



EUROPEAN SUPPLIERS OF WASTE-TO-ENERGY TECHNOLOGY

ESWET Response to EU Commission Consultation on the Climate Delegated Act and Environmental Delegated Act of the EU Taxonomy

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Response to EC Consultation on the Climate Delegated Act and Environmental Delegated Act of the EU Taxonomy

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.

We appreciate the opportunity to contribute to the European Commission consultation on the Climate Delegated Act and Environmental Delegated Act of the EU Taxonomy. We welcome the Commission's efforts to simplify and clarify the technical screening criteria for several economic activities and would like to take this opportunity to draw attention to an important issue that remains unaddressed: the absence of WtE from the EU Taxonomy. This omission has persisted despite a long-standing demand from stakeholders and growing recognition of WtE's essential role in treating non-recyclable waste, securing energy and secondary materials, supporting landfill diversion, reducing methane emissions, and contributing to Europe's climate and circular-economy objectives.

We note that this discussion is not new. In June 2023, when adopting the Environmental Delegated Act with the support of the Platform on Sustainable Finance, the Commission explicitly acknowledged - in recital 15 on page 14¹ - its intention to consider the recycling of Incinerator Bottom Ash (IBA) in the next revision of the EU Taxonomy. This acknowledgement confirms that the sector is relevant to the Taxonomy framework, even if not yet fully reflected in it.

In addition, the latest report² of the Platform on Sustainable Finance invited stakeholders to identify new activities for inclusion in the Taxonomy. Numerous submissions requested the inclusion of WtE. While the report acknowledges these requests, it ultimately made no recommendation on WtE and offered no explanation for its omission. This lack of clarity on whether WtE-related activities are Taxonomy-aligned remains a concern for the sector, and becomes even more

¹ European Commission (2023), Commission Delegated Regulation (EU) 2023/2486 supplementing Regulation (EU) 2020/852, available at: https://eur-lex.europa.eu/eli/reg_del/2023/2486/oj/eng?.

² Platform on Sustainable Finance (2025), *Advancing Sustainable Finance: Technical Screening Criteria for New Activities and First Review of the Climate Delegated Act*, available at: [Platform on Sustainable Finance report - Advancing sustainable finance: Technical criteria for new activities & first review of the Climate Delegated Act](#). Response to the EC Consultation on the Climate and Environmental DAs of the EU Taxonomy

problematic when considering the integration of Carbon Capture for Utilisation or Storage (CCUS) in WtE plants.

For these reasons, we believe it is necessary to reopen the discussion on the inclusion of WtE in the EU Taxonomy.

Key contributions of WtE to the EU's sustainability goals include:

- Ensuring high-quality recycling: WtE prevents contamination of recyclable material streams by safely treating residual waste and rejects from sorting and recycling processes.
- Recovering valuable materials: WtE facilities extract metals and secondary aggregates from bottom ash, contributing to material recovery supporting the circular economy.
- Providing secure, local energy supply: WtE contributes to energy security and grid stability by producing renewable and low-carbon energy, including electricity, heat, and steam for district heating networks and industrial processes.
- Safe treatment of hazardous substances: WtE ensures the controlled destruction of toxic and hazardous substances, preventing their uncontrolled release into the environment. Recent studies even prove that WtE is highly efficient in treating PFAs in waste too.
- Reducing methane emissions: Landfills remain the largest source of methane emissions from the waste sector in the EU. WtE is an essential tool in achieving landfill diversion targets, directly preventing methane emissions and aligning with EU methane reduction policies.

The exclusion of WtE from the EU Taxonomy creates a regulatory inconsistency. While WtE is explicitly recognised as a crucial technology for meeting EU waste management and energy objectives (e.g., in the Landfill Directive, the Waste Framework Directive, the Renewable Energy Directive, and the Energy Efficiency Directive, among others), it remains absent from the Taxonomy. WtE is not competing with recycling but complements it, ensuring that materials which cannot be recycled are treated in an environmentally sound manner. This is consistent with the EU's waste hierarchy and is fully aligned with the principles of the circular economy.

To ensure a coherent and science-based approach, we urge the Platform on Sustainable Finance to open a dedicated discussion on the inclusion of Waste-to-Energy as a standalone economic activity within the EU Taxonomy.

To ensure the Taxonomy remains a credible tool for supporting sustainable finance, we call on the European Commission to:

- a) provide a transparent explanation for the non-inclusion of WtE despite its presence in the Stakeholder Request Mechanism report of 2025;
- b) include WtE as a recognised economic activity within the Taxonomy;

C) revise the classification of carbon capture (CC) on WtE plants to acknowledge its role in reducing emissions in a hard-to-abate sector and achieving EU climate targets.

The EU’s climate and waste management ambitions cannot be met without a coherent and inclusive approach to sustainable waste treatment and emissions mitigation.

Given these considerations, the following sections outline why Waste-to-Energy meets the criteria for both the Climate Delegated Act and the Environmental Delegated Act, and why its inclusion in the EU Taxonomy is fully justified from a technical, environmental, and policy perspective.

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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.³ Since the waste treated in WtE plants is mixed, with a majority of biogenic (biomass) content, over 50% of the energy produced is considered renewable⁴. According to the IPCC guidelines⁵, biogenic CO₂ 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 secondary raw materials (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 Role of Waste-to-Energy in Circular Economy

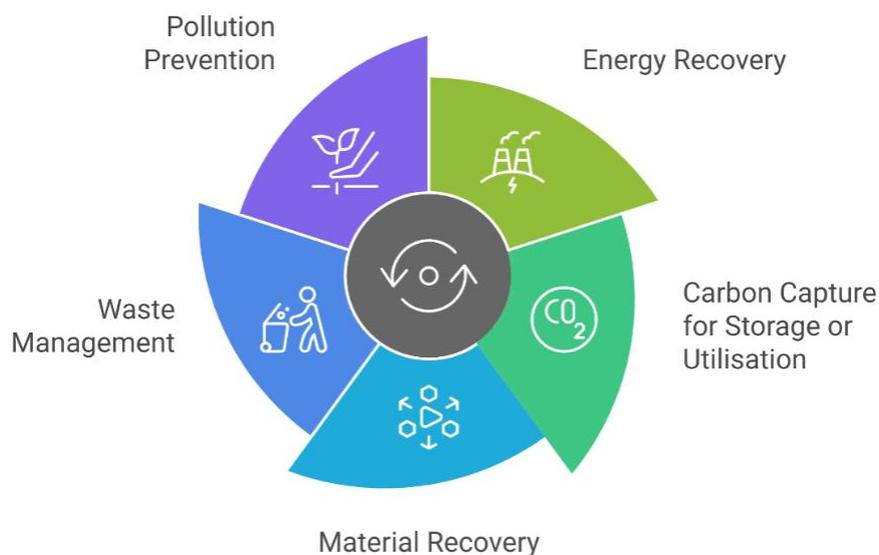


Figure 1. The role of Waste-to-Energy (WtE) in the circular economy, supporting pollution prevention, waste management, material recovery, and energy recovery to close resource loops. Image source: ESWET.

³ 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>

⁴ 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 ¹⁴C analysis of CO₂ 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]

⁵ Intergovernmental Panel on Climate Change (IPCC) (2006). *Guidelines for National Greenhouse Gas Inventories*. Geneva: IPCC. <https://www.ipcc-nggip.iges.or.jp/public/2006gl/>
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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 CO₂ 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.

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.

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 CO₂ for reuse in industrial applications.

This role in the circular economy was already acknowledged by the European Commission in 2017 in a Communication⁶ and by the European Economic and Social Committee (EESC) in its Opinion⁷ 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.

⁶ 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>

⁷ 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>

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It is also worth noting that in July 2025, in the draft Implementing Regulation⁸ 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.**

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".⁹ 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 - even though its role spans landfill diversion, pollution prevention, renewable and local energy generation, material recovery, and an increasing potential for carbon capture. Taken together, these pillars make WtE one of Europe's most comprehensive tools for achieving both circularity and climate neutrality.

2. WtE is an essential climate mitigation pillar today

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 1990¹⁰. 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 CEWEP¹¹, the diversion of non-recyclable waste from landfills to WtE results in **avoiding the emission of more than 600 kg of CO₂ 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 greenhouse gas (GHG) emissions, at an estimated 360 kg of CO₂ equivalent per tonne of waste treated**, while for **material recovery, the**

⁸ 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](https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=intcom:Ares(2025)5155732)

⁹ 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

¹⁰ European Environment Agency (2024). *Historical and projected greenhouse-gas emissions*. At: <https://www.eea.europa.eu/en/analysis/maps-and-charts/historical-and-projected-greenhouse-gas?activeTab=570bee2d-1316-48cf-adde-4b640f92119b>

¹¹ Confederation of European Waste-to-Energy Plants (CEWEP) (2022). *Waste-to-Energy Climate Roadmap Technical Annex (TA) main assumptions & methodology.*, Düsseldorf: CEWEP. Response to the EC Consultation on the Climate and Environmental DAs of the EU Taxonomy

abated emissions are 60 kg CO₂ equivalent per tonne of waste treated. Overall, WtE plants generate emissions of about 400-450 kg of fossil CO₂ 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 CO₂ emissions with avoided emissions amounting to more than 1000 kg CO₂ per tonne of waste treated.**

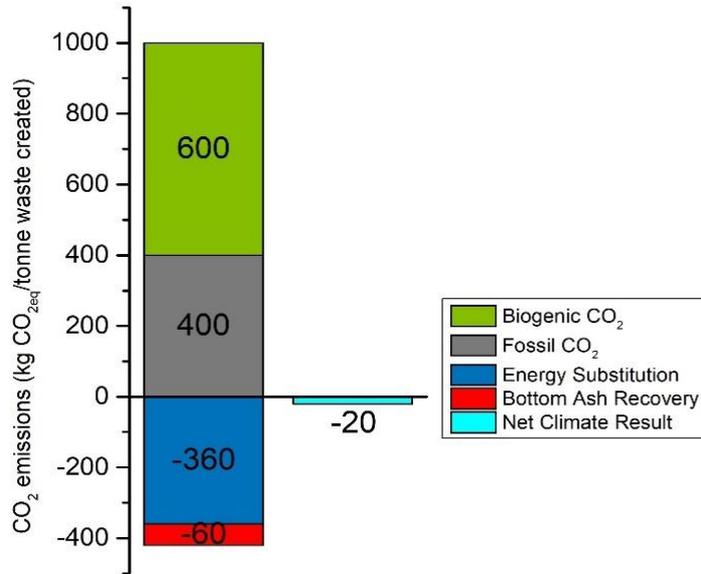


Figure 2. Net climate effect of treating one tonne of residual waste via Waste-to-Energy (WtE). Data source: CEWEP Climate Roadmap, 2022. Graphic source: ESWET.

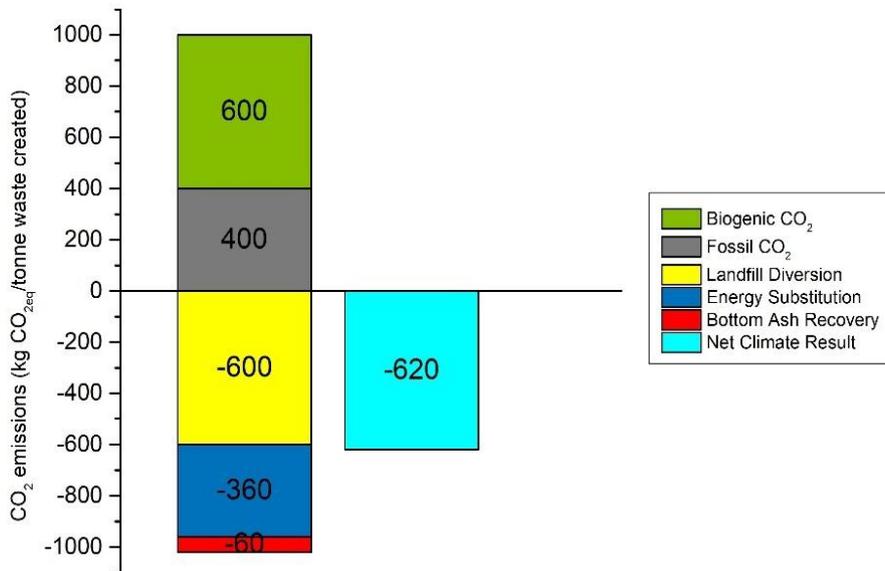


Figure 3. Net climate effect of treating one tonne of residual waste via WtE, taking into consideration also landfill diversion. Data source: CEWEP Climate Roadmap, 2022. Graphic source: ESWET.

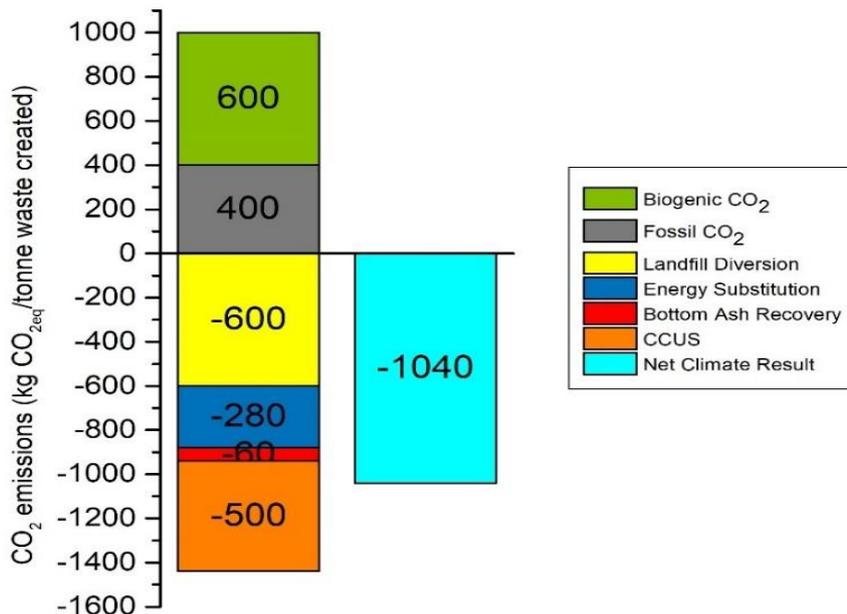


Figure 4. Net climate effect of treating one tonne of residual waste via WtE, taking into consideration also landfill diversion and CCUS. Data source: CEWEP Climate Roadmap, 2022. Graphic source: ESWET.

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 2) (Baseline – electricity-only WtE):** When only electricity is recovered, WtE delivers a marginal climate benefit of **-20 kg CO₂eq/tonne**, as fossil CO₂ emissions are only partially offset by energy substitution and bottom ash recovery.
2. **Graph 2 (Figure 3) (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 CO₂eq/tonne**.
3. **Graph 3 (Figure 4) (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 CO₂eq/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 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"**.¹²

According to the European Environment Agency's annual GHG inventories¹³, fossil CO₂ 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.¹⁴

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.

Additionally, bottom ash and fly ash offers promising potential for CO₂ 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 CO₂ - permanently capturing it - to form stable calcium carbonate

¹² 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

¹³ European Environmental Agency Data viewer on greenhouse gas emissions and removals, sent by countries to UNFCCC and the EU Greenhouse Gas Monitoring Mechanism. At: <https://www.eea.europa.eu/en/analysis/maps-and-charts/greenhouse-gases-viewer-data-viewers>

¹⁴ Confederation of European Waste-to-Energy Plants (CEWEP) (2022). *Waste-to-energy Climate Roadmap: The path to carbon negative*. Düsseldorf: CEWEP. <https://www.cewep.eu/wp-content/uploads/2022/06/CEWEP-WtE-Climate-Roadmap-2022.pdf.pdf>

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(CaCO₃). This process can capture around 30 to 65 kg of CO₂ per tonne of ash, contributing further to the sector's carbon mitigation potential.¹⁵

3. Cost-effectiveness is key for an affordable and fair transition

Achieving the EU's 2030–2040 climate milestones requires cutting the most emissions, fastest, with the finite public and private capital available. Cost-effectiveness is therefore not just an accounting preference; it is the organising principle for credible, scalable decarbonisation. By prioritising measures with the lowest cost per tonne of CO_{2eq} abated or removed - while considering system benefits and near-term warming impacts - the EU can deliver more climate impact for every euro spent, accelerate deployment timelines, and safeguard social acceptance by keeping consumer and taxpayer costs in check.

A cost-effective pathway looks beyond simple capital expenditure (CAPEX) to total system costs over time. It weighs durable abatement and removals against short-lived gains, accounts for integration costs, values dispatchability and reliability, and recognises avoided emissions, and co-benefits. It also minimises the risk of stranded assets by steering investment toward solutions that are compatible with net-zero end states and can scale within this decade.

A fair comparison on cost-effectiveness asks: how many tonnes of CO_{2eq} are avoided per euro spent, when those tonnes are avoided, and what system services are delivered alongside the abatement. For residual, non-recyclable waste, WtE performs strongly because it eliminates landfill methane formation, displaces fossil electricity and heat, and recovers materials - while fulfilling a mandatory public service.

WtE is a cost-effective decarbonisation solution because it delivers simultaneous climate, energy, and economic benefits at scale, generating stable revenue streams while avoiding high-cost emissions from landfilling and reducing system-wide decarbonisation costs. In practice:

- **Stable revenue streams offset net costs:** The net costs are offset by steady revenues from firm electricity and high-value heat for district networks and industry (revenues €84/MWh electricity¹⁶ and €56/MWh

¹⁵ Costa, G., Baciocchi, R., Poletti, A., et al. (2007). Current status and perspectives of accelerated carbonation processes on municipal waste combustion residues. *Environmental Monitoring and Assessment*, 135, 55-75. <https://link.springer.com/article/10.1007/s10661-007-9704-4>.

¹⁶ Year-to-date (up to 19 Aug 2025) price for electricity (unweighted average of spot price (year-to-date) for EU countries with WtE activity): €84/MWh for European countries with WtE Activity. Data from: Greek Regulatory Authority for Energy, Waste and Water (RAAEY) (2025, 19 August). Day-ahead Market Electricity Price Map of Europe. RAAEY. <https://www.raaey.gr/energeia/en/market-monitoring/european-wholesale-markets/day-ahead-electricity-price-map/>

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heat¹⁷), plus metals recovery (€200/t of scrap iron, €2,925/t of aluminium¹⁸, €20/t of bottom ash used in construction¹⁹). It is estimated that the revenues from energy recovery are €84/t of MSW²⁰ and that the revenues from metal recovery €15.3/t of MSW²¹, resulting in a total economic benefit of around €99/t of MSW.

- **High availability reduces unit costs:** Plants run at high availability with 85% capacity factor, spreading fixed costs over large throughputs²².
- **Avoided emissions deliver substantial economic value:** WtE avoids methane (CH₄) formation entirely for the portion of waste diverted. The avoided CH₄ emissions from landfills are significant and, on the basis of conservative estimates, they are estimated at 0.05 t/t of municipal solid waste (MSW) disposed of²³, while ammonia (NH₃) emissions are estimated at 0.0073 of CH₄ emissions, or 0.365 kg/t of MSW²⁴.

The average capture rate is 31%²⁵. Displacement of fossil fuel boiler heat and marginal grid electricity generation further contribute to avoided emissions, with savings of 215 kg CO_{2eq} per MWh_{th} and 415 kg CO_{2eq} per MWh_e, respectively. Additionally, recovering ferrous and non-ferrous metals from IBA in WtE plants is estimated to save around 60 kg CO_{2eq} per tonne

¹⁷ District heat prices vary considerably: Finland: €73/MWh ; Poland: €16-17.5/MWh. Estonia : €60/MWh, Denmark: €95/MWh (weighted average), Italy: 62-70/MWh, Lithuania: €31/MWh, France : €70/MWh, Sweden: €85/MWh (weighted average), Netherlands: €98/MWh (weighted average), Germany: €91/MWh (weighted average). Data from: Fernández, M., Bacquet, A., Bensadi, S., Morisot, P. & Oger, A. (2021). *Integrating renewable and waste heat and cold sources into district heating and cooling systems*. Luxembourg : Publications Office of the European Union. A price of €83.5/MWh for a case study in a European context was adopted for a case study by a manufacturer. On the basis of the above, a value of €80/MWh for DH is adopted by ESWET. 30% of the cost refers to distribution (Source: ESWET Members).

¹⁸ Scrap iron price is €200/t, aluminium price is €2,925/t. Scrap content in iron is assumed 85% Data from: ESWET Members; Allegrini, E., Vadenbo, C., Boldrin, A. & Astrup, T. F. (2015). Life cycle assessment of resource recovery from municipal solid waste incineration bottom ash. *Journal of Environmental Management*, 151, 132-143.

¹⁹ Massarutto, A. (2015). *Economic aspects of thermal treatment of solid waste in a sustainable WM system*. Udine: University of Udine.

²⁰ CEWEP (2022) gives values for a representative European plant concerning net exports of energy: 0.40 MWh_e/t, 0.90 MWh_{th}/t. Data from : Confederation of European Waste-to-Energy Plants (CEWEP) (2022). *Climate Roadmap 2022*. Technical Annex. Brussels: CEWEP.

²¹ Data from the Waste Incineration Best Available Techniques Reference Document (2019) BREF show an average of 6% of the IBA mass recovered as ferrous metals and 1.5% as non-ferrous metals. These figures are used for the calculations. If recovery of more precious metals is considered, the revenues can be much higher. Data from: Neuwahl, F., Cusano, G., Benavides, J. G., Holbrook, S. & Roudier, S. (2019). *Best Available Techniques (BAT) Reference Document for Waste Incineration*. Seville: Joint Research Center.

²² Massarutto, A. (2015). *Economic aspects of thermal treatment of solid waste in a sustainable WM system*. Udine : University of Udine.

²³ Themelis, N. J. & Bourtsalas, A. C. (2021). Methane Generation and Capture of U.S. Landfills. *Journal of Environmental Science and Engineering A*, 10, 199-206.

²⁴ Roe, S. M., Spivey, M. D., Lindquist, K. B., Strait, R. P. & E. H. Pechlan & Associates, Inc. (2004). *Estimating ammonia emissions from anthropogenic nonagricultural sources* – Draft final Report. Washington, DC : (US) EPA.

²⁵ Melliou, Ch., Scholz, S., Fakra, V. & Poretti, F. (2025). *Studies on Methane emissions from Landfills in Europe*. Brussels: ESWET/Kanadevia Inova.

of waste treated. Given the shadow prices for CH₄, CO₂ and NH₃ at €4,680/t, €130/t, and €25,200/t²⁶, respectively, and considering that WtE should already be considered carbon neutral even without CCUS implementation, the opportunity cost is estimated at €258 per tonne (€168 per tonne is associated with landfill diversion).

- **High technological readiness lowers transition and financing risks:** WtE is a mature, replicable technology that can be deployed on municipal timescales, unlike solutions requiring extensive grid upgrades. This reduces time-to-tonne and financing risk, improving effective cost per tonne in the 2030–2040 window.

How it compares with other major decarbonisation areas

- Versus landfill gas capture: Even when considering higher capture rates (50%), the opportunity cost that is avoided through landfill diversion and relates to the CH₄ emissions is €117/t of MSW. Considering the net savings that are associated with greenhouse gas (GHG) emissions, they are estimated at €199/t of MSW at 31% landfill gas capture rate and at €155/t of MSW at 50% landfill capture rate.
- Versus grid decarbonisation alone: Renewable energy systems (RES) are the backbone of power decarbonisation. An advantage that WtE offers over usual renewable energy technologies, particularly wind energy systems and solar photovoltaic systems, is the higher capacity factor (CF), compared to the average CFs of the RES²⁷. The use of feedstocks available throughout the year can lead to very high CFs, 85% or greater.

If policy design supports these advantages, WtE delivers some of the most cost-effective decarbonisation solutions today and a pragmatic, near-term scale-up of engineered removals this decade.

4. Contribution to the supply of critical and non-critical raw materials

Critical Raw Materials (CRMs) are essential for Europe's green and digital transition, powering technologies including electric vehicles, batteries, renewable energy systems, high-voltage cables, semiconductors, and data infrastructure. Because many CRMs are imported from geopolitically unstable regions,

²⁶ de Vries, J., de Bruyn, S., Boerdijk, S., Juijn, D., Bijleveld, M., van der Giesen, C., Korteland, M., Odenhoven, N., van Santen, W. & Pápai, S. (2025). *Environmental Prices Handbook 2024: EU27 version*. Delft: CE Delft.

²⁷ Global weighted average CFs for different technologies : Biomass 68%, geothermal 77%, hydropower 45%, solar photovoltaics (PV) 17%, solar concentrated solar power (CSP) 80%, onshore and offshore wind 39%. Data from: International Renewable Energy Agency (IRENA) (2022). *Renewable power generation costs in 2021*. Abu Dhabi: IRENA.

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strengthening domestic sources has become a strategic priority under the EU CRMA. Waste-to-Energy contributes directly to this objective: **Incineration Bottom Ash (IBA) contains significant quantities of both CRM (e.g., aluminum and copper) and non-CRM yet strategic metals, which can be recovered through advanced treatment processes.** This makes IBA one of Europe's most accessible and underexploited secondary CRM sources. In recognition of this opportunity, as previously written, in July 2025, the Commission explicitly recognised IBA from waste incineration as a waste stream with a **high CRM recovery potential** in its draft Implementing Regulation under Article 26 of the CRMA.

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 5).

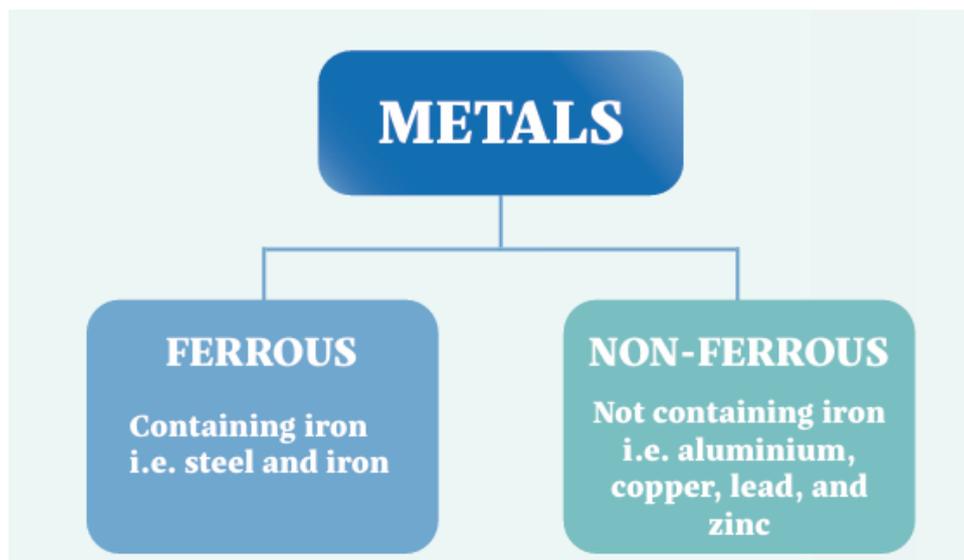


Figure 5. Classification of metals into ferrous and non-ferrous. Source: ESWET.²⁸

Minerals from IBA can substitute primary aggregates in construction²⁹ applications such as road foundations³⁰, concrete products, and engineered fill. Using these secondary minerals reduces pressure on virgin extraction, lowers lifecycle emissions, and supports circular construction. Despite these clear environmental

²⁸ ESWET. (2023). *Integrated Resources Recovery Facility*. At: <https://eswet.eu/documents/recovering-the-non-recyclable-the-integrated-resource-recovery-facility/>.

²⁹ 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>

³⁰ 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?>

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and economic benefits, the utilisation of the mineral fraction of IBA is not yet classified as “recycling”³¹ at EU level, even though its performance and utility are well demonstrated across many Member States. The recovery of materials from IBA therefore represents a major yet largely untapped opportunity to strengthen Europe’s domestic raw-material supply. Encouragingly, positive examples already exist: in the Netherlands, a national “Green Deal on Bottom Ash”³² has been in place since 2020, where all operators committed — through a public-private partnership — to full mineral recovery, demonstrating both feasibility and high added value.

Taken together, the simultaneous recovery of minerals and metals positions IBA as a climate-positive, resource-efficient, and strategically important solution. Scaling these practices across the EU would not only strengthen Europe’s material resilience but also support the CRMA objectives while reducing environmental impacts associated with primary mining and landfill disposal. Figure 6 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.

³¹ EC Implementing Decisions 2019/1004, WFD, metals separated and recycled after incineration are considered as recycled.

³² Born, Jan-Peter. 2026. *Dutch Green Deal Bottom Ash (IBA) – Status 2016*. Dutch Waste Management Association (DWMA). At:

https://ygoforum.fi/wp-content/uploads/2019/11/Born_Bottom_Ash_GreenDeal.pdf

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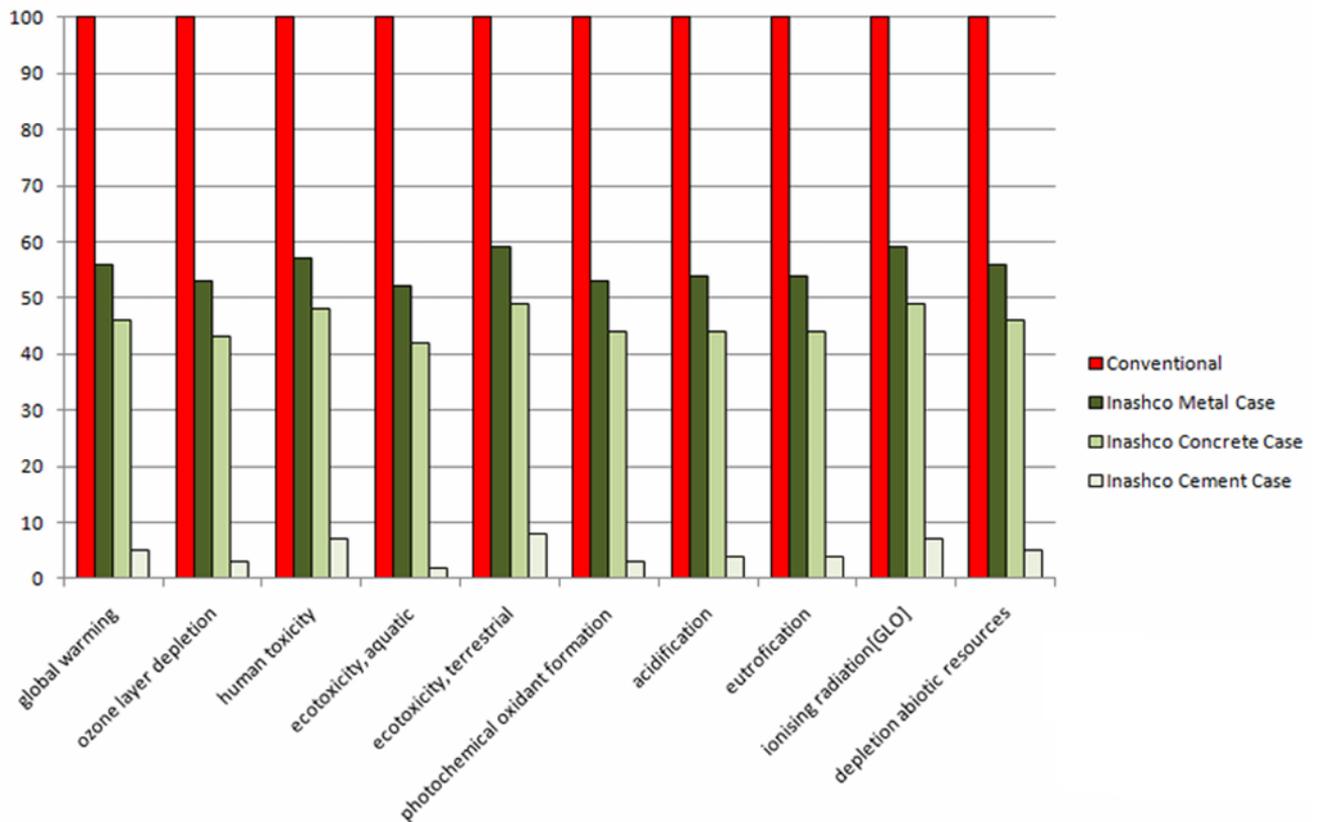


Figure 6. Environmental benefits of substituting conventional raw materials with minerals and metals recovered from IBA in metal, concrete, and cement applications. Source: TU Delft.³³

With approximately 500 WtE facilities operating in Europe, producing more than **20 million tonnes of IBA annually**³⁴, the metal recovery potential is significant, but only **one-third of the non-ferrous metals it contains are currently recycled**³⁵.

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**³⁶. In 2021, the market potential of fully recovered metals from

³³ 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>

³⁴ 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/>

³⁵ ESWET. (2023). *Integrated Resources Recovery Facility*. At: <https://eswet.eu/documents/recovering-the-non-recyclable-the-integrated-resource-recovery-facility/>.

³⁶ ESWET. (2023). *Integrated Resources Recovery Facility*. At: Response to the EC Consultation on the Climate and Environmental DAs of the EU Taxonomy

IBA was estimated at €2 billion³⁷, while reducing the extraction of virgin materials and avoiding up to 14.5 million tonnes of CO₂ emissions³⁸.

Redirecting just 300,000 tonnes of aluminium, copper, zinc, and lead currently lost to landfilling or downcycling³⁹ 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)⁴⁰ 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.

<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).

³⁷ 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>.

³⁸ From internal calculations based on figures from Geschäftsbericht der ZAV Recycling AG (2020).

³⁹ 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/>

⁴⁰ 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>

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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 7 below highlights this steady occurrence and the presence of numerous high-value outliers, demonstrating the consistency and profitability potential of IBA-based recovery.

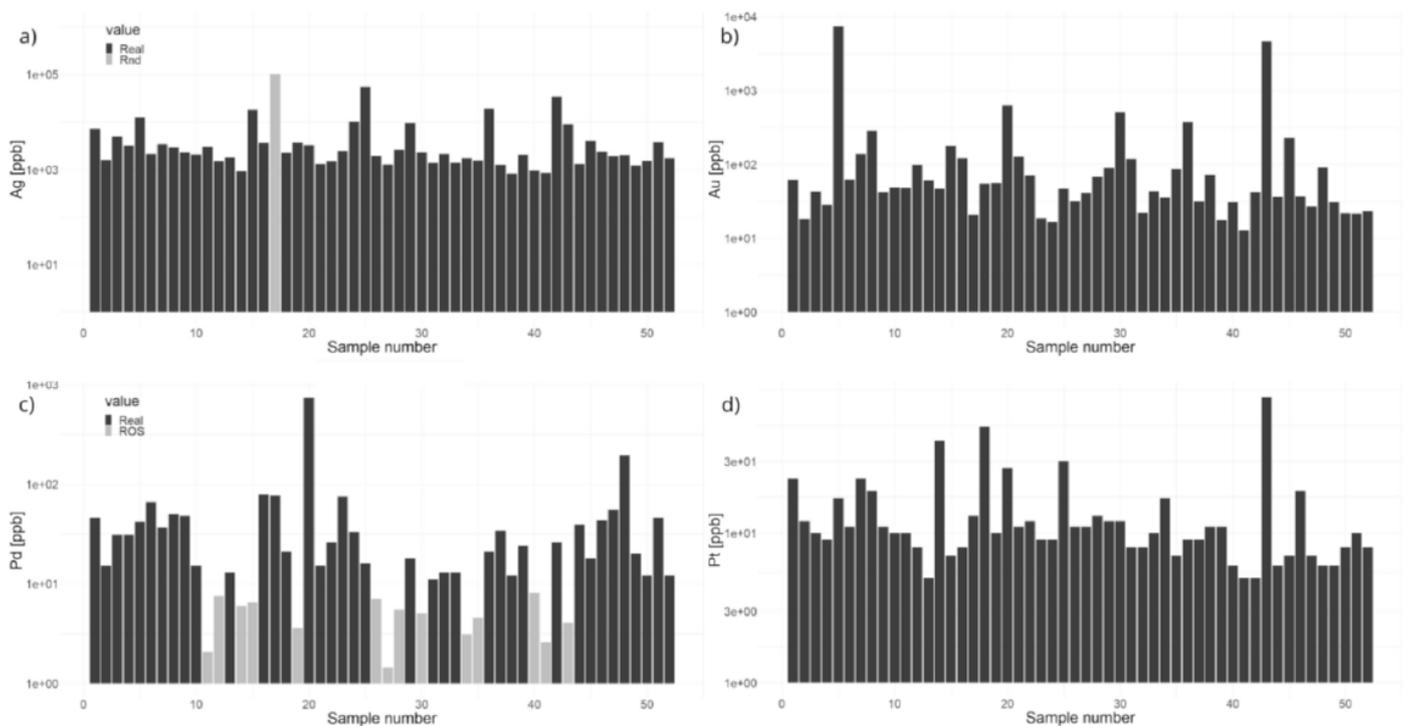


Figure 7. Concentrations of precious metals (Ag, Au, Pd, Pt) in weekly IBA samples from the Krakow Thermal Waste Treatment Plant, showing stable recoverability and numerous high-value outliers. Source: Chuchro et al., 2025.

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 8.

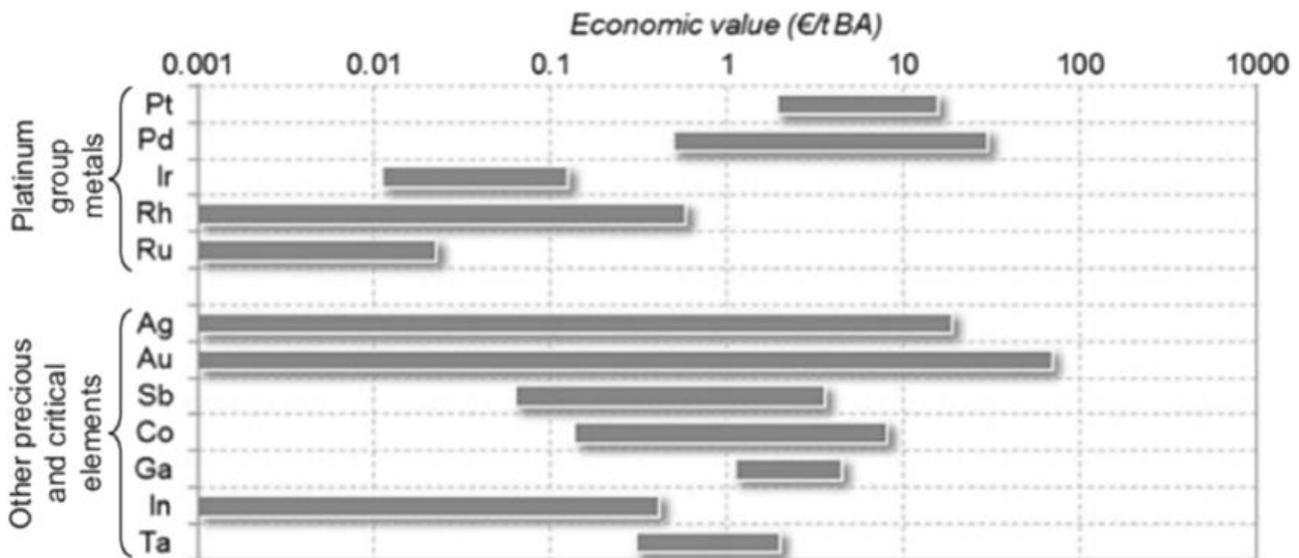


Figure 8. *Estimated total economic value of precious metals (Ag, Au, Pd, Pt) contained in IBA, illustrating the financial and material potential of Waste-to-Energy residues as a secondary raw materials source. Source: Adapted from Chuchro et al. (2025), based on Astrup et al. (2016)⁴¹.*

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, 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.⁴²

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.

It is evident that harnessing the full potential of SRMs recovered from waste will be indispensable for achieving the goals set by the EU Green Deal, the Clean

⁴¹ Astrup, T., Rosenblad, C., & Sloop, 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>

⁴² See for instance, the SwissZinc project (at <https://swisszinc.ch/index.html>). Response to the EC Consultation on the Climate and Environmental DAs of the EU Taxonomy

Industrial Deal, and the CRMA⁴³. A coherent EU policy framework should therefore recognise and support these recovery pathways. Including IBA treatment and mineral and metal recovery in the EU Taxonomy would provide the investment certainty needed to scale these solutions across Member States and ensure that valuable secondary resources are captured rather than lost, contributing simultaneously to climate mitigation, circular-economy objectives, and Europe's strategic material security.

5. 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 compounds⁴⁴, 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 studies⁴⁵ highlights that they generally suffer from methodological and fail to establish a causal relationship between the detected pollutants and WtE operations⁴⁶. Chemical fingerprinting often shows that pollutant signatures in environmental samples do not match those emitted by nearby plants⁴⁷, and in many cases other sources such as traffic, domestic heating, or industrial activities are far more significant contributors. This analysis is consistent with findings from the European Environment Agency and national authorities, which show that modern, well-regulated WtE plants account

⁴³ By 2030, the CRMA foresees EU recycling capacity capable of supplying at least 25% of annual strategic raw material consumption, with steadily increasing recovery from waste.

⁴⁴ Department for Environment, Food & Rural Affairs (Defra), *Project 21649*. At: <https://sciencesearch.defra.gov.uk/ProjectDetails?ProjectId=21649>

⁴⁵ 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>

⁴⁶ INERIS, *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

⁴⁷ 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>

for a very small share of industrial dioxin emissions in Europe, less than 0.2 percent.⁴⁸ 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"**.⁴⁹

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.⁵⁰ 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 (as can occur in landfills⁵¹). 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

⁴⁸ The European Pollutant Release and Transfer Register, <https://industry.eea.europa.eu/#/home>

⁴⁹ 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?>

⁵⁰ Gehrmann, H.-J., Taylor, P., Aleksandrov, K., Bergdolt, P., Bologna, 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.

⁵¹ ENDS Report (2024). ENDS Briefing: The PFAS Files. <https://www.endsreport.com/article/1859134/17-landfills-england-producing-toxic-liquid-containing-forever-chemicals-they>

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be recognised in both climate and environmental Delegated acts. 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.

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

As previously outlined, WtE contributes to climate mitigation through energy recovery, material recovery, and the diversion of residual waste from landfills. Building on this, it is important to emphasise that 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 displace fossil fuels, and enables the recovery of valuable materials such as metals from bottom ash.

According to the European Environment Agency's (EEA) historical and projected GHG trend for the EU, the majority of waste-sector emissions in the EU stem from landfilling, primarily methane, whereas emissions from incineration, which in the relevant EEA reporting include both modern WtE facilities and unregulated open burning (!), represent only a very small share of total EU GHG emissions, as seen in Figure 9 below. This underscores that the climate problem in the waste sector is overwhelmingly linked to landfilling, not to controlled thermal treatment.

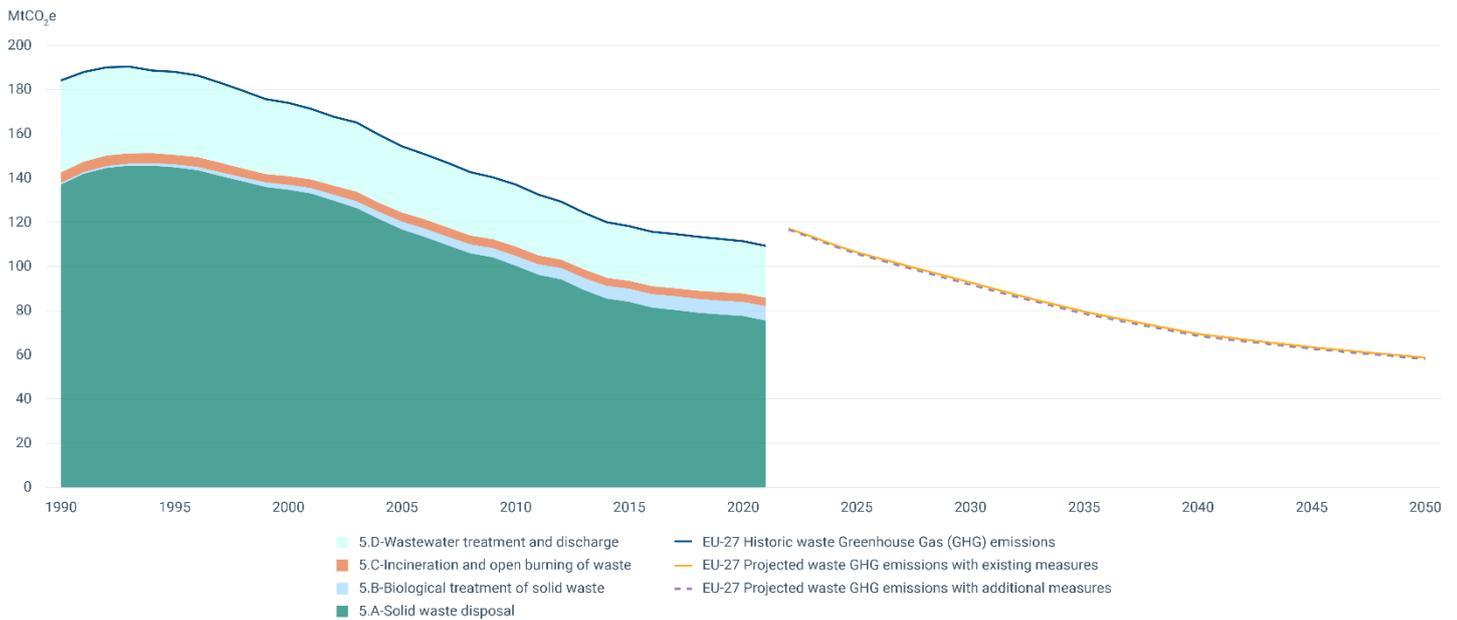


Figure 9. Historical and projected EU greenhouse gas emissions.

Source: EEA⁵².

To place the climate contribution of Waste-to-Energy in the broader EU emissions context that is depicted in the EEA works, despite reductions since 1990, **current policies remain insufficient to reach the 2030 and 2050 climate targets.** Accelerating methane mitigation in the waste sector, where landfill emissions are both the largest and the most underestimated component, is therefore essential. Accelerating landfill diversion is one of the few **immediate, scalable, and cost-effective** mitigation levers that can deliver meaningful reductions in this decade.

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 CO₂ over a 100-year time frame, and more than 80 times more potent over 20 years⁵³. In fact, about 19% of all human-caused methane emissions originate from the waste sector, with landfilling being the primary contributor⁵⁴.

Lately, it has become increasingly evident that landfill methane emissions are often underestimated and underreported.⁵⁵ This means that a substantial share of these

⁵² European Environment Agency (2024). *Historical and projected greenhouse-gas emissions*. At: <https://www.eea.europa.eu/en/analysis/maps-and-charts/historical-and-projected-greenhouse-gas?activeTab=570bee2d-1316-48cf-adde-4b640f92119b>

⁵³ Intergovernmental Panel on Climate Change (IPCC) (2014). *Climate Change 2014: Synthesis Report*. Geneva: IPCC. At: <https://www.ipcc.ch/report/ar5/syr/>

⁵⁴ Saunio, M., Martinez, A., Poulter, B., et al. (2024). Global Methane Budget 2000–2020. *Earth System Science Data*, 17(5), 1873-1958.

⁵⁵ 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., Maasackers, J. D., Lorente, A., et al. (2024). Response to the EC Consultation on the Climate and Environmental DAs of the EU Taxonomy

emissions continues to escape into the atmosphere, contributing to climate change in the short and long term.

The European Space Agency reported in 2021⁵⁶ 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.⁵⁷

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%)⁵⁸, with an EU average of methane capture efficiency of 31%, due to technical and design limitations, as Figure 10 shows below.

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>

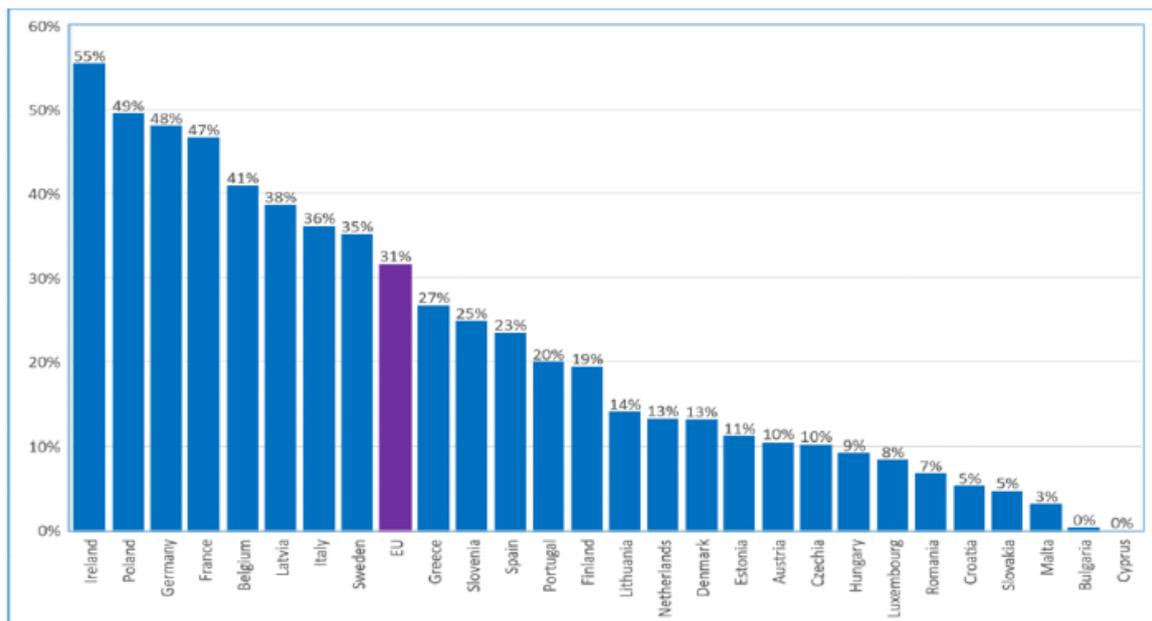
⁵⁶ European Space Agency (2021, 10 November). Satellites detect large methane emissions from Madrid landfills. At:

https://www.esa.int/Applications/Observing_the_Earth/Satellites_detect_large_methane_emissions_from_Madrid_landfills

⁵⁷ GHGSat, "Landfill methane emissions - Emissions monitoring for waste management (landfill methane)." At: <https://www.ghgsat.com/en/case-studies/landfill-gas/>

⁵⁸ 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.

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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 10. 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/2023/044.⁵⁹

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 CO₂ 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.

⁵⁹ 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>.
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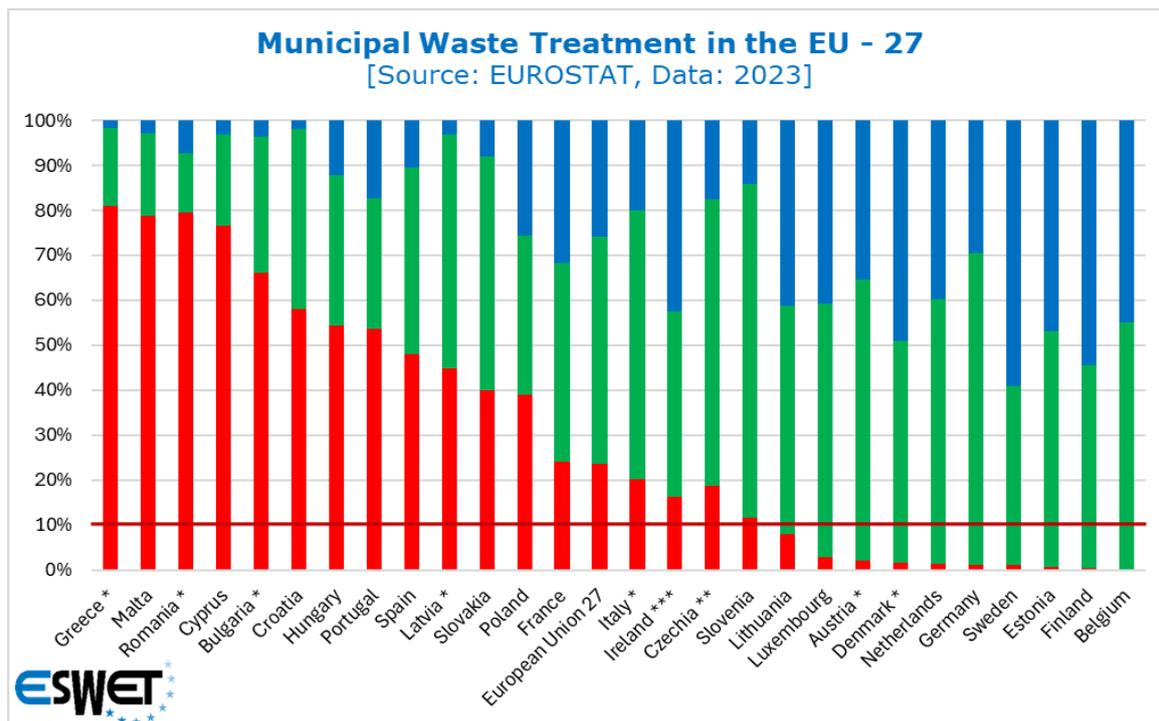


Figure 11. Share of municipal waste treatment methods in the EU27. Landfilling in red, Recycling in green, WtE in blue. The dark red line shows the 10% landfill target by 2035. Data source: Eurostat (2025) with data from 2023. Graphic source: ESWET.

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.

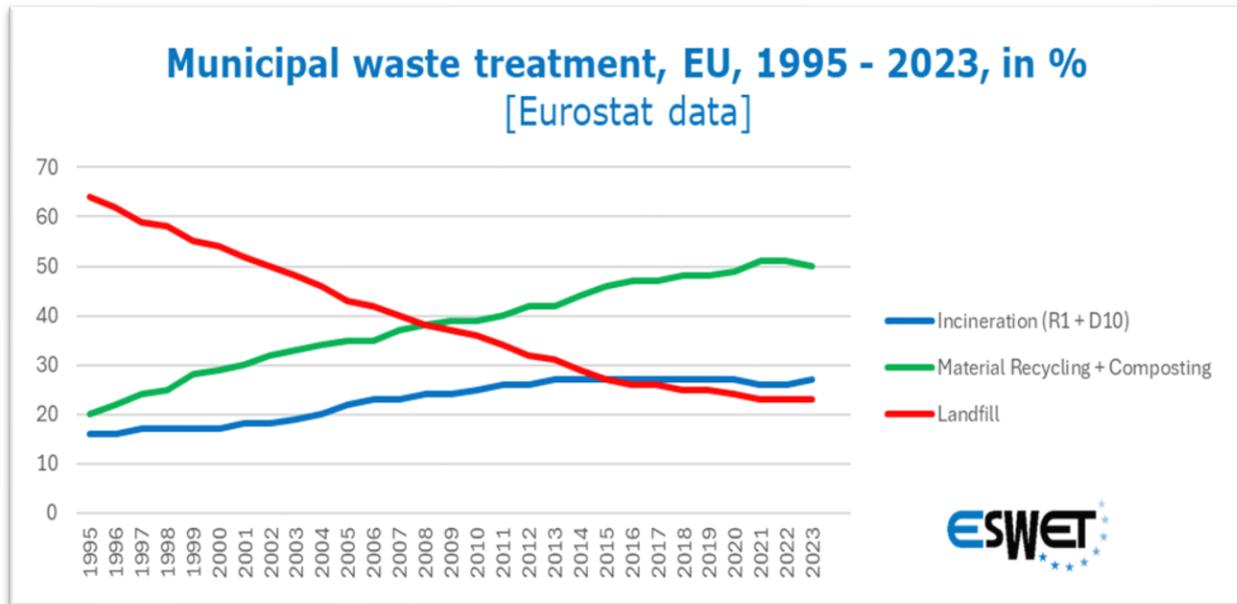


Figure 12. Trends in Municipal Waste Treatment in the EU (1995–2023). Data source: Eurostat (2025). Graphic source: ESWET.

Figure 12 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 CH₄ 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.

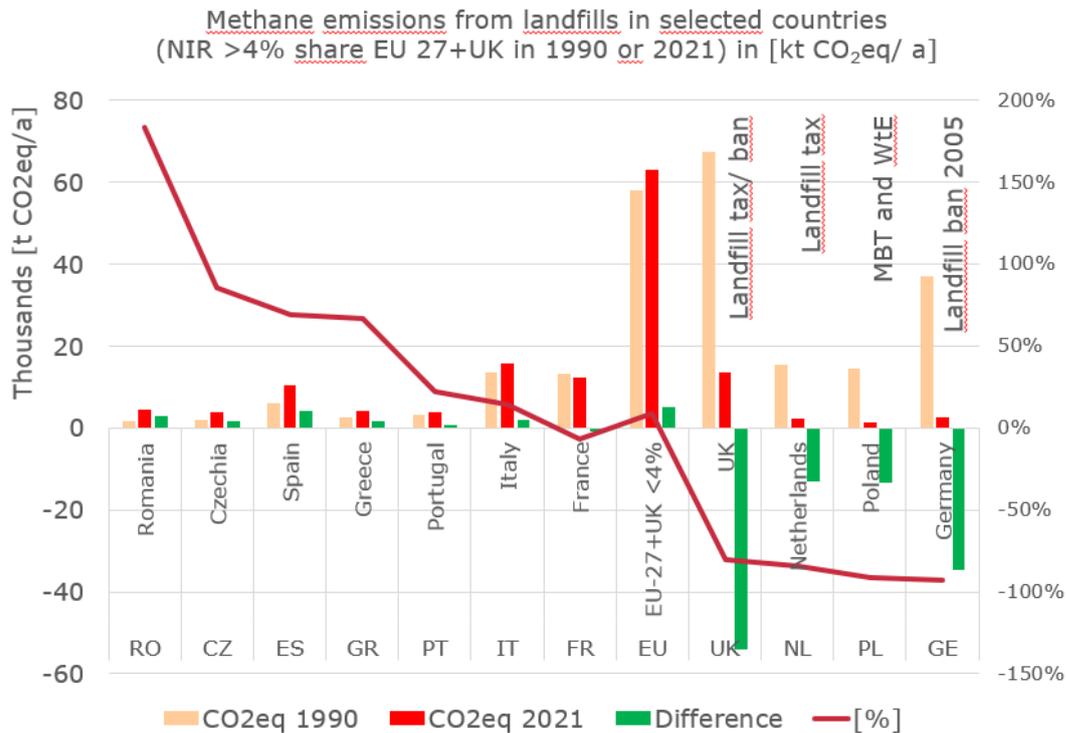


Figure 13. CH₄ emissions from landfills in selected EU countries and UK, 1990 Vs 2021, with policy impact shown. Data source: National Inventory Reports (NIR) with >4% share of EU27+UK total. Graphic source: ESWET.

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.

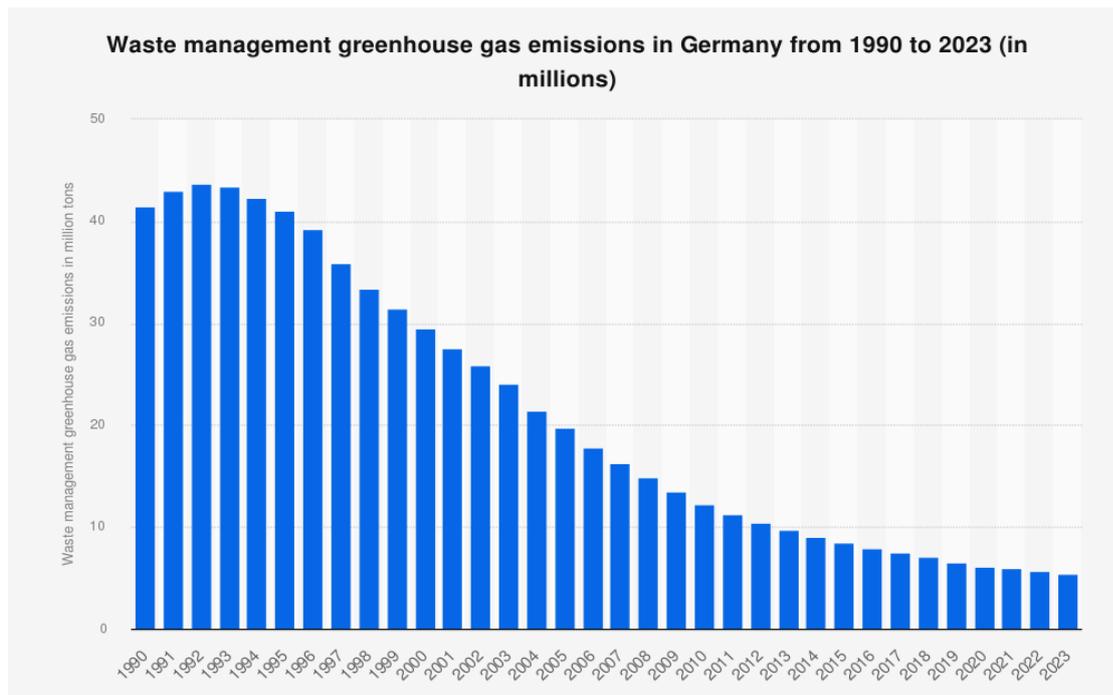


Figure 14. GHG emissions from the waste management sector in Germany, 1990–2023. Data source: Eurostat. Graphic source: Statista.

Methane mitigation through landfill diversion is both possible and highly effective. **CE Delft/Prognos⁶⁰ 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

⁶⁰ CE Delft & Prognos (2022). *CO₂ 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**⁶¹. 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.⁶² 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

Including Waste-to-Energy in the EU Taxonomy would send a clear and consistent investment signal and help mobilise the financing needed to reduce Europe's reliance on landfilling. By enabling sustainable investments in WtE facilities, the Taxonomy can contribute to a coherent pathway for landfill diversion, pollution control, and resource efficiency across all Member States.

7. WtE + Carbon Capture, Utilisation and Storage (CCUS)

A particularly problematic aspect of the current Taxonomy framework is the ambiguity regarding investments in Carbon Capture (CC) on WtE plants.

WtE emissions are hard-to-abate. WtE plants have a hygienic purpose to treat non-recyclable waste, which - even with the most ambitious waste prevention and recycling efforts - will remain. This means that WtE plants cannot switch fuel, like any other installation would do, to decarbonise itself. Capturing CO₂ emissions

⁶¹ ENDS Report (2024). ENDS Briefing: The PFAS Files. <https://www.endsreport.com/article/1859134/17-landfills-england-producing-toxic-liquid-containing-forever-chemicals-they>

⁶² 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>

from WtE is a necessary step towards climate neutrality. What is more, carbon removals in WtE result in negative emissions. As mentioned in the previous chapters, approximately 60% of the emissions from WtE plants are of biogenic origin⁶³. When CCS is applied, these biogenic emissions are permanently removed from the atmosphere rather than simply reduced (case of BECCS), a virtue that is clearly acknowledged by the IPCC.

The IPCC has highlighted the potential to capture about 60–70 MtCO₂ per year from European WtE facilities⁶⁴, and independent studies indicate up to ~31 MtCO₂ per year of durable negative emissions in Europe when infrastructure and siting constraints are accounted for⁶⁵. Early European deployments - AVR Duiven and Twence in the Netherlands, and Oslo's Klemetsrud project - demonstrate technical readiness, with capture rates exceeding 90%. The EU's Industrial Carbon Management Strategy rightly foresees that by 2040 close to half of captured CO₂ should be biogenic or atmospheric - an objective for which WtE with CCS is well suited.

Carbon removals are central to the EU's Industrial Carbon Management (ICM) Strategy's trajectory for 2030–2040. The ICM envisions a single EU CO₂ market, at least 50 Mt/yr of storage capacity by 2030, and, by 2040, regional carbon value chains where CO₂ is a tradable commodity with a substantial share from biogenic or atmospheric sources. For WtE, this means priority access to transport and storage infrastructure, clear permitting pathways, and investment certainty so plants can credibly deliver durable removals.

Permanent storage capacity and access are the bottlenecks. NZIA and TEN-E/CEF are accelerating cross-border CO₂ hubs and pipelines, but timely build-out and fair, third-party access terms will determine whether WtE projects can reach storage at reasonable cost. National ICM strategies (e.g., Germany, France, Austria) are beginning to clarify routes for permitting, liability, and state support; this momentum needs to be consolidated into predictable capacity reservation, tariff frameworks, and storage licensing that match the WtE investment cycle.

Alongside storage, Carbon Capture and Utilisation (CCU) plays a complementary role in decarbonisation and the circular economy. CCU technologies transform

⁶³ Giouse, F., Ravache, E. & Moutte, L. (2020). *Determination of the biogenic and fossil contents of residual household waste and a SRF*. [in French] <https://librairie.ademe.fr/energies/4007-4593-determination-des-contenus-biogene-et-fossile-des-ordures-menageres-residuelles-et-d-un-csr.html>

⁶⁴ Dhakal, S., et al. (2022). Emissions Trends and Drivers. In A. R. Shukla, J. Skea, R. Slade, et al. (Ed.), *IPCC 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 990). Cambridge University Press: Cambridge/New York, NY. At: https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf

⁶⁵ Muslemani, H., Struthers, I., Herraiz, L., Thomson, C. & Lucquiaud, M. (2023). *Waste not, want not: Europe's untapped potential to generate valuable negative emissions from waste-to-energy (WtE) using carbon capture technology*. Oxford: Oxford Institute for Energy Studies. At: <https://www.oxfordenergy.org/wpcms/wp-content/uploads/2023/03/Waste-Not-Want-Not-CM01.pdf>

unavoidable CO₂ emissions into valuable resources, enabling carbon to circulate within industrial systems rather than being released into the atmosphere.

CO₂ 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 CO₂ used to produce fuels, 42% for chemicals, and 8% for mineralisation in building materials.⁶⁶ Such substitution of fossil feedstocks with captured CO₂ 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.

The broader EU policy framework anticipates a major role for CCU: by 2050, approximately 320 Mt of CO₂ will need to be captured annually, with 55% utilised and the remainder stored. Around 250 Mt of GHG reductions could come from CCU technologies, contributing over 20% of the technological effort required for climate neutrality.⁶⁷

Under the current EU Taxonomy framework, it remains unclear how investments in Carbon Capture on WtE plants are treated, because the activity to which they are linked - WtE - is not recognised in the Taxonomy. This creates a regulatory gap whereby CCUS applications on WtE, despite being acknowledged in EU climate policy and identified as essential for decarbonising this hard-to-abate sector, lack a clear pathway for Taxonomy assessment. As highlighted in previous ESWET submissions to the Commission, this ambiguity risks discouraging investment in CCUS for WtE, contradicting EU climate objectives and the ICM.

To ensure coherence across EU initiatives, the EU Taxonomy should explicitly acknowledge CCUS from WtE as a climate mitigation solution primarily, and also as form of resource recovery. Doing so would align the Taxonomy with the Industrial Carbon Management Strategy, the Clean Industrial Deal, and the broader circular-carbon objectives, and support the emergence of a competitive and integrated carbon-management ecosystem in Europe.

8. The compatibility of WtE with the “Do No Significant Harm” (DNSH) principle

Another key issue is the current interpretation of the “Do No Significant Harm” (DNSH) principle in the EU Taxonomy. It does not reflect how waste-management

⁶⁶ 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 ; CO₂ 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

⁶⁷ CO₂ 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

systems operate, nor does it align with the waste hierarchy or the varied local realities across Member States. Designed as a financial signaling tool, DNSH is increasingly applied as a rigid environmental barrier, discouraging investment in WtE despite its recognised contribution to circularity, pollution prevention, and landfill diversion.

A relevant problem is the ambiguity of Article 17(d)(ii) of the Sustainable Finance Regulation, which states that an activity causes significant harm when it results in a “significant increase in the generation, incineration or disposal of waste.” This formulation is unclear: it does not specify what counts as a “significant increase”, nor whether “incineration” refers solely to waste destruction or whether it includes WtE, which EU legislation differentiates as energy recovery rather than disposal. As a result, new or modernised WtE capacity is often presumed to be harmful by default, even in regions where WtE is essential to replace landfilling and to treat residual waste that cannot be recycled. This interpretation makes it difficult - if not impossible - for many Member States to achieve the Circular Economy Package targets adopted in 2018.

This interpretation also conflicts with the EU waste hierarchy, which requires that non-recyclable waste be treated safely and in a way that prevents environmental harm. WtE fulfils this hygienic task by destroying pollutants and contaminants and by ensuring that material streams unsuitable for recycling do not end up in landfill or re-enter the environment. Once higher levels of the waste hierarchy have been exhausted, there is no technically feasible or environmentally safer alternative to WtE for treating residual waste. This logic is already reflected in the Taxonomy Regulation, which lists consistency with the waste hierarchy as a determinant for making a significant contribution, and it should therefore be reflected in DNSH assessments as well.

Preventing investment in such facilities sends an inaccurate signal to investors and undermines objectives related to pollution control, recycling quality, and the reduction of methane emissions from landfills. In Member States where landfilling remains predominant, DNSH assessments that disregard existing treatment gaps or local waste-management plans create regulatory outcomes at odds with EU climate and circular-economy goals.

Assessing DNSH without taking into account local waste-management plans, existing treatment gaps, and the role of WtE within integrated waste systems results in regulatory outcomes that contradict the very goals the EU has set for circularity and pollution prevention. For the EU Taxonomy to remain consistent with waste legislation and to support, rather than hinder, progress towards EU climate and circular-economy targets, the DNSH principle must be applied in a way that reflects the diversity of waste-management systems across the Union. This means acknowledging that, when consistent with the waste hierarchy and with local waste-management needs, WtE does not inherently cause significant harm. Instead, it enables Member States to reduce landfill dependency, improve pollution control, support recycling performance, and ensure the safe treatment of materials that cannot be reused or recycled. Only by recognising this reality can the

Taxonomy provide correct investment signals and contribute effectively to a clean, safe, and just transition across all regions of Europe.

9. Policy recommendations

WtE is an essential component of Europe's climate, circular-economy, and pollution-prevention agenda. It treats unavoidable residual waste safely, prevents methane emissions by diverting waste from landfills, recovers energy and secondary materials, prevents pollution, and has the potential to deliver carbon removals through carbon capture. Excluding WtE from the EU Taxonomy is inconsistent with EU law, climate science, and scientific evidence.

To support the deployment of sustainable and efficient WtE infrastructure and to maximise the benefits outlined in this paper, we call on the Commission to explicitly include in the EU Taxonomy the following activities:

explicitly include in the EU Taxonomy the following activities:

- **Waste-to-Energy as a whole process** - when compliant with the requirements to qualify as a recovery operation - in recognition of its essential public, climate, and environmental service.
- **Incinerator Bottom Ash (IBA) treatment and recovery**, including upgrading processes that maximise the extraction of metals and minerals.
- **Energy-efficiency improvements**, such as modernisation of turbines, boilers, and heat-exchange systems.
- **Advanced pollution-prevention and control technologies**, ensuring continuous progress in emission performance and environmental protection.
- **Heat recovery applications**, including support for connection with district heating and cooling networks.
- **Carbon Capture, Utilisation and Storage (CCUS)** solutions, which are essential for reducing emissions in a hard-to-abate sector and delivering durable carbon removals.

Recognising WtE as a Taxonomy-aligned activity would ensure coherence across EU policies, support a just and efficient transition, and enable Member States to meet their waste-management and climate objectives.

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