

Modern waste

Goals and Paths



Germany's expertise
for an advanced circular economy

Our goal:

Sustainable economic growth!

A global **circular economy** with waste avoidance, reuse preparation, recycling and energy recovery and with land-filling minimised so that by 2030, waste is predominantly used as a resource.



Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety



Federal Ministry
for Economic Cooperation
and Development



Federal Ministry
for Economic Affairs
and Energy



German RETech Partnership
Recycling & Waste Management
Made in Germany



Waste Treatment and
Recycling Technology

KfW



GERMANY
TRADE & INVEST

giz

Umwelt
Bundesamt

Deutsche Gesellschaft
für Abfallwirtschaft e.V.



Clear Concepts. Clean Environment.



BDE

Federation of the German Waste, Water
and Raw Material Management Industry
Industrial and Employers' Association



bvse

Federal Association for Secondary
Raw Materials and Waste Management

Preface

In view of the world's steadily growing population, people's increasing aspirations to wealth and the escalating costs of resources, the conservation and efficient management of our global resources is a challenge on the same scale as climate change mitigation and energy supply security. Inappropriate treatment of residential, commercial and industrial wastes impairs human health and puts additional pressure on the environment, increasingly and particularly on the oceans. At the same time valuable resources are lost irretrievably. Policymakers and societies in every country are called upon to confront these challenges and to develop solutions that are both technically appropriate and economically viable.

Case studies in many countries show that an advanced waste management sector is able to meet these challenges. Germany embarked on the path towards a modern circular economy in the 1970s. By now, around 79%¹ of municipal waste is recovered and some 65% is recycled. An economic sector in its own right has emerged, with a workforce of more than 200,000 and an annual turnover of some 40 billion euros. Germany continues to pursue this path, with a clear focus on resource efficiency and recycling.

An advanced waste management sector cannot be designed to a standard formula. The initial settings, regional characteristics and economic conditions diverge too widely from country to country for any such formula to apply. Nonetheless, other states, regions and municipalities can certainly benefit from practical experience, know-how and tried-and-tested waste management technology. Germany wishes to assist countries which aim to establish a circular economy. The German RETech Partnership, an alliance of leading German companies and institutions engaged in the circular economy with support from the German federal government, offers its expertise in this endeavour.

This document aims to assist and encourage in the step-by-step development of an advanced waste management sector. It cannot determine the right path for a country – that can only be established by working individually with experts. That is why at the back of the booklet you will find the contact details of institutions in Germany who can help you with this task.

1 cf.: Federal Environment Agency:

<https://www.umweltbundesamt.de/daten/abfall-kreislaufwirtschaft/verwertungsquoten-der-wichtigsten-abfallarten>



Hello,

As the mayor I am responsible for the wellbeing of a lot of people. A few years ago we decided to set up an advanced, reliable waste management sector. In doing this we followed the principles of a circular economy, because that way you can help to create a lot of jobs at the same time.

At first I thought that I had only to buy the ‘right’ technology to develop our waste management sector.

Now I understand that good technology is not enough on its own. You need a holistic approach involving all stakeholders – citizens, commerce, politicians – to which they all contribute. We got started a few years ago and have been systematically building our waste management sector. I have had a lot of help from German experts; without their advice and frank comments we would not have achieved the result we are so proud of today.

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“I went to a trade fair to find out about advanced waste technology, but all the experts advised me not just to buy modern technology. They persuaded me that we had to develop a waste management system with a social and statutory framework and told me about the five phases leading to an advanced waste management sector.”

The five phases of waste management

Phase 1

Extensive uncontrolled dumping

In many countries waste is dumped on uncontrolled tips; there is no properly managed waste collection. At best, recyclable materials such as metals and plastics are collected by the informal sector and re-enter the resource cycle through a number of stages.

People live on the rubbish heaps in appalling conditions. Basic principles of urban hygiene and environmental conservation are ignored. Rubbish is often used for heating and cooking with all the negative consequences for human health.

„Waste management is not easy to understand. Different stakeholders have to show their commitment in very different areas for the waste management sector to develop. That takes time. In Germany, we started in 1970 and still haven't finished. That is why German experts have developed the Five Phase model. It aims to help to establish the waste management situation in a region, so that the future course of action can be agreed. In a given country, the model need not develop in the strict sequence of phases and transitions are often fluid. If we regard it as a basis for discussion, it can help in reaching a better understanding of the many aspects of waste management.“

Naemi Denz

Managing Director VDMA industry association for waste management and recycling technology

Phase 2

Reliable collection and better landfill sites

Introducing systematic, regulated and reliable collection and establishing properly managed landfills comprises the first step in developing the waste management sector. Conveniently located transfer stations facilitate cost-efficient transportation of waste.

It is crucial that collection is carried out efficiently since this is the most expensive element of waste management. However, along with the sorting processes, it also offers the greatest employment potential. It is important to identify the 'right' collection system for each town or community and its particular circumstances.

Elements of a circular economy can be implemented even in this early phase, for example with separate collection and hand-sorting of recyclable materials. Simple composting facilities for park and market waste, using mobile equipment, mark the start of organic waste recycling.



© Dr. Wolfgang Pfaff-Simonett

Phase 3

Separate collection and sorting

Separating and collecting in several containers forms the basis of high-quality sorting and high-grade recycling processes². Efficient purpose-built vehicles with compactors are introduced for collecting the waste. The first optical separators make it possible to produce high-quality monofractions.

A downstream, secondary industry develops as the supply of inputs becomes reliable. Increasingly, the industry adapts its processes to these materials. A significant number of jobs are created and waste management becomes part of industrial policy.

The sorting facilities contain mechanical separation stages, screens and separators and prepare material for more efficient hand-picking. The first elements of a trading system emerge for recyclable materials that meet industry demand and bring in revenue (such as metal, PET and paper).

Composting separately collected organic waste and extracting fractions with high-calorific value to generate refuse-derived fuel (RDF) leads to the emergence of new products for which there is increasingly a market.

² The phases 3 – 5 constitute the transition from waste disposal to a circular economy. The objective of resource efficiency, through the use of waste as a material and energy resource, is increasingly becoming the priority.

Phase 4

Expanding the recycling industry

Modern sorting facilities produce high-quality monofractions from separated waste; these are prioritised for recycling. Processes to separate plastics and sort by colour are used. Compost and/or biogas are produced from organic waste in composting and fermentation plants. Residual waste undergoes energy recovery in incinerators or is treated in mechanical-biological treatment facilities (MBT). MBT extracts recyclable materials, delivers high-calorific fractions for energy generation and controls the decomposition of organic substances, which are mainly responsible for emissions from landfill sites – in particular landfill gas and leachate. Waste-to-energy facilities and waste biomass CHP plants replace primary fuels. This leads to a significant reduction in greenhouse gas emissions.

Waste management actively protects the climate

1. Advanced waste management prevents landfill gas, which has an impact on the climate 25 times greater than carbon dioxide
2. The use of secondary resources significantly reduces energy consumption: in glass production by 35%; steel by over 50%; plastics over 70%; aluminium over 90%
3. Waste that cannot be further recycled can undergo energy recovery and substitute fossil fuels



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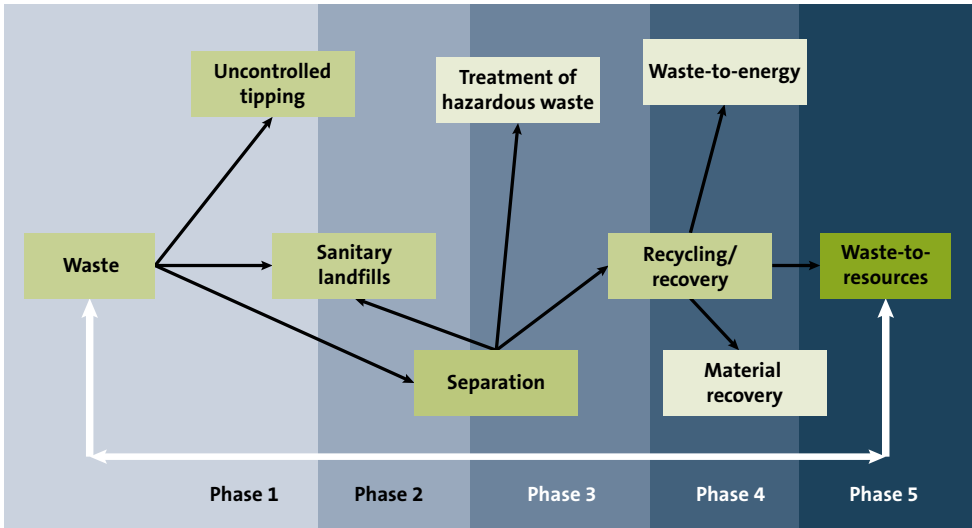
“I would certainly have had to resign if I had bought in expensive technology which had then turned out to be a disastrous investment. That’s why we decided to buy a plant that makes sense for our circumstances. Now that we are much further down the road to an advanced waste management sector, we have expanded some parts of the plant and replaced others with new, more efficient components.”

Phase 5

The circular economy – waste as a resource

In this phase waste is predominantly recycled or undergoes energy recovery; untreated household waste no longer goes into landfill. The high recycling rates achieved result in a functioning circular economy. Only small amounts of residual waste are landfilled and

do not harm the environment. Preventing waste and taking a life-cycle perspective are underlying principles in all production processes and many consumer choices. This is the goal we should work towards.



Areas for development in the waste management sector



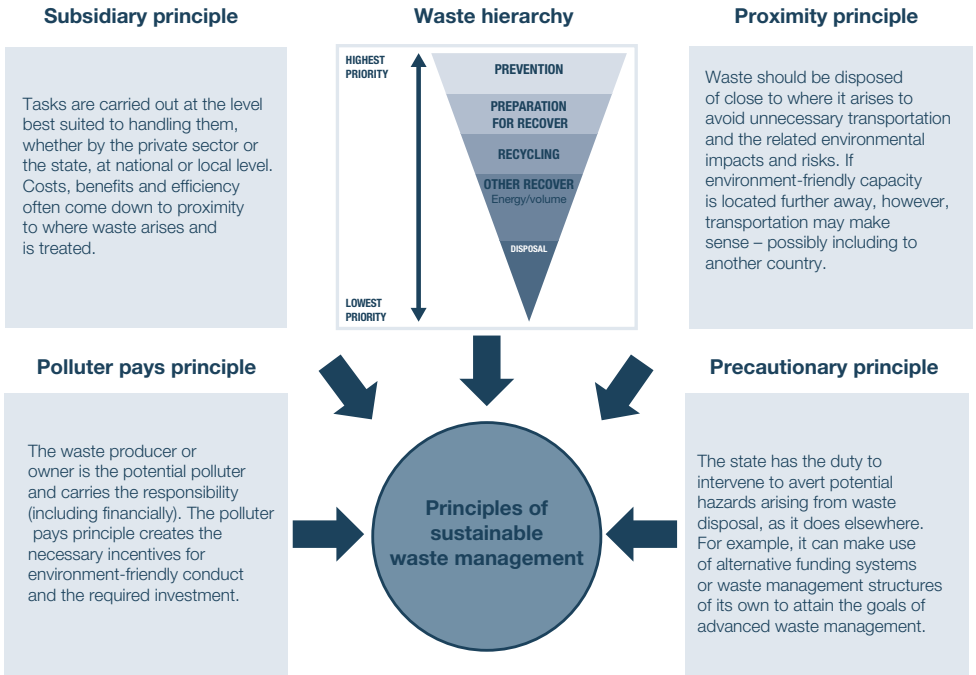
“We quickly realised that to be successful in the long term we needed the same framework throughout the country. The German experts said that too. So I got together with other mayors and asked for a meeting with our environment ministry. The idea was enthusiastically received and presented to the cabinet. Soon afterwards a policy decision was taken and various working groups were set up to devise the fundamental principles for the development of our national waste strategy. That was how we got the ball rolling, and we have gradually built up our system.”

Strategic and political governance

Fundamental to building an advanced waste management sector is a clear, reliable environment policy, which is not based on the electoral cycle and which provides the stakeholders in the waste management sector with long-term direction. This is the basis on which all those involved collaborate in developing a strategy for building the waste management sector.

The first step is to create a framework. This consists mainly of creating a legal basis; establishing state institutions to regulate and implement it; setting up well-resourced entities in charge of waste management; planning, implementing and financing the waste management infrastructure; and introducing socially acceptable ways of covering the costs.

10 MODERN WASTE MANAGEMENT GOALS AND PATHS



► Legal basis

Primary and secondary legislation forms the central pillar of the development of an advanced waste management sector. The legal basis, in the form of ordinances, directives, regulatory frameworks and guidelines, should be created by the country's highest legislative body. There may be different requirements for each regulatory area

(e.g. domestic, trade or hazardous waste, mixed building waste, recyclable materials). In all cases it must be stipulated who has what responsibility for waste management, with particular emphasis on the obligations of the waste producer and those involved in the management process. The responsibilities and powers must be clearly defined.

In the process of building an advanced waste management sector primary and secondary legislation must be adapted to the developing framework with caution yet guided by targets. This creates incentives for private, social and municipal stakeholders.

► Establishment of state institutions

Legal arrangements will only have their intended effect if compliance is monitored and enforced. The establishment of well-resourced technical, approval and supervisory institutions is a key task in the implementation of sustainable systems, including in waste management.

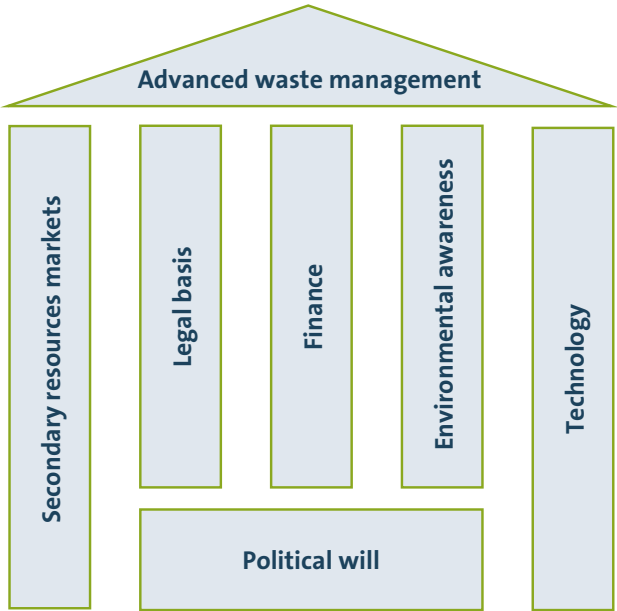
Without adequate institutional capacities and powers enshrined in law, all efforts come to nothing and merely aid lobbying, corruption and mismanagement.

Enforcement of the law is also very important with a view to private sector involvement. Companies cannot operate successfully in the market if competitors enjoy a cost advantage because they do not comply with standards. This applies equally to waste management enterprises and to waste producers. A level playing field must be created and maintained.

“With vision and clear political will it is easier to overcome the obstacles on the path to establishing the legal framework and the financial instruments needed for an advanced waste management sector. And the state can also help to promote the recycling market and environmental awareness.”

Ellen Gunsilius

GIZ (Deutsche Gesellschaft für internationale Zusammenarbeit)



► Establishment of entities in charge of waste management

An advanced waste management sector calls for cost-optimal solutions and capable, well-resourced entities in charge of disposal. As larger facilities deliver economies of scale, catchment areas should be made large enough and organisational structures developed to match.

In many cases direct responsibility for waste management lies with local authorities. Small and medium-sized authorities are often unable to take on the responsibility of

building and running waste disposal facilities, so ways of organising the central disposal facilities must be found which meet the needs of smaller authorities, for example by forming associations. Other solutions, such as using private-sector companies or a public-private partnership, can be one route to establishing efficient waste management structures. In small countries national entities can also provide a practical solution.

► Constructing and monitoring the waste management infrastructure

The central facilities require the greatest investment when a waste management system is set up. For that reason the catchment area of the main treatment facilities, population density and the existing administrative structures should be taken into account at the time of construction.

The effect of transport distance and transportation costs on the economic viability of a waste management system is often overestimated. If there is an adequate road network it is more cost-effective to haul waste over longer distances than to build high-tech disposal facilities on a small scale.



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©Michael Ludden,
Sitco Recycling Technik GmbH



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“I quickly discovered that, as a general rule, efficient waste management centres can only be built and in particular can only be economically viable when input quantities are guaranteed. Policymakers can ensure this, for example through obligations to make waste available to waste management operators, prohibitions on landfilling untreated waste, recycling obligations and quotas, and additional incentives.”

Social development

► Environmental awareness

The development of an advanced waste management sector is a process that requires the efforts of an entire generation. Although society can be encouraged to move towards an advanced waste management system through primary and secondary legislation, this route is only sustainable, and politically acceptable in the long term, if society at large is persuaded of the new aims and takes them on board. For this to happen, information and education is needed, for

instance via well-designed public relations; environmental education, if possible in nursery and primary schools; campaigns aimed at adults; activities; open days, and so on. The more sections of society that are actively involved in building an advanced waste management sector, the more quickly understanding of the task will grow.

“Policies can only succeed if society supports them. This means that people need to understand what an advanced waste management sector is and why it is high on the agenda. Education needs to start in schools to make people understand the importance of a properly managed waste industry, and of conserving resources and separating waste”

Thomas Obermeier

President, Deutsche Gesellschaft für Abfallwirtschaft

“An advanced, environmentally sound and economically viable waste management sector depends fundamentally on robust financing – ideally via a comprehensive, full-coverage system of charges. On the other hand, such a sector also generates revenues from a broad array of marketable secondary resources such as metals, glass, paper/cardboard and plastics. Furthermore, it persistently reduces the – often neglected – total macro-economic costs by avoiding health costs and the costs of cleaning up environmental damage.”

Ralf Menzel

German Federal Environment Agency



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► Informal sector involvement

The informal sector carries out rudimentary forms of recycling and waste use without developing an advanced waste management system. These people recover usable items of waste to support themselves. That is why they have a key role in the development of collection structures and marketing channels.

Society and administrative bodies can benefit considerably from their experience. This knowledge should be put to use in the social process towards a green economy.

► Building education and training capacity

An advanced waste management sector can only succeed in the long term if it has a skilled workforce. This workforce is increasingly trained in-country. At the same time more scientific training and research is carried out within the country, so that the sector becomes more self-reliant as it grows. The capacity for this must be created at national, regional and local levels.

Costs and funding

An advanced waste management sector comes at a price. Not only is investment required to purchase suitable technology and construct the management facilities, but ongoing costs are incurred primarily in the regulated collection of waste and recyclable materials and in operating the facilities. Compared with these, the costs of raising social awareness and of further education and training of technical staff are small.

There is a range of possible ways to finance the construction of waste facilities and the purchase of the technology, such as through bilateral and multilateral donors and development banks, who offer loans at preferential rates, or in some cases grants, to finance the investment. However, the means to cover the operating costs must be found by the state, region or local authority itself – this might be 70–80% of the total cost of the system. It is clear from this that meeting the running costs represents the greatest challenge in building a waste management system.

“Clarifying how the running costs are to be met is a difficult but necessary discussion process. Levying user fees – as is the norm in Germany – is only one option. Building an advanced waste management sector must not place an excessive financial burden on the poorer sectors of society. There are socially acceptable solutions that demand an appropriate contribution from the more affluent. Regardless of which policy is adopted, it is crucial to ensure that the costs are covered and that the instruments used are socially acceptable. Private sector companies will only come on board if they are confident that there is a robust strategy for covering costs and providing finance.”

Dr. Wolfgang Pfaff-Simoneit
KfW Entwicklungsbank

“People may tell you that there is money to be made in waste, but that is only true of parts of the waste industry. Although there is a profit to be had from recycling materials such as metal, PET and paper, the revenues attainable do not cover the cost of the whole system. Despite the high recycling rates achieved in Germany, the waste management system only works because the users contribute to cost coverage by paying charges.”

Michael Ludden

Managing Director, Sutco Recyclingtechnik/
board member German RETech Partnership

Yet even an advanced waste management sector is not necessarily expensive: the total cost of a progressive system can be around 20-30 euros per person per year. By comparison, regulated collection and dumping in sanitary landfill alone costs approximately 12 to 15 euros annually per person. However, the products of advanced waste management systems also generate income in the form of secondary resources, energy and soil

improvers. Modelling shows that the revenues from these products can cover a third or more of the total costs. If, in addition, special incentives at above market prices are offered, such as feed-in tariffs for electricity or energy from waste, then the proportion of costs covered by this income rises still further. With the right policy framework an advanced waste management sector is far less expensive than conventional ‘sanitary landfill’.

► Policy instruments ensuring finance and cost coverage

Meeting the costs of the waste management system from the revenues alone will prove impossible, so suitable strategies for covering the differential costs have to be developed. Without credible policies ensuring that the costs are met and without the use of suitable policy instruments, the advanced circular economy is not financially sustainable and therefore the private sector cannot be expected to invest.

More than two-thirds of the total cost consists of running costs that need an ongoing flow of revenues to meet them. In many cases, meeting the costs from

user fees alone is impractical. Potential policy instruments and sources of funding to cover the operating costs include:

- User/service charges
- Purpose-linked levies or levies designed to promote specific conduct
 - Environmental and tourism levies
 - Landfill charges
 - Product charges
- Special arrangements such as feed-in tariffs for energy generated from waste, recovery bonuses
- Funding from general tax revenues
- Product or producer responsibility
- Grants



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“I can only win people over to an advanced waste management system with persuasive arguments and the lowest possible financial burden. To make up the funding shortfall with the revenues from secondary resource materials I have to have a functioning recycling market.”

Imposing product responsibility or charging levies on waste-intensive products such as packaging are options especially well suited for covering operating costs – in Tunisia, for example, up to 80%. The appropriate policy mix needs to be laid down in law by way of a political decision-making process. The size of the contribution should be determined on the basis of realistic cost estimates.

Promoting the recycling market

An advanced waste management sector or circular economy is based on guaranteed marketing channels for secondary resources. The state can help the recycling industry to become established and be economically viable through relief on taxes and import duties, investment funding lines, subsidies and producer responsibility obligations to ensure recycling of their products.

The informal sector plays a major role in an emerging advanced waste management sector. Its involvement also helps to build initial and advanced training capacity, achieve greater equality of opportunity and reduce poverty.

Local or national buyers of the products of the recycling sector are vital pillars of a circular economy. A guaranteed supply of high-quality secondary resources leads to the emergence of industrial buyers who develop suitable production processes that make the circular economy possible.





“If the market functions, it means you have created a policy framework, your population has understood the potential of an advanced waste management sector and funding from secondary resource recovery and from charges and levies is ensured.”

Technical possibilities

For the most part, the technological solutions already exist; they simply need to be adapted to specific local circumstances.

Experience shows that the best outcomes for recycling and the environment are attained through segregated collections. Keeping waste fractions separate at source and collecting them separately is the first step towards the recovery of secondary resources. Plastics, glass, paper, metals, organic waste and minerals can best be reused if they are clean and unmixed.

Recyclable materials can be reclaimed from waste by separate collection or by using sorting and separation technologies. For efficient and effective recycling, each material requires a different set of processes: separately collected glass, for example, is sorted, cleaned and crushed before being made into new products in a glassworks. Paper, plastic and metals need sorting into grades and types and recycling in paper mills, plastics processing plants and metal foundries. The processing of mixed municipal waste is rather more complex.

“The most technically sophisticated solution is not necessarily always what is wanted, especially in developing countries and emerging economies. It is more important to use processes and technologies that take social issues into account, for example by creating jobs. That is often the more cost-effective alternative in these countries, too. As the waste management system continues to develop the technology can be expanded and adapted accordingly.”

Daniela Vaziri

German Trade and Invest

Separately collected organic waste is treated biologically and is suitable for material recovery. Depending on its composition it can be composted or used to generate biogas in fermentation plants. Appropriate processing turns the fermentation residues

into a valuable soil improver and fertiliser, much like compost, for agricultural and horticultural use. Liquid fermentation residues can be used as agricultural fertiliser in a similar way to liquid manure.

“Meanwhile, there are high-quality recycling products available on the market. No matter if recycled paper, plastics recycle or recycled construction material are concerned: The quality is right and possible fields of application are diverse. Recycling products can for instance be used in offices or in public projects in the area of building construction or civil engineering as well as in the field of vehicle construction.”

Eric Rehbock

bvse-Executive Director

As well as being burnt in incinerators, mixed residual waste can also be treated in mechanical-biological treatment (MBT) facilities. A series of treatment stages extracts recyclable materials such as metals and produces quality-assured refuse-derived fuel (RDF) for energy recovery.

In 'waste-to-energy' processes energy is recovered from waste in various ways: by generating electricity and heat in waste incineration plants or RDF-fuelled combined heat and power (CHP) plants; by using processed waste as refuse-derived fuel in industrial processes – mostly in cement works and coal-fired power stations; and by using organic waste to generate biogas.

Properly managed, environment-friendly landfills are indispensable and will remain so for the long term in some countries. A landfill should be thought of as a built structure which safely encloses otherwise unusable waste, preventing it from escaping into the soil, water or air, and which limits the emissions arising in the landfill body (landfill gas), or recovers them for energy use. At some time in the future, when resource and energy prices are higher and residues that are unusable today become resources in their own right, landfills may themselves become exploitable deposits (landfill mining).



“Our town is now beautifully clean and inviting for residents and visitors alike. We have created hundreds of new jobs, and recycling is giving rise to a new branch of industry, with a knock-on effect on employment. Visitors to the town enjoy being here and compliment us on our clean streets. Investors have confidence in our administration, because keeping the town clean is excellent proof of its capability.”

GERMAN EXPERTISE

Germany leads the way with its well-developed circular economy:

- 100% of all waste is collected separately
- 15,500 waste management facilities provide a nationwide infrastructure
- 64% of domestic waste is recycled
- 79% of all waste undergoes recycling or recovery
- 14% of resource demand is met from waste
- Landfilling of non-pretreated waste was banned in 2005
- Landfill methane emissions have been cut by 71% since 1990
- 25% of the world market for waste management technology comes from Germany

Abiding principles of the German waste management sector:

- Self-help assistance
- Proven, adapted solutions to every challenge
- Full capability range:
 - Labour-intensive to capital-intensive solutions
 - Low-tech to high-tech
 - Collection to recycling to disposal



- RETech is the contact for all public and private organisations and/or institutions domestic and abroad, taking an interest in the German resource and efficiency technology
- RETech activities are focused on the promotion of applying sustainable environmental technology of the German recycling abroad.

www.retech-germany.net

GTAI GERMANY
TRADE & INVEST

- Germany Trade & Invest is the economic development agency of the Federal Republic of Germany. With more than 50 offices in Germany and abroad and its network of partners throughout the world, Germany Trade & Invest supports German companies setting up in foreign markets, promotes Germany as a business location and assists foreign companies setting up in Germany.
- Environmental technologies – especially waste management – play an important role within the industry focus of GTAI.

www.gtai.de

**Umwelt
Bundesamt**

- The German Environment Agency is the scientific environmental authority under the jurisdiction of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, responsible for the most diverse range of topics.
- Our goals are to protect and maintain natural resources, also as an act of responsibility towards future generations, to advance sustainable development, to promote environmental protection as a matter of course in the thinking and action of everybody.

www.umweltbundesamt.de

DWA
Clear Concepts. Clean Environment.

- The German Association for Water, Wastewater and Waste (DWA) is strongly committed to the development of secure and sustainable water and waste management.
- It formulates technical rules, is involved in standardization works, supports research, promotes vocational training and lifelong learning and advises politics, science and industry

www.dwa.de

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Design and Layout

VDMA-Verlag DesignStudio

Status: September 2018

www.retech-germany.net