Enough is enough:

The case for a moratorium on incineration

Study

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Equanimator Ltd for Zero Waste Europe

zerowasteeurope.eu

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Executive Summary

Key Observations

Within the EU, in 2020 (the latest year for which data were available from Eurostat), treatment capacity at waste incinerators classified as 'D10' (disposal) and facilities incinerating municipal waste and co-incinerating waste (R1) was:

- 183.5 million tonnes at R1 facilities;
- 15.3 million tonnes at D10 facilities; and
- 198.8 million tonnes at R1 and D10 facilities combined.

The historic trend in capacity evolution in the EU has been for 8 million tonnes of capacity to be added annually over the period 2004-2020. On that basis, capacity may now, in the latter half of 2023, have reached around 220 million tonnes (although the COVID-19 pandemic may have slowed the pace of construction of new facilities).

Waste statistics taken from Eurostat indicate that in 2020, the combined quantity of waste actually treated through R1 and D10 was 10.5 million tonnes of hazardous waste and 128.2 million tonnes of non-hazardous waste.

These figures suggest that there was already capacity to treat 60 million tonnes or so of **additional** waste through existing D10 and R1 installations in 2020. There may, of course, be a mismatch between categories of waste available for treatment, and the nature of the installations where capacity is not fully utilised.

Over 90% of non-hazardous wastes dealt with via D10 and R1 are reported to come from seven waste categories, with four categories accounting for more than 80% of the wastes managed at such installations. Three of these are, to those familiar with EU waste statistics, the key mixed/leftover waste categories, household and similar wastes, sorting residues and mixed and undifferentiated materials.

Eurostat statistics on municipal waste (MSW) tell us that the vast majority of waste that is incinerated is sent to facilities that achieve the R1 threshold criterion. We noted in a previous report how this has progressively become a meaningless threshold (it is met by virtually any 'legislatively compliant' incinerator).[1]

[1] D. Hogg (2023) Debunking Efficient Recovery: The Performance of EU Incineration Facilities, Report for Zero Waste Europe, January 2023.

Table E-1: Key Non-hazardous Waste Categories Dealt with at D10 and R1 Facilities

	D10+R1	
Household and similar wastes	49,310,000	38%
Sorting residues	31,210,000	24%
Wood wastes	19,790,000	15%
Mixed and undifferentiated materials	7,210,000	6%
Animal and mixed food waste	5,160,000	4%
Common sludges	3,390,000	3%
Plastic wastes	2,680,000	2%
Industrial effluent sludges	1,800,000	1%

The quantity of MSW dealt with through R1 and D10 facilities (at 62 million tonnes) is 19 million tonnes lower than the amount of waste dealt with at incinerators being reported by CEWEP. The gap between the CEWEP figure and the MSW treatment figures ought to indicate non-municipal waste which is non-hazardous and treated at incineration. Our understanding (based on the Manual on Waste Statistics) is that this would not qualify as R1 and should be classified as D10, yet the difference between these figures far exceeds the amount of non-hazardous waste reportedly treated as D10 disposal.

If all the common material categories which are being dealt with by incinerators, and which are currently landfilled, were sent to incinerators, the quantity needing to be dealt with by D10 and R1 would increase by 76 million tonnes. **In that unlikely scenario, and with recycling and waste generation remaining at 2020 levels, then the shortfall in D10 and R1 capacity combined would be 15.8 million tonnes.**

It is clear, though, that EU policy and law seeks to reduce the amount of waste generated and increase the proportion of the waste which remains that is recycled. **If the EU meets its recycling targets**, then a further 36.4 million tonnes, equivalent to just under half of all the non-hazardous waste that was landfilled in 2020, would need to be recycled. This alone would move D10 and R1 capacity back into **a surplus of around 20.6 million tonnes, even when assuming all suitable wastes were being made available for R1 and D10 (and none were landfilled).**

Even countries with landfill bans or restrictions in place landfill some MSW (for all Member States, the figure is non-zero (recalling also that landfilling of incinerator residues is not counted as landfilling of MSW)). Some landfill very little such waste, others, a greater share, depending on the nature of the ban (and the reporting[2]). **The Landfill Directive allows landfilling of 10% of MSW**, so that this practice is likely to continue at some

[2] For Germany, for example, the figure has been estimated by Eurostat for every year since 2013.

level for fractions of municipal waste, as well as some other non-hazardous wastes which might otherwise be considered suitable for landfill**. If one considers the 10% figure to apply, other than in member States where MSW landfilled is already below 10%,** this would suggest that 15 million tonnes of waste might continue to be landfilled in future. **The surplus – even with all suitable wastes available for D10 and R1 moves up to 35.6 million tonnes.**

Either in their quest to meet recycling targets, or in their attempt to reduce the contribution of incineration to climate change, of for both reasons as we have indicated elsewhere, there is an **opportunity to deploy Leftover Mixed Waste Sorting (LMWS) to waste leftover after separate collection**. Because there is a rationale for focusing on (and a relative emphasis on) extracting plastics for recycling, the effect is to reduce the calorific value of the remaining waste. In principle, existing incinerators' capacity to deal with waste could be increased as a result of the associated drop in calorific value (since such facilities are generally limited in their capacity by the overall calorific content of waste being treated).

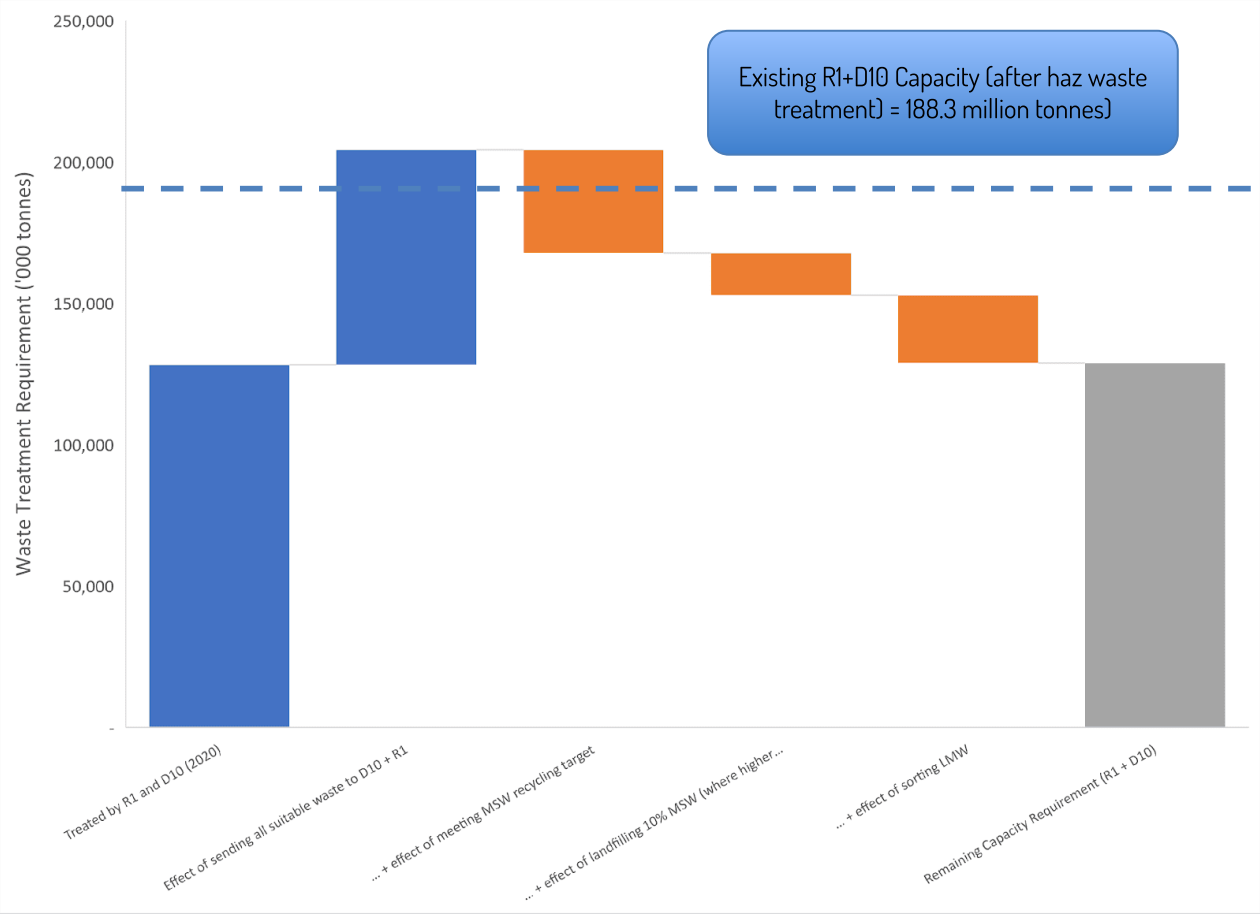
There are around 92 million tonnes of two categories - Household and similar wastes and Mixed and undifferentiated materials - currently either treated at D10 and R1 facilities or landfilled. In addition, there are 66 million tonnes of 'sorting residues'. If we consider that all household and similar wastes, mixed undifferentiated materials, and about 30 million tonnes of waste going to facilities (currently) for turning into refuse derived fuel / solid recovered fuel, could undergo LMWS, but that we subtract the additional amount requiring to be recycled, then we have just over 80 million tonnes would be eligible for such treatment.[3] Thanks to the lower net calorific value (NCV) of the resulting output, this would be capable of being managed at facilities currently managing around 56 million tonnes of waste, freeing up an additional 24 million tonnes of capacity. **The surplus relative to current R1 and D10 capacity would (combined with the above measures) increase to around 60 million tonnes, or much the same level of surplus as exists on paper**

[3] As of early 2017, ecoprog estimated that in Europe, there were 'around 570 active MBT plants with a treatment capacity of 55 million tons' (up from 490 with a capacity of 47 million tonnes in 2015). ecoprog expected a further 120 facilities with an estimated capacity of almost 10 million annual tons to be commissioned between 2017 and 2025 (see https://ecoprog.com/publications/report-market-for-mbt-plants-in-europe-2017 and Mark Döing (2016) The Market for Mechanical Biological Waste Treatment Plants in Europe, Waste Management, Volume 6, September 2016). Capacity for MBT in Germany was estimated as 3.9 million tonnes in 2022, with throughput of the order 3.2 million tonnes (ASA (2022) Gewährleistung der Entsorgungssicherheit durch mechanisch-biologische Abfallbehandlungsanlagen: Arbeitsgemeinschaft stoffspezifische Abfallbehandlung e. V., 23 June 2022, (www.asa-ev.de/fileadmin/Media/ASA-EV/Downloads/PDF/ASA_e._V._Notfallplan_Gas_-_Gewaehrleistung_der_Entsorgungssicherheit_durch_stoffspezifische_Abfallbehandlung_final.pdf). In 2020 in Italy, 18.5 million tonnes of authorised capacity for MBT accounted for treatment of 9.5 million tonnes of urban residual waste, mainly leftover mixed wastes (ISPRA (2021) Rapporto Rifiuti Urbani, Edizione 2021, Rapporti 355/2021, December 2021). In Spain, some 11.8 million tonnes of residual MSW were treated either through aerobic or anaerobic treatment, with a further 1.6 ,million tonnes treated at sorting plants prior to thermal treatment (MITECO (2020) Memoria Anual de Generación y Gestión de Residuos: Residuos de Competencia Municipal. 2019, www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/publicaciones/memoriaanual2019generacionygestionresiduosrescompetenciamunicipal_tcm30-534462.pdf).
Our figure of 30 million tonnes is an estimate of the current quantity treated through such facilities in the EU as a whole (Germany, Italy and Spain together account for 26.1 million tonnes). Whilst these facilities may remove some plastics, alongside some metals, they have not always been specifically configured with high quality sorting systems for removal of a range of plastics, with plastics mainly valued for calorific value rather than for the embodied carbon and energy savings.

today. This is somewhat remarkable in that it suggests that even if we were to channel all wastes 'broadly suitable' for management via R1 and D10, then if recycling targets are met, and if LMWS systems are widely deployed, roughly the same quantity of non-hazardous waste would remain to be managed via R1 and D10 as is being managed today.

These effects are shown, stepwise, in the Figure below. This highlights the fact that **even if all wastes suitable for D10 and R1 incineration / co-incineration were effectively sent to such facilities, then with targets for MSW being respected, and with some additional sorting of leftover mixed waste, combined R1 and D10 capacity would be much as it is today: the significant surplus of R1 and D10 capacity of 60 million tonnes or so would remain.** This figure falls to 50 million tonnes if we assume that MSW grows at historic rates between 2020 and 2035.

Figure E-1: Effects on Required R1 and D10 Capacity of Key Assumptions and Changes



We also examined the situation with specific reference to municipal waste. The heterogeneous nature of leftover mixed municipal waste is such that where it is not further sorted / treated, then incinerators receiving the waste tend to be designed specifically for this purpose. Some MSW is sorted so that a more-or-less-well prepared fuel is made available, but much of the reported 62 million tonnes sent to R1 facilities will be sent to dedicated incinerators, with CEWEP indicating a total capacity of incineration facilities of the order 81 million tonnes. In the absence of waste growth, then **simply meeting the 65% MSW recycling target leads to a situation where, if Member States currently landfilling more than 10% of MSW landfill no more than 10%, and with the amount sent to R1 installations remaining as in 2021, there is no requirement for additional non-landfill treatment capacity at the EU-27 level.**

There are Member States, however, for which existing incineration capacity is effectively (further) freed up, and ones for which additional non-landfill capacity is required. The quantities of additional non-landfill treatment required depend upon the recycling rates achieved, and how leftover mixed waste (after separate collection) is treated. The 10% landfill quota can also be 'expanded' somewhat through use of biological

stabilisation (reducing the mass of the waste landfilled, and its propensity to generate methane, and aligning with the spirit of the poorly articulated requirements in the Landfill Directive to pre-treat waste prior to landfilling).

Waste of the type we are discussing already crosses borders, and that movement is facilitated in part by the R1 criterion allowing for the trans-frontier movement of wastes. We have argued elsewhere that the R1 designation is unwarranted, and in any case, has been rendered irrelevant by the progressive watering down of a criterion which evolved out of considerations of what is best available technology. In other words, the criterion was initially intended to represent what facilities needed to do in order to be permitted at all.[4]

Recommendations

If the emerging issue of over-capacity were already acknowledged, then given the average life of facilities, somewhere around 5% of capacity might be being decommissioned / retired each year. The observed trend is very different.

Member States, when considering their own capacity needs, take different views regarding the desirability, or otherwise, of importing waste from other countries for incineration. There are pros and cons to both approaches, one of the cons being that territorial greenhouse gas emissions associated with incineration increase as a result, one of the pros being that a service of waste management is effectively exported to other countries (even as the waste is imported).

The capacity for managing leftover mixed waste is an issue, though, which would benefit from EU-wide coordination. If Member States that could otherwise offer freed-up capacity to others were considering compensating operators for an early decommissioning, then if that leads to new facility development elsewhere, the net effect is unlikely to be positive, especially if this takes place in the context of EU capacity continuing to increase, and taking into account the carbon embodied in the construction of new facilities, and the potential for lock-in effects, especially where facilities are configured to supply heat.

There would appear to be a strong argument for EU level coordination in this matter. Operating companies might not be able to discuss this openly for fear of accusations of collusion. There may, though, be a rationale for Member States to consider treatment capacity as a matter that is not confined purely to their own territorial borders (waste is, after all, already moving across frontiers within the EU). Any planned decommissioning would benefit from being carefully coordinated. Those Member States where excess capacity already exists should consider imposing moratoria, and potentially, managing a reduction in capacity. Factors that might come into play in that retreat would be the age of facilities, their role in a spatially coherent network, the ease with which they might access carbon capture and storage facilities and (this applies only to facilities already doing so) whether facilities are connected to district heat networks.

[4] D. Hogg (2023) Debunking Efficient Recovery: The Performance of EU Incineration Facilities, Report for Zero Waste Europe, January 2023.

In Member States which might otherwise be pushed to consider additional D10 or R1 capacity within their borders, it would seem exactly the right time (before more capacity is constructed because that is what EU policy and law may appear to require) to indicate the equivalence of landfilling and incineration, as long as the wastes received are both already subject to LMWS, and as long as waste being landfilled is stabilised to achieve a minimum stability criterion.[5] Eliminating the landfilling of untreated (or not-biologically-stable) waste, and placing incineration and landfill of suitably pre-treated waste on the same – lowest - tier of the waste hierarchy would likely give greater flexibility to Member States pursuing higher recycling rates, and allow more rapid progress towards climate mitigation in those where landfilling of LMW is still significant.

The flexibility of a strategy to scale down capacity for incineration is constrained by a commitment to the placing of incineration higher in the hierarchy than the landfilling of suitable treated residual waste that looks increasingly ideological. The decision-making process regarding decommissioning of facilities would be made that much easier if the limit of 10% of MSW landfilled, which loses its justification if the requirement to pre-treat waste prior to landfilling is sensibly enforced, was disapplied. What the EU needs, after all, is a continuing capacity – which diminishes over time – to manage LMW and the resulting residual waste in an environmentally responsible way (including sorting of LMW, as necessary). The 10% landfill limit artificially constrains choices as to how best to achieve this outcome.

Article 12 of the Waste Framework Directive noted:

> *2. By 31 December 2024, the Commission shall carry out an assessment of the disposal operations listed in Annex I, in particular in light of Article 13, and shall submit a report to the European Parliament and to the Council, accompanied, if appropriate, by a legislative proposal, with a view to regulating disposal operations, including through possible restrictions, and to consider a disposal reduction target, to ensure environmentally sound waste management.*

It might be a sensible time to re-consider the role of incineration in the waste management hierarchy, choosing to classify it as a disposal operation. Furthermore, in future, incinerators should only accept leftover mixed wastes from municipal sources where they have been through advanced sorting facilities.

[5] See Equanimator (2021) *Rethinking the EU Landfill Target*, Report for Zero Waste Europe, October 2021, zerowasteeurope.eu/library/rethinking-the-eu-landfill-target; Dominic Hogg (2022) *The Case for Sorting Recyclables Prior to Landfill and Incineration*, Special Report prepared for Reloop, June 2022.

Introduction

Equanimator was very happy to be asked by Zero Waste Europe (ZWE) to explore the case for a moratorium on incineration at the EU level. As part of this work, we have sought to shed light on the potential impact of the sorting of leftover mixed waste (LMW, i.e., that which remains after households or businesses have engaged in separate collection) on the ability of existing incineration facilities to manage the remaining residual waste (i.e., that which remains after mixed waste sorting).

Previous reports by Equanimator have highlighted:

- The weakness of the rationale for the current preference – in policy and legislation - for incineration over other ways of managing LMW;[6]
- The case for implementing sorting of LMW prior to incineration (so as to contribute to recycling and to reduce fossil CO_2 emissions from incineration);[7] and
- The case for alternatives to incineration for treating LMW on grounds of cost.[8]

This study draws on these studies, on data regarding waste management at the EU level, and on the evolution in these quantities as conceived in EU policy. It examines this mostly from the standpoint that the existing policy and law remains unchanged, though it refers also to changes which are already being mooted. It then considers the potential effect of sorting LMW in meeting these targets, and on existing incineration capacity.

It also considers the spatially uneven distribution of incineration capacity across the EU, particularly in terms of how much capacity each Member State has in relation to demand for incineration services and the amount of waste generated within that Member State. Logically, there would be some coordinating mechanism to enable capacity to be properly utilised across the EU: it makes little sense for built infrastructure assets to be under-utilised, not least if the counterfactual scenario is that other infrastructure assets need to be built elsewhere, with relatively high embodied carbon content and risking lock-in effects be imparted to the strategies developed in those areas.

Based on the assessment, it considers appropriate policy responses, including whether there is a case for a moratorium on new incineration capacity at the EU level (and if so, what coordinating mechanisms may be necessary, and for how long any moratorium might reasonably be applied).

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[6] Equanimator (2021) *Rethinking the EU Landfill Target*, Report for Zero Waste Europe, October 2021, zerowasteeurope.eu/library/rethinking-the-eu-landfill-target; D. Hogg (2023) Debunking Efficient Recovery: The Performance of EU Incineration Facilities, Report for Zero Waste Europe, January 2023.

[7] Dominic Hogg (2022) *The Case for Sorting Recyclables Prior to Landfill and Incineration*, Special Report prepared for Reloop, June 2022.

[8] Dominic Hogg and Dinkar Suri (2023) Nothing left behind: Modelling MRBT to maximise recovery of resources and minimise contributions to climate change, Report for Zero Waste Europe, April 2023.

Waste Management in the EU-27 – Current Situation

This section highlights key waste management data regarding waste management in the EU-27 and indicates the role being played by incineration in its broad sense.

A Note on the Statistics

Waste statistics are split between primary and secondary wastes. Primary wastes are derived by subtracting them from the total quantity of secondary wastes generated / treated. These are those resulting from the treatment of waste, e.g., ashes from incineration or sorting residues. The amount of secondary waste is approximated by the sum of the three waste categories:

- Sludges and liquid waste from waste treatment (EWC-Stat 3.3);
- Sorting residues and (10.3); and
- Mineral waste from waste treatment and stabilised waste (128.13).

Other waste categories probably include wastes which should, for completeness, be counted as 'secondary waste' but the share of secondary waste within these categories is not readily quantifiable.

Waste generation and treatment statistics are also used to derive indicators linked to 'Waste excluding major mineral wastes'. This is because indicators relating to all wastes would be distorted by the inclusion of these mineral wastes, which reflect the extent of mining and quarrying activity in a given Member State's economy (and this varies considerably across Member States). The 'major mineral waste' categories are the following:[9]

- Mineral waste from construction and demolition;
- Other mineral wastes;
- Soils; and
- Dredging spoils.

These are interesting to this study in that they are all categories which are unlikely to be attractive to those operating incineration plants. There are other mineral categories which are also unlikely to be of interest to incineration facilities, and we explore the matter further below.

[9] Eurostat (2013) *Manual on waste statistics: A handbook for data collection on waste generation and treatment*, 2013 Edition.

The term 'incineration' means many things at the EU level. In waste treatment statistics, incineration facilities appear under two main headings, these being 'D10 – incineration' and 'R1 – energy recovery'. The former covers those facilities that do not, or cannot, qualify as recovery installations. The key criterion in this respect is the R1 criterion in a footnote to Annex II of the Waste Framework Directive. In the WFD, R1 is described as 'R1 - Use principally as a fuel or other means to generate energy (*)'. This description would not normally cover a facility dedicated to the treatment of waste, but the WFD included the following as regards municipal waste:[10]

> *This includes incineration facilities dedicated to the processing of municipal solid waste only where their energy efficiency is equal to or above:*
>
> *— 0,60 for installations in operation and permitted in accordance with applicable Community legislation before 1 January 2009,*
>
> *— 0,65 for installations permitted after 31 December 2008, using the following formula:*
>
> *Energy efficiency = (Ep - (Ef + Ei))/(0,97 × (Ew + Ef))*
>
> *In which:*
>
> *Ep means annual energy produced as heat or electricity. It is calculated with energy in the form of electricity being multiplied by 2,6 and heat produced for commercial use multiplied by 1,1 (GJ/year)*
>
> *Ef means annual energy input to the system from fuels contributing to the production of steam (GJ/year)*
>
> *Ew means annual energy contained in the treated waste calculated using the net calorific value of the waste (GJ/year)*
>
> *Ei means annual energy imported excluding Ew and Ef (GJ/year)*
>
> *0,97 is a factor accounting for energy losses due to bottom ash and radiation.*
>
> *This formula shall be applied in accordance with the reference document on Best Available Techniques for waste incineration.*
>
> *The energy efficiency formula value will be multiplied by a climate correction factor (CCF) as shown below:*
>
> *1. CCF for installations in operation and permitted in accordance with applicable Union legislation before 1 September 2015.*
>
> *CCF = 1 if HDD[11] >= 3 350*

[10] Directive 2008/98/EC of the European Parliament and of The Council of 19 November 2008 on waste and repealing certain Directives.

[11] Note, HDD = heating degree days.

CCF = 1,25 if HDD <= 2 150

CCF = – (0,25/1 200) × HDD + 1,698 when 2 150 < HDD < 3 350

2. CCF for installations permitted after 31 August 2015 and for installations under 1 after 31 December 2029:

CCF = 1 if HDD >= 3 350

CCF = 1,12 if HDD <= 2 150

CCF = – (0,12/1 200) × HDD + 1,335 when 2 150 < HDD < 3 350

(The resulting value of CCF will be rounded at three decimal places)

Those incineration facilities which do not meet this criterion should not be included under the R1 definition, and should be classified as D10 installations instead. D10 facilities cover 'Incineration on land'. The wording of the above is ambiguous as regards the incineration of municipal waste in facilities which meet the R1 criterion, but which also treat non-municipal wastes. The Manual on Waste Statistics states:[12]

Item 1 [i.e. the R1 classification] *does not cover:*

• The combustion of municipal solid waste in incineration facilities that do not fulfil the energy efficiency standards set in Annex II of the Waste Framework Directive (FÆ Item 2).

• The combustion of non-municipal waste in dedicated waste incineration plants where the main purpose of the operation is the thermal treatment of the waste and not the production of energy (FÆ Item 2).

This suggests that even if a facility which is dedicated to the processing of waste meets the efficiency criterion set under R1, processing of wastes which are not municipal in origin should not qualify as R1. The ambiguity of the R1 definition extends to the fact that the definition, as worded, applies only to '*incineration facilities dedicated to the processing of municipal solid waste'.* As written, that would raise the question as to when a facility treating municipal waste might be considered no longer 'dedicated' to that task (but, for example, the treatment of a range of wastes).

Incinerators dedicated to the purpose of waste treatment are not the only facilities which are reported under the R1 classification. The classification also covers the incineration and co-incineration of waste in power stations and industrial facilities such as cement kilns where the resultant energy is used to generate heat or electricity. Other examples given in the Manual on Waste Statistics include the use of tyres, waste oils, or spent solvents in cement kilns, and co-incineration of sewage sludge or refuse-derived fuel (RDF) in power stations.

[12] Eurostat (2013) *Manual on waste statistics: A handbook for data collection on waste generation and treatment*, 2013 Edition.

The Manual also indicates criteria that should be met in order for an activity to be classified as an energy recovery operation.[13]

When considering the types of waste generated or treated, it is important to understand that although data reported to (and by) Eurostat include categories which are related to a particular material (e.g., plastics, or textiles), the data will not include all forms of wastes of that specific material under that category. The material-specific categories relate to wastes associated with processing those materials, as well as those which are separately collected (and, presumably, identifiable as such). A varying share (depending on the material) of each of the material-specific wastes will remain in the main 'mixed waste' categories, such as Household and similar wastes, sorting residues and mixed and undifferentiated materials.

Waste Generation and Treatment

Sets of statistics on waste generation and waste treatment are not always 'bought together', and so few attempts are made to properly reconcile the two. In the analysis that follows, we seek to bring the generation and treatment statistics together. The author is familiar with many of the vagaries of waste statistics. The nature of the requests, and the rules for reporting, do not always allow for a full 'mass balance' to be made, and in some cases, there are good reasons for that (which are progressively being addressed). For example, losses can occur through moisture loss and mass loss in biological treatment processes that are not considered to be 'final treatments'. However, as we see below, some of the gaps between reported generation and the amount of waste reported as being treated are large enough to be very worrying if they cannot be properly explained. Hence, the significance of reconciliation across waste datasets.

In the EU27, in the year 2020, some 2.15 billion tonnes of waste were generated. Of these 2.15 billion tonnes, 95.5 million tonnes were classified as hazardous waste, and the remainder, 2.06 billion tonnes, were classified as non-hazardous.

Hazardous Waste

Of the 95.5 million tonnes of hazardous waste, 83 million tonnes were so-called primary wastes. From the 95.5 million tonnes generated, 74.7 million tonnes of treatment of hazardous wastes was reported. The treatment pattern is shown in Table 1. The more than 20 million tonnes 'treatment gap' (generation minus treatment) could, in principle, be accounted for by exports (though exporting hazardous waste from the EU to other countries on such a scale might raise its own issues). In fact, more hazardous waste is reported as imported than is exported. That leaves, therefore, a 'treatment gap' of 25.5 million tonnes. Whilst there might be a reasonable explanation for this, it seems a large enough gap to warrant checking that it can, indeed, be

[13] Eurostat (2013) *Manual on waste statistics: A handbook for data collection on waste generation and treatment*, 2013 Edition.

explained. The alternative is that (some of the) up to a quarter of all hazardous waste that is generated has no counterpart treatment method, .

> "Rather worryingly, more than a quarter of hazardous waste generated in the EU-27 appears to have no corresponding treatment destination."
>
> **Dominic Hogg, Director, Equanimator**

Table 1: Pattern of Hazardous Waste Generation and Treatment (and trade) in the EU-27, 2020 (tonnes)

Treatment	Hazardous Waste Treated
Total Generated (EU-27)	**95,530,000**
D10	4,350,000
R1	6,130,000
R1 + D10	**10,480,000**
Landfill and other	35,460,000
Recovery (Recycling and Backfilling)	28,720,000
Total Treatment	**74,660,000**
Imports	12,834,016
Exports	8,188,209
Treatment Gap (generation + net imports - amount treated)	**25,515,807**

Source: Eurostat

Note that as far as hazardous wase is concerned, the amounts being either incinerated (D10) or sent for energy recovery (R1) are of the same order of magnitude. The D10 facilities are involved mainly in treating spent solvents, chemical wastes, industrial effluent sludges, sludges and liquid wastes from waste treatment, healthcare and biological wastes, sorting residues, soils and dredging spoils. Some of these may be smaller, more specialised facilities, such as incinerators at hospitals. The R1 facilities accept similar wastes, but they are more important as facilities for dealing with waste oils, wood wastes, sorting residues, and (somewhat surprisingly) 'mineral waste from construction and demolition' and 'combustion wastes' (it is less than clear what energy could be recovered from 180,000 tonnes of combustion wastes, for example).

Non-hazardous Waste

Where non-hazardous wastes are concerned, 2.06 billion tonnes are generated, or which 1.93 billion tonnes are primary wastes. 1.90 billion tonnes of total wastes (1.76 billion tonnes of primary waste and 0.14 billion tonnes of secondary waste,) are reported as treated (see Table 2). The EU was a net importer of wastes which are not considered hazardous, so the 'treatment gap' (generation – treatment – net exports) for non-hazardous waste was 164 million tonnes in 2020. Again, there may be rational explanations for this 'gap', but if those exist, they should be available. Otherwise, the 'gap' appears enormous, being an amount equivalent to around two-thirds of all municipal waste generated (see below).

Table 2: Pattern of Non-Hazardous Waste Generation and Treatment (and trade) in the EU-27, 2020 (tonnes)

Treatment	Non-Hazardous Waste Treated
Total Generated (EU-27)	**2,058,420,000**
D10	5,460,000
R1	122,730,000
R1 + D10	**128,190,000**
Landfill and other	760,500,000
Recovery (Recycling and Backfilling)	1,007,360,000
Total Treatment	**1,896,050,000**
Imports	15,569,909
Exports	14,056,875
Treatment Gap (generation + net imports - amount treated)	**163,883,034**

Source: Eurostat

What is noticeable from the comparison of Table 2 to Table 1, is that whilst the non-hazardous waste generated is more than 20 times the amount of hazardous waste generated, treatment via D10 accounts for only 25% more for non-hazardous waste than hazardous waste. On the other hand, the amount treated via facilities classed as R1 is around 20 times the amount for hazardous waste. While hazardous waste treatment through the R1 method is 1.4 times that of the D10 method, non-hazardous waste treatment through R1 is approximately 22.5 times greater than treatment via D10. Again, there may be rational explanations for this, but given the definition of R1, and given that 63 million tonnes of municipal solid waste were deemed to have been sent to be treated via D10 or R1 facilities in 2021, it requires us to have a plausible explanation for the classification of 60 million tonnes of non-municipal waste being treated at installations reported as R1. Of course, some non-municipal wastes treated via R1 installations will be correctly classified as 'recovery' (where, for example, they are combusted at cement kilns). Another explanation might be that the receiving facilities report non-MSW incineration as R1 even though their R1 status is only conferred for the purposes of dealing with MSW. It is fair to say that the wording is ambiguous in some of the relevant documents, but the wording in the Manual on Waste Statistics seems rather clear on this matter: if non-municipal waste is incinerated at a facility deemed to be R1 for the purposes of treating municipal waste, that is not an R1 operation if that facility's principal purpose is the treatment of waste. If the definition in the Manual was being adhered to, we would be better placed to understand how much non-municipal waste is being treated at facilities dedicated to the treatment of waste, and how much is dealt with at facilities where waste is used 'principally as a fuel or other means to generate energy' (i.e., typically, co-incineration facilities).

Municipal Waste

Statistics on municipal waste have generally received more attention than those considered above. Interest in balancing generation figures with those for treatment has been stronger, even though the quantity generated – 237 million tonnes in 2021 – is only 50% more than the treatment gap for the 2.05 billion tonnes of non-hazardous waste identified above. Some Member States (Bulgaria, Ireland, Italy, and Austria), still had reported no data for 2021 at the time of writing, and Greece had no data for 2020. For these Member States, we used data for the most recent year reported, which was 2020 for all but Greece, for which it was 2019. Our EU-27 aggregates are, as a result, marginally different to those reported by Eurostat. The figures for generation and treatment are shown in Table 3. As with the totality of non-hazardous waste, R1 features far more prominently than D10: indeed, as we argued elsewhere, since the R1 definition has been designed, and then further tweaked, to help all incinerators to comply with the R1 criterion, the distinction between R1 and D10 is now more or less meaningless for municipal waste. Presumably, the remaining D10 treatment – most of which is in Germany, Poland, Italy and the Netherlands – takes place at either older facilities, or ones which have seen

no reason to apply for an R1 determination.[14] More than a quarter of Municipal Solid Waste is treated at R1 facilities, and these account for 98.5% of the combined total treated through R1 and D10.

[14] In Italy, all incinerators have been mandated to be reclassified as R1 by the "Sblocca Italia" decree, which lends further support to the view that the R1 formula, including the CCF, basically fails to make any meaningful distinction between 'recovery' and 'disposal'.

Table 3: Generation and Treatment of MSW, thousand tonnes (2021, except for specific Member States – see text))

Member State	MSW Generated	MSW Treated	Recycled (material)	Composted / Digested	R1 (energy recovery)	D10 (incinera-tion)	Disposal (Landfill etc. not D10)
Belgium	8,795	8,980	2,749	1,894	4,259	2	31
Bulgaria	2,829	2,673	908	89	129	0	1,422
Czechia	5,991	6,103	1,835	762	722	4	2,768
Denmark	4,601	4,740	536	1,044	3,157	0	3
Germany	53,748	53,748	25,047	12,491	15,641	385	185
Estonia	525	518	142	18	255	0	103
Ireland	3,210	3,181	948	351	1,353	0	517
Greece	5,613	5,613	898	283	74	0	4,359

Member State	MSW Generated	MSW Treated	Recycled (material)	Composted / Digested	R1 (energy recovery)	D10 (incinera-tion)	Disposal (Landfill etc. not D10)
Spain	22,374	22,374	4,262	3,940	2,566	0	11,605
France	38,013	38,389	9,626	7,326	11,793	54	9,412
Croatia	1,767	1,590	467	89	5	0	1,030
Italy	28,945	26,304	8,004	6,868	5,457	158	5,817
Cyprus	570	455	78	7	14	0	354
Latvia	869	868	314	69	30	0	456
Lithuania	1,345	1,290	354	240	473	0	207
Luxembourg	508	508	152	128	207	0	20
Hungary	4,042	4,042	1,029	382	500	3	2,061

Member State	MSW Generated	MSW Treated	Recycled (material)	Composted / Digested	R1 (energy recovery)	D10 (incinera-tion)	Disposal (Landfill etc. not D10)
Malta	317	325	43	0	13	0	269
Netherlands	9,034	9,034	2,519	2,701	3,608	84	122
Austria	7,438	7,438	3,006	1,592	2,662	7	137
Poland	13,674	13,674	3,681	1,824	2,702	171	5,296
Portugal	5,311	5,671	726	893	1,237	0	2,816
Romania	5,768	5,345	384	270	335	0	4,356
Slovenia	1,077	844	493	152	97	21	66
Slovakia	2,702	2,656	901	419	219	0	1,099
Finland	3,376	3,376	831	422	2,103	6	14

Member State	MSW Generated	MSW Treated	Recycled (material)	Composted / Digested	R1 (energy recovery)	D10 (incinera-tion)	Disposal (Landfill etc. not D10)
Sweden	4,352	4,356	867	851	2,599	0	24
EU - 27	**236,794**	**234,095**	**70,800**	**45,105**	**62,210**	**895**	**54,549**
Treatment Shares, EU-27 (%)			30.2%	19.3%	26.6%	0.4%	23.3%

Source: Eurostat

Industry Data – CEWEP

The industry body, the Confederation of European Waste-to-Energy Plants (CEWEP), also provides data regarding waste-to-energy facilities in Europe. The 2020 data, which relates to the amount of waste treated, and excludes hazardous waste, are shown in Table 4. This data indicates a quantity treated just below 81 million tonnes in 2020. This lies somewhat between the 63 million tonnes of MSW treated at (D10 and) R1 facilities in 2021 and the 128 million tonnes of non-hazardous waste treated at D10 and R1 facilities in 2020.

This suggests that the CEWEP figures could be capturing the non-hazardous waste treated at facilities dedicated to the treatment of waste. Some of this data, however, may not necessarily capture all waste treated at such facilities.

Table 4; Number of Waste-to-energy Facilities and Amount of Non-hazardous Waste Treated In EU-27 Member States (2020)

Member State	Number	Amount Treated (million tonnes)	Average Quantity of Waste Treated per facility (tonnes)
Belgium	17	3.47	204,118
Bulgaria			
Czechia	4	0.7	175,000
Denmark	25	3.66	146,400
Germany	100	27	270,000
Estonia	1	0.22	220,000
Ireland	2	0.8	400,000
Greece			

Member State	Number	Amount Treated (million tonnes)	Average Quantity of Waste Treated per facility (tonnes)
Spain	13	2.76	212,308
France	117	14.26	121,880
Croatia			
Italy	37	6.24	168,649
Cyprus			
Latvia			
Lithuania	2	0.42	210,000
Luxembourg	1	0.17	170,000
Hungary	1	0.37	370,000
Malta			
Netherlands	12	7.57	630,833
Austria	11	2.6	236,364
Poland	7	0.97	138,571
Portugal	4	1.16	290,000
Romania			

Member State	Number	Amount Treated (million tonnes)	Average Quantity of Waste Treated per facility (tonnes)
Slovenia			
Slovakia	2	0.23	115,000
Finland	9	1.39	154,444
Sweden	37	6.89	186,216
EU - 27	**402**	**80.88**	**201,194**

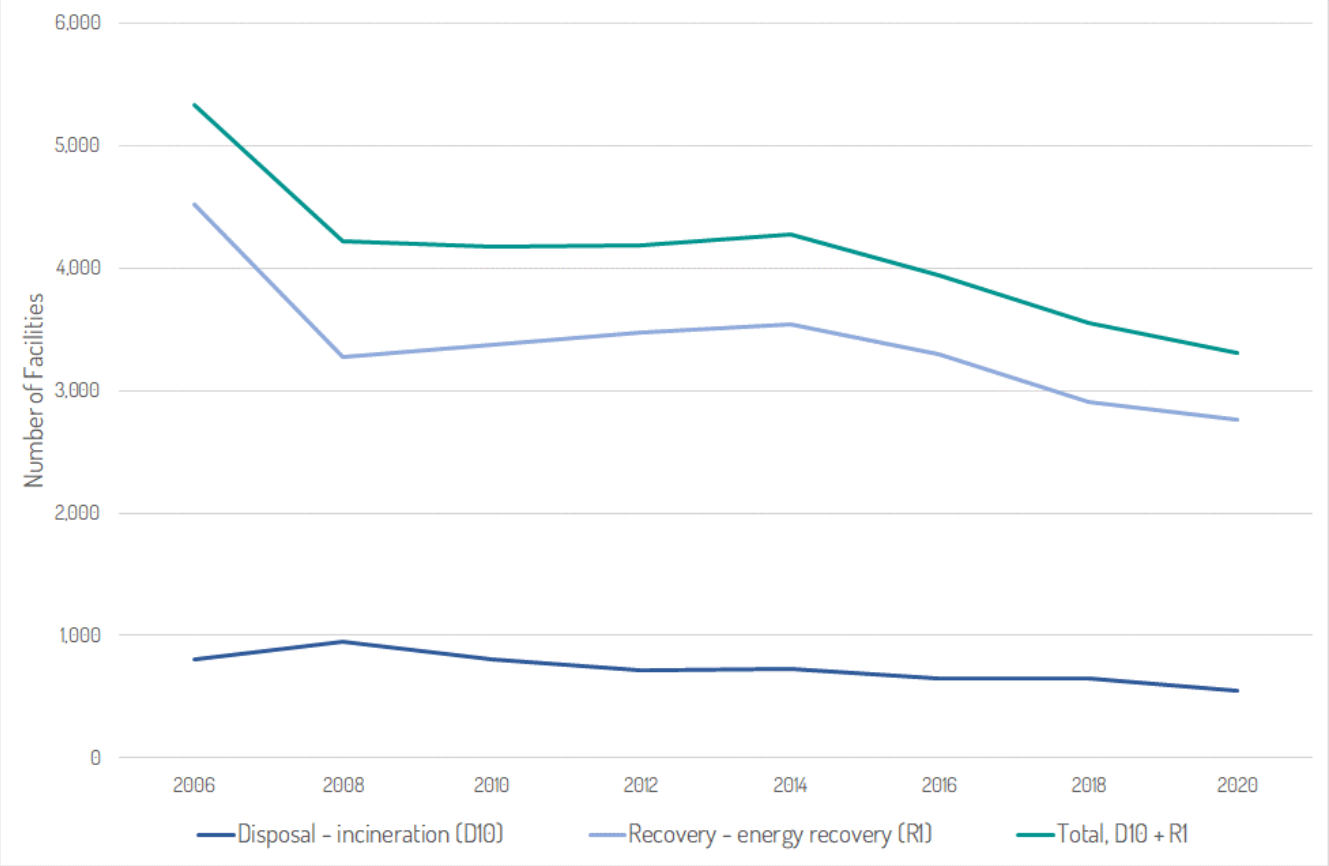
Source: CEWEP

Capacity Data for D10 and R1 Facilities

Eurostat also reports data on treatment capacity. The amount treated is expected to be less than the total treatment capacity available since (amongst other reasons) permitted capacity typically represents a maximum allowable quantity that can be incinerated, incinerators undergo routine maintenance / temporary closures, and co-incineration facilities may be in competition for feedstock of a suitable quality.

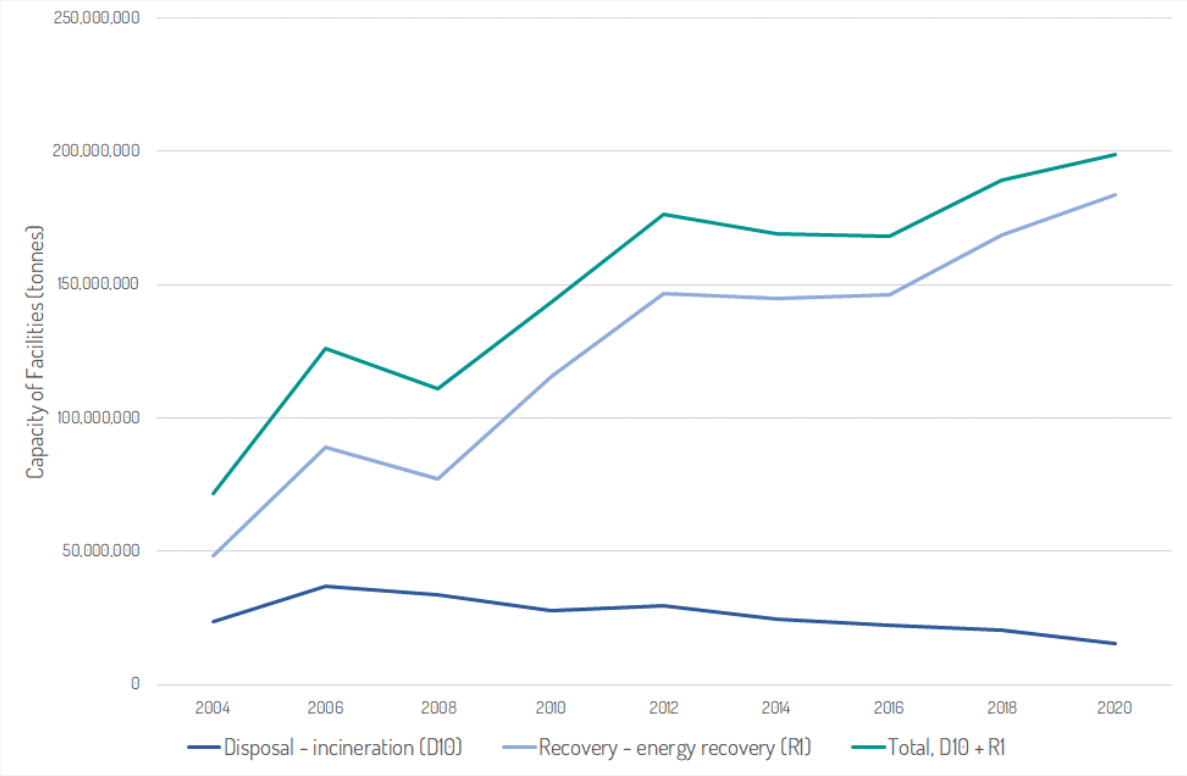
As regards D10 and R1, Eurostat gathers data on both the number of facilities and their capacity. The evolution over time in the former is shown in Figure 1, and evolution in the latter is shown in Figure 2. The number of facilities has declined steeply over the period 2006-2020, perhaps with the closure of older and smaller facilities, but capacity has increased significantly over the same period. In the EU-27, in 2004, combined capacity of R1 and D10 facilities was 71.9 million tonnes, but by 2020, this had increased to 198.8 million tonnes, indicating a compound annual growth rate of 6.6%. Successive revisions of the Waste Framework Directive will have led to A) a shift in capacity from D10 to R1, representing, in part, a switch in categorisation facilitated by the 2008 Directive (and also allowing freer movement of waste for incineration within the EU), B) an increase in installed capacity as the emphasis on moving waste up the hierarchy became more strongly enshrined in policy and law following the 2008 Directive, and C) renewed emphasis on avoiding the landfilling of municipal waste (through resort to R1) as a result of the 2018 Directive.

Figure 1: Evolution in Number of D10, R1 and D10+R1 Facilities, 2006-2020



Source: Eurostat

Figure 2: Evolution in Capacity of D10, R1 and D10+R1 Facilities, 2004-2020 (tonnes)



Source: Eurostat

Capacity as of 2020 stood at:

- 183.5 million tonnes at R1 facilities;
- 15.3 million tonnes at D10 facilities; and
- 198.8 million tonnes at R1 and D10 facilities combined.

The historic trend in capacity evolution in the EU has been for 8 million tonnes of capacity to be added annually over the period 2004-2020. On that basis, capacity may now (in the latter half of 2023) have reached around 220 million tonnes, although the COVID-19 pandemic may have slowed the pace of construction of new facilities.

In the period from 2010-2020, hazardous and non-hazardous waste, excluding major mineral waste, treated under D10 and R1 increased by 17 million tonnes whilst the amount of the same waste recycled increased by 28 million tonnes in the same period.

Nature of Wastes Treated Through R1 and D10 Facilities

Categories Being Treated in 2020

In considering how much demand there could be for incineration in future, it is of interest to note the nature of wastes which are currently being treated at R1 and D10 facilities. Given the far greater quantity of non-hazardous waste generated, and the fact that the majority of waste treated via D10 and R1 is non-hazardous, we have focused on treatment of the non-hazardous wastes.

In Table 5, we show the waste categories treated by D10 facilities and R1 facilities, and the two combined, and the proportion of the quantity treated accounted for by each waste category. The waste categories are listed in order of the proportion they contribute to the combined quantity of waste managed through D10 and R1 facilities. 13 waste categories account for 98% of all waste sent to R1 and D10 facilities. One interesting insight into the waste treated through D10 and R1 is that the second largest contributing category is 'Sorting residues': these are described, in the Manual on Waste Statistics, as follows:

> These wastes are sorting residues from mechanical sorting processes for waste; combustible waste (refuse derived fuel); and non-composted fractions of biodegradable waste. They mainly originate from waste treatment and separate collection. Sorting residues from demolition activities are excluded. They are hazardous when containing heavy metals or organic pollutants.

These would include, therefore, RDF / SRF, and such wastes may be more likely to be sent to co-incineration facilities. It is also notable that the category for which the share of total generation managed through R1 and D10 is highest (41%) is wood wastes.

We noted previously that there were 198.8 million tonnes of capacity at R1 and D10 facilities combined. We also noted that the combined quantity of waste treated through R1 and D10 was 10.5 million tonnes of hazardous waste and 128.2 million tonnes of non-hazardous waste. Although capacity estimates will be approximate (capacity likely depends, in part, on the calorific value of what is received, especially for dedicated waste treatment facilities), these figures suggest that in theory, there is already capacity to treat more than 60 million tonnes of additional waste through existing D10 and R1 installations.

Table 5: Non-hazardous Wastes Treated by D10 and R1 Facilities in 2020 (tonnes / %)

	D10		R1		D10+R1		D10 + R1 as % of Waste Category Generated
Household and similar wastes	2,240,000	41%	47,070,000	38%	49,310,000	38%	**37.4%**
Sorting residues	650,000	12%	30,560,000	25%	31,210,000	24%	**35.0%**
Wood wastes	110,000	2%	19,680,000	16%	19,790,000	15%	**41.0%**
Mixed and undifferentiated materials	270,000	5%	6,940,000	6%	7,210,000	6%	**18.1%**
Animal and mixed food waste	430,000	8%	4,730,000	4%	5,160,000	4%	**20.4%**
Common sludges	980,000	18%	2,410,000	2%	3,390,000	3%	**19.6%**
Plastic wastes	40,000	1%	2,640,000	2%	2,680,000	2%	**14.1%**
Industrial effluent sludges	120,000	2%	1,680,000	1%	1,800,000	1%	**15.9%**
Vegetal wastes	10,000	0%	1,780,000	1%	1,790,000	1%	3.3%
Animal faeces, urine and manure	450,000	8%	840,000	1%	1,290,000	1%	9.2%
Mineral waste from construction and demolition	0	0%	1,110,000	1%	1,110,000	1%	0.4%
Rubber wastes	0	0%	850,000	1%	850,000	1%	**29.1%**
Health care and biological wastes	40,000	1%	530,000	0%	570,000	0%	**27.5%**
Paper and cardboard wastes	0	0%	470,000	0%	470,000	0%	1.1%

	D10		R1		D10+R1		D10 + R1 as % of Waste Category Generated
Combustion wastes	0	0%	440,000	0%	440,000	0%	0.6%
Other mineral wastes	10,000	0%	380,000	0%	390,000	0%	0.1%
Chemical wastes	60,000	1%	180,000	0%	240,000	0%	1.4%
Textile wastes	10,000	0%	220,000	0%	230,000	0%	**11.8%**
Metal wastes, ferrous	0	0%	100,000	0%	100,000	0%	0.2%
Sludges and liquid wastes from waste treatment	10,000	0%	50,000	0%	60,000	0%	0.6%
Mineral wastes from waste treatment and stabilised wastes	0	0%	50,000	0%	50,000	0%	0.1%
Soils	10,000	0%	10,000	0%	20,000	0%	0.0%
Acid, alkaline or saline wastes	10,000	0%	0	0%	10,000	0%	0.2%
Glass wastes	0	0%	10,000	0%	10,000	0%	0.1%

Source: Eurostat, and calculations based on Eurostat data

"In theory, there is already capacity to treat more than 60 million tonnes of additional waste through existing D10 and R1 installations."

Dominic Hogg, Director, Equanimator

In the final column, we show the proportion of each waste category which is currently processed via D10 and R1 combined. This final column gives a rough indication of how well suited each waste category may be to D10 and R1 incineration / co-incineration, or the extent to which a given waste category is sought out by operators. D10 and R1 dealt with 18% of all non-hazardous waste generated in 2020. Waste categories for which the share managed through D10 and R1 are much higher than this would seem to be well-suited to incineration. Those wastes for which the share is far lower, though, might not be considered to be so well-suited.

'Textiles' is the only waste category outside the top 13 contributing categories for which more than 10% of generation is managed through D10 and R1 facilities. Textile wastes are generated by the leather and fur industry, the textile industry, the mechanical treatment of waste and unrecycled wastes from separate collection. This category does not include the textiles which are not separated (potentially) for recycling, and which remain in leftover mixed wastes from households and businesses: these are included within the categories 'household and similar wastes', 'mixed and undifferentiated materials' and 'sorting residues'.

This final column gives an indication of the categories of non-hazardous waste likely to be suitable for D10 and R1 in future under various scenarios.

How Much of the Wastes Suitable for Treatment through R1 and D10 is Currently Sent to Landfill and Other (non-D10) Disposal?

We can start by considering what might be described as the most extreme case, in which we consider how much waste would be available for D10 and R1 if all of the classes of waste suitable for such treatment, but which are currently sent to landfill and other disposal routes, were made available for D10 and R1 facilities. The total quantity of each type of waste is shown in Table 6, and amounts to 75.6 million tonnes. More than 70

million tonnes is associated with three categories: Household and similar wastes; Sorting residues; and Mixed and undifferentiated materials.

Table 6: Wastes Potentially Suitable for Management via D10 and R1 Which are Currently Sent to Landfill and Other (not D10) Disposal

Waste Category (EWC-Stat)	Quantity Sent to Landfill / Other (not D10) Disposal (tonnes)
Household and similar wastes	30,490,000
Sorting residues	34,380,000
Wood wastes	120,000
Mixed and undifferentiated materials	5,420,000
Animal and mixed food waste	1,180,000
Common sludges	1,240,000
Plastic wastes	590,000
Industrial effluent sludges	1,390,000
Vegetal wastes	860,000
Animal faeces, urine and manure	50,000
Rubber wastes	0
Health care and biological wastes	50,000
Textile wastes	150,000
TOTAL	**75,920,000**

Source: calculated from Eurostat data

We noted above that there were already 60.1 million tonnes of D10 and R1 capacity not being utilised (as of 2020). In the somewhat unlikely scenario of all the above wastes being pushed away from disposal and being suitable for the remaining D10 and R1 capacity, and with recycling at 2020 levels, then the shortfall in capacity would be 15.8 million tonnes.

This scenario is unlikely for a range of reasons. Neither the supply side – the quantity of waste available – is likely, and for a range of reasons. For example:

- If the EU-27 meets the targets it is seeking to achieve in future as regards recycling of packaging, municipal waste (and reuse and waste prevention), and textiles, then the quantity available – as regards at least two of the three main contributing categories (i.e., household and similar wastes, sorting residues) in Table 6 – is likely to decline significantly (see below);

- Policy might simply not support the scenario being envisaged: for example, even the restriction on landfilling of municipal waste in the Waste Framework Directive allows Member States to landfill 10% of the amount generated – it does not propose an outright ban. As another example, some Member States have adopted various degrees of restrictions for sludge spread to land, which implies incineration of some such wastes, but many others do not;
- Linked to the previous point, the economics may favour landfill disposal: where non-municipal wastes are concerned, if the waste is not suitable for co-incineration (or if that option is not available), then incineration ought to be considered 'disposal' (D10), and no higher in the waste hierarchy than landfilling (at least as regards EU policy and law).[15]
- The available 'surplus' capacity – for example, of R1 co-incineration - might not always be well 'matched' to the available wastes. Incinerators receive a considerable quantity of sorting residues, some of which may be derived from Mechanical Biological Treatment (MBT) facilities which prepare a combustible fraction, and a fraction suitable for landfilling: it seems unlikely that all sorting residues would be suitable for R1 when some are the landfilled output of facilities part of whose rationale is to prepare waste for co-incineration.

As regards the penultimate bullet point above, the combined effect of existing Member State taxes and restrictions is likely to be complemented by the inclusion, in future, of incineration within the EU-Emissions Trading Scheme. Some Member States have already made clear their intention to opt-in incineration, whilst others already do so. The effect would likely be to increase the emphasis on movement of waste management up the hierarchy, with businesses and municipalities seeking to reduce the quantity of wastes already being sent to R1 and D10 through prevention and recycling. This would be expected to affect some materials already sent for incineration, as well as some wastes not covered by the targets mentioned above.

Effect of the Municipal Waste Targets

Recycling targets set out in Article 11(2) of the WFD for municipal waste are:

> *(c) by 2025, the preparing for re-use and the recycling of municipal waste shall be increased to a minimum of 55 % by weight;*
>
> *(d) by 2030, the preparing for re-use and the recycling of municipal waste shall be increased to a minimum of 60 % by weight;*
>
> *(e) by 2035, the preparing for re-use and the recycling of municipal waste shall be increased to a minimum of 65 % by weight.*

[15] We have argued previously that the R1 recovery definition has become somewhat meaningless (see D. Hogg (2023) Debunking Efficient Recovery: The Performance of EU Incineration Facilities, Report for Zero Waste Europe, January 2023).

Some Member States may be eligible for a 5-year postponement. If we use 2021 data (the latest available), then we can estimate how much additional recycling would be required for each Member State to meet its 65% recycling target. The required amount is 36.4 million tonnes, equivalent to just under half of all the non-hazardous waste that was landfilled in 2020 in the EU27.

We noted above that there were already 60.1 million tonnes of D10 and R1 capacity not being utilised (as of 2020), and that if no further recycling took place, then there would be a shortfall in capacity of 15.8 million tonnes if all suitable wastes currently landfilled were sent to be managed via D10 and R1. **The additional 36.4 million tonnes of municipal wastes required to be recycled by 2035 (based on current rates of generation) would change that position significantly: the capacity deficit moves to a surplus of 20.6 million tonnes.** The same caveats still apply as those mentioned above: that the supply and demand sides are unlikely to match up so straightforwardly. Nonetheless, the suggestion is that with some careful management of existing capacity, there is enough capacity available to deal with all non-hazardous wastes once one considers the need to achieve recycling rates of 65% in future.

It might be argued that MSW quantities are growing at the EU level and so the quantity of residual MSW requiring management would rise accordingly. **At a compound annual growth rate of 1.08% (the level between 2012 and 2021), the additional residual waste by 2035 would be of the order 13.4 million tonnes, so that there would still be a surplus of R1 and D10 capacity even under a situation where the amount of non-hazardous waste sent to landfill was zero.**

The Waste Framework Directive does allow for 10% of MSW to continue to be landfilled: Member States are not required to eliminate landfill completely. If one assumes that those Member States who already landfill less than 10% of their MSW (typically those with restrictions or bans in place) continue to landfill at the current (below 10% of MSW) levels, and if one assumes that those above 10% simply meet the 10% restriction in future, that would allow for the continued landfilling of 15 million tonnes MSW (rising close to 19 million tonnes if MSW grows at 1.08% between now and 2035). **Under the assumption of zero growth in MSW, then the surplus of D10 and R1 capacity would be 35.6 million tonnes, or under the 1.08% growth rate assumption, 26.2 million tonnes.**

Either in their quest to meet recycling targets, or in their attempt to reduce the contribution of incineration to climate change, of for both reasons, then as we have indicated elsewhere, there is an opportunity to deploy Leftover Mixed Waste Sorting (LMWS) to waste leftover after separate collection.[16] Because there is a rationale for focusing on (and a relative emphasis on) extracting plastics for recycling, the effect tends to be to reduce the calorific value of the remaining waste. **In principle, existing incinerators' capacity to deal with waste could be increased as a result of the drop in calorific value associated with removal of plastics** (since such facilities are generally limited in their capacity by the overall calorific content of waste being treated).

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It is worth considering what wastes might be suitable for LMWS. In the above discussion, regarding how much waste could, in theory, be made available to D10 and R1, we noted some key categories of waste, including 'sorting residues'. Some sorting residues may be the output of existing, often relatively unsophisticated (in terms of their ability to sort plastics, for example) facilities which sort leftover mixed waste (LMW), though others may be the output of facilities used to sort wastes which were separately collected. There are currently around 92 million tonnes of two categories - Household and similar wastes and Mixed and undifferentiated materials - currently either treated at D10 and R1 facilities or landfilled. In addition, there are 66 million tonnes of 'sorting residues'. If we assume all household and similar wastes and mixed undifferentiated materials, and around 30 million tonnes of waste entering facilities oriented (currently) to preparing refuse derived fuel / solid recovered fuel, could be subject to LMWS, but that the quantity is reduced by the additional amount of MSW required to be recycled, then just over 80 million tonnes would be eligible for such treatment.[17] The resulting output would be capable of being managed at facilities currently managing around 56 million tonnes of waste of a higher calorific value. This would effectively free up an additional 24 million tonnes of capacity.

The resulting surplus relative to current R1 and D10 capacity (with the above measures applied) would increase to around 60 million tonnes, or much the same level of surplus as exists on paper today (the figure is just over 50 million tonnes if one assumes growth in MSW). In other words, **even if *all* wastes 'broadly suitable' for management via R1 and D10 were sent to such facilities, then if recycling targets are met, and if LMWS systems are widely deployed, roughly the same capacity of R1 and D10 treatment would be required as is required today**. It seems reasonable to ask why any additional capacity is required.

[17] As of early 2017, ecoprog estimated that in Europe, there were 'around 570 active MBT plants with a treatment capacity of 55 million tons' (up from 490 with a capacity of 47 million tonnes in 2015). ecoprog expected a further 120 facilities with an estimated capacity of almost 10 million annual tons to be commissioned between 2017 and 2025 (see ecoprog.com/publications/report-market-for-mbt-plants-in-europe-2017 and Mark Döing (2016) The Market for Mechanical Biological Waste Treatment Plants in Europe, Waste Management, Volume 6, September 2016). Capacity for MBT in Germany was estimated as 3.9 million tonnes in 2022, with throughput of the order 3.2 million tonnes (ASA (2022) Gewährleistung der Entsorgungssicherheit durch mechanisch-biologische Abfallbehandlungsanlagen: Arbeitsgemeinschaft stoffspezifische Abfallbehandlung e. V., 23 June 2022, (www.asa-ev.de/fileadmin/Media/ASA-EV/Downloads/PDF/ASA_e._V._Notfallplan_Gas_-_Gewaehrleistung_der_Entsorgungssicherheit_durch_stoffspezifische_Abfallbehandlung_final.pdf). In 2020 in Italy, 18.5 million tonnes of authorised capacity for MBT accounted for treatment of 9.5 million tonnes of urban residual waste, mainly leftover mixed wastes (ISPRA (2021) Rapporto Rifiuti Urbani, Edizione 2021, Rapporti 355/2021, December 2021). In Spain, some 11.8 million tonnes of residual MSW were treated either through aerobic or anaerobic treatment, with a further 1.6 ,million tonnes treated at sorting plants prior to thermal treatment (MITECO (2020) Memoria Anual de Generación y Gestión de Residuos: Residuos de Competencia Municipal. 2019, www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/publicaciones/memoriaanual2019generacionygestionresiduosrescompetenciamunicipal_tcm30-534462.pdf).
Our figure of 30 million tonnes is an estimate of the current quantity treated through such facilities in the EU as a whole (Germany, Italy and Spain together account for 26.1 million tonnes). Whilst these facilities may remove some plastics, alongside some metals, they have not always been specifically configured with high quality sorting systems for removal of a range of plastics, with plastics mainly valued for calorific value rather than for the embodied carbon and energy savings.

Municipal Waste: Spatial Considerations

One can look more closely at the situation for MSW by examining Table 7. This shows the situation, in aggregate, for each Member State. In the Table, we assume:

- No growth in waste;
    - For Member States already reported to be exceeding the recycling target, there is no change in the recycling rate;
    - For those below the 65% target, the additional recycling is calculated based on a 'gap to 65% recycling' (relative to most recent recycling rate figures). The required increase in recycling is assumed to reduce residual waste on a one-to-one basis;
    - For Member States currently landfilling less than 10% of MSW, the level of landfilling remains as today (we effectively assume that this is the effect of existing restrictions and bans, so that further reduction in landfilling is unlikely);
    - Other Member States (landfilling more than 10%) continue to landfill 10% of MSW (in principle, this waste could be stabilised prior to landfilling).

There are 15 Member States for whom there would be a need for additional 'non-landfill' treatment if they achieved – exactly – a 65% recycling rate, and if there was no further increase in MSW generation. For 12 Member States, however, the 'gap' as regards 'non-landfill' waste management is negative. These might be regarded as those Member States who, at least relative to current treatment patterns of MSW are concerned, have excess capacity relative to what is required to 'just meet' the targets. The balance between the two is shown at the bottom of Table 7. There is, across the EU-27, a need for an additional 8.57 million tonnes of non-landfill capacity in those Member States still short of their targets. On the other hand, around 9.35 million tonnes of such capacity would be freed up as a result of the extra recycling taking place in other Member States. For the EU as a whole, there is a net surplus of capacity (relative to 2021, or latest year where not available) of 0.78 million tonnes.

These imbalances, however, are (unsurprisingly) unevenly distributed in the spatial sense. Figure 3 shows the spatial distribution of additional capacity required (light grey) and capacity 'freed-up' (dark grey).

Table 7: Additional Non-landfill Treatment Required (or surplus emerging) Where Member States Meet 65% Recycling Target, and Landfill 10% of MSW (or existing level if already less than 10% is landfilled) ('000 tonnes)

	Recycling Rate	Additional Tonnes to be Recycled to Achieve 65%	Landfilled in Year	10% MSW Allowable to Landfill (or current, if already lower)[1]	Non-landfill Treatment Required (+ve) / Freed-up (-ve)[1]
EU-27	**50%**	**36,416**	**54,147**	**14,989**	**-780**
Belgium	53%	1,029	31	31	-1,029
Bulgaria[2]	35%	842	1,422	283	297
Czechia	43%	1,297	2,768	599	872
Denmark	34%	1,411	3	3	-1,411
Germany	71%	n/a	185	185	0
Estonia	30%	182	103	53	-132
Ireland[2]	41%	777	517	321	-581

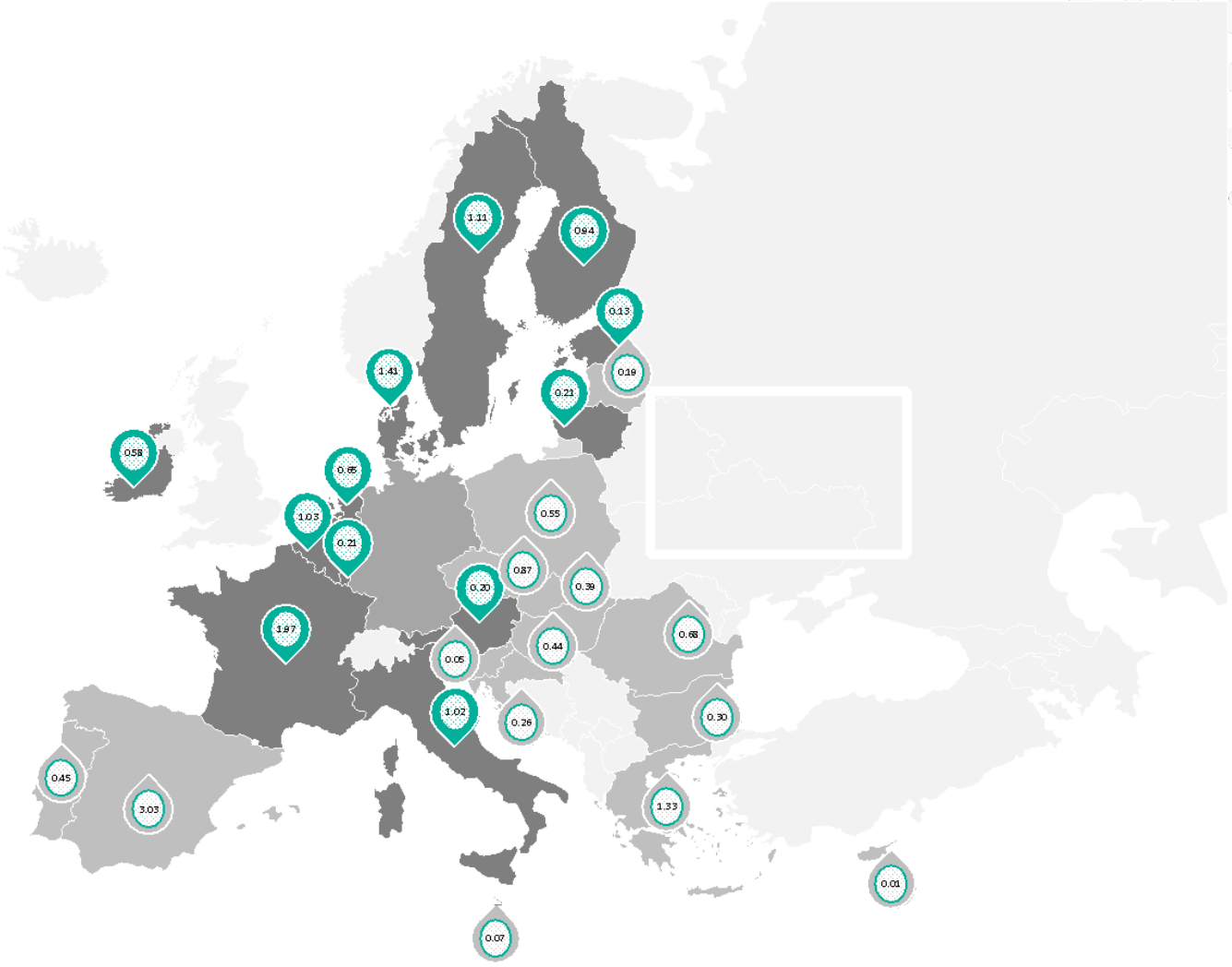
	Recycling Rate	Additional Tonnes to be Recycled to Achieve 65%	Landfilled in Year	10% MSW Allowable to Landfill (or current, if already lower)[1]	Non-landfill Treatment Required (+ve) / Freed-up (-ve)[1]
Greece[3]	21%	2,468	4,359	561	1,329
Spain	37%	6,341	11,605	2,237	3,027
France	45%	7,578	9,412	3,801	-1,968
Croatia	31%	594	1,030	177	260
Italy[2]	51%	3,942	5,817	2,895	-1,020
Cyprus	15%	284	354	57	14
Latvia	44%	182	456	87	187
Lithuania	44%	278	207	135	-206
Luxembourg	55%	49	20	20	-49

	Recycling Rate	Additional Tonnes to be Recycled to Achieve 65%	Landfilled in Year	10% MSW Allowable to Landfill (or current, if already lower)[1]	Non-landfill Treatment Required (+ve) / Freed-up (-ve)[1]
Hungary	35%	1,216	2,061	404	441
Malta	14%	163	269	32	74
Netherlands	58%	652	122	122	-652
Austria[2]	62%	203	137	137	-203
Poland	40%	3,383	5,296	1,367	546
Portugal	30%	1,833	2,816	531	452
Romania	11%	3,095	4,356	577	684
Slovenia	60%	54	66	66	-54
Slovakia	49%	436	1,099	270	393

	Recycling Rate	Additional Tonnes to be Recycled to Achieve 65%	Landfilled in Year	10% MSW Allowable to Landfill (or current, if already lower)[1]	Non-landfill Treatment Required (+ve) / Freed-up (-ve)[1]
Finland	37%	942	14	14	-942
Sweden	40%	1,109	24	24	-1,109
Total, MS Where Additional Capacity is Required					**8,574**
Total, MS Where Capacity is Freed Up					**9,354**

Notes: [1] Assumes that landfilling stays at current rate where the quantity landfilled is already <10%. This is typically in countries with bans / restrictions, so was deemed unlikely to fall further; [2] Data are for 2020; [3] Data are for 2019.

Figure 3: Spatial Allocation of Additional Capacity Requirement (lighter grey) and Capacity Released (darker grey) in 65% Recycling Scenario (million tonnes)



Source: Figures based on Equanimator calculations (graphic format by PresentationGO.com)

The additional non-landfill capacity freed up is predominantly in the north and west, though France, Italy and Austria also see additional capacity being freed up. It would be possible to consider a managed use of capacity taking place, with movements of waste occurring from Portugal and Spain into France, Italy and Benelux countries, Slovenia and Croatia making use of capacity in Italy and Austria, Latvia making use of the plentiful excess capacity in Nordic countries and the neighbouring Baltic States, and Poland making use of capacity in Denmark, Austria, and perhaps Germany. Bulgaria, Romania and Greece would have an additional capacity requirement of around 2.3 million tonnes, and theirs are the wastes furthest from Member States who are likely to see capacity freed up. Exports by ship via Greece to Italy could take place, as could road shipments over longer distances.

A possible alternative scenario is that competition for waste (as a feedstock for R1 and D10 facilities) increases as the amount of waste available for incineration falls. In that event, what may happen is that waste 'shunts' towards those Member States where the shortfall of feedstock (relative to capacity) is most pressing (and where, as a result, the prices for incineration and co-incineration are lowest). The effect of this might be, for example, that Finnish waste moves to Sweden, Baltic States send more to Finland, Poland sends more to Baltic States, and so on. That might lead to additional capacity appearing in Member States where there might otherwise appear to be none, though evidently, capacity cannot be freed up where none currently exists. Unutilised R1 capacity in the countries concerned in 2020 was:

- Just over 1 million tonnes of R1 capacity in Bulgaria;
- No capacity in Greece; and
- 5.25 million tonnes of R1 capacity in Romania

It may be possible to make use of other unutilised R1 capacity to manage suitably pre-treated wastes, if the view was taken that the distances to be covered were excessive. There are, though, already significant movements over considerable distances of some relevant waste streams. Three of the top 5 non-hazardous waste categories exported by Member States are sent to R1 facilities, and each of these three streams is likely to be municipal-type waste, or derived from it (see Table 8). The total quantity of these wastes reported as exported was around 4 million tonnes in 2020.

Table 8: Top 10 non-hazardous wastes exported, by European List of Waste (LoW) code, main treatments, exporting EU Member States and destination countries, 2020

Waste category	LoW code	Total quantity exported	Recovery / Disposal code	Quantity exported	Main exporting Member State	Quantity exported	Main destination country	Quantity imported from EU Member States
Soil and stones other than those containing hazardous substances (mentioned in 17 05 03*)	17 05 04	3 709 057	R5	3 466 259	Luxembourg	2 137 060	France	2 271 195
Wood other than that containing dangerous substances (mentioned in 19 12 06*)	19 12 07	2 711 674	R3	1 399 468	Germany	743 359	Germany	493 679
Other wastes (including mixtures of materials) from mechanical treatment of wastes other than those containing hazardous substances (mentioned in 19 12 11*)	19 12 12	2 146 405	R1	1 556 961	Italy	528 858	Netherlands	377 811
Combustible waste (refuse derived fuel)	19 12 10	1 191 902	R1	1 105 084	Germany	363 853	Sweden	165 314
Mixed municipal waste	20 03 01	675 769	R1	650 942	Netherlands	196 733	Germany	255 416
Bottom ash and slag other than those containing hazardous substances (mentioned in 19 01 11*)	19 01 12	633 259	R12	247 784	Belgium	210 015	Netherlands	493 408
Dredging spoil other than those containing hazardous substances (mentioned in 17 05 05*)	17 05 06	528 645	R5	461 885	Belgium	256 813	Netherlands	255 788
Mixtures of concrete, bricks, tiles and ceramics other than those containing hazardous substances (mentioned in 17 01 06*)	17 01 07	418 945	R5	418 924	Germany	287 430	France	232 281
Sludges from treatment of urban waste water	19 08 05	402 879	D10	156 254	Netherlands	176 833	Germany	151 650
Fibre rejects, fibre-, filler- and coating sludges from mechanical separation	03 03 10	242 226	R5	167 720	Germany	160 571	Netherlands	81 707

Note: The Recovery and Disposal codes refer to the operations included in Annex IA of the Waste Shipments Regulation (WshipR) and Annexes I and II of the Waste Framework Directive.
The treatment code 'Mix' means that, for the stated quantity, more than one treatment code has been allocated to the waste type in the reporting.
Source: Eurostat Waste Shipment Statistics,
ec.europa.eu/eurostat/statistics-explained/index.php?title=Waste_shipment_statistics#Non-hazardous_waste_.E2.80.93_main_treatment_and_exporting_and_importing_countries

Effect of Additional / Early MSW Recycling

If all Member States landed exactly on the desired level of MSW recycling (65%) and on the exact target date, that would indeed be a fortuitous outcome. Deliberately seeking to achieve such an outcome would be extremely risky. If every Member State is to meet its 65% target, some (or all) will achieve recycling rates above this. Germany was already reporting a recycling rate of 71% in 2021.[18] It should also be noted that there is a need to meet, simultaneously, other recycling targets (such as those in relation to packaging waste), whilst different Member States will likely have their own strategies to prevent waste, and enhance the contribution of improved waste management to meeting climate change objectives.

If we suppose that Member States were to achieve, on average a recycling rate of 70%, the number of Member States requiring additional non-landfill treatment capacity would fall from 15 to 11, and the capacity requirement of those 11 Member States would be 5.1 million tonnes, whilst 15.1 million tonnes of capacity would have freed up in other countries. The net capacity surplus for residual waste would have increased to 9.9 million tonnes.

At a rate of 75% recycling, the capacity requirement of 10 Member States needing such would be 2.3 million tonnes, whilst 23.6 million tonnes of capacity would have freed up in other countries. The net capacity surplus for residual waste would have increased to 21.2 million tonnes. The remaining requirement for capacity is somewhat more evenly distributed, though with Greece and Spain still requiring the greatest amount of additional capacity. Bulgaria, on the other hand, would barely require additional capacity, though Czechia, Slovakia and Romania would still have a need for some additional non-landfill capacity.

The remaining capacity requirement – assuming 10% of waste is still landfilled, and that a 75% recycling rate was achieved – would be as in Table 8 when expressed in terms of the level of waste generation. Unless, today, a significant share of landfilled waste is already pre-treated prior to landfilling, then it would be possible for countries for whom the additional capacity requirement is no more than around 5% of the total MSW generated to close the gap through biological stabilisation of waste prior to landfilling. In other words, instead of sending 10% of waste direct to landfill, 15% of waste would be sent for stabilisation (preferably, having been sorted – see below), with the stabilised output landfilled following pre-treatment.[19] The mass loss from biodegradation and from moisture loss would be expected to keep the landfilled quantity below 10%.

[18] The accuracy of all Member State reporting, against a consistently applied definition of MSW, and of what counts as recycling, is quite reasonably questioned, not least as definitions have changed, and the method for measurement of recycling has changed (see Eunomia (2017) Recycling – who really leads the world? Identifying the world's best municipal waste recyclers, December 2017 www.eunomia.co.uk/reports-tools/recycling-who-really-leads-the-world-issue-2

[19] This would also ensure compliance with the obligation on pretreatment as stipulated in the Landfill Directive 1999/31.

Table 9: Additional non-landfill Capacity Required @ 75% MSW Recycling (% of MSW)

Member State	Additional non-landfill Capacity Required @ 75% MSW Recycling (% of MSW)	
Greece	14%	Treatment Gap Implies Need for Some Additional Capacity to Treat Residual
Malta	13%	
Latvia	12%	
Croatia	5%	Treatment Gap may be Manageable through Biological Stabilisation
Czechia	5%	
Slovakia	5%	
Spain	4%	
Romania	2%	
Hungary	1%	
Bulgaria	1%	

Of the three remaining Member States, Latvia would be well placed to make use of capacity freed up in neighbouring countries, whilst Malta could ship the relatively small amount of waste requiring treatment to nearby countries, if it proved unable to close the gap further through waste prevention or further. Greece

would remain the one Member State which would, if it was unable to increase recycling rates further, need to consider relatively long-distance transport to access capacity that was freed up. As noted above, residual waste is already being moved some distance, so this might not be excessive.

Additional Effect of Mixed Waste Sorting

In terms of overall capacity, it seems already clear that capacity at R1 and D10 facilities is, and will be in future, more than adequate to deal with wastes likely to be generated at the EU level. There is, as we have seen, a spatially uneven distribution of the capacity which would be freed up as Member States move towards the higher recycling rates which are required to comply with the EU Waste Framework Directive (and the Packaging and Packaging Waste Directive). Additional capacity freed up in some Member States is likely to be suitable for use by Member States for whom additional non-landfill capacity is required under existing EU legislation. The requirements imposed by existing legislation could be readily avoided by revisiting the rationale for placing incineration above landfill-based systems, such as Material Recovery and Biological Treatment (MRBT) facilities, in the hierarchy.[20] Instead of forcing Member States to consider the relative balances of landfill and incineration in the context of a binding constraint on what is allowed to be landfilled, this would facilitate a stronger focus on achieving recycling targets, and fostering a more circular economy. After all, this is surely where new investment, in terms of both effort and capital, should be focused.

The ease with which additional requirements from other Member States could be accommodated can be increased if Member States make additional use of mixed waste sorting systems prior to incineration. They might do this as part of their approach to increase contributions to recycling (helping, for example, to meet plastic packaging recycling targets),[21] or as part of a move to reduce the GHG emissions from incineration (for which there is likely to be a financial incentive once incinerators are included within the EU Emissions Trading Scheme).[22]

Suppose one considers the application of sorting to leftover mixed waste, for which each tonne has a net calorific value (NCV) of 10-12MJ/kg. Net of rejected materials, this might give rise to around 0.85 tonnes of residual waste with NCV between 8-9.6 MJ/kg. The combined effect – the reduced quantity, and lower NCV – implies a 32% reduction in the total calorific content of the output relative to the input.[23]

[20] See Equanimator (2021) *Rethinking the EU Landfill Target*, Report for Zero Waste Europe, October 2021, zerowasteeurope.eu/library/rethinking-the-eu-landfill-target.
[21] See Eunomia (2023) Mixed waste sorting to meet the EU's Circular Economy Objectives, Report for Reloop and Zero Waste Europe, February 2023.
[22] See Equanimator (2021) *Rethinking the EU Landfill Target*, Report for Zero Waste Europe, October 2021, https://zerowasteeurope.eu/library/rethinking-the-eu-landfill-target.
[23] See Dominic Hogg (2022) *The Case for Sorting Recyclables Prior to Landfill and Incineration*, Special Report prepared for Reloop, June 2022; see also Equanimator (2021) *Rethinking the EU Landfill Target*, Report for Zero Waste Europe, October 2021, zerowasteeurope.eu/library/rethinking-the-eu-landfill-target.

In principle, this would increase the ability of existing incinerators to handle waste. It might be considered, though, that this depends on whether the LMWS contributes to meeting recycling targets or provides additional recycling over and above what is required to meet targets. In the former case, some of the materials extracted for recycling from LMWS will be materials which would have needed to be recycled by other means had they not been extracted from leftover mixed waste. In the latter case, the impact is 'over and above' what would have been required to meet targets. In the former case, it is somewhat more difficult to attribute *all* the change in the nature and content of residual waste to the LMWS facility.

One can consider the change in the quantity of waste which incinerators could handle under various assumptions regarding how much of the potential additional quantity is attributable to LMWS. The proportion would be affected by A) the effect of the LMWS on waste relative to the counterfactual 'compliance' scenario; and B) the proportion of the existing incineration capacity which might receive waste treated via LWMS. If both are set at 100%, then the facilities currently handling 62 million tonnes of MSW might be able to handle the output from an input of 91 million tonnes to LMWS facilities. Alternatively, and more realistically, assuming that by 2035, perhaps 70% of LMW is subject to LMWS, and if half of the reduction in calorific value would have taken place anyway, then the capacity of installations currently receiving waste would be increased from 62 million tonnes to 72 million tonnes.

It should be noted that if around 15% of the input could be recycled from LMW as a result of applying LMWS, then the amount that would have to be recycled from separate collection would need to be (on average across the EU) no less than 59%. The quantity of LMW remaining under this scenario would be 97 million tonnes if there is no growth in waste, or 113 million tonnes in 2035 if waste grows at 1.1% per annum. If 70% of this LMW was treated via LMWS, then the residual waste quantity would be 87 million tonnes at no growth, or 101 million tonnes at 1.1% growth of waste to 2035. If the existing 62 million tonnes capacity was able to treat 72 million tonnes of residual MSW at R1 facilities, that would leave 14 (no growth) – 29 (1.1% growth to 2025) million tonnes, or 6% and 10%, respectively, of MSW generated to be landfilled. Given that Member States are entitled to continue to landfill 10% under the Landfill Directive, then at the aggregate level, there is no need for additional capacity.

At higher recycling rates, the need for capacity declines. If we assume a 65% recycling rate achieved via separate collection alone, then with all else remaining the same, the landfilled quantities fall to 1% and 5% of MSW, respectively, under the no-growth and 1.1% waste growth scenarios. It can be argued that it also becomes more credible to assign the full reduction in NCV of the waste to the LMWS facilities themselves. At the aggregate level, under the no waste growth scenario, there is no need for any landfilling any more (the existing R1 facilities could receive more waste than would be available), and 1% of all MSW would – at the aggregate level, and in 2035 - need alternative treatment under the 1.1% growth scenario.

Note that if some of the waste was treated, following LMWS, through biological treatment following biological stabilisation, the quantity effect might not be to reduce the amount landfilled: on the contrary, such an

approach could increase the quantity landfilled relative to one where LMWS was utilised only prior to incineration. It would, though, make the argument for any additional incineration capacity still less compelling.

Prospects for De-commissioning Existing Incineration Facilities

The above analysis has been based on a consideration of the capacity for incineration remaining static over time. One might ask the question, 'what happens if there is a significant reduction in the available capacity for incineration?'

In the first instance, we can comment on past trends, and on what might be considered the 'business as usual' scenario. We noted above that the historic trend in capacity has been for 8 million tonnes of R1 capacity to be added annually over the period 2004-2020. For MSW, the amount treated through R1 and D10 has increased by around 1 million tonnes per annum over the 2012-2021 period (equivalent to a compound annual growth rate of 1.8%). So, first of all, it would seem likely that, at the aggregate level, even if there may have been local instances of facilities being decommissioned, overall capacity is not falling at present.

On the contrary: it seems likely to be increasing. Where incinerators are concerned, there will be facilities which are in various stages of their project development cycle – feasibility study, application for relevant land use / pollution control consents, in construction, and in commissioning – prior to their contributing, in full, to additional capacity. Projects could, in principle, be set aside with least regret at feasibility. From applying for consents to completion of commissioning could be expected to take four years or longer: not all projects are likely to obtain all relevant consents, and some will, therefore, not go ahead. Those which do obtain consents could, in principle, simply choose not to go ahead, but if the costs of obtaining the consents are considerable, a decision not to go ahead might be a difficult one to make. From commencement of construction to completion of commissioning is likely to take two years or longer. It follows that without any change in approach, and even if no new applications to build were made, there are likely to be new (and replacement) facilities coming forward in construction for at least two years, and depending on decisions made, potentially for the next four to five years. As regards projects in the consenting phase, much will depend on which decisions are made by the relevant authorities responsible for awarding the relevant consents.

Although no longer in the EU, the UK situation is of some relevance to the EU Member States since the UK has been an exporter of refuse derived fuel to EU Member States for incineration. Particularly in England (the

situation in Wales and Scotland is very different – see below), capacity continues to increase despite the fact that if the UK were to achieve targets set out in the circular economy package – which UK government stated it was intending to achieve – then the existing capacity would likely already be sufficient. UKWIN estimates that there is currently around 18.75 million tonnes of incineration capacity operational or under construction in England alone (based on 90% of permitted capacity for existing plants) of which 14.37 million tonnes is already operational and 4.38 million tonnes is under construction. In addition to this, there is currently around 8.26 million tonnes of capacity which has planning consent and is in active development, but which has not yet commenced construction (based on 90% of headline capacity). RDF exports from the UK were in excess of 3 million tonnes in 2016-2018, but fell to 1.76 million tonnes in 2020, and 1.71 million tonnes in 2021. The growth in capacity in England might well see this fall further, especially if over-capacity in the UK leads to more intense price competition, contributing somewhat to the likelihood of over-capacity emerging in the EU (82% of exports from the UK were destined for four EU countries: Sweden, Netherlands, Germany and Denmark).

Nonetheless, it is interesting to note that there are Member States, and regions within them (some of them traditionally heavily reliant on incineration as the primary way of managing waste) that now appear to be actively considering the decommissioning of incineration capacity, or which have already implemented a moratorium on new facilities. Some instances of this are given below.

Denmark

Denmark has examined the issue of reducing incineration capacity. The matter was a key issue discussed in a 'climate plan for a green waste sector and circular economy' agreed by government and other political parties.[24] The Plan notes the climate impacts of energy generated by incineration:

> *While incineration of waste has historically been an important part of our energy utilization, as waste has displaced other fossil sources, such as coal, oil and gas in heat and power production, waste itself is now on its way to becoming the largest fossil heat and energy source in 2030.*

It went on to identify the capacity problem:

> *Today, Denmark has 23 incineration plants, but in the future there will be a need for far fewer. The remaining facilities, together with the industry, must handle the remaining amount of Danish waste which either cannot be recycled or which is environmentally unsound to recycle, for example due to the content of problematic substances.*

The parties to the agreement agreed that there should be a "controlled shutdown" of incineration capacity in Denmark and to set aside a pool of a total of DKK 200 million to compensate municipalities for stranded costs

[24] See Miljøministeriet (2020) Climate plan for a green waste sector and circular economy; see also *Klimaplan for en grøn affaldssektor og cirkulær økonomi*, Aftale mellem regeringen (Socialdemokratiet) og Venstre, Radikale Venstre, Socialistisk Folkeparti, Enhedslisten, Det Konservative Folkeparti, Liberal Alliance og Alternativet, 16 June 2020.

of up to 70 per cent of the loss associated with winding up a waste incineration facility. Provision was made to develop a plan as follows:

> *• A capacity ceiling corresponding to the development in Danish waste quantities is set, which is expected to be reduced by 30 per cent by 2030 compared to today. This means that the total Danish environmentally approved capacity for the incineration of waste (according to the Environmental Protection Act, Chapter 5) must be reduced to the national waste volumes by 2030, as projected by the Ministry of the Environment and Food (The current capacity is 3.95 million tonnes, while the expected national quantities of waste for incineration at multi-fuel and dedicated waste incineration plants in 2030 is 2.6 million tonnes).*
>
> *• The plan must list facilities for shutdown according to the above capacity ceiling.*
>
> *• The plan must ensure that the environmentally worst facilities close.*

We are not clear as to how far matters have progressed in the direction foreseen above.

Region of Flanders, Belgium

The Flemish region of Belgium has implemented a moratorium on incineration capacity, as it was concerned that over-capacity may be emerging as an issue, and that additional capacity would undermine the objective of increasing recycling. The Implementation Plan for household waste and similar industrial waste (HAGBA), which was approved in 2016, aimed to achieve a balance between supply of combustible waste and treatment capacity. HAGBA included an aim to reduce residual waste by 200-250kt through recycling and prevention.

In Belgium's National Energy and Climate Plan, there is further recognition of the desirability of reducing incineration capacity by 25% or so (or around 700kt) by 2030. A number of existing facilities, accounting for around 1.5 million tonnes of capacity (or 65% of capacity in Flanders) have authorisations that are due to expire in the years 2030-2033.[25] The Plan notes:

> *The starting point for granting new authorisations at that time must be that only facilities needed to meet the capacity requirement and compatible with a CO_2-neutral society in 2050 will be authorised. This will require an effective set of criteria for assessing whether or not a facility can continue to be operated.*

It seems possible, therefore, that some capacity reduction could take place in the early part of the next decade once authorisations at existing facilities expire.

[25] Belgian Integrated National Energy and Climate Plan 2021-2030: Section A: National Plan (Context, objectives, policies and measures), Approved by the Consultation Committee on 18 December 2019.

Brussels Region, Belgium

Similar considerations are reflected in the approach of the Brussels Region in Belgium's National Energy and Climate Plan. An interesting comment on the approach to planning for capacity was made:

> *[T]he long-term planning exercises (energy, climate (75), air, waste, etc.) need to be repeated at an accelerated rate in the coming years. The Governance Regulation actually provides for these exercises to be repeated at least every 10 years. For its part, the Paris Agreement provides for global stocktakes (76), i.e. regular assessments that may, where appropriate, lead to the current plan being adapted and new measures being adopted with a view to increasing the level of ambition. In this context, the fact that the environmental permit for such key plants is granted for a period of 15 years can create lock-in effects, which means that discussions need to take place on adapting the legal framework of these environmental permits.*

This is an important point. As we noted above, the time taken to move from feasibility, through consenting, to construction, followed by commissioning, is a lengthy one. There is not only a lock-in effect from the fact that facilities have a lengthy operating life / authorisation period, but an additional problem of inertia in the pipeline. Effectively, decisions are being taken today whose impact will still be being felt in twenty years' time. The need for planning for future capacity is an urgent one, not least to avoid investment in what may become stranded assets.

The Plan goes on to say:

> *With regard to such plants, the government needs to take specific action as follows.*
>
> - *Establish a long-term phased timetable for the adaptation of the Neder-Over-Heembeek regional facility taking into account the gradual reduction in flows destined for incineration, while maintaining self- sufficiency in terms of the Brussels Capital Region managing its own waste and also public control over this strategic facility. [...] The government will study the phasing out of this facility, which is desirable in order to meet the region's GHG emission obligations. As a result of this phasing out, the benefits deriving from the green certificates granted to the incinerator will be used to achieve the objectives of the PGRD and the Regional Circular Economy Programme (PREC) (77). Green certificates will no longer be granted to the incinerator. [...]*
> - *[...] Develop the legal framework for granting environmental permits to avoid lock-in effects that would make it impossible to meet the region's decarbonisation and energy transition commitments and targets.*
> - *Achieve its climate objectives by respecting the hierarchy of waste treatment methods, namely: recycling, material recovery, energy recovery, and finally landfill.*

We question whether the last of these bullets is entirely accurate. Notwithstanding this point, however, there is the expressed intent to phase out the existing regional incinerator.

Netherlands

The Netherlands, like Flanders, had introduced a moratorium on new capacity in 2010, but this was later withdrawn (October 2014) as it was deemed contrary to EU competition rules:[26]

Scotland and Wales, UK

Although not in the EU, Wales (2021) and Scotland (2023) in the UK have both implemented a moratorium on new incineration facilities. The Welsh Government introduced its moratorium on incineration as part of 'Wales' drive towards becoming a zero-waste, carbon net-zero nation by 2050'.[27] Scottish Government has taken on board recommendations from a review of the role of EfW in the waste hierarchy.[28] It accepted a recommendation that 'no further planning permission for incineration facilities should be granted'.[29]

Summary

The EU jurisdictions discussed above would – if they implement the plans they intend to implement – remove 2.5 million tonnes of incineration capacity by 2030 or thereabouts. The capacity reductions in these 'mature' markets for incineration are aiming for reductions in capacity of 25-30% by 2030 (and in Brussels, the phasing out of the one facility in the region). These levels of reduction in capacity by 2030 appear, at one level, ambitious. On the other hand, based on a lifetime of, say, 20 years, on average, around 5% of capacity would be up for review each year if all were of equal size and of randomly varying vintage. Even these planned reductions, therefore, anticipate a slower pace of decommissioning than what might be expected, 'on average', to be the amount of capacity coming up for retirement / renewal. The Flemish case highlights, though, that capacity will come to the end of its useful life in a more 'lumpy' manner(i.e., not as a smooth annual amounts, but with larger amounts in some years than others). It is also clear that Member States may want to ensure that what capacity they retain is suitably distributed geographically so as not to increase transport movements unnecessarily, and also, to ensure that the facilities which are kept in operation are those which have the greatest opportunity to achieve the best environmental performance. Indeed, it might be considered that – as per our discussions elsewhere – Member States might determine that there are better ways to deal with LMW

[26] Tolvik (2015) RDF Exports: Here for Good? A report into the Combustible Waste Market in Europe, 2015 Briefing Report, February 2015.

[27] See Welsh Government (2021) Wales takes action on Circular Economy with funding, upcoming reforms on plastic and a moratorium on large-scale waste energy, 24 March 2021 www.gov.wales/wales-takes-action-circular-economy-funding-upcoming-reforms-plastic-and-moratorium-large-scale; and

[28] Independent Review of the Role of Incineration in the Waste Hierarchy in Scotland (2022) *Stop, Sort, Burn, Bury - incineration in the waste hierarchy: independent review*, www.gov.scot/publications/stop-sort-burn-bury-independent-review-role-incineration-waste-hierarchy-scotland/documents

[29] Scottish Government (2022) Putting Limits on Incineration Capacity, 16 June 2022. Putting limits on incineration capacity - gov.scot (www.gov.scot)

than incineration (and might justify departures from the hierarchy in line with Article 4 of the Waste Framework Directive). This option is more obviously available to those countries already landfilling less than 10% of MSW.

It is not clear how far advanced other Member States may be in considering the need to reduce capacity in the coming years, if indeed they are discussing this at all. Germany, for example, reports to be recycling more than the target percentage of MSW required under the Waste Framework Directive, and so its considerable capacity might not necessarily be about to be scaled back. Germany also imports waste for incineration from other Member States. Sweden appears to have increased capacity well in excess of what is needed to manage waste being generated within its borders. It may yet be the case that climate change becomes the main driver for reducing incineration capacity as it steadily dawns upon policy makers that, whether configured to generate electricity or heat, the carbon intensity of energy generated by incineration no longer offers a justification for additional capacity: on the contrary, the associated greenhouse gas emissions will increasingly emerge as a problem.

Member States where a significant proportion of capacity is used to provide district heating – such as Sweden – might find a particularly strong lock-in to the existing capacity. This is a point alluded to in the case of Swedish incineration by the Stockholm Environment Institute:[30]

> *At the same time, continued investment in new waste-burning combined heat and power plants has led to a debate about over-capacity, lock-in of waste incineration, and dependency on waste imports. The Swedish heat regime is thus experiencing increasing tensions, disagreements and competing interests among regime actors. A lock-in of waste incineration as a major fuel source would conflict with the EU Waste Framework Directive (2008/98/EC), which defines disposal through incineration as the second least effective treatment of waste, after landfills. In addition, waste incineration may be disrupting the potential of industrial waste heat in district heating systems.*

Ideally, in such situations, other fuel sources – such as heat pumps – replace the incinerators as the sources of heat for the network. Of some concern is the move to link more incineration capacity to district heating networks, given that a key 'network externality' may be the locking-in of incinerators as a heat source for the network.

[30] Stockholm Environment Institute (2017) Swedish heat energy system – new tensions and lock-ins after a successful transition: Policy Brief, mediamanager.sei.org/documents/Publications/SEI-2017-PB-Dzebo-Nykvist-SweHeatEnergySystem-eng.pdf

Summary and Conclusions

Summary

There are a range of figures which are available regarding the capacity currently available at incinerators, but the picture is complicated somewhat by the inclusion – in waste statistics – of R1 as a single category. Since R1 installations include co-incineration facilities, and since the 'capacity' at such facilities might sometimes be better understood as a maximum tolerable or permissible amount of waste which can be dealt with at a given installation type, then the figures for capacity available at R1 figures must be interpreted with some care. Facilities may also be permitted to receive, or their design may constrain their ability to receive, only a constrained range of waste categories (rather than all non-hazardous wastes, for example).

Equally, the R1 classification would appear to being applied to the treatment of nun-municipal waste at facilities dedicated to the treatment of waste. It is unclear that such a classification is correct (though the wording is ambiguous in this regard).

These caveats having been noted, then treatment capacity in 2020 stood at:

- 183.5 million tonnes at R1 facilities;
- 15.3 million tonnes at D10 facilities; and
- 198.8 million tonnes at R1 and D10 facilities combined.

The historic trend in capacity evolution in the EU has been for 8 million tonnes of capacity to be added annually over the period 2004-2020. On that basis, capacity may now (latter half of 2023) have reached around 220 million tonnes (although the COVID-19 pandemic may have slowed the pace of construction of new facilities). Taking this into consideration, our calculations for all non-hazardous waste (based on capacities in 2020) may be considered conservative.

Waste Statistics taken from Eurostat indicate that in 2020, the combined quantity of waste treated through R1 and D10 was 10.5 million tonnes of hazardous waste and 128.2 million tonnes of non-hazardous waste. Although capacity estimates will be approximate (capacity likely depends, in part, on the calorific value of what is received, especially for dedicated waste treatment facilities), these figures suggest that in theory, there was already capacity to treat more than 60 million tonnes of additional waste through existing D10 and R1 installations in 2020, though again, we note the potential mismatch between categories of waste available for treatment, and the nature of the receiving installations.

The industry body CEWEP estimated that in the same year, incinerators operated by / reported by member organisations treated just under 81 million tonnes of non-hazardous waste at just over 400 facilities. That

would suggest that around 47 million tonnes of non-hazardous waste were being managed via R1 and D10 installations that were outside the purview of CEWEP. These might include wastes dealt with at co-incineration facilities, and at smaller clinical waste incinerators (not all such waste is hazardous) as well as other installations. Nonetheless, over 90% of non-hazardous wastes dealt with via D10 and R1 are reported to come from seven waste categories, with four categories accounting for more than 80% of the wastes managed at such installations. Three of these are, to those familiar with EU waste statistics, the key mixed / leftover waste categories, Household and similar wastes, Sorting residues and Mixed and undifferentiated materials.

Table 10: Key Non-hazardous Waste Categories Dealt with at D10 and R1 Facilities

	D10+R1	
Household and similar wastes	49,310,000	38%
Sorting residues	31,210,000	24%
Wood wastes	19,790,000	15%
Mixed and undifferentiated materials	7,210,000	6%
Animal and mixed food waste	5,160,000	4%
Common sludges	3,390,000	3%
Plastic wastes	2,680,000	2%
Industrial effluent sludges	1,800,000	1%

Eurostat statistics on municipal waste tell us that the vast majority of waste that is incinerated is sent to facilities that achieve the R1 threshold criterion. We noted elsewhere how this has progressively become a meaningless threshold (it is met by virtually any 'legislatively compliant' incinerator).[31] The quantity of MSW dealt with through R1 and D10 (at 62 million tonnes) is 19 million tonnes lower than the amount of waste dealt with at incinerators being reported by CEWEP. The gap between the CEWEP figure and the MSW treatment figures ought to indicate non-municipal waste which is non-hazardous and treated at incineration. Our understanding (based on the Manual on Waste Statistics) is that this would not qualify as R1 and should be classified as D10, yet the difference between these figures far exceeds the amount of non-hazardous waste reportedly treated as D10 disposal.

If all the common material categories which are being dealt with by incinerators, and which are currently landfilled, were made available to incinerators, the quantity needing to be dealt with by D10 and R1 would increase by 76 million tonnes. In the somewhat unlikely scenario of all the above wastes being pushed away

[31] D. Hogg (2023) Debunking Efficient Recovery: The Performance of EU Incineration Facilities, Report for Zero Waste Europe, January 2023; also Equanimator (2021) *Rethinking the EU Landfill Target*, Report for Zero Waste Europe, October 2021, zerowasteeurope.eu/library/rethinking-the-eu-landfill-target

from landfills, and being suitable for the remaining D10 and R1 capacity, and with recycling and waste generation remaining at 2020 levels, then the shortfall in D10 and R1 capacity combined would be 15.8 million tonnes.

It is clear, though, that EU policy and law seeks to reduce the amount of waste generated, and increase the proportion of the waste which remains that is recycled. **If the EU meets its recycling targets**, then a further 36.4 million tonnes, equivalent to just under half of all the non-hazardous waste that was landfilled in 2020, would need to be recycled. This alone would move D10 and R1 capacity back into **a surplus of around 20.6 million tonnes, even when assuming all suitable wastes were being made available for R1 and D10 (and none were landfilled).**

Even countries with landfill bans or restrictions in place landfill some MSW (for all Member States, the figure is non-zero (recalling also that landfilling of incinerator residues is not counted as landfilling of MSW)). Some landfill very little such waste, others, a greater share, depending on the nature of the ban (and the reporting[32]). **The Landfill Directive allows landfilling of 10% of MSW**, so that this practice is likely to continue at some level for fractions of municipal waste, as well as some other non-hazardous wastes which might otherwise be considered suitable for landfill**. If one considers the 10% figure to apply, other than in member States where MSW landfilled is already below 10%,** then this would suggest that 15 million tonnes of waste might continue to be landfilled in future. **The surplus – even with all suitable wastes available for D10 and R1 moves up to 35.6 million tonnes.**

Either in their quest to meet recycling targets, or in their attempt to reduce the contribution of incineration to climate change, of for both reasons, as we have indicated elsewhere, there is an **opportunity to deploy Leftover Mixed Waste Sorting (LMWS) to waste leftover after separate collection**. Because there is a rationale for focusing on (and a relative emphasis on) extracting plastics for recycling, the effect is to reduce the calorific value of the remaining waste. In principle, existing incinerators' capacity to deal with waste could be increased as a result of the associated drop in calorific value (since such facilities are generally limited in their capacity by the overall calorific content of waste being treated).

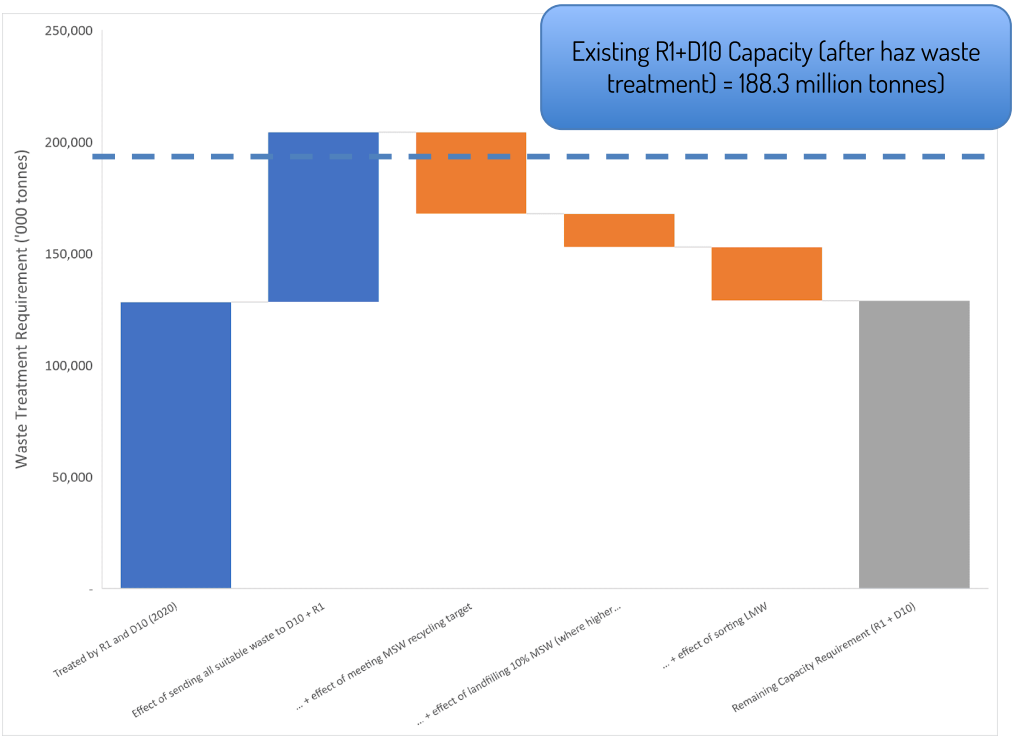
There are currently around 92 million tonnes of two categories - Household and similar wastes and Mixed and undifferentiated materials - currently either treated at D10 and R1 facilities or landfilled. In addition, there are 66 million tonnes of 'Sorting residues'. If we assume all household and similar wastes and mixed undifferentiated materials, as well as around 30 million tonnes of waste currently entering facilities oriented (currently) to preparing refuse derived fuel / solid recovered fuel, could be subject to LMWS, but that the quantity is reduced by the additional amount requiring to be recycled, then just over 80 million tonnes would be eligible for such treatment.[33] Thanks to the lower NCV of the resulting output, this would be capable of

[32] For Germany, for example, the figure has been estimated by Eurostat for every year since 2013.

[33] As of early 2017, ecoprog estimated that in Europe, there were 'around 570 active MBT plants with a treatment capacity of 55 million tons' (up from 490 with a capacity of 47 million tonnes in 2015). ecoprog expected a further 120 facilities with an estimated capacity of almost 10 million annual tons to be commissioned between 2017 and 2025 (see ecoprog.com/publications/report-market-for-mbt-plants-in-europe-2017 and Mark Döing (2016) The Market for Mechanical

being managed at facilities currently managing around 56 million tonnes of waste, freeing up an additional 24 million tonnes of capacity. **The surplus relative to current R1 and D10 capacity would (combined with the above measures) increase to around 60 million tonnes, or much the same level of surplus as exists on paper today.** This is somewhat remarkable in that it suggests that even if we were to channel all wastes 'broadly suitable' for management via R1 and D10, then if recycling targets are met, and if LMWS systems are widely deployed, roughly the same quantity of non-hazardous waste would remain to be managed via R1 and D10 as is being managed today.

Figure 4: Effects on Required R1 and D10 Capacity of Key Assumptions and Changes



Biological Waste Treatment Plants in Europe, Waste Management, Volume 6, September 2016). Capacity for MBT in Germany was estimated as 3.9 million tonnes in 2022, with throughput of the order 3.2 million tonnes (ASA (2022) Gewährleistung der Entsorgungssicherheit durch mechanisch-biologische Abfallbehandlungsanlagen: Arbeitsgemeinschaft stoffspezifische Abfallbehandlung e. V., 23 June 2022, (www.asa-ev.de/fileadmin/Media/ASA-EV/Downloads/PDF/ASA_e._V._Notfallplan_Gas_-_Gewaehrleistung_der_Entsorgungssicherheit_durch_stoffspezifische_Abfallbehandlung_final.pdf). In 2020 in Italy, 18.5 million tonnes of authorised capacity for MBT accounted for treatment of 9.5 million tonnes of urban residual waste, mainly leftover mixed wastes (ISPRA (2021) Rapporto Rifiuti Urbani, Edizione 2021, Rapporti 355/2021, December 2021). In Spain, some 11.8 million tonnes of residual MSW were treated either through aerobic or anaerobic treatment, with a further 1.6 ,million tonnes treated at sorting plants prior to thermal treatment (MITECO (2020) Memoria Anual de Generación y Gestión de Residuos: Residuos de Competencia Municipal. 2019, https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/publicaciones/memoriaanual2019generacionygestionresiduosrescompetenciamunicipal_tcm30-534462.pdf).
Our figure of 30 million tonnes is an estimate of the current quantity treated through such facilities in the EU as a whole (Germany, Italy and Spain together account for 26.1 million tonnes). Whilst these facilities may remove some plastics, alongside some metals, they have not always been specifically configured with high quality sorting systems for removal of a range of plastics, with plastics mainly valued for calorific value rather than for the embodied carbon and energy savings.

We also examined the situation with specific reference to municipal waste. The heterogeneous nature of leftover mixed municipal waste is such that where it is not further sorted / treated, then incinerators receiving the waste tend to be designed specifically for that purpose. Some MSW is sorted so that a more-or-less-well prepared fuel is made available, but much of the reported 62 million tonnes sent to R1 facilities will be sent to dedicated incinerators, with CEWEP indicating a total capacity of incineration facilities of the order 81 million tonnes. In the absence of waste growth, then **simply meeting the 65% MSW recycling target leads to a situation where, if Member States currently landfilling more than 10% of MSW landfill no more than 10%, and with the amount sent to R1 installations remaining as in 2021, there is no requirement for additional non-landfill treatment capacity at the EU-27 level**. There are Member States, however, for which existing incineration capacity is effectively (further) freed up, and ones for which additional non-landfill capacity is required. The quantities of additional non-landfill treatment required depend upon the recycling rates achieved, and how leftover mixed waste (after separate collection) is treated. The 10% landfill quota can be 'expanded' somewhat through use of biological stabilisation (reducing the mass of the waste landfilled, and its propensity to generate methane, and aligning with the spirit of the poorly articulated requirements in the Landfill Directive to pre-treat waste prior to landfilling).

Waste of the type we are discussing already crosses borders, and that movement is facilitated in part by the R1 criterion allowing for the trans-frontier movement of wastes. We have argued elsewhere that the R1 designation is unwarranted, and in any case, has been rendered irrelevant by the progressive watering down of a criterion which should evolved out of considerations of what is best available technology. In other words, the criterion was initially intended to represent what facilities needed to do in order to be permitted at all.[34]

Conclusion

In a recent review of three Member States' (Austria, Sweden and Finland) paths to higher recycling, incineration capacity was noted as 'an issue'. The author noted:

> *Incineration as a dominant treatment method is difficult to change because of the existing economic (investments in facilities and agreements between waste dealers and facilities) and political lock-ins (interests of certain waste operators). It would also require changes in the current energy regime. So far, the challenge of overcapacity seems to complicate Finland the least out of all the studied countries* [Finland, Sweden and Austria].

It was concluded:

> *Recycling markets are not limited to the borders of one country, while the political will to establish national economic incentives for the use of recycled plastic, for example, may be too weak. Identified economic lock-ins are mainly common to all studied countries* [Finland, Sweden and Austria], *e.g., the*

[34] D. Hogg (2023) Debunking Efficient Recovery: The Performance of EU Incineration Facilities, Report for Zero Waste Europe, January 2023.

*malfunction of markets for recyclables and **excessive incineration capacity. Therefore, these challenges should be tackled at the level of EU policy**.*[35]

None of the studied countries were deemed to be seeking to reduce incineration capacity.

That does not mean some operators of aging facilities might not withdraw from the market when their authorisations run out, or when the facility itself is in need of major maintenance work. On the other hand, if this were already happening across Member States, then a significant share of around 5% of the market would be decommissioned / retired each year. As we have seen, the observed trend is very different.

Member States do, when considering their own capacity needs, appear to take different views regarding the desirability, or otherwise, of importing waste from other countries for incineration. There are pros and cons to both approaches, one of the cons being that territorial emissions associated with incineration increase as a result. This is an issue, though, which would benefit from some EU-wide coordination. If Member States that could otherwise offer freed-up capacity to others were considering compensating operators for an early decommissioning, then if that leads to new facility development elsewhere, the net effect is unlikely to be positive, especially if this takes place in the context of EU capacity continuing to increase, and taking into account also the carbon embodied in the construction of new facilities.

There would appear to be a strong argument for EU level coordination in this matter. Operating companies might not be able to discuss this openly for fear of accusations of collusion. There may, though, be a rationale for Member States to consider treatment capacity as a matter that is not confined purely to their own territorial borders (waste is, after all, already moving across frontiers within the EU). Any planned decommissioning would benefit from being carefully coordinated.

It would also seem to be a sensible time to re-consider the role of incineration in the waste management hierarchy. In future, incinerators should only accept wastes derived from household / municipal wastes where they have been through advanced sorting facilities.

Our analysis took as its starting point a view where all suitable wastes were channelled to R1 and D10 facilities. We showed that even if this happens, then as long as existing MSW recycling targets are met, and if LMW are sorted prior to being incinerated (or stabilised prior to landfilling) then the required capacity is much as it is today. Given that not all wastes will be channelled to D10 and R1 in future for various reasons, then it seems reasonable to envisage a future where the capacity requirement for D10 and R1 falls in future. Particularly in those Member States where excess capacity already exists, a managed retreat would seem sensible. Factors that might come into play in that retreat would be the age of facilities, their role in a spatially coherent network, the ease with which they might access carbon capture and storage facilities and (this applies only to facilities already doing so) whether facilities are connected to district heat networks.

[35] Hanna Salmenperä (2021) Different pathways to a recycling society – Comparison of the transitions in Austria, Sweden and Finland, Journal of Cleaner Production, Volume 292, 2021, 125986, https://doi.org/10.1016/j.jclepro.2021.125986.

Conversely, in Member States which might otherwise be pushed to consider additional D10 or R1 capacity within their borders, it would seem exactly the right time (before more capacity is constructed because that is what EU policy and law may appear to require) to indicate the equivalence of landfilling and incineration, as long as the wastes received are both already subject to LMWS, and as long as waste being landfilled is stabilised to achieve a minimum stability criterion.[36] Eliminating the landfilling of untreated (or not-biologically-stable) waste, and placing incineration and landfill – in the forms as described above - on the same – lowest - tier of the waste hierarchy would likely give greater flexibility to Member States pursuing higher recycling rates, and allow more rapid progress towards climate mitigation in those where landfilling of LMW is still significant.

The flexibility of a strategy to scale down capacity for incineration is constrained by a commitment to the placing of incineration higher in the hierarchy than the landfilling of suitable treated residual waste that look increasingly ideological. The decision-making process regarding decommissioning of facilities would be made that much easier if the limit of 10% of MSW landfilled, which loses its justification if the requirement to pre-treat waste prior to landfilling is sensibly enforced, was disapplied. What the EU needs, after all, is a continuing capacity – which diminishes over time – to manage LMW and the resulting residual waste in an environmentally responsible way (including sorting of LMW, as necessary). The 10% landfill limit artificially constrains choices as to how best to achieve this outcome.

Article 12 of the Waste Framework Directive noted:

> *2. By 31 December 2024, the Commission shall carry out an assessment of the disposal operations listed in Annex I, in particular in light of Article 13, and shall submit a report to the European Parliament and to the Council, accompanied, if appropriate, by a legislative proposal, with a view to regulating disposal operations, including through possible restrictions, and to consider a disposal reduction target, to ensure environmentally sound waste management.*

It might be a sensible time to re-consider the role of incineration in the waste management hierarchy, choosing to classify it as a disposal operation. Furthermore, in future, incinerators should only accept leftover mixed wastes from municipal sources where they have been through advanced sorting facilities.

[36] See Equanimator (2021) *Rethinking the EU Landfill Target*, Report for Zero Waste Europe, October 2021, zerowasteeurope.eu/library/rethinking-the-eu-landfill-target; Dominic Hogg (2022) *The Case for Sorting Recyclables Prior to Landfill and Incineration*, Special Report prepared for Reloop, June 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.

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