The case for sorting recyclables prior to landfill and incineration

Special report prepared for Reloop:

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June 2022

EXECUTIVE SUMMARY

Times change. Things that were once considered articles of faith can, with progress in our state of knowledge and the development of technology, take on the appearance of dogma if we don't adapt our views accordingly.

EU waste law rightly (or so it seems for the time being) places an emphasis on separate collection of waste in order to facilitate its recycling. For many years, experience with sorting of recyclables of mixed waste [*] proved more or less incapable of delivering materials of the required quality for recycling markets, and this remains true, to a greater or lesser extent, for some key materials. For others, such as plastics, for which the sorting capability has markedly improved, and for which the share in unrecycled mixed waste can be expected to have increased over time, the potential to extract (additional) materials for recycling is now clearly demonstrated [1].

Similarly, the choice of approach to dealing with unrecycled waste is no longer adequately represented by a binary choice of either 'landfill' or 'incineration'. The climate change impacts of landfilling (and the impacts in other regards also) can be mitigated considerably through stabilising waste prior to landfilling.

In jurisdictions where targets have been set to reduce climate change emissions close to zero, where those jurisdictions are reliant on incineration to manage unrecycled waste, recognition of the fact that emissions of fossil-derived carbon dioxide (CO2) from burning plastics have led to an enhanced interest in sorting of plastics from the unrecycled waste stream (as well as, in some cases, carbon capture and storage of the emitted CO2, whether of fossil- or non-fossil origin).

The review of the existing approach to managing unrecycled waste is clearly 'in revision' in some locations. This paper argues the case for a much broader application of mixed waste sorting (MWS) systems to all leftover mixed (municipal, and potentially other similar types) waste.

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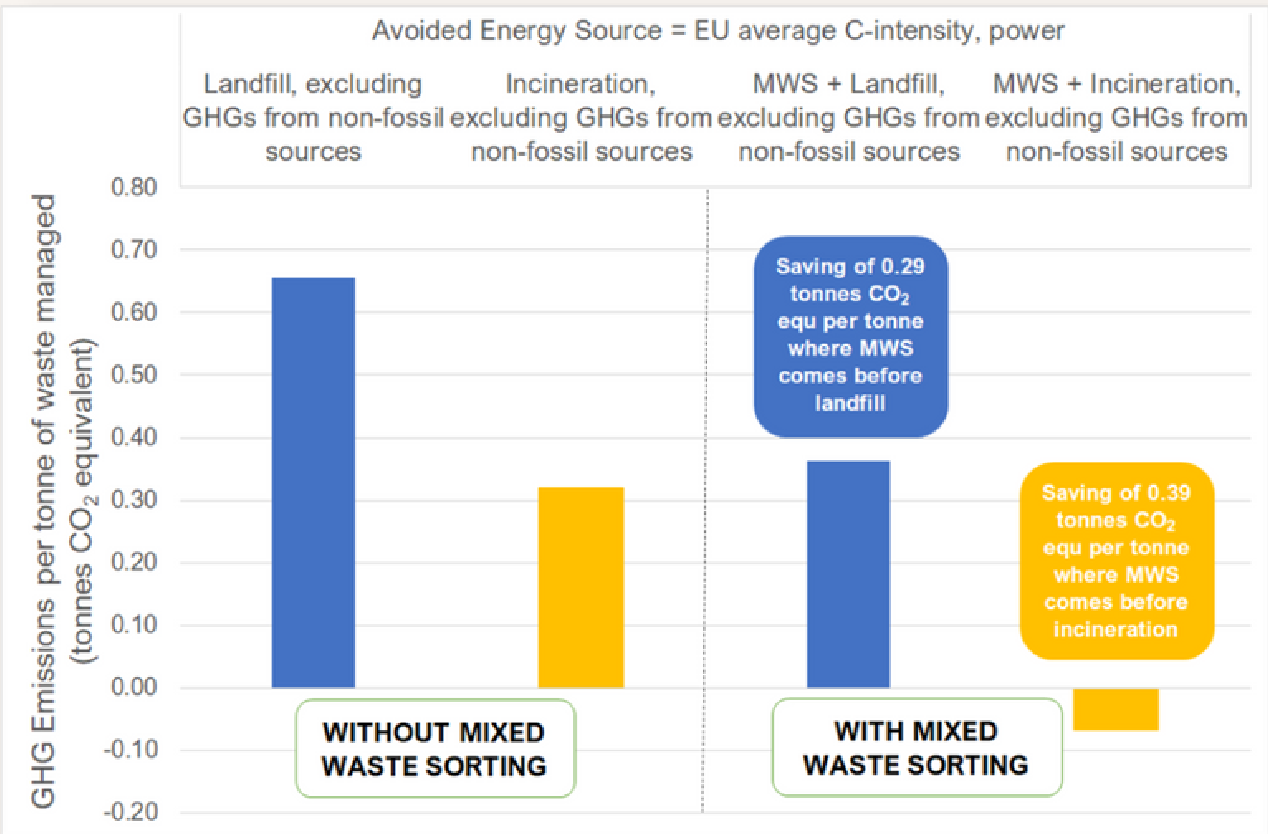
[*] A note on terminology. The term 'residual waste' is often used to refer to waste leftover after separate collection. Given that, in this report, we are considering how to extract more recyclables from the waste leftover following separate collection, we often refer to that waste in this report as 'leftover mixed waste'. This is the waste from which further recyclables can be extracted by mixed waste sorting. Once that material has been subject to further sorting, then we consider it appropriate to use the term 'residual waste'.

[1] Eunomia (2021) Waste in the Net-Zero Century: Testing the Holistic Resources System via Three European Case Studies, Report for TOMRA, July 2021.

E.1.0. Change in GHG Emissions from Managing a Tonne of Leftover Mixed Waste

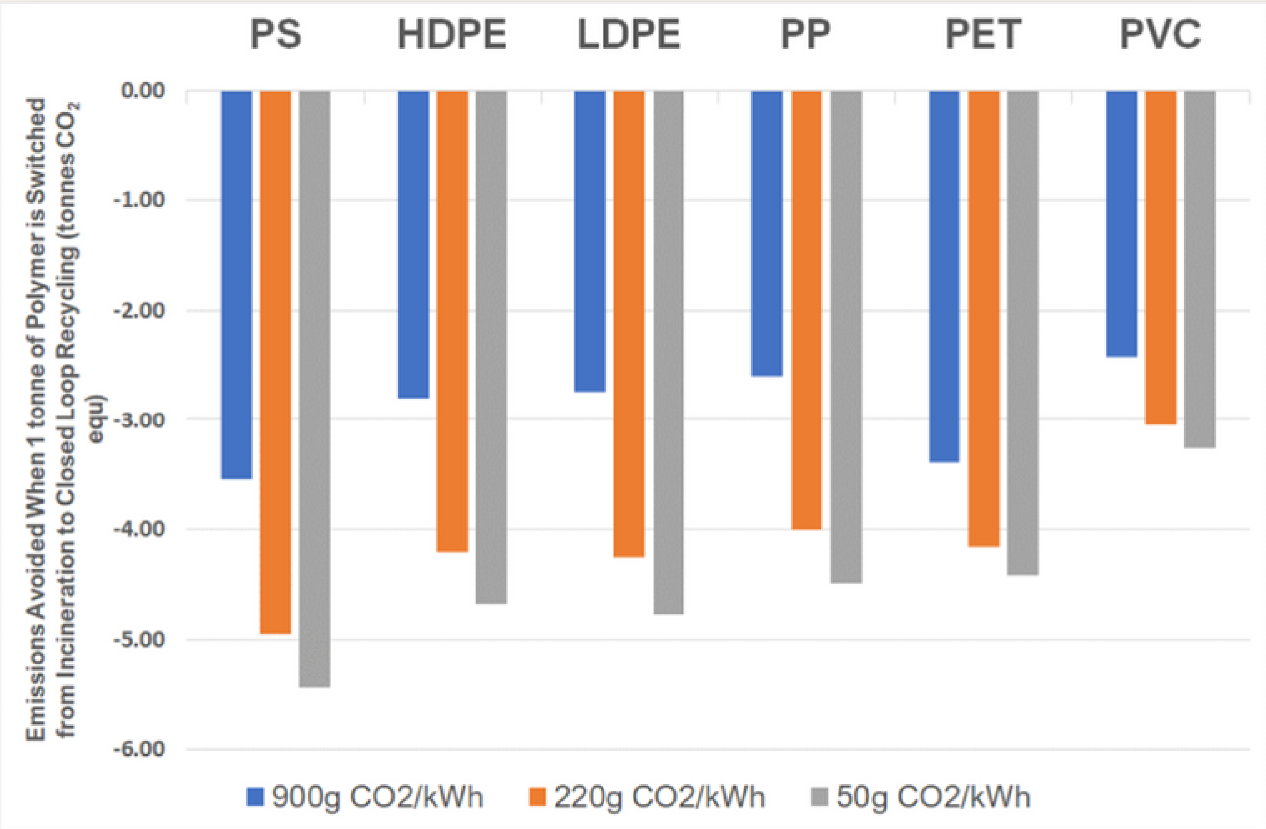
Figure E - 1 below shows the upside of introducing MWS before an incinerator or before a landfill. These figures do not include emissions of CO2 of non-fossil origin. The reduction is larger for the incinerator as a result of the fact that not only are there benefits from recycling the materials being sorted, but there is a reduction in the emissions associated with the incinerator itself as a result of the removal of a source of fossil-derived carbon from the waste. Removing plastics from landfills, on the other hand, leaves the landfill system's performance relatively unchanged. The effect, specifically on plastics, of removing a tonne of plastic waste from an incinerator and into a recycling system where the recycled polymer replaces the same primary polymer, is shown in Figure E - 2. This highlights why municipalities that have set net-zero targets, or have declared 'a climate emergency', might be interested in deploying MWS.

Figure E - 1: Effect on GHG Emissions from Managing a tonne of Mixed Leftover Waste when MWS is Used Prior to Landfilling and Incineration (assumes incineration generates electricity, and avoids generation of electricity at 220 g CO2e/ kWh)



Source: Equanimator

Figure E - 2: Effect of MWS in 'Switching' a Tonne of a Specific Polymer into Recycling where Secondary Polymers Displace Primary Ones (tonnes CO2 per tonne of Plastic)

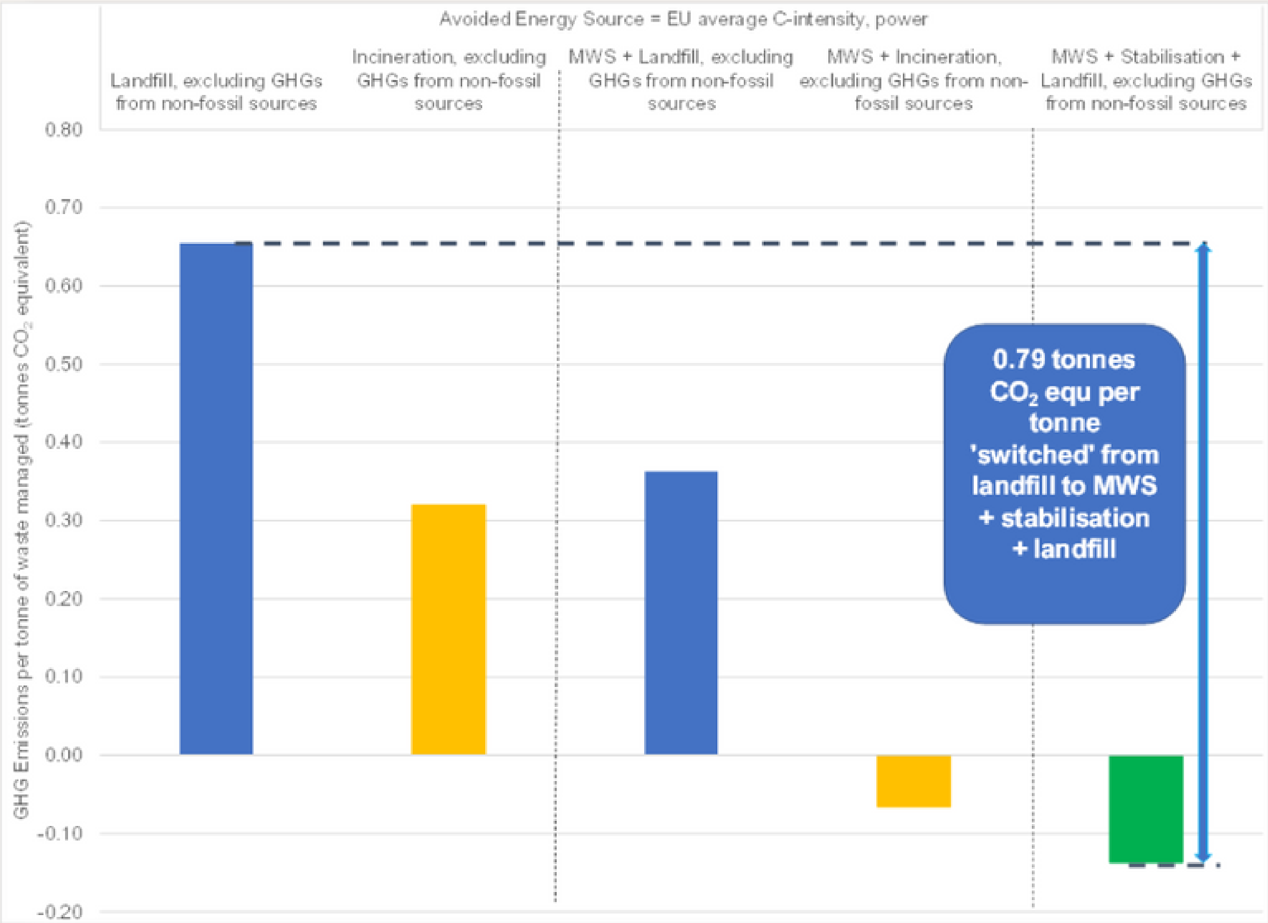


Source: Equanimator – note, negative figures indicate a reduction in CO2 emissions

Figure E - 3 demonstrates what might be the situation for the landfill system where waste is biologically 'stabilised' following sorting, and prior to the waste being landfilled. The argument is that if all leftover mixed waste which is 'en route' to a landfill were to be subject to MWS prior to landfilling, then it makes sense to add the biological stabilisation step to the landfill system. We have argued elsewhere that changes in EU law should seek to facilitate a situation where no waste that would benefit from such stabilisation is landfilled without being subject to it [2].

[2] See Equanimator (2021) Rethinking the EU Landfill Target, Report for Zero Waste Europe, October 2021.

Figure E - 3: Effect on GHG Savings from Deploying both MWS and Stabilisation of Waste prior to Landfilling



Source: Equanimator

E.2.0 Benefits of EU-wide Application

E.2.1 Reduced GHG Emissions

Figures reported to Eurostat regarding municipal waste indicated that around 224 million tonnes of municipal waste were generated in the EU27 in 2019. Of this, around 60 million tonnes were incinerated and 53 million tonnes were landfilled (note that these figures will not reveal the quantity entering into mechanical biological treatment processes, the outputs from which will contribute to the figures for landfill and incineration).

According to reporting under the Waste Statistics Regulation (WSR), in 2018, R1 energy recovery installations treated 132 million tonnes of non-hazardous waste and 6.3 million tonnes of hazardous waste. In addition, incineration plants classified as disposal facilities treated 17 million tonnes and 5 million tonnes of non-hazardous and hazardous waste, respectively.

Of 'municipal type waste' (Household and similar wastes, Mixed and undifferentiated materials and Sorting residues), some 97 million tonnes were still being landfilled in 2018.

The outcomes of applying MWS to all leftover mixed waste will depend upon the breadth of its application (and suitability thereof). Were MWS being applied to all these wastes today:

• Regarding municipal waste landfilled and incinerated, MWS could deliver savings of the order 39 million tonnes CO2e. This figure rises to 65 million tonnes CO2e if one assumes the waste destined for landfill is also subject to biological stabilisation (and if non-fossil CO2 emissions are included in the accounting, the figures are 52 and 81 million tonnes CO2e, respectively);

• If the same exercise is conducted with all non-hazardous waste reported as incinerated under the WSR, and all landfilled 'household type' waste, these figures rise to 86 million tonnes and 134 million tonnes CO2e, respectively (rising to 113 and 166 million tonnes CO2e if non-fossil CO2 emissions are accounted for).

The upper end figure – of 134 million tonnes CO2equ – exceeds the annual GHG emissions reported to the UNFCCC in 2019 of all but six of the EU Member States [3]. It is a figure that lies between the annual GHG emissions reported by Belgium (117 million tonnes CO2e) and the Netherlands (181 million tonnes CO2e). It amounts to approximately 4% of total EU-27 emissions reported in 2019 [4].

Evidently, 100% adoption is unlikely to take place, and it is hoped that the quantity of mixed leftover / residual waste requiring management will decline over time. This does give an indication, however, of the potential scale of possible GHG mitigation.

[3] Based on emissions reported, excluding those associated with LULUCF (land use, land use change and forestry) – see European Environment Agency (2021) Annual European Union Greenhouse Gas Inventory 1990–2019 and Inventory Report 2021, Submission to the UNFCCC Secretariat, 27 May 2021EEA/PUBL/2021/066.
[4] Strictly speaking, these figures are not completely comparable. The figures we have derived assume a global warming potential of methane over a 100 year period (GWP100) of 34, whereas for the reporting to the UNFCCC, it is likely that reported figures use the GWP100 figures in the IPCC's fourth assessment report (where the GWP100 figure for methane was 25). This would mainly affect the benefits assumed to be related to stabilisation of the currently landfilled fraction (so there would not be a pro-rata reduction in the savings implied by our use of the higher GWP100 figure).

E.2.2 Contribution to employment

If the EU is to meet its 65% recycling target for municipal waste, then a maximum of 79 million tonnes of mixed leftover waste would need to be managed, assuming no further growth, or reduction, in municipal waste over the period until 2035. Using mixed waste sorting across the totality of the 79 million tonnes could, in the fullness of time, create around 23,700 jobs across the EU in associated reprocessing facilities (that assumes the material is not exported).

If there is scope to extend MWS to applications beyond what is currently reported as municipal waste (a more rigorous application of the definition set out in the Waste Framework Directive may lead to higher figures being reported), then additional material could be extracted.

It would be reasonable to consider doubling the above figure to capture the full impact (through multiplier effects) of applying MWS to all leftover mixed municipal waste in future. That would suggest a potential effect of 47,400 jobs including conservatively estimated multiplier effects.

E.2.3 Contributing to recycling targets

For every tonne of leftover mixed municipal type waste, then depending on detailed composition, an additional contribution to recycling of around 10-15% of the input may be expected [5]. These contributions could be important and Member States could gain additional certainty that they can achieve recycling targets for plastic packaging, of 55% by the end of 2030 (though with some Member States eligible for 5 year derogations), and municipal waste, of 65%, to be met by end of 2035 (though again, with some Member States eligible for 5 year derogations).

One study reviewing specific case studies indicated, an additional 5.2 percentage points, and an additional 4.6 percentage points, respectively, to the recycling of the (municipal type) wastes in scope [6]. The same report indicates a more prominent role for mixed waste sorting to the overall level of plastics recycling although the figures are not necessarily transferable.

[5] See main report for assumptions.
[6] Eunomia (2021) Waste in the Net-Zero Century: Testing the Holistic Resources System via Three European Case Studies, Report for TOMRA, July 2021.

In absolute terms, if MWS were deployed at the front of all 'ways of managing' leftover mixed municipal solid waste, then almost 10 million tonnes of additional waste for recycling could be delivered. If there is scope to extend MWS to waste which is landfilled and incinerated beyond what is currently reported as municipal waste, then the figure would be higher.

This suggests a potential role for EPR systems to support, financially, the use of MWS systems. Evidently, this argument becomes more compelling in cases where performance still lies just short of the demands of existing laws (assuming that suitable and credible sanctions for failing to achieve targets are in place).

E.2.4 Effect on Capacity of Incinerators to Treat Waste

MWS has two important effects on leftover mixed waste:

- It reduces the quantity of residual waste left to be incinerated (or stabilised prior to landfilling);
- It reduces the calorific value of the remaining residual waste.

These effects, when combined, contribute to either:

a) increasing the amount of waste that can be handled using an existing incineration facility – our estimate is that for each tone handled by an incinerator today, around 1.33 tonnes of waste could be handled by the 'MWS+incinerator' combination; or

b) reducing the required capacity of new incineration plants where they may be being considered.

Indeed, if the 65% recycling target for MSW is to be met, then if existing incineration facilities remained operational, the effect of MWS might be to reduce the need for additional incineration capacity below zero. However, this abstracts from the spatial distribution of facilities, as well as the age of the existing facilities.

Nonetheless, the deployment of MWS, when combined with existing recycling targets, raises the prospect of a coordinated approach to making better use of incineration capacity as demand for the service of managing residual waste declines.

E.2.5 Contribution to Landfill Directive Targets

Three contributions could be made by the deployment of MWS (and a requirement to stabilise waste prior to landfilling):

a) first, MWS reduces the amount of waste that might otherwise be sent to landfill where a ‘landfill system’ is considered. This assumes, though, that the 65% target has already been met through source separation (otherwise, we are double counting the effect on recycling targets and landfill directive targets);

b) second, the stabilisation prior to landfilling reduces the quantity remaining following the ‘MWS-plus-stabilisation’ to around half of the initial quantity. Instead of one tonne being landfilled for each tonne of leftover mixed waste, two tonnes can be treated for each tonne landfilled where material is subject to MWS and stabilisation; and,

c) third, as noted above, the capacity of existing incinerator installations is increased.

These effects can each support planning for a waste management system which is the most conducive to the development of a circular economy in the period between now, and when the Landfill Directive target has to be met.

E.3.0 Recommendations

Recognising the contribution that can be made by MWS to GHG mitigation, recycling and employment, and recognising also that stabilisation of waste prior to landfilling can enhance the GHG benefits, the following policy recommendations are made with a view to increasing the uptake of MWS through market-based measures (and regulation).

E.3.1 Include Incineration within the EU-ETS

At present, Article 24 of the EU-ETS Directive (Procedures for unilateral inclusion of additional activities and gases) enables Member States to expand the coverage of the EU-ETS by opting in activities, installations and greenhouse gases not originally covered by the scheme. Sweden and Denmark have used the opt-in for incineration, but others have not [7] [8]. It makes sense, given the emissions generated by incineration, to include them so as to impact incentives to reduce emissions in future. This could be through use of MWS and / or other methods.

Our suggestion would be to 'phase incineration in' sooner rather than later. This could be done in a number of ways, possibly necessitating a raising the cap, though perhaps more preferably, following announcement of intent to include incineration, commencing their inclusion from, say, 2024 or 2025, and then requiring installations to purchase allowances to cover an increasing proportion of their emissions with allowance purchases.

This could allow for 'full inclusion' (requiring EUAs to be purchased by operators so as to cover 100% of each installation's emissions) by 2028, but would have the merit of phasing in the additional demand, and allowing the owners of waste installations some time to adjust to the new regime. Evidently, other decisions regarding (changes in) scheme operation would need to be made in the full knowledge of the changes to be made.

[7] Ellen Philipsson (2020) Emissions trading for waste incineration plants with energy recovery in Sweden, Master's thesis in Energy and Environmental Engineering, Linköping University Department of Management and Engineering, Spring Semester 2020.

[8] Energistyrelsen (2018) Annex 1 to Denmark's First DRAFT Integrated national energy and climate plan pursuant to Articles 3-11 and ANNEX I of Regulation [_][Governance] on the GENERAL FRAMEWORK FOR INTEGRATED NATIONAL ENERGY AND CLIMATE PLANS, Part 1: General framework, SECTION A: NATIONAL PLAN, 30 November 2018.

There are strong arguments, in our view, for including the non-fossil CO2 emissions. Currently, the EU-ETS Directive (2003/87/EC, as amended), in Annex IV, states, ‘The emission factor for biomass shall be zero.’ ‘Biomass’ is not defined in the Directive itself. It is defined in the Renewable Energy Directive (EU) 2018/2001 (Art 2(24)), and includes:

the biodegradable fraction of waste, including industrial and municipal waste of biological origin;

The ‘biodegradable fraction of waste’ is rarely, if ever, combusted at incineration plants without there also being fossil-derived materials present. We would expect a reduction in the fossil carbon content of waste following residual waste sorting, but not its complete elimination. We suggest, therefore, amending the underlined fraction above so that:

a) incinerated waste is not considered as a ‘renewable’ source of energy, and,

b) the inclusion of incineration under the EU-ETS covers all CO2 emissions, whether of fossil, or non-fossil origin.

This is likely also to considerably simplify monitoring and verification.

E.3.2 Re-focus Taxes on Incineration towards Air Pollutants

Where countries have existing taxes in place on incineration, there may be justification for modifying the rates to account for incineration’s inclusion under the EU-ETS. On the other hand, there may be good reasons to re-focus the basis for taxes on emissions of, for example, NOx (and other pollutants) from incineration

E.3.3 Regulate for MWS plus Stabilisation

Whilst it might, in theory, be possible to also include landfill under the EU-ETS, in practice, there are greater difficulties, three of which are: a) that the actual emissions of interest are 'fugitive' and take place across the area occupied by the landfill, b) the emissions from landfill take place over an extended period of time after waste has been landfilled, and c) the equivalence between methane and carbon dioxide is an ongoing matter for discussion given the different residence times of the gases.

The more pragmatic approach would be to regulate for MWS plus stabilisation, possibly supporting this through minimum tax rates. The former would be aligned with Article 6 of the Landfill Directive, which effectively requires 'treatment' of waste prior to landfilling, but which suffers from the absence of a meaningful definition of 'treatment'. A suggested definition of 'treatment', of ruse in the Landfill Directive (LFD), would be:

a) The sorting of the waste, with sorting defined through the process set out at Article 27 of the WFD. Such a definition could, potentially, alter the sorting requirements in line with what is achieved through source separation;

b) The subsequent stabilisation of any waste destined for landfill. The objective should be to ensure the prospects for fugitive methane emissions are minimised through the combination of stabilisation, and the use of suitable oxidation layers at the receiving landfill.

• In respect of the former, a threshold for stability (e.g. 10mg O2 / g dm) should be set aimed at reducing the potential for methane generation to low levels so that residual fluxes of methane can be oxidised by cover layers;

• In respect of the latter, the General Requirements for all Classes of Landfills, set out at Annex I of the LFD, could be amended to consider appropriate cover layers (and para 4, regarding Gas Control, could be amended so the need for gas control was linked to stabilisation being achieved, and the oxidation layer used.

Member States should be required to implement this by no later than 2028.

E.3.4 'Minimum Tax Rates' for Landfilling

It would be appropriate for Member States to incentivise the shift indicated above, and to do so in a manner which reflects the difference in GHG emissions from landfills where waste is treated in accordance with the above definition, and where it is not. Whilst it is clear that the European Commission is not in the habit of intervening in setting tax rates (the Energy Tax Directive provides as an interesting exception), the rational here would follow from the inclusion of incineration within the EU-ETS. Without ensuring some broadly equivalent treatment of landfill and incineration, operators of the latter might feel understandably aggrieved.

We suggest that there is established a schedule (increasing over time to 2028) of minimum landfill tax rates for landfilling of untreated waste, as well as a minimum differential between the taxes applied to 'treated' (stabilised) waste and untreated waste. If the differentials were set so that over time, they became sufficiently high (gap between lower and upper rates no less than, for example, €75 per tonne of waste landfilled), then this ought to incentivise a swift move away from landfills receiving untreated waste.

E.3.5 Mandating MWS at Incineration Facilities

It could be useful to mandate MWS, with the EU-ETS designed to incentivise its performance (in reducing measured CO2 emissions). Specific requirements for MWS pre incineration could be included. The best opportunities for doing so may be through Article 44 of the EU Industrial Emissions Directive (IED), or through Article 27 of the WFD (or both).

This / these would mandate the use of mixed waste sorting systems of a defined quality at the front of all new incineration plants, as well as those which have been operational for less than ten years (with many years of their operational life still to run). This could also be defined as a requirement for the 'treatment of waste prior to incineration' (mirroring the requirement in respect of landfill), with elements of the sorting requirements made common to both types of facilities. There may need to be some exception for some existing facilities where there are serious spatial constraints.

E.3.6 Removal of Implicit Subsidies for Incineration

All Member States implement taxes on the energy products in scope of the Energy Tax Directive (ETD) [9]. Some Member States also have carbon taxes in place. The way in which different sources of energy are treated under the different tax systems applied by Member States is such that they are not all treated ‘equally’ under the different tax systems.

Tax rates which should reasonably be applied to incineration (and landfill), but from which incineration is exempt, should be applied unless there are clear justifications for exemptions (e.g. other policies mimic the effect that the tax would otherwise have).

One of the merits of including incineration within the EU-ETS is exactly this – that an implicit subsidy for incineration in most countries is removed. Our suggested approach for taxing landfill also seeks some equivalence in treatment, recognising the practical problems with including landfills within the EU-ETS.

[9] The proposal for a revised ETD presented by the Commission, whilst changing the basis for taxation, does not seem to make major changes in this regard where domestic heating fuels are concerned (see Proposal for a Council Directive restructuring the Union framework for the taxation of energy products and electricity (recast), Brussels, 14.7.2021 COM(2021) 563 final).

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1.0 Background

1.1 We Know Recycling Makes Good Sense

It's well understood that the best way to manage waste is to prevent it from arising in the first place. If we consume differently, or less, then the amount of waste we generate can fall significantly.

Of the waste we do generate, once 'stuff' has been discarded, then in the majority of cases, it makes sense to keep materials in use as materials as far as possible. When we consume, we are effectively consuming, energy, water, and the constituent input materials that are used to manufacture, and then distribute, the things we consume. Their use generates pollution – greenhouse gases, air pollutants, water pollution, emissions on land. The extraction of materials can also lead to degradation of land and habitat. As we consume, so we pollute.

By recycling, some of these processes can be avoided, and as long as the process is well managed, the amount of energy, water, materials and polluting emissions that are associated with consumption can be reduced relative to the situation where primary materials are used, and there may be some reduced impact on land and habitat.

Where materials are not recycled, then in the EU, they may be either landfilled, incinerated, or treated using mechanical biological treatment. These ways of managing waste materials generate environmental impacts of their own. Recycling also helps avoid the negative consequences of these management methods.

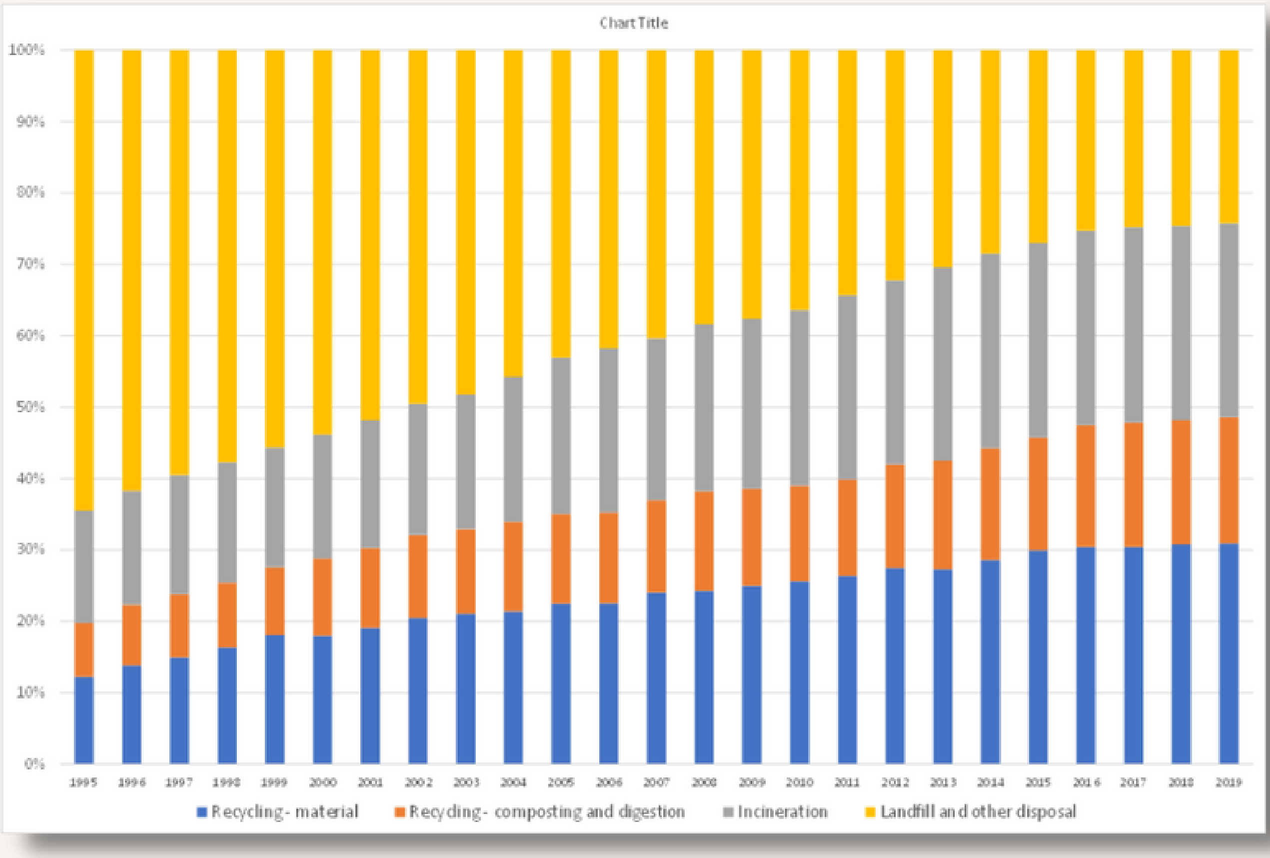
In summary, the things we consume embody, to varying extents, pollution of land, air and water, emissions of greenhouse gases, and degradation of habitats. By recycling, we can usually reduce these 'embodied impacts' so in further cycles of production and consumption.

1.2 Although Reported Levels of Recycling have been on the Increase, More Needs to be Done

Although recycling has increased significantly in the EU as a whole, there is plenty of recyclable material that is not sorted by households and businesses for recycling through the collection systems available to them, and still more that could be recycled if what we consumed was designed to be recycled once it has been discarded. It remains the case that less than half of municipal waste in the EU-27 was being reported as recycled or composted in 2019.

Much more will need to be done to achieve the targets set in the Waste Framework Directive, and in the Packaging and Packaging Waste Directive, not least since new rules setting out how to measure how much waste is actually recycled will likely lead to reported recycling rates being lower than would otherwise have been the case.

Figure 1: Management of Municipal Waste in the EU (% by Final Treatment, 1995-2019)



Source: Eurostat | Note: because mechanical biological treatment is not considered as 'a final treatment', it does not show in figures reported by Eurostat (and although the associated mass losses should be accounted for in reporting by Member States, these are not captured in the above graphic).

1.3 Separate Collection of Materials in Waste Helps to Support Recycling

The Waste Framework Directive makes separate collection of waste a requirement where it is necessary to facilitate or improve preparing for re-use, recycling and other recovery operations (Art 10(2)), albeit with some derogations allowed for (in Art 10(3)). This helps to ensure that the quality of some materials which are widely collected for recycling – for example, paper and card – are of sufficient quality to allow them to be easily recycled.

1.4 But Recycling Behaviours are Never Perfect

Yet because not all citizens are perfectly accurate in sorting their waste, then even if quality collection services are made available, there are always some recyclable materials which are left unsorted, and which remain in mixed waste, typically destined for landfill or incineration. As a thought experiment, suppose that waste was composed of ten different materials. If each of them was targeted for recycling, and if households correctly sorted three-quarters of each of the materials present in the waste, then the leftover mixed waste would contain one quarter of each of the materials that was present at the start. As a result, the material composition of the leftover mixed waste would be exactly the same as the material composition of the entirety of the waste at the start.

In practice, however, different materials tend to be sorted and recycled better or worse than others, although this is also influenced by the collection services being provided. In particular, plastics are not especially well recycled at present, so where other materials are being targeted for recycling, the proportion of plastics in the leftover mixed waste tends to be higher than in the waste before separate collection.

A graphical depiction of this is shown in Figure 2. This shows, for the situation in the UK, the amount of each material type in municipal waste, and for each material type, how much is recycled, and how much is 'left behind' in mixed waste [10]. The same information is presented in Table 1. Note that in the bottom right-hand corner, the overall capture of waste for recycling is 41%. Effectively, relative to its composition in the totality of municipal waste, a given material becomes 'more concentrated' in leftover mixed waste (i.e. its share in the composition of leftover mixed waste is higher than its share in the total municipal waste) wherever the proportion captured for recycling is below the 41% average, with the opposite being true if the capture rate is above the 41% average.

So, because the capture of all plastics for recycling is much lower (18%) than for the totality of municipal waste (41%), its composition is higher (16%) in leftover mixed waste than in the totality of municipal waste (12%). It follows that even if all plastics in municipal waste were recycled at higher rates in future, that if those higher rates remain below the average for all municipal waste (because the target for all municipal waste is also increasing), then plastics would still be 'concentrated' in leftover mixed waste.

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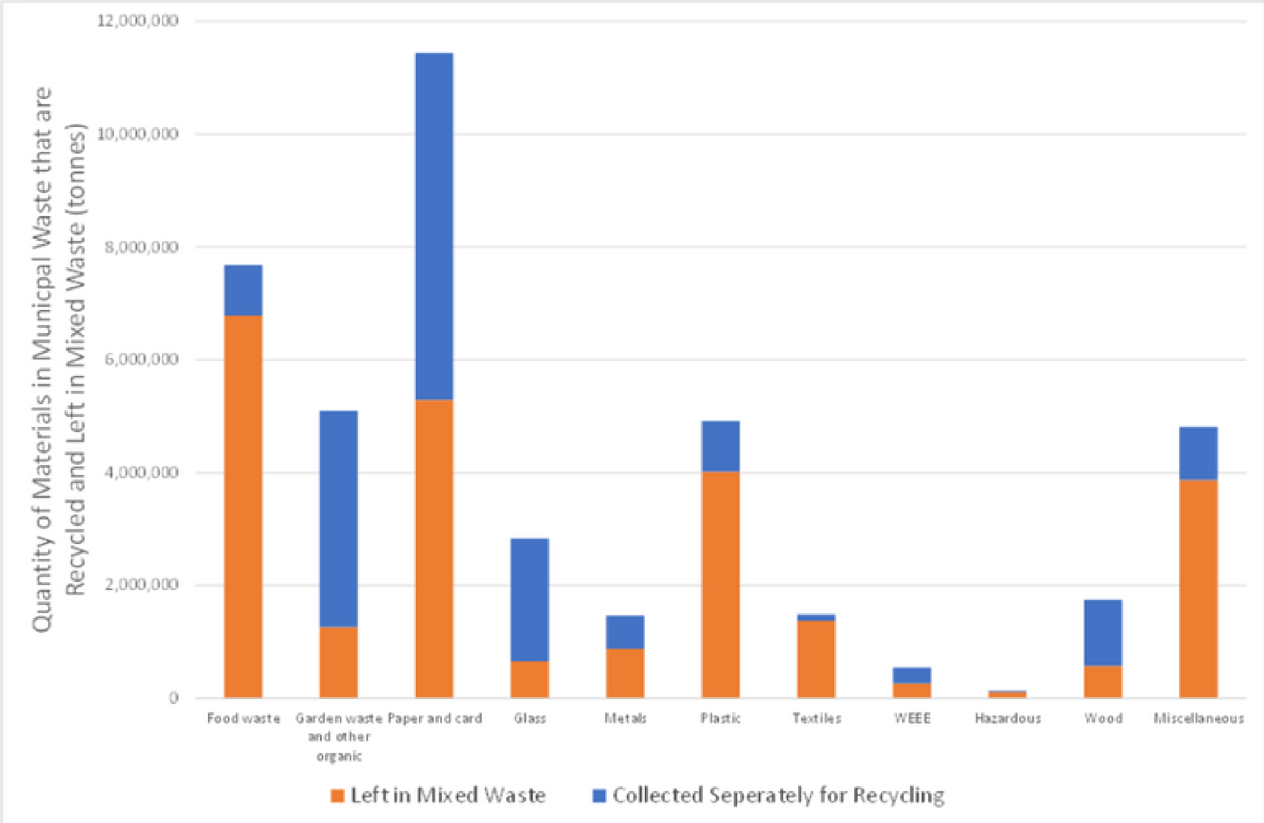
[10] Strictly speaking, where this graphic indicates 'recycling', it would be more accurate to say that the waste is 'collected for recycling'.

Figure 2: Shares of Materials in UK Municipal Waste that are Collected for Recycling or Left in Mixed Waste



Source: Eunomia (2020) National Municipal Waste Composition, England 2017, Report for WRAP, January 2020.

Table 1: Compositions of Municipal Waste and Leftover Mixed Waste, Alongside Capture for Recycling of Each Material

Material	All Municipal Waste	Leftover Mixed Waste	Capture by Material (collected for recycling as % total material)
Food waste	18.20%	27.03%	12%
Garden waste and other organic	12.10%	5.02%	75%
Paper and card	27.10%	21.07%	54%
Glass	6.70%	2.62%	77%
Metals	3.50%	3.52%	40%
Plastic	11.70%	16.02%	18%
Textiles	3.50%	5.47%	8%
WEEE	1.30%	1.07%	51%
Hazardous	0.30%	0.46%	15%
Wood	4.20%	2.30%	67%
Miscellaneous	11.40%	15.41%	20%
TOTAL			41%

Source: Equanimator analysis, based on Eunomia (2020) National Municipal Waste Composition, England 2017, Report for WRAP, January 2020.

1.5 Neither landfilling nor incineration is an appropriate way to manage waste in the twenty-first century

EU waste legislation has developed, over time, progressively to improve waste management. This evolution has taken policy and legislation through successive phases:
1. Improving the management of waste which is not recycled, and setting recycling targets at relatively low levels;
2. Increasing recycling targets and seeking to enhance standards of management of unrecycled waste;
3. Further increasing recycling targets and emphasising separate collection of waste whilst seeking to progressively eliminate landfilling.

In the current stage of evolution. The focus is on developing a circular economy, with greater emphasis on reuse, alongside still higher recycling targets, and a further reduction in unrecycled waste [11].

For some years, progress made by Member States in managing municipal waste was assessed in terms of how little waste was landfilled. This effectively negated any differences in how the 'wastes that were not being landfilled' were managed. Landfill appeared to be relegated to bottom place in the waste hierarchy simply by virtue of its name [12].

1.6 A Growing Share of Unrecycled Waste is being Sent for Incineration

The majority of the EU's waste that is not being recycled is being sent directly to either landfills or incineration plants. Some unrecycled waste is sent to mechanical biological treatment facilities, which may carry out some sorting of mixed waste, and may also prepare a solid recovered fuel for use at industrial facilities or incineration plants, whilst landfilling residues (which may be biologically stabilised, to varying extents, prior to landfilling). The sorting processes used are not always the most technologically advanced, and the emphasis has not always been on 'recycling', but on preparing outputs that are suitably modified for the next treatment step(s).

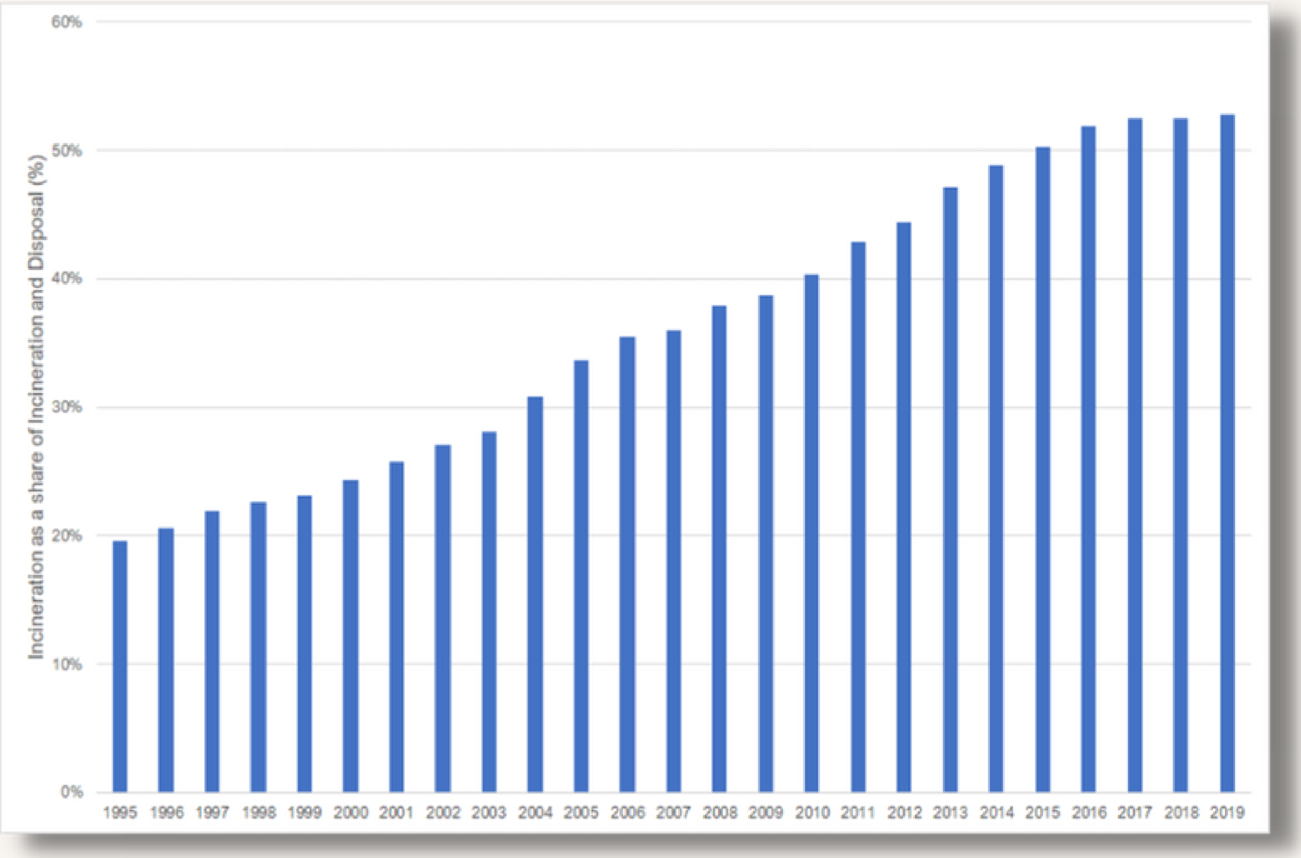
[11] See, for example, Communication from The Commission to the European Parliament, the Council, the European Economic and Committee and the Committee of the Regions (2020) A New Circular Economy Action Plan For a Cleaner and More Competitive Europe, COM/2020/98 final.
[12] A separate report has detailed the way in which policy at the EU level has evolved in terms of the way it addresses landfill and incineration – see Equanimator (2021) Rethinking the EU Landfill Target, Report for Zero Waste Europe, October 2021.

The share of unrecycled waste being sent to incineration, as opposed to landfill, is increasing (see Figure 3). EU policy has supported the view that incineration is a better way of dealing with waste than landfilling as long as the efficiency with which energy is recovered exceeds a defined threshold (the so-called R1 criterion) [13].

The amount of municipal waste being incinerated doubled in the period 1995-2019, whilst landfilling fell to less than half its 1995 level over the same period. Incineration's share in the treatment of unrecycled municipal waste has risen from less than 20% to more than 50% over the same period.

This rate may be slowing (see Figure 3) not least because existing capacity across the EU seems likely to be capable of meeting much of the EU's capacity requirement for unrecycled waste, not least as the amount separately collected for recycling increases.

Figure 3: Share of Incineration in Quantity of EU Municipal Waste Landfilled and Incinerated, 1995-2019



Source: Eurostat.

[13] The extent to which policy has leant in favour of incineration goes further than its ranking vis a vis incineration in the waste hierarchy. Of course, there is nothing wrong with this if the ranking is justified, but closer investigation suggests it might not be, or at least, that there are reasons to challenge the extent to which incineration if favoured relative to landfilling. This is explored in greater depth in Equanimator (2021) Rethinking the EU Landfill Target, Report for Zero Waste Europe, October 2021.

1.7 There is no clear reason to favour incineration of mixed waste over landfilling of waste

Whilst there emerged a clear preference for incineration of waste over landfilling, the basis for such a preference was not always obvious from an economic perspective. Whilst well-operated landfills could be viable at fees to users of €50 per tonne, and sometimes much lower at larger sites with favourable siting conditions, the costs of incinerating waste were typically of the order €100 per tonne or more, other than in countries where elevated revenues were generated from the supply of heat or/and electricity, these constituting either implicit or explicit subsidies (the more so as emissions from the power sector were being progressively internalised through mechanisms such as, for example, the EU- Emissions Trading Scheme, where the issuing of free allowances to the power sector has more or less ceased, and Member State taxes on domestic heating fuels).

In economic terms, a basic cost-benefit test would have required the external costs of incineration to be some €50 per tonne lower than those for landfill. To our knowledge, no study has, yet, demonstrated that such a differential exists, or indeed, that it ever did [14]. Indeed, back in 2000, before further revisions to the waste hierarchy sought to formalise a distinction between disposal and recovery through reference to the R1 criterion in Annex II of the Waste Framework Directive, a study funded by the EU indicated that the external costs of an incinerator generating electricity only were greater than those for a landfill operated in a manner compliant with the EU Landfill Directive [15]. Other studies have reached a similar result [16], but policy makers have generally acted as though the opposite was the case [17].

[14] It is worth noting that there has been evolution in the performance, the framing conditions (affecting 'net' environmental performance) and the unit externalities associated with different pollutants over time.

[15] See COWI (2000) External Costs of Landfill and Incineration, Final Report to the European Commission. Note that the study assumed that all energy generated displaced coal-fired generation, which is an assumption which is favourable to incineration in a comparative assessment vis a vis landfill. The study also modelled a facility generating combined heat and power (CHP), a configuration which delivers a higher quantity of useful energy. The assumption for the facility was that the energy it would displace was generated from coal. Although the performance of this facility, as modelled, led to an assumption of a significant net benefit, closer inspection reveals that the study incorrectly assumed that the CHP facility would generate the same amount of electricity (25% relative to the lower heating value of waste) as the efficient electricity generating facility, as well as recovering 58% of the net calorific value of the waste as heat. Technically, such performance is probably impossible to achieve; the effect, in the analysis, was to overstate the benefit from avoided emissions (especially, those linked to CO_2, NO_x, SO_x and particulate matter) where the CHP incinerator was concerned.

[16] See Enviros and EFTEC (2004) Valuation of the External Costs and Benefits to Health and Environment of Waste Management Options, Final Report for Defra, December 2004; HM Customs & Excise (2004) Combining the Government's Two Heath and Environment Studies to Calculate Estimates for the External Costs of Landfill and Incineration, December 2004; E. Dijkgraaf and H. Vollebergh (2005) Literature review of social costs and benefits of waste disposal and recycling, in EAI (2005) Rethinking the Waste Hierarchy, EAI: Copenhagen, pp. 80-98.

1.8 The Environmental Performance of Incineration Worsens – both in Absolute Terms, and Relative to Landfill - as Cleaner Energy Systems are Introduced

In most situations, and for reasons explained in Section 1.4, the proportion of plastics in leftover mixed waste is generally greater than the proportion in the totality of municipal waste. Plastics are effectively being 'concentrated' in leftover mixed waste because the captures, through separate collection, of other materials constituting the majority of waste is generally higher, on average, than for plastics (see Section 1.4)[18].

The carbon content of plastics – which are usually hydrocarbons – is typically high. A polymer comprising chains of monomers with two hydrogen atoms for each carbon atom (such as polyethylene or polypropylene) is 86% carbon by weight. Because other molecules will be present in plastics (for example, oxygen in PET, or chlorine in PVC), the actual proportion that is carbon will be lower (63% and 39%, respectively). In addition, plastics have a low inherent moisture content; indeed, reducing moisture content to a minimum is an objective in manufacture.

Where biogenic materials are concerned, the molecules are somewhat more complex, and whilst carbon and hydrogen are still present, other elements, especially oxygen, and sometimes, nitrogen, and to a lesser extent, additional trace elements contribute a significant proportion to the weight of the molecule, oxygen having a higher molecular weight than carbon. Furthermore, the moisture content of biogenic molecules tends to be relatively high, usually well above 50% for food waste. The carbon content of food waste, therefore, may be only 15% or so of the wet weight of the food.

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[17] A more detailed presentation of this argument can be found in Equanimator (2021) Rethinking the EU Landfill Target, Report for Zero Waste Europe, October 2021. It is possible that if one used assumptions that might have been justifiable in past decades – that all energy from incineration displaced energy that would have been generated by coal-fired, or oil-fired generation – and also used up-to-date damage costs for carbon dioxide emissions, then the 'gap' between landfill and incineration might be of that order. But the assumption that incineration would always displace the dirtiest sources of energy – which has been contestable for a long time, given the way demand for electricity was evolving and the way in which national systems determined which sources would be used at different times – is rarely valid any longer. As the damage costs which might have justified the ranking have increased, so it has become more difficult to sustain an argument that the avoided emissions related to air quality and greenhouse gases are as large as was once claimed. An alternative view might be that our assumptions about what may or may not be better has rarely been aligned with the prevailing state of our knowledge.

[18] This is reflected in, and may also be a reflection of, the lower recycling targets that have generally been applied to recycling of plastic packaging than are applied to other materials. Although these material-specific recycling rates were increased in the 2018 amendment to the packaging and packaging waste Directive, the target rate for recycling plastic packaging in the previous iterations of the Directive was a lowly 22.5%, and measured in such a way that 'mass losses' (between sorting outputs and final recycling) could be largely overlooked if Member States chose to do so.

As a basic rule of thumb, even though there may be only 15-20% plastics in leftover mixed waste, as compared with around 45-50% of garden waste and waste food, wood, paper and card, the carbon content is likely to be such that the fossil carbon content of the plastics in waste is roughly the same (in absolute terms) as the non-fossil carbon content of the biogenic materials in the waste [19]. Together, when combusted, these materials may be responsible for the release of around 1 tonne of carbon dioxide per tonne of wet waste input. In conditions largely present in the EU, approximately half a tonne will be released from fossil-derived materials, with the remainder coming from non-fossil materials.

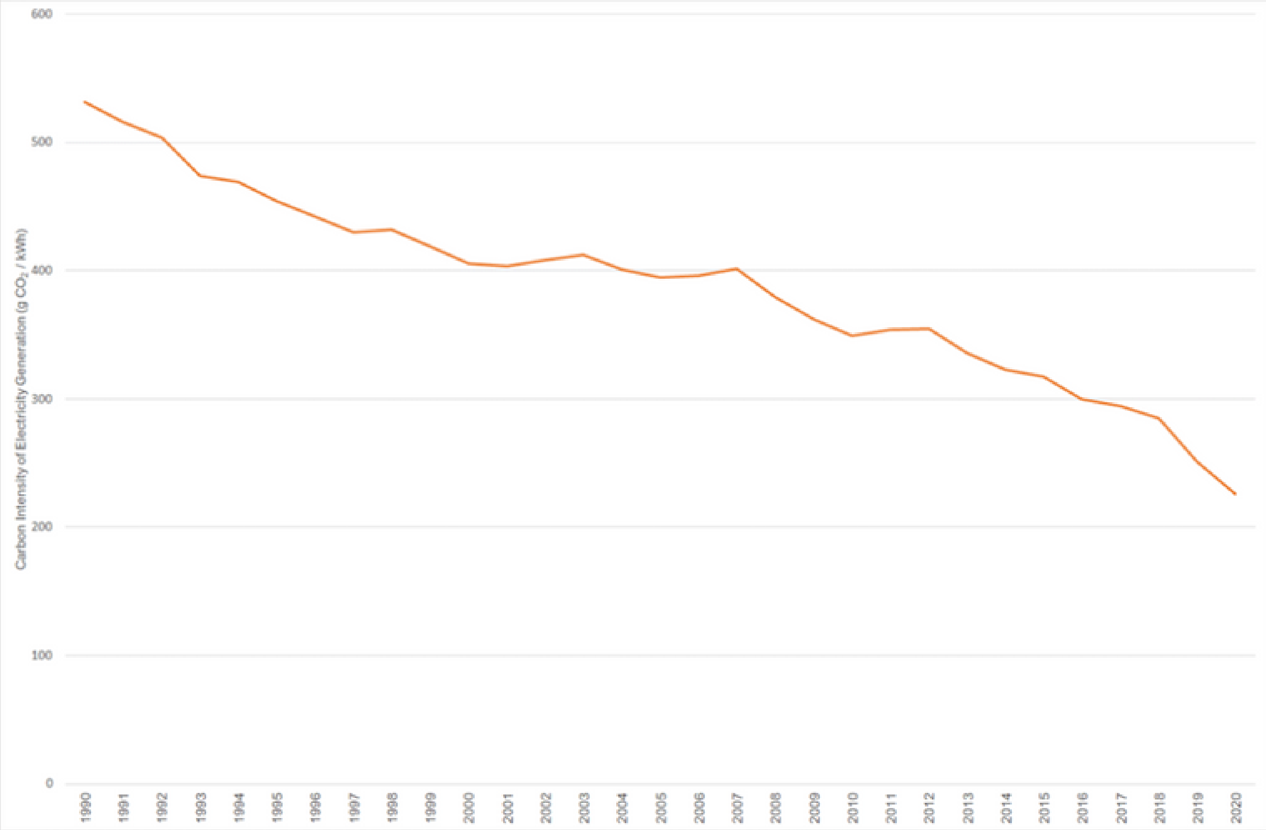
Furthermore, today, the carbon intensity of energy generation is, thankfully, on a downward trajectory, and this is expected to continue. Coal, as a source of power, is being phased out. The trajectory, in terms of the carbon intensity of power generation in the EU, is shown in Figure 4.

It is no longer credible to claim that energy derived from incineration (or any other waste treatment technology) is displacing coal other than under circumstances which are not only exceptional, but also, unlikely to persist over the expected lifetime of an incinerator.

In some countries, heat and electricity are decarbonising at different rates and so the size of, and persistence of, claims regarding avoided emissions may vary depending on the mix of heat and power generated by incinerators, and the counterfactual sources of such energy (what would be used to supply the same heat or power if the incinerator was not there?).

[19] In the past, at least one study has suggested that credits for ‘renewable energy’ should be claimed based on the composition of (wet) waste. The discussion here highlights, in part, why that should never be the case; the other part of the discussion relates to the energetic content of the wastes concerned. Food wastes are not generally autogenic (they do not sustain combustion). Plastics, on the other hand, are autogenic and release considerable energy. Basing a discussion either of carbon, or ‘renewable’, or ‘environmentally friendly’ contributions on the composition of wet waste is inadvisable.

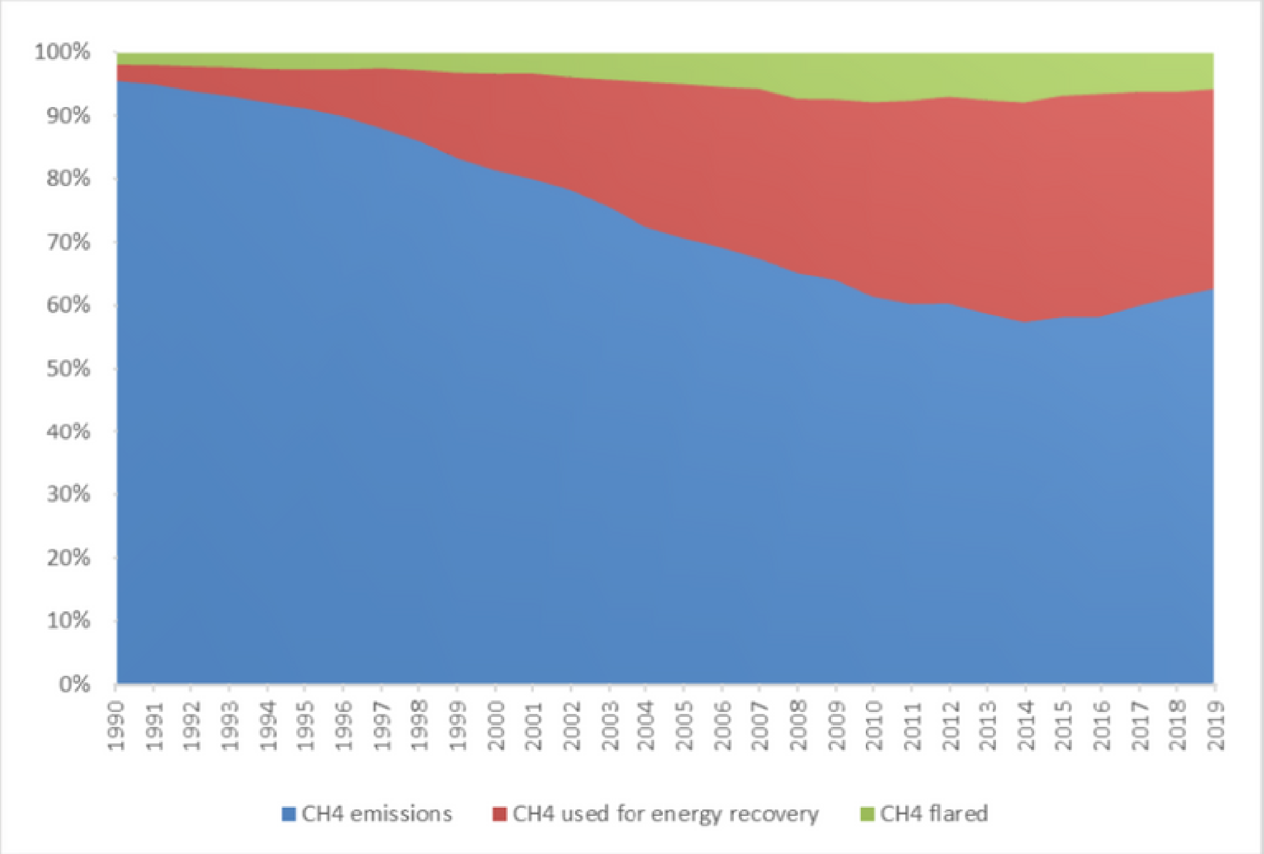
Figure 4: Average Carbon Intensity of Power Generation in the EU (gCO2/kWh, 1990-2020



Source: based on data from EEA (to 2017), and from Ember estimates (from 2018-2020 inclusive)

In the meantime, the performance of landfills which receive untreated waste, may have improved somewhat in terms of, for example, the capture of landfill gas. Figure 5 shows how the proportion of methane that is released from landfills is believed to have changed over time. Because they generate less energy, landfills' 'net' performance is affected to a lesser extent by changes in the benefit claimed for avoidance of energy generation by other means. In the comparative sense, where climate change is concerned, landfills' performance improves as the justifiable claim for the climate (and air pollution) credit associated with each unit of avoided energy generation diminishes.

Figure 5: Proportion on Landfill Methane Emissions Used for Energy, Flared or Emitted to Atmosphere (1990-2019)



Source: European Environment Agency (2021) Annual European Union Greenhouse Gas Inventory 1990–2019 and Inventory Report 2021, Submission to the UNFCCC Secretariat, 27 May 2021EEA/PUBL/2021/066.

The climate change performance of incineration is likely to be worsening on at least two fronts:

1. The fossil carbon content of unrecycled waste, and hence of CO2 emissions from incineration plants, may be (it seems likely to be) on the rise as plastics account for a greater share of packaging over time, and because the capture of plastics through separate collection is low compared with the captures of other fractions that contribute significantly to the waste stream; and,

2. Any credit that can be claimed for incineration in respect of 'avoided emissions' is in decline. This affects not only the 'climate change' impacts of incineration, but also, the air quality benefits.

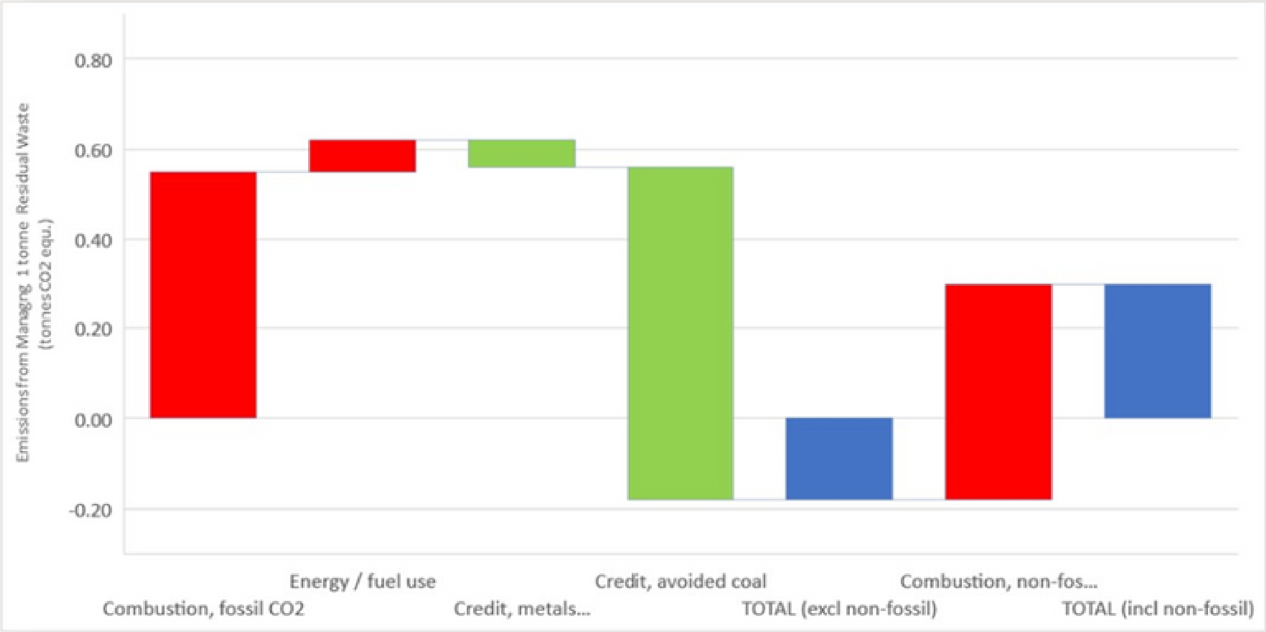
In the comparative sense, the former issue tends to have a positive impact on emissions from landfill; the latter issue affects landfill negatively, but to a far lesser extent than incineration because landfills generate less energy. It follows that the relative impacts of landfill and incineration are also shifting. These points have been highlighted in various studies [20].

The effects of these changes are summarised in the graphics below, which illustrate, in successive waterfall diagrams, how the net GHG emissions from incineration change as the assumptions regarding the carbon intensity of the avoided energy source are changed, reflecting progressive decarbonisation of power generation.

As we move from an assumption of coal being avoided, through to gas, and then to the (estimated) EU average carbon intensity of power, so the GHG emissions from incineration, net of the avoided emissions, change from being close to -0.20 tonnes CO2e per tonne waste incinerated to more than +0.30 tonnes CO2e per tonne waste incinerated where only fossil-derived CO2 is considered. If one takes into account the non-fossil CO2 also, then the change is from around +0.30 tonnes CO2e per tonne waste incinerated to around +0.80 tonnes CO2e per tonne waste incinerated. The change is significant.

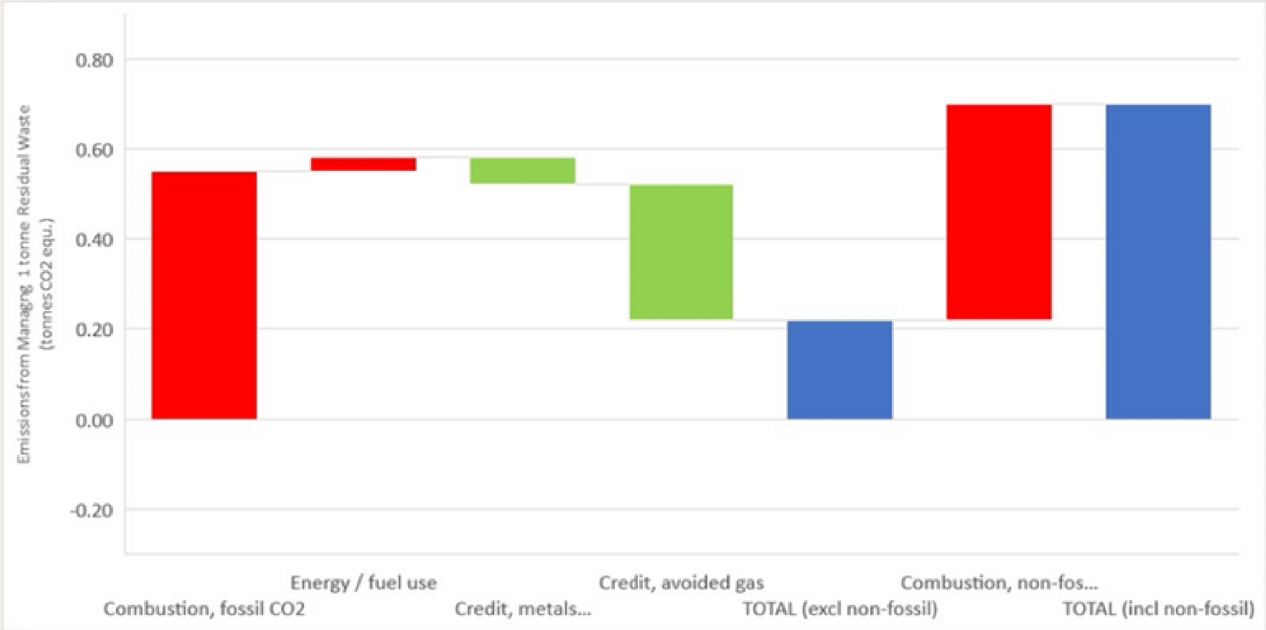
[20] Eunomia (2006), A Changing Climate for Energy From Waste, Final Report for Friends of the Earth; ERM (2014) Energy Recovery for Residual Waste – A Carbon based Modelling Approach, Report for Defra, February 2014; D. Hogg and A. Ballinger (2015) The Potential Contribution of Waste Management to a Low Carbon Economy, Main Report, prepared by Eunomia for Zero Waste Europe; Zero Waste Scotland (2021) The Climate Change Impacts of Burning Municipal Waste in Scotland, June 2021; Eunomia (2020) Greenhouse Gas and Air Quality Impacts of Incineration and Landfill, Report for Client Earth, December 2020; Zero Waste Europe (2021) Building a Bridge Strategy for Residual Waste: Material Recovery and Biological Treatment to Manage Residual Waste within a Circular Economy, Policy Briefing, January 2021.

Figure 6: GHG Emissions from Incineration (assumes power from incineration avoids generation of electricity using coal)



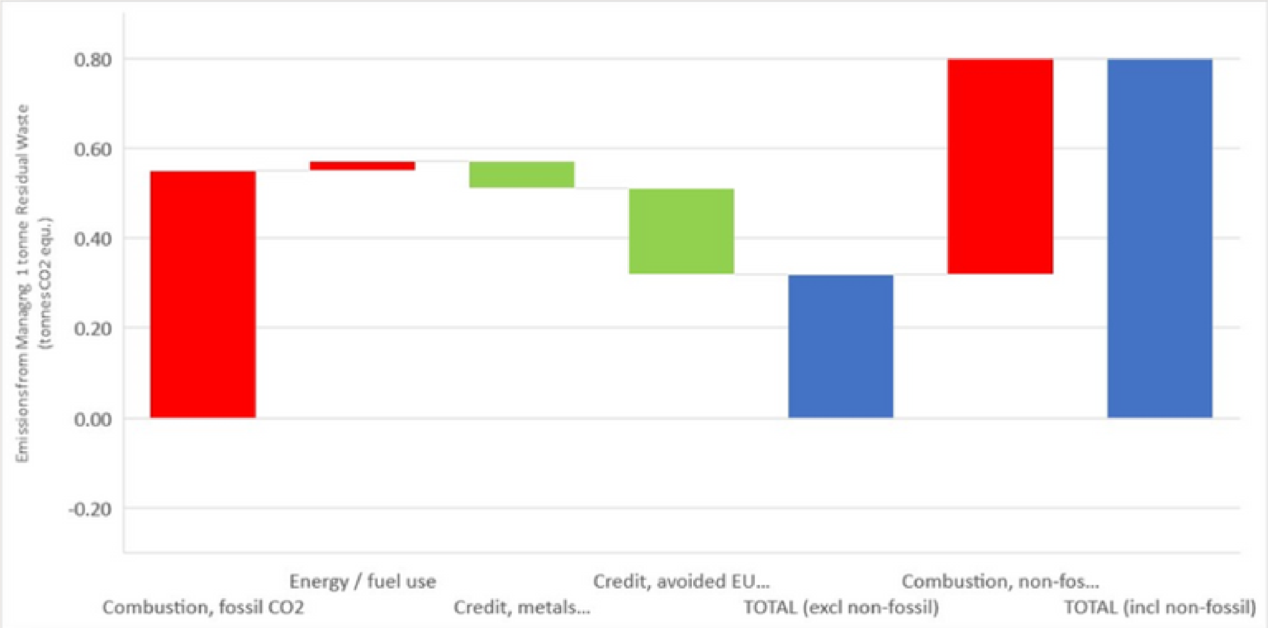
Source: Equanimator

Figure 7: GHG Emissions from Incineration (assumes power from incineration avoids generation of electricity using gas)



Source: Equanimator

Figure 8: GHG Emissions from Incineration (assumes power from incineration avoids generation of electricity at EU average for 2020 = 220gCO2e/kWh)



Source: Equanimator

Added to this, whilst emissions from the power sector are all covered by the EU Emissions Trading Scheme, with the issuance of free allowances having been phased out, relatively few incineration installations are covered by the EU ETS, or by other policy instruments that might largely internalise the known externalities (this matter is taken up in more detail in Section 3.2).

1.9 We can reduce the quantity, and impact of, managing leftover mixed waste by ensuring it is subject to sorting (and biological treatment of remaining waste where the disposal route is landfilling)

Relatively little focus has been given, at least in policy-making at the EU level, to ways of extracting material resources from leftover mixed waste; an exception has been the extraction of metals from incinerator bottom ash, now explicitly recognised as contributing to recycling targets. This might not be considered so surprising given experiences from previous decades in seeking to sort material that could be recycled from mixed waste. So-called 'dirty MRFs' [21] were touted, initially, as means by which recyclable materials such as paper and card could be sorted from unsorted mixed waste. Indeed, they were often marketed on the basis that their use could sidestep the need for householders to do any sorting themselves: the machine would take care of the sorting needed to extract the materials.

The reality, however, was that the quality of the materials extracted was often poor, and where paper and card was concerned, the material would attract only low prices, if indeed it was accepted at all by recyclers. Wet/dry separation schemes evolved to try to address this, the idea being that if the wetter putrescible materials were kept separate from the targeted recyclables, the quality of the recyclables would not be so negatively affected. Paper and card would supposedly remain drier / cleaner, for example, and the materials could be sorted more accurately and with lower levels of non-target materials. Whilst attractive in theory, in practice, this still requires accurate separation of two fractions, with potential still for the 'wet' to contaminate the 'dry', with attendant loss in material quality and value.

In the current situation in the EU, Articles 10 and 11 emphasise the desirability of separate collection. It is clear, therefore, that a preference for separate collection has emerged as a means to deliver high quality recycling. This is very much as it should be, not least with materials such a paper and card, which also benefit from being kept separate from glass. Yet the past thirty years have witnessed major innovations in mechanical sorting technology. This has been particularly noticeable in the case of the sorting of plastics, where innovations in mechanical sorting have led to such approaches enabling efficient and accurate sorting of plastics into sub-fractions more suitable for marketing to end-users.

[21] A MRF is a 'materials recycling / recovery facility' – a sorting plant.

Over the same period, plastics have steadily increased in their range of use, especially (though not only) for packaging, and in the complexity of their design. Mechanical sorting of the steadily growing plastic fraction of waste may be essential in the coming years if Member States are to meet recycling targets set out in the Waste Framework Directive (WFD) and the Packaging and Packaging Waste Directive, not least given the revised approach to measuring recycling [22].

At least in the near-term, this will be true even where novel technologies for reprocessing plastics are being introduced to the market since many technologies, whatever their current claims, are likely to display limited tolerances towards materials which compromise their ability to operate on a continuous basis, especially if they are to deliver the desired outputs (as opposed to energy products based on fossil-derived carbon).

There is enough evidence to suggest, therefore, that using mixed waste sorting (MWS), the quantity of leftover (mixed residual) waste can be further reduced, that additional materials can be extracted for recycling, and that where incinerators are concerned, the removal of additional plastics, in particular, for recycling can reduce the quantity of fossil-derived CO_2 released from the combustion of waste. Allied to this, where landfills are concerned, deploying MWS in conjunction with biological stabilisation can significantly reduce the greenhouse gas emissions from ‘a landfill system’.

[22] Commission Implementing Decision (EU) 2019/665 of 17 April 2019 amending Decision 2005/270/EC establishing the formats relating to the database system pursuant to European Parliament and Council Directive 94/62/EC on packaging and packaging waste (notified under document C(2019) 2805).

2.0 Why Should we Sort Mixed Waste?

2.1 What are the Climate Change Benefits of Mixed Waste Sorting (MWS)?

When MWS is used at the front of an incineration plant, or at the front of a landfill, there is a marked improvement in the climate change performance of managing leftover mixed waste, relative to a situation where it is burned or landfilled without prior sorting.

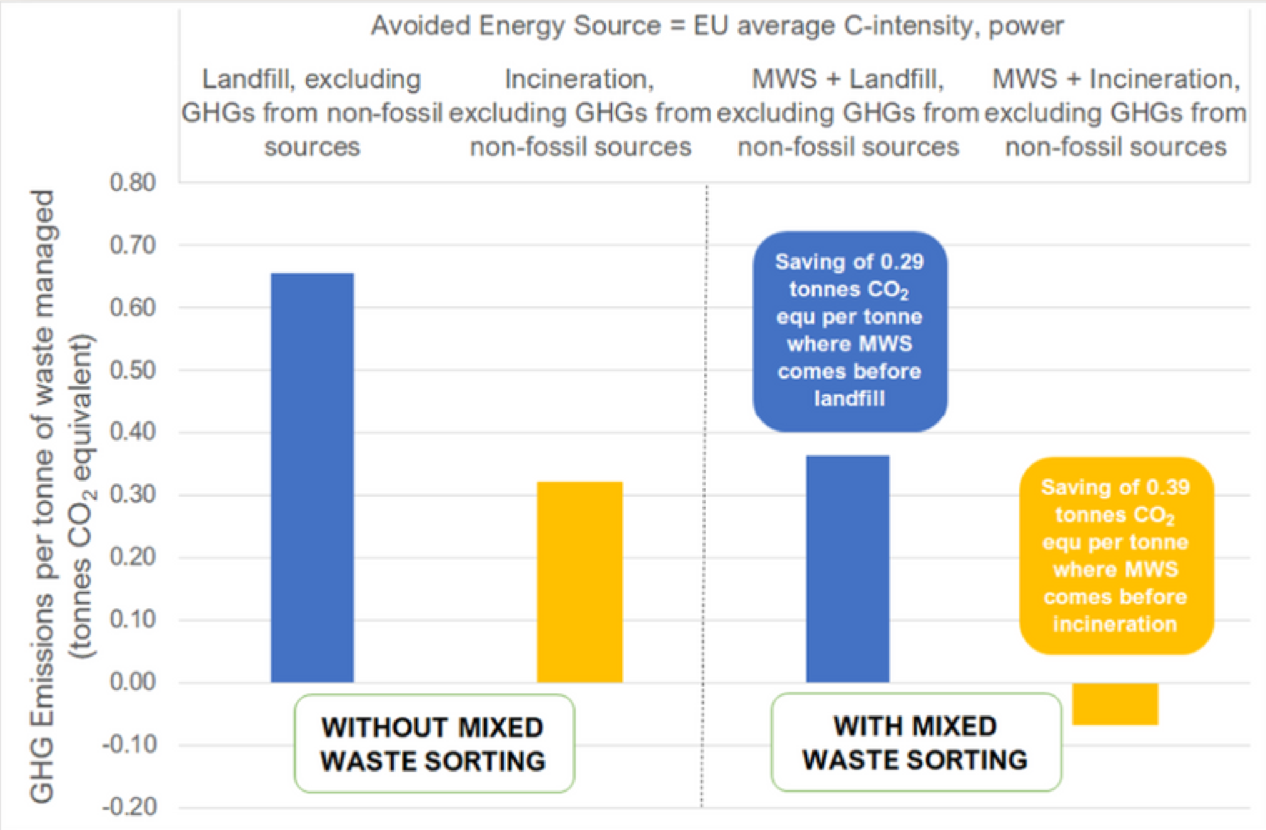
In the case of the landfill, the improvement relates, almost entirely, to the potential reduction in greenhouse gas emissions that can be derived from recycling the materials extracted from the sorting process; most of these materials are not ones that degrade in landfills, so there is comparatively little effect on the emissions related to the act of landfilling itself. To address these emissions requires an additional step to stabilise the wastes that would otherwise generate methane once landfilled (see below, especially Figure 11).

In the case of the incineration plant, the effect is further enhanced because, as well as the improvement linked to some additional recycling of materials, because some of these materials – most obviously, the plastics - are manufactured using fossil-derived carbon, there is a reduction in the fossil-derived emissions of CO2 associated with their combustion. From the discussion in Section 1.8, it may be appreciated that the 'credit' related to avoided GHG emissions associated with energy generation becomes insufficient to offset the emissions directly associated with combustion. As both power and heat decarbonise, as they must in the coming years, so the improvement offered by mixed waste sorting (MWS) is likely to increase.

In Figure 9, we show the effect of using MWS as part of a) a landfill system, and b) a system where incineration of waste generates power, and where the avoided energy source is electricity generated at the EU average carbon intensity in 2020 (around 220g CO2/kWh). Currently, for such an incinerator, the benefits of using mixed waste sorting instead of incinerating directly are estimated to be of the order 0.39 tonnes CO2 per tonne of waste managed.

For a landfill, the benefits of using mixed waste sorting are lower, and of the order 0.29 tonnes CO2 per tonne of waste managed. These figures increase – to 0.42 tonnes CO2e and 0.49 tonnes CO2e, respectively - if one includes non-fossil CO2 emissions in the analysis.

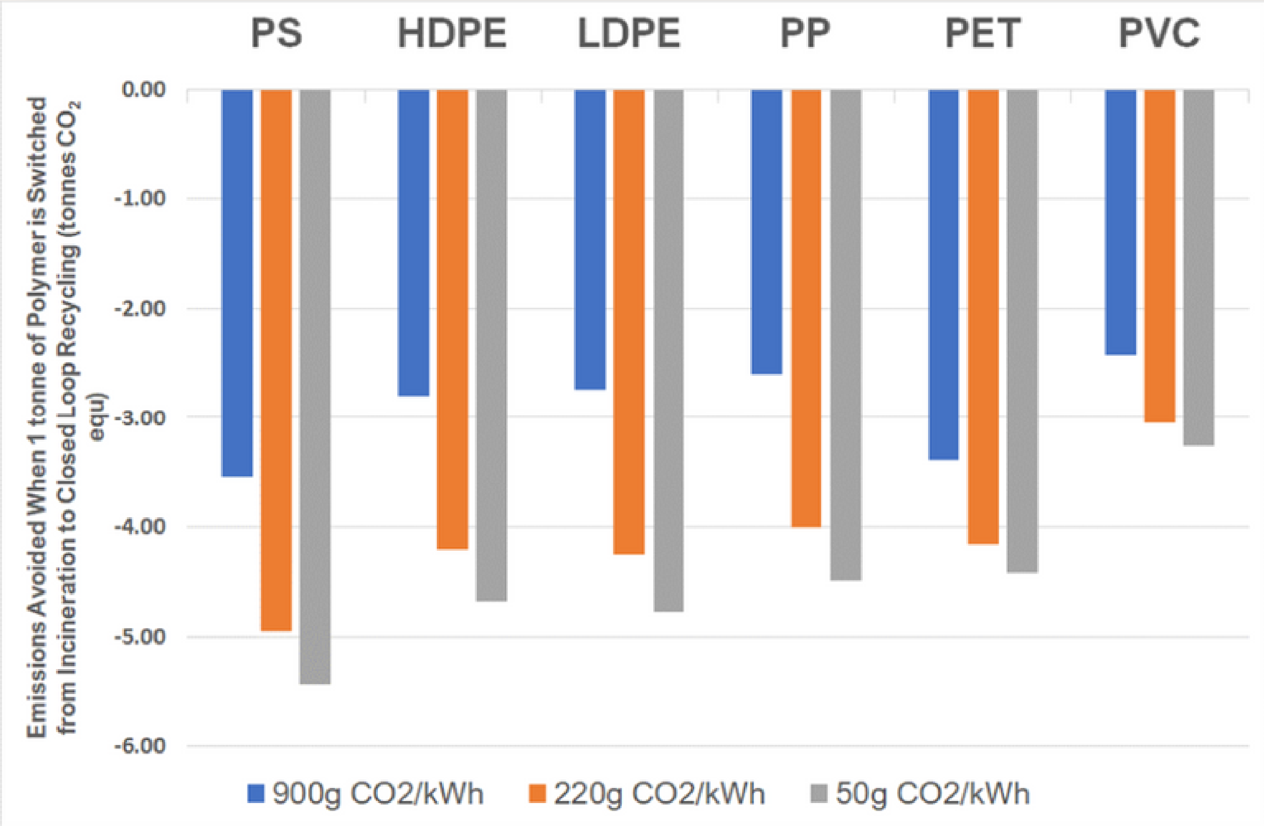
Figure 9: Effect on GHG Emissions from Managing a tonne of Mixed Leftover Waste when MWS is Used Prior to Landfilling and Incineration (assumes incineration generates electricity, and avoids generation of electricity at 220 g CO2e/ kWh)



Source: Equanimator

Where incineration is concerned, the effect on plastics of introducing MWS is especially marked. In Figure 10, we isolate the effect of the change on different polymers (each of which has a different chemical formula, and elemental make-up, and different calorific values), also showing how changing assumptions about the carbon intensity of power generation affects the analysis. For the polymers for which the molecules the highest proportion of their mass is carbon, at EU average carbon intensity of power generation, removing a tonne of a polymer from incineration and into recycling can, where the recycling replaces the use of the same primary polymer, lead to a saving of around 4 tonnes CO2e. This benefit increases as the carbon intensity of power generation declines still further (approaching a 5 tonne CO2 saving per tonne of plastics being ‘switched’ as the carbon intensity of energy generation approaches zero).

Figure 10: Effect of Mixed Waste Sorting in 'Switching' a Tonne of a Specific Polymer into Recycling where Secondary Polymers Displace Primary Ones (tonnes CO2 per tonne of Plastic)



Source: Equanimator

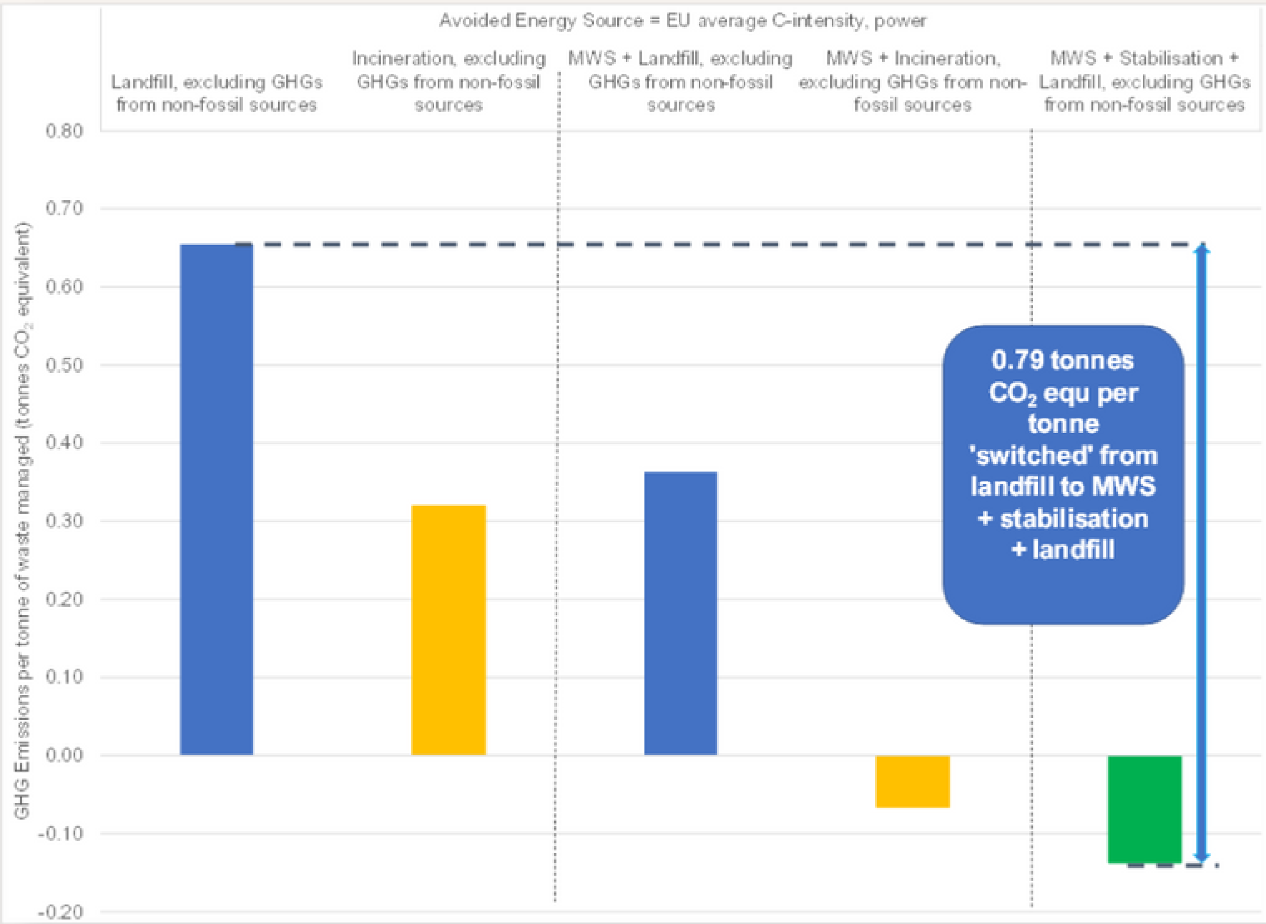
This realisation – that burning fossil-derived carbon in incineration plants is unsustainable in a world that needs to rapidly decarbonise - is increasingly widely recognised. Some cities have woken up to the fact that if they are serious about committing to 'net zero', or 'carbon neutrality', then if they already incinerate waste, or are considering doing so, then minimising the amount of plastic that is incinerated (and maximising what is recycled) is an important part of reducing those emissions that municipalities can directly influence.

2.1.1 Adding a Stabilisation Step Prior to Landfilling

The performance of the landfill-oriented system can be further enhanced through biological stabilisation of the remaining residual waste prior to landfilling. Biological stabilisation is a treatment akin to a composting process, but applied to mixed waste, and with the main objective of reducing the potential of the remaining waste to generate methane such that the residual flux of methane is low enough to be largely eliminated through use of suitable oxidation layers at the surface of the landfill.

The effect of this is shown in Figure 11. We estimate that adding the biological stabilisation step to the 'sorting and landfill' system increases the extent of the saving from 0.29 tonnes CO2e per tonne of waste managed to 0.79 tonnes CO2e per tonne of waste managed, and effectively places the landfill system on equivalent footing to the incineration + MWS system.

Figure 11: Indication of Additional GHG Savings from Deploying Stabilisation of Waste prior to Landfilling



Source: Equanimator

2.1.2 Potential Contributions from Deploying MWS (and Stabilisation)

The above figures begin to look extremely significant once the potential impact of widespread deployment of MWS is considered. In 2019, figures reported to Eurostat regarding municipal waste indicated that around 224 million tonnes of municipal waste were generated in the EU27. Of this, around 60 million tonnes were incinerated and 53 million tonnes were landfilled (note that these figures will not reveal the quantity entering into mechanical biological treatment processes, the outputs from which will contribute to the figures for landfill and incineration).

According to reporting under the Waste Statistics Regulation, in 2018, R1 energy recovery installations treated 132 million tonnes of non-hazardous waste and 6.3 million tonnes of hazardous waste. In addition, incineration plants classified as disposal facilities treated 17 million tonnes and 5 million tonnes of non-hazardous and hazardous waste, respectively. Of 'municipal type waste' (Household and similar wastes, Mixed and undifferentiated materials and Sorting residues), some 97 million tonnes were still being landfilled in 2018.

Using these figures, and assuming that similar benefits can be derived from treating all such waste as could be derived from municipal waste as modelled above (in practice, this is unlikely to be true given, for example, the fact that some of these wastes will be liquids, and others will be residues less amenable to such sorting), then:

- If one makes the somewhat crude assumption that one can apply the above savings to all municipal waste reported as landfilled and incinerated in 2019, then the savings possible are of the order 39 million tonnes CO2e, rising to 65 million tonnes CO2e if one assumes the waste destined for landfill is also subject to biological stabilisation.
- If the same exercise is conducted with all non-hazardous waste reported as incinerated under the WSR, and all landfilled 'household type' waste, these figures rise to 86 million tonnes CO2e and 134 million tonnes CO2e, respectively.

The upper end figure – of 134 million tonnes CO2equ – exceeds the annual GHG emissions reported to the UNFCCC in 2019 of all but six of the EU Member States [23]. It is a figure that lies halfway between the annual GHG emissions reported by Belgium (117 million tonnes CO2e) and the Netherlands (181 million tonnes CO2e). This is clearly not a trivial contribution, and amounts to around 4% of total EU27 emissions reported in 2019 [24].

[23] Based on emissions reported, excluding those associated with LULUCF (land use, land use change and forestry) – see European Environment Agency (2021) Annual European Union Greenhouse Gas Inventory 1990–2019 and Inventory Report 2021, Submission to the UNFCCC Secretariat, 27 May 2021EEA/PUBL/2021/066.

[24] Strictly speaking, these figures are not completely comparable. The figures we have derived assume a global warming potential of methane over a 100 year period (GWP100) of 34, whereas for the reporting to the UNFCCC, it is likely that reported figures use the GWP100 figures in the IPCC's fourth assessment report (where the GWP100 figure for methane was 25). This would mainly affect the benefits assumed to be related to stabilisation of the currently landfilled fraction (so there would not be a pro-rata reduction in the savings implied by our use of the higher GWP100 figure).

2.2 What Employment Benefits Could There Be?

Because the potential exists to increase recycling as a result of MWS, there is the potential for additional employment to be generated, both in the sorting process itself, and in the subsequent processing of the materials. We estimate that for each million tonnes of leftover mixed waste managed through MWS, the onward processing of the 10-15% of materials that are recycled have the potential to generate an additional 300 jobs [25].This excludes the net jobs that might be created through the sorting itself, though these ought to be considered 'net' of any reduction in jobs at landfills and incineration facilities.

We noted above that if the EU is to meet its 65% recycling target for municipal waste, then around 79 million tonnes of leftover mixed waste would remain to be managed, assuming no further growth, or reduction, in municipal waste over the period until 2035. Using mixed waste sorting across the totality of the 79 million tonnes could, in the fullness of time, create around 23,700 jobs across the EU in associated reprocessing facilities. That assumes the material extracted for recycling is not exported. That assumption should be considered in light of the fact that the majority of the reprocessing jobs relate to additional plastics recycling, and the export of plastics is becoming more difficult following the passing of Regulation (EU)2020/2174 [26].

If there is scope to extend MWS to applications beyond what is currently reported as municipal waste (a more rigorous application of the definition set out in the Waste Framework Directive may lead to higher figures being reported), then additional material could be extracted.

[25] This is based on an assumed 12.5% recycled of each tonne being sorted. Of this recycled material, 40% is assumed plastics, 25% is assumed 'other metals', 15% is paper / board, and 10% is assumed to be glass. Employment per 1,000 tonnes of input was based on previous studies, and lower end figures were used to reflect technical progress and the associated increase in labour productivity that would be expected. Figures assumed were (per 1,000 tones): plastics 5; cans 0.5; other metals 0.5; paper / board 1.5; glass 0.3. (See Cascadia Consulting Group (2009) Recycling and Economic Development: A Review of Existing Literature on Job Creation, Capital Investment and Tax Revenues; Eunomia (2011) From waste to work: the potential for a deposit refund system to create jobs in the UK; R W Beck (2001) US recycling economic information study, prepared for The National Recycling Coalition by R W Beck, Inc; Friends of the Earth (2010) More jobs less waste: potential for job creation through higher rates of recycling in the UK and EU; Container Recycling Institute (2011) Returning to Work – Understanding the Domestic Jobs Impacts from Different Methods of Recycling Beverage Containers, December 2011, http://www.container-recycling.org/assets/pdfs/reports/2011-ReturningToWork.pdf).

[26] Commission Delegated Regulation (EU) 2020/2174 of 19 October 2020 amending Annexes IC, III, IIIA, IV, V, VII and VIII to Regulation (EC) No 1013/2006 of the European Parliament and of the Council on shipments of waste (Text with EEA relevance).

The above estimates make no assumptions regarding multiplier effects. Employment multipliers in relation to recycling, where estimated, appear to be of the order 2 for direct and indirect effects (Type I multipliers) and of the order 3 for the direct, indirect and induced effects (Type II multipliers). It might not be wholly reasonable to consider, therefore, doubling the above figure to capture the full impact of applying MWS to all leftover mixed municipal waste in future. That would suggest a potential effect of 47,400 jobs. Evidently, this is a fairly simplistic derivation, but equally, in the absence of more comprehensive macroeconomic modelling (against which, these changes might be considered a small perturbation), it broadly follows other work undertaken in this space.

2.3 What Contribution Can Mixed Waste Sorting Make to Recycling Targets (MSW and packaging)?

The practice of sending mixed waste to either incineration or landfill has no place in a circular economy: burning or burying waste takes materials out of the chain of utility. Both, and derivatives of them (including use of mixed waste sorting) should rightly be considered as technologies which have a role to play as the fate of last resort for materials which society uses, and discards.

Given the technological developments in sorting technology, it makes sense for waste to be subjected to ‘a second round’ of separation for recycling. This approach complements, rather than replaces, separate collection. This is already being recognised in some countries and circumstances where separate collection, deposit refund schemes for beverage containers, and mixed waste sorting are being used in combination to optimise the performance of the overall system in respect of costs and benefits.

As noted above, a key benefit of MWS is the additional contribution it can make to recycling, with the attendant savings in GHG emissions and energy use. For every tonne of leftover mixed waste, then depending on detailed composition, and on the quality of the sorting system, an additional contribution to recycling of around 10-15% of the input to mixed waste sorting may be expected [27]. For specific materials, the rate of removal for recycling is higher; significantly, for plastics, depending on system configuration, and which types of plastic are targeted, 40% or more of all plastics may be extracted for recycling.

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[27] In a recent report by Eunomia, a mixed waste sorting facility delivered 36kg to reprocessors from 254kg per inhabitant of input to sorting, whereas in Stavanger, the figure was 21kg of each 134kg of input per inhabitant. Subsequent losses prior to recycling were around 20% in Friesland and around 14% in Stavanger. This gives a figure of around 12% of input recycled from Friesland, and around 14% of input in Stavanger (see Eunomia (2021) Waste in the Net-Zero Century: Testing the Holistic Resources System via Three European Case Studies, Report for TOMRA, July 2021).

These figures are important since, when assessed using the revised measurement methods proposed under Implementing Decisions 2019/665 and 2019/1004 [28], Member States are likely to have to work very hard to achieve the recycling target for plastic packaging, of 55% by the end of 2030 (though with some Member States eligible for 5 year derogations), and the municipal waste recycling target of 65%, to be met by end of 2035 (though again, with some Member States eligible for 5 year derogations). MWS is likely to contribute to ensuring these goals are exceeded, and that the climate change impacts of waste management are improved.

MWS systems appear to be configured, locally, to (sensibly) target those plastics for which markets are known to exist. The suggestion is that the extent of extraction of plastics could be increased if functional markets emerge for a wider range of plastics. Accuracy might also be helped in situations where captures of food waste are sufficiently high that the proportion in mixed leftover waste is maintained at lower levels.

In Eunomia's work reviewing specific case studies, the mixed waste sorting systems in Friesland and Stavanger contributed, respectively, an additional 5.2 percentage points, and an additional 4.6 percentage points to the recycling of the (household / municipal) wastes in scope [29].

These figures will not necessarily be transferable, but they indicate the order of magnitude of what could be achieved. These case studies indicate a far more prominent role for MWS to the overall level of plastics recycling; however, these figures are somewhat atypical since neither jurisdiction segregates plastics, other than those within scope of the respective national deposit refund systems, at source through door-to-door collections. They also indicate a much greater contribution to GHG mitigation from enhanced recycling of waste than the quantities suggest (between 12-22% of the GHG savings from the municipalities' recycling systems).

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[28] Commission Implementing Decision (EU) 2019/665 of 17 April 2019 amending Decision 2005/270/EC establishing the formats relating to the database system pursuant to European Parliament and Council Directive 94/62/EC on packaging and packaging waste (notified under document C(2019) 2805); Commission Implementing Decision (EU) 2019/1004 of 7 June 2019 laying down rules for the calculation, verification and reporting of data on waste in accordance with Directive 2008/98/EC of the European Parliament and of the Council and repealing Commission Implementing Decision C(2012) 2384.

[29] Eunomia (2021) Waste in the Net-Zero Century: Testing the Holistic Resources System via Three European Case Studies, Report for TOMRA, July 2021.

Nonetheless, the suggestion from experiences being gained is that MWS systems have the ability to extract relatively clean materials from mixed waste where the sorting system is targeted to do so. Whether to augment supply of plastics which are rendered, over time, increasingly easy to handle by mechanical recycling systems, or whether to supply materials that satisfy the tolerances of newer recycling technologies, these sorting systems are likely to contribute important marginal tonnages for recycling as countries strive to meet future targets.

In absolute terms, using the same performance assumptions as were used to estimate employment gains, then if MWS were deployed at the front of all 'ways of managing' leftover mixed municipal solid waste, then almost 10 million tonnes of additional waste for recycling could be delivered. If there is scope to extend MWS to applications beyond what is currently reported as municipal waste (a more rigorous application of the definition set out in the Waste Framework Directive may lead to higher figures being reported), then additional material could be extracted.

Note that there may well be potential for MWS systems to be partially funded via extended producer responsibility (EPR) schemes. The targets for recycling of plastic packaging are likely to challenge some, if not all, Member States. MWS facilities, therefore, could be supported financially by Extended Producer Responsibility (EPR) schemes in lieu of their additional contribution to recycling, the more if meeting the relevant targets requires additional contributions of this nature. This argument becomes more compelling in cases where performance still lies just short of the demands of existing laws (assuming that suitable and credible sanctions for failing to achieve targets are in place).

2.4 What are the Effects of Mixed Waste Sorting on Capacity Requirements for Incinerating Waste?

MWS facilities remove materials from mixed waste and make them available for recycling. Evidently, this has the effect of reducing the quantity of the remaining waste, but it also affects the quality of that waste. Especially where plastics are strongly targeted, the net calorific value of the remaining waste can decline (measured per unit of weight). Based on modelling, and consistent with a relatively high capture of plastics from mixed waste, the decline may be of the order 20-25%.

For specific incineration facilities which may be, locally, short of waste feedstock for incineration, this could be problematic (and the actual implications for the parties in any contractual situation would also need to be considered). The effect, otherwise, on incineration plants may be to effectively increase the quantity of waste that can be treated at a given facility (because the calorific value has declined), whilst it could also have the effect of reducing the size of facilities which are being constructed (or the same facility could receive wastes from a larger catchment).

If MWS was used prior to incinerating waste, the 60 million tonnes or so of incineration capacity currently used to treat leftover mixed municipal waste could likely treat around 75 million tonnes or more of waste which had already been subjected to sorting, and therefore, had lower calorific value.

Looking at the MWS-plus-incineration system as a whole, and taking into account the change in both quantity left after MWS, and the change in calorific value, incineration capacity to treat around 60 million tonnes of mixed municipal waste could be sufficient to treat what is left over from subjecting 90 million tonnes of municipal waste to MWS. The principle is demonstrated in Figure 12.

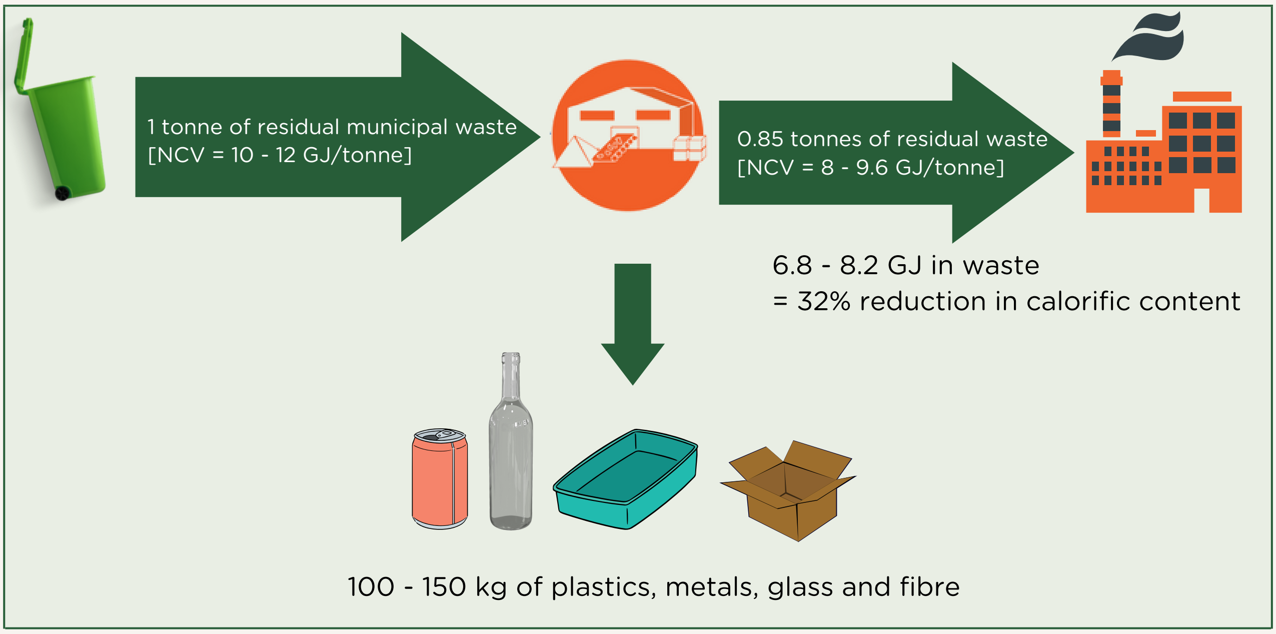
If the EU is to meet its municipal waste recycling target of 65% in future, then the quantity of unrecycled waste would be of the order 79 million tonnes if municipal waste generation remains broadly constant (at 224.45 million tonnes in 2019).

Although that suggests that, if mixed waste sorting is implemented in front of incinerators, there is no additional capacity requirement for unrecycled municipal waste, this makes light of the fact that the existing capacity is of varying vintage (and some facilities will soon face a decision as to ‘what should happen next?’), and is unevenly distributed in spatial terms.

That may suggest that facilities with more of their life to run should be required to be equipped with MWS, whilst ageing facilities may be phased out at an early opportunity.

That would leave parts of Europe with less capacity for residual waste treatment to consider the option of using mixed waste sorting prior to stabilisation and landfilling, which may imply lower unit capital costs, and allow greater flexibility in the waste management system, or mixed waste sorting coupled to incineration.

Figure 12: Effect of MWS on Quantity and Calorific Value / Content of Waste



Instead of each different Member State considering how best to achieve a limit on the quantity of waste permitted to be landfilled, a coherent EU-level strategy for dealing with unrecycled waste could help to manage the climate change performance, and feedstock requirements, of existing incineration facilities, recognising that phase-out of capacity seems likely to be an increasingly necessary component of the move to a more circular economy (and a consequence of its desirable evolution).

Constructing new facilities in countries which are currently reliant on landfill might not be optimal as these countries seek to develop their recycling systems. Indeed, in countries currently reliant on landfills for managing unrecycled waste, there may be more to be said for implementing systems of MWS coupled to biological stabilisation of the remaining waste prior to landfilling.

2.5 What Contribution Can Mixed Waste Sorting Make to Landfill Targets?

The revised Landfill Directive included a target for reducing landfilling at Article 5(5). The objective is to reduce landfilling of municipal waste to no more than 10% of total municipal waste by 2035. We have questioned the underlying rationale for this target in a separate document [30]. Nonetheless, assuming the target remains as it currently stands, then it is worth considering the contribution that mixed waste sorting (and stabilisation) could make to this target.

In Section 2.2 above, we have already considered the impact of using MWS in conjunction with incineration as regards the ability of existing facilities to treat waste. MWS also contributes to extending the capacity of 'the landfill system'. Biological stabilisation would further reduce the weight of waste landfilled as a result of reducing mass by degrading the carbon and reducing the moisture content of the waste (and would likely increase placement density). Depending on composition, for each tonne of waste treated through MWS and biological stabilisation, typically, around 450-550kg might remain needing to be landfilled.

This might be of interest to Member States seeking to minimise resort to incineration, or reduce overall capital outlays in managing mixed residual waste. If a landfill cap of 10% is applied, then this would equate, broadly to an input that resulted from 20% of municipal waste entering facilities with MWS followed by stabilisation.

This would require some 80% of waste to be dealt with through other means. Assuming that 12.5% of the input to MWS plus stabilisation was still recycled, then in order to achieve a 65% recycling rate, at least 60% of municipal waste that was not sent to the MWS plus stabilisation facilities would need to be recycled. A maximum requirement for incineration and / or co-incineration of 20% of municipal waste would remain, with this requirement falling to zero if the amount recycled 'up front' increased to the full 80%. If mixed waste sorting was linked to incineration, then the quantity actually entering an incineration plant might be further reduced (around 18% of total MSW), whilst the size of any facilities required (as assessed by their thermal rating) might also be reduced if the fall in calorific value indicated above is reasonable to expect.

[30] Equanimator (2021) Rethinking the EU Landfill Target, Report for Zero Waste Europe, October 2021.

The point here is that, whatever the justification for the existing landfill limit, the existing target pushes Member States towards incineration unless they achieve very high recycling rates, well above existing recycling target levels. Using MWS and stabilisation prior to landfilling can effectively 'expand' the effective landfill quota, whilst the use of MWS at existing / new facilities can make more capacity available at existing facilities and reduce the scale of any new facilities deemed necessary. Member States could take a strategic view as to where, for example, because of the existing law, they might best a) utilise their 'landfill quota', and b) make use of capacity that may be available elsewhere, and c) how to use any co-incineration capacity, and d) where any incineration capacity that might be necessary might best be sited, and scaled, alongside MWS.

3.0 Recommendations

3.1 A Change in Perspective

As we have indicated elsewhere, the European (Commission's) perspective on unrecycled waste ought to be revisited and updated[31]. Setting higher recycling targets should reduce the amount of waste treated as 'residual waste', but an updated view could acknowledge:

1. That more attention is warranted in terms of how to manage waste left over after separate collection. The choice of how best to deal with waste leftover after source separation is no longer a simple one between 'landfill' and 'incineration'. Leftover mixed wastes ought to be treated as part of 'a landfill system', or an 'incineration system', or another 'system', in which MWS plays a role. Fostering better management of this waste is likely to emphasise 'having a second go' at separating materials before they enter an incinerator or a landfill, and in the case of landfills, also requiring waste to be stabilised prior to landfilling. In the context of a climate emergency, no mixed residual waste should be sent directly either to a landfill or an incineration plant. As far as possible, all should be subject to high quality MWS prior to treatment / disposal, and we would suggest that no waste should be landfilled if its propensity for methane generation exceeds a threshold level.

Mechanisms to incentivise, or mandate, MWS deserve close and urgent consideration;

2. Where landfill is concerned, virtually all Member States have introduced landfill taxes, albeit at widely varying rates. Some – including Germany, one of the few Member States with no landfill tax in place - have also introduced landfill restrictions, or bans. The EU has also sought to restrict quantities sent to landfill through the Landfill Directive and the Waste Framework Directive. No such restrictions exist for incineration, other than to the extent that recycling targets lead to a reduction in quantities below capacity. Seven [32] Member States have incineration taxes in place, and as of 2021, in all cases where incineration taxes were in place, higher landfill taxes had also been implemented. In all but one of those countries (Portugal, whose taxes are at relatively low rates) [33], some form of landfill restriction or ban was also in force.

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[31] See Equanimator (2021) Rethinking the EU Landfill Target, Report for Zero Waste Europe, October 2021.
[32] Seven includes 'Belgium', where both Flanders and the Walloon Region have taxes in place, but Brussels region does not. In addition, Catalunya in Spain also has such a tax in place.
[33] Catalunya also has no such restriction or ban in place.

The Member State picture is heterogeneous, even though, where incineration has been defined as 'recovery', a facility in one country can accept waste generated in another. That compromises the Single Market to the extent that various policies can distort competition among those providing waste management services;

3. The nature and form of policies used, at the EU level, to 'steer' unrecycled waste is, currently, likely to lead to an outcome where a progressively increasing share of unrecycled waste is shifted from landfill to incineration, but is insufficiently focused on delivering the best outcomes for unrecycled waste. Whilst Member States have taxed / restricted and banned landfilling, incineration has escaped most forms of incentive to restrict its use, with most (not all) incineration taxes at low levels, and only one country-wide incineration tax in a Member State that has not effectively already banned / restricted landfilling. Facilities sometimes benefit from price support for power delivered either through their being defined as a source of renewable energy, or because they are treated beneficially in the way the tax system is applied to energy products (effectively, the receive an implicit subsidy).

Incineration sits outside the EU Emissions Trading Scheme (ETS) unless Member States choose to opt to include it (see Section 3.2.1), even though – wherever energy is generated by incinerators – they are treated as Power Stations for the purpose of inventories reported to the UNFCCC. Power generation installations meanwhile, have seen the phase-out of free allowances under the ETS.

4. Policy has become unduly lopsided, with an ever-weaker link to the changing nature of the circumstances, and the associated evidence base.

These issues suggest correcting the regulatory environment and the system of incentives so that:

- The measures drive forward the EU's climate change agenda;
- There is greater harmonisation in the implementation of incentives-based measures across the EU.

The following recommendations are designed to address these issues with a view to improving management of mixed leftover waste.

3.2 Proposed Changes in Policy to Support Diffusion of MWS – Correcting Incentives

Key instruments affecting mixed waste at the Member State level are taxes on landfill and incineration, and bans / restrictions on landfill. The picture is uneven, with landfill taxes varying enormously across Member States, and taxes on incineration varying by almost as much, albeit, they are applied in fewer countries. The basis for most landfill and incineration taxes is relatively crude (exceptions being Denmark's policy instruments affecting incineration).

Setting a more uniform set of incentives in relation to the management of residual waste would be helpful, and if those incentives target GHG (and other) emissions which can clearly be abated through the use of MWS (and stabilisation in the case of landfill) or other means, then there is a prospect that the market will deliver some of the desired abatement. Ideally, the mechanism(s) applied to landfill would incentivise stabilisation (as well as MWS), and the mechanism(s) applied to incineration would incentivise a reduction in (fossil-derived) CO2 emissions as well as a reduction in key air pollutants such as NOx [34].

Two options present themselves:

a) Inclusion of waste installations within the EU-Emissions Trading Scheme, with Member States left to set their own tax rates to tackle emissions other than CO2; and,

b) A schedule of minimum tax rates to be applied to different waste management methods, akin to the approach use in the Energy tax Directive.

The issue becomes how best to make use of these in order to deliver the best outcomes. We address this separately for incineration and landfill.

[34] Although NOx is included within the BAT Conclusions of the Incineration BREF, there are relatively few countries with taxes on air pollution from stationary sources such as incineration, and the majority of these are applied at low rates.

3.2.1 Incineration

In relation to climate change, installations which treat waste are not currently required to be included under the EU-ETS. Article 24 of the EU-ETS Directive (Procedures for unilateral inclusion of additional activities and gases) enables Member States to expand the coverage of the EU-ETS by opting in activities, installations and greenhouse gases not originally covered by the scheme. Some Member States (Sweden and Denmark) have chosen to add incineration facilities, unilaterally, within the scope of the EU.

Under the system of reporting of greenhouse gas inventories, in line with the Intergovernmental Panel on Climate Change (IPCC) Guidelines, emissions from incineration plants, where the incinerators generate energy, are reported not under the 'Waste' section, but under the 'Energy' [35]. The omission of incineration from the ETS is becoming all the more glaring as the rest of the energy sector decarbonises.

Once coal is phased out, incineration plants will be by far the most carbon intense form of power generation in the EU. As we have indicated in Section 2.1, there are ways to improve their carbon performance, but at present, there is no incentive for an operator to do so.

Including incineration within the EU-ETS, therefore, would seem to make a great deal of sense at the present time. Not only would this ensure that incinerators were incentivised to reduce their GHG emissions (and not only through the use of MWS), but there would be greater harmonisation of the treatment of incineration across the EU at least for the purposes of the treatment of CO2 emissions.

It should be considered that emissions of fossil-derived CO2 have a cumulative effect as regards the contribution they make to global temperature change. Each year of delay, therefore, potentially draws down more of the carbon budget which remains (before net-zero is reached) in order to stabilise global temperatures below a 1.5 degree C increase relative to the early 1800s.

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[35] See, for a discussion, D. Hogg (2022) Problems in the Reporting of GHG Emissions from 'Waste': Indicators and Inventories, Equanimator Report, February 2022.

The amount of waste now being incinerated suggests that the additional demand for EU allowances (EUAs) that could result might be of the order 60-70 million tonnes CO2 (if only the fossil-derived emissions are included), or around 4% of the annually available quantity [36].This quantity could double (to around 130 million tonnes) if the inclusion of incineration within the EU-ETS was such that non-fossil sources of CO2 were also to be included, a more significant addition to the total demand for allowances. That assumes a static picture, however, where there is no response in respect of (for example) waste prevention, separate collection or MWS. In a dynamic context, and with sufficient lead-in time for investments to be considered, the expected demand for allowances could diminish significantly.

3.2.1.1 Treatment of CO2 of Non-fossil Origin

There are strong arguments, in our view, for including the non-fossil CO2 emissions. These have some links to the issue regarding whether or not energy derived from 'waste' should qualify as 'renewable' (which may have implications for the eligibility of such energy sources for financial support).

Arguably, some confusion has arisen, historically, from a tendency to conflate the question of whether a source of energy is renewable, with whether or not it is 'low carbon'. A decision regarding the former, properly considered, ought to reflect on the nature of the source of energy. A decision on the latter ought to consider the contribution made by a specific activity to greenhouse gas emissions, preferably based on a life-cycle perspective; this lens, however, has been somewhat distorted by the view that 'non-fossil' sources of CO2 either 'don't count', or should be treated only as a memorandum item.

Taking these positions, it is difficult – as well as being inconsistent with EU policy – to consider any form of waste as 'a renewable source'. For well over twenty years, however, various forms of energy from waste – whether from incineration, landfill gas, or biogas – have been treated as though they were 'renewable'.

[36] Our very basic estimate is higher than that made by Geert Warringa (2021) Waste Incineration under the EU ETS: An assessment of climate benefits, Report by CE Delft for Zero Waste Europe. One of the benefits of inclusion of incineration is likely to be that the quality of reporting, and hence, the level of certainty of the level of emissions, is increased.

EU waste policy requires that, other than in cases where a departure from such ordering is justified, Member State policy and legislation should implement the waste hierarchy as a priority ordering. Waste prevention lies at the top of that hierarchy. Legally binding targets are due to be set by end 2023 to reduce food waste across the EU, defined against a baseline for EU food waste levels set following the first EU-wide monitoring of food waste levels.

On the 'low carbon' aspect, currently, the EU-ETS Directive (2003/87/EC, as amended), in Annex IV, states, 'The emission factor for biomass shall be zero.' 'Biomass' is not defined in the Directive itself. It is, however, defined in the Renewable Energy Directive (EU). Art 2(1) of the Renewable Energy Directive (EU) 2018/2001 defines renewable energy as follows [37]:

'energy from renewable sources' or 'renewable energy' means energy from renewable non-fossil sources, namely wind, solar (solar thermal and solar photovoltaic) and geothermal energy, ambient energy, tide, wave and other ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas, and biogas;

Biomass – a source of renewable energy - is then further defined, under Art 2(24) of the same Directive (EU) 2018/2001 as:

'biomass' means the biodegradable fraction of products, waste and residues from biological origin from agriculture, including vegetal and animal substances, from forestry and related industries, including fisheries and aquaculture, as well as the biodegradable fraction of waste, including industrial and municipal waste of biological origin;

This definition, in particular, is counterproductive, especially where incineration is concerned: the 'biodegradable fraction of waste' is never, at incineration plants, combusted without there also being fossil-derived materials present. To be clear, and as indicated above, we would expect a reduction in the fossil carbon content of mixed waste following MWS, but not complete elimination. Burning 'biomass', where incineration is concerned, will invariably, if not always, imply the combustion of wastes that are of fossil origin at the same time.

Article 3(3) seeks to place some limits on the use of incineration as a means to meet renewable energy targets:

[37] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001&from=EN

Member States shall ensure that their national policies, including the obligations deriving from Articles 25 to 28 of this Directive, and their support schemes, are designed with due regard to the waste hierarchy as set out in Article 4 of Directive 2008/98/EC to aim to avoid undue distortive effects on the raw material markets. Member States shall grant no support for renewable energy produced from the incineration of waste if the separate collection obligations laid down in that Directive have not been complied with.

This is a relatively weak limitation, however, and it might easily be under-interpreted, not least because what is implied by the 'separate collection obligations' is not abundantly clear.

A small number of possibilities present themselves:

Option 1 : In the Renewable Energy Directive, redefine 'biomass' in the following way:

'biomass' means the biodegradable fraction of products, ~~waste~~ and residues from biological origin from agriculture, including vegetal and animal substances, from forestry and related industries, including fisheries and aquaculture ~~as well as the biodegradable fraction of waste, including industrial and municipal waste of biological origin;~~

In the EU-ETS Directive, cross-refer to the above definition.

These changes would render 'waste' no longer a source of renewable energy, and would imply that all sources of CO_2 from incineration were within scope of the EU-ETS (there would be no 'zero rating' for the non-fossil sources of CO_2). This would be the most preferable of the options considered here.

Option 2: This option leaves the Renewable Energy Directive untouched, but amends the phrasing in Annex IV of the EU-ETS Directive as follows:

The emission factor for biomass shall be zero, except for the biomass component of waste which is incinerated, whether with or without the generation of energy.

This change would mean that all sources of CO_2 from incineration were within scope of the EU-ETS (there would be no 'zero rating' for the non-fossil sources of CO_2), but the treatment of incineration under the RED would be unchanged.

Option 3: This option allows the definition of biomass to be retained in the Renewable Energy Directive, but would amend either Article 3(3) or Article 29 (either at para 1 or para 10) so as to ensure that the waste incinerated was first subject to a sorting process, or other ways to mitigate CO2 emissions. For example, Article 3(3) could be amended as follows:

Member States shall ensure that their national policies, including the obligations deriving from Articles 25 to 28 of this Directive, and their support schemes, are designed with due regard to the waste hierarchy as set out in Article 4 of Directive 2008/98/EC to aim to avoid undue distortive effects on the raw material markets. Member States shall grant no support for renewable energy produced from the incineration of waste only if the separate collection obligations laid down in that Directive have not been complied with, and where the following are true:

a) the waste to be incinerated has been subject to MWS [to be defined]; and,
b) the fossil-derived CO2 accounts for less than [a defined figure - we suggest:] 35% of all CO2 emitted.

This would have its mirror in Annex IV of the EU-ETS Directive, which would be worded as follows:

The emission factor for biomass shall be zero, except for the biomass component of waste which is incinerated, which will be given a zero emission factor only if the fossil-derived CO2 accounts for less than [the same defined fraction - we suggest:] 25% CO2 emitted.

Taken together, these measures would have the effect of ensuring i) that where mixed waste sorting was not in place, no energy generated by incineration would be considered to contribute towards renewable energy shares / obligations, and none was eligible for financial support; and ii) it would incentivise mixed waste sorting through the ETS. The 'gain' from MWS (in terms of reducing requirements to obtain allowances) could be considerable. The monitoring and verification processes would be somewhat more complicated, requiring an appropriate mechanism for establishing the fossil- and non-fossil fractions of carbon dioxide emitted (and not of the waste fraction on an as received basis).

The European Parliament's Committee on the Environment, Public Health and Food Safety, suggested a change to Article 29(1), subparagraph 2 [**]:

[**] European Parliament (2022) Opinion of the Committee on the Environment, Public Health and Food Safety for the Committee on Industry, Research and Energy on the proposal for a directive of the European Parliament and of the Council amending Directive (EU) 2018/2001 of the European Parliament and of the Council, Regulation (EU) 2018/1999 of the European Parliament and of the Council and Directive 98/70/EC of the European Parliament and of the Council as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652 (COM(2021)0557 – C9-0329/2021 – 2021/0218(COD))

> **However, biofuels, bioliquids and biomass fuels produced from waste and residues, other than agricultural, aquaculture, fisheries and forestry residues, are required to fulfil only the greenhouse gas emissions saving criteria laid down in paragraph 10 in order to be taken into account for the purposes referred to in points (a), (b) and (c) of the first subparagraph. In the case of the use of mixed wastes, however, the operators are required to apply mixed waste sorting systems of defined quality aimed at removing fossil materials. This subparagraph shall also apply to waste and residues that are first processed into a product before being further processed into biofuels, bioliquids and biomass fuels.**

On its own, this change would not, perhaps, generate such a strong incentive for abating CO2 emissions from incineration facilities except in cases where incinerators are currently in receipt of financial support in lieu of what was previously considered the renewable component of energy generation. Given that in some countries, the support comes more in the form of subsidies that are implicit rather than explicit, then the effect might be limited to specific countries with, currently, explicit financial support for the biodegradable fraction of incinerated waste. It follows that for adequate effect to be given to support MWS across all countries, a similar 'mirror' change to Annex IV of the EU-ETS Directive would be necessary.

Option 4: This would simply amend Annex IV of the EU-ETS Directive, which would be worded as follows:

The emission factor for biomass shall be zero, except for the biomass component of waste which is incinerated, which will be given a zero emission factor only if the fossil-derived CO2 accounts for less than [a defined figure - we suggest:] 35% of the total CO2 emissions.

Again, these changes would generate a similarly strong incentive for abating all CO2 emissions from incineration facilities. This would, however, still leave energy generated from incineration of waste defined as 'renewable energy'. As per Option 3, the 'gain' from MWS (in terms of reducing requirements to obtain allowances) would be considerable. The monitoring and verification processes would be somewhat more complicated, requiring an appropriate mechanism for establishing the fossil- and non-fossil fractions of carbon dioxide emitted (and not of the waste fraction on an as received basis).

Our clear preference would be for Option 1. Whilst the current phrasing of Annex IV in the EU-ETS Directive might reflect the way in which countries report emissions under inventories reported to UNFCCC, at least in the narrow sense, the case for ignoring non-fossil CO2 emissions from incineration in circumstances where there is no positive impact on the capacity of the biosphere to act as a sink for CO2 (there may be a negative one relative to certain counterfactuals) is not at all compelling. It send the right signals but with minimal need for change in the two relevant Directives.

3.2.1.2 Phasing

There are legitimate questions to be asked as to the best way to 'phase incineration in' to the EU-ETS. This could be done in a number of ways, possibly necessitating a raising of the cap, though more preferably, following announcement of intent to include incineration, commencing their inclusion from, say, 2024 or 2025, and then requiring installations to purchase allowances to cover an increasing proportion of their emissions with allowance purchases. This could allow for 'full inclusion' (requiring EUAs to be purchased by operators so as to cover 100% of each installation's emissions) by 2028, but would have the merit of phasing in the additional demand, and allowing the owners of waste installations some time to adjust to the new regime. Evidently, other decisions regarding (changes in) scheme operation would need to be made in the full knowledge of all the anticipated changes to be made to the EU-ETS.

Note that inclusion in the EU-ETS should not necessitate removal of all incineration taxes. Where such taxes explicitly seek to internalise the damages associated with CO2 emissions, and where these do not already anticipate inclusion within the scope of the EU-ETS, then there could be arguments for corresponding downward adjustment in tax rates. The argument, though, for taxing air emissions, not least on the basis of the monitored amounts, would remain strong. The Commission could choose to give guidance around minimum expected rates in this regard.

3.2.2 Landfill

Where landfills are concerned, similar considerations may be said to apply as regards their absence from the EU-ETS, although as previously noted, taxes on landfill are much more widespread than taxes on incineration, and landfill taxes are, wherever they are applied, higher than those for incineration for 'municipal type' wastes. Providing an incentive to improve climate change performance would, in principle, be of merit, notably, if an incentive could be imparted to reduce fugitive emissions through stabilisation of the biodegradable fraction prior to landfilling (but also, post deposit, seeking to further reduce residual emissions at older sites).

Relatively few landfill taxes have been designed with this in mind – the Austrian ALSAG tax was a case in point where different rates were applied to waste which had been stabilised, and waste which had not.

Including landfill within the ETS would likely prove problematic. The main (indeed, if just fossil-derived emissions were considered, the only) GHG of interest is methane. This is generated over an extended period of time, and the concern rests principally in the fugitive (uncaptured) methane that escapes from the landfill. Techniques for the measurement of the quantity of fugitive emissions are improving over time but given the type of information likely to be required under the scheme, it seems likely that indirectly derived estimates of emissions would be required.

In addition, there is the potential for including sites at a time in their life-cycle where they have already received (and may have paid an associated tax) on most of the waste received by them, but which – if they were then expected to purchase allowances – they would have no obvious revenue source through which to recover (additional) costs of allowances linked to their emissions (sites will generate methane after they have ceased accepting waste). The question as to how best to establish 'equivalence' between methane and CO2 emissions also remains a live discussion.

Whilst these issues could probably be overcome, they would more than likely end up in a situation where the ETS becomes very similar to a tax. The New Zealand ETS – which includes landfills – works in such a way that this is effectively what happens: operators are free to choose to use either a default emissions factor for each tonne of waste, set by the government using data from landfills around the country, or, if a participant believes that the emissions factor for their landfill should be lower than the default one, they may apply to the EPA for a "Unique Emissions Factor" which reflects the actual emissions from their facility. Essentially, the quantity of allowances required to be surrendered is equal to the emissions factor multiplied by the amount of waste (note that these emissions factors effectively require surrendering of allowances for emissions which will take place in future years). Separately, New Zealand also has implemented a landfill levy.

Given the extent of already existing landfill taxes, therefore, a more pragmatic approach is likely to be:

a) to regulate for MWS plus stabilisation, and,
b) to support this through minimum tax rates (akin to the Austrian ALSAG).

The former would be aligned with Article 6 of the Landfill Directive, which effectively requires 'treatment' of waste prior to landfilling. We have discussed elsewhere the limitations of the definition of treatment, and of subsequent rulings, and we indicated the uneven manner in which the terms 'treatment' had been interpreted across Member States [38]. A suggested definition of 'treatment', for use in the Landfill Directive, would be:

• The sorting of the waste, with sorting defined through the process set out at Article 27 of the WFD). Such a definition could, potentially, alter the sorting requirements in line with what is achieved through source separation;

• The subsequent stabilisation of any waste destined for landfill. Here, it should be considered that the way in which 'thresholds' have been set in the past have differed across countries. The objective should be to ensure the prospects for fugitive methane emissions are minimised through the combination of stabilisation, and the use of suitable oxidation layers at the receiving landfill.

  o In respect of the former, a level of stability at, or equivalent to, the level considered in the Draft Biowaste Directive, of 10mg O_2 / g dm, or equivalent measure, gives a suitable measure that would reduce the potential for methane generation to a significant degree without incurring excessive cost.
  o In respect of the latter, the General Requirements for all Classes of Landfills, set out at Annex I of the LFD, could be amended to consider appropriate cover layers, and might para 4, regarding Gas Control, could be amended such that the need for gas control was linked to whether or not waste was treated, and the nature of the oxidation layer used.

Member States should be required to implement this by no later than 2030.

It would be appropriate for Member States to incentivise the shift indicated above, and to do so in a manner which reflects the difference in GHG emissions from landfills where waste is treated in accordance with the above definition, and where it is not. Whilst it is clear that the European Commission is not in the habit of intervening in setting tax rates (the Energy Tax Directive provides as an interesting exception), the rational here would follow from the inclusion of incineration within the EU-ETS. Without ensuring some broadly equivalent treatment of landfill and incineration, operators of the latter might feel aggrieved.

[38] Equanimator (2021) Rethinking the EU Landfill Target, Report for Zero Waste Europe, October 2021.

We suggest that there is established a schedule (increasing over time to 2030) of minimum landfill tax rates for landfilling of untreated waste, as well as a minimum differential between the taxes applied to 'treated' (stabilised) waste and untreated waste. If the differentials were set sufficiently high (gap between lower and upper rates no less than, for example, €75 per tonne of waste landfilled), then this ought to incentivise a swift move away from landfills receiving untreated waste.

3.3 Mandating MWS at Incineration Facilities

The previous section sought to derive some basis for a market-based approach to encouraging the uptake of MWS. In the case of landfill systems, it was deemed appropriate to establish a minimum specification of 'treatment' designed to facilitate the application of differential rates of landfill tax.

In principle, it is possible that nothing else is needed to drive change, and that the EU-ETS and air pollution tax on incineration could drive the necessary change. On the other hand, for incineration, it could be useful to mandate MWS, with the EU-ETS designed to incentivise its performance (in reducing measured CO2 emissions). Specific requirements for MWS pre incineration could be included.

The best opportunities for doing so may be through Article 44 of the EU Industrial Emissions Directive (IED), or through Article 27 of the WFD (or both). This / these would mandate the use of mixed waste sorting systems of a defined quality at the front of all new incineration plants, as well as those which have been operational for less than ten years (with many years of their operational life still to run). This could also be defined as a requirement for the 'treatment of waste prior to incineration' (mirroring the requirement in respect of landfill), with elements of the sorting requirements made common to both types of facilities. There may need to be some exception for some existing facilities where there are serious spatial constraints.

3.4 Removal of Implicit Subsidies for Incineration

All Member States implement taxes on the energy products in scope of the Energy Tax Directive (ETD) [39]. Some Member States also have carbon taxes in place.

The way in which different sources of energy are treated under the different tax systems applied by Member States is such that they are not all treated 'equally' under the different tax systems. In some cases, for example, specific energy sources, such as district heating provided by waste incineration plants, are exempt from taxes applied to other heating fuels. The effect of such exemptions is that an 'implicit subsidy' is given to the sources of energy that are exempted.

Consider that if other sources have to sell energy at a 'tax inclusive' price, then the exempt sources gain a competitive advantage, and can charge higher prices in the market for their heating service. For an incineration plant, this means that revenues from energy sales are raised correspondingly, and the costs of incinerating waste, net of the associated revenue, falls. In other words, implicit subsidies of this type can lower the cost of incineration, thereby undermining the financial case for recycling, and leading to market that is over-supplied with incineration relative to other waste management approaches.

The Commission should treat such implicit subsidies as the market distortions that they are. The Commission has frequently indicated its intent to highlight, and encourage elimination of, environmentally harmful subsidies, both explicit and implicit. It would be helpful if those which accrue to incineration (or other waste management methods) as a result of unjustifiably favourable treatment under existing tax regimes were eliminated. It might be possible for this to happen through the ETD revision, which could prevent the more favourable treatment of different forms of heating.

[39] The proposal for a revised ETD presented by the Commission, whilst changing the basis for taxation, does not seem to make major changes in this regard where domestic heating fuels are concerned (see Proposal for a Council Directive restructuring the Union framework for the taxation of energy products and electricity (recast), Brussels, 14.7.2021 COM(2021) 563 final).

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June 2022

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