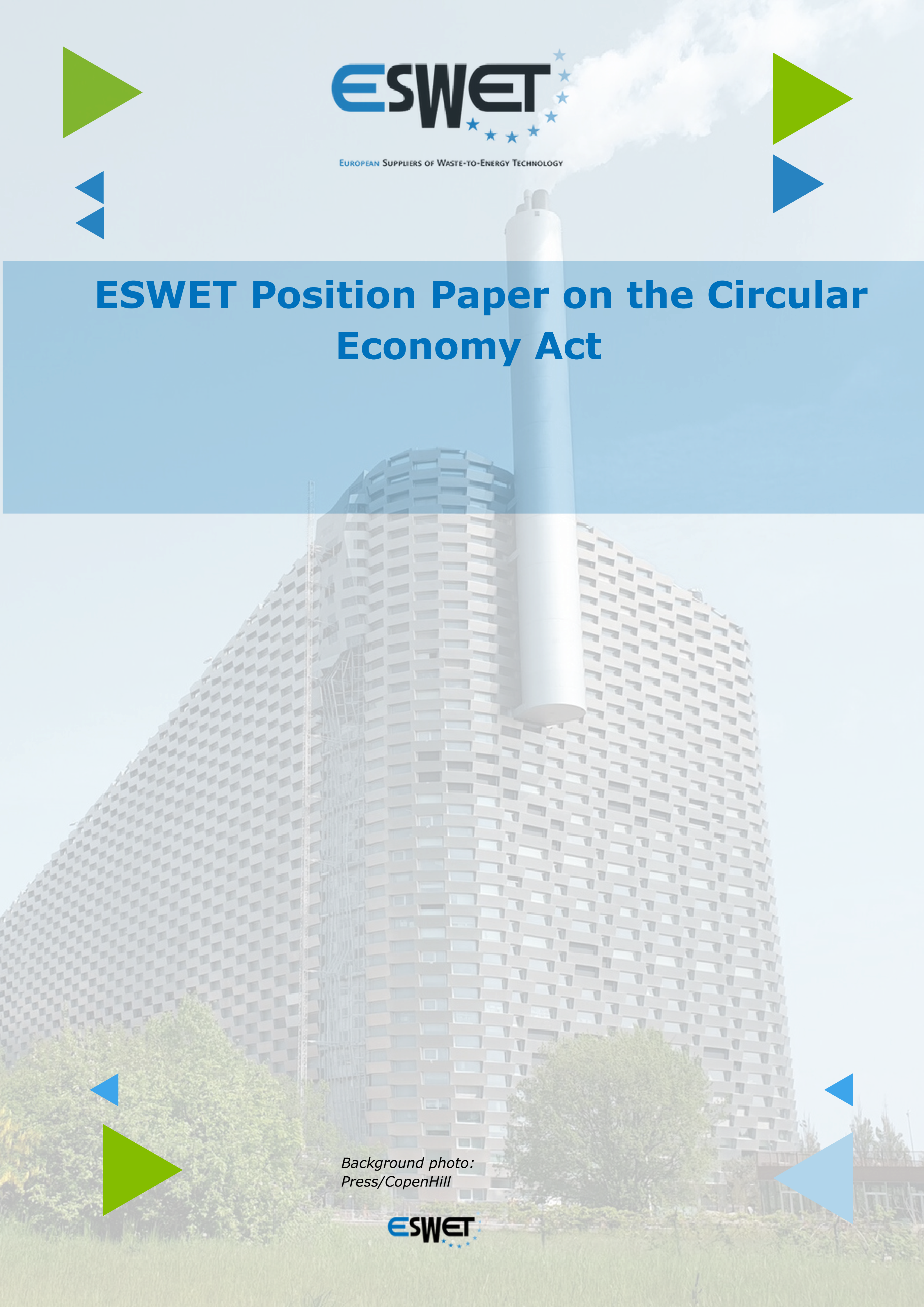

EUROPEAN SUPPLIERS OF WASTE-TO-ENERGY TECHNOLOGY

ESWET Position Paper on the Circular Economy Act

Background photo: Press/CopenHill

Brussels, November 2025

ESWET position paper on the EC Call for Evidence for a Circular Economy Act

ESWET - the European Suppliers of Waste-to-Energy Technology represents companies that have built and supplied over 95% of the Waste-to-Energy (WtE) plants in operation in Europe. Its mission is to promote technologies that safely treat non-recyclable waste while recovering valuable energy and materials, contributing to Europe's climate goals, resource efficiency, and energy resilience.

As the EU moves forward with the Circular Economy Act (CEA), ESWET welcomes this initiative as a timely opportunity to strengthen Europe's resource security, industrial competitiveness, and environmental sustainability. Reducing the EU's dependence on imported raw materials and fossil energy requires recognising the contribution of recovery solutions that help keep resources and energy circulating within the European economy.

To achieve a truly circular system, all stages of waste management must work together. While waste prevention, reuse, and recycling remain top priorities under the waste hierarchy, not all waste can be feasibly or safely recycled. Many waste streams are not designed for recycling, or can be contaminated, made of complex composite materials, or degraded to the point where recycling is no longer technically or economically viable. If not properly managed, this residual waste poses serious environmental and health risks, contributing to pollution and undermining Europe's circularity and climate goals.

Even in a fully circular economy, non-recyclable waste will continue to exist. At present, this waste can only be managed in two ways: either through landfilling or through Waste-to-Energy (WtE), which combines energy and material recovery. Residual waste represents the boundary of what recycling systems can handle, and modern WtE facilities help close the loop by recovering valuable resources that would otherwise be lost.

In this context, WtE should be recognised as a public service - a societal necessity that ensures non-recyclable waste is treated safely and hygienically, without polluting land, water, or air.

Despite these clear contributions, the role of Waste-to-Energy in both resource and energy recovery remains largely overlooked in EU policy frameworks. The Circular Economy Act (CEA) offers a key opportunity to address this gap by recognising WtE as an essential component of a sustainable waste management system.

As the EU works to reduce its dependence on imported raw materials and fossil energy, it must ensure that residual waste is treated in a way that supports resource efficiency, energy recovery, and climate protection. WtE technologies already make this possible, safely transforming what cannot be recycled into heat, power, and **secondary raw materials (SRMs)**.

In addition, recognising WtE as **a complementary partner to recycling** is essential. By managing non-recyclable fractions including recycling residues, WtE safeguards the integrity of recycling systems, prevents pollution from improperly disposed waste, and recovers energy and materials that would otherwise be lost. Following and supporting recycling, WtE forms the backbone of a circular, resilient, and climate-neutral Europe where no valuable resource is wasted.

This position paper outlines ESWET's contribution to the legislative discussion and provides concrete recommendations to ensure that the Circular Economy Act fully recognises the role of WtE in managing non-recyclable waste, recovering valuable materials, and supporting the EU's decarbonisation and circularity goals.

The paper is structured in three main sections:

- **Section 1** analyses the current status of residual waste management in Europe, detailing how WtE contributes to material recovery, pollution prevention, and climate mitigation. It also clarifies the legal and economic principles underpinning WtE's role within the waste hierarchy.
- **Section 2** presents policy measures needed to improve circularity within the upcoming Circular Economy Act. These include creating a single market for SRMs, harmonising end-of-waste criteria, improving Extended Producer Responsibility (EPR), ensuring overall policy coherence, and maintaining WtE's recovery status.
- **Section 3** summarises ESWET's key recommendations for EU policymakers, aiming to promote fair and coherent circular economy legislation that values the contribution of recovery technologies alongside recycling and prevention.

Executive Summary

Waste-to-Energy (WtE) is a cornerstone of Europe's circular economy, providing an essential public service for the safe, hygienic, and climate-responsible treatment of residual, non-recyclable waste. By converting this waste into renewable energy and secondary raw materials (SRMs), WtE ensures that no resource is lost while protecting citizens and the environment from pollution.

Across Europe, WtE plants generate **electricity and heat** equivalent to the needs of more than 35 million citizens while **recovering metals and minerals** from bottom and fly ash that contribute directly to Europe's **resource security**. By **diverting waste from landfills**, WtE prevents the release of methane — over 80 times more potent than CO_2 — making it one of the most effective near-term measures to cut greenhouse gas emissions in the waste sector. Operating under the strictest environmental standards of the Industrial Emissions Directive, WtE also prevents the spread of pollutants such as PFAS and other persistent substances, providing a controlled and traceable end-of-life solution.

Preserving the recovery status of WtE within EU law is therefore essential. Downgrading it or conflating it with disposal operations would undermine decades of investment, weaken circular progress, and risk a return to landfilling. Maintaining WtE's position above disposal in the waste hierarchy guarantees legal clarity, policy coherence, and environmental integrity, ensuring that Europe continues to manage its residual waste responsibly and within its borders.

Looking ahead, **Carbon Capture, Utilisation and Storage (CCUS)** technologies will enable WtE to move from carbon-neutral to carbon-negative operations. By capturing the biogenic share of its CO_2 emissions and supplying captured carbon as a feedstock for fuels, chemicals, and construction materials, WtE can help close the carbon loop — turning unavoidable emissions into valuable resources.

Recognition of WtE under the EU Taxonomy for sustainable activities is equally critical to ensure consistency between EU financial, waste, and climate frameworks. Despite its legal recognition in the Waste Framework, Landfill, and Renewable Energy Directives, WtE remains excluded from the Taxonomy — a gap that restricts access to green investment for a sector that demonstrably supports circularity, energy recovery, and pollution prevention. Including WtE as a Taxonomy-eligible activity would strengthen the EU's ability to achieve landfill diversion, climate mitigation, and resource recovery objectives, while enabling investments in plant modernisation and decarbonisation through **CCUS**. Recognising both WtE operations and CCUS applications under the Taxonomy would provide the policy coherence needed to deliver a climate-neutral, circular European economy.

As Europe advances the Circular Economy Act, it must recognise the full contribution of WtE to circularity, climate neutrality, and industrial resilience. WtE complements recycling, supports landfill diversion, and provides a bridge between waste management, clean energy, and carbon circularity — ensuring that the EU's transition to a sustainable economy leaves no resource behind.

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Section 1: Current status of residual waste management

1.1 Waste-to-Energy in the circular economy

WtE facilities play a fundamental and irreplaceable role in the EU's waste management system by providing an environmentally sound solution for residual waste that cannot be recycled, such as certain plastics, multi-material packaging, or residual biomass that has no viable recycling pathway.

Beyond their environmental function, WtE plants are also powerful contributors to Europe's energy and resource resilience. The heat generated during treatment can be supplied to district heating and cooling networks, displacing fossil fuels and providing affordable, stable energy for households, hospitals, and industries. The electricity produced supports the European grid, helping to strengthen energy security at a time when diversification of supply is more important than ever.

In 2019, in Europe, WtE generated 43 billion kWh of electricity and 99 billion kWh of heat, which provided 20 million citizens with electricity and 17 million citizens with heat.[1] Since the waste treated in WtE plants is mixed, with a majority of biogenic (biomass) content, over 50% of the energy produced is considered renewable[2]. According to the IPCC guidelines[3], biogenic CO_2 is considered carbon neutral and is therefore excluded from greenhouse gas accounting.

In addition to that, WtE facilities also play a crucial role in material recovery. Through advanced treatment processes, valuable SRMs, metals such as aluminium, copper, zinc, and minerals can be extracted from incineration bottom ash and fly ash. These recovered materials reduce Europe's dependence on imports and support the development of a more resilient industrial base.

The climate contribution of WtE extends far beyond energy and material recovery. By diverting residual waste from landfills, WtE prevents the release of methane, a greenhouse gas over 80 times more potent than CO_2 over a 20-year period. Methane leakage from landfills remains one of the most underestimated and persistent sources of emissions in the waste sector. In contrast, WtE ensures that organic waste is safely oxidised and stabilised, avoiding long-term methane generation while recovering usable energy and materials. This landfill diversion effect alone makes WtE one of the most effective near-term mitigation levers in the waste chain.

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[1] Confederation of European Waste-to-Energy Plants (CEWEP) (2022). *Waste-to-energy Climate Roadmap: The path to carbon negative.* At: https://www.cewep.eu/wp-content/uploads/2022/06/CEWEP-WtE-Climate-Roadmap-2022.pdf.pdf

[2] Giouse, F., Ravache, E. & Moutte, L. (2020). *Determination of the biogenic and fossil content of residual household waste and of an SRF, based on a ^{14}C analysis of CO_2 from post-combustion gases*. ADEME – Cabinet Merlin – ENVEA. UIOM 14C Program – Measurement campaign on municipal solid waste incineration plants (UIOM) and SRF boiler. [in French]

[3] Intergovernmental Panel on Climate Change (IPCC) (2006). *Guidelines for National Greenhouse Gas Inventories.* Geneva: IPCC. https://www.ipcc-nggip.iges.or.jp/public/2006gl/

Furthermore, modern WtE facilities act as advanced pollution prevention systems. Operating under the EU Industrial Emissions Directive and Best Available Techniques (BAT) standards, they safely destroy pathogens and hazardous organic compounds, including PFAS and other persistent pollutants, while controlling acid gases, particulates, and heavy metals through sophisticated flue gas treatment. In doing so, WtE ensures that non-recyclable, contaminated, or sanitary waste streams are managed in a way that protects both the environment and public health.

Beyond emissions prevention, WtE contributes directly to carbon removal and sequestration. The mineral fraction of incinerator bottom ash (IBA) naturally absorbs CO_2 through carbonation, permanently storing between 30 and 65 kg of CO_2 per tonne of ash. In addition, integrating Carbon Capture and Storage (CCS) technologies with WtE plants offers a major opportunity to move the sector from carbon neutral to carbon negative, as approximately 60% of WtE emissions are biogenic. When this fraction is captured and permanently stored, WtE provides measurable and durable carbon removals (BECCS) that can help the EU achieve its 2040 and 2050 climate targets. Lastly, integrating CCU in WtE plants enables the sector to reach a new level of resource recovery through carbon circularity, by supplying captured CO_2 for reuse in industrial applications. This role in the circular economy was already acknowledged by the European Commission in 2017 in a Communication[4] and by the European Economic and Social Committee (EESC) in its Opinion[5] in 2024. In the latter, the EESC recognises the untapped potential of WtE in advancing a more resource-efficient economy. It specifically notes that "both incinerator bottom ash and fly ash - residues from incineration - hold potential as sources of SRMs. It is essential to incentivise the recovery of metals, minerals, aggregates, potassium, sodium and calcium in salt form at EU level via appropriate legislation and by removing regulatory barriers [...]". The EESC also recommends including WtE in the EU Taxonomy Delegated Acts, a proposal ESWET strongly supports, as it would provide long-overdue recognition of the sector's environmental and economic value.

It is also worth noting that in July 2025, in the draft Implementing Regulation[6] under Article 26 of the Critical Raw Materials Act (CRMA), **the European Commission explicitly recognised IBA from waste incineration as a waste stream with a high Critical Raw Material (CRM) recovery potential.**

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[4] European Commission. (2017). *The role of waste-to-energy in the circular economy*. COM(2017) 34 final. At: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52017DC0034&from=en

[5] European Economic and Social Committee (EESC). (2024). *From waste plants to resource plants*. Opinion CCMI/228-EESC-2024. At: https://www.eesc.europa.eu/en/our-work/opinions-information-reports/opinions/waste-plants-resource-plants

[6] European Commission. (2025). *Commission Implementing Regulation (EU) …/... listing the products, components and waste streams considered as having a relevant critical raw materials recovery potential under Regulation (EU) 2024/1252 (INTCOM Ares(2025)5155732). EUR-Lex.* At: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=intcom:Ares(2025)5155732

The United Nations Economic Commission for Europe (UNECE) recognised WtE's contributions in a 2022 report, describing WtE as "the most sustainable solution for non-recyclable waste as it recovers energy and materials while providing an alternative to highly polluting landfills and waste exports".[7] Therefore, WtE is regarded as a vital link in a comprehensive, circular, and climate-aligned waste management chain.

Despite this strong performance, the full contribution of Waste-to-Energy remains often overlooked in EU climate policy. By combining landfill diversion, pollution prevention, renewable and local energy generation, material recovery, and the growing potential of carbon capture, WtE stands out as one of Europe's most comprehensive tools for achieving both circularity and climate neutrality.

1.2 Contribution to the supply of critical and non-critical raw materials

As previously explained, non-recyclable waste still holds valuable materials. **Incineration Bottom Ash (IBA),** the main solid residues of the thermal process, **is a key source of valuable secondary metals and minerals**, offering both immediate and scalable solutions to meet CRM goals.

IBA is composed of 80 to 85% of minerals, 10 to 12% of ferrous metals (iron, steel), and 2 to 5% of non-ferrous metals (such as aluminium, copper, zinc, lead, silver, gold, and others) (Figure 1).

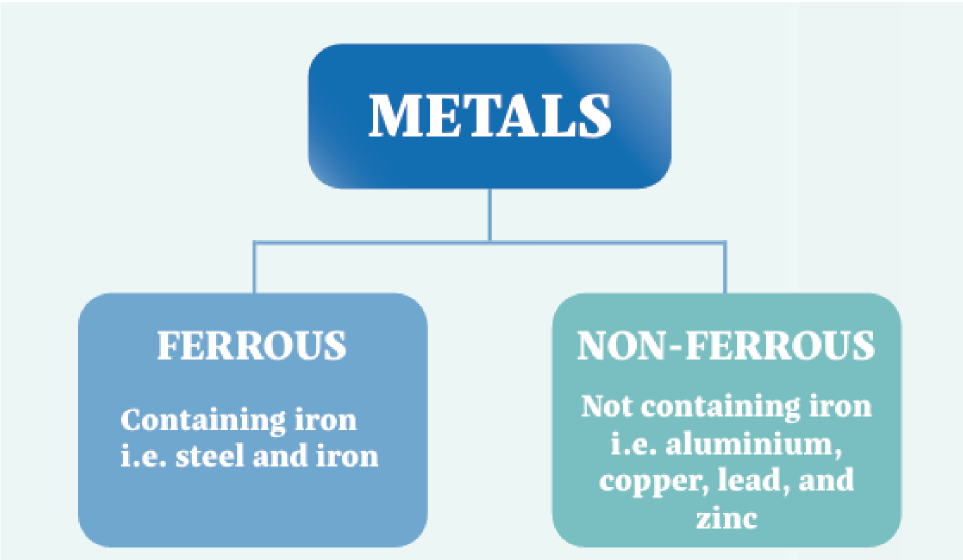

Figure 1. *Classification of metals into ferrous and non-ferrous. Source: ESWET.*[8]

[7] United Nations Economic Commission for Europe (UNECE) (2022). *Guidelines on Public-Private Partnerships for the Sustainable Development Goals in Waste-to-Energy Projects for Non-Recyclable Waste: Pathways towards a Circular Economy.* At: https://unece.org/sites/default/files/2022 10/ECE_CECI_WP_PPP_2022_03-en.pdf

[8] ESWET. (2023). *Integrated Resources Recovery Facility.* At: https://eswet.eu/documents/recovering-the-non-recyclable-the-integrated-resource-recovery-facility/.

The recovery of metals and minerals from IBA presents a major yet underutilised opportunity to strengthen the EU's domestic raw material supply. While metal recovery from IBA is already recognised as recycling at EU level[9], minerals, despite their valuable use in construction[10] (e.g. roads[11], bridges, bricks), still lack this status. In the Netherlands, a "Green Deal on Bottom Ash" has been in place since 2020, where all operators committed to full mineral recovery through a public-private partnership.

Figure 2 below refers to the comparison of environmental performance of using conventional raw materials with that of substituting them with minerals and metals recovered from IBA, based on Life Cycle Assessment (LCA) results from TU Delft. The results clearly show that the recovery and reuse of materials from IBA significantly reduce environmental impacts across all impact categories, including global warming, human toxicity, ecotoxicity, acidification, eutrophication, and resource depletion.

The conventional scenario (in red) consistently exhibits the highest environmental impact levels, while all three recovery scenarios show substantial environmental gains. Among these, the cement scenario demonstrates the greatest overall environmental benefit, achieving reductions of up to around 60-90% compared to the baseline.

These results confirm that integrating SRMs from (treated) IBA into industrial processes (such as metal recovery, concrete production, and cement manufacturing) can deliver systemic reductions in life-cycle impacts, supporting both resource efficiency and climate objectives. The environmental benefits arise mainly from the avoidance of primary raw material extraction, reduced energy consumption, and lower greenhouse gas emissions associated with virgin production.

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[9] EC Implementing Decisions 2019/1004, WFD, metals separated and recycled after incineration are considered as recycled.

[10] Blasenbauer, D., Huber, F., Lederer, J., et al. (2020). Legal situation and current practices of waste incineration bottom ash utilisation in Europe. *Waste Management, 102*, 868-883. At: https://hal.science/hal-02472497

[11] In Denmark, for instance, after the recovery of recyclable metals, almost 99% of the bottom ash is used for construction: See *Factsheet from the Danish Ministry of Environment*. At: https://cirkulaer.dk/files/media/document/MSWI%20Bottom%20ash%20in%20Denmark%20-%20In%20English.pdf?.

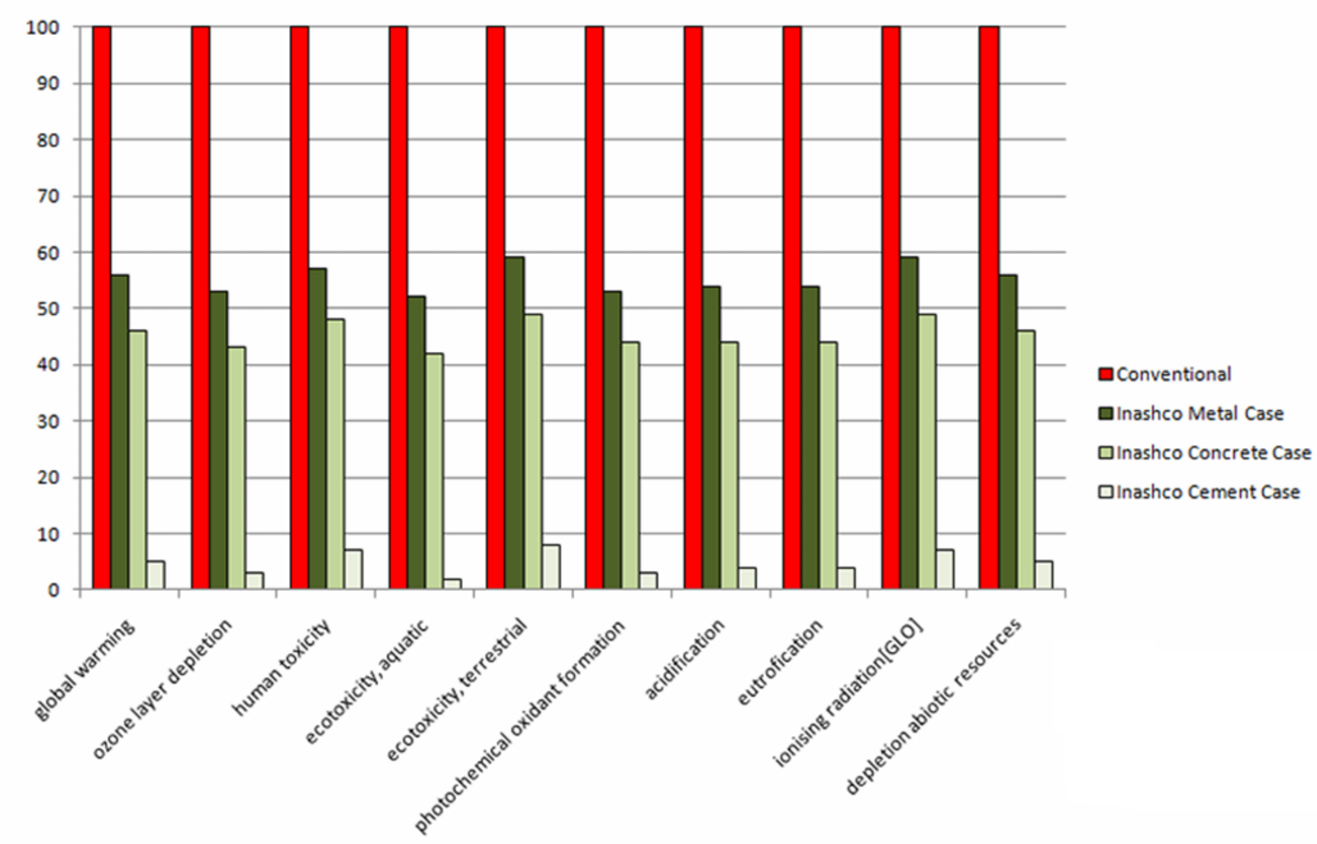

Figure 2. *Environmental benefits of substituting conventional raw materials with minerals and metals recovered from IBA in metal, concrete, and cement applications. Source: TU Delft.*[12]

With approximately 500 WtE facilities operating in Europe, producing more than **20 million tonnes of IBA annually**[13], the metal recovery potential is significant,but only **one-third of the non-ferrous metals it contains are currently recycled**[14].

Advanced technologies, such as dry extraction systems, could enable the recovery of up to **0.7 million tonnes of aluminium - equivalent to 11% of EU imports**[15]. **In 2021, the market potential of fully recovered metals from**

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12 TU Delft. (2013). *Recycling of Incinerator Bottom Ash: A study on the recycling potential of incinerator bottom ash in the Netherlands*. At: https://filelist.tudelft.nl/CiTG/Over%20faculteit/Afdelingen/Engineering%20Structures/Resources%20%26%20Recycling/Incinerator%20Bottom%20Ash/recyclingiba1.pdf

13 TU Delft. (n.d.). *Incinerator bottom ash recycling* [Research & Innovation, Recycling Technologies]. At: https://www.tudelft.nl/en/ceg/about-faculty/departments/engineering-structures/sections-labs/resources-recycling/research-innovation/recycling-technologies/incinerator-bottom-ash-recycling/

14 ESWET. (2023). *Integrated Resources Recovery Facility.* At: https://eswet.eu/documents/recovering-the-non-recyclable-the-integrated-resource-recovery-facility/.

15 ESWET. (2023). *Integrated Resources Recovery Facility.* At: https://eswet.eu/documents/recovering-the-non-recyclable-the-integrated-resource-recovery-facility/. For reference, a tonne of aluminium is worth about 2,209 € (February 2023).

IBA was estimated at €2 billion[16], while reducing the extraction of virgin materials and avoiding up to 14.5 million tonnes of CO_2 emissions[17].

Redirecting just 300,000 tonnes of aluminium, copper, zinc, and lead currently lost to landfilling or downcycling[18] into true recycling could significantly improve the EU's raw material resilience and contribute to circular economy goals.

In the past, IBA treatment plants needed to be centralised in order to collect enough bottom ash to justify a viable business case. Today, however, technological advancements in the sector allow each WtE plant to have its own dedicated treatment facility. This significantly simplifies the integration of such a system into existing WtE plants. Moreover, the cost of adding an IBA treatment unit is roughly less than 5% of the total WtE plant investment, making it a relatively small add-on. However, environmental and economic benefits are limited by the efforts and economics of different processing concepts.

The use of IBA still varies widely across Member States due to regulatory barriers, differences in primary material availability, and public perception.

While there are materials recovered from IBA not classified as CRM, such as gold and silver, they are still essential in achieving the energy and digital transition. Precious metals including the ones just mentioned and strategic materials such as copper and nickel are key elements in the manufacturing of batteries - vital for the energy storage of renewable energy, solar power and thermal panels, or wind turbine blades. While the amount is smaller for those specific materials, they can also be recovered from WtE in some state-of-the-art treatment plants.

IBA represents a consistent and highly enriched secondary source of precious metals, with concentrations several orders of magnitude higher than natural ores! In addition, their recovery requires far less energy and environmental impact compared with conventional mining and refining.

The study by Chuchro *et al.* (2025)[19] found average contents of 6,973 ppb silver, 314 ppb gold, 41 ppb palladium, and 14 ppb platinum, corresponding to enrichment factors of 930×, 7,800×, 27×, and 275× above their average levels in the Earth's crust.

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[16] Blasenbauer, D., Huber, F., Lederer, J., et al. (2020). Legal situation and current practices of waste incineration bottom ash utilisation in Europe. *Waste Management, 102*, 868-883. At: https://hal.science/hal-02472497.
[17] From internal calculations based on figures from Geschäftsbericht der ZAV Recycling AG (2020).
[18] TU Delft. (n.d.). *Incinerator bottom ash recycling* [Research & Innovation, Recycling Technologies]. At: https://www.tudelft.nl/en/ceg/about-faculty/departments/engineering-structures/sections-labs/resources-recycling/research-innovation/recycling-technologies/incinerator-bottom-ash-recycling/
[19] Chuchro, M., Jędrusiak, R., & Bielowicz, B. (2025). Statistical analyses of precious metal contents in waste incineration bottom ashes. Scientific Reports, 15, 8149. At: https://doi.org/10.1038/s41598-025-91855-7

Notably, silver concentrations exceed those reported in the benchmark Swiss Hinwil plant (5,300 ppb) and are comparable to high-performing Italian facilities, confirming Europe-wide recoverability potential.

The statistical analyses demonstrate that these metals occur without seasonal or trend variability, ensuring **stable recovery yields throughout the year**, while 14–20% of samples showed outlier concentrations, pointing to particularly rich fractions that could significantly increase profitability when targeted with advanced separation methods. Figure 3 below highlights this steady occurrence and the presence of numerous high-value outliers, demonstrating the consistency and profitability potential of IBA-based recovery.

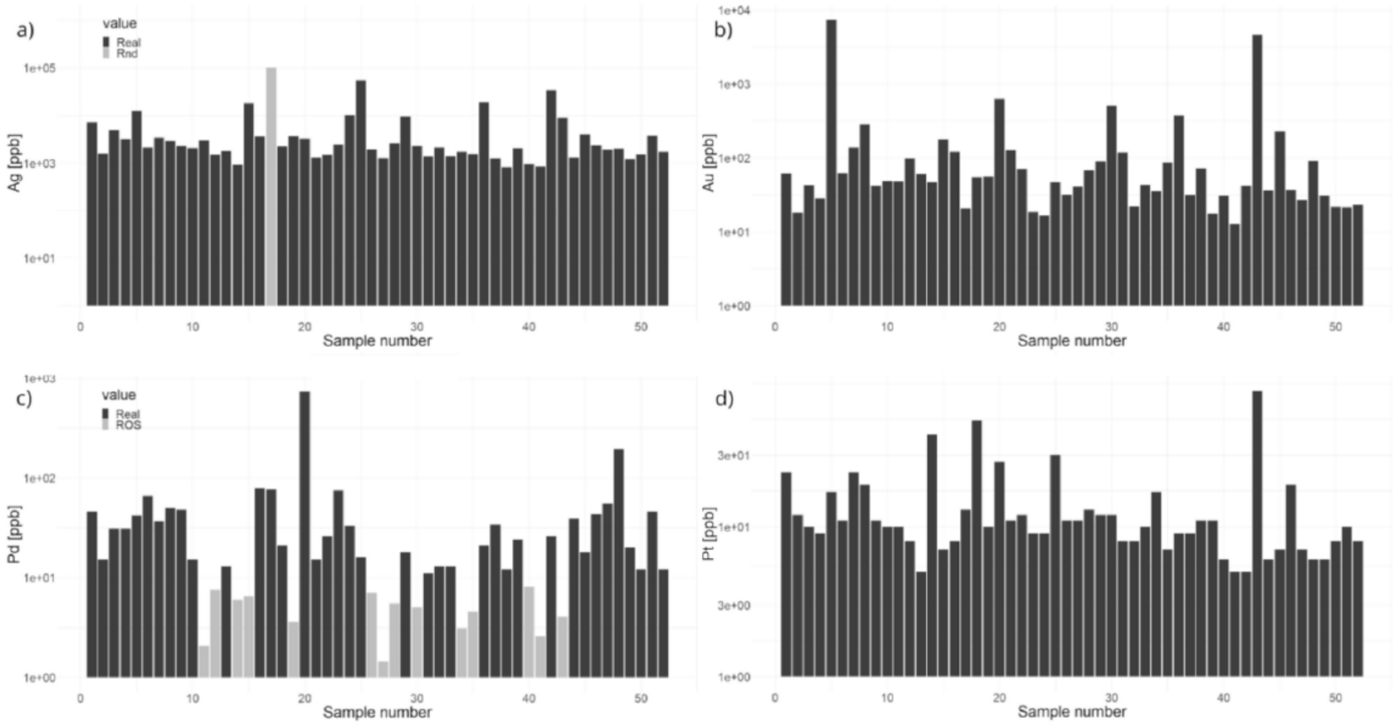

Figure 3. *Concentrations of precious metals (Ag, Au, Pd, Pt) in weekly IBA samples from the Krakow Thermal Waste Treatment Plant, showing stable recoverability and numerous high-value outliers. Source: Chuchro et al., 2025.*

Although the standalone Internal Rate of Return (IRR) for precious metals recovery was calculated at 4.4 %, comprehensive recovery of both precious and non-ferrous metals — as already implemented in several European facilities — **can raise returns well above 20%, underlining IBA's strategic importance in securing Europe's access to critical and high-value raw materials**, as illustrated in Figure 4.

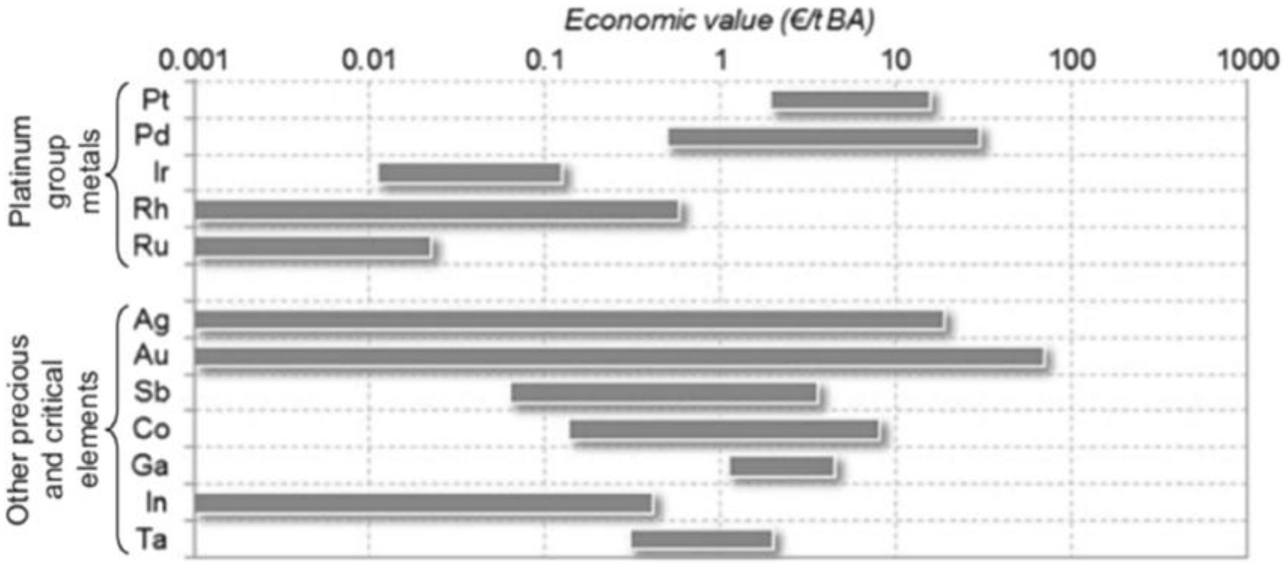

Figure 4. *Estimated total economic value of precious metals (Ag, Au, Pd, Pt) contained in IBA, illustrating the financial and material potential of Waste-to-Energy residues as a secondary raw materials source. Source: Adapted from Chuchro et al. (2025), based on Astrup et al. (2016)*[20].

Yet, the recovery of metals from IBA is not only an economic opportunity but a climate imperative. **With growing pressure to decarbonise, Europe cannot afford to overlook any domestic source of critical or secondary raw materials that can strengthen its circular economy.**

Aside from IBA, which is a non-hazardous material, essential materials can also be recovered from another residue of combustion: fly ash. Fly ash is classified as hazardous in the majority of EU countries and represent a smaller amount compared to IBA, but several state-of-the-art treatment plants are able to recover materials from it such as heavy metals. Thanks to advanced acidic washing technologies, facilities in Denmark, Sweden, and Switzerland can recover zinc, lead and copper and cadmium.[21]

The above recovery processes are not commonly applied in the European WtE sector, but they could be more widely deployed if a market for those SRMs were to develop.

[20] Astrup, T., Rosenblad, C., & Sloot, H. A. van der. (2016). Treatment and reuse of incineration bottom ash. In R. D. Billings & E. E. Park (Eds.), Environmental materials and waste: Resource recovery and pollution prevention (pp. 607–645). Elsevier. At: https://doi.org/10.1016/B978-0-12-803837-6.00024-X

[21] See for instance, the SwissZinc project (at https://swisszinc.ch/index.html).

The EU Green Deal, the Clean Industrial Deal, the digital transformation, and green technologies, such as wind turbines, batteries, and solar panels, all rely heavily on CRMs, many of which are currently imported from geopolitically unstable regions.

To address this, the **Critical Raw Materials Act** sets targets to:

- Extract at least 10% of the EU's annual consumption from domestic sources.
- Process at least 40% of its annual CRM consumption within the EU.
- Recycle at least 25% of annual CRM consumption.

ESWET believes that these targets cannot be achieved without leveraging the potential of **SRMs recovered from waste**, especially from non-recyclable municipal solid waste processed in WtE facilities as shown in this analysis.

1.3 Waste-to-Energy contributes to pollution prevention

As already mentioned, beyond energy recovery and material extraction, modern WtE plants provide an essential yet often overlooked environmental service: the prevention of pollution. By treating non-recyclable waste under strictly controlled conditions, WtE avoids uncontrolled emissions and pollutant dispersal that would otherwise occur through open burning, illegal dumping, or the long-term degradation of waste in landfills. This function is particularly relevant for persistent pollutants such as dioxins, PFAS, and other hazardous compounds[22], which require high-temperature destruction and advanced flue gas cleaning systems to be managed safely.

Criticism of WtE has often relied on biomonitoring studies, for instance using mosses, pine needles, or backyard eggs, to suggest links between WtE plants and local pollution. However, a recent ESWET review of such studies[23] highlights that they generally suffer from methodological flaws and rarely establish a causal relationship between the detected pollutants and WtE operations[24]. Chemical fingerprinting often shows that pollutant signatures in environmental samples do not match those emitted by nearby plants[25], and in many cases other sources such as traffic, domestic heating, or industrial activities are far more significant

[22] Department for Environment, Food & Rural Affairs (Defra), *Project 21649*. At: https://sciencesearch.defra.gov.uk/ProjectDetails?ProjectId=21649

[23] ESWET. (2025). *Studies and findings in response to claims regarding pollution from WtE*. At: https://eswet.eu/wp-content/uploads/2025/07/ESWET-studies-and-findings-in-response-to-claims-regarding-pollution-from-WtE-July-2025.pdf

[24] NERIS, *Guide de surveillance de l'impact sur l'environnement des émissions atmosphériques des installations d'incinération et de co-incinération de déchets non dangereux et de déchets d'activités de soins à risques infectieux* (Report No. DRC-13-136338-06193C), published by Ministère de la Transition écologique et solidaire. At: https://www.ecologie.gouv.fr/sites/default/files/documents/INERIS-_DRC-13-136338-06193C_1_finalsigne_cle4cac8a.pdf

[25] Sako, L., Suzova, J., & Vesely, P. (2025). *Research on contamination of eggshells*. At: https://eswet.eu/wp-content/uploads/2025/04/Sako-Research-on-contamination-of-egg-shells-Suzova-J.-Vesely-P.pdf

contributors. This analysis is consistent with findings from the European Environment Agency and national authorities, which show that modern, well-regulated WtE plants account for a very small share of industrial dioxin emissions in Europe, less than 0.2 percent.[26] Reviews such as the one conducted by the UK Health Security Agency and updated as of 9 June 2025, conclude that **"modern, well-run and regulated municipal waste incinerators are not a significant risk to public health"**.[27]

WtE also offers a reliable means of treating PFAS in waste. Recent studies confirm that under the high-temperature and well-controlled combustion conditions typical of WtE plants, PFAS compounds are largely destroyed rather than emitted. A 2024 study by the Karlsruhe Institute of Technology confirmed that fluoropolymers, which make up the majority of PFAS used globally, are almost completely degraded (>99.99%) under typical European incineration conditions of 850°C and 2 seconds residence time.[28] Far from being significant sources of contamination, WtE facilities act as a barrier, preventing these persistent pollutants from entering the wider environment through uncontrolled leakage. This is reinforced by the fact that WtE plants operate under some of the strictest environmental and emissions regulations in the EU, with continuous monitoring, advanced flue gas cleaning systems, and high stacks that ensure dispersion and minimal local impact.

The pollution prevention service of WtE becomes even clearer when compared to alternatives. If residual waste containing plastics, chemicals, and persistent pollutants is not treated in WtE plants, it will most often be landfilled or illegally burned, both of which create much higher risks of soil, water, and air contamination. In landfills, these substances may leach into groundwater for decades, while uncontrolled combustion produces unfiltered emissions far more damaging than those from WtE plants operating under the Industrial Emissions Directive and the strictest Best Available Techniques standards. **By reliably treating contaminated rejects from sorting and recycling** (composite materials, contaminated waste, and other non-recyclables), **WtE confines pollutants to controlled residues,** such as fly ash or flue gas treatment by-products, which can then be safely managed and, where possible, recovered, **and stabilises the overall waste system, enabling higher-quality recycling and closing resource loops without compromising environmental integrity.**

Because WtE does not generate the waste it treats but rather fulfils a public service mission in managing society's residual waste, its role in preventing pollution must

[26] The European Pollutant Release and Transfer Register, https://industry.eea.europa.eu/#/home
[27] UK Health Security Agency (UKHSA) (2025). *Health impacts of emissions from incinerators: UKHSA opinion of the evidence.* At: https://www.gov.uk/government/publications/municipal-waste-incinerators-emissions-impact-on-health?
[28] Gehrmann, H.-J., Taylor, P., Aleksandrov, K., Bergdolt, P., Bologa, A., Blye, D., Dalal, P., Gunasekar, P., Herremanns, S., Kapoor, D., Michell, M., Nuredin, V., Schlipf, M. & Stapf, D. (2024). *Mineralization of fluoropolymers from combustion in a pilot plant under representative European municipal and hazardous waste combustor conditions*. *Chemosphere*. DOI: 10.1016/j.chemosphere.2024.143403.

be recognised in both climate and environmental policy. This means acknowledging that WtE is part of the solution to pollution challenges such as PFAS and other persistent contaminants, not a cause of them. As regulations around PFAS and micro-pollutants become stricter, it is vital that WtE's contribution as a safe and controlled treatment pathway is fully reflected in policy frameworks. Recognising this function ensures that residual waste is handled in the cleanest and most climate-sensible way, while protecting public health and the environment from uncontrolled releases.

1.4 Calculating the environmental, climate, and strategic benefits of Waste-to-Energy

Across the EU, moving residual waste up the hierarchy from landfilling to recycling and WtE has already driven more than a 40% cut in waste-sector emissions since 1990. The climate value of WtE comes from three integrated effects: landfill diversion that avoids methane emissions, fossil energy substitution via reliable baseload electricity and heat, and material recovery from bottom ash.

According to CEWEP[29], the diversion of non-recyclable waste from landfills to WtE results in **avoiding the emission of more than 600 kg of CO_2 per tonne of waste treated** in a 100-year time perspective. In other words, WtE plants prevent the formation of landfill gas by treating the organic methane-producing compounds in MSW, therefore decreasing their net emissions. Additionally, the energy recovered by WtE plants can displace energy from fossil fuel sources, **helping abate GHG emissions, at an estimated 360 kg of CO_2 equivalent per tonne of waste treated**, while for **material recovery, the abated emissions are 60 kg CO_2 equivalent** per tonne of waste treated. Overall, WtE plants generate emissions of about 400-450 kg of fossil CO_2 per tonne processed by delivering a public service of general interest and providing a treatment option for residual waste, but above all, **WtE plants help prevent CO_2 emissions with avoided emissions amounting to more than 1000 kg CO_2 per tonne of waste treated.**

[29] Confederation of European Waste-to-Energy Plants (CEWEP) (2022). *Waste-to-Energy Climate Roadmap Technical Annex (TA) main assumptions & methodology.*, Düsseldorf: CEWEP.

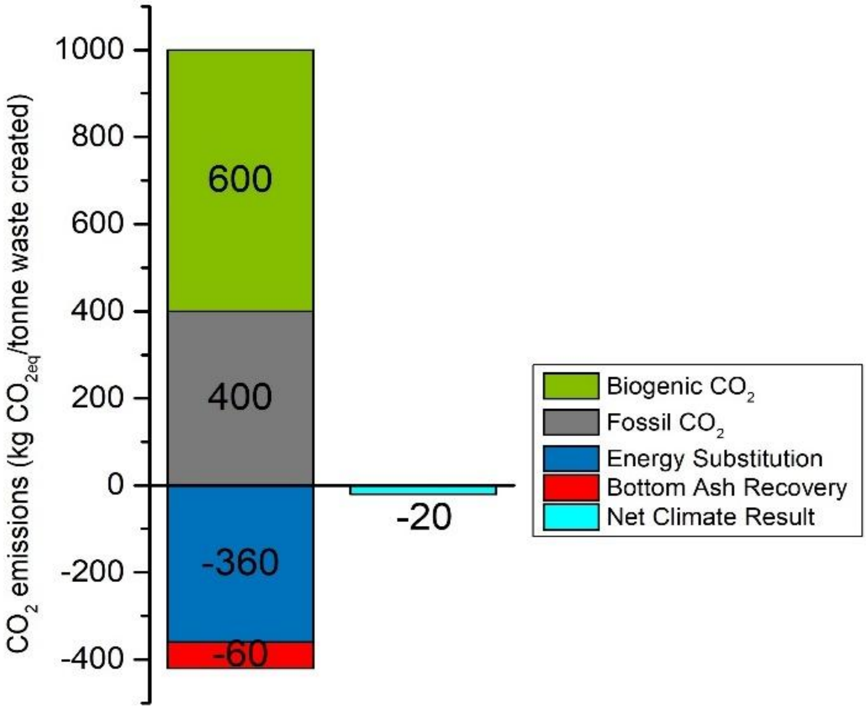

Figure 5. *Net climate effect of treating one tonne of residual waste via Waste-to-Energy (WtE). Data source: CEWEP Climate Roadmap, 2022. Graphic source: ESWET.*

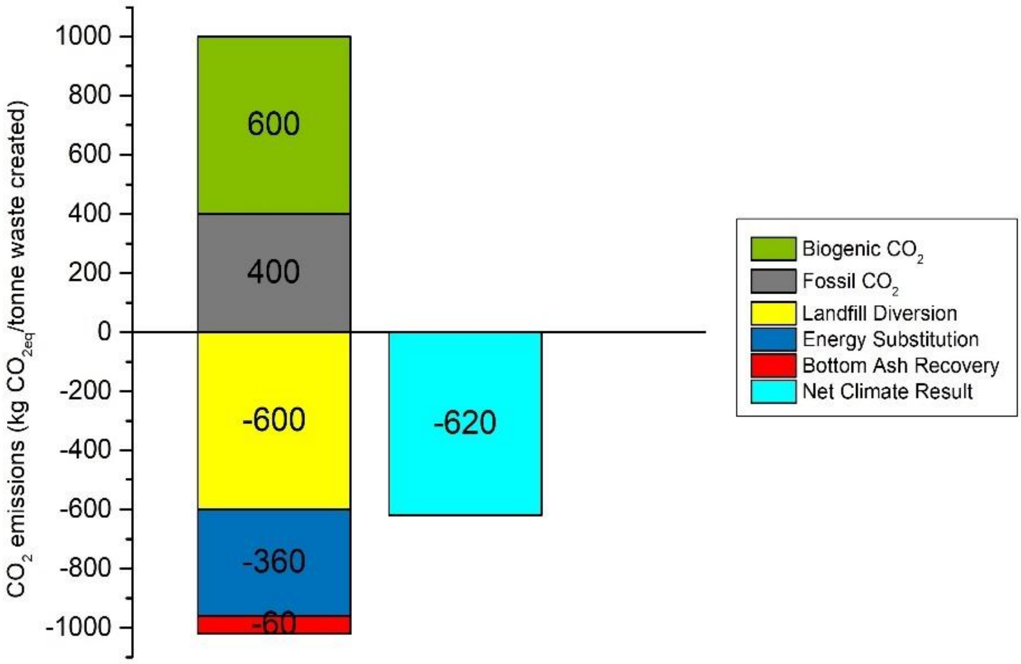

Figure 6. *Net climate effect of treating one tonne of residual waste via WtE, taking into consideration also landfill diversion. Data source: CEWEP Climate Roadmap, 2022. Graphic source: ESWET.*

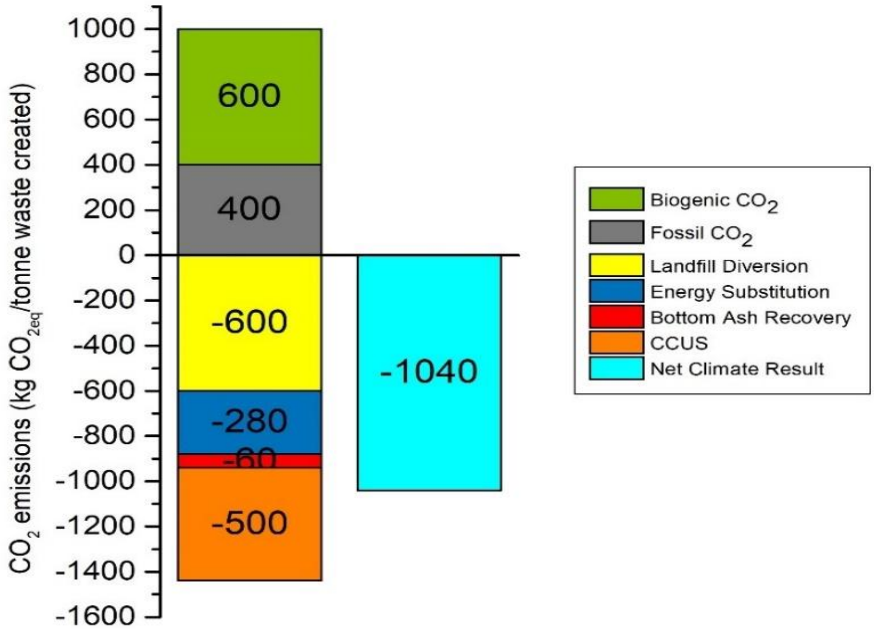

Figure 7. *Net climate effect of treating one tonne of residual waste via WtE, taking into consideration also landfill diversion and CCUS. Data source: CEWEP Climate Roadmap, 2022. Graphic source: ESWET.*

The three graphs above show the net climate effect of treating one tonne of residual waste via WtE, highlighting the contributions from emissions and avoided impacts:

1. **Graph 1 (Figure 5) (Baseline – electricity-only WtE):** When only electricity is recovered, WtE delivers a marginal climate benefit of **–20 kg CO_2eq/tonne**, as fossil CO_2 emissions are only partially offset by energy substitution and bottom ash recovery.
2. **Graph 2 (Figure 6) (WtE with landfill diversion):** Diverting waste from landfills to WtE adds a substantial climate benefit due to avoided methane emissions, leading to a net result of **–620 kg CO_2eq/tonne**.
3. **Graph 3 (Figure 7) (WtE with CCUS):** Combining landfill diversion with Carbon Capture, Utilisation and Storage (CCUS) further enhances the climate performance, achieving a total benefit of **–1040 kg CO_2eq/tonne**.

[Data and analysis from CEWEP Climate Roadmap, 2022].

These figures highlight the significant climate mitigation potential of WtE, which is highly relevant in the context of climate targets and broader decarbonisation efforts. The primary mission of the WtE sector is to safely treat society's residual, non-recyclable waste; unlike other industrial sectors, WtE cannot "switch fuels" (by the way, waste in general, and residual, non-recyclable waste more specifically, is not a fuel) or control the composition of its input, as it is determined by upstream consumption and product design. Despite this, WtE delivers substantial greenhouse gas reductions by diverting waste from landfills, preventing methane emissions, recovering energy that substitutes fossil fuels, and enabling material recovery from incineration bottom and fly ashes. This means that, when considering the full system benefits, the sector is already close to climate neutrality or even net negative in terms of emissions. However, these societal and environmental benefits are often **not fully captured** in standard life-cycle assessments (LCAs) or in the design of carbon pricing mechanisms like the ETS. As a result, the unique role of WtE in supporting both climate and circular economy objectives risks being **overlooked**, potentially leading to policies that do not reflect the sector's true contribution to decarbonisation and resource efficiency.

The Intergovernmental Panel on Climate Change (IPCC) explicitly acknowledges WtE's climate mitigation role, stating that **"When WtE technologies are equipped with proper air pollution reduction facilities, they can contribute to clean electricity production and reduction of GHG emissions"**.[30] Furthermore, The United Nations Economic Commission for Europe has defined WtE as **"the most sustainable solution for non-recyclable waste as it recovers energy and materials while providing an alternative to highly polluting landfills"**.[31]

According to the European Environment Agency's annual GHG inventories[32], fossil CO_2 emissions from WtE plants have consistently accounted for just 1% of total greenhouse gas emissions in Europe. Notably, this share has remained stable over the past decade, even as the volume of waste treated by WtE facilities has grown. This highlights the relatively modest climate footprint of the sector.[33]

When evaluating the climate impact of WtE, it is important to consider the broader context: approximately 100 million tonnes of residual waste are treated annually through WtE in Europe - waste that might otherwise end up in landfills or be exported outside the EU.

With emissions savings of up to 2,000 kg CO_{2eq} per tonne of recycled metal, the recovery of metals from WtE alone could save up to 3.8 million tonnes of CO_{2eq} each year, highlighting the sector's key role in reducing emissions and bolstering Europe's material security in a time of growing geopolitical uncertainty.

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[30] Intergovernmental Panel on Climate Change (IPCC) (2022). Climate Change 2022 Mitigation of Climate Change. Working Group III Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change 2022. At: https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf

[31] United National Economic Commission for Europe (UNECE) (2022). Guidelines on Public-Private Partnerships for the Sustainable Development Goals in Waste-to-Energy Projects for Non-Recyclable Waste: Pathways towards a Circular Economy. At: https://unece.org/sites/default/files/2022-10/ECE_CECI_WP_PPP_2022_03-en.pdf

[32] European Environment Agency. (2025). *EEA greenhouse gases - data viewer*. At: https://www.eea.europa.eu/en/analysis/maps-and-charts/greenhouse-gases-viewer-data-viewers

[33] Confederation of European Waste-to-Energy Plants (CEWEP) (2022).*Waste-to-energy Climate Roadmap: The path to carbon negative.* CEWEP. At: https://www.cewep.eu/wp-content/uploads/2022/06/CEWEP-WtE-Climate-Roadmap-2022.pdf.pdf

Additionally, as briefly mentioned in the previous chapters, bottom ash and fly ash offers promising potential for CO_2 sequestration through natural carbonation. As the mineral fraction of the ash matures through exposure to air and rain, the lime it contains reacts with atmospheric CO_2 - permanently capturing it - to form stable calcium carbonate ($CaCO_3$). This process can capture around 30 to 65 kg of CO_2 per tonne of ash, contributing further to the sector's carbon mitigation potential.[34]

The carbon sequestration potential of IBA was also recognised by the European Commission in the proposed Act[35] on permanent CCU, which aimed to define the conditions under which greenhouse gas emissions can be considered permanently embedded in a product.

In the UK, an "end-of-waste" status was granted for the carbon negative aggregate - made of fly ash and captured CO_2 - by the Environment Agency in 2011, meaning that it can be considered as a product at the legislative and commercial level.

Moreover, on the environmental benefits of material recovery, fly ash can also be used as an adsorbent in flue gas and wastewater treatment, either within the facility itself or externally, further enhancing the sector's circular economy profile. Fly ash also contains recoverable heavy metals such as zinc, which can **substitute virgin materials in industrial processes.** One promising example is a pilot-scale zinc recovery process applied to acid-washed fly ash[36]. While various treatment methods for fly ash already exist and can be further deployed, targeted funding and policy support are essential to scale up these technologies and unlock their full potential.

Supporting the recovery of valuable materials from (treated) IBA and fly ash offers wide-ranging environmental and strategic advantages. It directly contributes to the objectives of the Landfill Directive by reducing the volume of residual waste sent to landfill. At the same time, it reduces reliance on primary resource extraction, thus lowering environmental degradation and aligning with EU sustainability goals.

1.5 The problem of plastic production and pollution

The limitations of mandatory pre-sorting highlight the importance of tackling waste generation at its source - most notably in the case of plastics, where a fair application of the Polluter Pays Principle remains essential. Despite ongoing efforts to improve waste prevention and recycling, the volume of plastic placed on the

[34] Costa, G., Baciocchi, R., Polettini, A., et al. (2007). Current status and perspectives of accelerated carbonation processes on municipal waste combustion residues. *Environmental Monitoring and Assessment, 135*, 55-75. At: https://link.springer.com/article/10.1007/s10661-007-9704-4.

[35] European Commission. (2023). *Emissions trading system (ETS) - permanent emissions storage through carbon capture and utilisation*. At: https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14135-Emissions-trading-system-ETS-permanent-emissions-storage-through-carbon-capture-and-utilisation_en

[36] Karlfeldt Fedge, K. & Andersson, S. (2020). Zinc recovery from Waste-to-Energy fly ash – A pilot test study. *Waste Management, 118*, 90-98.

market continues to grow at an alarming pace, placing disproportionate pressure on downstream waste management systems, including WtE. In 2023, the worldwide production of plastics reached 413.8 million metric tons, from 370.7 million metric tons in 2018. Of these 413.8 million metric tons, 374.2 million metric tons were virgin, i.e., fossil-based plastics.[37]

Plastic production has surged over the past decades to become a major contributor to environmental damage and climate change. In 2019, plastics were responsible for approximately 1.8 billion tonnes of greenhouse gas emissions, accounting for around 3.4% of global total emissions, largely stemming from their production and conversion from fossil fuel feedstocks. By 2060, emissions linked to the plastics lifecycle are projected to triple, reflecting the sector's growing climate impact.[38]

Over half of all plastic ever manufactured has been produced since 2000, and projections suggest that global annual plastic production may double by 2050 if current trends continue.[39] The EU alone consumed around 62.8 million tonnes of plastic in 2022 - about 140 kg per person - with nearly 42.5 million tonnes of plastic waste generated in that same year[40].

According to the **European Commission's Joint Research Centre (JRC)**, plastics account for approximately **193 million tonnes of CO_2 equivalent emissions annually in the EU**, mainly from the production and conversion of fossil-based polymers. This trajectory is incompatible with the EU's 2050 climate neutrality objective and highlights the need for systemic action that targets emissions at the source.

Figure 8 below, taken from the European Environment Agency (EEA), highlights this correlation between plastic production and climate impact. Although demand from European plastic converters (the industries transforming polymers into products) slightly fluctuated between 2014 and 2022, it remained consistently high - above 45 million tonnes. In parallel, the sector's GHG emissions stayed above 190 Mt CO_2e, showing no significant decline despite increased policy attention to recycling and waste prevention.

[37] Plastics Europe. (2024). *Plastics – the fast facts 2024*. At: https://plasticseurope.org/wp-content/uploads/2024/11/PE_TheFacts_24_digital-1pager.pdf

[38] OECD. (2022). *Plastic leakage and greenhouse gas emissions are increasing.* At: https://www.oecd.org/en/data/insights/data-explainers/2022/08/plastic-leakage-and-greenhouse-gas-emissions-are-increasing.html

[39] Geyer, R., Jambeck, J. R. & Law, K. L. (2017). *Production, use, and fate of all plastics ever made. Sci. Adv., 3*(7), e1700782. At: https://www.science.org/doi/pdf/10.1126/sciadv.1700782

[40] OECD. (2023). *Plastics*. At: https://www.oecd.org/en/topics/plastics.html

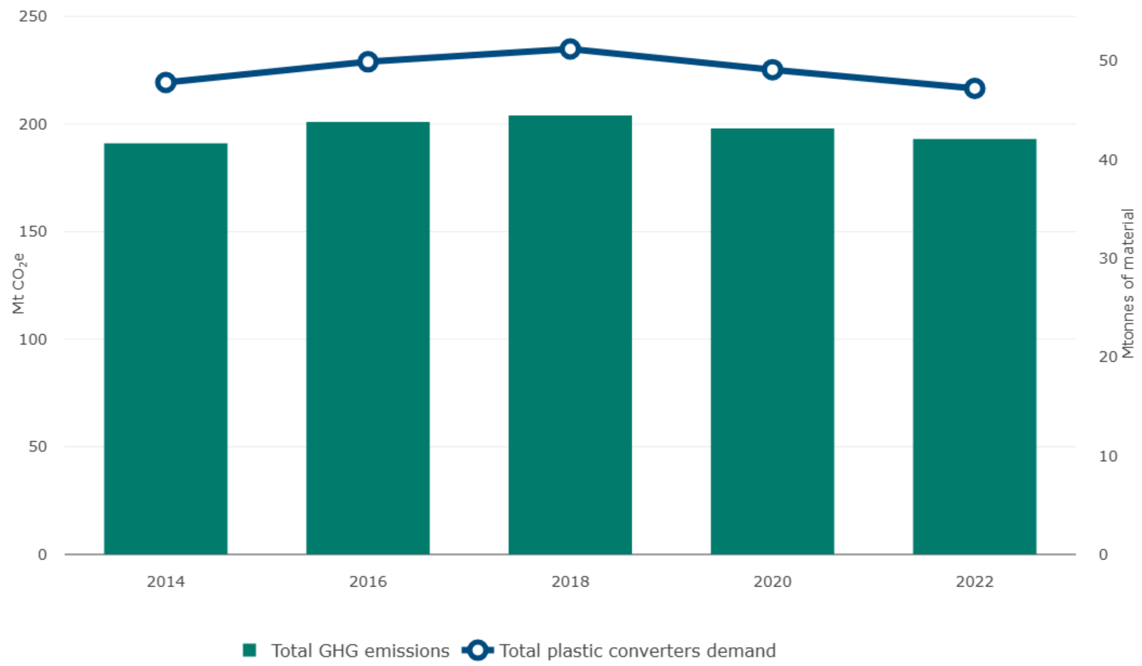

Figure 8. *GHG emissions from EU's plastics value chains, EU27+3 2014-2022. Source: EEA.*[41]

The stability of the aforementioned trends illustrates how efficiency gains and recycling improvements alone are insufficient to offset the rising emissions generated by virgin polymer production. As long as fossil-based plastics dominate the market, total emissions will remain high, regardless of downstream recycling performance.

When it comes to plastic waste, the numbers are also disappointing. According to the OECD, global plastic waste is projected to nearly triple by 2060.[42] Despite the growing volumes, only a fraction of plastic waste is ever recycled. Globally, **just 9% of all plastics ever produced have been recycled**.[43] In 2019, about 22% of all plastic waste bypassed formal waste management systems, ending up in open dumps, being burned in the open, or leaking into soils and water bodies. This shows that even with improvements in recycling infrastructure, the sheer volume of plastic produced will continue to overwhelm waste management systems.

41 European Environment Agency (EEA) (2024). *GHG emissions from EU's plastics value chain*. At: https://www.eea.europa.eu/en/circularity/sectoral-modules/plastics/ghg-emissions-from-eus-plastics-value-chain.

42 OECD. (2022). *Global plastic waste set to almost triple by 2060, says OECD*. At: https://www.oecd.org/en/about/news/press-releases/2022/06/global-plastic-waste-set-to-almost-triple-by-2060.html.

43 European Environment Agency (EEA) (2024). *Plastics*. At: https://www.eea.europa.eu/en/topics/in-depth/plastics.

Moreover, plastic recycling itself cannot break the cycle of overproduction. Each recycling loop degrades the material, requiring new virgin polymers to be added to maintain product quality. Recycling also generates residues and rejects, meaning that a significant proportion of collected plastic still ends up in WtE or is landfilled. In addition, many products, such as multilayer packaging, composite plastics, or plastics with complex additives, are technically unrecyclable.

Sorting and processing mixed plastic waste leads to high levels of residue and rejects, fibres, mixed polymer types, colouring or chemical additives, that weaken output purity. For some recycling streams, losses (materials discarded as unrecyclable or sub-standard) can amount to 20-50% of the input material.[44]

As long as virgin plastic production continues unchecked, the EU will remain structurally unable to achieve true circularity. Reducing production and consumption at the source is therefore indispensable, not only to relieve the pressure on waste treatment systems but also to ensure a fair application of the Polluter Pays Principle, where responsibility for plastic-related emissions lies primarily with those who design and market fossil-based materials.

1.6 Practical limitations of pre-sorting of mixed municipal waste

Policy discussions on improving recycling often focus on technical measures aimed at increasing the recovery of materials from municipal waste. Among these, mandatory pre-sorting of mixed waste has been proposed as a way to boost recycling tonnages and improve material flows.

Following the recent revision of the Waste Framework Directive (on food and textile waste), the European Commission is mandated to assess by the end of 2029 the possibility of introducing prior sorting of mixed municipal waste to prevent waste that can be recovered for preparing for re-use, or recycling from being sent to waste incineration or landfilled.[45] While pre-sorting of mixed municipal waste may appear as a simple technical fix, **evidence shows that it carries important and well-documented downsides in terms of material quality, cost-efficiency, and overall circularity outcomes.**

First, the **loss of material quality** is a major limitation. When recyclables are collected together with residual waste, contamination rises sharply, reducing the purity and recyclability of recovered materials. According to the **European Commission**, ***plastic recycling is 13 times higher when collected separately*** — demonstrating how decisive source separation is for achieving real

[44] Tenhunen-Lunkka, A., Rommens, T., Vanderreydt, I. & Mortensen, L. (2023). *Greenhouse gas emission reduction potential of European Union's circularity related targets for plastics*. *Circular Economy and Sustainability*). At: https://doi.org/10.1007/s43615-022-00192-8

[45] See Article 41a of the Directive (EU) 2025/1892 of the European Parliament and of the Council amending Directive 2008/98/EC on waste. Official Journal of the European Union, L 251/1. At: https://eur-lex.europa.eu/eli/dir/2025/1892/oj/eng

circularity. According to the 2017 Deloitte analysis[46] of European plastics flows, only around **42% of sorted plastics** were actually recycled in 2014, and approximately **17% of the material entering recycling plants was rejected** due to contamination, quality issues, or technical limitations. This means that **barely one-third of all plastics sorted for recycling were ultimately converted into new materials**. **These figures highlight a structural gap between collection, sorting, and actual recycling performance.** They also confirm that sorting alone cannot ensure circularity unless supported by high-quality separate collection, eco-design for recyclability, and stricter quality standards for recycled inputs. Improving upstream waste segregation and product design is therefore essential to increase yields and reduce rejections within the recycling chain. In addition, Deloitte's analysis also found that countries with mature separate collection systems, such as Germany and Italy, achieve higher recycling rates for polyolefins and PET, compared to countries where recyclables are partly collected from mixed residual waste.[47]

From a **technical standpoint**, recyclates recovered from mixed municipal waste are frequently downgraded due to the presence of incompatible resins, organic residues, and chemical additives that weaken their mechanical and visual properties. Advanced and costly sorting technologies can mitigate, but not eliminate, these effects, while the need for extra cleaning, reprocessing, and re-melting raises the overall environmental footprint. Studies confirm that sorting from mixed waste streams leads to high input losses and produces outputs that the recycling industry often rejects due to low quality and purity, contrary to streams coming from source separation and separate collection.[48]

Economically, mandatory pre-sorting is inefficient: it demands additional investments in infrastructure, transport, energy, and labour to handle lower-quality material flows. These hidden costs often outweigh the marginal gains in recycling tonnage when compared with **well-implemented source separation and separate collection systems** (e.g., at the household or building level).

Moreover, large-scale mixed waste sorting is often unable to supply the consistently pure material fractions that modern recycling industries need; according to a European Investment Bank study, "some 80% of the sorting facilities in Europe sort mixed waste streams with varying output quality - often

[46] Deloitte Sustainability. (2017). *Blueprint for plastics packaging waste: Quality sorting & recycling*. At: https://www.cewep.eu/wp-content/uploads/2025/04/pre-blueprint-packaging-waste-2017.pdf
[47] Deloitte Sustainability. (2017). *Blueprint for plastics packaging waste: Quality sorting & recycling*. At: https://www.cewep.eu/wp-content/uploads/2025/04/pre-blueprint-packaging-waste-2017.pdf
[48] Damigos, D., Voronova, V. & Kleinheyer, B. (2022). *Comparative study of municipal solid waste (MSW) management regulations in each country. O1.A1.* At *https://blockwasteproject.eu/wp-content/uploads/2022/12/EN_O1.A1.-Comparative-study-of-Municipal-Solid-Waste.pdf?*

only of limited use for the recycling industry and showing high input material loss during the sorting process."[49]

In contrast, from a policy and lifecycle perspective, **source separation remains the cornerstone of EU waste law precisely because it results in higher capture rates, lower contamination, and better material yields.** The Waste Framework Directive requires separately collecting paper, metal, plastic and glass, as well as (by set deadlines) bio-waste and textiles, in order to minimise contamination and maximise recyclability. Introducing a blanket EU requirement for mixed-waste pre-sorting risks diverting political and financial capital away from what truly matters — **harmonising separate collection, advancing eco-design, improving EPR schemes, and boosting demand for recycled content made in Europe**.

While mandatory pre-sorting of mixed municipal waste may superficially raise reported recycling figures or prevent recyclable fractions from ending up in WtE or landfills, the **trade-offs in quality, efficiency, and real environmental benefit make it a risky and often counterproductive policy choice**. The Commission's upcoming 2029 assessment should therefore prioritise separate collection, eco-design, and market uptake as the most effective path to high-quality recycling and genuine circularity.

1.7 Who holds responsibility for waste generation and management

As already analysed, WtE facilities operate under the strictest environmental regulations in the EU, ensuring high standards of pollution control and public health protection.

But most importantly, the WtE sector does not generate the waste it treats - it manages it as part of a broader public service mission. Operators are increasingly aware[50] of the climate impact of fossil-based waste, such as plastic, and many already take steps to reduce or reject[51] plastic feedstock. In parallel, the sector actively supports systemic efforts to cut plastic production and improve upstream design. However, in the absence of adequate upstream action, WtE facilities are left to deal with - and pay for the relevant costs of - society's non-recyclable residues.

A more effective and equitable solution to this issue is to apply the Polluter Pays Principle (PPP) at the source, targeting producers and importers of fossil-based products. This ensures that those who place plastics and other fossil-derived

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[49] European Investment Bank. (2023). *Cutting plastics pollution: Financial measures for a more circular value chain*. Luxembourg: European Investment Bank. At https://www.eib.org/attachments/lucalli/20220248_cutting_plastics_pollution_en.pdf?

[50] Chartered Institution of Wastes Management (CIWM) (2024). CIWM responds to BBC study on recycling rates and waste incineration. https://www.ciwm.co.uk/ciwm/news/2024/ciwm_responds_to_bbc_study_on_recycling_rates_and_waste_incineration.aspx

[51] For reference, see here.

materials on the market bear the responsibility for their full environmental impact, creating strong incentives for better product design, material choices, and waste prevention.

The 2021 Special Report of the European Court of Auditors on the application of the Polluter Pays Principle[52] found that, although EU waste legislation reflects the PPP, it does not ensure that polluters cover the full cost of pollution. Article 14 of the Waste Framework Directive explicitly provides that, "in accordance with the polluter-pays principle, the costs of waste management, including for the necessary infrastructure and its operation, shall be borne by the original waste producer or by the current or previous waste holders."[53] Moving beyond this general recognition, ESWET calls on EU legislators to empower the PPP so that those responsible for waste generation pay for the environmental and climate impacts of their products. This interpretation has also been supported by the Court of Justice of the European Union, which has adopted a broad understanding of the PPP, confirming that the persons who "cause the waste" are financially liable for its management - whether they are current or former holders of the waste or producers of the product from which it originated.[54] Thus, designing environmental policies that burden Waste-to-Energy as if it were solely responsible for environmental damages - without considering the responsibility of waste producers or previous waste holders - raises concerns about the lawful and fair application of the PPP.

From a legal and policy perspective, the PPP must be applied in proportion to the origin or cause of pollution and the scope of each legislative instrument. For instance, in the case of plastic waste, EU legislation should make plastic producers bear a larger share of the economic responsibility once their products become waste. The continued increase in virgin plastic production each year proves that waste-management instruments alone cannot offset upstream overproduction. Experiences from countries where WtE has been included in emissions-trading or equivalent carbon-pricing schemes show that such measures, when applied downstream, have **limited effect** on reducing plastic production or consumption. Even when additional costs are passed on through the waste-management chain, **the overall volume of plastic placed on the market continues to rise, driven by upstream production and design choices**. This demonstrates that measures targeting waste treatment occur too far from the source of pollution to effectively address the root cause - the unchecked production of virgin plastics.

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[52] European Court of Auditors (2021). The Polluter Pays Principle: Inconsistent application across EU environmental policies and actions. p. 17-19. At: https://www.eca.europa.eu/Lists/ECADocuments/SR21_12/SR_polluter_pays_principle_EN.pdf

[53] Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste, OJ L 150, 14.6.2018, pp. 109–140. At: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32018L0851

[54] Van de Walle, E. (2004). *Case C-1/03 Van de Walle*, ECLI:EU:C:2004:490, paragraph 58. At: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:62003CJ0001

This highlights the urgent need to shift responsibility upstream through robust and comprehensive EPR schemes. Under a well-designed EPR system, producers must be held accountable for the full lifecycle of their products, including the costs and emissions associated with end-of-life treatment. In particular, EPR schemes for packaging shift the financial responsibility for waste management from municipalities to producers, encouraging eco-design and recyclability by linking fees to packaging materials through modulated fees. The topic of EPR schemes is addressed in more detail further below, in section 2.4 of this paper.

The composition of residual waste - and therefore the amount of plastic it contains - is determined primarily by upstream design, production, and sorting performance, not by WtE operations. It is therefore disproportionate to burden WtE with the cost of emissions and waste treatment stemming from design failures elsewhere in the value chain.

In this regard, WtE acts as a pollution mitigator, being responsible only for ensuring high-quality treatment and compliance with emission thresholds. EU policies applying the Polluter Pays Principle must acknowledge WtE’s positive contribution to pollution prevention and its indispensable place in the waste hierarchy.

Overburdening WtE through multiple environmental policy instruments — while overlooking the responsibilities of upstream actors — would constitute a breach of the Polluter Pays Principle. Instead, the EU should strengthen the PPP by ensuring that the costs of new infrastructure, modernisation, and environmental upgrades (such as sorting systems, CCUS deployment, higher energy efficiency, and maximised material recovery) are shared proportionately between businesses, industries, and municipalities, and primarily financed by the actual polluters. Waste management should not face additional punitive measures, but constructive incentives that enable it to perform its public mission effectively and efficiently.

In summary, a correct and reinforced application of the Polluter Pays Principle must ensure that financial and regulatory responsibility lies with those who generate waste and its embedded pollution - not with the facilities mandated to manage it safely and protect the environment.

➢ The structural challenges outlined in Section 1 show that ensuring fairness in waste management is only one part of the solution. Beyond applying the Polluter Pays Principle effectively, Europe must also address the root causes of waste generation and strengthen the systems that enable true circularity. This requires a broader approach, one that combines upstream action to prevent waste and reduce overall resource consumption, not just plastics, with downstream solutions that recover energy and materials efficiently.

Section 2: Measures to improve the Circular Economy

The forthcoming Circular Economy Act is expected to address what the European Commission has identified as the "remaining bottlenecks to the circular transition." These include the absence of an effective single market for waste, secondary materials, and sustainable products; harmonisation of End-of-Waste (EoW) criteria; insufficient demand for SRMs; and the continued distortion of markets, where the prices of virgin materials fail to account for their environmental and social externalities. Please find below ESWET's recommendations:

2.1 Creating a single market for waste and secondary materials

The creation of a single market for waste and SRMs is a foundational step toward achieving the EU's circular economy and industrial resilience objectives. At present, the lack of harmonised standards, definitions, and administrative procedures across Member States leads to significant legal uncertainty and operational barriers for the trade of SRMs.

These disparities discourage cross-border flows, fragment markets, and inhibit economies of scale in the recycling and recovery sector. Materials derived from thermal treatment processes - such as metals and minerals extracted from IBA are often subject to divergent interpretations of waste status, hindering their uptake in downstream applications, particularly in construction and metallurgy. Despite their growing technical quality and safety (as previously explained), such materials are still burdened by outdated perceptions or lack of recognition under national EoW criteria.

For WtE facilities that have invested in state-of-the-art sorting and recovery technologies, this lack of market integration translates into underutilised resource streams and missed opportunities for circularity. For instance, aluminium and ferrous metals recovered from IBA can substitute virgin materials, saving both carbon emissions and energy, yet their classification as waste (and the non-granting of EoW status) in some Member States makes it difficult to integrate them into EU industrial supply chains. The situation is further complicated by discrepancies in permitting and certification requirements, which delay or block the movement of recovered materials even when they meet comparable performance and environmental standards.

A functioning single market would also coherent product policies, common rules on quality assurance, digital traceability systems, and mutual recognition of conformity assessments. Crucially, it would enable greater participation from WtE operators and other waste processors in supplying reliable SRMs for strategic sectors, such as construction, battery manufacturing, and low-carbon technologies.

By recognising the role of thermal treatment in stabilising waste and recovering materials otherwise lost to landfill, the EU can tap into an underexploited reservoir of critical and non-critical resources - making the internal market more circular, competitive, and resilient.

2.2 Harmonising End-of-Waste (EoW) and by-product criteria

As briefly explained under section 2.1 above, one of the most critical barriers to unlock the full potential of circular economy solutions in the EU is the absence of harmonised EoW and by-product criteria. Under the current framework, each Member State retains discretion in determining when a waste ceases to be waste or when a substance qualifies as a by-product. This fragmented approach results in legal uncertainty, underfunded municipalities, administrative complexity, and reduced trust in secondary materials, particularly when traded across borders. It also interferes with economies of scale, discourages investment in recovery technologies, and leads to inefficiencies in the functioning of the Single Market.

This challenge is particularly acute for materials derived from incineration residues, such as (treated) IBA which can substitute primary construction aggregates. However, in the absence of clear and harmonised EoW criteria, the treatment and valorisation of IBA varies widely across Member States[55]. In some countries, (treated) IBA and fly ash are handled as a resource[56], with mature recovery chains and market uptake. (It goes without saying, that fly ash utilisation comes with significantly more hurdles compared to IBA, due to their hazardous composition.) For example, in the UK, a carbon-negative aggregate made from fly ash and captured CO_2 was granted EoW status in 2011[57], allowing it to be marketed as a product and supporting its use in the circular economy. However, in other countries, it remains classified as waste, severely limiting its reuse and creating unnecessary landfilling, even when the material meets high environmental and technical standards.

Construction materials such as concrete and insulation correspond roughly to half of the EU's total raw material consumption and nearly one-third of its annual waste generation[58]. Transitioning towards a circular economy is therefore critical to reduce resource dependency and foster a competitive, decarbonised European

[55] Blasenbauer, D., Huber, F., Lederer, J., et al. (2020). Legal situation and current practices of waste incineration bottom ash utilisation in Europe. *Waste Management, 102*, 868-883. https://hal.science/hal-02472497
[56] LIPOR. (2025). *LIPOR is a candidate for the CEWEP Technological Innovation Award 2025 with the WASH project*. https://www.lipor.pt/en/news/lipor-is-a-candidate-for-the-cewep-technological-innovation-award-2025-with-the-wash-project/
[57] Gunning, P., Hills, C. D., & Carey, P. J. (2013). *Commercial application of accelerated carbonation: Looking back at the first year.* In ACEME 2013 (pp. 185-192). Leuven, Belgium. Retrieved from https://gala.gre.ac.uk/id/eprint/13577/
[58] Lederer, J., Gassner, A., Fellner, J., Mollay, U. & Schremmer, C. (2021). *Raw materials consumption and demolition waste generation of the urban building sector 2016–2050: A scenario-based material flow analysis of Vienna*. *Journal of Cleaner Production*, 288, 125566. https://doi.org/10.1016/j.jclepro.2020.125566

construction sector that minimises environmental impacts and moves away from the unsustainable extraction of natural resources. In this context, aggregates recovered from IBA offer a valuable secondary resource that can substitute for virgin construction materials such as sand, gravel, and crushed rock. This not only helps close material loops, but also reduces the need for environmentally harmful extraction activities, supporting both circularity and climate objectives.

Figure 9 shows that replacing natural aggregates with minerals recovered from IBA can improve material performance. At 30% replacement, the flexural tensile strength (FTS) of the concrete increases from around 5.9 MPa to about 6.8 MPa.[59] This demonstrates that IBA minerals can not only substitute part of the raw materials in cement and concrete production but also enhance the mechanical strength of the final product.

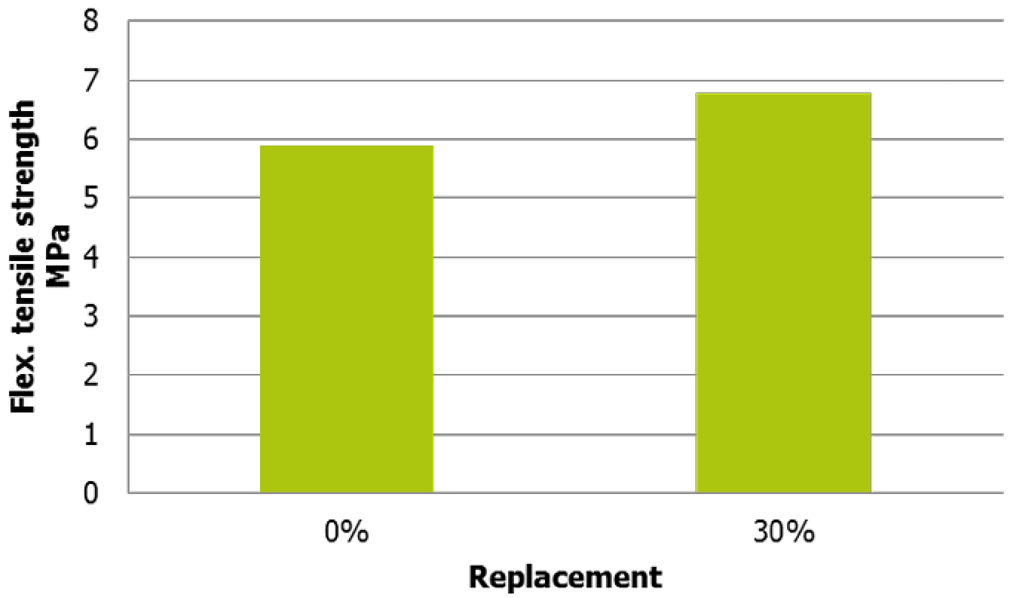

Figure 9. *Effect of replacing natural aggregates with incineration bottom ash (IBA) minerals on concrete performance. Source: TU Delft.*[60]

The lack of clarity also inhibits the development of technologies capable of recovering metals and minerals at higher purity levels. Innovators are less likely to invest in advanced treatment systems, such as dry bottom ash processing, if the recovered outputs cannot consistently access SRMs markets. Moreover, this

[59] Delft University of Technology (n.d.). *Recycling of Incinerator Bottom Ash: A study on the recycling potential of incinerator bottom ash in the Netherlands*. At: https://filelist.tudelft.nl/CiTG/Over%20faculteit/Afdelingen/Engineering%20Structures/Resources%20%26%20Recycling/Incinerator%20Bottom%20Ash/recyclingiba1.pdf

[60] TU Delft. (2013). *Recycling of Incinerator Bottom Ash: A study on the recycling potential of incinerator bottom ash in the Netherlands*. At: https://filelist.tudelft.nl/CiTG/Over%20faculteit/Afdelingen/Engineering%20Structures/Resources%20%26%20Recycling/Incinerator%20Bottom%20Ash/recyclingiba1.pdf

regulatory uncertainty increases transaction costs for companies operating in multiple Member States, further weakening the competitiveness of Europe's circular economy industries.

The CEA offers a unique opportunity to address this systemic gap. The upcoming legislation should prioritise the development of EU-wide EoW and by-product criteria, using a risk-based and performance-based approach. This would involve setting harmonised standards that reflect the actual environmental risk and material quality, rather than relying solely on origin or process-based distinctions.

Such a framework would:

- Facilitate the free movement of compliant SRMs across EU borders;
- Enhance market confidence in the safety and quality of recycled products;
- Promote the uptake of high-quality secondary materials in industrial processes and construction;
- Encourage greater investment in resource recovery from residual waste streams;
- Support the implementation of the Critical Raw Materials Act by unlocking domestic sources of strategic materials.

In addition to EoW, clearer rules on by-product status are also needed. Many materials generated during waste treatment or industrial processes - such as recovered carbonates, ashes, or biochar - could qualify as by-products rather than waste. If appropriately defined, this could create new circular value chains while reducing administrative burdens and accelerating reuse.

Overall, establishing coherent and science-based EoW and by-product criteria at EU level is a foundational step to mainstream circularity, support innovation, and shift Europe's economy away from extraction and disposal toward regeneration and resource preservation.

2.3 Tackling plastic production before it becomes waste

As mentioned above, the structural imbalance between growing plastic production and limited recycling capacity highlights the need for a broader systemic approach, one that addresses the problem at its source rather than merely managing its consequences. While WtE and recycling are essential to recover value from non-recyclable waste, they cannot resolve themselves the environmental burden caused by the continuous production and consumption of virgin fossil-based plastics.

To make the circular economy work in practice, Europe must combine upstream prevention with downstream efficiency. Reducing plastic consumption and production is the first and most necessary step. The EU should introduce binding targets to limit the use of primary plastic polymers, encourage the substitution of fossil-based materials with circular and sustainable alternatives, and prioritise the design of products for reuse, durability, and recyclability. Product design rules must also eliminate unnecessary single-use plastics and harmful additives that hinder recycling or create pollution during end-of-life treatment.

At the international level, recognition of the need for such upstream measures is rapidly growing. The United Nations Environment Programme (UNEP) is leading negotiations for a Global Plastics Treaty[61] through the Intergovernmental Negotiating Committee (INC). The emerging framework includes legally binding targets to reduce virgin plastic production, phase-outs of problematic plastic products and chemical additives, and product-design standards to improve recyclability and traceability across value chains.[62]

These ambitions were reaffirmed at the Ocean Conference in Nice in June 2025, where 95 countries endorsed the "Nice Call for an Ambitious Treaty on Plastic Pollution",[63] calling for binding obligations to phase out the most problematic plastic products and chemicals, measurable targets for reducing production of primary plastic polymers, and lifecycle-wide measures to enhance circularity.[64]

Aligning EU policy with these international ambitions is critical for credibility and effectiveness. Recycling should remain a central pillar, but its physical and economic limits must be acknowledged, and it should be complemented with upstream measures that prevent waste generation in the first place. Without upstream reduction, downstream measures such as recycling or even CO_2 pricing on WtE will not curb plastic pollution. The only durable solution is to curb the production and consumption of virgin plastics and move towards a system where reuse, repair, and substitution with sustainable materials are the priority.

2.4 Improving Extended Producer Responsibility (EPR) schemes

As mentioned previously, **WtE facilities do not generate waste; they manage it as part of their essential public hygiene function.** WtE plants are expected to manage emissions, recover materials, and align with circular economy goals, but they don't have any influence on waste generation. Moreover, as thoroughly elaborated on Section 1 of this paper, WtE cannot and should not bear this burden alone. The primary responsibility for managing non-recyclable waste (especially plastics, composites, and difficult-to-recycle materials) should lie upstream, with producers and product designers. The responsibility for managing non-recyclable waste must be fairly distributed, ensuring that those who place products on the market contribute to the safe and sustainable handling of waste generated

[61] For reference, see United Nations Environment Programme. (2025). *Intergovernmental Negotiating Committee on Plastic Pollution*. https://www.unep.org/inc-plastic-pollution
[62] For reference, please see Global plastics treaty - House of Commons Library
[63] For reference, please see Nice Call for an Ambitious Treaty on Plastic Pollution
[64] For reference, please see In Nice, countries call for an 'ambitious treaty' to end plastic pollution

downstream. It is therefore essential that EPR schemes reflect this reality by allocating responsibility appropriately and ensuring producers and upstream waste holders bear their fair share of the environmental and economic burden. Today, several issues remain unresolved.

The problem of free riders, i.e. non-compliant producers who avoid their obligations, continues to be a recurring concern. The recent Packaging and Packaging Waste Regulation (PPWR)[65] has been a step towards harmonisation of EPR rules and raising recycling targets, which can further consolidate the sector and improve its overall efficiency.

Transboundary shipments of second-hand goods and waste must not be allowed to bypass national EPR obligations, creating loopholes that undermine fairness. An EU-level body could oversee governance, data exchange, and enforcement, ensuring that contributions are fairly distributed across borders.

EPR has the potential to evolve from a basic waste management mechanism into a strategic pillar of circular resource governance. Current EPR schemes remain fragmented across Member States, leaving significant gaps in accountability and enforcement. The upcoming CEA presents a unique opportunity to reform EPR at EU level. **This should focus on improving the coherence, transparency, and cost-efficiency of existing EPR schemes, ensuring that responsibilities are applied proportionately and that all actors contribute fairly to achieving circularity objectives.**

It must be underlined that national experiences, such as in France, highlight the risks of poorly designed EPR schemes. As noted in recent ministerial and parliamentary reports[66], the French EPR model suffers from excessive administrative complexity, conflicts of interest due to producer-only governance, and a lack of long-term industrial vision, making it **administratively burdensome, costly, and inefficient** in delivering environmental outcomes.

Critically, the fees of well-designed EPR schemes should reflect the real environmental impact of products, incentivising design for recyclability and supporting investments in advanced recovery technologies, including technologies that enable the recovery of materials from residual waste streams treated through WtE. Ensuring cost-efficiency and proportionality in fee structures is essential to maintain competitiveness and avoid unnecessary inflationary effects. By embedding the Polluter Pays Principle at the source and linking EPR contributions

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[65] European Parliament & Council of the European Union. *Regulation (EU) 2025/40 of the European Parliament and of the Council of 19 December 2024 on packaging and packaging waste, amending Regulation (EU) 2019/1020 and Directive (EU) 2019/904, and repealing Directive 94/62/EC (Text with EEA relevance)*. *Official Journal of the European Union*, L22/1. At: https://eur-lex.europa.eu/eli/reg/2025/40/oj/eng

[66] Inspection générale de l'environnement et du développement durable (IGEDD). (2024). *Performances et gouvernance des filières à responsabilité élargie du producteur*. At : https://www.igedd.developpement-durable.gouv.fr/performances-et-gouvernance-des-filieres-a-a4040.html?lang=fr

to circularity and material recovery potential, the system can become a catalyst for innovation, fair cost-sharing, and a more resilient circular economy.

2.5 Ensuring strict waste shipments application

An often-overlooked aspect of Europe's circular economy transition is the need to manage its own waste responsibly, within its own borders. Exporting waste to countries that may lack the infrastructure or regulatory capacity[67] to handle it safely is neither sustainable nor ethical. Environmental consequences do not stop at national borders.

When waste leaves Europe (but also when it is not correctly managed within EU borders), the issue is not just the risk of uncontrolled emissions. It also raises serious public health concerns linked to improper waste treatment, including toxic leakages, pollution due to per- and polyfluoroalkyl substances (PFAS) [68], water pollution[69], and, consequently, unsafe drinking water[70]. Moreover, contaminated plastic and non-recyclable waste often get mixed into exported shipments and end up in illegal processing centers or uncontrolled dumps, where they pose further risks to people and the environment[71] (and several countries are starting to restrict waste imports and tighten regulations on incoming waste streams[72]). These impacts often affect vulnerable communities in regions with weaker environmental and social protections, perpetuating environmental injustice on a global scale[73].

Unfortunately, a double standard persists. WtE is frequently criticised due to misconceptions (which are dispelled by the data presented in this position paper), meanwhile, far less scrutiny is given to the export of residual waste abroad, sometimes under the misleading label of recycling. This practice undermines

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[67] Center for Public Health and Environmental Development (CEPHED) (2019). *NEPAL PFAS Country Situation Report.* https://ipen.org/sites/default/files/documents/nepal_pfas_country_situation_report_mar_2019.pdf

[68] Watanabe, M. X., Kunisue, T., Tao, L., et al. (2010). *Dioxin-like and perfluorinated compounds in pigs in an Indian open waste dumping site: toxicokinetics and effects on hepatic cytochrome P450 and blood plasma hormones. Environmental Toxicology and Chemistry, 29*(7), 1551-1560. At: https://pubmed.ncbi.nlm.nih.gov/20821605/

[69] Richie, H. (2022) *Ocean plastics: How much do rich countries contribute by shipping their waste overseas? Our World in Data.* https://ourworldindata.org/plastic-waste-trade

[70] Sharma, B. M., Kharat, G. K., Tayal, S., et al. (2016). *Perfluoroalkyl substances (PFAS) in river and ground/drinking water of the Ganges River basin: Emissions and implications for human exposure*. *Environmental Pollution, 208*(Pt B), 704-713. https://pubmed.ncbi.nlm.nih.gov/26561452/

[71] BBC (2019). *Why some countries are shipping back plastic waste*. https://www.bbc.com/news/world-48444874

[72] Varkkey, H. (2019). *By exporting trash, rich countries put their waste out of sight and out of mind. CNN.* https://edition.cnn.com/2019/07/29/opinions/by-exporting-trash-rich-countries-put-their-waste-out-of-sight-and-out-of-mind-varkkey; Environmental Investigation Agency (EIA) (2025). *Malaysia strengthens plastic waste controls to close the door on 'waste colonialism' from other countries.* https://eia-international.org/news/malaysia-strengthens-plastic-waste-controls-to-close-the-door-on-waste-colonialism-from-other-countries/

[73] Statista Research Department (2025). *Waste trade worldwide - statistics & facts. Statista.* https://www.statista.com/topics/7943/global-waste-trade/#topicOverview

Europe's circular economy goals, shifts the problem elsewhere, and increases the global environmental burden.

Managing non-recyclable waste in Europe through high-standard, controlled processes like WtE ensures emissions are monitored, pollution is prevented[74], and valuable resources such as energy and SRMs are recovered. By contrast, shipping waste to countries with weaker environmental controls often leads to improper treatment or illegal dumping, with serious consequences for the climate and global ecosystems. The planet shares one atmosphere, and turning a blind eye to waste once it leaves Europe is neither environmentally nor climate responsible.

A truly circular and climate-resilient economy must prioritise local treatment solutions that respect the waste hierarchy, reduce landfilling, and ensure that what cannot be recycled is managed to the highest environmental standards. WtE plays a key role in this system, safely treating non-recyclable waste, while contributing to resource recovery and energy security. Europe must move away from the "out of sight, out of mind" mindset and invest in sustainable, accountable (non-recyclable) waste management, like WtE infrastructures, that supports its circular economy and climate goals.

2.6 Incentivising mandatory Green Public Procurement

Effective circular economy policies require a combination of economic incentives and regulatory measures. **Mandatory Green Public Procurement (GPP) rules and targets** can play a decisive role in driving demand for recycled and environmentally sustainable products. Public authorities represent a significant share of market demand, and by embedding strict environmental criteria into procurement processes, they can stimulate innovation, support sustainable businesses, and incentivise the development of circular supply chains.

By creating a coherent policy environment that promotes responsible consumption and production, reduces waste, and fosters the uptake of secondary raw materials, — and by combining behavioural incentives with systemic market influence — mandatory GPP can become a key driver for Europe's climate-resilient, resource-efficient, and circular future. Through the purchasing power of the public sector, policymakers can ensure that waste is treated as a valuable resource rather than a disposal problem, reinforcing the principles of a truly circular economy.

2.7 Setting clear "made in Europe" recycled content targets

Recycled content targets have proven instrumental in boosting recycling efforts and market uptake for plastics, but their scope must now be broadened. The Circular Economy Act offers a timely opportunity to promote "made in Europe" recycled materials by extending such targets to a wider range of materials,

[74] Water Research Centre Limited (WRC) (2024). *Persistent Organic Pollutants Destruction Efficiency in UK Energy from Waste.* Swindon: WRC.

including metals, paper, and composites. These materials represent a significant share of post-consumer waste and offer untapped potential for reducing resource extraction, energy use, and greenhouse gas emissions.

Future targets should apply equally across sectors and material types, with a clear focus on using post-consumer waste as the input source. This is critical to ensure that recycled content contributes meaningfully to resource circularity and does not simply shift waste streams within the value chain. Therefore, a technology-neutral, performance-based approach is essential, with mechanical recycling being prioritised over chemical recycling.

At the same time, the EU should ensure that recycled content targets actively stimulate demand for **"made in Europe" recycled materials**, strengthening local recycling markets, supporting industrial competitiveness, and avoiding the environmental leakage associated with imported recyclates of uncertain quality or traceability. It is worth noting that in the plastics sector, Europe faces a worrying situation where allegedly "recycled" material imported from outside the EU is flooding the market, while domestic recyclers are being forced to shut down existing recycling capacities.

Finally, the success of recycled content targets will depend not only on regulatory clarity and economic signals but also on industry uptake and consumer confidence. Clear labelling, transparent reporting mechanisms, and support for innovation in recycling technologies will be essential to ensure that these targets drive meaningful, long-term transformation across the EU economy.

2.8 Ensuring a level playing field between virgin and secondary raw materials (SRMs)

Another major barrier to circularity is that secondary raw materials remain more expensive than virgin ones. Despite years of policy efforts and significant investments in recycling capacities — particularly for plastics, the EU's circularity rate has stagnated[75], and imported material dependency remains high[76]. These low-cost imports often compete unfairly with domestically produced secondary raw materials, forcing European recyclers to scale down or shut existing capacities. This trend undermines both the integrity of the internal market and the broader goal of building a resilient, circular, and resource-efficient European economy.

The afore-mentioned circularity stagnation reflects deeper structural issues in Europe's material economy. Circularity efforts have so far focused heavily on improving recycling rates, yet the overall **Circular Material Use Rate (CMUR)** has risen only marginally over the past decade — from 11.8% in 2023, with a target to reach 22.4% by 2030, as seen in Figure 10 below. Achieving this goal

[75] Eurostat (2023). *EU's circular material use rate slightly up in 2022.* At: http://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20231114-2

[76] Eurostat (2025). *Physical imports and exports.* At: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Physical_imports_and_exports#Import_dependency

would require an annual increase of over 1.5 percentage points, more than double the pace seen so far.[77]

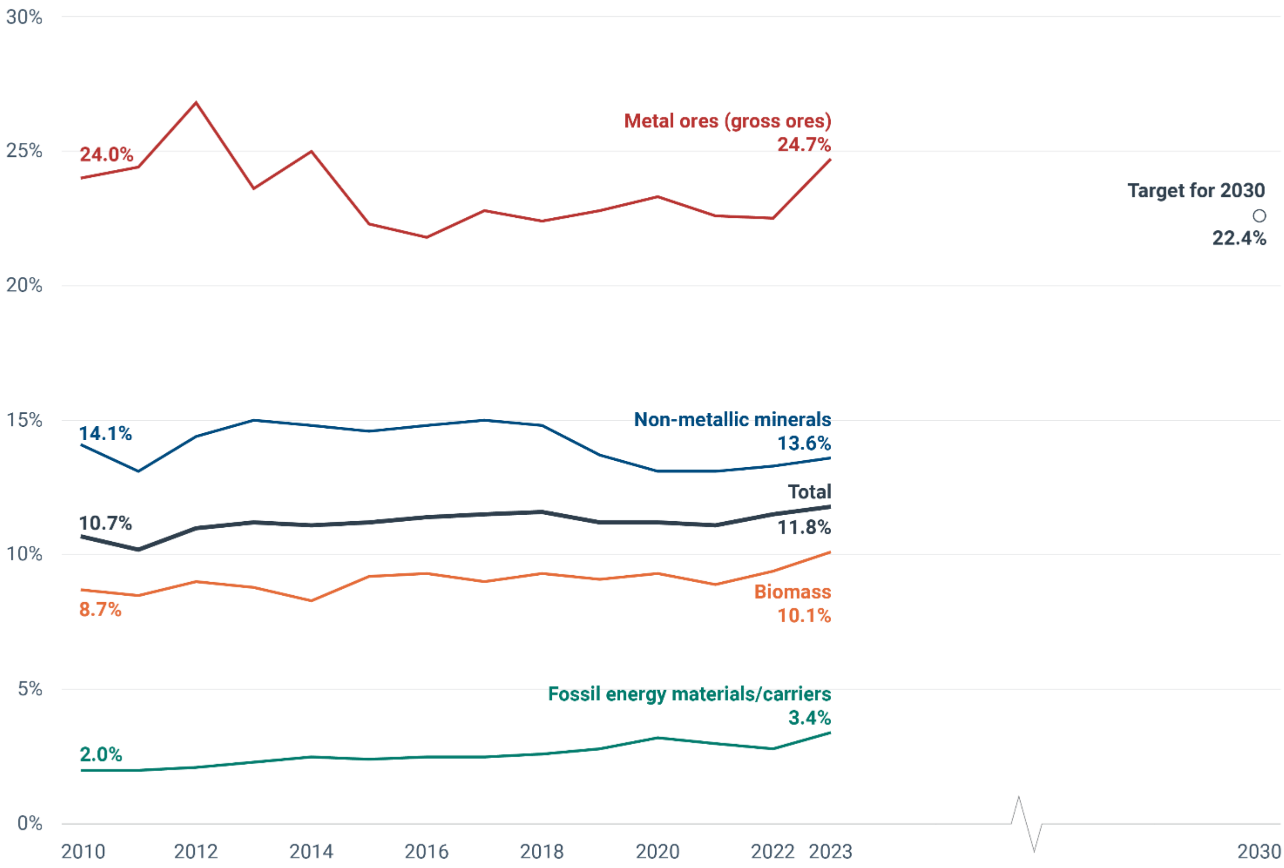

Figure 10. *Circular material use rate in the EU and breakdown by material group between 2010 and 2023. Source: EEA and Eurostat.*[78]

Given OECD projections of growing material demand[79] it is unlikely that higher recycling rates alone will close Europe's material use gap. This underscores the need for complementary measures to reduce overall material consumption, enhance product durability, and promote reuse and circular design.As highlighted

[77] European Environment Agency (EEA). (2024). *Circular material use rate in Europe*. At: https://www.eea.europa.eu/en/analysis/indicators/circular-material-use-rate-in-europe?activeAccordion=ecdb3bcf-bbe9-4978-b5cf-0b136399d9f8

[78] European Environment Agency (EEA). (2024). *Circular material use rate in Europe*. At: https://www.eea.europa.eu/en/analysis/indicators/circular-material-use-rate-in-europe?activeAccordion=ecdb3bcf-bbe9-4978-b5cf-0b136399d9f8; Eurostat. (2025). *Circular material use rate by material type)*. At: https://ec.europa.eu/eurostat/databrowser/view/env_ac_curm__custom_13756021/default/table?lang=en

[79] OECD. (2023). *Global Material Resources Outlook to 2060*. At: https://www.oecd.org/en/publications/global-material-resources-outlook-to-2060_9789264307452-en.html

in the Draghi report[80], recycling is still often more costly than landfilling[81] or using primary materials, due in part to the lack of coherent internal markets for SRMs and fragmented regulatory frameworks. To counter this, the EU must develop a strategic approach to resource use that includes effective incentives to increase the uptake of SRMs, such as fiscal tools to internalise the environmental cost of virgin resource extraction and targeted support for efficient recovery technologies like advanced IBA treatment systems.

Tax incentives such as reduced value-added tax (VAT) for products made with certified recycled content, coupled with taxes on virgin raw materials (especially plastics and critical raw materials), could shift market dynamics in favour of circular products. These measures would help bridge the price gap between primary and secondary materials, making recycled content more competitive and commercially attractive.

Beyond fiscal measures, a comprehensive strategy is needed to improve market conditions for SRMs, ensuring they can compete fairly with primary resources. This includes harmonising quality standards for recycled materials, reducing administrative barriers to cross-border SRM trade, and enhancing buyer confidence through certification and traceability schemes.

Within this framework, WtE plants can play a key role. Through the recovery of significant quantities of metals and minerals from IBA, they represent an important — yet underutilised — source of strategic materials. Unlocking this potential, however, requires stable and predictable markets for recycled outputs, where recovered SRMs from WtE can be reliably traded, recognised, and reintegrated into European value chains.

While overall demand for SRMs in Europe remains limited compared to the availability of recovered materials, the situation varies significantly across material types. For SRMs derived from waste incineration processes — particularly metals and mineral aggregates recovered from IBA — market demand tends to correlate with the quality and consistency of the recovered output. High-purity metals and well-characterised mineral fractions often find ready applications in the construction and manufacturing sectors, whereas lower-grade materials face weaker or more volatile demand. These variations underscore the need for EU-level measures that foster market stability and reward high-quality recovery, including harmonised quality standards, certification schemes, and targeted incentives for the use of SRMs in industrial value chains.

Another important enabling factor for market uptake of SRMs is the development of EoW and by-product criteria, as discussed in previous sections. Given the absence of harmonised EU-level criteria for minerals and aggregates recovered

[80] Draghi, M. (2023). *The Draghi Report on EU Competitiveness.* At: https://commission.europa.eu/topics/eu-competitiveness/draghi-report_en

[81] This is a trend observed in many Member States, rather than an absolute statement.

from WtE processes, **sub-national or local EoW frameworks** can play a crucial interim role. They allow competent authorities to recognise high-quality recovered materials as non-waste products based on clear environmental and technical performance standards. This flexibility is particularly valuable where EU legislation remains incomplete or inconsistent across Member States.

Local or regional criteria can accelerate the safe use of WtE-derived materials in construction and infrastructure projects, providing certainty to both recovery operators and end-users. Over time, these experiences can inform the development of harmonised EU EoW benchmarks, ensuring that materials with proven environmental safety and quality performance can circulate freely within the internal market.

The utilisation of recovered and recycled materials at large should be facilitated at EU level, through both regulation and access to funding for innovative projects. To support the development of a robust SRMs market from (treated) IBA, the European Commission should also integrate IBA-related material recovery projects into existing EU funding mechanisms. This includes recognising such projects under Important Projects of Common European Interest (IPCEI), Horizon Europe calls, the Innovation Fund, and the LIFE programme. These instruments can play a key role in scaling up innovative solutions in IBA processing and material recovery. Furthermore, the establishment of public-private partnerships is essential to foster technological advancements in IBA sorting and the selective extraction of critical raw materials.

To further strengthen the competitiveness of recycled products, integrating carbon accounting into the life cycle of recycled materials can play a pivotal role. Carbon accounting allows for the quantification and certification of the environmental benefits derived from the use of SRMs over virgin resources, offering a clear metric of the climate impact reduction associated with recycling.

By establishing a carbon footprint reduction benchmark for recycled products, policymakers can create an additional layer of incentives to promote the circular economy. Products with a lower carbon footprint could be subject to lower carbon taxes or eligible for carbon credits. This would further internalise the environmental costs of primary resource extraction, encouraging manufacturers to prefer recycled content not only for its cost-effectiveness but also for its climate credentials.

Furthermore, carbon accounting for recycled products would align with the EU's wider Green and Clean Industrial Deals and climate-neutral objectives, thus enabling companies to track their progress towards carbon neutrality and enhancing their sustainability profiles. It would also improve the visibility of the positive impact of recycling and give consumers more insight into the environmental benefits of purchasing recycled products, thus fostering greater demand for circular products.

Ultimately, integrating carbon accounting into recycling incentives could bridge the price gap between virgin and SRMs, providing both economic and environmental benefits. By creating a clear and quantifiable link between recycling and climate impact, the EU could not only enhance market conditions for SRMs but also accelerate the transition toward a carbon-neutral, circular economy. Moreover, carbon accounting can enhance the quantification of indirect CO_2 emissions, which are a critical factor in evaluating the net climate impact of WtE plants. The topic of considering avoided emissions from WtE plants alongside their direct emissions, to determine the climate mitigation potential of the sector, was analysed in detail in Section 1.4 of this paper.

2.9 Integrating material recovery policies into national waste management plans and industrial strategies

The misclassification of IBA discourages investment in recovery infrastructure complicates cross-border shipment of IBA for processing and limits its acceptance as a source of SRMs.

In addition, contrary to metal recovery, **mineral recovery from IBA is not currently recognised** as contributing to the EU's recycling targets, underestimating its impact.

In contrast, Member States should be encouraged to incorporate IBA metal recovery into their national waste management plans and CRM resilience strategies. Such integration would ensure coherent policy frameworks and facilitate the uptake of advanced recovery techniques across the EU. In parallel, the EU should promote the creation of knowledge-sharing platforms that enable the dissemination of best practices and innovation in IBA treatment technologies, fostering harmonisation and cross-border collaboration.

What is more, raising awareness of the **environmental and societal benefits of SRMs** will also help to respond to issues of public acceptance, by shifting the perception of waste to be seen as a valuable resource.[82]

2.10 Diverting waste away from landfills to meet circular economy and climate objectives

WtE and landfilling are not equivalent waste management options. For residual waste that cannot be prevented, reused, or recycled, **WtE not only performs a critical pollution prevention and sanitary function but also delivers materially lower lifecycle greenhouse gas emissions than landfills.** By safely destroying pollutants and organic matter that would otherwise generate methane, WtE prevents uncontrolled emissions, recovers energy and heat that

[82] While reducing waste at the source is the most preferable solution, municipal waste generation is still on the rise in Europe, with the latest Eurostat data estimating that citizens produced about 517 kg per capita of municipal waste in 2020, compared to 504 kg in 2019.

displace fossil fuels, and enables the recovery of valuable materials such as metals from bottom ash.

Landfilling is the least preferred option in the waste hierarchy and is only used when no other recovery is possible. According to the IPCC, landfills are a major source of methane emissions - a greenhouse gas 28 times more potent than CO_2 over a 100-year time frame, and more than 80 times more potent over 20 years[83]. In fact, about 19% of all human-caused methane emissions originate from the waste sector, with landfilling being the primary contributor[84].

Lately, it has become increasingly evident that landfill methane emissions are often underestimated and underreported.[85] This means that a substantial share of these emissions continues to escape into the atmosphere, contributing to climate change in the short and long term.

The European Space Agency reported in 2021[86] that a number of satellites (Copernicus Sentinel-5P and GHGSat satellites) detected methane being emitted at a rate of 8,800 kg/hour from two landfill sites not far from the centre of Madrid. This was the highest emission rate that GHGSat had ever observed in Europe, and it had been estimated that it would be sufficient to provide power for 350 000 households.[87]

Even well-managed sites with gas collection systems experience delayed and incomplete capture. Fugitive methane persists for decades as organic fractions decompose, with capture rates varying over time. The value of this recovered energy is highly variable. Studies have shown that landfill gas collection efficiencies can vary significantly (from 10% to 90%)[88], with an EU average of methane capture efficiency of 31%, due to technical and design limitations, as Figure 11 shows below.

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[83] Intergovernmental Panel on Climate Change (IPCC) (2014). Climate Change 2014: Synthesis Report. Geneva: IPCC. At: https://www.ipcc.ch/report/ar5/syr/

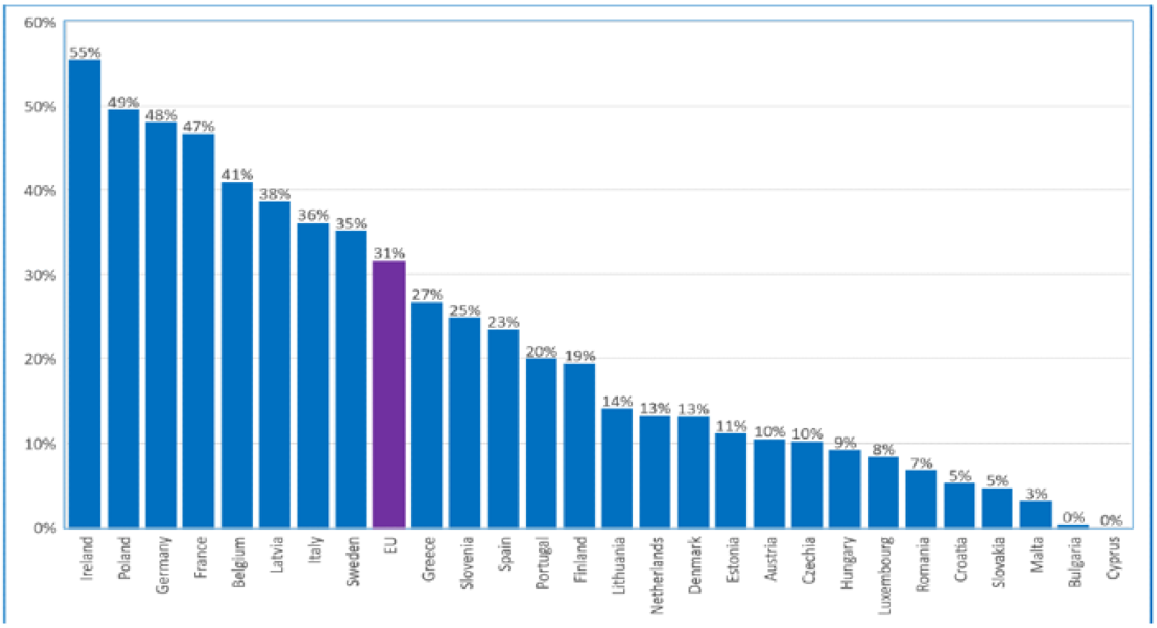
[84] Saunois, M., Martinez, A., Poulter, B., et al. (2024). Global Methane Budget 2000–2020. *Earth System Science Data, 17*(5), 1873-1958.

[85] Cusworth, D. H., Duren, R. M., & Ayasse, A. K., et al. (2024). *Quantifying methane emissions from United States landfills.* Science, 383(6690), 1499-1504. At: https://doi.org/10.1126/science.adi7735; Nesser, H., Maasakkers, J. D., Lorente, A., et al. (2024). *High-resolution U.S. methane emissions inferred from an inversion of 2019 TROPOMI satellite data: Contributions from individual states, urban areas, and landfills*. *Atmospheric Chemistry and Physics*, 24, 5069–5091. https://doi.org/10.5194/acp-24-5069-2024

[86] European Space Agency (2021, 10 November). Satellites detect large methane emissions from Madrid landfills. At: https://www.esa.int/Applications/Observing_the_Earth/Satellites_detect_large_methane_emissions_from_Madrid_landfills

[87] GHGsat, "Landfill methane emissions - Emissions monitoring for waste management (landfill methane)." At: https://www.ghgsat.com/en/case-studies/landfill-gas/

[88] Scheutz, C., Duan, Z., Møller, J., et al. (2023). Environmental assessment of landfill gas mitigation using biocover and gas collection with energy utilisation at aging landfills. *Waste Management, 165*, 40-50.



CH_4 recovery and flaring in % = (CH_4 recovery in Gg + CH_4 flared in Gg)/ (CH_4 recovery in Gg + CH_4 flared in Gg + CH_4 emissions 5A1/0,9 in Gg)
CH_4 emissions from 5A2 unmanaged landfills are not included in this calculation
Source: CRF 2023 Table 5A

Figure 11. Methane recovery fraction (recovery + flaring) for managed solid waste disposal in EU Member States, 2021. EU average is only 31%, with most Member States well below the levels often assumed in models (>70–90%). *Source: EEA/PVNL/2023/044.*[89]

Moreover, the temporal profile of landfill emissions concentrates warming in the near term, when the climate system is most sensitive. In contrast, WtE oxidises biogenic carbon to CO_2 immediately, avoiding methane formation altogether.

To meet the EU's **both climate and circular economy objectives** cost-effectively, it is essential to accelerate landfill diversion, phase down the landfilling of biodegradable waste, and prioritise Waste-to-Energy for residual streams and methanation for biowaste — while upholding the waste hierarchy and maximising upstream prevention and recycling. In Member States that still rely heavily on landfilling, structured pathways to shift residual waste to WtE can deliver rapid reductions in greenhouse gas emissions and advance the transition toward a more circular, resource-efficient economy.

[89] EEA/PVNL/2023/044: Annual European Union greenhouse gas inventory 1990–2021 and inventory report 2023. Submissions to the UNFCCC Secretariat. 15. April 2023. At: https://unfccc.int/documents/627851.

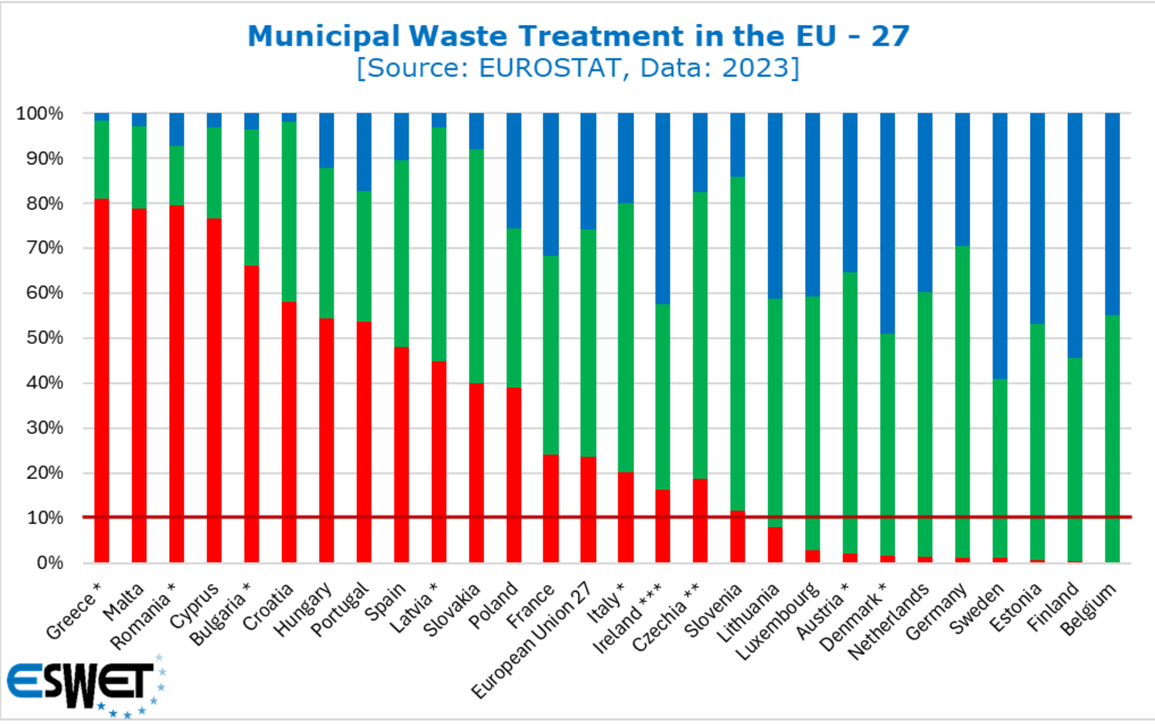


Figure 12. *Share of municipal waste treatment methods in the EU27. Landfilling in red, Recycling in green, WtE in blue. The dark red line shows the 10% landfill target by 2035. Data source: Eurostat (2025) with data from 2023. Graphic source: ESWET.*

The graphic above shows the share of municipal waste treatment methods in the EU27. Many Member States still rely heavily on landfilling, with an average of 23%, (with Greece, Malta, Romania, Cyprus, Bulgaria, Croatia, Hungary, and Portugal exceeding 50%), while recycling rates are at and EU average of 50% and Waste-to-Energy at 26%. There is a clear division at EU level between countries that have already met the EU Landfill target (10% of municipal waste landfilled by 2035), such as Belgium, Denmark, or Sweden, and those that are struggling and are very far from reaching the target, such as Greece, Romania, or Bulgaria.

The graph above also reveals another **important truth**, that is: Waste-to-Energy and recycling are **not** an alternative for each other, *rather they are **complementary***. The countries that have met the landfill target have done so through a combination of Waste-to-Energy and recycling.

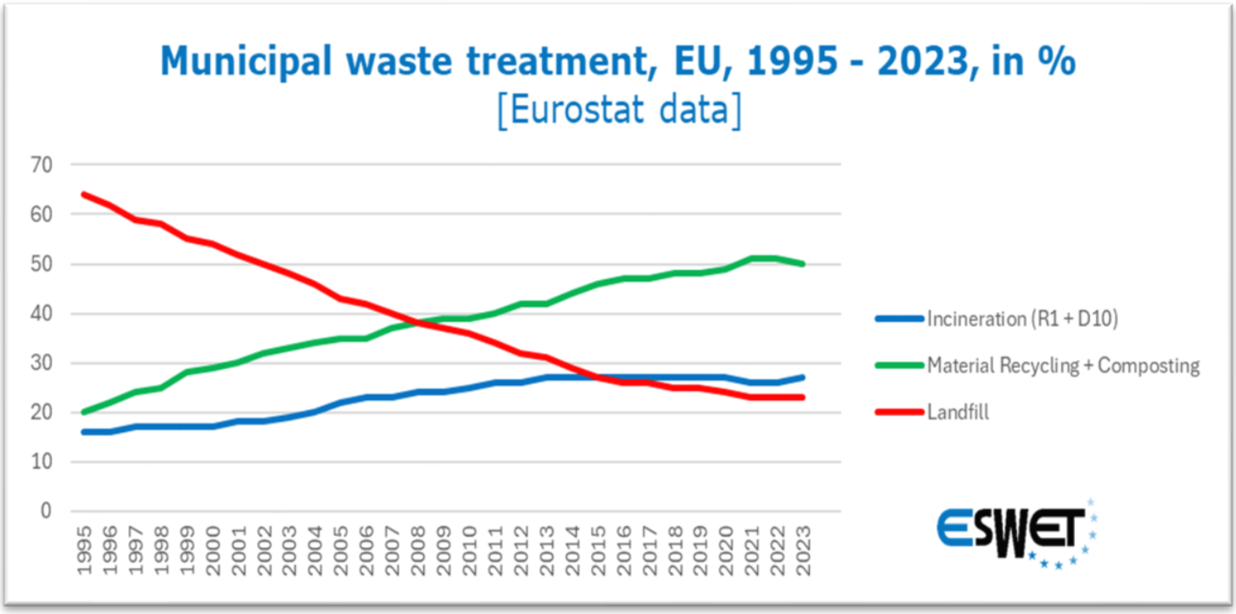


Figure 13. *Trends in Municipal Waste Treatment in the EU (1995–2023). Data source: Eurostat (2025). Graphic source: ESWET.*

Figure 13 above illustrates the long-term shift in municipal waste management across the EU. It shows a clear decline in landfill use, while both material recycling with composting (green line) and WtE (i.e., incineration) (blue line) have increased. The data highlights how recycling and WtE are complementary strategies that work together to reduce landfill dependency, supporting a more sustainable circular economy. Therefore, a broader systemic transition is highlighted, away from the historically dominant reliance on landfill, and toward a multi-tiered approach that combines prevention, recycling, and energy recovery.

This shift supports the objectives of a sustainable circular economy, where the environmental impact of waste is minimised and value is extracted from every stage of the material life cycle.

It is, therefore, evident that if circular economy policies are in place to ensure diversion of waste away from landfills, the EU waste management system will not only avoid CH_4 emissions but also boost the recovery of valuable energy and materials from non-recyclable waste.

The real dichotomy is not between recycling and Waste-to-Energy, but between the latter and landfilling; hence, to support landfill diversion (and thus, greatly reducing the waste management sector emissions) it is essential to support other modes of treatment, including Waste-to-Energy, and introduce further restrictions to landfills that should accept only ultimate waste. Evidence **shows that countries that implemented robust landfill taxes and restrictions, alongside increased WtE and MBT capacity, achieved dramatic reductions**

in landfill-related greenhouse gas emissions over the past decades. For example, NL and DE, both of which introduced strict landfill bans and high landfill taxes, have reduced their landfill methane emissions by more than 80% since the 1990s. In contrast, countries with less stringent landfill policies continue to report much higher emissions from landfilling.

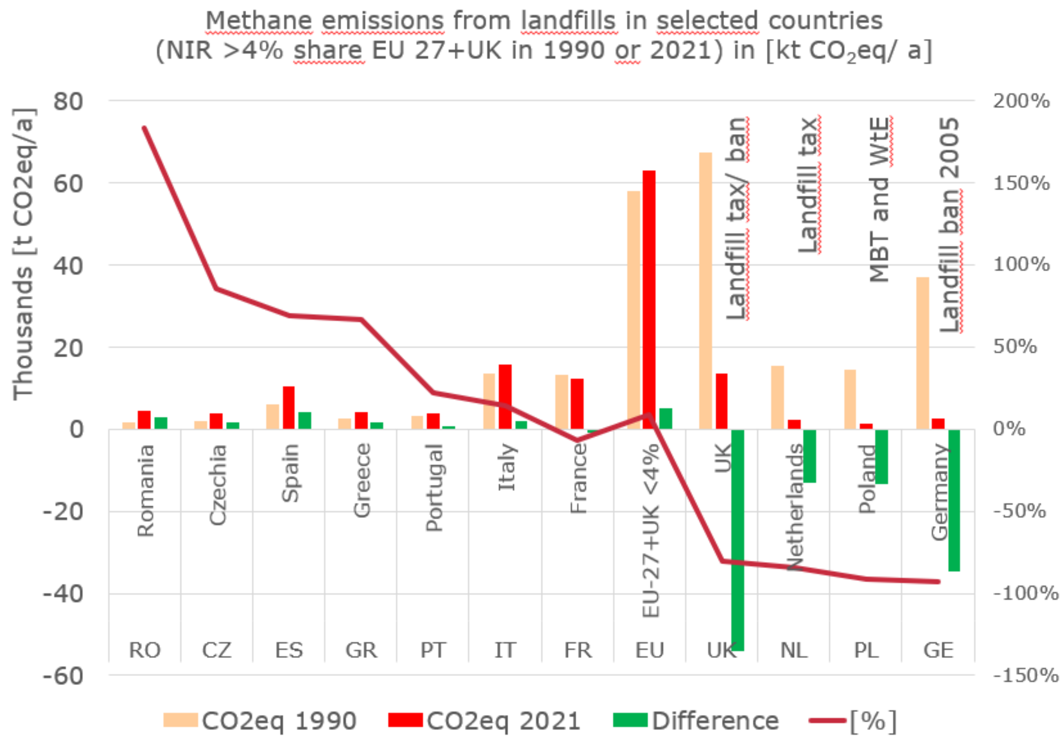


Figure 14. *CH4 emissions from landfills in selected EU countries and UK, 1990 Vs 2021, with policy impact shown. Data source: National Inventory Reports (NIR) with >4% share of EU27+UK total. Graphic source: ESWET.*

The figure above shows the development of methane emissions from landfills (1990–2021) in selected EU countries and the UK. The chart illustrates how countries with higher shares of WtE and supportive measures, such as landfill taxes, restrictions, or alternative treatments (e.g., MBT together with WtE), have achieved greater reductions in landfill methane emissions, while those relying more on landfilling continue to emit at higher levels. Also, despite gas capture systems, emissions from landfills persist due to leakage.

This real-world experience demonstrates that landfill taxes are not just theoretical tools — they are proven, highly effective levers for driving down methane emissions from the waste sector. Without these complementary measures, the inclusion of WtE in the ETS risks simply shifting waste to landfill, resulting in higher overall greenhouse gas emissions due to methane's much greater short-term climate impact.

Looking at the case of Germany more specifically, after it banned landfilling of untreated organic waste in 2005 and expanded WtE infrastructure, methane emissions from landfills plummeted from 35.5 million tonnes in 1990 to just 7.5 million tonnes in 2018. This reduction is reflected in the broader decrease of greenhouse gas emissions from the waste management sector in Germany between 1990 and 2023, as shown in the Eurostat data below.

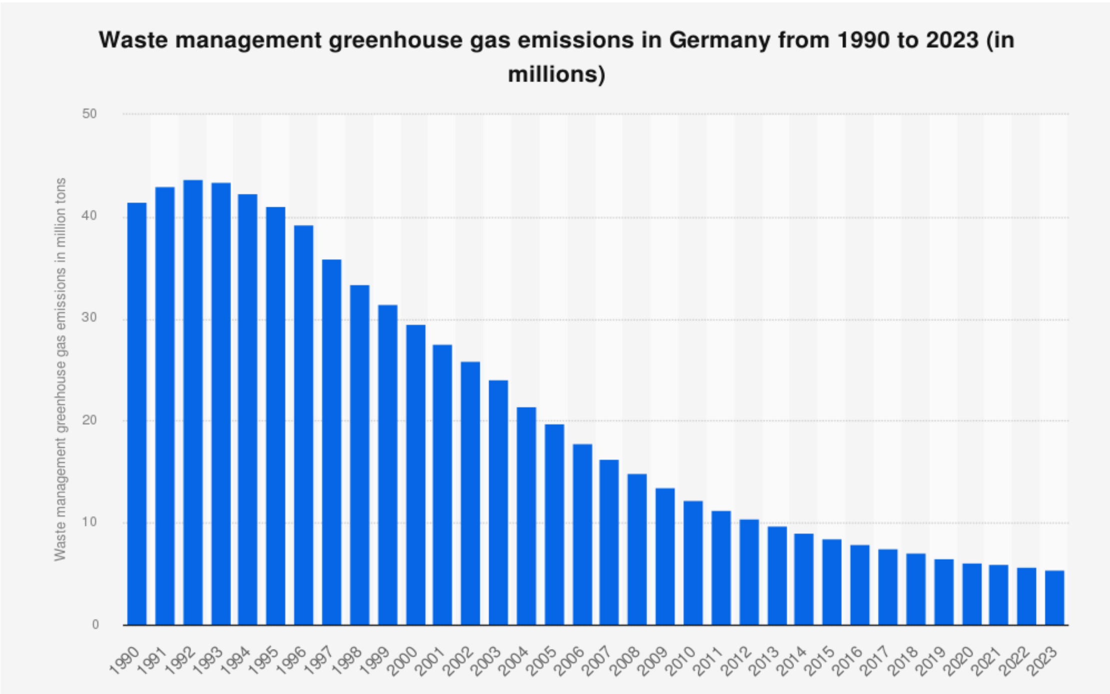


Figure 15. *GHG emissions from the waste management sector in Germany, 1990–2023. Data source: Eurostat. Graphic source: Statista.*

Methane mitigation through landfill diversion is both possible and highly effective. **CE Delft/Prognos[90] estimate a reduction potential of up to 90 Mt CO_{2eq} by 2035** if strict WAC and diversion policies are enforced. And, as mentioned in Section 1.4 above, according to CEWEP, diverting non-recyclable residuals to Waste-to-Energy avoids over **600 kg CO_{2eq} per tonne** on a 100-year GWP basis, with even greater immediate benefits when methane is properly accounted for using GWP20.

Reducing landfilling and ensuring it is correctly regulated is not only critical for achieving the EU's climate neutrality objectives but also for protecting **public health and the environment**. Indeed, risks associated to landfilling extend

[90] CE Delft & Prognos (2022). *CO_2 reduction potential in European waste management.* At: https://cedelft.eu/wp-content/uploads/sites/2/2022/01/CE_Delft_Prognos_CO2_reduction_potential_European_waste_mngt_FINAL.pdf.

beyond GHG emissions. Landfills are major sources of **air, water, and soil pollution**, releasing **methane, volatile organic compounds (VOCs), ammonia, odours, and particulate matter** into surrounding areas. **Leachates** often contain toxic substances — including **PFAS, heavy metals, and persistent organic pollutants** — that threaten water, soil, and human health, particularly in developing regions.

A UK study recently revealed PFAS levels in landfill leachate **260 times above safe limits**[91]. Moreover, microplastics and chemical additives continue to leach for decades after closure, spreading contamination through groundwater and ecosystems. The Am Brenten landfill (Germany), still causing issues 25 years after closure, is a clear example.[92] What is more, the materials buried are lost forever, undermining the goals of a circular economy.

The Landfill BREF (LAN BREF) is currently under development and is intended to provide guidance on Best Available Techniques for landfill management under the Industrial Emissions Directive (IED). However, the document is far from being finalised, and there is significant uncertainty regarding its final content and scope.

At this stage, it is unclear which environmental and operational aspects will be fully addressed. For example, critical topics such as landfill fires, long-term methane emissions, and leachate management under extreme conditions may not be explicitly included. Without clarity on these issues, it is difficult to assess whether the LAN BREF will provide comprehensive guidance for the most significant risks associated with landfills

To address these persistent impacts, the **Circular Economy Act should strengthen landfill regulation** by introducing clear acceptance criteria for biodegradable waste, ensuring proper monitoring of legacy sites, and linking landfill diversion directly to circular economy targets, **while upholding the 10% landfill target by 2035.** Integrating landfill methane pricing and mandatory remediation plans would further align environmental protection with the EU's climate and resource-efficiency objectives.

2.11 Preserving the recovery status of WtE

As part of the upcoming Circular Economy Act, the European Commission has also announced plans to revise the Waste Framework Directive (WFD) to better align it with climate and circularity objectives. In this context, it is essential to safeguard the **recovery status of Waste-to-Energy (WtE)**, whose role is defined under

[91] ENDS Report (2024). ENDS Briefing: The PFAS Files. https://www.endsreport.com/article/1859134/17-landfills-england-producing-toxic-liquid-containing-forever-chemicals-they

[92] Waste-to-Energy Research and Technology Council (WtERT) (n.d.). "Costs of the "Am Brenten" household waste landfill 25 years after the end of operations. https://www.wtert.net/bestpractice/3140/Costs-of-the-Am-Brenten%20household-waste-landfill-25-years-after-the-end-of-operations.html

Article 4 of the WFD[93], which establishes the fundamental principle of the waste management hierarchy, ensuring that WtE remains clearly distinguished from disposal operations such as landfilling.

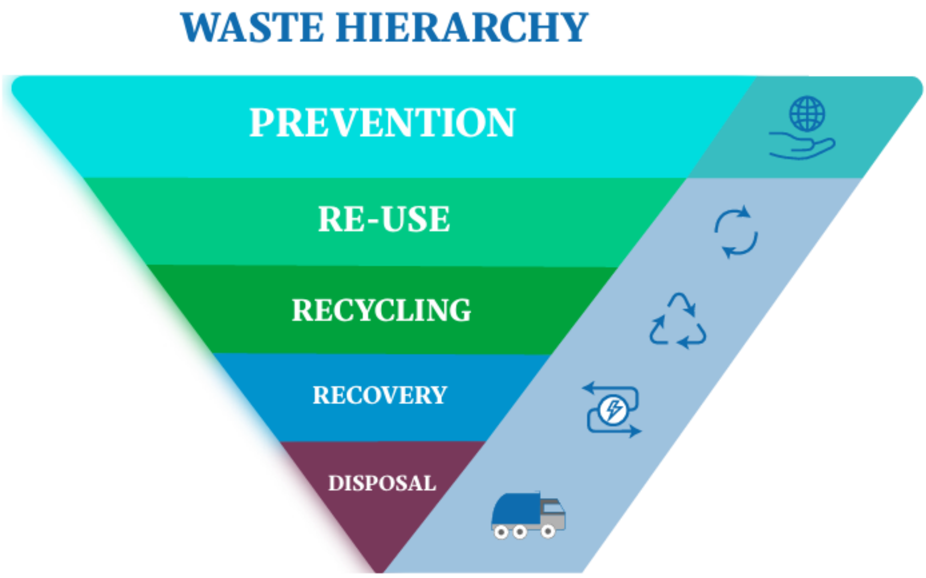


Figure 16. *The Waste Management Hierarchy (in short, Waste Hierarchy) under the EU Waste Framework Directive. Graphic source: ESWET.*

As analysed in the first Section of this position paper, WtE provides a **critical environmental and sanitary service** by managing residual waste that cannot be feasibly recycled, whether due to contamination, composite material content, or material degradation after multiple recycling cycles. By converting this waste into energy, WtE supports energy security, decarbonisation, and pollution prevention, while also recovering valuable SRMs from incineration residues, such as metals and minerals. This positions WtE as an **essential recovery operation** that complements recycling and strengthens Europe's overall resource efficiency and circularity.

Maintaining the recovery status of WtE is not merely a technical classification; it sends a **vital policy signal**. Downgrading WtE or conflating it with landfilling would undermine decades of investment in **clean, modern facilities** operating under the EU's strictest environmental standards. Worse, it could unintentionally lead to a resurgence in landfilling, which carries significantly higher environmental risks.

[93] Directive (EU) 2018/851 of the European Parliament and of the Council amending Directive 2008/98/EC on waste. Official Journal of the European Union, L 150, 109-140. At: https://eur-lex.europa.eu/eli/dir/2018/851/oj/eng

Furthermore, **WtE contributes directly to climate and circularity objectives** by avoiding methane emissions from landfills, substituting fossil fuels in energy systems, district heating, and industry, and enabling future carbon capture and utilisation (CCU) and carbon removals (BECCS). These functions make WtE an indispensable bridge between waste management, renewable energy, and industrial decarbonisation.

It is therefore crucial that the CEA, as well as the follow-up revision of the WFD:

- **Explicitly reaffirm the recovery status of WtE**, maintaining its position above disposal in the hierarchy;
- **Recognise WtE as complementary to recycling**, ensuring that residual waste is treated safely and efficiently in alignment with circular and climate goals; and
- **Encourage Member States to integrate WtE into national circularity strategies** and carbon management frameworks, supporting the use of recovered energy and materials within local and regional value chains.

Preserving the recovery status of WtE guarantees **legal clarity, policy coherence, and environmental integrity**. It prevents backsliding towards landfilling, supports investment certainty, and ensures that Europe continues to manage its residual waste responsibly — within its borders and according to the highest environmental standards.

2.12 Recognising the role of Carbon Capture and Utilisation (CCU) in the Circular Economy

A genuinely circular and climate-neutral economy cannot rely solely on material recycling; it must also close the carbon loop. In this context, Carbon Capture and Utilisation (CCU) represents a critical enabler of circularity by transforming unavoidable CO_2 emissions into valuable raw materials, such as synthetic fuels, chemicals, and construction products.

CCU technologies transform unavoidable CO_2 emissions into valuable resources, enabling carbon to circulate within industrial systems instead of entering the atmosphere.

By 2050, approximately 320 Mt of CO_2 will need to be captured annually in the EU — with 55% of it utilised and the remainder stored. This makes CCU a necessary tool for achieving the EU’s climate-neutrality target. Around 250 Mt of greenhouse gas reductions could come directly from CCU technologies, contributing to over 20% of the technological effort required for climate neutrality.[94]

[94] CO_2 Value Europe (2024). *EU Roadmap for Carbon Capture and Utilisation by 2050.* Brussels. At : https://co2value.eu/wp-content/uploads/2024/01/FINAL-LAYOUT_CVEs-EU-Roadmap-for-CCU-by-2050.pdf

CO_2 can be used as a feedstock in numerous industrial processes and applications, from the production of methanol and urea to synthetic fuels, polymers, and construction materials, with half of the captured CO_2 used to produce fuels, 42% for chemicals, and 8% for mineralisation in building materials.[95] Such substitution of fossil feedstocks with captured CO_2 enables industries — particularly chemicals and energy-intensive sectors — to decouple growth from fossil resource use and create a **carbon circular economy**. In other words, CCU not only mitigates emissions but **creates economic value** by producing marketable products, strengthening the EU's industrial competitiveness.

Despite these benefits, current regulatory frameworks remain fragmented. The EU ETS still treats most CO_2 used in products as "emitted", discouraging investment in CCU processes. Moreover, while CCU fuels are now partially recognised under RED III and ReFuelEU, other pathways — such as CCU chemicals and materials — lack policy incentives. The CEA offers a key opportunity to close this regulatory gap by **explicitly recognising captured carbon as a strategic circular resource** and integrating carbon circularity into product and waste legislation.

Recognising CCU within the Circular Economy Act would align waste management, resource recovery, energy, and industrial decarbonisation policies under a single principle: carbon should be seen as a reusable raw material, not a pollutant to be discarded.

WtE facilities, in particular, are strategically positioned to support this integration: while treating non-recyclable waste, they generate a continuous, concentrated CO_2 stream that can serve as a stable carbon source for industrial processes. By capturing biogenic and fossil CO_2 for reuse in the production of renewable and low-carbon fuels, synthetic materials, and carbonates, WtE plants can turn residual emissions into new value chains and reduce the need for fossil carbon feedstocks.[96]

By supporting CCU alongside recycling and energy recovery, the CEA can help build closed carbon cycles that reduce dependency on imported fossil resources while promoting European innovation and industrial competitiveness. Enabling policies — such as common EU standards for captured CO_2, transparent carbon accounting rules, and incentives for the use of captured carbon in circular products — will be essential to scale up these solutions.

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[95] Frieden, F. (2021). *Carbon Capture and Utilisation – A new building block for Circular Economy? Journal of Business Chemistry*, Vol. 18(3), pp. 80–108. At: https://www.businesschemistry.org/wp-content/uploads/2020/09/202110_ResearchPaper_FriedenFlorian.pdf ; CO_2 Value Europe (2024). *EU Roadmap for Carbon Capture and Utilisation by 2050.* Brussels. At : https://co2value.eu/wp-content/uploads/2024/01/FINAL-LAYOUT_CVEs-EU-Roadmap-for-CCU-by-2050.pdf

[96] However, it must be underlined that not all WtE plants can be equipped with carbon capture technologies, given the space constraints, the absence of equal infrastructure development for transport and storage across Europe, as well as the high costs entailed.

To ensure coherence across EU initiatives, the Circular Economy Act should explicitly acknowledge CCU as a form of resource recovery when the resulting products achieve verified climate benefits. This would align the CEA with the EU's Clean Industrial Deal, the Carbon Management Strategy, and the NZIA, supporting the emergence of a new circular carbon economy in Europe.

2.13 Ensuring the inclusion of WtE in the EU Taxonomy

The EU Taxonomy represents a unique opportunity to guide sustainable investments towards technologies that deliver tangible environmental benefits. WtE stands out among them as a proven, EU-regulated solution that directly supports the circular economy, energy transition, and climate mitigation objectives, as elaborated in the previous section of this paper.

Although these positive and strategic functions are explicitly recognised in EU law and policy, WtE's exclusion from the Taxonomy hinders the mobilisation of sustainable finance for essential circular and decarbonisation investments. This omission also contradicts the Taxonomy's own principle of alignment with EU legislation and the waste hierarchy.

Recognising WtE as a Taxonomy-eligible economic activity would encourage the modernisation and higher efficiency of existing plants, support the integration of CCUS technologies to achieve negative emissions — given that around 60% of WtE's CO_2 emissions are biogenic — promote the recovery of materials and energy from residual waste as part of Europe's resource-security strategy, and enable consistent financing conditions across the waste management, energy, and climate sectors.

The inclusion of WtE and its associated CCUS technologies in the EU Taxonomy — with clear safeguards to respect the waste hierarchy and recycling objectives — **would bring policy coherence, investment certainty, and environmental integrity**. This recognition is vital to ensure that Europe can finance the next generation of sustainable WtE infrastructure, contributing directly to **climate neutrality, circular resource use, and pollution prevention**.

Going into material recovery (from treated IBA) more in detail, a proper recognition under the EU Taxonomy would unlock its potential, by sending a strong market signal, driving innovation and scaling-up of technologies that transform residues into valuable SRMs. Such recognition would also strengthen Europe's strategic autonomy by fostering domestic recovery of raw materials, reducing dependence on imports, and ensuring a more resilient supply chain.

Notably, in the Taxonomy Environmental Delegated Act[97] adopted in June 2023, the Commission acknowledged the potential of IBA recycling and expressed its

[97] European Commission (2023). Communication from the Commission: Establishing the technical screening criteria for determining the conditions under which an economic activity qualifies as contributing substantially to the sustainable use and protection of water and marine resources, to

intention to consider its inclusion in the next revision of the EU Taxonomy, a welcome step that now needs to be followed by concrete action. The upcoming revision represents a crucial opportunity to align Europe's sustainable finance framework with its circular economy and resource efficiency ambitions.

While we welcome the European Commission's commitment in Recital 15 of the Environmental Delegated Act (June 2023) to consider IBA recycling in the next revision of the EU Taxonomy, we stress that further action is urgently needed. The recent joint statement[98] by ESWET, FEAD, CEWEP, FIR, EURIC and Municipal Waste Europe reflects a shared industry concern: this omission continues to hinder investment and market recognition.

2.14 Differentiating fiscal measures in line with the waste hierarchy

In parallel with the EC Call for Evidence for the upcoming CEA, the Commission has opened a public consultation, in which it inquiring about the introduction of taxes or fees on incineration and/or landfilling, as well as the reduction of subsidies that prevent circularity (Question 2 points d and i of the questionnaire), with the aim of improving resource efficiency and circularity. ESWET would like to take the opportunity of this submission to underline a few things.

First of all, it is essential to distinguish between landfilling — a disposal operation at the bottom of the waste hierarchy — and Waste-to-Energy, which performs an essential recovery and pollution-prevention function, as explained throughout this paper.

Evidence from multiple Member States shows that landfill taxes have been an effective policy tool to divert waste upwards in the hierarchy, and their continuation or strengthening is therefore justified. In contrast, fees (such as under an ETS) on WtE have not delivered measurable benefits for recycling or circularity, as highlighted by the 2023 FNADE/FEDENE study[99], and in some cases have led to increased exports of residual waste or greater reliance on landfills. Such measures risk penalising a sector that already operates under stringent environmental and emission-control standards, and that contributes to energy security, carbon reduction, and material recovery.

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the transition to a circular economy, to pollution prevention and control, or to the protection and restoration of biodiversity and ecosystems. COM(2023) 3851 final. At: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=intcom:C%282023%293851

[98] FEAD, FIR, EuRIC, Municipal Waste Europe, CEWEP & ESWET (2025). *Joint statement in support of the Commission's mandate to consider Technical Screening Criteria for the recycling of incineration bottom ashes*. Brussels, 6 March 2025. At: https://fead.be/wp-content/uploads/2025/03/20250306-Joint-statement-IBA-in-handover-note.pdf

[99] Fédération Nationale des Activités de la Dépollution et de l'Environnement (FNADE). (2023). *Étude de l'impact sur l'inclusion des unités de valorisation énergétique des déchets ménagers et assimilés dans le système européen d'échange de quotas d'émission de gaz à effet de serre (EU ETS)*. At: https://www.fnade.org/fr/kiosque-agenda/publications/5109,Etude-sur-l-impact-de-l-inclusion-des-UVE-dans-le-systeme-EU-ETS

Similarly, the idea of phasing out subsidies for "incineration and landfilling" must be reconsidered. WtE should not be treated as a non-circular activity: when properly integrated into circular value chains and combined with heat recovery, SRM recovery, or CCU, it contributes directly to the EU's decarbonisation and resource-efficiency objectives. Subsidies or support mechanisms that facilitate investment in state-of-the-art WtE infrastructure, material and energy recovery, carbon capture, and related innovations should therefore be maintained, for instance in the NZIA and the CISAF, and also strengthened, as is the case with the EU Taxonomy for Sustainable Activities.

A one-size-fits-all approach to fiscal measures risks undermining the very objectives of the Circular Economy Act. Instead, a differentiated policy framework is needed — one that continues to apply economic disincentives to landfilling, while supporting the recovery role of WtE as an indispensable part of Europe's integrated circular economy model.

2.15 Aligning EU legislation to strengthen material recovery from waste

The upcoming revision of the Waste Framework Directive (WFD), alongside the implementation of the Critical Raw Materials Act, the ambitions outlined in the EU Steel and Metals Action Plan and the anticipated developments under the future CEA, all under the Clean Industrial Deal umbrella, present a timely opportunity to reinforce the recovery of critical and strategic raw materials from residual waste.

To fully unlock this potential, ESWET encourages policymakers to ensure that the revised WFD acknowledges the value of mineral recovery from IBA and supports its integration into national waste and raw materials strategies. Furthermore, as the new CEA takes shape, there is a clear opportunity to better align circularity targets with CRM supply objectives, especially by promoting innovative, high-efficiency recovery technologies. In parallel, the EU Steel and Metals Action Plan should explicitly consider secondary sources like metals out of treated IBA as part of the solution to reduce Europe's dependence on primary extraction.

In addition, it is worth mentioning that the Net Zero Industry Act (NZIA)[100] adopted in 2024 already recognises several WtE-linked technologies - such as CCS, CCU, heat recovery, sustainable biomethane, and alternative fuels - as contributing to its 40% domestic clean-tech manufacturing target. However, material recovery technologies, particularly those related to IBA and fly ash, even though they play a vital role in supporting the EU's clean-tech value chains, are currently not listed among NZIA's core objectives. Despite that, material recovery technologies fall

[100] European Parliament and Council of the European Union. (2024). *Regulation (EU) 2024/1735 of the European Parliament and of the Council of 13 June 2024 on establishing a framework of measures for strengthening Europe's net-zero technology manufacturing ecosystem and amending Regulation (EU) 2018/1724*. Official Journal of the European Union, L 1735, 28 June 2024. At: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02024R1735-20240628

within the scope of the Clean Industrial Deal State Aid Framework (CISAF)[101]. These technologies strengthen EU industrial resilience and security of supply, therefore, Section 6 of the draft CISAF seems to explicitly cover WtE-related manufacturing activities, including material recovery technologies, as eligible for state aid.

Moreover, as previously mentioned in this position paper, the role of WtE in clean-tech manufacturing and resource efficiency should also be recognised in the EU Taxonomy, specifically when it comes to (treated) IBA recovery.

To deliver a coherent and efficient circular economy framework, further systemic action is required. Establishing harmonised EoW and by-product criteria across the EU is critical to facilitate the movement of SRMs and reduce legal fragmentation. The creation of a genuine single market for waste and secondary materials must be a priority to overcome current cross-border barriers and unlock new industrial opportunities.

Preserving the recovery status of WtE is equally important to maintain its role in safely managing non-recyclable waste while recovering energy and materials, rather than being unfairly equated with landfilling. At the same time, Europe must ensure a level playing field between virgin and SRMs, internalising the environmental costs of primary resource extraction while boosting the competitiveness of recyclates. Expanding recycled content targets beyond plastics is also crucial to drive demand for SRMs in sectors such as metals, textiles, and construction materials, supporting a resilient EU circular economy.

Given the complex regulatory landscape, it is evident that a coherent, cross-sectoral policy approach is essential to foster investment, remove regulatory barriers, and recognise the full spectrum of the contribution of WtE technologies to decarbonisation, circularity, and EU strategic autonomy.

Finally, clear and practical guidance is needed on how such cooperation can be structured in compliance with competition law. ESWET welcomes continued dialogue with the European Commission on these matters and remains committed to contributing constructively to the next stages of the circular economy agenda.

2.16 Advanced thermal processes are part of the Circular Economy

Advanced thermal processes — such as gasification, pyrolysis, and plasma conversion — represent a new generation of circular technologies capable of transforming specific waste streams into high-value carbon and energy carriers. By converting non-recyclable residues, biomass, and other complex waste streams into synthesis gas (syngas) and secondary raw materials, these processes enable

[101] European Commission. (2025). *Communication from the Commission: Framework for State Aid measures to support the Clean Industrial Deal*. Official Journal of the European Union, C/2025/3602, 4 July 2025. At: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:C_202503602

both material and carbon circularity, aligning closely with the objectives of the CEA.

In a circular economy, materials and energy are kept in use for as long as possible. Gasification and related thermochemical processes support this principle by returning the carbon content of waste to productive use. Syngas can be upgraded into hydrogen, methanol, ammonia, or other platform chemicals, serving as low-carbon feedstock for industrial and energy applications.[102] When integrated with CCU systems[103], these technologies create opportunities to reuse CO_2 in the production of fuels, chemicals, and construction materials — effectively closing the carbon loop and contributing to defossilisation of key value chains.

Beyond carbon recycling, advanced thermal technologies support the valorisation of secondary materials. Solid residues such as slag, vitrified ash, or char can be used in the construction sector, improving material efficiency and reducing the need for virgin aggregates and clinker. In doing so, these processes promote industrial symbiosis by linking waste management, energy, and manufacturing sectors in mutually reinforcing circular loops.

Gasification and other advanced conversion routes also enable resource recovery from heterogeneous or contaminated waste streams, such as composite plastics, textiles, or organic residues that cannot be treated through mechanical recycling. This flexibility allows for maximum resource utilisation across different material types while minimising pollution risks and dependency on primary raw materials.

By embedding these advanced technologies in the Circular Economy Act, Europe can create a framework that turns residual waste into a domestic source of renewable carbon and materials, supporting climate neutrality, resource resilience, and industrial innovation.

[102] Vinayak, A. K., Ashokan, H., Sinha, S., et al. (2024). *Role of biomass gasification in achieving circular economy. Recent Innovations in Chemical Engineering*, 17(3), 170–189. DOI: 10.2174/0124055204319671240515060552 ; Ungureanu, N., Vlădut, N.-V., Biriş, S.-Ș., et al. (2025). *Municipal solid waste gasification: Technologies, process parameters, and sustainable valorization of by-products in a circular economy*. *Sustainability*, 17(6704). At: https://doi.org/10.3390/su17156704

[103] Lyons, B., Bernardi, A., & Chachuat, B. (2025). *Waste-to-X: Quantifying the enviro-economic performance of chemical production via municipal solid waste gasification. Sustainable Production and Consumption, 57 (167-182).* At: https://doi.org/10.1016/j.spc.2025.05.004

Section 3: ESWET policy recommendations

Pursuant to the analysis above, ESWET calls for the following:

Policy Recommendations

1. Reduce plastic production to tackle the plastic pollution problem at the source.
2. Maintain the recovery status of Waste-to-Energy in EU legislation and acknowledge its role in the circular economy, particularly in supplying partly renewable energy and secondary raw materials (SRMs) (metals and minerals).
3. Recognise minerals recovered from (treated) IBA as recycling, and similarly recognise metals and minerals from fly ash, too.
4. Provide regulatory clarity and financial support to promote the deployment of advanced IBA treatment technologies.
5. Harmonise the end-of-waste (EoW) status for treated IBA at the EU level to enable its use as a SRM and construction aggregate.
6. Expand recycled content targets beyond plastics to include metals, and construction materials.
7. Ensure strong rules and effective implementation governing waste shipments, to guarantee that waste is managed within the EU according to high environmental and circular economy standards.
8. Ensure policy coherence between CRM-related legislation, the Waste Framework Directive, the Net Zero Industry Act, the CISAF, the Steel and Metals Action Plan, and the upcoming Circular Economy Act.
9. Create a true Single Market for SRMs and waste-derived products , supported by market incentives such as reduced VAT for recycled materials and taxes on primary raw materials, to facilitate circularity and strengthen Europe’s resource security.
10. Promote public-private partnerships to support innovation and scale-up of high-efficiency IBA recovery technologies.
11. Include IBA treatment and recovery in the EU Taxonomy, as referenced by the European Commission in June 2023.[104]
12. Adopt a unified LCA-based carbon accounting system that credits recycling, recovery, and landfill diversion for their true climate benefits.

[104] In Recital 15, on p. 14 of the Environmental Delegated Act, the Commission highlighted the intention to consider the recycling of Incinerator Bottom Ash (IBA) in the next revision of the EU Taxonomy.

13. Recognise CCU as a circular solution within the CEA, establishing criteria for the environmental performance and traceability of carbon-derived products.
14. Ensure alignment between the CEA, the EU Carbon Management Strategy, and all relevant EU legislation, to promote the integration of carbon capture into circular value chains.
15. Recognise advanced thermal processes — such as gasification — as recovery operations when producing usable energy or fuels, and as recycling operations when generating secondary raw materials (e.g., polymers), wherever appropriate and technically justified.

Finally, ensure policies are in place to effectively divert waste from landfills towards higher levels of the waste hierarchy, prioritising prevention, reuse, and recycling, and for non-recyclable waste, waste incineration with energy recovery.

A truly circular economy recognises that all waste holds potential value. By transforming non-recyclable waste into energy and recovering valuable materials, Waste-to-Energy exemplifies Europe's commitment to viewing waste as a resource, thereby advancing a climate-resilient and resource-efficient future.

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