Waste Incineration under the EU ETS

Assessment of climate benefits – Update 2025

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Content

Summary

Municipal waste incineration is currently excluded from the European Emissions Trading System (EU ETS). If incineration is included in 2028, waste companies will have to buy emission credits for each tonne of CO_2 they emit when treating household, company, and industrial waste. This additional cost of incineration can act as an incentive for waste prevention and recycling, which will then become more competitive (less costly) than incineration. A shift of (not biologically pre-treated) waste to landfills should be avoided and is already restricted under the Landfill Directive. Zero Waste Europe and Reloop have requested CE Delft to determine the impacts of inclusion of incineration under EU ETS in 2030 and 2040.

The results of this study show that including incineration under the EU ETS would encourage waste prevention and recycling, yielding both climate and employment benefits:

- Incorporating waste incineration under EU ETS will result in emission reductions of at least 4 to 7 Mtonnes in 2030 and 18 to 32 Mtonnes in 2040 within the EU ETS system. The reduction may result from a combination of precollection sorting and sorting of residual mixed waste, recycling of waste, waste prevention, CCS measures and reduction measures in other sectors of EU ETS. This is a minimum, as emission reduction outside the Scope 1 emissions of EU ETS are not incorporated in these figures. Waste prevention and recycling will for instance reduce import from virgin plastics and associated greenhouse gas emissions from outside the EU such as the United States and China.
- Additional jobs amount to 8,700 to 16,400 in 2030 and 11,600 to 21,700 in 2040. Extra jobs will be created since recycling activities are more labour-intensive than waste incineration.

To further reinforce the impact of including incineration under the EU ETS, additional policies might be implemented, such as a mandatory recycled content for plastics, obligatory cost coverage from EPR for recyclables extracted from mixed waste after sorting, introduction of more variable waste tariffs for citizens across municipalities in Europe, or cheaper waste bins for separate collection.

1 Introduction

1.1 Background

The EU Emissions Trading System (EU ETS) is a market-based CO_2 reduction mechanism which incentivises companies to reduce greenhouse gas emissions (and protect the climate) in a cost-effective way. It is the largest emissions trading system in the world and covers all the larger industrial emitters in the EU, including power stations and multiple sectors in (heavy) industry such as refineries, iron and steel production, cement production and fertiliser production.

If waste incineration is included in the EU ETS, waste companies will have to buy emission credits for each tonne of CO_2 they emit. This additional cost of incineration can stimulate waste prevention and recycling, which will then become more competitive (less costly) than incineration.[1] Zero Waste Europe has requested CE Delft to conduct a study in 2021 to determine the potential climate benefits of extending the scope of the EU ETS to municipal waste incineration. This study estimated potential impacts of 4.3 to 8.8 Mtonnes per year in 2030.

Since 2021 there have been significant developments which could alter these results. For example, in January 2024, waste incineration was included under the national Emission trading scheme in Germany. Furthermore, there are more recent insights on the development of the price of EU ETS CO_2 credits and the share of biogenic and fossil CO_2 emissions of waste incineration. Zero Waste Europe and Reloop have therefore requested CE Delft for an update of the impacts of inclusion of incineration under EU ETS in 2030 and calculate the impacts for 2040 as well (in the previous report impacts were assessed for 2030). This report presents the results.

1.2 Objective

The objective of this study is to give an update of the climate impacts of extending the scope of the EU ETS to municipal waste incineration, including both household waste and industrial and company waste.

We assess two alternative scenarios:
1. Extending the scope to CO_2 emissions of fossil origin ('fossil CO_2' FC scenario, 31 Mt in 2021).
2. Extending the scope to CO_2 emissions of both fossil and organic origin ('fossil and biogenic CO_2 FBC' scenario, 55 Mt in 2021).

The climate benefits are determined for the full life cycle of the products and materials that are recycled instead of incinerated.

[1] According to Systemic (2025), EU ETS would help level the playing field for fossil-free alternatives, reduce cost distortions, promote circularity, and increase demand for fossil-free alternatives.

1.3 Considerations on potential redirection of waste to landfill

As landfill disposal of (not biologically pre-treated) waste has a greater climate impact than waste incineration, a precondition for including incineration in the EU ETS is that (biologically untreated) waste is not directed to landfill. Just like the previous study, we assess the impact of a policy package to include incineration under the EU ETS, considering that Member States will have to implement national measures under the Landfill Directive to prevent landfilling of (not biologically pre-treated) waste.

1.4 Scope

The study covers all the countries participating in the EU ETS, viz. EU Member States minus Sweden, Denmark and Germany, plus Norway, Iceland and Liechtenstein. Sweden and Denmark are not included, as these countries already operate waste-to-energy (WtE) plants under the EU ETS. Germany is also not included in this study, as waste incineration is already included under a national trading system since 2024. In a baseline scenario without EU ETS, German waste incinerators still have a comparable price incentive to reduce their emissions under the national system.[2]

The incentive for waste prevention and recycling will depend on the increase in the cost of waste incineration and therefore on the EU ETS carbon price. As this price is forecast to rise in the future, impacts have been determined for the year 2030 (projected price of 108 €/tonne) and the year 2040 (projected price of 184 €/tonne).

1.5 Approach and outline

The climate effects of including waste incineration in the EU ETS are assessed based on two approaches:

1. An assessment of extra recycling and waste prevention activities based on so called price elasticities (chapter 2).
2. An assessment of the potential CO_2 reduction by multiplying the extra emissions that are included under the EU ETS cap with the annual reduction factor (chapter 3).

Chapter 4 presents the conclusions and recommendations.

[2] The price in the German system is € 55 in 2025 (EU ETS price is € 67 per tonne in 2025). From 2026, the certificates in Germany will be auctioned on a European level within a price corridor of € 55 and € 65. From 2027, price for emissions in those sectors will be based on free auction prices.

2 Emission reduction from waste recycling and prevention

2.1 Approach

In this chapter, the climate effects of including waste incineration in the EU ETS were assessed in a multistep process, as follows:

1. First, the relative increase in the price of waste disposal if incineration is included in the EU ETS, was estimated, assuming the CO_2 costs are passed through by waste companies to parties disposing of waste (municipalities, companies and industry).
2. In the second step we assessed the percentage reduction in waste incineration volumes resulting from this price increase, based on a literature study of price elasticities. A distinction was made between municipal waste and industrial waste, for which markets and price incentives differ substantially, as follows:
   - Companies are generally charged according to on the volume of waste they wish to dispose of and will therefore have a direct price incentive to prevent or recycle their waste when the cost of incineration increases. Companies responsible for the collection of company and industrial (C&I) waste often charge their commercial clients (waste disposers) based on factors such as container volumes and frequency of collection. A study of the University of Amsterdam showed a significant relation between the costs of incineration/landfilling and company waste recycling in the period 1995-2003 in the Netherlands, while the impacts on household waste was neglectable due to the flat tariffs (Bartelings et al., 2005). Approximately 50% of waste going to incinerators is company and industrial waste.
   - Households are charged for domestic refuse disposal by municipalities, which will have to pass the increased cost of incineration through to households. If this is by way of a variable tariff paid per kg of waste disposed of, households will be incentivised to greater recycling and/or waste prevention. Such 'pay-as-you-throw' systems are on the rise in many European countries (e.g., Germany, Netherlands, Belgium, France). The municipality itself may also be stimulated to implement additional recycling policies if waste management costs increase, through better-designed collection schemes, enhanced education and outreach, and possibly the adoption of pay-as-you-throw (PAYT) systems.
3. In the third step the CO_2 benefits and employment impacts of waste reduction/recycling were determined, based on waste of average composition. The national results for selected countries were extrapolated to the EU as a whole, considering that waste markets vary widely in terms of tariffs, taxes, municipal waste policies and so on.
   In addition, we estimated the likely impact on jobs based on a study of the employment impacts of recycling and incineration.

2.2 Effect of EU ETS on cost of incineration and waste disposal

In order to calculate emission reduction, we assess how much the total cost of waste disposal (collection and incineration) will increase if incineration is included in the EU ETS and to what extent this will make recycling and waste prevention more competitive.

The price increases for disposers of waste (municipalities, companies) will depend on the extent to which the new CO_2 costs of waste incineration are passed through by waste companies to their clients. Empirical data show that for each tonne of waste incinerated, on average approximately 1.11 tonne of CO_2 is emitted.

If waste companies lower emissions per tonne of waste by capturing CO_2 emissions (CCS) or if they opt for decreased profitability by absorbing part of the costs, there will be less price increase. This possibility has not been included in this chapter, however.

The forecasted EU ETS price is € 108 per tonne CO_2 in 2030. Based on this price, gate tariffs in Europe will increase on average by € 74 to € 132 per tonne of waste in the FC (fossil carbon) and FBC (fossil and biogenic) scenario, respectively (see Figure 1 and Table 1). With forecasted price of € 184 per tonne gate fees in Europe increase on average by € 125 to € 225 per tonne of waste in the FC and FBC scenario, respectively.

Figure 1 - Impact on cost price incineration per scenario

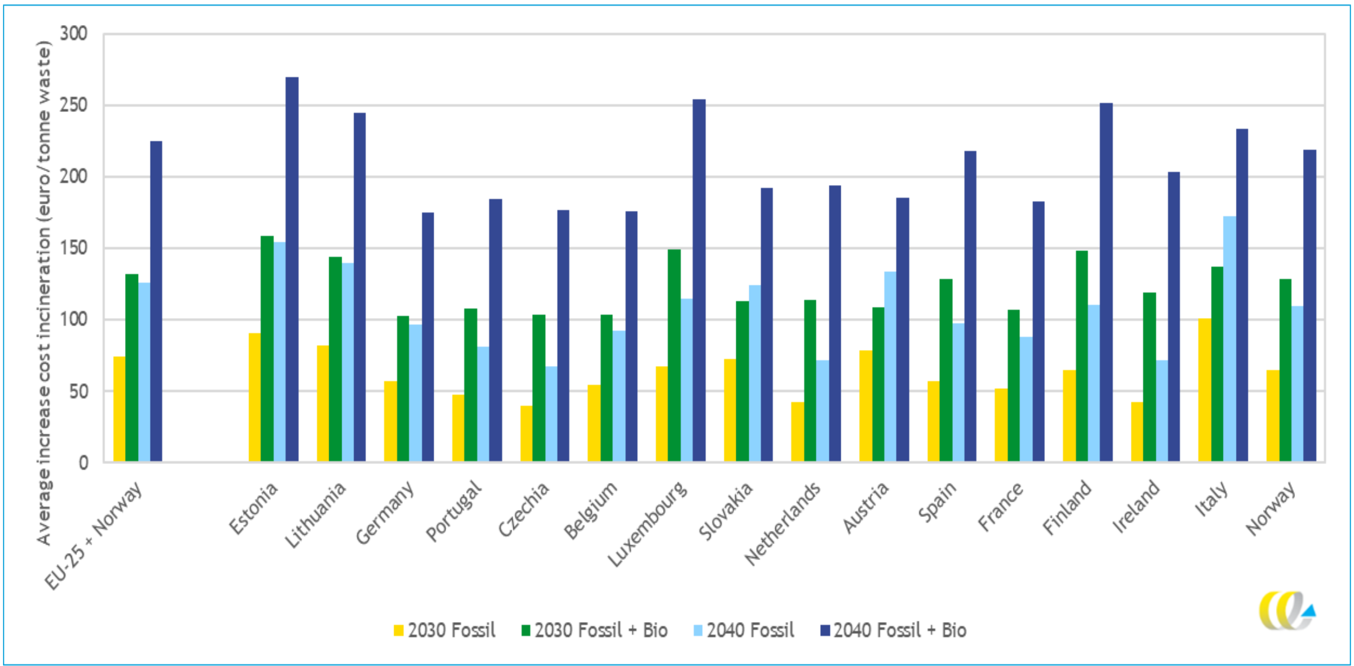


Table 1 – CO_2 emissions from incinerators in 2021 and EU ETS costs per tonne waste

							Price EU ETS € 108 per tonne		Price EU ETS € 184 per tonne	
Country	Waste incinerated (ktonnes)	WTE biomass CO_2 (ktonnes)	WTE fossil CO_2 (ktonnes)	Total (ktonnes)	Share fossil in total (%)	CO_2 emissions per tonne of waste	FC scenario	FBC scenario	FC scenario	FBC scenario
Austria**	2,700	749	1,964	2,712	72%	1,00	79	108	134	185
Belgium	3,480	1,579	1,741	3,321	52%	0,95	54	103	92	176
Bulgaria	NA	170	259	429	60%	NA	NA	NA	NA	NA
Croatia	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cyprus	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Czechia	720	428	261	689	38%	0,96	39	103	67	176
Denmark	3,550	2,329	1,733	4,063	43%	1,14	53	124	90	211
Estonia	210	132	175	308	57%	1,47	90	158	154	270
Finland	1,550	1,194	927	2,121	44%	1,37	65	148	110	252
France	14,000	7,177	6,696	13,873	48%	0,99	52	107	88	182
Germany**	25,000	10,631	13,077	23,708	55%	0,95	56	102	96	174
Greece	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hungary*	370	527	911	1,438	63%	3,89	266	420	453	715
Ireland	810	579	314	893	35%	1,10	42	119	71	203
Italy	6,020	2,013	5,627	7,639	74%	1,27	101	137	172	233
Latvia	NA	150	141	291	48%	NA	NA	NA	NA	NA
Lithuania	620	354	471	824	57%	1,33	82	144	140	245
Luxembourg	160	121	99	221	45%	1,38	67	149	114	254
Malta	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Netherlands**	7,390	4,934	2,857	7,791	37%	1,05	42	114	71	194
Norway**	16,30	970	970	1,940	50%	1,19	64	129	109	219
Poland*	1,260	622	5,120	5,742	89%	4,56	439	492	748	839
Portugal**	1,080	606	473	1,079	44%	1,00	47	108	81	184
Romania	60	NA	NA	NA	NA	NA	NA	NA	NA	NA
Slovakia**	230	85	154	240	64%	1,04	73	113	124	192
Slovenia	NA	56	126	182	69%	NA	NA	NA	NA	NA
Spain	2,970	1,943	1,572	3,515	45%	1,18	57	128	97	218
Sweden	6,830	4,194	2,877	7,071	41%	1,04	45	112	78	190
Total excl. Sweden, Denmark & Germany	**45,260**	**24,390**	**30,858**	**55,247**	**56%**	**1,22**	**74**	**132**	**125**	**225**

Source ktonnes waste incineration: (CEWEP, 2021, 2022). Source CO_2 emissions: (UNFCCC country reports). Source ETS-prices: (PBL, 2024).

* CO_2 impacts per tonne in Poland and Hungary are too high. Data might therefore be inaccurate for these countries.

** CO_2 emissions from 2018. No updated WtE emissions were available from UNFCCC reports.

2.3 Effects of EU ETS on total cost of waste disposal

The previous study showed that costs for collection and incineration of non-separated household waste range from € 155 to € 170 per tonne in selected Member States Belgium, the Netherlands and Italy. Costs for company and industrial waste ranged from € 130 to € 150 per tonne. We refer to the previous study for more details on these figures.

If all costs are passed through, cost increases in 2030 for household waste in the fossil scenario range from 27% (Netherlands) to 61% (Italy). In 2040, costs increase by 46% (Netherlands) to 104% (Italy) in the fossil scenario. In the FBC scenario, costs in 2040 increase by 125% (Netherlands) to 142% (Italy).

Figure 2 - Increase costs of household waste collection and incineration (%)

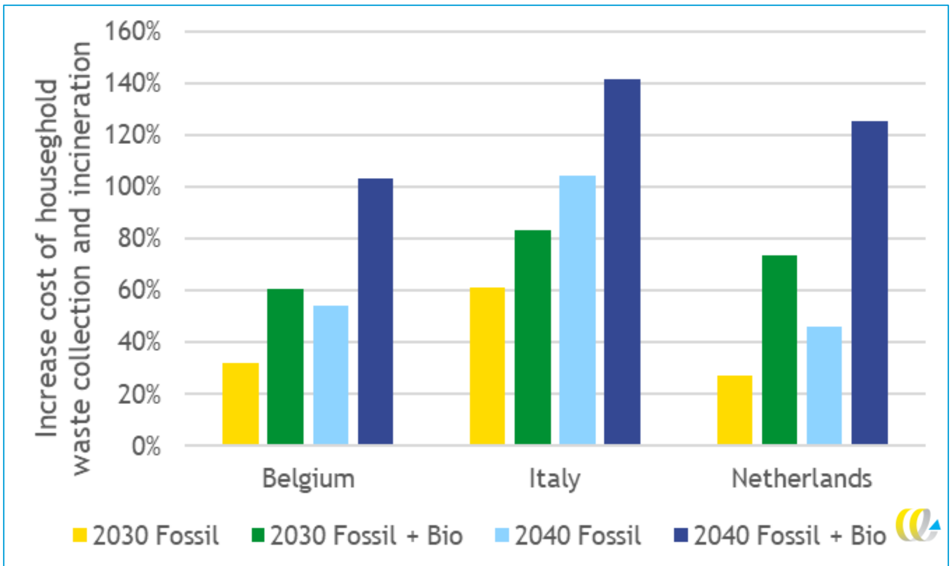


Table 2 - Cost increases household waste (€/tonne waste and % increase collection and incineration costs)

Country	Current collection and incineration costs	Price increase scenario fossil CO_2 2030 (EU ETS € 108 per tonne)		Price increase scenario fossil CO_2 2040 (EU ETS € 184 per tonne)		Price increase scenario fossil and biogenic CO_2 2030 (EU ETS € 108 per tonne)		Price increase scenario fossil and biogenic CO_2 2040 (EU ETS € 184 per tonne)	
	€/t waste	€/t waste	%	€/t waste	%	€/t waste	%	€/t waste	%
Belgium	170	54	32%	92	54%	103	61%	176	103%
Italy	165	101	61%	172	104%	137	83%	233	142%
Netherlands	155	42	27%	71	46%	114	73%	194	125%

Source: Own calculation.

For company and industrial waste, costs in Belgium (the only country with publicly available information on C&I gate tariffs) increase in 2030 by 37% (FC scenario) and 71% (FBC scenario) in 2030. In 2040, costs for C&I waste increase by 63% (FC scenario) and 121% (FBC scenario).

Figure 3 - Cost increases company and industrial waste (Belgium)

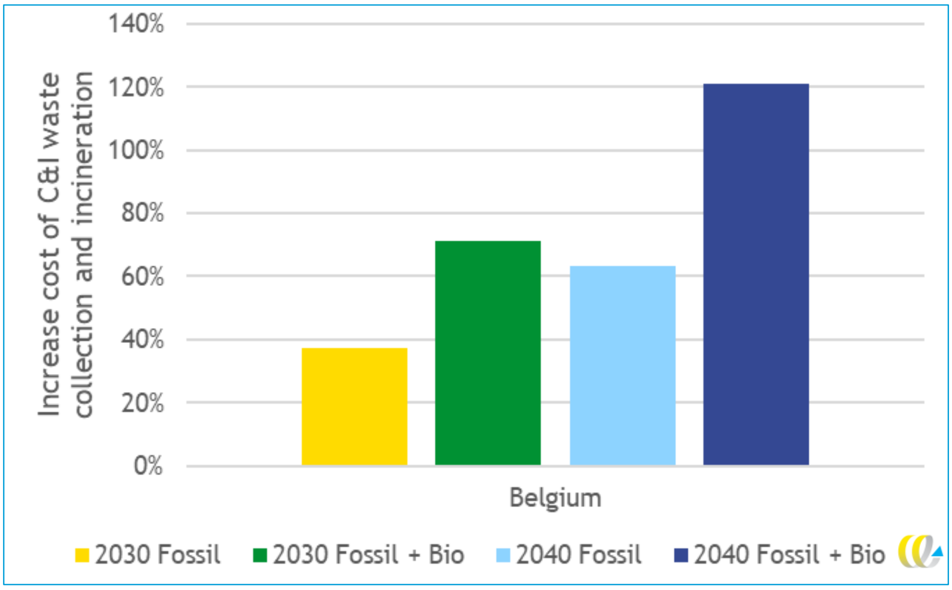


Table 3 - Cost increases company and industrial waste (€/tonne waste and % increase in collection and incineration costs)

Country	Current collection and incineration costs	Price increase scenario FC scenario 2030 (EU ETS € 108 per tonne)		Price increase scenario FC scenario 2040 (EU ETS € 184 per tonne)		Price increase scenario FBC scenario 2030 (EU ETS € 108 per tonne)		Price increase scenario FBC scenario 2040 (EU ETS € 184 per tonne)	
	€/t waste	€/t waste	%	€/t waste	%	€/t waste	%	€/t waste	%
Belgium	145	54	37%	92	63%	103	71%	176	121%

Source: Own calculation.

2.4 Effects on pre-collection sorting of household waste

The impact of including waste incinerators in the EU ETS on recycling and prevention of household waste will depend on the extent to which municipalities pass on cost increases to households, and on the extent to which sorting installations for residual mixed waste are introduced.

By increasing the cost of managing residual waste, the ETS will — directly or indirectly — drive efforts to further reduce residuals. Initially, this shift will likely come from local authorities (LAs), through better-designed collection schemes, enhanced education and outreach, and possibly the adoption of pay-as-you-throw (PAYT) systems:
- Municipalities charge households a variable tariff that increases for each kg of waste disposed of. These so-called pay-as-you-throw (PAYT) schemes are in force in (parts of) Italy, France, the Netherlands, Austria and Germany, for example.
- The variable tariff is based on the actual costs of waste disposal. Municipalities will pass through costs increases to households.

Given the results of Allers and Hoeben (2010) and experiences in the USA, an average price elasticity of -0.2 for household waste seems reasonable. This would give the following results for the reduction of unsorted household waste in 2021 and 2030 if PAYT implementation rates in Europe remain the same in 2030 as in 2021. This is probably a conservative assumption. If implementation rates were to double, for example, the reduction impacts given in Table 4 would double as well.

Table 4 - Reduction of unsorted household waste per scenario

	FC scenario 2030	FBC scenario 2030	FC scenario 2040	FBC scenario, 2040
Belgium	-3.2%	-6.1%	-5.4%	-10.3%
Italy	-0.3%	-0.4%	-0.5%	-0.7%
Netherlands	-1.0%	-2.6%	-1.7%	-4.5%
France	-0.2%	-0.3%	-0.3%	-0.6%

2.5 Effects on company and industrial waste

For C&I waste the impacts will be greater than for household waste, since the incentives for reducing waste will be more direct. Companies collecting C&I waste often charge their clients based on factors such as container volume and collection frequency. The University of Amsterdam has estimated the relation between the costs of waste disposal (landfill/incineration) and recycling of company waste for the period 1995-2003. While no significant impacts were found for household waste, the data show that higher costs for landfilling and incineration increase the share of recycling, with elasticities centring around -0.4.[3] Higher substitution elasticities mean these sectors are more sensitive and responsive to price changes.

Table 5 - Substitution elasticities

	Substitution elasticity waste treatment/recycling
Wholesale sector	-0.37
Retail sector	-0.38
Catering sector	-0.29
Repairment sector	-0.37
Transport sector	-0.43
Financial sector	-0.42
Other sectors	-0.31
Total	**-0.4**

Source: (Bartelings et al., 2005).

[3] This is in turn based on Bartelings et al. (2005), who explicitly translate their estimates to elasticities for different sectors around an average of -0.4. More recently, De Weerdt et al. (2020) – based on a Flemish dataset for industrial waste in the period 2005-2016 - find that taxation on incineration has a strong negative effect on the growth of waste generation. Unfortunately, it is difficult to establish an elasticity from their results, as prices and taxes on waste are both included on the right-hand side of their estimated equation.

Given the price elasticity of -0.4, the amount of unsorted company waste will decrease by 15% (FC scenario) and 28% (FBC scenario) in 2030. In 2040, the reduction will be 22% and 41% for the respective scenarios.

Table 6 - Price increase and reduction of C&I waste per scenario

Belgium								
Price increase FC scen 2030	Price increase FBC scen 2030	Price increase FC scen 2040	Price increase FBC scen 2040	Price elasticity	Waste reduction FC scen 2030	Waste reduction FBC scen 2030	Waste reduction FC scen 2040	Waste reduction FBC scen 2040
37%	71%	54%	103%	-0.4	-15%	-28%	-22%	-41%

2.6 Reduction in greenhouse gas emissions

To estimate the climate impacts of the waste reduction ensuing from inclusion of waste incinerators in the EU ETS, we assessed the climate impacts of recycling over the life cycle of products and materials compared with incineration. As Table 7 shows, recycling results in a net climate benefit of 0.75 tonne CO_2 per tonne waste.

Table 7 - Climate benefit of recycling one tonne of municipal waste in Europe versus incineration[4]

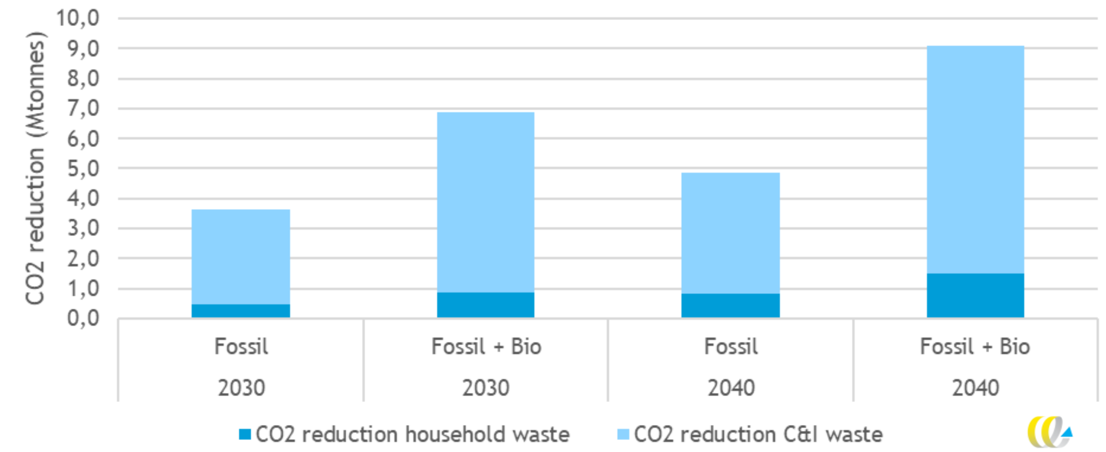
	Share in municipal waste	CO_2 reduction per tonne of respective waste category
Food waste	25%	-0.15
Paper and board	18%	-0.51
Plastic	12%	-2.51
Garden waste	6%	-0.07
Glass	5%	-0.17
Rubble	5%	0.00
Textiles	4%	-2.35
Sanitary products	3%	-0.40
Steel	2%	-0.01
Aluminium	1%	-1.71
White goods	1%	-2.14
Other	18%	-0.91
Total	**100%**	**-0.75**

Source composition: Trinomics (2020).
Source CO_2 reduction: CE Delft (2020).

CO_2 reduction from pre-collection sorting ranges from around 3.6 (FC scenario) to 6.9 Mtonnes (FBC scenario) in 2030. In 2040, the reduction is around 4.9 to 9.1 Mtonnes.
For the calculation, it was assumed that all components of the waste are reduced in equal measure. However, emission reductions may be greater if, for instance, relatively more plastics, textiles and aluminium are recycled, while the impacts will be lower if more food waste is sorted and recycled, for example.

[4] Given the lack of specific data on the composition of all waste streams going to municipal waste incinerators, we have taken the composition in Table 7 as representative for all waste streams processed in European incinerators, also given the fact that at least 80% of waste going to British incinerators is similar to household waste.

Figure 4 - Emission reduction from pre-collection sorting in EU27 minus Denmark and Sweden and Germany, plus Norway



2.7 Reduction through sorting facilities of residual mixed waste

The calculations are based on pre-sorting activities of households and companies. However, EU ETS can also trigger investments in sorting installations of residual mixed waste. These installations can separate out plastics and other materials from the residual waste mix after collection of (unsorted) waste. Experience in Sweden with the EU ETS shows that some waste companies have invested in residual mixed waste sorting facilities to separate out plastic waste (Avfall Sverige, 2021).

The emission reduction potential of residual mixed waste sorting installations is large. Experiences in the Netherlands show that the recycling yield of plastic packaging in municipalities with both pre-collection and residual mixed waste sorting is a factor 1.6 higher than in municipalities with only pre-collection sorting.[5] Furthermore, there is a large potential for residual mixed waste sorting of company and industrial waste.

Without EU ETS and other financial stimulations investments in residual mixed waste sorting installations are not profitable yet. Equanimator Ltd (2023) calculated costs of € 226 to € 550 per tonne of sorted plastic for a 100 ktonne installation and € 32 to € 210 per tonne of sorted plastic for a 200 ktonne installation.[6]

It was not possible to calculate the specific impacts of EU ETS on residual mixed waste sorting installations, as investments depend on many factors, such as contributions from EPR systems, government subsidies and the interplay with EU ETS. However, the potential impact of EU ETS is large, in particular because residual mixed waste sorting decreases fossil CO_2 emissions of waste incineration and becomes more profitable if fossil CO_2 emissions get a price under the EU ETS. Table 1 shows that 45 Mtonnes of waste is incinerated in the countries that are included under EU-ETS. A 12% plastic share (see Table 7) would correspond with around 5 Mtonnes of plastic waste. Other statistics suggest even more plastic waste. According to Plastics Europe, around 16 Mtonnes of post-consumer plastic waste is incinerated in Europe. Although this figure includes the UK, Germany,

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Sweden and Denmark, which are not included in our analysis, 5 Mtonnes of plastic waste is a conservative figure.

According to PwC, with only pre-collection sorting, the recycling yield (compound rate) of plastics is 25% in the Netherlands, which increases to 40% when pre-collection and residual mixed waste sorting are combined.[7] Based on these figures, residual mixed waste collection sorting of plastics may therefore result in (40 to 25%) * 5 Mtonnes (plastic waste) * 2.5 kg CO_2/kg plastics = 2 Mtonnes additional CO_2 reduction.

However, this potential can increase if higher yields are achieved and more materials can be sorted (glass, aluminium, paper). According to Eunomia (2023), the additional recycling potential in Europe (including Germany, UK, Denmark and Sweden) could be 10 to 28 Mtonnes reduction of CO_2 eq.[8] The study highlights the climate benefits of implementing mixed waste sorting facilities: facilities for the separation of municipal waste for recycling before incineration or landfill disposal. Furthermore, the study notes that recovering recyclable materials such as plastics and metals from residual waste can prevent these materials from being incinerated or landfilled, and reducing greenhouse gas emissions at the same time. According to the report, the potential emission savings from MWS range between 10.2 and 28.1 million tonnes of CO_2-eq. per year in the EU, which represents 9 to 25% of the total greenhouse gas emissions from the EU waste sector in 2020.

The scenarios compare a baseline scenario with improved recyclability, a deposit return scheme, only minor improvements in waste collection and (advanced) MWS to scenarios with improved waste collection and recyclability alongside (advanced) MWS. The largest greenhouse gas emission reductions of 28.2 million tonnes of CO_2-eq is achieved when the advanced MWS is combined with the first scenario. Unfortunately, data on the isolated impact of (advanced) MWS was not publicly available.
In addition, climate impacts may be greater if more waste is prevented instead of recycled (Eunomia, 2015). This shows that the climate benefits of waste prevention (avoided production, e.g. because of Ecodesign, repair or reuse activities) are significantly greater than additional recycling activities.

2.8 Effects on employment

Recycling activities are more labour-intensive than incineration of waste or landfilling. Several studies have identified the employment benefits of increased recycling activity. According to the Ellen Mc Arthur Foundation, 2 FTE are created per 1,000 tonnes of recycled waste, while waste disposal (incineration/landfilling) leads to 0.1 FTE (Ellen Mc Arthur Foundation , 2015). These figures are more or less in line with previous research by (CE Delft, 2013). According to CE Delft (2013), the employment associated with plastics recycling is 1.7 FTE per 1,000 tonnes, and for incineration 0.3 FTE per 1,000 tonnes.[9] According to Hall and Nguyen (2012), the employment impacts of landfilling and incineration are, respectively, 0.1 FTE and 0.3 FTE per 1,000 tonnes. Based on the creation of 2 FTE per 1,000 tonnes of waste recycled and a loss of 0.2 FTE at incinerators (or landfills

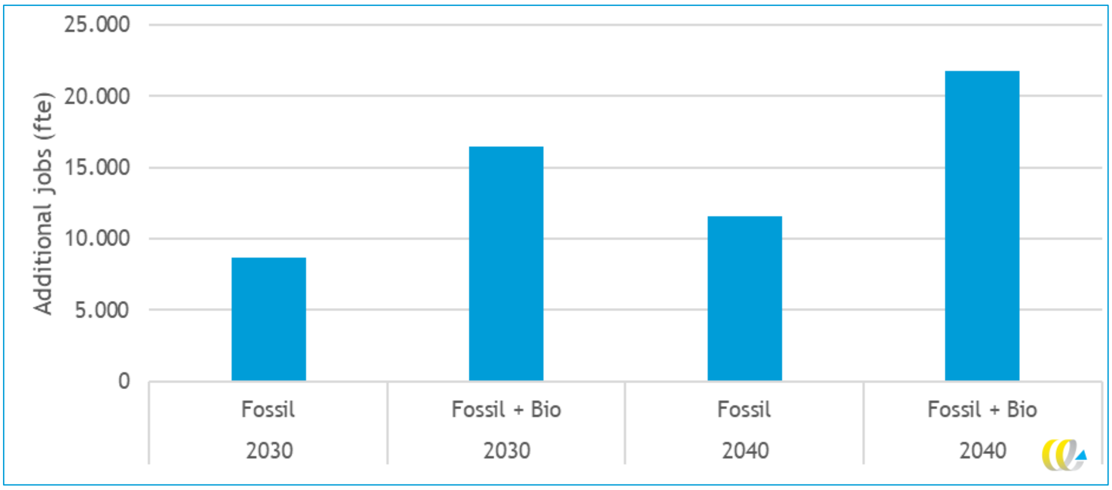
[7] Plastic Pathways | Strategy&

[8] Eunomia report template

[9] According to a survey by CE Delft among recycling companies, plastics recycling leads to additional employment of 1.7 FTE per 1,000 tonnes; the net employment loss for incineration is 0.2 FTE per 1,000 tonnes (*Inzetting op meer recycling. Een maatschappelijke Kosten Baten Analyse*. CE Delft, 2013).
Hall and Nguyen (2012) reports 0.3 jobs per 1,000 tonnes for incineration and 0.1 jobs for landfilling.

if incinerator capacity is used for landfill waste), job creation ranges from 8,700 extra FTE in the fossil scenario in 2030, up to over 21,000 FTE in the fossil and bio scenario in 2040.

Figure 5 – Direct employment impacts per scenario



For these calculations it was assumed that waste is recycled instead of incinerated. If more waste is prevented, for instance through repair activities, the employment impact may be significantly greater. The employment impact of repair activities is around 40 FTE per 1,000 tonnes, respectively a factor 20 and 200 greater than recycling and incineration/landfilling (GAIA, 2021).

These are the estimated direct impacts. In addition, though, there may also be indirect impacts if households and companies lower their spending owing to higher costs. These indirect impacts will be partially or totally mitigated, however, as the government may increase spending or lower taxes elsewhere.

2.9 Effects on households and companies

Various studies, such as CE Delft (2013), Ellen Mc Arthur Foundation (2015) and McKinsey (2015), have shown that more recycling results in net positive welfare impacts. However, including incineration in the EU ETS will increase gate fees and may increase waste management costs for households as well as companies and industries. In order to mitigate cost increases, the revenues from CO_2 emission credits could be recycled from the government to households and businesses.

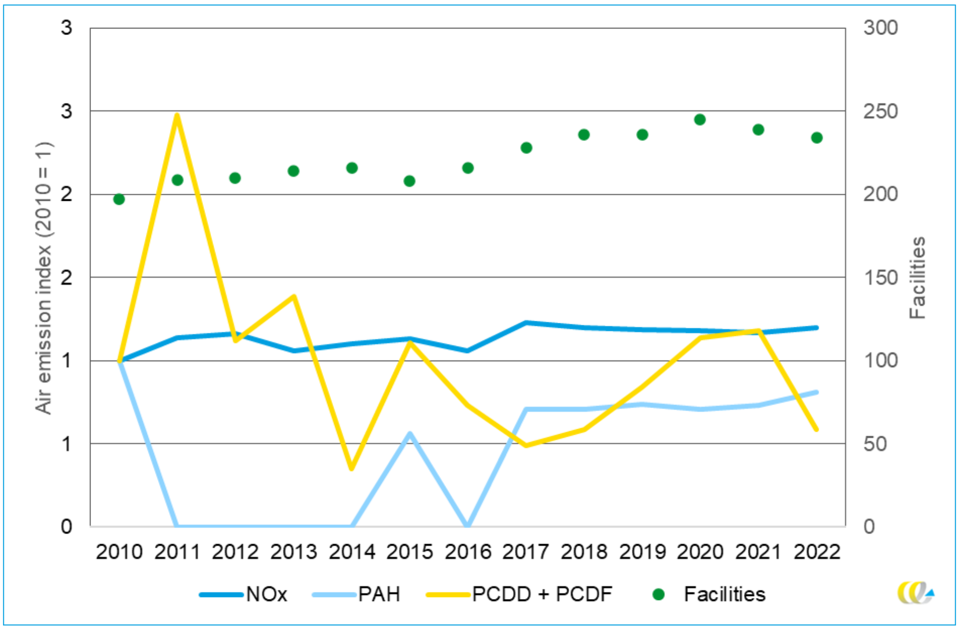
2.10 Effects on citizens

Analysis of pollutant emissions from waste incineration facilities between 2010 and 2022 reveals that, although the number of incineration facilities has increased, emissions of NO_x have remained relatively stable, see Figure 7 (European Environment Agency, 2025). However, PAHs and PCDD/PCDFs[10] show significant variability, indicating that there is still

[10] PAHs (Polycyclic Aromatic Hydrocarbons): toxic compounds formed during incomplete combustion of organic material.
PCDD + PCDF (Dioxins and Furans): highly toxic, persistent organic pollutants formed during waste combustion.

potential for further reduction, for example through recycling. Increased recycling reduces harmful emissions by diverting materials like plastics and organics from incineration, thereby lowering the formation of toxic compounds such as dioxins as the volume and composition of waste sent for combustion is significantly altered. Therefore, recycling can lead to improved air quality for citizens, with lower concentrations of fine particulate matter (e.g. $PM_{2.5}$, $PM_{10,}$ etc.).

Figure 6 - Pollutant emission from waste incineration



Source: (European Environment Agency, 2025).

At the same time also bottom ash formation has to be considered with waste incineration. Bottom ash is the residue that remains after the incineration of waste. In its raw form, bottom ash still contains many metals (ferrous and non-ferrous), which are recovered by waste-to-energy plants and specialised processing companies. After the recovery of these (valuable) materials, approximately 92% of the mass remains (CE Delft, 2022). A study by Equanimator Ltd for Zero Waste Europe reveals that municipal waste incineration produces over 12 million tonnes of bottom ash and approximately 2 million tonnes of air pollution control residues each year. Contrary to claims that incineration eliminates the need for landfills and allows full recovery of residues, the report estimates that between 11.3 and 16 million tonnes of incineration residues are still landfilled annually of which around 6.4 million tonnes originates specifically from municipal waste incineration (Equanimator Ltd, 2022). If not properly managed, bottom ash can pose environmental and health risks due to the potential leaching of heavy metals and toxic substances into soil and groundwater. This can lead to indirect human exposure, particularly through contaminated water sources or agricultural land.

2.11 Conclusion

Including incineration in the EU ETS will result in CO_2 emission reduction. Impacts from more pre-collection sorting ranges from 3.6 Mtonnes in 2030 in the fossil scenario up to approximately 6.9 Mtonnes in the fossil and biogenic scenario in 2030. In 2040, the reduction is 4.9 (fossil scenario) to 9.1 Mtonnes (fossil and biogenic scenario).
In addition, there is the potential for creating 8,700 up to over 21,000 additional jobs. Cost increases for households and companies and industries can be mitigated by recycling revenues from CO_2 emission credits from the government to households and businesses.

Effects from residual mixed waste sorting systems and CCS have not been quantified in this chapter but can be significant. In the next chapter we therefore assess the overall emission reduction within the EU ETS sector based on a different approach: calculation of CO_2 impacts based on the reduction of the annual cap. This calculation includes potential impacts from CCS and residual mixed waste sorting facilities.

3 Reduction within EU ETS sectors

3.1 Calculating emission reduction

If waste companies are included under the EU ETS, they will be stimulated to reduce their emissions. Waste companies may invest in residual mixed waste sorting systems, removing plastic packaging from waste and lower fossil CO_2 emissions of waste incineration. Furthermore, emissions of waste incineration may decrease when households and companies sort their waste better (pre-collection sorting, see chapter 2) and waste companies can invest in Carbon Capture and Storage (CCS) to reduce emissions.

Inclusion of waste incineration under EU ETS may not only reduce emissions within the waste sector. More recycling and waste prevention reduces CO_2 impacts over the total life cycle of products and materials (winning, production and usage of products and materials). Furthermore, waste companies will have to buy emissions rights from other sectors, stimulating greenhouse gas reduction measures in these sectors. For instance, if a steel company decarbonises, it can sell their remaining credits to waste companies. Waste incineration under EU ETS may therefore lead to emission reductions in both the waste sector and other sectors.

As an alternative to chapter 2, the emission reduction within all EU ETS sectors can be calculated based on the reduction of the cap on emissions. Each year the cap of the emission trading system decreases by 4.4%. If there are more emitters included in the system, the reduction factor of 4.4% leads to more emission reduction. For instance, lowering the cap of 4.4% per year in a system which includes 100 Mtonnes of emission rights is twice as high as a 4.4% reduction in a system with 50 Mtonnes.

Inclusion of waste incineration of the EU ETS countries (excluding Sweden, Denmark and Germany) will increase the fossil cap by around 30 Mtonnes (see Figure 7). If biogenic and fossil emissions would be included under the systems, the cap increases by 55 Mtonnes. The corresponding emission reduction of these increases of the cap, is respectively 4 to 7 Mtonnes in 2030[11] and 18 to 32 Mtonnes in 2040[12] (see Figure 7).

The reduction of 4 to 7 Mtonnes in 2030[13] and 18 to 32 Mtonnes in 2040[14] may result from a combination of emission reduction of waste incineration by CCS measures, pre- and post-collection sorting and recycling of waste, waste prevention and reduction measures in other sectors of EU ETS. These figures however only include Scope 1 emissions within EU ETS sectors and therefore represent the minimum reduction.

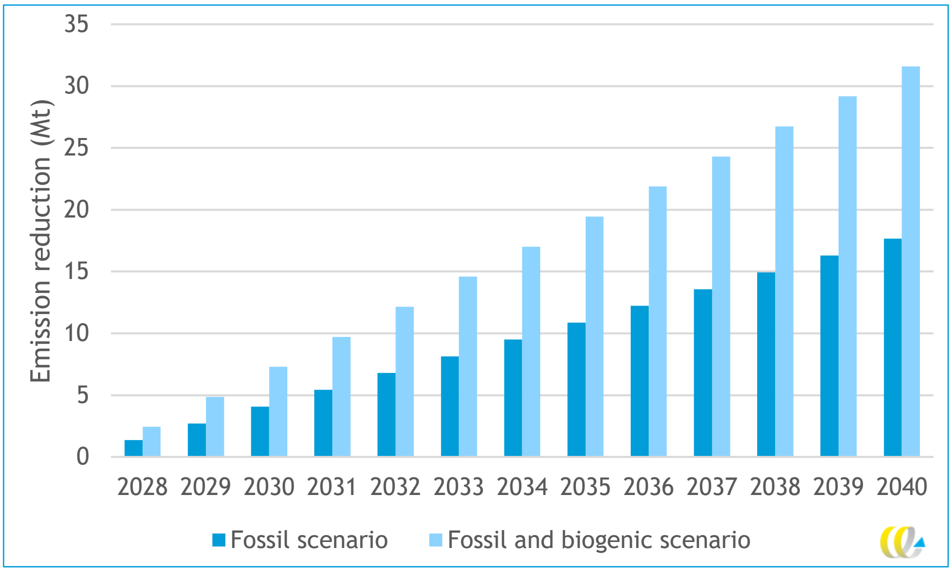
[11] Lowering the cap each year from 2028 by 4.4% leads to a reduction of 13% (3 * 4.4%) of emissions in 2030. The reduction is 13% * (30 to 55) Mtonnes = 4 to 7 Mtonnes.

[12] Lowering the cap each year from 2028 by 4.4% leads to a reduction of 57% (13 * 4.4%) of emissions in 2040. The reduction is 57% * (30 to 55) Mtonnes = 18 to 32 Mtonnes.

[13] Lowering the cap each year from 2028 by 4.4% leads to a reduction of 13% (3 * 4.4%) of emissions in 2030. The reduction is 13% * (30 to 55) Mtonnes = 4 to 7 Mtonnes.

[14] Lowering the cap each year from 2028 by 4.4% leads to a reduction of 57% (13 * 4.4%) of emissions in 2040. The reduction is 57% * (30 to 55) Mtonnes = 18 to 32 Mtonnes.

Figure 7 - Emission reduction if waste incineration is included under the EU-ETS system



In addition, emission reduction may occur outside the scope of EU ETS (Scope 2 and 3 emissions), as recycling and waste prevention reduces emissions over the total life cycle of products and materials from activities that do not fall under EU ETS. For instance, although European plastic production is part of EU ETS, waste prevention and recycling will also reduce imported plastics from outside the EU and results in emission reduction by less production of virgin plastics in countries like the United States and China. Extra emissions may also occur outside the scope of EU ETS because of the energy requirement of recycling activities. However, this would be limited as CO_2 emissions of recycling activities mostly result from electricity use and electricity production is part of EU ETS. The total emission reduction will therefore be larger than Scope 1 emissions within the EU ETS sector.

3.2 Conclusions

Incorporating waste incineration under EU ETS will result in total emission reductions of at least 4 to 7 Mtonnes in 2030 and 18 to 32 Mtonnes in 2040 within the EU ETS system. This is a minimum, as emission reduction outside the scope of EU ETS are not incorporated in these figures.

4 Conclusions

Zero Waste Europe requested CE Delft to assess the environmental benefits of incineration in EU ETS in 2030 and 2040. The main conclusions are as follows:

- Inclusion of incineration in EU ETS will stimulate sorting and recycling activities by households and companies. The impacts will be (much) larger for companies (19 to 45% waste reduction) than for households (2.8 to 8.7% waste reduction). This is first because companies act more rationally in terms of costs and benefits than households. Second, companies have a more direct price incentive if incineration is included under EU ETS. Impacts from more pre-collection sorting ranges from 3.6 Mtonnes in 2030 in the fossil scenario up to approximately 6.9 Mtonnes in the fossil and biogenic scenario in 2030. In 2040, the reduction is 4.9 (fossil scenario) to 9.1 Mtonnes (fossil and biogenic scenario). Impacts may be even larger than assessed in this study. Experiences in Sweden with EU ETS show that some waste companies have invested in after-sorting facilities to separate out plastic waste (Avfall Sverige, 2021). These installations can separate out plastics from the residual waste mix after collection of (unsorted) waste.

- An alternative approach is calculating the emission reduction under the EU ETS cap. Based on this approach, incorporating waste incineration under EU ETS will result in total emission reductions of at least 4 to 7 Mtonnes in 2030 and 18 to 32 Mtonnes in 2040 within the EU ETS system. The reduction may result from a combination of emission reduction of waste incineration by CCS measures, pre-collection sorting and residual mixed waste sorting, recycling of waste, waste prevention and reduction measures in other sectors of EU ETS. These figures represent a minimum, as emission reduction outside the scope of EU ETS are not incorporated in these figures.

- As recycling activities are more labour-intensive than incineration of waste or landfilling, incineration in EU ETS may result in 8,700 extra jobs in the fossil scenario 2030, up to over 21,000 jobs in the fossil and bio scenario in 2040.

- Cost increases for households and companies and industries can be mitigated by recycling incomes of CO_2 emission credits that could be recycled from the government to households and businesses and companies.

- Additional policies could be implemented to reinforce the impacts of including incineration in EU ETS, such as obligatory cost coverage from EPR for recyclables extracted from mixed waste after sorting, a mandatory recycled content for plastics, introducing more PAYT across municipalities in Europe or fiscal measures such as cheaper waste bins for separate collection.

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