zukunft
SEIT 1909
denken

WATER • WASTEWATER • WASTE

EXPERT PAPERS

By the Austrian Association for Water and Waste Management (ÖWAV)

ÖWAV Expert Paper

The Role of Waste-to-Energy Technologies in the Circular Economy, by Example of Austria

Compiled by the ÖWAV Working Committee for "Thermal Treatment" of the Expert Group for "Waste Management and Remediation of Contaminated Sites"

Vienna 2020

Österreichischer Wasser- und Abfallwirtschaftsverband
1010 Wien, Marc-Aurel-Straße 5

This expert paper is the result of voluntary technical and scientific cooperation.
This expert paper is an important, yet not the only source of knowledge for a professional solution. Its application does not exempt any user from being responsible for their own actions or for the correct application in a specific case. Any liability of the authors is excluded.

Imprint

Media owner and publisher: Österreichischer Wasser- und Abfallwirtschaftsverband, Wien

Producer: druck.at Druck- und Handelsgesellschaft mbH, Leobersdorf

Translated by Mag. Angelika Weichhart

Editing, setting, and layout: Mag. Fritz Randl, Mag. Heidrun Schiesterl, MA (both ÖWAV)

INTRODUCTION

The Austrian Association for Water and Waste Management (Österreichischer Wasser- und Abfallwirtschaftsverband – ÖWAV) is a non-profit association and its more than 2,300 member organisations cover the entire management of water, wastewater, and waste in Austria. ÖWAV is designed as a neutral and independent information and networking platform that provides the professional community with its expertise in the fields of water, wastewater, and waste management.

The intended implementation of the EU Circular Economy Package has driven the focus of policy makers and the general public on the issue of waste recycling as well as on the measures involved to achieve the recycling targets. This growing interest has prompted the ÖWAV Working Committee for "Thermal Treatment" to conduct a detailed assessment of the significance and the future importance of waste-to-energy technologies within the framework of an integrated waste management in Europe.

Therefore, this ÖWAV expert paper particularly addresses representatives of politics, economy, and administration, of NGOs and the media, and, last not least, all sectors of the waste management industry.

AUSTRIAN ASSOCIATION
FOR WATER AND WASTE MANAGEMENT

Vienna, July 2020

ÖWAV Expert Paper

THE ROLE OF WASTE-TO-ENERGY TECHNOLOGIES IN THE CIRCULAR ECONOMY, BY EXAMPLE OF AUSTRIA

A study compiled by the ÖWAV Working Committee for "Thermal Treatment" of the Expert Group for "Waste Management and Remediation of Contaminated Sites"

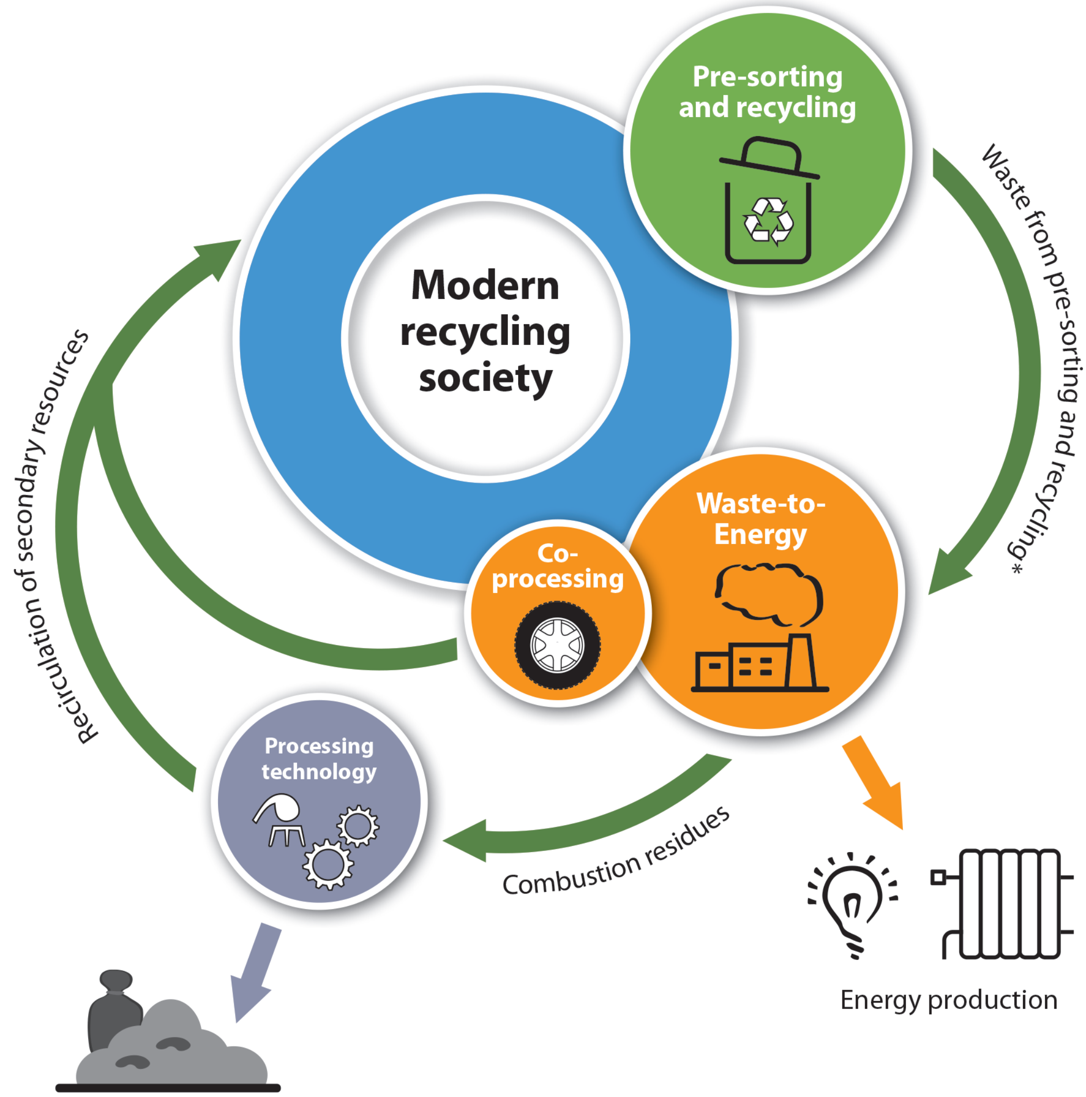

Fig. 1: Modern recycling society

Source: Own design

* Still containing recyclable materials that may be recovered after waste-to-energy treatment (e. g. metals, glass).

1. SUMMARY

Energy recovery in Austria – a story of success

- In 1963, the first Austrian waste incineration plant went into operation. Currently, about 40 % of the municipal waste undergoes thermal recovery in 11 waste incineration plants and in 51 co-incineration plants. Despite the significant role of waste-to-energy, about 60 % of the municipal waste is recycled. This makes Austria one of the top-ranked countries for recycling and energy recovery in Europe.
- The state-of-the-art systems technology applied in Austria, together with strict legal provisions and open communication with the public have led to the wide acceptance of waste incineration.

Hygiensation, destruction, and removal of hazardous substances

- Various kinds of waste are not suitable for recycling because of contamination and their composition. Hazardous materials require immediate and safe treatment and need to be removed from the cycle. Incineration contributes to the hygiensation of the waste, and hazardous substances are either destroyed or immobilised (i.e. bound in a solid matrix).
- The waste volume is reduced to about 10 %; weight reduction amounts to about 25 %. This ensures the economical use of the available landfill volume.

Recovery/recycling of important reusable substances and materials

- Phosphorus is a limited, non-substitutable resource. The incineration of sludge is a key means of the effective and efficient recycling of phosphorus.
- Ferrous and non-ferrous metals contained in slags and bottom ashes may be recovered by up to 90 %.
- Gypsum is a limited natural resource that may be recovered from flue gas cleaning of waste incineration plants.
- Glass may be separated from the bottom ashes of fluidised bed incinerators and, thus, be recycled.
- The so-called co-processing technology is applied for material recycling and energy recovery from waste, mainly in the cement industry. As a result, natural minerals are spared and fossil fuels, such as coal, oil, and gas, are substituted.

Substantial contribution to the EU climate and energy targets

- Without a doubt, energy recovery enhances achieving the climate and renewable energy targets. These endeavours should be acknowledged and credited for.
- Strategies for energy recovery considerably reduce the emission of methane from landfills (global warming potential of 28), which is extremely harmful to the climate. This is another measure to significantly reduce greenhouse gas emissions from waste management.
- Utilising waste as a resource helps substitute fossil fuels, such as coal, oil, and gas. Moreover, the biogenic components included in the waste are considered climate neutral. The created energy is used as electricity, heat, and/or process steam.

Demanding the acknowledgement of energy recovery programmes as a cornerstone of the EU Circular Economy Package

- Recycling of renewables (metals, glass, clean mineral residues, and co-processing in the cement industry) recovered from thermal utilisation should be included to the EU recycling rate. This would certainly boost innovations for recycling combustion residues.
- Landfilling of untreated waste causes environmental burdens and high economic costs. The deadline of the “landfill ban” must not be extended. Moreover, the consumption of landfill volume needs to be reduced EU-wide (by charging, for instance, a landfill fee).
- To achieve the targets of the Landfill Directive in due time, EU-wide measures are required for the advancement of energy recovery projects.

2. WASTE INCINERATION – STATE OF THE ART

In 1963, the Waste Incineration Plant Flötzersteig in Vienna started to operate as the first Austrian industrial-scale waste incineration plant, with a capacity of 200,000 t/a. All the other residual waste was deposited in landfills. It certainly marked an essential milestone towards modern circular economy in Austria, when in 2004 the deposit of recyclable and combustible waste was banned (1996 Landfill Ordinance). This strategy introduced a remarkable turning point, shifting from landfilling to recycling and energy recovery (see Fig. 2).

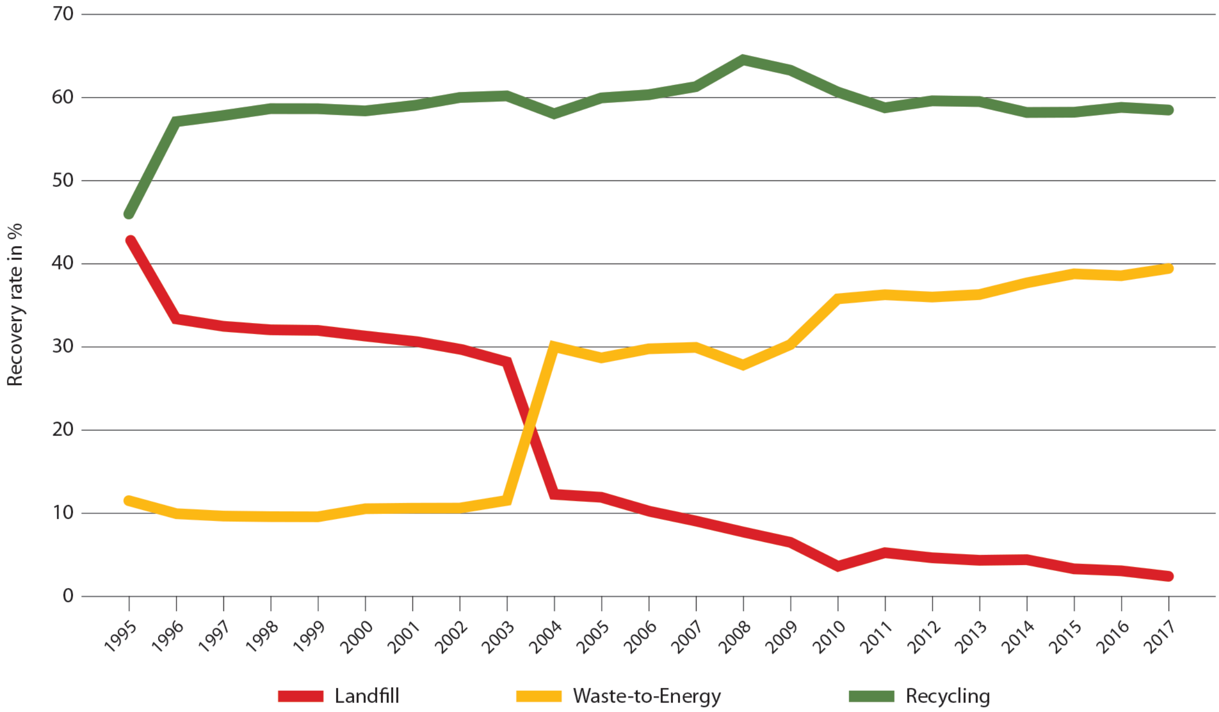

Fig. 2: Municipal waste treatment in Austria, 1995 – 2017 (in per cent).
Source: EUROSTAT 2019

Municipal waste in Austria totals about 4.3 million tonnes. As displayed in Figure 2, about 40 % is subjected to thermal utilisation and more than half of it is recycled. Apart from municipal waste, other waste streams (e.g. old tyres, waste oil, paper fibre residues) are used in waste incineration plants and co-incineration plants. Thus, Austria is one of the frontrunners, compared to other European countries (see Fig. 3).

Besides waste incineration, capacities of co-incineration have been on the rise: Co-incineration refers to the use of waste as substitute fuel for energy generation and the production of material products. Since the end of the 1980s, for instance, the Austrian cement industry has been using an increasing amount of waste as substitute fuel. They already cover more than 80 % of the energy consumption required for producing cement clinker (see Fig. 4).

In Austria, strict and precisely defined legal requirements for the energy recovery from waste took effect in the late 1980s. The Collective Waste Incineration Ordinance (BGBl. II No. 389/2002) transposed the regulations of the European Waste Incineration Directive (RL 2007/76/EK) into national law, which in parts included stricter requirements for air emissions. As values partly fall considerably below the EU threshold values, incineration plants are responsible for national air emissions only to a small degree. Co-incineration plants have to observe additional input threshold values for substitute fuels.

Plant operators are obliged to provide annual emission information to the appropriate authorities; the data is included in an annual report issued by the Federal Ministry of Environment (Federal Ministry of

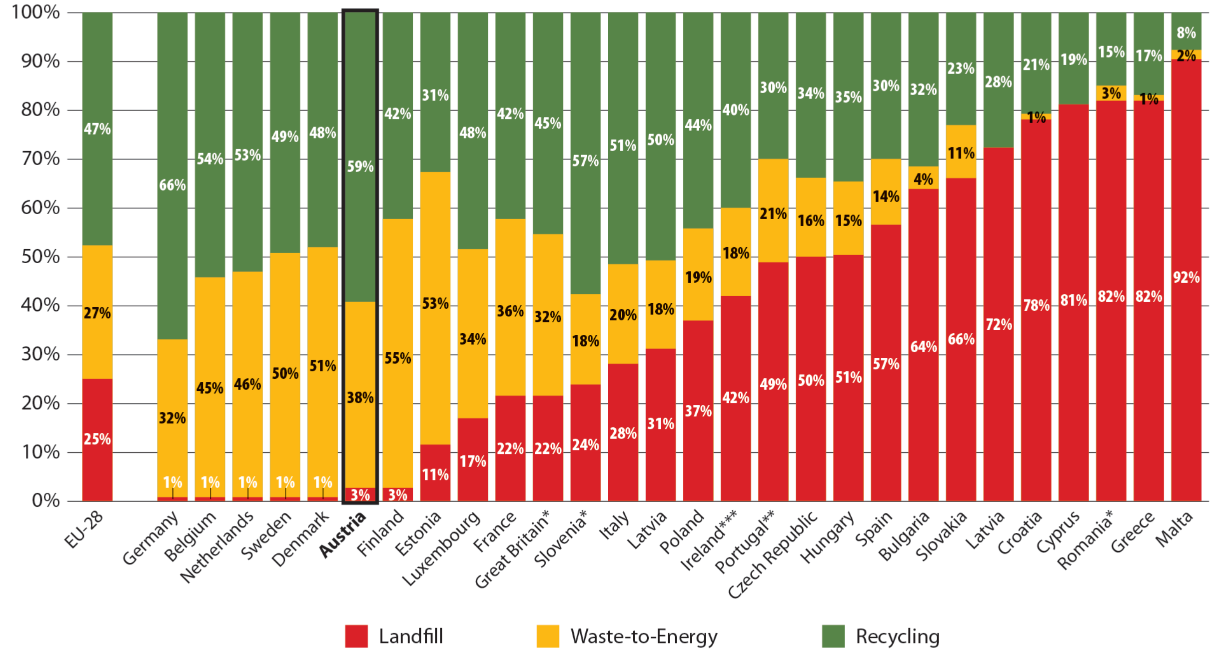

Fig. 3: Municipal waste treatment in the EU-28 Member States (2018).
Source: EUROSTAT 2019
* Data 2015, ** Data 2014, *** Data 2012

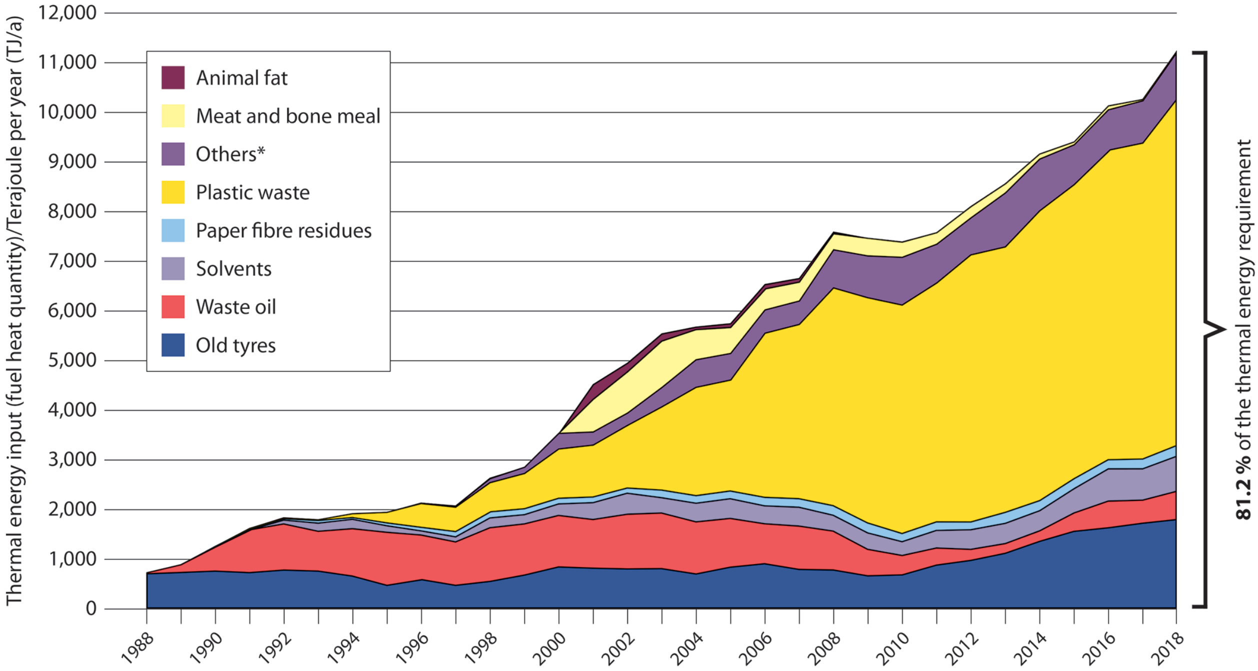

Fig. 4: Development of the recovery of secondary fuels in the Austrian cement industry: 1988 – 2018.
Source: MAUSCHITZ 2019
* E. g. sawdust, wood waste, rubber waste, fractions high in calorific value, and agricultural residues.

Climate Action, Environment, Energy, Mobility, Innovation and Technology).[1] Moreover, a number of operators of waste (co-)incineration plants publish real-time emission data on their respective websites, which is available to the public.

The reliable technology practised in Austria for decades, along with strict threshold values and the open, systematic information of the public have achieved the broad acceptance of the energy recovery from waste.

[1] https://www.bmlrt.gv.at/umwelt/abfall-ressourcen/behandlung-verwertung/behandlung-thermisch/avvbericht.html

3. WASTE-TO-ENERGY POLICY: A NECESSITY

Energy recovery from waste and recycling are two essential, complementary components of modern sustainable recycling society.

Despite a well-established separate waste collection system and high recycling rates, various waste fractions (e.g. household and commercial waste as well as residues) are still accumulated at the end of the recycling process that are not suitable for recycling or must not be fed into the recycling process.

Incineration and co-incineration plants treat these non-recyclable materials according to the latest state-of-the-art technology, thus providing a substantial contribution to an efficient waste management and to the protection of mankind, environment, and climate.

Energy recovery in incineration and co-incineration plants offer the following advantages:

- hygiensation and inertisation of waste;
- safe treatment of hazardous and non-recyclable waste;
- destruction of organic pollutants, including persistent organic pollutants (POPs);
- reduction of the waste volume by more than 90 %;
- reduction of the mass of waste by more than 75 %;
- contributing to climate protection by avoiding the emission of greenhouse gases (e.g. methane from landfills);
- contributing to the EU targets for renewable energies (substitution of fossil fuels) and energy efficiency (security of supply and import independence).

In addition, waste incineration plants provide for the removal of non-recyclable residual waste and hazardous substances as well as for their safe disposal in landfills.

Applying co-processing technology during co-incineration (e.g. in the cement industry) simultaneously allows for both thermal and material recycling.

BENEFITS IN DETAIL

Incineration ensures the discharge of hazardous substances from the economic cycle and is indispensable for the functioning of the circular economy:

In general, the recycling process produces combustible waste which cannot be utilised anymore or has been in the cycle so often that any further treatment is technically not possible. Moreover, this waste may contain pollutants and does not meet the standards of high-quality recycling. To ensure an environmentally friendly circular economy, this waste needs to be incinerated.

According to the 2017 Federal Waste Management Plan (BMNT 2017), about 1.4 million tonnes of mixed municipal waste (also called “household waste” or “residual waste”) have been produced by private households and similar facilities in 2016. This type of waste is highly heterogenous and is characterised by a diverse composition. Residual waste also contains problem materials and hazardous waste. By means of waste incineration, these pollutants are not only destroyed through mineralisation and hygiensation or bond into a solid matrix (inertisation), but they are also deposited in secure sinks (landfills), thus being permanently removed from the economic cycle. Furthermore, by disposing residual waste of incineration plants bound in a solid matrix, pollution of the ground water is prevented.

Recyclable materials contained in the incineration residues are recovered and innovation processes are fostered:

The recovery and recycling processes discussed below require fulfilling the ecological framework conditions and the technical product specifications for application.

→ **Recycling of metals**

Slags and bottom ashes from incineration plants contain ferrous and non-ferrous metals. By means of modern separators, about 90 % of these recyclables may be recovered. Various methods for recovering zinc and other metals from fly ashes are in progress.

→ **Recycling of glass**

Besides the valuable ferrous and non-ferrous metals, incineration residues contain a considerable percentage of glass. Nowadays, glass may be successfully separated from the bottom ashes of fluidised bed incinerators, thus being available for recycling (e.g. for producing foam glass or glass wool). However, research demand still exists in the recovery of glass from slugs. In general, it is much easier to recover glass from the dry, fine-grained bottom ashes.

→ **Recycling of phosphorus**

Phosphorus represents a limited resource not to be substituted. By incinerating sludge, phosphorus is concentrated in the ashes, making it suitable for various recycling processes. With these processes, resources, such as phosphoric acid used in the food and feed industries, or fertilisers may be produced. The recovery of phosphorus also helps reduce the dependence on imported rock phosphate and cut down the environmental impacts of rock phosphate mining.

→ **Recycling of gypsum**

Gypsum is a limited natural resource. By applying a special technology, gypsum is extracted from flue gas cleaning of incineration plants and is used in the building materials industry. As the yield of recycled gypsum from coal power plants is strongly declining, the recovery of gypsum from incineration plants is gaining importance. Thus, waste incineration makes a welcome contribution to the preservation of natural gypsum reserves.

→ **Recycling of inert residues**

Progress made by the de-metallisation of slags is promising for the use of the mineral slag fractions as building materials. However, besides the ecological impacts, the technical suitability of mineral fractions for the building materials industry still needs to be studied more closely.

→ **Capture and use of CO_2**

Regarded in the light of the European climate targets, the capture and use of CO_2 in the course of incineration processes are gaining increasing importance. Therefore, the recovery of CO_2 from the flue gas of incineration and co-incineration plants may be considered a relevant future field of activity.

→ **The combined energetic and material recovery of waste in the cement industry (co-processing)**

The so-called co-processing technology has been developed to use both the combustible components as energy source and the minerals included in the fuel as resource for the creation of new products. The recovery of old tyres providing energy as well as the required iron for producing cement clinker may be regarded as a case in point.

Incineration reduces the volume of landfills:

Energy recovery decreases the waste volume to about 10 % and its weight is reduced by about 75 %, thus considerably saving landfill volume.

Incineration ensures current und future supply with heating, cooling, and electricity, saves CO_2, and replaces fossil fuels:

Austrian incineration plants are to be regarded as facilities for waste recovery and not for waste disposal. All incineration plants using municipal and commercial waste, such as residual waste, meet the requirements of the R1 criterion (predominant use as fuel or as other means to generate energy) as stipulated by the 2002 Waste Management Act (AWG 2002). The energy produced by waste recovery in incinerators and co-incinerators is provided and used as electricity, heat, and/or process steam (waste-heat utilisation). As the plants are located near the consumers (being municipalities or industrial sites), energy is easily provided for other processes, and the use of primary fuels like oil or coal is substantially reduced. Moreover, long-distance transport is avoided, which constitutes another contribution to climate protection.

The waste treated in incinerators and co-incinerators consists of biogenic and fossil components. Thus, the CO_2 emissions as well as the generated or decoupled energy originate from renewable sources, proportionally delivering climate neutrality. As compared to conventional fossil energy resources, the energy (electricity and heating) generated in Austrian waste incineration plants is more climate-beneficial and contributes to meeting the climate targets. Co-incineration plants avoid fossil CO_2 emissions and, what is more, completely utilise the mineral components of fuels by way of co-processing. Hence, this technology combines aspects of climate protection and resource efficiency, the key elements of modern circular economy.

Accordingly, energy recovery represents an integrated part of advanced waste management and is indispensable for the ecologically sustainable implementation of the EU Circular Economy Package.

Meeting the EU climate and energy targets is substantially supported:

The Austrian incineration and co-incineration facilities actively contribute to climate protection by considerably reducing the emission of climate-damaging methane from landfills. The global warming potential of methane is 28 times higher than that of CO_2. Compared to 1990, this efficiency is impressively underscored by the 28-time decrease in greenhouse emissions originating from the sector of waste management (Klimaschutzbericht 2018). Without a doubt, this positive development in Austria has been driven by the consistent implementation of the landfill ban of organic waste (Deponieverordnung 1996).

Another significant factor of reducing greenhouse gas emissions constitutes the growing energy recovery from renewable resources. A lot of different kinds of waste include a considerable amount of biomass, which are referred to as being climate neutral in case of energy recovery. Therefore, incineration and co-incineration plants provide a valuable contribution to the energy recovery from renewable resources. So, fossil resources, such as coal, oil, and gas, are substituted for generating energy, and greenhouse gas emissions are reduced.

Encouraging the energy recovery from waste also contributes to reducing the dependence of energy imports from third countries. This strategy serves to secure and improve energy supplies as well as protect scarce energy resources.

Energy recovery from waste contributes considerably to the national economy:

The incinerators and co-incinerators ensure that the waste accumulated in Austria is treated according to the principles of short distances and of environmental responsibility, thus contributing to securing business locations and jobs. This responsible strategy is not only beneficial for the plants themselves but also for enterprises and jobs of third parties, such as suppliers, maintenance and assembling companies.

As studies have shown, each single employee in the waste recovery sector actually creates three more jobs in the region concerned (Baaske 2016). Consequently, without the incinerators and co-incinerators, the overall number of employees in Austria would have declined by a few thousands. One euro of revenue resulting from waste-to-energy actually generates an increase of 1.5 Euro in Austria. Considering spill-over effects for abroad, this value rises to 1.8. Or to provide another example of commercial benefits: One euro of value added from the energy recovery from waste produces more than three additional euros in other Austrian enterprises. Including effects for abroad, the total value added multiplies by 3.6. What is more, waste-to-energy facilities contribute considerably to local taxes.

4. MAKING DEMANDS ON POLITICAL DECISION MAKERS

Separate collection of secondary materials and biogenic waste as well as the efficient energy recovery from non-recyclable waste are key cornerstones of modern recycling society. To foster an environmentally sound circular economy and meet the recycling rates specified, the following requirements need to be implemented:

- Energy recovery represents an integral part of circular economy and makes an effective contribution to decarbonisation. These endeavours deserve adequate acknowledgement and should be credited against the renewable energy targets.
- The high-quality recovery of incineration residues or their components (metals, glass, clean mineral residues, and co-processing in the cement industry) makes ecological sense and should be credited against the EU recycling rates for municipal waste.
- Landfilling waste with considerable organic content has a strong impact on the climate, soil, water, and, last but not the least, on human health and involves high follow-up costs for the national economy. Therefore, the deadline for the Europe-wide "landfill ban" for this waste must not be extended. The amendments stated in the EU Landfill Directive (2018/850) of 30 May 2018 need to be implemented and landfill volume be reduced in a sustainable manner across the EU.
- To meet the targets of the Landfill Directive as scheduled, it is essential to take measures that will enhance the expansion of energy recovery.

The political acknowledgement and support of waste-to-energy would be in line with the targets of the EU Circular Economy Package and would drive technical innovation in Europe. A high innovation potential may be identified in the following fields: processing/sorting, incineration technologies, and flue gas cleaning as well as processing and recycling of incineration residues. All these kinds of development will create jobs and make Europe a pioneer in environmental technology.

To put it in a nutshell, energy recovery represents an integrated part of high-quality waste management and makes an essential and ecologically sustainable contribution of the EU Circular Economy Package.

REFERENCES

Baaske W. E. (2016): Aggregierte Analyse der sozial- und regionalwirtschaftlichen Effekte der österreichischen Zementstandorte 2015. Wien.

BMNT (Bundesministerium für Nachhaltigkeit und Tourismus) (2017): Der Bundesabfallwirtschaftsplan 2017, Teil 1. Wien.

EUROSTAT (2019): Siedlungsabfälle nach Abfallbewirtschaftungsmaßnahmen [env_wasmun]. http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do (letzter Abruf: 04.10.2019).

Mauschitz G. (2019): Emissionen aus Anlagen der österreichischen Zementindustrie. Berichtsjahr 2018. Wien.

zukunft
SEIT 1909
denken

Österreichischer Wasser- und Abfallwirtschaftsverband

Gegründet 1909
1010 Wien, Marc-Aurel-Straße 5
Tel. +43-1-535 57 20, Fax +43-1-535 40 64, buero@oewav.at, www.oewav.at

Das österreichische **Kompetenz-Zentrum** für **Wasser-, Abwasser- und Abfallwirtschaft**.

Veranstaltungen
- Österreichische Abfallwirtschaftstagung
- Österreichische Wasserwirtschaftstagung
- Österreichische Umweltrechtstage
- Seminare und Fortbildungskurse zu aktuellen Themen der Wasser- und Abfallwirtschaft
- Erfahrungsaustausch für Betreiber von Abwasser-, Abfallbehandlungs- und Hochwasserschutzanlagen
- Kurse für das Betriebspersonal von Abwasseranlagen, Praktikum auf Lehrklär- und Lehrkanalanlagen, Kanal- und Kläranlagen-Nachbarschaften
- Kurse für das Betriebspersonal von Abfallbehandlungsanlagen
- Kurse in den Bereichen Gewässerpflege, kleine Stau- und Sperrenanlagen, Hochwasserschutz- und Beschneiungsanlagen
- Gemeinsame Veranstaltungen mit in- und ausländischen Fachorganisationen
- Exkursionen

Fachgruppen und Arbeitsausschüsse
- Ausarbeitung von Regelblättern, Arbeitsbehelfen, Merkblättern und Leitfäden
- Erarbeitung von Positions- und Ausschusspapieren sowie Stellungnahmen zu Gesetzesvorhaben

Beratung und Information
- Auskünfte und individuelle Beratung
- Wasser- und abfallwirtschaftliche Informationsschriften und Beiträge, Öffentlichkeitsarbeit

Veröffentlichungen
- Fachzeitschrift „Österreichische Wasser- und Abfallwirtschaft“ (ÖWAW)
- ÖWAV-Homepage (www.oewav.at)
- ÖWAV-News (HTML-Newsletter)
- Tätigkeitsbericht des ÖWAV
- Schriftenreihe des ÖWAV (Wasser- und Abfallrechtliche Judikatur in Leitsatzform)
- Veröffentlichungen zu Tagungen und Seminaren des ÖWAV
- Regelblätter*), Arbeitsbehelfe*) und Merkblätter des ÖWAV, Positions- und Ausschusspapiere
- Informationsreihe Betriebspersonal Abwasseranlagen*)
- ÖWAV-WKO-Umweltmerkblätter für Gewerbebetriebe
- KA-Betriebsinfo[1])
- Wiener Mitteilungen Wasser-Abwasser-Gewässer[1])

Verbindungsstelle (Nationalkomitee) der
- European Water Association – EWA

Mitglied der österreichischen Vertretung zur
- European Union of National Associations of Water Suppliers and Waste Water Services – EUREAU (gem. mit ÖVGW)
- International Solid Waste Association – ISWA
- International Water Association – IWA (gem. mit ÖVGW)

*) in Kommission bei Austrian Standards plus GmbH, Wien
[1]) Mitherausgeber