Processing, i.e. the use of alternative fuels derived from waste.

At almost 30%, the highest production costs are fuel costs, so that the cement industry can increasingly be regarded as a pillar of sustainable waste management. In this context, co-processing is the keyword for the material and thermal utilization of suitable waste that has been processed in line with demand, which can then be used as alternative fuels and raw materials (AFR) in a quality-assured manner.

In accordance with these requirements, several entry points are usually available on the rotary kiln, so that the substitute fuels with their corresponding properties are also named differently.

The calciner is most frequently used for feeding low-grade, simply prepared and poor-quality refuse derived fuels (RDF). However, the installation of this feed point requires well-founded preliminary work in order to design the bottlenecks and possibilities in the overall process or in the calciner with regard to temperature profile, oxygen supply, throughput, dwell time and burnout behavior or with regard to the pre-treatment depth. The investment is enormous and the construction as well as the preliminary work should therefore be well prepared.

High-grade SRF is easier to feed via a satellite burner or sinter zone burner at the end of the kiln. However, this requires a higher degree of pre-treatment and a similar calorific value to lignite and does not tolerate 3D particles, which can even affect clinker quality under reductive burning conditions.

In recent years, the pre-combustion chambers have been designed to feed a so-called high calorific fraction (HCF) with a particle size of about 300 mm. These materials are difficult to process or burn, such as windmill blades, sticky tar, resin or coarse biomass and wood.

Case study on processing of RFD by WhiteLabel TandemProjects e.U. in Mexico[36]

10 Landfill

10.1 Landfilling in the Baltic States

The following chart clearly shows how far the states in the Baltic region have already overcome landfilling.

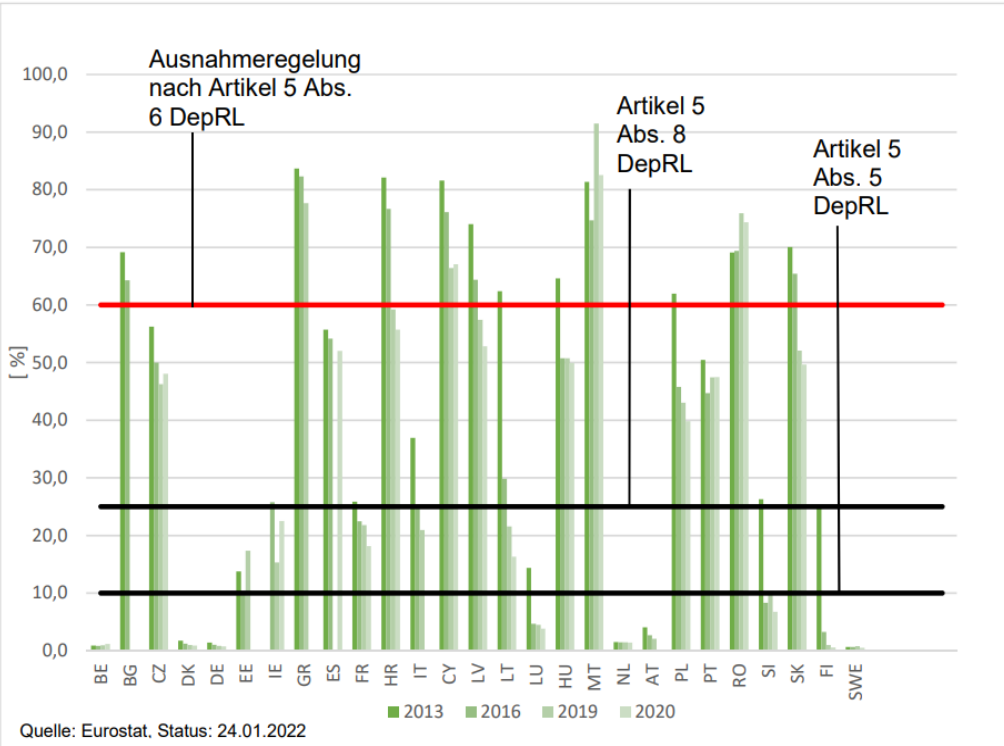

Figure 9: Landfilling in the EU[37]

[36] https://www.wtert.net/bestpractice/158/Pre-Treating-of-non-hazardous-Commingled-Solid-Waste-in-Mexico

[37] Bachmann, A. (2022) Entwicklungen im europäischen und nationalen Deponierecht, Kasseler Abfallforum 2022, Witzenhausen Institut

Lithuania (LV) is still far from the target of only 10% landfilling; Estonia (EE) is doing well; Latvia (LT) has caught up enormously in the years since 2013.

10.2 Climate Relevance of Open Landfills

"The main greenhouse gas contributor is methane emissions from landfills[38], which are formed by anaerobic decomposition of organic material. The National Inventory Report [NIR 2010], in which Germany reports its greenhouse gas emissions to the United Nations Climate Change Secretariat, credits the German waste management industry with reducing emissions by approximately 28 million metric tons of carbon dioxide equivalents (for the period 1990 to 2008) due to the reduction in the amount of waste sent to landfills and the capture and use of landfill gas methane for energy generation. Compliance with the criteria of the Waste Dumping Ordinance can only be maintained by mechanical-biological or thermal treatment of the waste."

10.3 Emissions from Landfills

Over 2 Mg of CO_2 equivalents are generated from one ton by weight (Mg) of non-pretreated municipal waste.

A landfill that consistently deposits 100,000 Mg of municipal waste per year thus emits over 200,000 Mg of CO_2 equivalents per year. This is equivalent to approx. the total contribution of 20,000 -30,000 inhabitants per year. This represents a significant contribution to the greenhouse gas effect. Therefore, landfill gas must be collected and disposed of without harm and, if possible, recycled for energy. The foundations and techniques for this have been developed over the last few decades. Here it has been shown that is especially of importance that the gases are recorded from the start of operation and the facility is continuously adapted to the changing conditions in landfills.

10.4 Measures to Improve Energy Recovery from Landfills

It is important already during the operation of a landfill that the gases are completely captured, i.e. a high degree of capture is achieved. In practice, sometimes only coverage levels of 20-30 are achieved. Determining the degree of detection is therefore a prerequisite for the construction and operation of an optimal gas detection system. This is based on the calculation (gas forecast) or measurement of gas development (indirect measurement of methane change in the vicinity of the landfill).

In Germany, the foundation for the "planning, operation and construction of landfills" has basically been developed in a set of rules issued by the Association of Engineers (VDI). In the meantime, this has been largely adopted in a "Federal Quality Standard 10-1 "Landfill Gas"". In Germany, this must be elaborated by the operators in the next 4 years and reviewed by the authorities.

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[38] Climate relevance of waste management, UBA Januar 2011

10.5 Leachate from Landfills

Depending on the site-specific project boundary conditions, various solution options are available for the treatment of landfill leachate.

The primary task of planning is to estimate the amount of leachate to be expected in the future, the leachate quality and the determination of discharge limits. To achieve the set goals, leachate-oriented biological, chemical-physical and membrane technology systems are used.

Case study for the treatment of liquid waste in Poland of the company Wehrle[39]

[39] https://www.wtert.net/bestpractice/507/Project-Starylas-liquids-treated-in-Poland

11 Outlook - Future Climate Strategy in the Baltic States

This Strategy Paper Baltic States provides impulses for sustainable waste management in Estonia, Latvia, and Lithuania taking into regard experiences made in Germany. These impulses are divided into individual activities, the approach to which is documented in case studies.

Here, the responsibility for activities to improve "waste prevention" or "preparation for reuse" is designated to the higher-level waste management organization. Bans (such as the landfill ban in Germany), taxes and levies, or a consistent demand for producer responsibility have a higher steering force than hoping for the population to "see things through".

Especially for the individual countries of the Baltic States, it is helpful if, beyond efforts to increase recycling, measures of energy recovery are prioritized in time. All three Baltic States are currently in the process of breaking away from the energy dependence on Russia. Being aware that sustainable waste management has a lot of energy-saving and energy-generating potential helps to support the goal of a self-sufficient energy supply.

A stronger focus on measures that particularly counteract climate change and save greenhouse gases is also pointed out. It is shown (see chapter 2 and chapter 10) that the avoidance of methane emissions in landfills makes the greatest contribution to the reduction of greenhouse gases.

The arguments summarized in the strategy paper prove that the contribution of waste management to the reduction of climate gases is considerably underestimated. The contribution of energy recovery is also underestimated, without which the closure of landfills for organic waste has not been and cannot be achieved anywhere in Europe.

Munich, May 11th,2022

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