ZERO WASTE EUROPE

# Incineration residues in the EU: Quantities and fates

*Executive summary*

September 2022 – Equanimator Ltd for Zero Waste Europe

# Executive Summary

## E.1.1. Background

When Member States report figures regarding how they manage their municipal waste to DG Eurostat, the figures include quantities of municipal waste landfilled. Landfilled waste 'goes no further' (unless it is mined at some future date). In other words, there is no 'waste management destination' for the waste which is sent to landfills.

The same is not true of most other approaches to managing waste. For example, if waste is sent to a sorting facility, it is expected that there may be some 'residues', and that some of these may be landfilled. The same is true of mechanical biological treatment facilities, where some of the outputs may be recycled, some may be used for the generation of energy (at various types of facility) and others may be landfilled, hopefully, following stabilisation of the fraction destined for landfill.

Article 5(5) of Directive 1999/31/EC on the landfill of waste states:

*Member States shall take the necessary measures to ensure that by 2035 the amount of municipal waste landfilled is reduced to 10 % or less of the total amount of municipal waste generated (by weight).*

Eurostat Guidance on reporting clarifies how this should be done. It clarifies that the amount of waste landfilled should include:

*the weight of waste resulting from treatment operations prior to recycling or other recovery of municipal waste, such as sorting or mechanical biological treatment, which is subsequently landfilled.'*

This is as one might expect, recognising that such activities may give rise to residues which are landfilled.
The same logic, though, is not extended to incineration. Incineration of waste clearly results in the generation of solid residues, and some of these may be landfilled. The way this is to be accounted for as regards the landfill target under Article 5(5), however, is completely different depending on whether the facility is classified as an R1 or a D10 facility. Hence:

*In addition, the total amount of landfilling shall include the amount of waste entering incineration disposal operations, less the amount of material recovered from such operations.*

If the intention is to report on waste which is landfilled, then whether or not the energy generation of an incinerator is such that it meets the R1 criterion would appear to be besides the point. It also seems very strange that the mass loss occurring in respect of the solid waste outputs (relative to the input) is not to be considered where D10 facilities are concerned.

More generally, because the majority of municipal waste incinerated in the EU-27 was classified as (R1) recovery, and not (D10) disposal (60.4 million tonnes of a total of 61.4 million tonnes, or 98%), so there is no clear reporting of how much waste derived from incineration of municipal waste was actually landfilled. Whereas it is accepted that other forms of waste management – including D10 incineration - can lead to landfilling of waste, the assumption regarding R1 incineration is effectively that nothing further happens. It could be argued that the

waste from incinerators is 'no longer municipal' and falls into a different classification of waste. Since the landfill limit applies to 'municipal waste', so the change in the nature of the waste renders any landfilling 'uninteresting'.

There are, though, good reasons to be concerned as to how much residue, and of what type, is generated as a result of incineration, and how this is being managed. Some, after all, notably the residues associated with air pollution control, are likely to be hazardous.

This study has been desk-based, and sought to understand the quantity of residues generated by incineration of waste in the EU, and what happens to those residues. In particular, there was interest in how much residue may be being landfilled. Because the study has been desk-based, it has relied upon data in various published reports and available in public sources. Although the report is focused mainly on incineration, the report has sought to understand the quantity of residues from both incineration and co-incineration when considering 'all wastes'. The Industrial Emissions Directive distinguishes these according to whether the facility is 'dedicated to the thermal treatment of waste' (incineration) or a facility whose main purpose is the generation of energy or production of material products (co-incineration).[1]

## E.2.0 Estimated Quantity of Residues Generated

The study first of all reviewed high level EU data – as reported to DG Eurostat – to understand how much waste – municipal only, and then all wastes – were sent for either R1 or D10 incineration. Immediately, one of the issues which presents itself is how the differences between the reporting on municipal waste and the reporting on 'all wastes' are to be accounted for. The use of the R1 classification for wastes can include a range of different types of installation, including cement kilns and power plants. The quantity, nature and fate of residues is likely to be quite different across these installations. Interpreting high level data of this nature requires some care to be taken.

High level data are available regarding residues from incineration, though the classifications of waste under which these are likely to fall in high level reporting mean that the data might not be especially accurate.
We sought to gain more detailed information from Member State level data sources as a means to derive a bottom-up estimate of the residues generated. We focused on the 11 Member States which, when combined, account for 92% of all municipal waste sent for R1 and D10 incineration, and 93% of all wastes sent to R1 and D10 facilities.

Based on the countries from which reliable estimates were obtained, and grossing up based on quantities of waste sent to R1 and D10 facilities, we made a first estimate of the quantity of residues. We called this the bottom-up approach. The figures are presented in Table E - 1, and they indicate a total residue quantity of 28.7 million tonnes based on data pertaining to the end of the last decade (2018-2020). Of this, almost a quarter was estimated to be hazardous in nature, the majority of this being air pollution control residues (of which, more than 90% were hazardous in nature).

[1] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control), eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32010L0075

**Table E - 1: Estimated Quantities of Bottom Ash and Air-pollution Control Residues, by Bottom-up Method ('000 tonnes)**

| | Total generated | Non-hazardous | Hazardous |
|---|---|---|---|
| Bottom ash, excl. extracted metals | 23,671 | 21,758 | 1,913 |
| Air pollution control residues | 5,090 | 462 | 4,628 |

Source: Equanimator estimate

In alternative top-down approaches, we estimated quantities of residues (excluding the quantity of metals likely to be extracted for recycling) for both 'municipal solid waste' (as reported to DG Eurostat) and for 'all wastes' sent for D10 and R1 incineration / combustion. We have estimated average quantities per tonne of input at the low and high level. There is at least some indication that bottom ash residues, expressed per tonne of waste input, may be lower (or at least, they are reported as lower) when one considers 'all wastes' as opposed to 'municipal waste' only. There may be all sorts of reasons for this (the wastes themselves are lower in ash content, or the R1 facilities dealing with waste through co-incineration are such that the reported ash quantities are lower than would be expected if the same wastes were incinerated (for example, if wastes sent to cement kilns that might – if incinerated – be a source of bottom ash are largely reporting to clinker, and not to ash residues). In our judgement, this justified lower unit figures when considering 'all wastes' than when considering only MSW.

The figures so derived are shown in Table E - 2. These are shown alongside some other estimates, including figures for bottom ash from Blasenbauer et al, discussed in Section 4.2 of the Main Report, figures quoted directly by CEWEP in a briefing note, and figures derived from the amount of waste reported by CEWEP as being sent to waste-to-energy facilities in 2019, combined with unit generation estimates.

For comparison, Eurostat reports data for 'mineral wastes from waste treatment', which cover 'wastes from waste incineration (bottom ash, slag, fly ash, etc.), mineral fractions from mechanical treatment, and solidified, stabilised or vitrified wastes'. Wastes from co-incineration are included in the category 'combustion waste'. If one restricts the source activity for these wastes to 'Waste collection, treatment and disposal activities; materials recovery', then the total quantity reported to Eurostat is 38.6 million tonnes, of which 5.2 million tonnes were reported as hazardous. These figures are shown in the rightmost column of Table E - 2.

## E.3.0 Treatment of Residues

Because the treatment of residues is affected by policy and law, and because this varies by Member State, a grossing up based on a subsample of the total was deemed unwise. The only reliable way to understand the data regarding how residues from incineration are managed is to understand the flows at Member State level, sometimes implying a need to trace cross-border movements of such residues.

We assumed that (see Main Report for rationale):

- 40-50% (low / high) of bottom ashes (pre- or post-treatment) are landfilled; and
- 35-55% (low / high) of APCr are landfilled,

Then the total quantity of residues being landfilled can be estimated based on mid-point estimates from the bottom-up and the top-down estimates derived above. These figures are shown in Table E - 3.

To summarise, it would appear that:

- Regarding municipal waste:
  - Around 12.5 million tonnes of bottom ash and around 2 million tonnes of air pollution control residues are generated (this excludes metals captured for recycling) as a result of the incineration of municipal waste;
  - Together, this amounts to 14.5 million tonnes, or just over 6.4%, of MSW generated;
  - Of this, just under half – or around 6.5 million tonnes – is estimated to be landfilled;
  - The fate of much of the remainder seems likely to be oriented, in the case of bottom ash, towards either road building or other construction related activities, and in the case of air pollution control residues, to filling of salt mines. Although the latter (or the process preceding it) is frequently defined as a recovery activity, it might be reasonable to question whether it should be classified as such;
  - The air pollution control residues are mostly hazardous in nature in their raw form. Most bottom ash is reported as non-hazardous, though it would be helpful to understand the accuracy of this reporting (of the hazardousness, or otherwise, of bottom ash).

**Table E - 2: Estimated Generation of Residues from R1 and D10 Facilities, Top-Down Estimates, '000 tonnes**

| | Based on unit estimates | | | | CEWEP (2019) | CEWEP (2022) (mid-point unit estimates, low) | CEWEP (2022) (mid-point unit estimates, high) | Blasenbauer et al (2020) (excl. UK) | Eurostat reporting for all wastes |
|---|---|---|---|---|---|---|---|---|---|
| | **MSW, low** | **MSW, high** | **All wastes, low** | **All wastes, high** | **W-t-E, excl haz wastes** | **W-t-E, excl haz wastes** | **W-t-E, excl haz wastes** | **Municipal waste incinerators** | **All wastes** |
| **R1 incineration** | 57,919 | 57,919 | 129,720 | 129,720 | | | | | 129,720 |
| **D10 Incineration** | 1,116 | 1,116 | 14,360 | 14,360 | | | | | 14,360 |
| **Basis Waste Quantity** | 59,035 | 59,035 | 144,080 | 144,080 | 96,000 | 99,000 | 99,000 | 78,000 | 144,090 |
| **Unit quantity bottom ash, excl metals (kg/tonne input)** | 0.185 | 0.240 | 0.160 | 0.230 | | 0.173 | 0.235 | | |
| **Unit quantity APC residues (kg/tonne input)** | 0.027 | 0.040 | 0.027 | 0.040 | | 0.027 | 0.040 | | |
| | | | | | | | | | |
| **Bottom ash, excl metals** | **10,921** | **14,168** | **23,053** | **33,138** | **19,000** | **17,078** | **23,265** | **16,100** | **33,340**[a] |

| | Based on unit estimates | | | | CEWEP (2019) | CEWEP (2022) (mid-point unit estimates, low) | CEWEP (2022) (mid-point unit estimates, high) | Blasenbauer et al (2020) (excl. UK) | Eurostat reporting for all wastes |
|---|---|---|---|---|---|---|---|---|---|
| | **MSW, low** | **MSW, high** | **All wastes, low** | **All wastes, high** | **W-t-E, excl haz wastes** | **W-t-E, excl haz wastes** | **W-t-E, excl haz wastes** | **Municipal waste incinerators** | **All wastes** |
| **APC residues** | **1,594** | **2,361** | **3,890** | **5,763** | | **2,673** | **3,960** | | **5,240**[b] |
| | | | | | | | | | |
| **Total IBA + APCr, MSW only** | 12,515 | 16,530 | | | | | | | |
| **Total IBA + APCr, All wastes** | | | 26,943 | 38,902 | | 19,751 | 27,225 | | 38,580 |
| **Quantity of all residues (kg/tonne input)** | *0.212* | *0.280* | *0.187* | *0.270* | | *0.200* | *0.275* | | *0.268* |

[a] this is the Eurostat figure reported as the non-hazardous component of the relevant mineral and combustion residues
[b] this is the Eurostat figure reported as the hazardous component of the relevant mineral and combustion residues
Sources: Equanimator estimates; CEWEP (u.d.) Bottom Ash Factsheet; CEWEP (u.d.) Waste to Energy Plants in 2019, www.cewep.eu/waste-to-energy-plants-in-europe-in-2019; Dominik Blasenbauer et al (2020) Legal situation and current practice of waste incineration bottom ash utilisation in Europe, Waste Management, 102 pp.863-883; DG Eurostat waste Data Database.

## Table E - 3: Quantity of Incineration and Combustion (of waste) Residues Generated and Quantity Landfilled

| Generation based on... | Bottom-up, all wastes | | Top-down, all wastes | | Top-down, MSW, central | |
|---|---|---|---|---|---|---|
| **Waste Generated and Quantity Landfilled** | **Low** | **High** | **Low** | **High** | **Low** | **High** |
| Bottom Ash | 23,671 | | 28,096 | | 12,545 | |
| APC Residues | 5,090 | | 4,827 | | 1,978 | |
| Landfilled Bottom Ash | 9,468 | 11,836 | 11,238 | 14,048 | 5,018 | 6,272 |
| Landfilled APC Res | 1,782 | 2,800 | 1,689 | 2,655 | 692 | 1,088 |
| Total Landfilled | 11,250 | 14,635 | 12,928 | 16,702 | 5,710 | 7,360 |

- Regarding all wastes:
    - Between 23.7 and 28.1 million tonnes of bottom ash (this excludes metals captured for recycling) and between 4.8 and 5.1 million tonnes of air pollution control residues are generated as a result of the incineration and combustion of all wastes;
    - Together, this amounts to 28.7-32.9 million tonnes, equivalent to between 12.7% and 14.6% of the quantity of MSW generated;
    - Of this, between 11.3 and 16.7 million tonnes – is estimated to be landfilled;
    - As with municipal waste, the fate of much of the remainder seems likely to be oriented, in the case of bottom ash, towards either road building or other construction related activities, and in the case of air pollution control residues, to filling of salt mines;
    - Again, as with municipal wastes, the air pollution control residues are mostly hazardous in nature in their raw form. Most bottom ash is reported as non-hazardous, though as noted above, it might be helpful to understand the accuracy of this reporting (of the hazardous nature, or otherwise, of bottom ash).

# E.4.0 Concluding Observations

## E.4.1 Equal Treatment?

There are good reasons to question why residues from incineration should be excluded from calculations regarding the quantity of municipal waste landfilled. When waste is incinerated, the residues are no longer classified as municipal waste. Whilst Eurostat Guidance notes the same may be true of residues from mechanical biological treatment (MBT), the Landfill Directive requires residues from MBT which are landfilled to be included in the scope of the target.[2]

Equality of treatment (of different treatments) would reflect on the following options:

- that the target is amended to exclude the residues from MBT also; or
- that the target is amended to include all residues from incineration – both R1 and D10 - which are landfilled); or
- that the landfill target is re-specified so as to ensure (in conjunction with other changes) that management of residual wastes delivers the most beneficial outcome.[3]

What ought to matter is what is being landfilled as a result of the management of municipal waste, and what are the implications of managing these wastes. There are relevant questions to be asked as to whether landfilling 10% of waste as a biostabilised residue from mechanical biological treatment is more or less harmful than handling 12 million tonnes of bottom ash, and 2 million tonnes of mainly hazardous air pollution control residues resulting from incinerating municipal waste.

[2] Eurostat (2021) *Guidance for the compilation and reporting of data on municipal waste according to Commission Implementing Decisions 2019/1004/EC and 2019/1885/EC, and the Joint Questionnaire of Eurostat and OECD*, Version of 12/08/2021, ec.europa.eu/eurostat/documents/342366/351811/Guidance+on+municipal+waste+data+collection

[3] See proposals for change set out in Equanimator (2021) *Rethinking the EU Landfill Target*, Report for Zero Waste Europe, October 2021, zerowasteeurope.eu/library/rethinking-the-eu-landfill-target

## E.4.2 Lack of Harmonisation

Where the treatment of residues is concerned, the framing laws and policies, as well as the available treatments, are not homogeneous across Member States. Because of differences in regulation, processes which are permissible in one Member State might not be considered permissible in another. This may lead to movements of waste that are either unnecessary (if the exporting Member State is 'over-regulating'), or unhelpful (if the receiving Member State is 'under-regulating').

Similarly, because of differences in interpretation of law, it may be that processes which are classified as 'recovery' in one Member State might not be classified as 'recovery' in another. This could have the effect of allowing waste to cross boundaries for the purposes of being recovered in a receiving Member State even though the process would not be classified as recovery in the Member State from which the waste originated;

Particular issues in this regard may be the categorisation of some treatments for APC residues as 'recovery' operations when they might be more properly classified as D9 disposal operations, and the extent to which activities classed as 'backfilling' should be classed as such.

Regarding APC residues, issues associated with classifying disposal and recovery processes were examined by a recent ruling in the UK. The Court upheld the decision of the Environment Agency of England and Wales to refuse a license to export air pollution control residues to a Norwegian facility on grounds that the waste would be undergoing a disposal operation, and not a recovery operation.[4] As reported in the Court Ruling, whilst the Swedish Environmental Protection Agency had a similar view to the Environment Agency of England and Wales, the Norwegian Environment Agency had consented to the export on the basis that the waste would be subject to a recovery operation.

# E.5.0 Recommendations regarding reporting

It is recognised that our desk-based study will not have uncovered all sources and figures, but it seems clear that gaining information on the residues associated with incineration (including co-incineration) and of their fates is not entirely straightforward. The quality of data made available by different Member States appears rather variable.

The Main Report includes a small number of recommendations regarding reporting of data. Perhaps the most important of these in the context of this study's objectives relate to the way in which residues from incineration which are sent for treatment may then lead to residues further along the chain which may themselves need landfilling. In some respects, this highlights exactly the issue that this study seeks to address – the fact that the incineration of waste gives rise to residues which need further management, with some being landfilled. Exactly the same applies to some of the incineration residues which are not being reported as landfilled directly, but which may be reported as being treated, or recovered.

[4] Royal Courts of Justice (2022) The Queen (on the Application of New Earth Solutions (West) Limited) – Claimant – and Environment Agency – Defendant – and (1) Noah Solutions AS and (2) Norwegian Environment Agency, Case No: CO/4172/2021, 19/07/2022, www.bailii.org/ew/cases/EWHC/Admin/2022/1883.pdf

We sought to understand the extent to which this was the case in Germany. Where bottom ash was concerned, as far as we could discern, if one accounted for quantities of waste through the chain, then the quantity of (treated) wastes landfilled seemed to increase from 27% of the weight of residues initially generated (when reported at the point of generation) to 40% of the weight of residues initially generated (when taking into account residues generated by treatment processes). Evidently, the landfilled component of a treated waste of type A may not be 'waste of Type A' (indeed, for some hazardous wastes, it might be argued that such a treatment would be of limited value). However, tracing residues through the various treatment pathways to their end-points is important if one is to understand the amount of waste actually disposed of as a result of incinerating waste.

Hopefully, this study might encourage others to improve our understanding of the flows of different incinerator residues through various treatment steps.

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Zero Waste Europe, 2022

Zero Waste Europe is the European network of communities, local leaders, experts, and change agents working towards the elimination of waste in our society. We advocate for sustainable systems and the redesign of our relationship with resources, to accelerate a just transition towards zero waste for the benefit of people and the planet.

Zero Waste Europe gratefully acknowledges financial assistance from the European Union. The sole responsibility for the content of this material lies with Zero Waste Europe. It does not necessarily reflect the opinion of the funder mentioned above. The funder cannot be held responsible for any use that may be made of the information contained therein.