Waste Incineration under the EU ETS

An assessment of climate benefits

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ZERO WASTE EUROPE

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Content

Summary

Municipal waste incineration is currently excluded from the European Emissions Trading System (EU ETS). If incineration is included, 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.

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

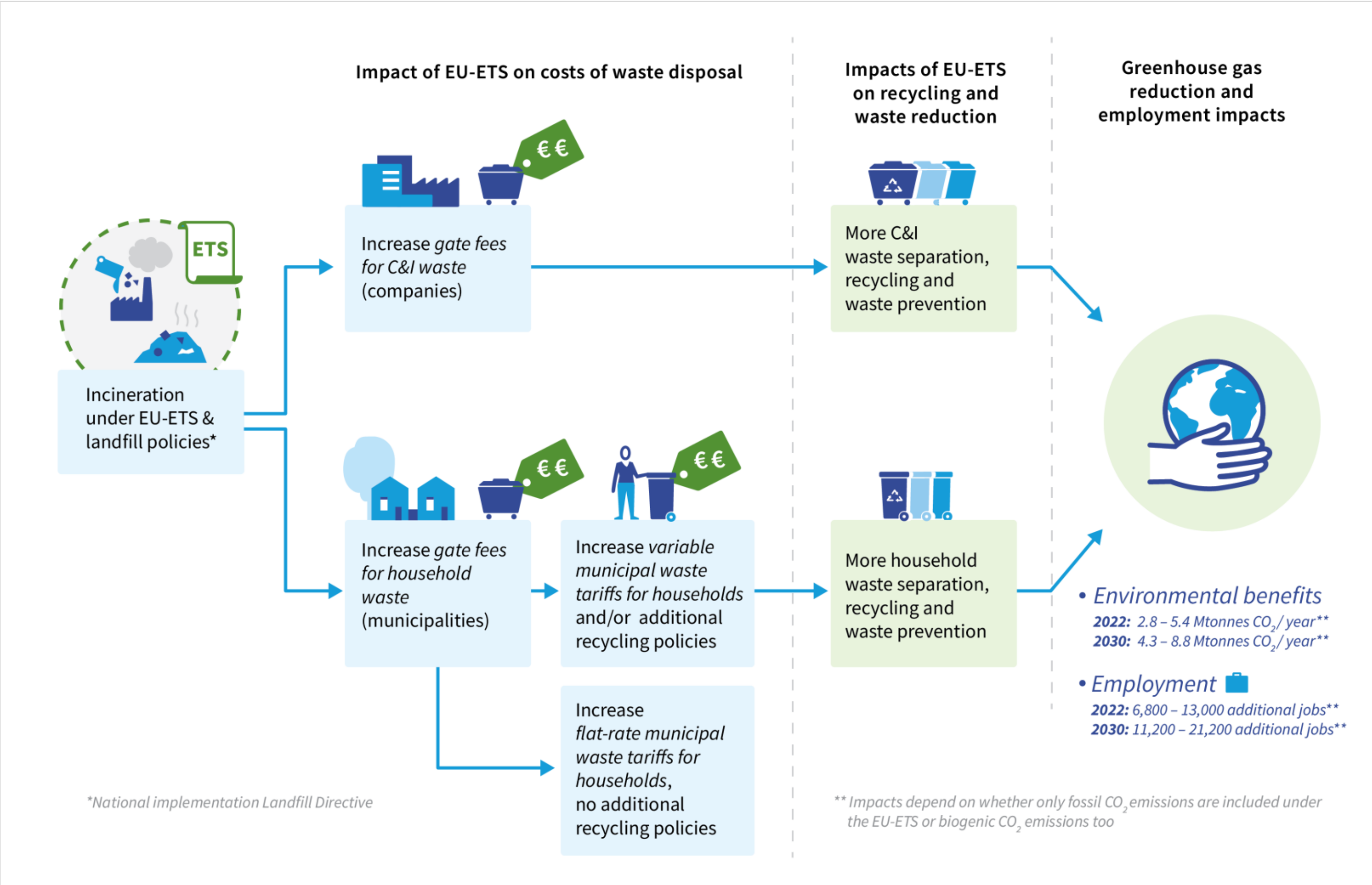
- CO_2 emissions are estimated to decrease by 2.8 to 5.4 Mt per year in 2022 and 4.3 to 8.8 Mt per year in 2030. The benefits gradually increase up to 2030 because carbon prices are expected to rise, making recycling relatively more competitive. The upper end of the range reflects the benefits if both fossil CO_2 emissions (CO_2 emissions from e.g., incinerating plastics) and biogenic CO_2 emissions (stemming from incinerating food waste) are included under the EU ETS. The lower bound reflects the benefits if only fossil CO_2 emissions are included.

- Additional jobs amount to 6,800 to 13,000 in 2022 and 11,200 to 21,200 in 2030. Extra jobs will be created since recycling activities are more labour-intensive than waste incineration.

By far the greatest benefits (over 90%) can be attributed to company and industrial waste reduction. This is, first, because companies act more rationally in terms of costs and benefits than households, leading to more waste prevention as prices increase. Second, companies have a more direct price incentive if incineration is included under the EU ETS. Households are not charged directly for their waste disposal, as it is municipalities that are responsible for waste collection and transport to incinerators, with citizens generally paying municipalities a fixed price rather than per kg waste.

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, introduction of more variable tariffs across municipalities in Europe, or cheaper waste bins for separate collection. The impacts of incineration under the EU ETS are summarised in Figure 1.

Figure 1 - Impacts of incineration under the EU ETS



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.

Since its inception in 2005 the EU ETS has been (or will be) expanded to include more sectors. Aviation has been included under EU ETS since 2012.[1] The 'Fit for 55' package, published by the European Commission in July 2021, presented legislative proposals to extend the scope of the EU ETS to shipping and introduce a separate Emissions Trading System for road transport and buildings.

Municipal waste incineration is still specifically excluded from the EU ETS, however. The EU ETS regulations state that activities are excluded if the primary purpose of an installation is the incineration of hazardous or municipal waste.[2] According to the Confederation of European Waste-to-Energy Plants (CEWEP), there are around 390 so-called waste-to-energy plants operating in the countries participating in the EU ETS.[3] In 2018 these plants together emitted 79 Megatonnes (Mt) of CO_2: 43 Mt from fossil waste and 36 Mt from organic waste.

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. Zero Waste Europe asked CE Delft to conduct a study to determine the potential climate benefits of extending the scope of the EU ETS to municipal waste incineration. This report presents the results of that exercise.

1.2 Objective

The objective of this study is to determine 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' scenario, 43 Mt in 2018).
2. Extending the scope to CO_2 emissions of both fossil and organic origin ('fossil and biogenic CO_2' scenario, 79 Mt in 2018).

[1] Although only for flights within the European Air Space.
[2] "An installation's primary purpose is considered to be the incineration of hazardous or municipal waste where this waste is combusted, with or without heat recovery, and where the installation will shut down in the event that the supply of waste is interrupted for any period of time."
[3] EU27 and Norway, Iceland and Liechtenstein, excluding Denmark and Sweden, as incineration is these countries is already included under the EU ETS.

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

1.3 Considerations on potential redirection of waste to landfill

The residual waste treatment capacities vary between countries. In South and Eastern Europe, particularly, landfilling is still the predominant treatment method for municipal waste. 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.

When considering the potential re-direction of residual waste form incineration to landfills then the EU Landfill Directive already restricts impacts of landfills waste by:
1. Mandating pre-treatment of waste.
2. Setting a target of 10% for the share of municipal waste landfilled in 2035.
3. Imposing restrictions on landfilling of all waste that is suitable for recycling or other material or energy recovery from 2030.
4. Obliging EU countries to implement national strategies to progressively reduce the amount of biodegradable waste sent to landfill.

In this 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 and Denmark, 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. Following Brexit, on 1 January 2021 the UK left the EU ETS and implemented its own Emissions Trading Scheme (UK ETS). British waste incinerators are therefore not included in the assessment, although the UK government could decide, in line with EU decisions, to include municipal incinerators in the UK ETS as well.

In addition, in assessing environmental impacts our focus is on waste prevention and recycling activities. While including incineration in the EU ETS may also move waste companies to use carbon capture to reduce their CO_2 emissions, such measures are not considered here. Our study is therefore a conservative assessment of total potential CO_2 reductions.

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 in the current situation (2021, EU ETS price 55 €/tonne) and the year 2030 (projected price of 90 €/tonne).

1.5 Approach and outline

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) (Chapter 2).

2. In the second step (Chapter 3) 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 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.

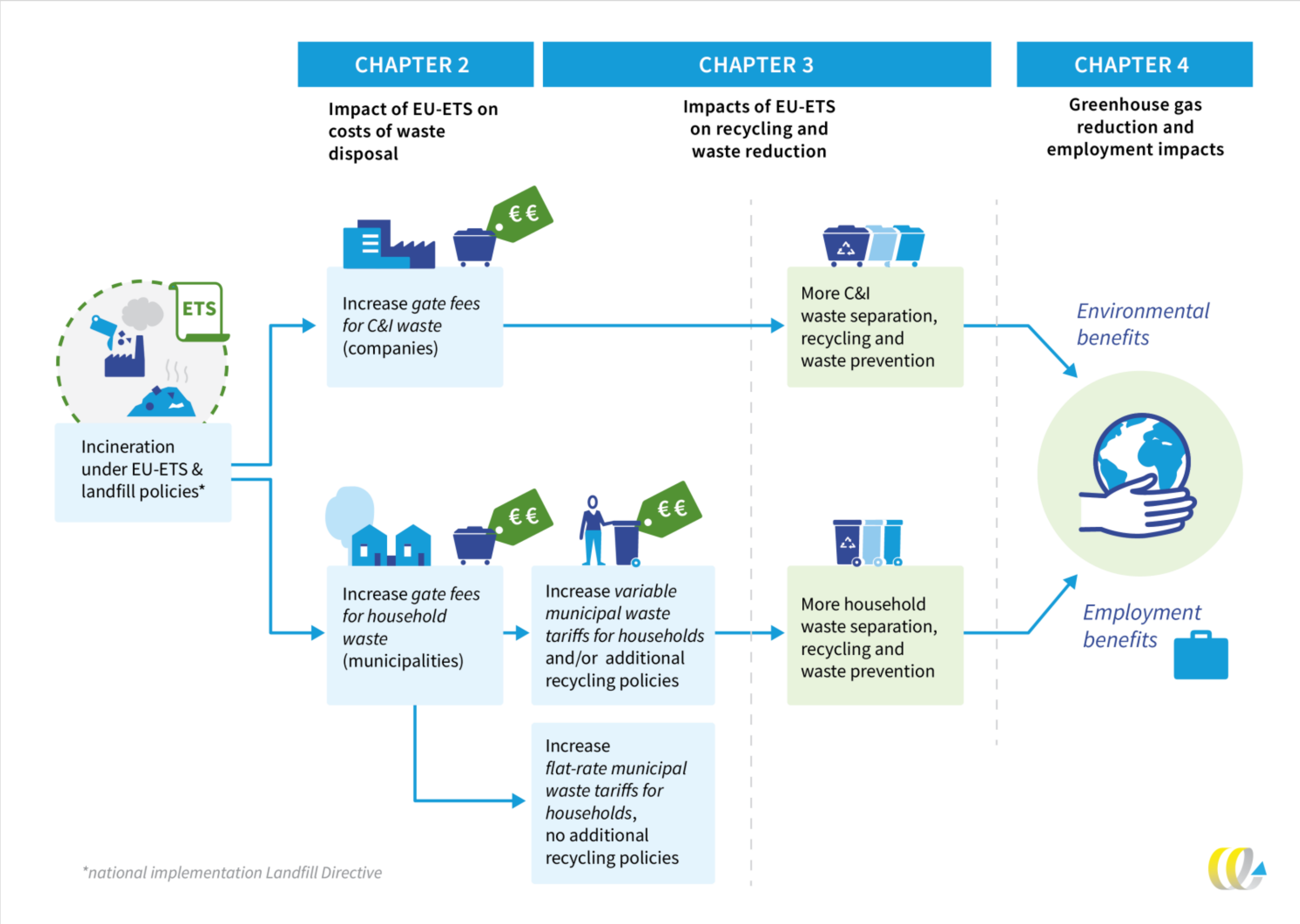
   - Households are charged for domestic refuse disposal by municipalities, which will have to pass the increased cost of incineration through to households. If this is by way of a variable tariff paid per kg of waste disposed of, households will be incentivised to greater recycling and/or waste prevention. 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. If costs are passed through to households by increasing a flat rate (common practice in e.g., Greece and 50% of Dutch municipalities) and no additional recycling policies are implemented, the impacts on extra recycling and/or waste prevention will be very limited or absent.

3. In the third step (Chapter 4) 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.

4. In the final step (Chapter 5) the conclusions and recommendations are presented.

The analytical framework of this study is presented in Figure 2.

Figure 2 - Analytical framework



2 Impact of EU ETS on costs of waste disposal

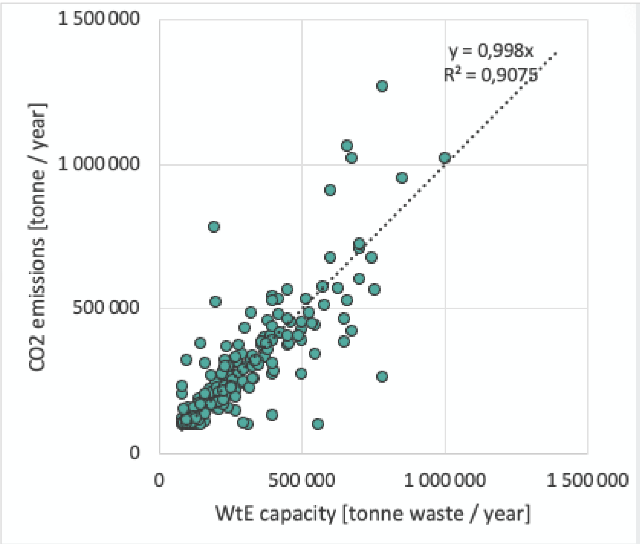
2.1 Impact of EU ETS on cost of incineration

The first question is how much the total cost of waste disposal (collection and incineration) will increase if incineration is included in the EU ETS, obliging waste companies to pay for each tonne of CO_2 emitted. This will depend on the policy design. Two options are considered:

1. Only CO_2 emissions of fossil origin are included in the EU ETS ('fossil CO_2 scenario', FC scenario).
2. CO_2 emissions of both fossil and organic origin are included ('fossil and biogenic CO_2' scenario, FBC scenario).

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 (see Figure 3 and Table 1).

Figure 3 - CO_2 emissions (fossil and biogenic) and capacity for 252 waste-to-energy plants in Europe



Source: CEWEP and CaptureMap[4].

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 the present study, however.

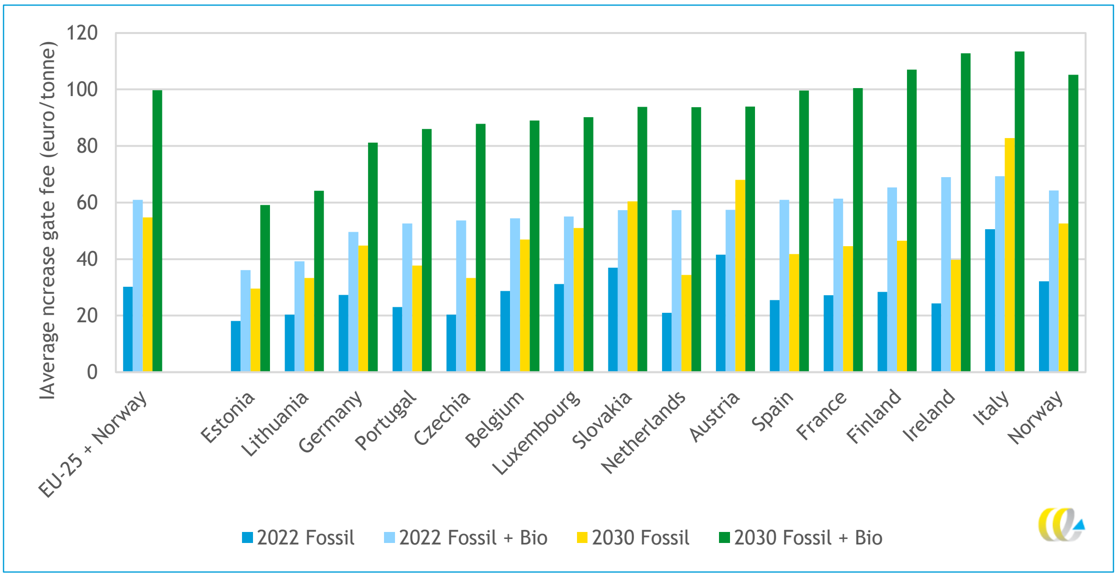
[4] Endrava : The CCS potential for Waste-to-Energy plants

In the FC scenario the cost increase will depend on the relative proportion of fossil waste incinerated. In Ireland and the Netherlands, for example, the share in the mix is around 35%. Given that this scenario only considers fossil emissions, for each tonne of waste the price will be lower than in countries with higher fossil shares, such as Austria (72%) and Italy (73%).

The current EU ETS price is 55[5] € per tonne CO_2. Based on this price, gate tariffs in Europe will increase on average by 30 to 61 € per tonne of waste in the FC and FBC scenario, respectively (see Figure 4 and Table 1).

How prices will increase in the future will depend on development of the carbon price and is therefore inherently uncertain. ICIS forecast the EU ETS price increasing to up to 90 € per tonne by 2030.[6] If all costs are passed through, this will increase gate fees in Europe on average by 55 to 100 € per tonne of waste in the FC and FBC scenario, respectively.

Figure 4 – Impact on cost price incineration per scenario



5 Sandbag: Tracking the European Union Emissions Trading System carbon market price day-by-day

6 Source: Euractiv: Analyst: EU carbon price on track to reach €90 by 2030 The currently high EU ETS carbon price is driven by: 1) the 2018 ETS reform; 2) high gas prices, and 3) expectations of a tighter supply of CO_2 allowances until 2030. By 2030, ICIS anticipates carbon prices hitting €90 per tonne and electricity firms building up reserves of CO_2 allowances in anticipation of a tighter market.

Table 1 – CO_2 emissions from incinerators in 2018 and EU ETS costs per tonne waste

							Price EU ETS 55 €/tonne		Price EU ETS 90 €/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	2,600	749	1,964	2.712	72%	1.04	42	57	68	94
Belgium	3,390	1,587	1,767	3.354	53%	0.99	29	54	47	89
Bulgaria	NA	122	136	258	53%	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	670	406	248	654	38%	0.98	20	54	33	88
Denmark	3,400	2,439	1,779	4,218	42%	1.24	29	68	47	112
Estonia	210	69	69	138	50%	0.66	18	36	30	59
Finland	1,620	1,088	837	1,925	43%	1.19	28	65	47	107
France	14,000	8,689	6,937	15,626	44%	1.12	27	61	45	100
Germany	26,300	10,631	13,077	23,708	55%	0.90	27	50	45	81
Greece	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hungary*	370	263	630	893	71%	2.41	94	133	153	217
Ireland	720	585	318	902	35%	1.25	24	69	40	113
Italy	6,330	2,157	5,820	7,977	73%	1.26	51	69	83	113
Latvia	NA	104	131	235	56%	NA	NA	NA	NA	NA
Lithuania	260	89	96	185	52%	0.71	20	39	33	64
Luxembourg	170	74	96	170	56%	1.00	31	55	51	90
Malta	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Netherlands	7,480	4,934	2,857	7,791	37%	1.04	21	57	34	94
Norway	1,660	970	970	1,940	50%	1.17	32	64	53	105
Poland*	950	412	5,213	5,625	93%	5.92	302	326	494	533
Portugal	1,130	606	473	1,079	44%	0.96	23	53	38	86
Romania	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Slovakia	230	85	154	240	64%	1.04	37	57	60	94
Slovenia	NA	20	13	32	40%	NA	NA	NA	NA	NA
Spain	3,010	1,935	1,397	3,332	42%	1.11	26	61	42	100
Sweden	5,920	3,836	2,377	6,213	38%	1.05	22	58	36	94
Total excl. Sweden & Denmark	71,100	35,574	43,205	78,778	55%	1.11	30	61	55	100

Source ktonnes waste incineration (CEWEP, 2021) Source CO_2 emissions (UNFCCC country reports).

* CO_2-impacts per tonne in Poland and Hungary seem to be too high. Data might therefore not be accurate.

2.2 Impacts of EU ETS on total cost of waste disposal

Household waste

To assess the incentive for recycling and waste prevention using price elasticities, the relative price increase must first be determined. In other words, by what percentage will the cost of waste disposal (collection, transport and incineration) increase compared with the pre-EU ETS situation? Table 2 and Figure 5 present the average gate fees and collection and transport costs for household waste in selected EU Member States.

Figure 5 - Costs for collection and incineration of non separated household waste for selected EU Member States (euro per tonne)

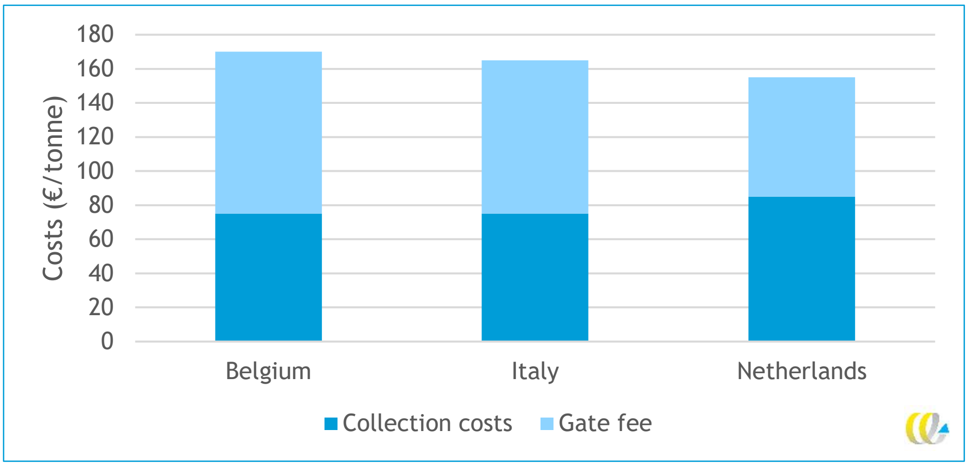


Table 2 - Costs for collection and incineration of non separated household waste for selected EU Member States (euro per tonne)

	Collection	Gate fee	Total costs
Belgium	75 (60-90)	95 (N.A)	170 (N.A.)
Italy	75 (50-250)	90 (65-115)	165 (115-365)
Netherlands	85 (80-100)	70 (55–85)	155 (135-185)

Sources: (Watkins et al., 2012); (NVRD, 2019); (OVAM, 2020); (Eunomia & Ecotec, 2001); (Moretto et al., 2019).
N.A.: range not available.

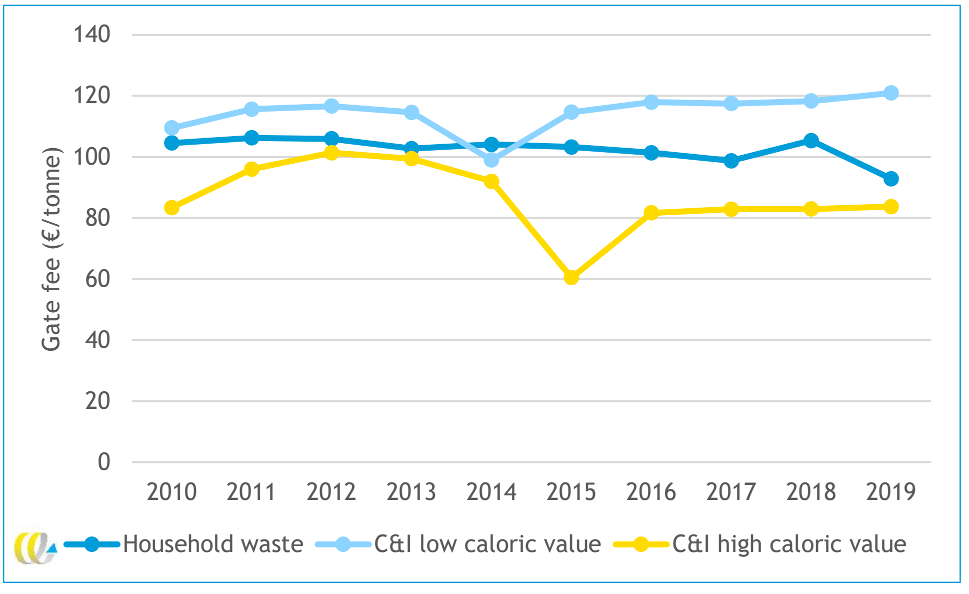
Variations in costs among country can be explained by differences in labour costs, capital costs and national policies and standards, including (Eunomia ; Ecotec, 2001):
- Incineration taxes and import tariffs (e.g. 33 euro/tonne in the Netherlands).
- Public shareholders that own incinerators and use a part of the operating profits for social purposes.
- Subsidies for heat and electricity sales (lowering gate fees, e.g. Spain and Italy with elevated prices for electricity).
- Varying incineration capacities and waste volumes.
- Revenues received for recovery of packaging materials (e.g. Italy).
- Subsidies on capital costs (e.g. Netherlands, Portugal and Spain).
- Operating standards and technologies used for air pollution control.
- Treatment and disposal standards/recovery of ash residues.

- Variations in typical situation regarding number of collection points passed per unit time.
- The nature of the setting out of residual waste and the costs of containers used.
- Variations in quantity of residual waste collected per collection point (lower volumes mean higher costs per tonne).
- The vehicles used (and their maximum payload).
- Labour costs.

C&I waste

There is limited publicly available data on gate fees for company and industrial waste. The waste authority in Flanders (Belgium) has published average tariffs for both household and company waste for the period 2008-2019 (OVAM, 2020). These data show that tariffs for company waste depend on the waste's caloric value, low-caloric waste being more expensive than household waste, while company waste with a high-caloric value has a lower tariff. If tariffs for low- and high-caloric value waste are averaged, fees work out more or less comparable to gate fees for household waste.

Figure 6 - Gate fees for household and company waste in Flanders 2009-2019



Source: (OVAM, 2020).

Tolvik Consulting, (2015) reports C&I gate fees for Germany over the period 2010-2014. In northern Germany, spot prices ranged from about €65 to €120 per tonne in 2010, decreasing to 60 to 90 € per tonne in 2014. In the west of the country spot prices ranged between 60 and 90 € per tonne from 2010 to 2014. Gate fees thus tend to be rather lower in Germany than in Belgium, at least in the period 2010-2014. However, differences might also be explained by the fact that Tolvik Consulting, (2015) reports spot prices, while the Belgian gate fees may be an average of long-term contract prices and spot prices (this is not specifically mentioned in (OVAM, 2020)).

Data on collection costs for company waste are also scarce. Transport costs for company waste tend to be lower than for households waste. in Belgium these costs are estimated at 30 € per tonne (Tritel & CE Delft, 2012). In the Netherlands, costs of approximately 40% are

cited (10% for container rental, 30% for collection).[7] If applied to Belgium, this would result in tariffs of 30 to 50 € per tonne for collection and transport of company waste.
Total costs for C&I waste are in the range of 130 to 150 € per tonne.

Figure 7 - Costs for collection and incineration of C&I waste in Flanders (Belgium)

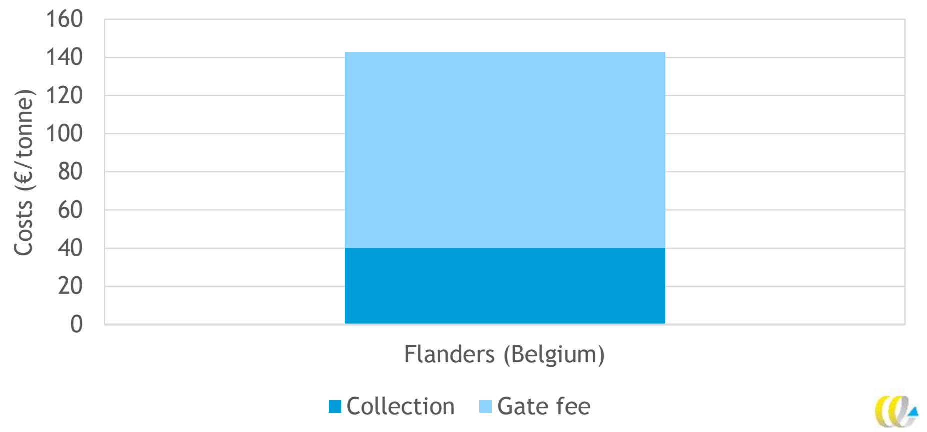


Table 3 - Costs C&I waste

	Collection costs	Gate fee	Total costs
Flanders (Belgium)	30-50	100*	130-150

* Average for low and high-caloric value.

2.3 Conclusion: cost increases per scenario

Combining the outcomes of Section 2.2 and Section 2.3 yields the following results. If all costs are passed through, cost increases for household waste range from 14% (Netherlands, FC scenario 2022) to 69% (Italy, FBC scenario, 2030).

[7] Kosten rolcontainer, betaal voor het gewicht - wel zo eerlijk!

Figure 8 - Increase costs of household waste collection and incineration (%)

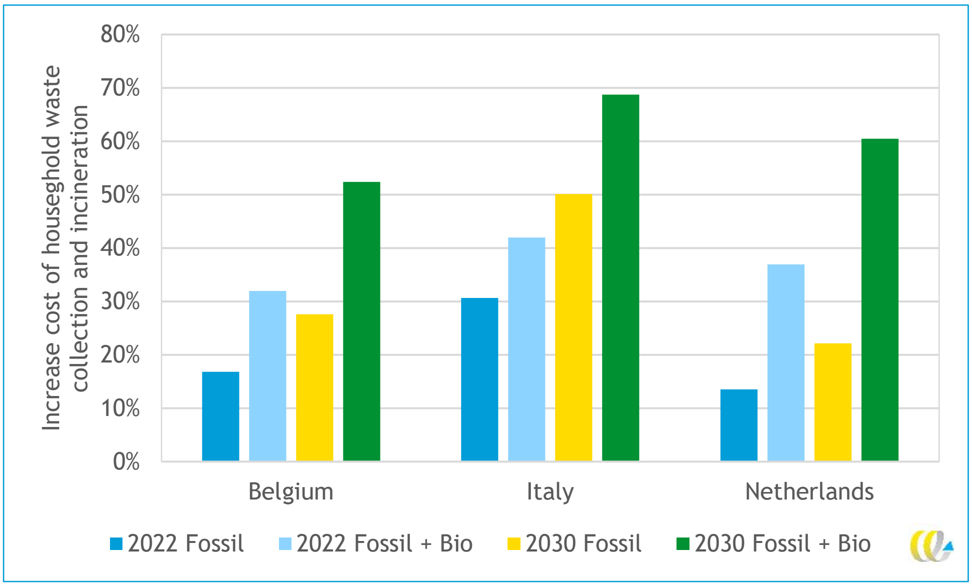


Table 4 - Cost increases household waste (€/tonne waste and % increase collection and incineration costs)

Country	Current collection and incineration costs	Price increase scenario fossil CO_2 2021 (EU ETS 55 €/tonne)		Price increase scenario fossil CO_2 2030 (EU ETS 90 €/tonne)		Price increase scenario fossil and biogenic CO_2 2021 (EU ETS 55 €/tonne)		Price increase scenario fossil and biogenic CO_2 2030 (EU ETS 90 €/tonne)	
	€/t waste	€/t waste	%	€/t waste	%	€/t waste	%	€/t waste	%
Belgium	170	29	17%	47	28%	54	32%	89	52%
Italy	165	51	31%	83	50%	69	42%	113	69%
Netherlands	155	21	14%	34	22%	57	37%	94	60%

Source: Own calculation.

For C&I waste, costs in Belgium (the only country with publicly available information on C&I gate tariffs) increase by 20% (FC scenario) and 38% (FBC scenario) in 2021. In 2030, costs for C&I waste increase by 33% (FC scenario) and 62% (FBC scenario).

Figure 9 - Cost increases company and industrial waste (Belgium)

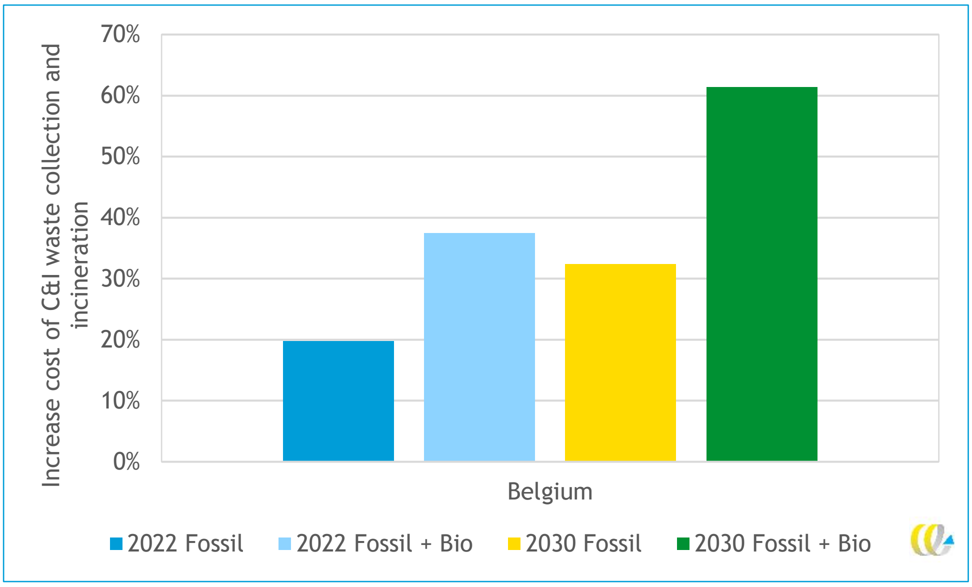


Table 5 - Cost increases company and industrial waste (€/tonne waste and % increase in collection and incineration costs)

Country	Current collection and incineration costs	Price increase scenario FC scenario 2022 (EU ETS 55 €/tonne)		Price increase scenario FC scenario 2030 (EU ETS 90 €/tonne)		Price increase scenario FBC scenario 2022 (EU ETS 55 €/tonne)		Price increase scenario FBC scenario 2030 (EU ETS 90 €/tonne)	
	€/t waste	€/t waste	%	€/t waste	%	€/t waste	%	€/t waste	%
Belgium	145	29	20%	47	33%	54	38%	89	62%

Source: Own calculation.

In the next chapter, we will estimate the impact of these cost increases on recycling and waste prevention activities for households and companies.

3 Impacts of EU ETS on recycling and waste reduction

3.1 Impacts on household waste

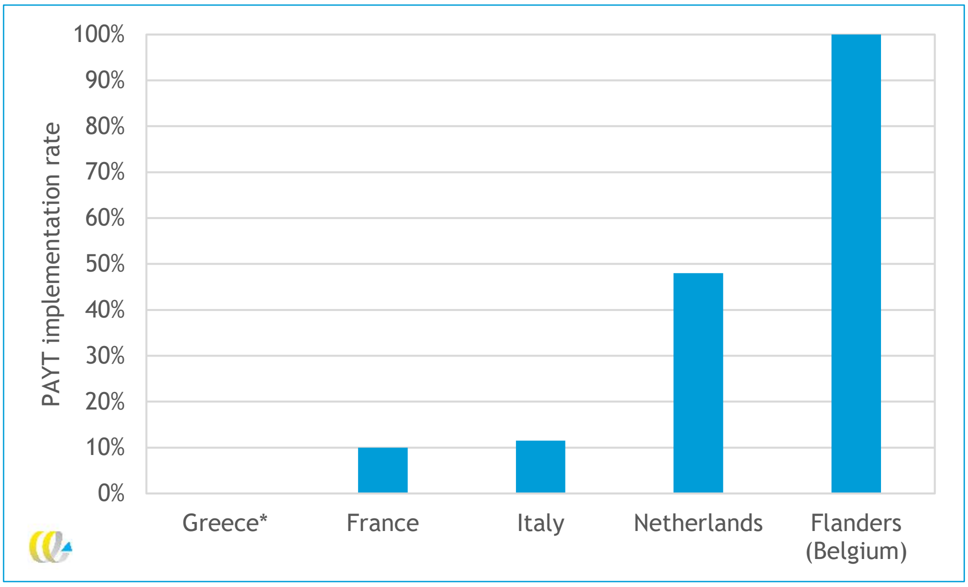
Cost-pass-through from municipalities to households

The impact of including waste incinerators in the EU ETS on recycling and prevention of household waste will depend on the extent of pass-through of cost increases from municipalities to households. Impacts occur under the following conditions:

- Municipalities charge households via 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.

Roll-out of PAYT schemes differs significantly among and within Member States. In Italy (Drosi et al., 2020) and France, around 10% of municipalities have implemented such a scheme, though the share of households will probably be lower, as it is relatively smaller municipalities where it has been implemented. In the Netherlands 48% of municipalities have implemented PAYT, with the share of households standing at 36% (Rijkswaterstaat, 2020), while in Flanders (Belgium) it is now standard in all municipalities (ADEME & GIRUS, 2018); (IPR Nomag, 2021) . In Greece there is limited experience with PAYT, gained mostly from pilot-scale programmes. According to (Vitoraki, 2019), lack of appropriate legislative support is creating barriers and reducing the potential for implementation at the municipal and national level.

Figure 10 – Rate of implementation PAYT schemes for selected Member States (share of municipalities)



* No data available but limited.

Source: (ADEME & GIRUS, 2018); (Drosi et al., 2020); (Vitoraki, 2019); (IPR Nomag, 2021).

The incentives for increased separation of household waste will therefore differ substantially across Member States. In the Netherlands and Flanders (Belgium) particularly, increased waste disposal costs may have an impact if municipalities opt for cost-pass-through via a variable tariff. In South European countries the impacts will probably be low. However, the number of municipalities with PAYT schemes is increasing across Europe. By 2030, impacts may therefore be greater if more municipalities have implemented PAYT schemes. Furthermore, increases in incineration costs may also encourage municipalities to implement more recycling policies. Results in the Netherlands, among other countries, have shown that municipalities with PAYT policies have higher recycling rates and lower for waste disposal costs.

Impacts will only occur when local governments opt for cost-pass-through via a variable tariff. A recent evaluation of Dutch PAYT schemes (IPR Nomag, 2021) showed that municipalities set their variable tariffs based on (a) social and political acceptability and (b) the actual costs of waste collection and incineration. The tariff must be high enough to incentivise sorting behaviour but not too high, in order to prevent fly-tipping or waste transfer to neighbouring municipalities with no PAYT scheme. In most cases a hybrid approach is taken, with the variable tariff rate at first based on social acceptability, but increasing if collection and incineration costs increase. It therefore seems plausible that an increase in incineration costs will lead to an increase in variable tariffs for households, too.

However, most Dutch PAYT municipalities cannot be regarded as pure PAYT schemes, as households are charged via both a fixed fee (often over 50% of the overall tariff) and a variable rate. This is also the case in Italy, for instance. One of the arguments for a fixed fee is that a 100% variable rate would lead to less financial stability and lower guaranteed incomes. Municipalities with PAYT could therefore also opt to increase the fixed charge (or finance the extra costs from the general budget). We estimate that Dutch municipalities with PAYT schemes will pass-through 50% of the cost increase in the variable tariff and 50% in the fixed charge. For municipalities with no PAYT, we expect significant impacts only if the local government decides to implement additional recycling policies because of the increased cost of waste management.

Impact on reduction and recycling of household waste

A precondition for increased sorting of household waste is that there are due provisions for such behaviour, in the form of separate bins for paper, plastic, cans, organic waste and so on. Research on price elasticities shows that in Dutch municipalities with PAYT schemes the amount of unsorted waste decreases substantially, with the price elasticity ranging from -0.1 and -0.3. This means that a 10% higher tariff would result in 1-3% less unsorted waste (Allers & Hoeben, 2010). The upper boundary of the price elasticity is for municipalities that have just implemented a PAYT scheme, the lower boundary for municipalities where PAYT has been in place for longer and separation rates are already higher.

The Dutch results are comparable with the results of studies conducted in the USA, where price elasticities for household waste range from -0.03 to -0.45, i.e. a 10% higher tariff leads to a reduction in unsorted waste of 0.3 to 4.5%.

Table 6 - Price elasticities for household waste in the USA

Study	Region	Price elasticity
Wertz (1976)	San Francisco	-0.15
Hong et al (1993)	Portland	-0.03
Jenkins (1993)	14 municipalities in USA	-0.12
Reschovsky and Stone (1994)	Tompins Country, New York	-0.24
Strathman et al. (1995)	Portland	-0.45

Source: (Bartelings et al., 2005).

Given the results of Allers&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 7 would double as well.

Table 7 - Reduction of unsorted household waste per scenario

	FC scenario 2022	FBC scenario 2022	FC scenario 2030	FBC scenario, 2030
Belgium	-1.7%	-3.2%	-2.8%	-5.2%
Italy	-0.4%	-0.5%	-0.6%	-0.8%
Netherlands	-0.5%	-1.3%	-0.8%	-2.2%
France	-0.2%	-0.4%	-0.3%	-0.6%

3.2 Impacts 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.[8] Higher substitution elasticities mean these sectors are more sensitive and responsive to price changes.

Table 8 - 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 sector	- 0.31
Total	- 0.4

Source: (Bartelings et al., 2005).

Reduction of C&I waste

Given the price elasticity of -0.4, the amount of unsorted company waste will decrease by 8% (FC scenario) and 15% (FBC scenario) in 2021. In 2030, the reduction will be 13 and 25% for the respective scenarios.

Table 8 - Price increase and reduction of C&I waste per scenario

Belgium								
Price increase FC scen 2022	Price increase FBC scen 2022	Price increase FC scen 2030	Price increase FBC scen 2030	Price elasticity	Waste reduction FV scen 2022	Waste reduction FBC scen 2022	Waste reduction FC scen 2030	Waste reduction FBC scen 2030
20%	38%	32%	61%	-0.4	-8%	-15%	-13%	-25%

8 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.

3.3 Conclusion

The increase in gate fees will incentivise sorting and recycling by both households and companies, though (much) more for companies (8 to 25%) than for households (0.2 to 5%). This is, first, because companies act more rationally in terms of costs and benefits than households and, second, because companies have a more direct price incentive if incineration is included in the EU ETS. In the next chapter we assess the environmental and employment impacts of this increased sorting and recycling behaviour.

4 Greenhouse gas reduction and employment impacts

4.1 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 9 shows, recycling results in a net climate benefit of 0.75 tonne CO_2 per tonne waste.

Table 9 - Climate benefit of recycling one tonne of municipal waste in Europe versus incineration

	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).

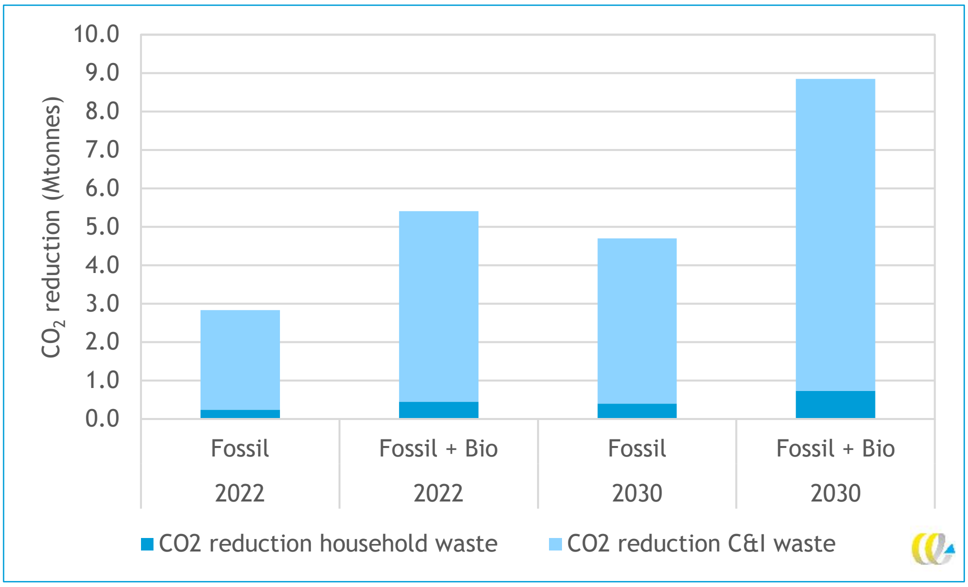
The question now is to what extent the composition of municipal waste reported in Table 9 is representative of the waste incinerated in municipal incinerators across the EU. According to CEWEP, approximately 50% of waste treated in municipal incinerators is company and industrial waste. To some extent, waste from companies is already included in the definition of municipal waste. Municipal waste is produced mainly by households, though similar waste from sources such as commerce, offices and public institutions are also included (EEA, 2013).

Little data is available on the composition and volume of waste streams other than municipal waste in incinerators. In its latest update on waste composition in the UK, Defra (Government Statistical Service, 2020)reports that the majority of incinerated waste (80%) consists of household and similar waste, with a relatively small proportion consisting of woody waste (6%) and the remainder unspecified. In Flanders (Belgium), approximately 10% of the waste consists of sludge (OVAM, 2020) in the Netherlands this stream is less than 3% (RWS, 2020). 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 9 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 11 shows the emission reduction for the EU27 minus Denmark and Sweden (where incinerators are already operated under the EU ETS) plus Norway. The figure shows that estimated CO_2 emission reduction impacts range from 2.8 Mtonnes per year in 2022 in the fossil scenario up to 8.8 Mtonnes per year in the fossil and bio scenario in 2030. Over 90% of the environmental benefits result from C&I waste reduction, as waste reduction for companies and industries is much more significant (see also Chapter 3). Impacts on household waste may be larger than assessed in this study. Experience in Sweden with the EU ETS shows that some waste companies have invested in post-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. The climate benefits of these post-sorting activities have not been estimated in this study.

In addition, climate impacts may be greater if more waste is prevented instead of recycled (Eunomia, 2015). 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.

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.

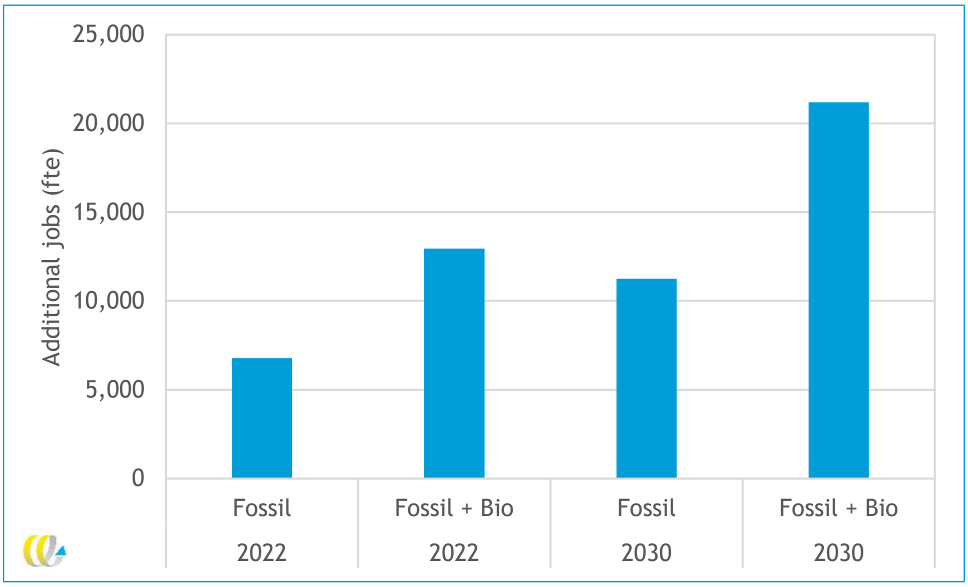
Figure 11 - Emission reduction in EU27 minus Denmark and Sweden, plus Norway



4.2 Impacts 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&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 if incinerator capacity is used for landfill waste), job creation ranges from 6,800 extra FTE in the fossil scenario in 2022, up to over 21,000 FTE in the fossil and bio scenario in 2030.

Figure 12 - 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.

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 (CE Delft, 2013).
Hall&Nguyen, (2012) reports 0.3 jobs per 1,000 tonnes for incineration and 0.1 jobs for landfilling.

4.3 Impacts on households and companies

Various studies, such as CE Delft, (2013), Ellen Mc Arthur Foundation, (2015) and Mc Kinsey, (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.

4.4 Conclusion

Including incineration in the EU ETS will result in CO_2 emission reduction impacts ranging from 2.8 Mtonnes in 2022 in the fossil scenario up to approximately 8.8 Mtonnes in the fossil and bio scenario in 2030. Over 90% of the environmental benefits result from C&I waste reduction. In addition, there is the potential for creating 6,800 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.

5 Conclusions

Zero Waste Europe asked CE Delft to determine the environmental benefits of incineration in EU ETS. 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 (8 to 25% waste reduction) than for households (0.2 to 5% 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.

- Incineration in EU ETS may reduce CO_2 emissions ranging from 2.8 Mtonnes per year in 2022 in the fossil scenario up to 8.8 Mtonnes per year in the fossil and bio scenario in 2030. Over 90% of the environmental benefits result from C&I waste reduction. These figures are based on averages as benefits depend on the efficiency of energy production from WTE plants which vary per country.

- Impacts on household waste may be 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. The climate benefits of these after-sorting activities have not been estimated in this study.

- As recycling activities are more labour-intensive than incineration of waste or landfilling, incineration in EU ETS may result in 6,800 extra jobs in the fossil scenario 2022, up to over 21,000 jobs in the fossil and bio scenario in 2030.

- 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.

- In several countries, such as the Netherlands, there are taxes on incineration. In this assessment we assume that national policies remain unchanged if incineration is included in the EU ETS. If national government decide to abolish these taxes, the impacts assessed in this study may be lower.

- Additional policies could be implemented to reinforce the impacts of including incineration in EU ETS, such as an 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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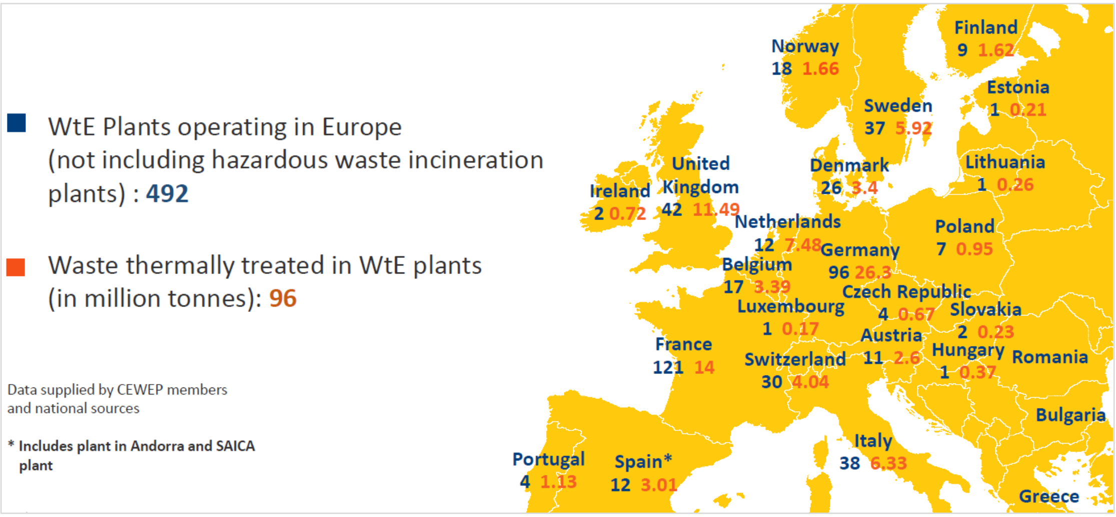
A Incineration capacity and shipment of waste

Figure 13 shows that there are some 500 incinerators operating in Europe, burning 96 million tonnes (Mt) of waste.

Figure 13 - Number of incineration plants in 2018 and treatment of waste (Mton)

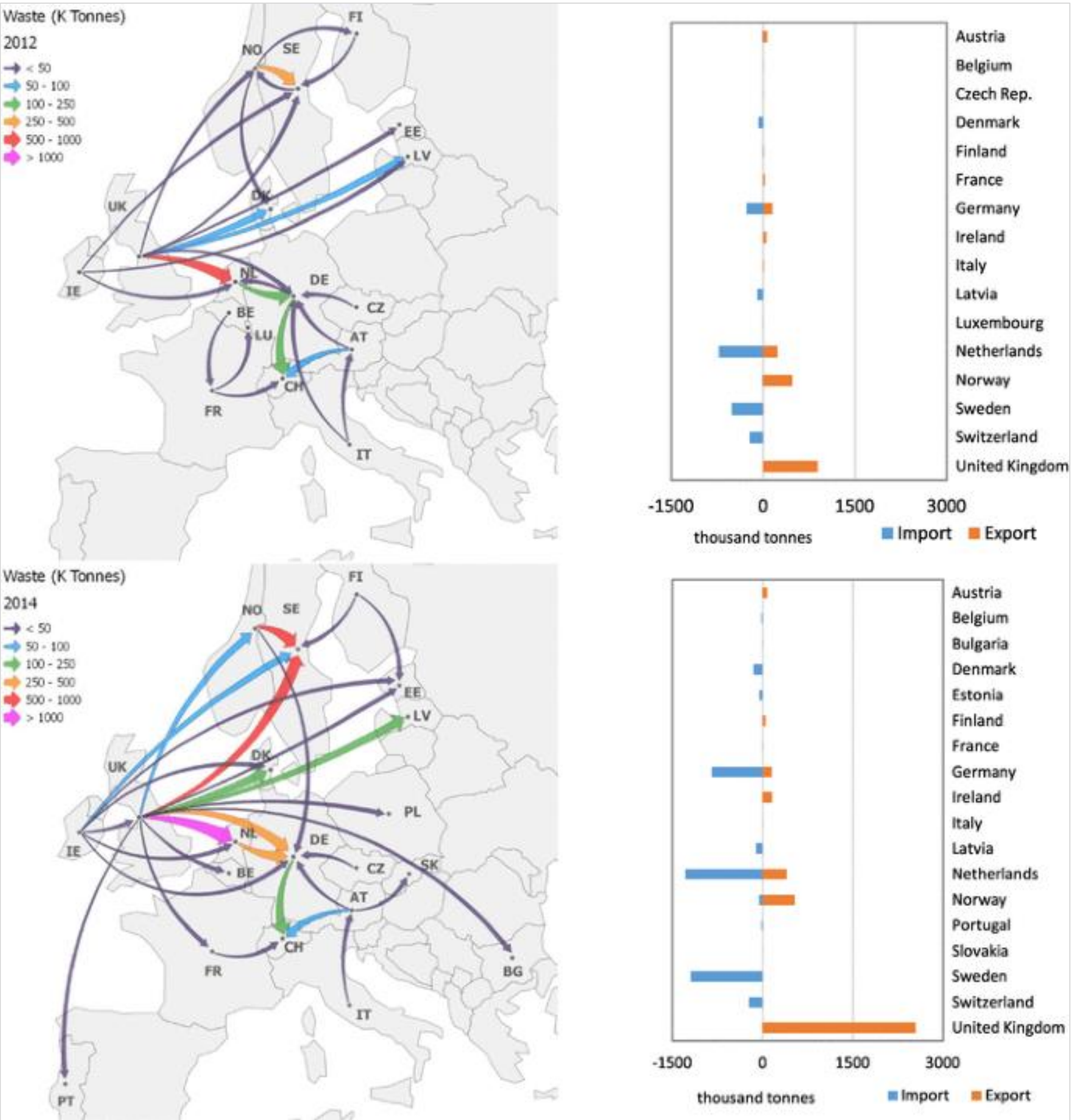


Source: CEWEP, (2021).

In 2012 and 2014 there were relatively few countries involved in shipment of waste. In those years the Netherlands, Sweden and Germany imported waste, suggesting that capacity in these countries was greater than the amount of waste generated domestically.[10]

[10] In Germany capacity for processing imported waste seems to be decreasing., however In November 2019 the German trade association BVSE argued for a ban on imports because of a lack of capacity. [German EfW plants in 'precarious' situation]

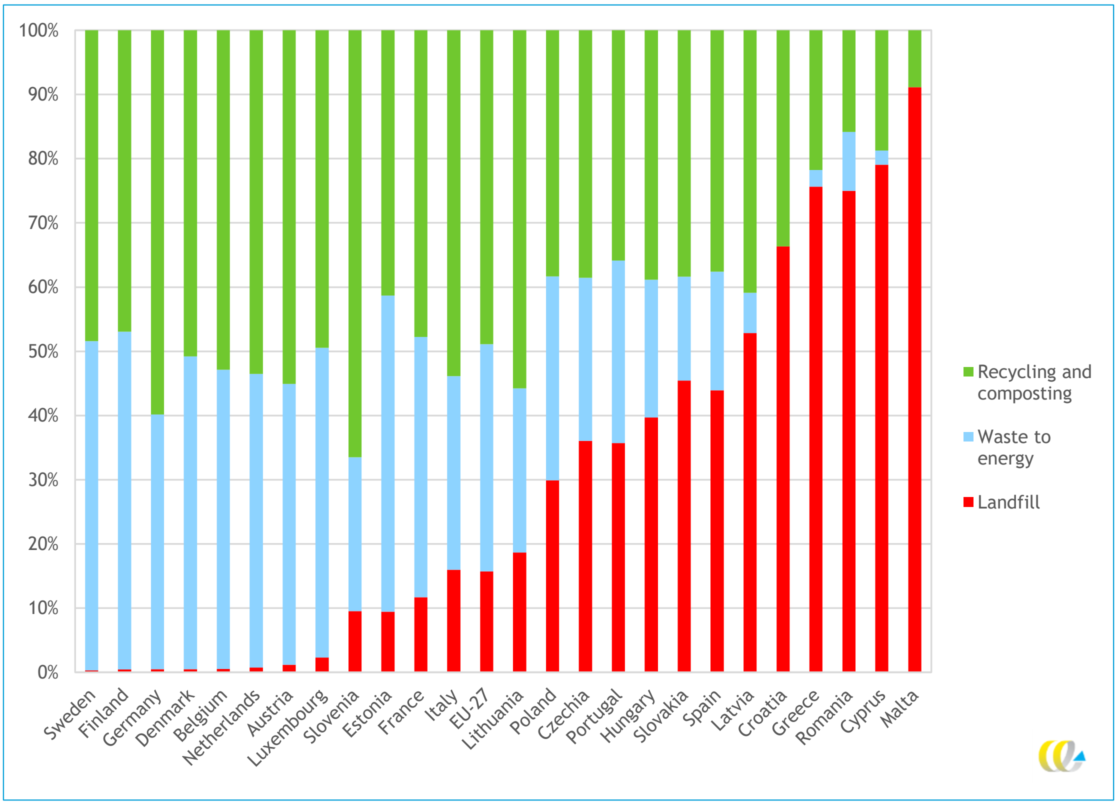
Figure 14 – Trade flows of waste



Source: (Scarlat et al., 2019).

In countries where incineration capacity is lower than the amount of waste generated domestically, much of the waste is landfilled. In South and East Europe, particularly, a relatively large proportion of waste is landfilled.

Figure 15 – Share recycling, incineration and landfilling in EU countries



Source: (Eurostat, 2021).