Additional profits of sectors and firms from the EU ETS

2008-2019

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Delft, CE Delft, May 2021

Publication code: 21.200402.063

Emissions / Tradable permits / Companes / European Union / Costs / Profits / Economic aspects / Literature review

Client: Carbon Market Watch

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Content

Summary

This study has calculated the additional profits that sectors and companies have made from the EU ETS between 2008 to 2019 for the fifteen most CO_2-intensive sectors plus aviation in nineteen EU countries. In our study we have investigated three types of profits:

1. Profits from overallocation of free emission allowances.
2. Profits from using cheaper international offsets for compliance.
3. Profits from passing through (part of) the opportunity costs of freely obtained allowances into product prices.

Profits from **overallocation of emission allowances** have been generated because industry – excluding aviation - received more free allowances (37 M) than needed for covering their emissions in the period 2008-2019. On average, the CO_2-intensive sectors in those countries did not need to pay for any emission allowances to cover their carbon emissions under the EU ETS. Instead, they could earn from selling their freely obtained allowances in excess of demand at the spot market resulting in additional profits worth an estimated € 1.6 billion. Especially the cement sector and other building materials (bricks and lime) have profited from this, resulting in around € 4 billion additional profits from simply taking part in European climate policies.

Next to this, industry has profited from **using cheaper international offsets for compliance**. Companies were entitled to use a certain amount of credits obtained through the Clean Development Mechanism (CDM) or Joint Implementation (JI) scheme for compliance between 2008 and 2020. As the price of these credits was substantially below the price of an emission allowance, this has created additional profits worth € 3 billion between 2008 and 2019. The iron and steel sector has profited most from this exchange (€ 850 million).

The largest amount of additional profits was earned from **'cost pass-through'**. The design of the EU ETS, with a hybrid mix between free allocation and auctioning for emissions above the benchmarks, make it likely that product prices contain CO_2 costs of marginal firms which acts as a producer surplus to other firms. There is ample empirical evidence that such producer surpluses have been stimulated by the EU ETS even though most firms do not intentionally pass through their carbon costs. In our research we have used a cautious estimate of the possibility to pass through the costs to accommodate the uncertainty that is involved in such calculations. We also estimated the loss in profits that result from the loss in market shares from those higher prices. For all sectors the additional profits from passing through carbon costs have outweighed the loss in profits from the reduced market shares resulting from cost pass-through. Our estimates indicate that an additional profit of € 26 to € 46 billion was earned between 2008 and 2019 from cost pass-through in industry. Especially the iron and steel sector has profited (€ 12-16 billion) followed by refineries (€ 7-12 billion).

In total, the additional profits for the fifteen sectors in the nineteen countries ranged between € 30 to over € 50 billion in the period 2008-2019. In absolute terms, additional profits were the highest in the iron and steel sector (€ 11.9 to € 16.1 billion) followed by the cement (€ 7.1 to € 10.3 billion) and refineries (€ 5.9-11.3 billion).

For the aviation sector, given that airlines have been net buyers of allowances, the additional profits from cost pass-through and the use of international credits have been outweighed by the need to buy allowances. The sector therefore did not experience additional profits as the industry did – the total balance was a 150 million loss on participating in the EU ETS.

For the future, several developments may result in a change in the additional profits. On the one hand, additional profits will be lower as the possibility to use cheaper international credits has ceased and the total number of free allowances will be reduced in Phase 4 which effectively reduces the additional profits. On the other hand, the higher CO_2 prices and the possible instalment of a CBAM, if not accompanied with an abolishment of free allocation, will result in higher additional profits. It is difficult to predict beforehand which factor will dominate. We state here that it is likely that additional profits from the ETS may remain dominant in Phase 4 unless improvements are implemented in the context of the 'Fit for 55' agenda.

The most effective means of reducing additional profits is to drastically reduce the number of freely issued allowances. The conclusions of this research should read that free allocation may not be fit for purpose in the future of European climate policies.
As the costs seem to be passed through, it results in additional profits at the expense of European consumers. At the same time, despite the issuance of free allowances, the higher costs may have resulted in a loss in market shares. This all casts doubt on the appropriateness of free allocation in preventing carbon leakage, although this should be investigated in more detail in future work.

Making allocation more dynamic, reflecting actual output, would solve part of these problems but comes at a cost. First, individual companies may no longer factor in carbon costs in their production decisions thereby resulting in overproduction. Second, a muted carbon price signal through the value chain will reduce consumer choices for low-carbon products. Therefore the main policy recommendation for policy makers would be to investigate other ways to ensure European industries decarbonise while remaining competitive on a global playing field: either through enhanced investment subsidies, such as through the Innovation Fund, or through the instalment of Carbon Border Adjustment Mechanisms and the phase-out of free allocation. Both solutions may be at odds with each other as an effective carbon border adjustment mechanism that is WTO compliant may also need to take into account the subsidies that are given to European industries.

1 Introduction

1.1 Background

The EU ETS is a cornerstone of the climate policies of the European Union and in operation for over fifteen years now. Through the EU ETS about 40% of GHG emissions are being regulated from electricity generation, aviation and larger industrial installations in all EU27 MS plus Norway, Iceland and Liechtenstein and the United Kingdom until 31 December 2020. When measured in size, the EU ETS was for long the largest emission trading system in the world. It has served as a blueprint for many emission trading systems implemented or being designed worldwide.

The EU ETS is now in its fourth phase which lasts from 2021-2030. Earlier phases suffered from overgenerous allocation of emission allowances which have long suppressed the price signal from the EU ETS. Between the beginning of 2012 up till early 2018, CO_2 prices were well below the € 10/tCO_2. However, due to the changes announced in Phase 4, and in particular through the Market Stability Reserve, prices have been increasing. Since the beginning of 2021, in the light of ongoing discussions about increasing the overall EU level of ambition to at least -55% by 2030, prices have been trespassing the threshold level of € 30/tCO_2, which was considered as a 'target' price when the ETS was constructed. Therefore, most analysts consider that the ETS is showing that it is working and that growing scarcity is reflected in higher prices for emissions of carbon.

While the weak price signals may have been addressed properly by the changes in the ETS in Phase 4, other weaknesses in the scheme persist. This deals mostly with the exemptions that energy-intensive industries have been granted due to the risk of carbon leakage. While electricity generators have to buy their allowances on an auction, energy-intensive industries receive their allowances still for free up to a predefined benchmark. A system of total 54 benchmarks have been settled in 2008 and in operation since 2013. They have resulted in a massive allocation of free allowances to companies, often trespassing their demand for allowances.

Earlier analysis by CE Delft (2016) showed that industry did not have to pay for their allowances between 2008 and 2015: instead they received more allowances than they needed which were often sold to electricity producers who were short of allowances. The CE Delft (2016) report calculated that between 2008 and 2015, industry received a total of € 7.5 billion additional profits from receiving more allowances than they needed. Various companies listed the sale of emission allowances as a source of profits on their balance sheets. Other profits from participating in the ETS were related to passing through the opportunity costs of freely obtained allowances into product prices and the generous provisions to use the much cheaper international offsets (credits from the Kyoto Protocol CDM and JI mechanisms) instead of EU's emission allowances for compliance.

In total CE Delft (2016) calculated that industry participating in the EU ETS obtained additional profits from participating in the EU ETS worth € 16.7-29.1 billion for the fifteen most energy-intensive sectors in nineteen EU countries. These profits have been paid for largely by consumers who have seen increases in electricity costs and more expensive products on European markets.

Since 2016, the situation in the ETS has gradually changed resulting in higher prices and less free allocation for industry. The question is to what extent this has altered the cost distribution in the EU ETS and the development of additional profits.

1.2 Objective

The objective of this study is to analyse the additional profits that sectors and companies have made from the EU ETS between 2008-2019 and to make a forecast how the development of additional profits may change in the future during Phase 4 of the EU ETS (2021-2030) for a selected set of countries and sectors, responsible for the majority of the greenhouse gas emissions of industrial installations under the EU ETS.

1.2.1 Delineation: countries included

The analysis has been undertaken for nineteen countries (all of the EU MS that are also part of the OECD, minus Luxembourg). The countries are:

- Austria;
- Belgium;
- Denmark;
- Finland;
- France;
- Germany;
- Greece;
- Ireland;
- Italy;
- The Netherlands;
- Portugal;
- Spain;
- Sweden;
- United Kingdom;
- Poland;
- Hungary;
- Czech Republic;
- Slovak Republic;
- Slovenia.

1.2.2 Delineation: sectors included

The analysis has been undertaken for the fifteen industrial sectors that have the highest carbon emissions in the ETS plus the aviation sector. Not included are sectors producing solely electricity and heat.

The following sectors have been included in this study:

- Refineries 19.20;
- Extraction of crude petroleum and gas 06.10;
- Iron and Steel 24.10;
- Manufacture of coke oven products 19.10;
- Cement 23.51;
- Lime 23.52;
- Petrochemicals 20.14;
- Inorganic chemicals 20.13;
- Industrial gases 20.11;
- Manufacture of plastics in primary form 20.16;
- Fertilisers 20.15;
- Flat glass 23.11;
- Hollow glass 23.13;
- Other glass 23.14;
- Manufacturing of bricks 23.32.

These fifteen sectors provide the totals in our study. In addition we have also investigated how additional profits may have developed in the aviation sector (NACE codes 51.10 and 51.21). The aviation sector is discussed separately (see Chapter 2.6) from the sectors with stationary installations.

1.2.3 Delineation: additional profits considered

Additional profits have been defined here as profits stemming from three categories:

1. **Overallocation of free emission allowances.**
   Free allowances have often been granted in excess to the verified emissions, especially during the period 2008-2015 so that industry received more free allowances than they needed. The surplus of allowances was sold on the market, used for compliance in later years when companies were short of allowances, or banked for use in Phase 4.
2. **Possibility to use cheaper international offsets for compliance (2008-2020).**
   In Phase 2 and 3, companies could use cheaper international credits from the Kyoto Protocol's market mechanisms for compliance instead of EU allowances. This refers to Certified Emission Reduction (CER) and Emission Reduction Units (ERU) credits entitled through the Clean Development Mechanism (CDM) and Joint Implementation (JI) respectively.
   As the price of these CER/ERUs was much cheaper than that of an EU Allowances (EUA), companies have used CER/ERUs for compliance, selling their freely allocated EUAs on the sport market gaining additional profits.
3. **Passing through carbon costs.**
   Although the allowances have been granted for free, the majority of sectors were able to pass through (some of the) opportunity costs of these allowances into product prices obtaining so-called windfall profits according to the research literature on this topic.

Other costs and benefits that are generated through the EU ETS **have not been** quantified in this study. This includes, *inter alia*:

- costs for abatement of carbon emissions;
- administrative costs for compliance to the EU ETS;
- benefits from compensation of indirect emission costs that was granted in eleven of the nineteen countries included in our research;
- benefits from the NER 300 (e.g. the predecessor of the Innovation Fund) subsidies;
- costs or benefits from higher prices of inputs or auxiliary outputs (e.g. electricity and heat including cross-sectoral heat and electricity flows);[1]
- eventual costs and benefits associated with banking and/or hedging on ETS markets;
- eventual costs and benefits from indirect consequences, such as substitution of materials in consumer products, costs of paid dividends, impacts on the labour market, etc.

These cost and benefit categories are not straightforward to quantify in a uniform way and treatment of these falls outside the scope of the present study. Moreover, various categories can in some circumstances be a benefit and in other circumstances present itself as a cost. For the total EU28, these costs and benefits are most likely to be relatively small, though for individual companies or sectors, they can be more substantial. Therefore some caution should be paid to the interpretation of the analysis in this study: while we believe

[1] Companies have received additional free allowances for heat purchased from installations that fall under an auctioning rule. Under the EU ETS Directive owners of such installations do not receive free allowances for the part of the heat that goes to an ETS consumer, as the ETS heat consumer will receive the free allowances for the heat it consumes. We have regarded these allowances as 'benefits' that can be used to verify the company's own emissions. Eventual higher costs for heat deliveries that have been negotiated in these heat transfers have thus not been taken into account. A similar situation holds for companies that operate a CHP unit under their account. For the electricity part, this installation has not received free allowances. Eventual shortage in allowances have in our accounts thus been recorded as a cost to the company, while in fact the electricity most likely is delivered to the grid including coverage for carbon costs so that there have been no additional carbon costs.

that the most important cost categories have been captured adequately by the study, the figures are not fully accurate for *all* additional costs and benefits from participating in the EU ETS.

Contrary to the previous studies, we have now corrected all the additional profits for inflation, so that all figures are given in real 2019 Euro.[2]

1.2.4 Delineation of companies

We use in this research, next to sectors and installations, individual companies by linking the installations to their legal owners. This provides additional information on the total net profits for individual companies.

It should be well understood that our information on the company level is different from what normally is being considered as a 'company'. In our analysis a company does not constitute a legal entity, but is defined as the sum of all installations that a company has in the chosen sectors in the EU ETS. If one company runs more than one installation, these installations were merged together. However, only the installations that fall under the abovementioned fifteen sectors are taken into account in the calculus. If, e.g., a company active in the manufacturing of bricks (NACE 23.32), also has installations that produce tiles (NACE 23.31), these installations are not being attributed to this individual company.

The second delineation has to be made on the basis of information available in the EUTL database. We have selected data here on the basis of a combination of sources: the last name of the account holder, as defined in the EUTL, the coupling of the University of Florence of EUTL data with company information (Jaraite et al., 2013) and the observed linkage between installations and the E-PRTR that was conducted by CE Delft. By combining these sources we have allocated each installation in the EUTL to a given company. However, in some cases such companies have been listed as separate entities in the EUTL by adding the type of production to the last name. In the Netherlands operates, for example, Shell installations in the refineries and petrochemical industries. In this case the installation in the refineries industry was labelled as a company Shell Netherlands Refinery and the installations in the petrochemical industry were labelled as Shell Netherlands Chemicals in the EUTL. In this case, we have included these as two different companies in our database.

It should therefore be understood that our analysis on the company level is really on installation names rather than on ownership. We did not investigate ownership relations in the present research.

[2] We have used a common deflation for the EU28, based on the EU28 consumer price index. We have not differentiated inflation across countries.

1.3 Comparison with earlier studies

The analysis resembles in subject, methodology and approach similar studies that have been published in 2015 and 2016 on the additional profits from the EU ETS over the period 2008-2015. Compared to that analysis, a few changes have been made, which can be summarised as:

- Contrary to the 2015/2016 analysis, we include now a component to correct for the loss in demand due to the higher product prices from passing through the costs of freely obtained allowances from import substitution. This is stemming from earlier critiques on our analysis by companies that our analysis does not provide the full picture as the loss in market shares was not quantified. By including the loss in profit from a loss in market shares we have a more realistic approach on the *net* impacts on profitability from passing through the opportunity costs of freely obtained allowances – even though uncertainties remain substantial.
- Air transport sector (NACE 51) is included.
- CER/ERUs to EUA conversions have now been updated to cover the period 2013-2019 as well assuming that all companies have fully used their possibilities to use CER/ERUs instead of EUAs (see Annex C).
- Waste gas transfers have been more precisely allocated to individual companies on the basis of additional information on the installations that produce waste gas transfers (see Annex C).

We have also attempted to correct for heat transfers within the system by asking competent authorities in the largest member states for additional information on the company shares of freely allocated allowances related to heat transfers (see Annex D). However, all competent authorities have responded that such information is not publicly available and cannot be shared with us for reasons of confidentiality.

2 Methodological approach and generalised results

2.1 Introduction

In this chapter we explain the methodological choices that we made to calculate the additional profits in our chapter. The methodological approach is largely similar to our earlier studies CE Delft (2015 and 2016) but includes some improvements that have been identified in Paragraph 1.3 and above.

2.2 Profits from overallocation

2.2.1 Mechanisms

In Phase 2 of the EU ETS, firms have received a substantial amount of free allowances often exceeding their verified emissions. These excess allowances could have been sold on the market, or banked to use in later years. In Phase 3 of the EU ETS, which started in 2013, the amount of free allowances was reduced every year by 1.74% (the linear reduction factor). Firms received allowances according to the following formula:

$$FA = BM \times HAL \times CLEF \times CSCF$$

Where FA = amount of free allowances, BM = the benchmark value[3], HAL = the historic activity level[4], CLEF is the carbon leakage factor[5] and CSCF is the cross sectoral correction factor.[6] Free allocation of allowances was reduced over time, as CSCF was reduced every year. While most firms still received excess free allowances in 2013, they were on average short on allowances in 2019.[7]

[3] From Phase 3 (2013-2020) onwards, a benchmark value was calculated for 52 product groups plus two general groups (heat and fuel) that could be used as a fallback option. The benchmarks were calculated as the average of the best performing 10% of the installations producing that product in the EU and EEA-EFTA states in the year 2007/2008. In Phase 3 the benchmark value was fixed and not adjusted to reflect technological progress.

[4] Firms could choose if their average production of 2005-2007 or 2009-2010 was used as a historic activity level. Most firms used the 2005-2007 values as these were higher due to the effect of the global financial crisis of 2008/2009.

[5] The CLEF was for all sectors investigated in this study equal to 1. Some sectors that were assessed to be not prone to carbon leakage, had a CLEF starting at 0.8 in 2013 gradually reduced to 0.3 in 2020.

[6] This factor was introduced to assure that the total EU ETS emissions would be 21% below the emissions in 2005 (at the start of the EU ETS) corrected for scope changes. In the CSC is a linear reduction assumed. The used values for the CSC were 94,272151% in 2013, 92,634731% in 2014; 90,978052% in 2015; 89,304105% in 2016; 87,612124% in 2017, 85,903685% in 2018, 84,173950% in 2019 and 82,438204% in 2020.

[7] In 2019 the shortage was 7,7% of the verified emissions of that year for the 15 sectors in the 19 countries.

2.2.2 General calculus

Firms receiving more allowances than needed could either bank them or sell them on the spot market, earning additional incomes. We do not know if firms have banked their previous allowances for future use as firms do not report their amount of banked allowances. Therefore we assessed the value of their allowances against the average price of allowances in the years that a surplus or shortage was created using the formula:

$$AP_{allocaiton,i,t} = \sum_{2008}^{2019} P_{CO2,t} \cdot (AE_{i,t} - VE_{i,t})$$

which states that the additional profits from overallocation are equivalent to the sum of allocated minus verified emissions multiplied by the average price of an emission allowance in year t. The average prices of emission allowances have been obtained by observing the daily spot market prices from SENDECO$_2$ and averaging them over the year. They are given in Table 1.

Table 1 - Average price EUA €/tCO$_2$, current prices

Year	Average price EUA (€/tCO$_2$)
2008	22.02
2009	13.06
2010	14.32
2011	12.89
2012	7.33
2013	4.45
2014	5.96
2015	7.68
2016	5.35
2017	5.83
2018	15.88
2019	24.84
2020	24.75

Source: SENDECO$_2$.

Note: Prices have been rounded to cents. In our calculations we have used average prices that were not rounded to cents.

2.2.3 Treatment of transfer of waste gases

Producers of waste gases receive free allowances but the verified emissions of the installations where those waste gases are being used often are located in a different sector. This happens for example in the iron and steel sector where blast furnace gases are being distributed to electricity producers generating electricity or heat from those gases.
The iron and steel company then receives free allowances for the difference in carbon content of those waste gases compared to natural gas. The receiver of free allowances passes these through to the electricity generator to compensate for the higher carbon content of waste gases compared to natural gas. Without correction for this, additional profits of the iron and steel sector will be overestimated.

There is no public information available that quantifies the amount and market value of allowances that are passed through to the electricity generators. Therefore, in this research, we have quantified the iron and steel's waste gas transfers to electricity generators from the International Energy Agency (IEA). The IEA provides information on transfers from waste gases between 2008-2019 from the iron and steel industry to electricity generators.[8] Using caloric value of blast furnace waste gases and comparing them with that of natural gas we have determined the assumed amount of emission allowances that likely have to be passed through to the electricity producers to be compensated for the higher carbon emissions from blast furnace gas compared to natural gas.

While this provides an accurate estimation of the CO_2 allowances allocated for waste gas transfers to the iron and steel sector at the national level, it provides a challenge to allocate this to individual firms. The IEA data have been allocated to individual firms that operate blast or basic oxygen furnaces on the basis of the of verified emissions of these companies in the total sector emissions of the country. This method may introduce some small errors as we do not know exactly the production of waste gases for each location, but they are expected to be very small.[9] In Annex C we provide an overview of the installations to which we have allocated waste gases.

For the refinery sector IEA data show that most of the waste gases are consumed within the sector boundaries and that the total impact of refinery gas on an eventual misallocation between verified and allocated emissions was minimal. Therefore we have not considered a correction.

2.2.4 Treatment of other transfers

In addition to waste gas transfers, transfers of heat or CO_2 can constitute another reason why allocated and verified emissions differ within one installation. For $CO_{2,}$ transfers only absorption in precipitated carbon is considered as an eligible transfer of CO_2 from one sector to another. This only applies to a few production units in the lime industry and has not been quantified in our research. Other waste gas transfers outside the iron and steel industry are probably quite small: waste gases in the chemical and refinery sectors are often consumed within the industry.

For heat transfers we have consulted with the national emission authorities of the biggest countries (UK, France, Germany, Italy, Spain, Poland and the Netherlands). The emission authorities indicated that such information is confidential and cannot be given to other parties. Therefore, no such correction could be calculated.

2.2.5 Results

Table 2 gives the results of this analysis for the industry sectors for the years 2008-2019 on a sector level. This table shows that the number of verified emissions in this time period is higher than the number of freely allocated emission rights. Since 2013 the delineated sectors have an underallocation of emission rights. This shortage is the largest in the refinery sector whilst the overallocation is the largest in the cement sector.

[8] For Italy, the Netherlands, Slovak Republic and Spain 2019 statistics were not available and we calculated the 2019 values from the 2018 values multiplied by the change in verified emissions in the iron and steel sector between 2019 and 2019.

[9] The present method, where we only allocate sectoral emissions to selected companies that operate blast or basic oxygen furnaces is an improvement over the previous method we used in 2016 (CE Delft, 2016) where we allocated the waste gas transfers to all installations reporting emissions in the iron and steel sector.

Measured in Euro the fifteen sectors cumulative profits from overallocation still exist. These additional profits increased in 2008-2012 towards more than € 8 billion (2019 prices). Since 2013 additional profits are negative (see Figure 1).

Table 2 – Allowances, allocated and verified, per sector, 19 countries, 2008-2019, mio tCO_2

Nace	Sector	Allocated	Verified	Difference	Additional profits overallocation
		Mt CO_2			*€ mio*
06.10	Extraction of crude oil and gas	194	224	-30	-285
19.10	Manufacture of coke oven products	65	76	-11	-124
19.20	Refineries	1,333	1,504	-171	-1,801
20.11	Industrial gases	70	71	-1	-24
20.13	Inorganic chemicals	122	109	12	156
20.14	Petrochemicals	684	645	39	601
20.15	Fertilisers	217	245	-28	-272
20.16	Manufacture of plastics in primary form	40	40	0	15
23.11	Flat glass	70	66	4	63
23.13	Hollow glass	116	122	-6	-45
23.14	Other glass	15	14	1	17
23.32	Manufacturing of bricks	122	88	34	478
23.51	Cement	1,561	1,310	251	3,057
23.52	Lime	340	309	30	477
24.10	Iron and steel*	1,678*	1,766	-88	-707
Total 15 sectors**		**6,627**	**6,590**	**37**	**1,604**

* Excluding 608 mio tCO_2 allowances allocated for waste gas transfers.

** Totals and subtotals can differ slightly due to rounding.

Figure 1 – Overallocation (mio tCO_2) and profits from overallocation (mio EUR_{2019}), per year, 2008-2019

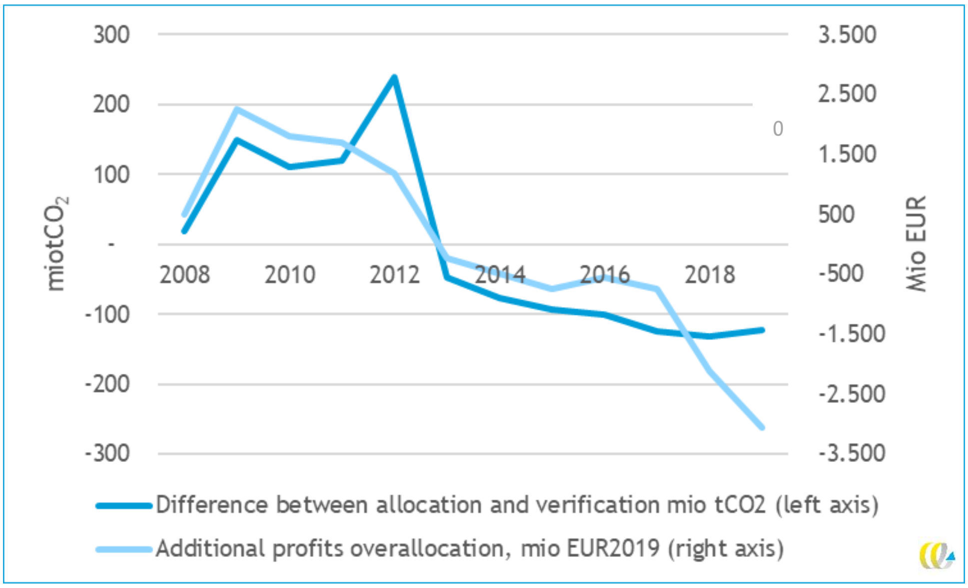


Table 3 shows the results on a country level. The situation per country differs considerably. On the one hand, companies in Austria and Germany were short in summed allowances over the 2008-2019 period resulting companies having to pay for (a small share of their) verified emissions. However, other countries have still received more allowances than they needed sot that companies could sell the excess allowances on the spot market (or bank them for future use). Especially, companies in Belgium and Spain still received considerable additional profits. However, differences on a company level are often high and determine the results. E.g. in Spain CEMEX and Arcelor Mittal together absorb half of the additional profits (see Chapter 3 for more details on the company and country level).

Table 3 - Allowances, allocated and verified, per country, 15 sectors, 2008-2019

	Country	Allocated ($MtCO_2$)	Verified ($MtCO_2$)	Waste gases ($MtCO_2$)	Difference ($MtCO_2$)	Profits from over-allocation (€ mio)
AT	Austria	199	228	33	-62	-743.3
BE	Belgium	416	338	42	37	520.8
CZ	Czech Republic	212	189	20	2	23.5
DK	Denmark	62	58	0	4	63.6
FI	Finland	126	121	15	-10	-114.4
FR	France	779	721	53	5	86.9
DE	Germany	1,518	1,443	175	-100	-794.5
GR	Greece	173	153	0	20	310.2
HU	Hungary	88	77	10	1	-21.2
IE	Ireland	47	35	0	12	153.9
IT	Italy	809	710	62	37	240.2
NL	Netherlands	448	396	56	-3	-41.0
PL	Poland	404	388	37	-21	-198.3
PT	Portugal	131	119	0	12	187.6
SK	Slovakia	168	158	4	6	205.6
SI	Slovenia	13	12	0	1	3.9
ES	Spain	696	578	23	94	1363.7
SE	Sweden	168	131	18	19	260.3
GB	United Kingdom	775	736	57	-17	97.1
Total 19 countries*		**7,235**	**6,590**	**608**	**37**	**1,604.7**

* Totals and subtotals can differ slightly due to rounding.

If we analyse the number of installations, we see that 37% of the installations did not receive enough allowances for free over the period 2008-2019 to cover their verified emissions. In other words: 63% of the installations in the industry did not have to pay anything for their emission allowances over the period 2008-2019. In 2019 those installations represented 201 million tons of CO_2 emissions. This is 37% of the total verified emissions in 2019 of the installations within the delineation of this study.

Table 4 - Number of installations with underallocation and overallocation in delineated sectors, per country 2008-2019

		Underallocation	Overallocation	% Overallocation
06.10	Extraction of crude oil and gas	92	55	37%
19.10	Manufacture of coke oven products	5	22	81%
19.20	Refineries	86	55	39%
20.11	Industrial gases	24	24	50%
20.13	Inorganic chemicals	45	74	62%
20.14	Petrochemicals	141	270	66%
20.15	Fertilisers	72	53	42%
20.16	Manufacture of plastics in primary form	25	51	67%
23.11	Flat glass	26	38	59%
23.13	Hollow glass	122	95	44%
23.14	Other glass	19	37	66%
23.32	Manufacturing of bricks	182	811	82%
23.51	Cement	60	211	78%
23.52	Lime	71	181	72%
24.10	Iron and steel	256	119	32%
Total 15 sectors*		**1,226**	**2,095**	**63%**

* Totals and subtotals can differ slightly due to rounding.

2.3 International credits conversions (CERs/ERUs)

2.3.1 Mechanisms

Under the Kyoto Protocol, two financial instruments were introduced that could issue emission credits. Certified Emission Reductions (CERs) are carbon credits issued by the Clean Development Mechanism (CDM) Executive Board for emission reductions achieved by projects in developing countries. Emission Reduction Units (ERUs) were carbon credits issued under the Joint Implementation (JI) Mechanism - allowing industrialised countries to meet part of their required cuts in greenhouse gas emissions by paying for projects that reduce emissions in the countries in transition (e.g. formerly centrally planned economies).

In Phase 2 of the EU ETS, both carbon credits were eligible for compliance under the EU ETS up to a certain percentage limit determined in each Member State's National Allocation Plans. Under Phase 3, EU wide harmonised allocation rules would apply.
In Phase 3, CERs and ERUs are no longer compliance units within the EU ETS but can be exchanged for EUAs. Operators can request the exchange of CERs and ERUs for EUAs up to their individual entitlement limit set within the Union Registry. Therefore, companies were able to exchange a credit of low value (IC) with an allowance of much higher value (EUA), which is how this system created additional profits for companies. CERs and ERUs will be abbreviated to ICs (International Credits) in this chapter.

2.3.2 Calculations

In the earlier studies by CE Delft (2015 and 2016) we have only quantified the use of ICs (International Credits) for the years 2008-2012 but did not consider conversions afterwards. In the present research we concluded that most of the countries still had quite substantial potential left in Phase 3 to use the conversion facilities, that we decided to include this conversion in our calculations.

The general formula for assessing the additional profits from conversion of ICs has been calculated as:

$$AP_{Conversion,i,j,t} = \sum_{2008}^{2012} SE\_ic_{i,j,t} * (P_{EUA,t} - P_{CER,t}) + UCF_{i,j} * (P_{EUA,avg} - P_{CER,avg})$$

Where SE_ics = surrendered international credits for compliance, P_{EUA} is the price for an emission allowances in the ETS, P_{CER} is the international price for CERs and subscripts i, j and t stand for company, sector and time respectively. The UCF is the unused conversion facility companies had for the years 2013-2020 (see Annex C) and the subscript *avg* relates to the average price in the years 2013-2019.

It should be noted that in this calculation we assume that the price of CERs are a good approximation of the price of ERUs as well.[10] We did not differentiate price developments between both types of international credits. Second, we assume in this calculation that the companies in the sectors and countries under scrutiny in this research have exhausted their conversion facilities by the end of 2019. This is not an unrealistic assumption: as most companies were short in emission allowances in 2018 and 2019, and prices of an emission allowance started to increase considerably, these companies have sought ways to lower their costs of compliance and this was an easy way to do so. The *Report on the functioning of the European carbon market* (EC, 2020) states that companies have used 96% of their estimated allowed maximum conversion by June 2020.

2.3.3 Results

In total 201 million allowances were used for International Credit Conversions in the period 2008-2012. For 2013-2019 we estimate this maximum number of convertible allowances is 230 million (see Table 45) for the nineteen countries and sectors involved.

Table 5 - IC/EUA conversions, mio tCO_2 allowances, 19 countries, per sector, 2008-2019

	2008-2012	2013-2019	Total
Extraction of crude oil and gas	3	10	13
Manufacture of coke oven products	2	3	4
Refineries	26	54	80
Industrial gases	0	3	4
Inorganic chemicals	3	3	6
Petrochemicals	13	28	40
Fertilisers	1	10	12
Manufacture of plastics in primary form	2	1	3
Flat glass	4	1	5
Hollow glass	5	3	7
Other glass	1	0	1
Manufacturing of bricks	4	5	9
Cement	49	44	93
Lime	15	7	22
Iron and steel	74	59	133
Total 15 sectors*	**201**	**230**	**432**

* Totals and subtotals can differ slightly due to rounding.

[10] Around 40% of international conversion credits were converted ERUs.

For the 2008-2012 period we exactly know the annual number of ICs/EUA conversions and can calculate the additional profits by multiplying the number of surrendered ICs with the spread between the EUA price and CER price. For 2013-2019 we estimate the maximum additional profits by using the average spread for these years. Due to the sharp decrease of the average CER price the additional profits in the 2013-2019 are more than three times higher than in the previous period. In total, industry gained a € 3 billion additional profits from conversion of cheap international credits for EUAs.

Figure 2 - Average EUA and CER prices and spread per year, 2008-2019, EUR2019

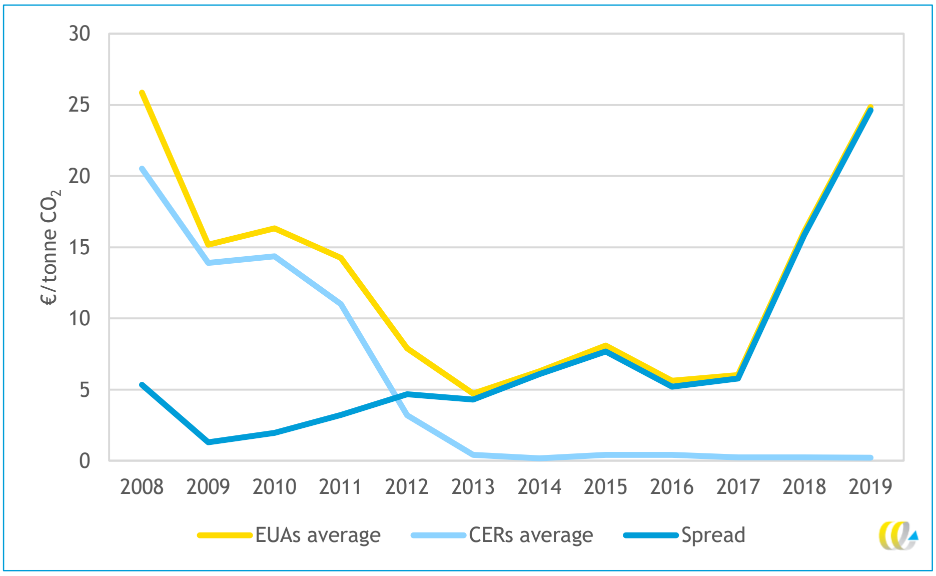


Table 6 - Additional profits IC/EUA conversion, mio EUR constant prices of 2019, 19 countries, per sector, 2008-2019

	2008-2012	2013-2019	Total
Extraction of crude oil and gas	14	95	108
Manufacture of coke oven products	5	26	31
Refineries	96	536	632
Industrial gases	1	30	32
Inorganic chemicals	11	34	44
Petrochemicals	47	274	321
Fertilisers	5	103	107
Manufacture of plastics in primary form	8	8	15
Flat glass	15	13	28
Hollow glass	16	28	44
Other glass	3	4	6
Manufacturing of bricks	12	52	63
Cement	165	442	607
Lime	58	67	125
Iron and steel	267	582	850
Total*	**722**	**2,292**	**3,014**

* Totals and subtotals can differ slightly due to rounding.

2.4 Cost pass-through and loss in potential demand

2.4.1 Mechanisms

One of the most debated category of additional profits are related to cost pass-through – that is, companies forwarding the (implicit) costs of freely obtained emissions allowances into their product prices yielding so called ‘windfall profits’.[11] Companies participating in the EU ETS receive the largest share of their required emission allowances for free and use these for compliance to cover their verified emissions. However, they could also sell these allowances on the carbon exchange market. Using these free allowances for compliance hence presents an opportunity cost to the firm: companies could also gain additional profit by not using these allowances and selling (part) of these allowances. Economic theory now predicts that companies would use these allowances up to the point where the marginal benefit of a unit additional production equals the marginal benefit of selling these allowances on the carbon markets. In other words, the value of these allowances is being used in production decisions, and through that the value of a freely obtained allowance tends to be reflected in the product prices.

Through the design of the EU ETS, with a hybrid mix between free allocation and auctioning, the mechanism that carbon costs are passed forward in the price of products is encouraged. In the last few years, most firms have received slightly less than 100% of their allowances for free. If a firm that is already short on allowances is expanding production, this simply implies that more permits must be bought as the amount of free allocation is fixed. Therefore, passing through these allowances in product prices is a matter of rational economic behaviour when expanding production. If firms pass through the product prices in markets with homogenous goods, the general price level in such markets will be increased – so even producers that did not intentionally pass through the costs are implicitly profiting from higher product prices. Such mechanisms are more likely in tight markets, where everybody is producing at full capacity.

The tendency to pass through carbon costs is also enforced by the present system of benchmarks. In every market (whether it is refinery products, cement or steel), there are some carbon intensive companies that receive less than half of their verified emissions for free. These are often inefficient firms that operate (far) above the benchmark levels. Such inefficient firms can often be regarded as price setters on their markets: their production costs tend to be higher and thus they determine the price level of homogenous products on a given market. Such firms have no other option than to forward the carbon costs in the price of their products, as these are tangible costs to them. An increase in the price of homogenous products that incorporate the carbon costs of inefficient firms, does imply that all other suppliers in these markets experience rising price signals, and therefore accrue additional profits even if they do not intentionally pass through carbon costs.

It is therefore not surprising that several econometric studies have revealed that carbon prices are passed through into product prices for a range of products from the cement, iron and steel, refineries, chemicals and building materials industries (see e.g. Oberndorfer et al., 2010; Alexeevi-Talebi, 2011, CE Delft, 2011 and 2016), even though uncertainties remain substantial (Neuhoff & Ritz, 2019). In Annex A a full review of the available literature is given.

[11] In this research we prefer the name ‘additional profits’ over ‘windfall profits’.

In the past, companies have reported that passing through the opportunity costs of freely obtained allowances does not match their actual market behaviour (see e.g. the comments in EC, 2015). It could be that some companies are operating in restricted monopolies or oligopolies that actually may reduce the tendency to pass through opportunity costs (see Annex A). However, it is more likely that, as indicated above, cost pass-through does not need to be an intentional decision: it can be simply that the market absorbs CO_2 costs made by inefficient producers, thereby generating additional profits for all other producers.

If companies forward the costs of freely obtained allowances into product prices, they could experience a loss in market shares against non-EU competitors. In our previous studies on additional profits (CE Delft, 2015, 2016) we did not quantify this loss in market shares.[12] From the empirical literature so far, we conclude that the actual losses in market share resulting from the introduction of the EU ETS are very small (Sato & Dechezleprêtre, 2015) or could hardly be discerned (Ecorys and Öko Institut, 2013). However, various ex-ante economic models have indicated that losses in market shares could be expected from higher EU ETS prices (see Annex B). For the present analysis we therefore propose to also estimate the potential *loss in profits* from a loss in market shares in order to accommodate the criticism that the previous results were flawed by omitting the loss in market shares from the analysis. This is not to say that we expect that such losses in market shares indeed do materialise. Empirical research (see e.g. (Sato & Dechezleprêtre, 2015)) show that such losses in market shares are expected to be small. But it is rather a cautious calculation of the gain in additional profits from passing through the costs.

2.4.2 Calculations

To calculate the net additional profits from cost pass-through, we first calculated the additional profits without taking into account price effects on market share. The following formula was used to calculate these gross additional profits from cost pass-through:

$$\text{Gross additional profits by cost pass-through}_{i,j,t,m} = CPT_{j,m} * VE_{i,j,t} * P_{EUA,t} \qquad (1)$$

Here, cpt_{jm} is the cost pass-through rate, $VE_{i,j,t}$ displays the verified emissions and $P_{EUA,t}$ is the price for an emission allowance in the ETS. Furthermore, subscripts i, j and t stand for company, sector and time {2008-2019] respectively while subscript *m* stands for {*Minimum, Average*} to take account of the two variants for which the additional profits from cost pass-through have been calculated.

The cost pass-through rates per sector were mainly derived from the last study (CE Delft, 2016), with the exception of aviation, which was newly estimated.[13] In Table 7 an overview is given of the applied cost pass-through rates in this study for the fifteen sectors under consideration. Further justification can be found in Annex A.

[12] Some industries claimed, publicly or privately, that our results would be seriously underestimating the true costs of the EU ETS as the loss in market shares were not quantified. This was for example concluded in a NERA study made on request of EUROFER. This study can no longer be found on the internet.

[13] In our review of the available literature we concluded that since 2016, not many new studies have touched upon the subject of industrial cost pass-through (see Annex A).

Table 7 – Cost pass-through rates used in the main analysis

		Minimum	Average	*Maximum*
06.10	Extraction of crude petroleum and gas	*40%*	*70%*	*100%*
19.10	Manufacture of coke oven products	*55%*	*75%*	*100%*
19.20	Refineries	40%	70%	*100%*
20.11	Industrial gases*	0%	0%	*0%*
20.13	Inorganic chemicals**	10%	24%	*37%*
20.14	Petrochemicals	15%	50%	*100%*
20.15	Fertilisers	10%	50%	*100%*
20.16	Manufacture of plastics	42%	70%	*100%*
23.11	Flat glass***	0%	40%	*80%*
23.13	Hollow glass 23.13;	30%	55%	*80%*
23.14;	Other glass 23.14;	24%	50%	*80%*
23.32	Manufacture of bricks^^	*30%*	*40%*	*80%*
23.51	Cement	20%	39%	*58%^*
23.52	Lime***	0%	40%	*80%*
24.10	Iron and Steel	55%	75%	*100%*

* Nowhere estimated in empirical work.

** Only estimated ex-post in one study for two different products.

*** Only estimated in one ex-ante study which has been taken here as max. value.

^ Maximum value calculated as average from maximum values literature review and new empirical estimates for a range of products.

^^ Only estimated in two studies with three results, as average value is now taken the mean value.

We want to emphasise here that in our calculations we have only used the minimum and average cost pass-through rates in our calculations. Hence, we make a conservative estimate of the total cost pass-through, partly to accommodate criticism (like Neuhoff, 2019) stating that the empirical basis of cost pass-through is suffering from uncertainty – even though some form of cost pass seems to be likely as it is supported by economic theory (see Paragraph 2.4.1).

In a second step, the gross additional profits from cost pass-through have been corrected for the profits lost due to market share effects to derive an estimate of the *net* additional profits from cost pass-through. To calculate the industrial loss of market share that results from passing through the (opportunity) costs of emissions allowances, we make use of so-called *Armington Elasticities* (Armington, 1969). These elasticities express the price elasticity of substitution between demand for domestic and foreign goods. The main idea behind the concept is that the world economy displays two-way trade: similar products are both imported and exported by a producing country. If a domestic firm raises its product prices, one would hence expect that demand in the firm's home country declines, and demand for the imported variety increases.

In the context of the EU ETS, we should think of domestic demand as *demand within the European Union* – after all, we expect cost pass-through to occur not only in specific countries, but rather EU-wide. [14] We therefore investigated similar Armington elasticities across countries in this research. However, EU wide-level Armington elasticities are sparse in the literature, and to our best knowledge, they do not exist for the industrial sectors at the four-digit NACE level. In order to be able to calculate Armington elasticities we

[14] For example, for the European cement industry, the relevant Armington elasticity will hence display the effect of an increase in EU produced cement prices on the proportion of EU-produced cement sales within the EU.

therefore decided to use the Armington elasticities for US industries by GTAP (Gallaway, et al., 2003). We notice here that most economic models assume uniform Armington elasticities across regions (see e.g. Capros et al., 2013), so our assumption is consistent with standard economic modelling practice.[15]

In order to calculate the loss in market shares, we cannot simply apply Armington elasticities to the present market shares as present market shares include the loss of output from cost pass-through. Therefore we have to calculate a counterfactual baseline indicating *how large output would be if costs were not passed through*.

For each sector we have determined the relative price increase resulting from cost pass-through by:

$$\text{Relative price increase}_{j,m} = \frac{CPT_{j,m}}{R_{c,j,m} - CPT_{j,m}} \tag{2}$$

Here, R_c equals the total turnover in the reference scenario where companies in the given sector pass through their allowance costs. Again subscripts *j* and *m* display the sector and minimum or average cost pass-through, respectively. Using the Armington elasticities found in the literature and the calculated relative price increase, we then estimated the fraction of domestic demand over import in a hypothetical scenario without cost pass-through.[16] . Subsequently, the factor by which domestic demand increases was calculated by dividing new sales by old sales. For a more elaborate explanation of these steps, we refer to Annex B.

In the analysis, a distinction was made between domestic sales and exports. The percent decrease in export sales because of cost pass-through was assumed to be twice as high as the percent decrease in domestic sales from cost pass-through. This assumption reflects the finding that countries are less sensitive to domestic price fluctuations than to foreign price fluctuations (this is known as home bias). The factor two was inspired by, but does not follow directly from, the rule of thumb that micro Armington elasticities tend to be roughly twice as large as macro Armington elasticities (rule of two).[17]

Finally, total costs were calculated by assuming that variable costs per product remain unchanged when firms stop passing through their allowance costs and that firms face a fixed costs percentage of 25% in the reference scenario. Having estimated both turnover and total costs, this enabled us to determine total profits in the scenario without cost pass-through. The difference between gross profits from cost pass-through and total profits in the scenario without cost pass-through gave us the net additional profits (NAPs). The NAPs were then expressed as a percentage of the gross additional profits. These percentages were assumed to be equal for each country and firm in a given sector, so that NAPs on a more fine-grained scale could be estimated.

[15] When available, we used long-term Armington elasticities. If only short-term elasticities were given, we applied the rule of thumb that the long-term elasticity is twice as large as the short-term elasticity.

[16] In our calculations we had to incorporate the assumption of zero price elasticity of demand for industrial products. Hence, we assumed that total European demand (domestic + import) does not change as a result of European cost pass-through. It should be noticed that the impact of price elasticity of European demand is minimal, as the cost price increases in the products are very small and industrial price elasticities of demand are often below 1. Hence, if EU produced cement becomes more expensive, European buyers will simply import more cement from outside the EU rather than consume less cement.

[17] Note that we cannot directly apply the rule of two, since the non-EU country that imports European variety can have a different Armington Elasticity, as well as a different domestic consumption to import ratio. See Annex B for an elaboration on the calculations.

The effect of cost pass-through on market shares is displayed by expressing the net additional profits (additional profits when taking market share effects into account) as a proportion of gross additional profits (additional profits without correcting for market share effects). The results for the fifteen sectors are depicted in Table 8 for the average cost pass-through.[18] This table shows that for all sectors the *profit* from passing through the value of allowances into product prices is larger than the loss in market shares. The biggest loss in market shares occur in the coke oven products sector, and the smallest in the manufacturing of bricks. The size of the Armington elasticities (see Annex B), the import and export shares plus the profitability of the sector (in terms of profits relative to turnover) are important determinants explaining the differences between sectors.

Table 8 - Net additional profits as percentage of gross additional profits - average CPT

Nace	Sector	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
06.10	Extraction of crude oil	83%	85%	83%	81%	83%	83%	86%	85%	86%	83%	86%	87%
19.10	Coke oven products	65%	86%	74%	88%	91%	87%	80%	77%	66%	62%	36%	35%
19.20	Refineries	94%	94%	93%	93%	93%	92%	92%	92%	93%	92%	92%	93%
20.11	Industrial gases*	-	-	-	-	-	-	-	-	-	-	-	-
20.13	Inorganic chemicals	90%	90%	90%	88%	87%	86%	82%	82%	81%	92%	84%	82%
20.14	Petrochemicals	86%	81%	84%	84%	85%	86%	85%	81%	78%	82%	83%	83%
20.15	Fertilisers	83%	88%	83%	81%	82%	83%	82%	81%	83%	82%	85%	84%
20.16	Primary plastics	83%	82%	73%	76%	74%	75%	72%	68%	66%	64%	64%	64%
23.11	Flat glass*	97%	98%	97%	98%	98%	98%	98%	98%	97%	97%	98%	98%
23.13	Hollow glass	94%	95%	93%	94%	94%	94%	94%	94%	93%	94%	94%	93%
23.14	Other glass	92%	94%	91%	90%	89%	91%	90%	99%	87%	87%	87%	86%
23.32	Manufacture of bricks	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
23.51	Cement	98%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%
23.52	Lime	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%
24.10	Iron and steel	95%	98%	95%	95%	96%	96%	95%	95%	95%	94%	94%	95%

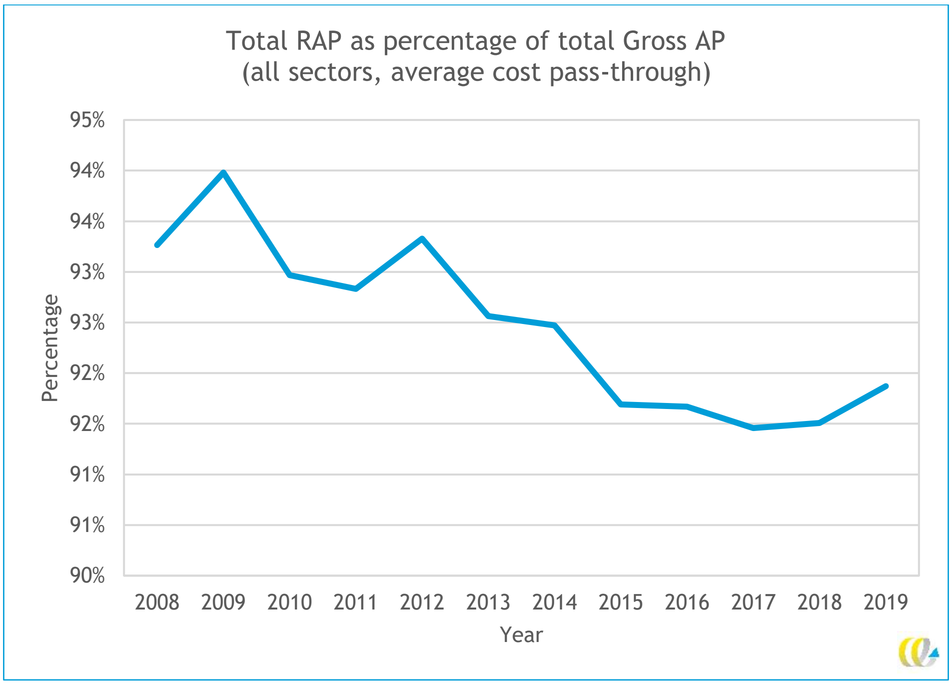
* For flat glass and lime no results are displayed since the minimum cost pass-through rates were estimated to equal zero.

** For aviation, no results are presented between 2008 and 2012 since the sector only entered the EU ETS in 2012.

In Figure 3 we present the total net additional profits (sum of all sectors) as percentage of the total gross additional profits over time. As can be seen, the graph stays well above 90% but shows a slight negative trend. This is in line with expectations: when EUA prices increase – which is what happened over the last years – one would expect the loss of market share to have a more dampening effect on profits. The relationship of profits to turnover is another important variable influencing these results in the sense that a higher profit per unit of sales increases the loss in profits from a loss in market shares.

[18] The percentages for the minimal cost pass-through scenario are very similar to these. Under the minimum cost pass-through, less costs are passed through, so both the gross and net additional profits are lower.

Figure 3 – Total net additional profits as percentage of total gross additional profits



Note: The increase in 2019 is probably due to data limitations: profit data for 2019 was often not yet unavailable in Eurostat. In these cases we assumed profit in 2019 to equal profit in 2018.

2.4.3 Results

Table 9 presents the gross and net profits from passing through the costs of freely obtained allowances for both scenarios of cost pass-through. The analysis shows that the net additional profits from passing through the opportunity costs of freely obtained allowances have yielded additional profits between the € 26 and € 46 billion over the period 2008-2019.

Table 9 - Gross and net CPT, minimum and average estimation (mio EUR constant prices of 2019), nineteen countries

NACE	Sector	Min			Average		
		Gross profits from CPT	Profits lost due to market share loss	Net profits from CPT	Gross profits from CPT	Profits lost due to market share loss	Net profits from CPT
06.10	Extraction of crude oil and gas	1,150	185	965	2,012	323	1,689
19.10	Manufacture of coke oven products	533	186	346	726	246	480
19.20	Refineries	7,651	532	7,119	13,390	928	12,462
20.11	Industrial gases	-	-	-	-	-	-
20.13	Inorganic chemicals	129	18	111	304	43	261
20.14	Petrochemicals	1,601	266	1,335	4,803	795	4,007
20.15	Fertilisers	395	67	328	1,317	219	1,098
20.16	Manufacture of plastics in primary form	207	57	150	344	95	250
23.11	Flat glass	-	-	-	339	9	330
23.13	Hollow glass	466	30	436	853	54	800

NACE	Sector	Min			Average		
		Gross profits from CPT	Profits lost due to market share loss	Net profits from CPT	Gross profits from CPT	Profits lost due to market share loss	Net profits from CPT
23.14	Other glass	42	4	38	88	9	79
23.32	Manufacturing of bricks	345	1	344	460	2	459
23.51	Cement	3,437	41	3,396	6,701	77	6,625
23.52	Lime	-	-	-	1,572	11	1,561
24.10	Iron and steel	12,318	595	11,723	16,797	807	15,991
Total*		**28,273**	**1,982**	**26,291**	**49,706**	**3,616**	**46,089**

* Totals and subtotals can differ slightly due to rounding.

Additional profits from cost pass-through were the most substantial in the iron and steel sector (€ 12-16 billion) followed by refineries (€ 7-12 billion) and cement (€ 3-7 billion). The loss in profits due to a loss in market shares is relatively small compared to the gain in profits from passing through the opportunity costs of freely obtained allowances.

2.5 Total additional profits

If we sum up the three categories of additional profits, we arrive at an estimate of total additional profits from participating in the EU ETS. Table 10 summarises the total results. These results show that total additional profits for the 15 sectors in the 19 countries vary from over € 30 billion (minimum cost pass-through rates) to over € 50 billion (average cost pass-through rates) in the period 2008-2019.

Table 10 - Additional profits (mio EUR, constant prices of 2019), per sector, 19 countries, 2008-2019

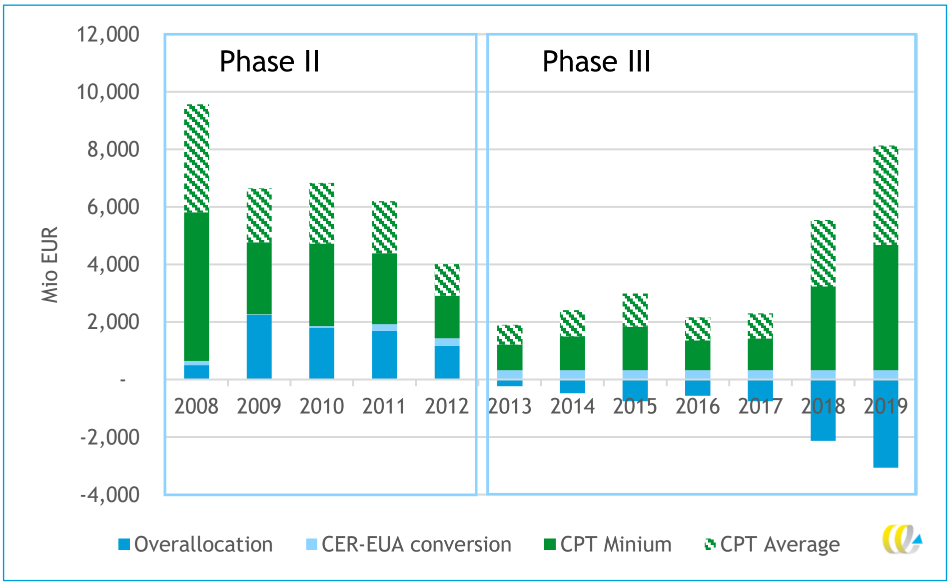
NACE	Sector	Over-allocation (a)	CER/ ERUs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
06.10	Extraction of crude oil and gas	-285	108	965	1,689	789	1,513
19.10	Manufacture of coke oven products	-124	31	346	480	253	387
19.20	Refineries	-1,801	632	7,119	12,462	5,950	11,293
20.11	Industrial gases	-24	32	-	-	7	7
20.13	Inorganic chemicals	156	44	111	261	311	461
20.14	Petrochemicals	601	321	1,335	4,007	2,256	4,929
20.15	Fertilisers	-272	107	328	1,098	164	933
20.16	Manufacture of plastics in primary form	15	15	150	250	180	280
23.11	Flat glass	63	28	-	330	91	421
23.13	Hollow glass	-45	44	436	800	435	798
23.14	Other glass	17	6	38	79	61	102
23.32	Manufacturing of bricks	478	63	344	459	885	1,000
23.51	Cement	3,057	607	3,396	6,625	7,059	10,288
23.52	Lime	477	125	-	1,561	602	2,162
24.10	Iron and steel	-707	850	11,723	15,991	11,865	16,133
Totals*		**1,604**	**3,014**	**26,291**	**46,089**	**30,909**	**50,708**

* Totals and subtotals can differ slightly due to rounding.

In absolute terms, additional profits were the highest in the iron and steel sector, despite the sector being short on emission allowances. However, CER/ERU conversions and especially cost pass-through resulted in an estimated additional profits between the € 11.9 and € 16.1 billion over 2008-2019. Next to the iron and steel sector, companies operating in the cement (€ 7.1 to € 10.3 billion) and refineries (€ 5.9-11.3 billion) sectors also obtained substantial additional profits. Most sectors primarily obtained additional profits from cost pass-through. However, additional profits from overallocation were also dominant in the cement sector and the manufacturing of bricks were profits from overallocation mounted to around 50% of total additional profits.

Figure 4 shows the evolution of additional profits over the years. We can see that the profits from passing through the costs have been dominant for every year. In Phase 2 of EU ETS (2008-2012) profits from overallocation were also important. Since the start of Phase 3I (2013) profits from overallocation are negative. Since 2018 the EUA price is rising, which is reflected in higher profits from cost pass-through, but also in reduced profits from overallocation.

Figure 4 – Additional profits (mio EUR, constant prices of 2019), per year, 15 sectors, 19 countries, 2009-2019



Note: profits from CER-EUA conversion between 2013-2019 are equally distributed over the years.

2.6 Aviation sector

The aviation sector differs from the other sectors with stationary installations and that is why we have separated it from the other analysis. The aviation sector has been part of the EU ETS since 2012. The original legislation covered all flights outgoing and incoming to the European Economic Area (EEA).
However, the EU has temporarily halted obligations for all airlines for flights partially or fully outside of the EEA in order to support the development of a global measure to reduce aviation emissions. Therefore only flights within the EEA are part of the scheme.

The aviation sector only receives part of their allowances for free. 82% of allowances up to the benchmark are allocated for free, while 15% is being auctioned (and 3% put aside for a fund for new entrants or fast-growing airlines). On the other hand, the aviation sector does not have distorting competition impacts as all airline companies are subject to the scheme on flights where both departure and arrival take place in the EEA. Hence the loss in market share does not occur through ‘carbon leakage’ but rather through the mechanism of reduced demand due to the higher ticket prices, even though ‘carbon leakage’ cannot be ruled out entirely.[19]

2.6.1 Approach

For the aviation sector we have calculated the same three categories of additional profits.

1. For the calculation of the overallocation we only used information from the EUTL over the years 2013-2019. For the year 2012, a correction was made to the number of freely allocated allowances to airlines, due to the subsequent scope change in covering international flights. However, this correction may not have been properly included in the EUTL. Therefore we have omitted the year 2012 from the analysis.
2. For the calculation of the additional profits from the conversion of international credits into EUAs we have used the same routine as for the other sectors for the years 2013-2019.
3. To calculate the net additional profits from cost pass-through in the aviation sector, we again first calculated the additional profits without taking into account price effects on market share. The same formula was used to calculate these gross additional profits from cost pass-through:

$$\text{Gross additional profits by cost pass-through}_{i,j,t} = CPT_j * VE_{i,j,t} * P_{EUA,t} \tag{3}$$

We used here an average cost pass-through rate of 60% (see the literature discussion in Annex A), which seems to be a good approximation (though slightly conservative) of values reported in the literature.[20] In order to analyse the impacts on market shares, a different method was used. Note that Armington elasticities are meaningless in the context of intra-EU aviation as passengers cannot exchange their intra-EU flights for an ‘imported’ flight outside the scope of the EU ETS (all intra-EU flights fall under the EU ETS). Instead, a more straightforward approach was followed that relied on the price elasticity of demand.

As passenger flights are responsible for the vast majority of commercial aviation CO_2 emissions (ICCT, 2020), the market share analysis was based solely on passenger flight data. It was assumed that the yearly RAPs expressed as a percentage of gross additional profits are equal for passenger flights and cargo flights. The price elasticity of demand was gathered from a study by the International Air Transport Association (IATA, 2008), and was taken to equal -0,8 for the long-term intra-EU market.

To determine total turnover and profit from intra-EU passenger flights, we made use of Eurostat data. In the ‘Annual detailed enterprise statistics for services’ database, there is no distinction between profit from intra-EU flights and non-intra-EU flights. We therefore assumed that the intra-EU turnover equals total turnover multiplied by the proportion of passenger-kilometres from intra-EU flights[21]:

[19] There is still a debate about two possible carbon leakage channels: (i)_passengers going to EU neighbour countries to board their flights; (ii) Airlines using hubs outside the EU for their connecting flights. However, compared to the price effects, these effects are expected to be small.

[20] Notice that the possibilities to pass through the costs may differ between the various routes. Therefore the 60% figure seems to be a conservative estimate of what we perceive as “minimal possible” on the various routes within Europe.

[21] Data on passenger kilometres was taken from the Eurostat database ‘Air transport statistics’.

$$\text{Turnover from intra-EU flights} = \text{total turnover} * \frac{\text{intra-EU passenger-kilometers}}{\text{total passenger-kilometers}} \quad (4)$$

An analogous estimation was made for intra-EU profit. Having estimated turnover and profit in the reference scenario (which, again, includes cost pass-through), we could estimate the relative price increase resulting from cost pass-through. The calculation is the same as for the industrial sectors:

$$\text{Relative price increase}_{j,m} = \frac{CPT_{j,m}}{R_{c,j,m} - CPT_{j,m}} \quad (5)$$

Using the relative price increase and the price elasticity of demand, the increase in demand when moving to a situation without cost pass-through could be calculated. To determine the effect on turnover and, in turn, profit, the exact same method was used as for the industrial sectors.

Table 11 gives the net additional profits as percentage of the gross additional profits from cost pass-through.

Table 11 - Net additional profits as percentage of gross additional profits for the aviation sector

2013	2014	2015	2016	2017	2018	2019
79%	77%	76%	76%	74%	75%	75%

2.6.2 Results

Table 12 gives the total calculated additional profits for the aviation sector using the methodology explained in Paragraph 2.6.1. This shows that the aviation sector, on average, did not experience profits from participating in the EU ETS. A substantial additional profit of € 2 billion from passing through the costs into product prices, was counterbalanced by a reduction in profits from being short on emission allowances. While the sector did profit from passing through the costs of CO_2 allowances into product prices, a large share of these costs were real costs as the sector was, on average, short on allowances. Under the light of these considerations, we think that our average cost pass-through rate of 60% may be slightly conservative. If a cost pass-through rate of 75% was chosen, the sector would have almost equalised in terms of costs and benefits and would not have entailed any additional costs from participating in the EU ETS.

Table 12 - Additional profits (mio EUR, constant prices of 2019), aviation sector, per country, 2013-2019

Country	Overallocation	CER/ERUs	CPT	Totals
Austria	-59.8	1.5	65.7	7.3
Belgium	-58.4	1.4	43.8	-13.2
Czech Republic	-7.0	0.5	15.4	8.8
Denmark	-13.1	0.6	18.2	5.6
Finland	-44.3	1.1	36.0	-7.2
France	-144.0	4.2	131.7	-8.1
Germany	-278.4	9.4	292.6	23.6
Greece	-33.7	1.0	35.1	2.4
Hungary	-92.3	1.9	65.9	-24.6
Ireland	-418.9	10.6	362.1	-46.2

Country	Overallocation	CER/ERUs	CPT	Totals
Italy	-47.5	2.1	65.0	39.8
Netherlands	-105.5	2.7	87.9	-14.9
Poland	-50.5	0.9	30.3	-19.3
Portugal	-60.1	1.2	43.6	-15.3
Slovakia	-0.1	0.0	0.4	0.4
Slovenia	-2.8	0.1	2.5	-0.2
Spain	-202.0	4.5	152.1	-45.3
Sweden	-88.6	2.9	89.9	4.3
United Kingdom	-414.2	12.0	373.2	-29.0
Total*	**-2,121.1**	**58.5**	**1,911.4**	**-151.2**

* Totals and subtotals can differ slightly due to rounding.

There are remarkable differences between countries. Airline companies registered in Ireland, Spain, the UK and Hungary were more often short on allowances and hence had net costs from participating in the EU ETS. On the other hand, airline companies in Italy and Germany had, on average, still profits from participating in the EU ETS. Such differences are primarily due to differences in growth of the airline companies, where fast growing airline companies in general were short on allowances more than less successful companies.

Table 13 and Table 14 present the situation for individual companies. The ten largest airline companies in terms of verified emissions in the EU ETS are presented in Table 13. Of these companies, easyJet, seems to have gained from participating in the EU ETS. Vueling and Wizz Air are companies that have predominantly shown additional costs from participating in the EU ETS.

Table 13 - Top 10 airlines ranked by CO_2 verified emissions (mton) and additional profits (mio EUR, constant prices of 2019), 19 countries, 2013-2019

	Verified emissions	Over-allocation (a)	CERs (b)	CPT avg (c)	Tot avg (a+b+c)
Ryanair Limited	58.7	-324.2	8.7	296.5	-19.0
Deutsche Lufthansa AG	28.7	-148.3	4.3	136.5	-7.6
easyJet Airline Company Ltd	26.9	-56.4	4.0	88.5	36.1
British Airways PLC	18.2	-92.8	2.7	85.1	-4.9
Air France	17.0	-78.3	2.5	79.3	3.4
Scandinavian Airlines System SAS	16.8	-81.0	2.5	78.2	-0.3
Vueling Airlines, S.A.	13.1	-101.6	2.0	65.2	-34.4
Wizz Air Hungary LTD	12.5	-92.0	1.9	65.4	-24.7
KLM	11.7	-70.7	1.8	57.0	-11.9
Norwegian Air Shuttle ASA	11.1	-47.6	1.7	48.5	2.6

Table 14 shows the companies that have received the highest additional profits.

Table 14 - Top 10 airlines ranked by total additional profits, verified emissions (mton) and additional profits (mio EUR, constant prices of 2019), 19 countries, 2013-2019

	Verified emissions	Over-allocation (a)	CERs (b)	CPT avg (c)	Tot avg (a+b+c)
Air Berlin PLC & Co. Luftverkehrs KG	8.0	60.0	1.2	22.5	83.7
easyJet Airline Company Ltd	26.9	-56.4	4.0	88.5	36.1
Iberia Lineas Aereas de Espana SA Operadora	5.5	-5.0	0.8	27.3	23.2
Thomson Airways Limited	5.9	-10.7	0.9	28.8	19.0
Thomas Cook Airlines Ltd	2.4	8.4	0.4	8.6	17.4
Alitalia – Società Aerea Italiana S.p.A.	10.5	-33.0	1.6	48.3	16.8
easyJet Europe Airline GMBH	2.3	-10.8	0.3	25.2	14.8
České aerolinie a.s.	1.2	5.4	0.2	5.9	11.4
Germanwings GmbH	5.2	-6.6	0.8	15.5	9.7
AerLingus	5.8	-19.2	0.9	27.4	9.1

3 Results per sector and company: 2008-2019

In this chapter we show the results on a sector and company level. On company level we rank by the verified emissions in 2008-2019. For Germany, France, Italy, UK, Spain, Poland, and the Netherlands we give a top 10 and for the twelve smaller countries a top 5. All figures for individual companies have been rounded to € million.

3.1 Austria

Table 15 - Additional profits (mio EUR, constant prices of 2019), per sector, Austria, 2008-2019

NACE	Sector	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
06.10	Extraction of crude oil and gas	-	-	-	-	-	-
19.10	Manufacture of coke oven products	-	-	-	-	-	-
19.20	Refineries	-87.8	6.3	156.9	274.6	75.3	193.1
20.11	Industrial gases	-	-	-	-	-	-
20.13	Inorganic chemicals	4.5	0.3	0.2	0.5	5.0	5.3
20.14	Petrochemicals	-3.0	1.4	6.2	18.7	4.6	17.1
20.15	Fertilisers	9.7	3.3	9.9	33.0	22.8	46.0
20.16	Manufacture of plastics in primary form	2.4	0.1	1.6	2.7	4.1	5.1
23.11	Flat glass	-	-	-	-	-	-
23.13	Hollow glass	-3.3	0.4	7.4	13.5	4.4	10.6
23.14	Other glass	0.2	0.0	0.2	0.3	0.4	0.6
23.32	Manufacturing of bricks	6.1	1.3	11.5	15.4	18.9	22.8
23.51	Cement	5.7	8.4	80.4	156.9	94.6	171.1
23.52	Lime	6.1	2.3	-	44.9	8.4	53.3
24.10	Iron and steel	-683.9	56.4	902.2	1,230.7	274.8	603.3
Total*		**-743.3**	**80.1**	**1,176.5**	**1,791.2**	**513.3**	**1,128.0**

* Totals and subtotals can differ slightly due to rounding.

Table 16 - Top 5 companies ranked by CO_2 verified emissions (kton) and additional profits (mio EUR, constant prices of 2019, rounded), Austria, 2008-2019

Company	Main sector	KT verified	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
VOEST-ALPINE AG	Iron and steel*	140,016	-686	57	892	1235	263	607
OMV AKTIENGESELLSCHAFT	Refineries	33,426	-88	6	157	275	75	193
Lafarge Zementwerke GmbH	Cement	10,742	-13	2	27	53	15	42
BOREALIS GROUP	Fertilisers**	7,658	12	3	11	35	26	50
w&p Zement & Kalk GmbH	Cement*	6,352	15	2	14	33	31	50

* Also includes 23.52 lime.

** Also includes 20.16 Manufacture of plastics in primary form.

3.2 Belgium

Table 17 - Additional profits (mio EUR, constant prices of 2019), per sector, Belgium, 2008-2019

NACE	Sector	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
06.10	Extraction of crude oil and gas	-	-	-	-	-	-
19.10	Manufacture of coke oven products	2.3	0.5	3.6	4.9	6.4	7.7
19.20	Refineries	-75.1	36.3	350.7	613.9	311.9	575.1
20.11	Industrial gases	15.6	5.3	-	-	20.8	20.8
20.13	Inorganic chemicals	10.3	1.7	3.9	9.1	15.8	21.1
20.14	Petrochemicals	157.9	45.2	149.6	449.4	352.8	652.5
20.15	Fertilisers	22.5	2.8	8.6	28.9	34.0	54.2
20.16	Manufacture of plastics in primary form	14.6	2.7	30.5	50.9	47.8	68.2
23.11	Flat glass	20.2	5.2	-	39.3	25.4	64.7
23.13	Hollow glass	0.7	0.6	4.4	8.1	5.7	9.4
23.14	Other glass	0.9	0.6	3.8	7.9	5.3	9.4
23.32	Manufacturing of bricks	19.9	4.0	23.4	31.2	47.3	55.1
23.51	Cement	53.7	23.3	119.6	233.3	196.5	310.2
23.52	Lime	30.1	14.2	-	152.9	44.3	197.2
24.10	Iron and steel	247.2	63.8	504.0	687.5	815.0	998.6
Total*		**520.8**	**206.0**	**1,202.2**	**2,317.2**	**1,929.0**	**3,044.0**

* Totals and subtotals can differ slightly due to rounding.

Table 18 - Top 5 companies ranked by CO_2 verified emissions (kton) and additional profits (mio EUR, constant prices of 2019), Belgium, 2008-2019

Company	Main sector	KT verified	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
ArcelorMittal Belgium*	Iron and steel*	58,920	-6	41	416	568	451	603
TOTAL S.A.	Refineries**	57,478	-56	29	244	455	216	428
BASF	Petrochemicals***	33,333	62	24	65	196	151	281
EXXON MOBIL CORP	Extraction of crude oil & gas****	23,541	-9	11	109	191	112	193
Cimenteries CBR Cementbedrijven	Cement	19,622	32	10	48	94	90	136

* Also includes 19.10 Manufacture of coke oven products.
** Also includes 20.14 Petrochemicals, 20.16 Manufacture of plastics in primary form.
*** Also includes 20.13 Inorganic chemicals.
**** Also includes 20.16 Manufacture of plastics in primary form.

3.3 Czech Republic

Table 19 - Additional profits (mio EUR, constant prices of 2019), per sector, Czech Republic, 2008-2019

NACE	Sector	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
06.10	Extraction of crude oil and gas	-	-	-	-	-	-
19.10	Manufacture of coke oven products	11.7	0.6	7.8	10.8	20.1	23.1
19.20	Refineries	-1.9	2.3	55.1	96.5	55.5	96.9
20.11	Industrial gases	-15.0	1.3	-	-	-13.7	-13.7
20.13	Inorganic chemicals	7.3	0.3	0.6	1.4	8.2	9.0
20.14	Petrochemicals	-81.1	11.5	71.1	213.5	1.4	143.8
20.15	Fertilisers	-17.7	2.3	13.1	43.7	-2.3	28.3
20.16	Manufacture of plastics in primary form	0.5	0.0	0.1	0.1	0.6	0.7
23.11	Flat glass	12.3	1.5	-	17.3	13.8	31.1
23.13	Hollow glass	2.5	0.9	9.6	17.6	13.0	21.1
23.14	Other glass	-0.4	0.3	3.2	6.6	3.1	6.5
23.32	Manufacturing of bricks	14.8	1.4	9.9	13.1	26.1	29.4
23.51	Cement	-1.4	10.1	77.6	151.4	86.3	160.1
23.52	Lime	-5.8	3.5	-	58.4	-2.3	56.1
24.10	Iron and steel	97.7	40.0	525.6	717.0	663.3	854.7
Total*		**23.5**	**76.0**	**773.7**	**1,347.5**	**873.2**	**1,447.0**

* Totals and subtotals can differ slightly due to rounding.

Table 20 - Top 5 companies ranked by CO_2 verified emissions (kton) and additional profits (mio EUR, constant prices of 2019), Czech Republic, 2008-2019

Company	Main sector	KT verified	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
ArcelorMittal CZ	Iron and steel	39,598	131	31	287	391	448	553
UNIPETROL RPA, s.r.o.	Petrochemicals*	33,156	-86	11	56	169	-18	95
TŘINECKÉ ŽELEZÁRNY, a. s.	Iron and steel	31,387	-43	8	208	283	172	248
Českomoravský cement, a.s.	Cement	12,917	-6	5	34	66	33	65
Česká rafinérská, a.s.	Refineries	10,288	-4	2	49	86	47	84

* Also includes 20.11 industrial gases.

3.4 Denmark

Table 21 - Additional profits (mio EUR, constant prices of 2019), per sector, Denmark, 2008-2019

NACE	Sector	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
06.10	Extraction of crude oil and gas	20.7	11.9	87.0	152.3	119.6	185.0
19.10	Manufacture of coke oven products	-	-	-	-	-	-
19.20	Refineries	-14.0	3.9	52.0	91.0	41.9	80.9
20.11	Industrial gases	-	-	-	-	-	-
20.13	Inorganic chemicals	-	-	-	-	-	-
20.14	Petrochemicals	0.5	0.1	0.3	0.8	0.8	1.3
20.15	Fertilisers	-	-	-	-	-	-
20.16	Manufacture of plastics in primary form	-	-	-	-	-	-
23.11	Flat glass	-	-	-	-	-	-
23.13	Hollow glass	-0.1	0.3	2.4	4.3	2.6	4.6
23.14	Other glass	0.0	0.0	0.3	0.7	0.4	0.7
23.32	Manufacturing of bricks	1.3	0.6	5.3	7.1	7.2	9.0
23.51	Cement	52.7	11.9	57.2	111.5	121.7	176.1
23.52	Lime	3.7	0.4	-	3.1	4.0	7.1
24.10	Iron and steel	-1.2	0.4	6.8	9.3	6.0	8.5
Total*		**63.6**	**29.5**	**211.2**	**380.0**	**304.3**	**473.1**

* Totals and subtotals can differ slightly due to rounding.

Table 22 - Top 5 companies ranked by CO_2 verified emissions (kton) and additional profits (mio EUR, constant prices of 2019), Denmark, 2008-2019

Company	Main sector	KT verified	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
Aalborg Portland A/S	Cement	22,369	53	12	57	111	122	176
Maersk Olie og Gas	Extraction of crude oil and gas	16,758	28	10	72	126	109	163
Statoil Refining Denmark A/S	Refineries	6,091	-10	2	28	50	20	41
A/S Dansk Shell	Refineries	5,023	-4	2	24	41	22	40
HESS CORPORATION	Extraction of crude oil and gas	2,215	-9	1	9	16	2	9

3.5 Finland

Table 23 - Additional profits (mio EUR, constant prices of 2019), per sector, Finland, 2008-2019

Sector	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
Extraction of crude oil and gas	-	-	-	-	-	-
Manufacture of coke oven products	-	-	-	-	-	-
Refineries	-69.7	17.6	181.3	317.3	129.2	265.3
Industrial gases	10.6	-	-	-	10.6	10.6
Inorganic chemicals	-0.0	0.1	0.3	0.6	0.3	0.6
Petrochemicals	-2.3	1.0	12.4	37.3	11.1	36.0
Fertilisers	6.4	0.6	1.5	5.0	8.4	11.9
Manufacture of plastics in primary form	-	-	-	-	-	-
Flat glass	-	-	-	-	-	-
Hollow glass	0.5	0.1	0.3	0.5	0.9	1.1
Other glass	1.9	0.3	0.9	2.0	3.1	4.1
Manufacturing of bricks	1.1	0.2	0.8	1.1	2.0	2.3
Cement	32.7	5.1	25.3	49.4	63.2	87.2
Lime	12.6	3.0	-	34.3	15.6	49.9
Iron and steel	-108.2	26.9	393.2	536.3	311.9	455.1
Total*	**-114.4**	**54.8**	**615.9**	**983.7**	**556.4**	**924.1**

* Totals and subtotals can differ slightly due to rounding.

Table 24 - Top 5 companies ranked by CO_2 verified emissions (kton) and additional profits (mio EUR, constant prices of 2019), Finland, 2008-2019

Company	Main sector	KT verified	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
Ruukki Metals Oy	Iron and steel	46,961	-166	17	310	423	162	275
NESTE OIL OYJ	Refineries	38,181	-70	18	181	317	129	265
Finnsementti Oy	Cement	9,802	33	5	25	49	63	87
OUTOKUMPU OYJ	Iron and steel	7,509	30	5	49	67	85	102
Borealis	Petrochemicals	6,017	-2	1	12	37	11	36

3.6 France

Table 25 - Additional profits (mio EUR, constant prices of 2019), per sector, France, 2008-2019

Sector	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
Extraction of crude oil and gas	13.6	2.1	6.8	11.9	22.6	27.6
Manufacture of coke oven products	-	-	-	-	-	-
Refineries	-101.5	66.6	744.8	1,303.7	709.9	1,268.9
Industrial gases	-4.4	2.3	-	-	-2.1	-2.1
Inorganic chemicals	28.8	9.8	31.1	73.0	69.7	111.6
Petrochemicals	127.5	38.4	186.3	559.5	352.3	725.4
Fertilisers	-12.6	8.6	25.7	85.8	21.6	81.8
Manufacture of plastics in primary form	1.7	0.8	6.2	10.3	8.6	12.7
Flat glass	8.9	2.4	-	39.6	11.3	51.0
Hollow glass	27.3	7.2	84.0	154.0	118.5	188.5
Other glass	0.4	0.6	5.4	11.3	6.4	12.3
Manufacturing of bricks	36.9	4.3	33.4	44.6	74.6	85.7
Cement	231.9	35.4	315.2	614.9	582.5	882.2
Lime	44.4	8.8	-	168.5	53.2	221.7
Iron and steel	-316.0	62.6	1,517.9	2,070.6	1,264.4	1,817.1
Total*	**86.9**	**249.9**	**2,956.7**	**5,147.6**	**3,293.6**	**5,484.5**

* Totals and subtotals can differ slightly due to rounding.

Table 26 - Top 10 companies ranked by CO_2 verified emissions (kton) and additional profits (mio EUR, constant prices of 2019), France, 2008-2019

Company	Sector	KT verified	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
ARCELORMITTAL S.A.	Iron and steel	207,679	-337	56	1.412	1.927	1.131	1,645
TOTAL S.A.	Refineries*	88,331	-87	35	431	755	380	704
LAFARGE SA	Cement**	47,545	102	14	122	240	237	356
TOUFFAIT	Refineries***	46,860	-26	23	188	363	184	359
CIMENTS CALCIA	Cement	43,048	44	12	110	214	166	270
VICAT	Cement	23,593	69	6	60	117	135	192
NAPHTACHIMIE	Petrochemicals	18,257	-20	6	39	116	25	102
COMPAGNIE PETROCHIMIQUE DE BERRE	Petrochemicals****	17,315	62	8	51	127	121	197
LEUCKX	Petrochemicals	16,696	36	12	36	108	84	156
PETROINEOS MANUFACTURING FRANCE SAS	Refineries	15,246	-4	4	72	126	72	126

* Also includes 06.10 Extraction of crude oil and gas.
** Also includes 23.52 Lime.
*** Also includes 20.16 Manufacture of plastics in primary form.
**** Also includes 19.20 Refineries.

3.7 Germany

Table 27 - Additional profits (mio EUR, constant prices of 2019), per sector, Germany, 2008-2019

Sector	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
Extraction of crude oil and gas	-5.1	0.9	8.7	15.2	4.4	10.9
Manufacture of coke oven products	-237.6	12.8	193.0	267.9	-31.8	43.0
Refineries	-191.5	110.8	1,280.9	2,242.0	1,200.1	2,161.3
Industrial gases	-17.6	10.0	-	-	-7.6	-7.6
Inorganic chemicals	14.0	13.7	28.2	66.2	55.8	93.9
Petrochemicals	55.1	70.2	305.6	917.7	430.9	1,043.0
Fertilisers	-68.3	20.5	66.0	220.8	18.3	173.0
Manufacture of plastics in primary form	-46.9	6.6	57.1	95.2	16.8	54.9
Flat glass	-11.6	7.1	-	86.3	-4.5	81.8
Hollow glass	-10.9	7.9	71.7	131.5	68.7	128.5
Other glass	-1.2	1.5	8.5	17.7	8.8	18.0
Manufacturing of bricks	29.0	7.0	60.3	80.4	96.3	116.4
Cement	-71.7	80.1	588.7	1,148.4	597.1	1,156.8
Lime	57.2	36.4	-	452.2	93.6	545.8
Iron and steel	-287.5	222.9	3,086.8	4,210.6	3,022.1	4,146.0
Total*	**-794.5**	**608.2**	**5,755.3**	**9,951.9**	**5,569.0**	**9,765.6**

* Totals and subtotals can differ slightly due to rounding.

Table 28 - Top 10 companies ranked by CO_2 verified emissions (kton) and additional profits (mio EUR, constant prices of 2019), Germany, 2008-2019

Company	Sector	KT verified	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
THYSSENKRUPP AG	Iron and steel	163,944	-221	94	1,079	1,472	953	1,346
SALZGITTER AG	Iron and steel	92,473	-484	22	604	824	142	362
BASF SE	Petrochemicals*	76,222	12	38	137	416	187	466
ARCELORMITTAL S.A.	Iron and steel**	59,594	422	30	365	506	817	958
HeidelbergCement AG	Cement***	58,165	-16	28	141	285	153	298
Hüttenwerke Krupp Mannesmann GmbH	Iron and steel	55,616	134	37	368	501	539	673
RUHR OEL GESELLSCHAFT	Refineries	53,519	-43	21	249	435	226	413
ROGESA Roheisengesellschaft Saar mbH	Iron and steel	51,803	320	22	350	478	692	820
Shell Deutschland Oil GmbH	Refineries	44,009	-23	19	207	363	203	359
Rheinkalk GmbH	Lime	36,132	27	16	-	184	43	227

* Also includes 20.11 Industrial gases, 20.15 Fertilisers.

** Also includes 19.10 Manufacture of coke oven products.

*** Also includes 23.52 Lime.

3.8 Greece

Table 29 - Additional profits (mio EUR, constant prices of 2019), per sector, Greece, 2008-2019

Sector	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
Extraction of crude oil and gas	4.8	0.5	4.2	7.3	9.4	12.5
Manufacture of coke oven products	-	-	-	-	-	-
Refineries	-177.7	19.3	265.4	464.6	107.0	306.2
Industrial gases	-	-	-	-	-	-
Inorganic chemicals	0.1	0.1	0.1	0.3	0.3	0.5
Petrochemicals	-	-	-	-	-	-
Fertilisers	-0.4	0.4	0.8	2.6	0.8	2.6
Manufacture of plastics in primary form	-	-	-	-	-	-
Flat glass	-	-	-	-	-	-
Hollow glass	0.1	0.3	2.0	3.6	2.4	4.0
Other glass	-	-	-	-	-	-
Manufacturing of bricks	45.9	3.8	9.3	12.4	59.0	62.1
Cement	362.9	34.1	192.8	376.2	589.8	773.2
Lime	44.6	3.7	-	26.4	48.4	74.8
Iron and steel	30.0	4.1	73.8	100.6	107.8	134.7
Total*	**310.2**	**66.3**	**548.4**	**994.1**	**924.9**	**1,370.7**

* Totals and subtotals can differ slightly due to rounding.

Table 30 - Top 5 companies ranked by CO_2 verified emissions (kton) and additional profits (mio EUR, constant prices of 2019), Greece, 2008-2019

Company	Sector	KT verified	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
TITAN CEMENT COMPANY S.A.	Cement	37,888	87	13	96	188	196	287
ΕΛΛΗΝΙΚΑ ΠΕΤΡΕΛΑΙΑ ΑΕ	Refineries	34,236	-130	11	152	266	34	148
ΑΓΕΤ ΗΡΑΚΛΗΣ	Cement	32,017	257	19	87	170	363	446
ΜΟΤΟΡ ΟΙΛ - Δ. ΚΟΡΙΝΘΟΥ	Refineries	24,489	-48	8	113	198	73	158
ΓΜΜΑΕ ΛΑΡΚΟ	Iron and steel	8,776	7	2	56	76	64	85

3.9 Hungary

Table 31 - Additional profits (mio EUR, constant prices of 2019), per sector, Hungary, 2008-2019

Sector	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
Extraction of crude oil and gas	0.5	0.0	0.5	0.9	1.0	1.5
Manufacture of coke oven products	1.0	0.9	10.3	14.3	12.2	16.2
Refineries	-30.5	6.9	84.9	148.5	61.3	124.9
Industrial gases	-3.7	0.4	-	-	-3.3	-3.3
Inorganic chemicals	0.2	1.1	2.3	5.5	3.6	6.8
Petrochemicals	-14.0	6.7	29.3	88.0	22.1	80.7
Fertilisers	-9.3	2.6	7.6	25.5	0.9	18.7
Manufacture of plastics in primary form	7.3	0.2	4.2	7.1	11.8	14.6
Flat glass	-0.0	0.5	-	7.3	0.5	7.8
Hollow glass	-0.5	0.2	2.4	4.4	2.1	4.1
Other glass	0.2	0.0	0.1	0.1	0.3	0.3
Manufacturing of bricks	21.8	2.4	11.4	15.2	35.6	39.4
Cement	69.8	11.2	41.8	81.6	122.8	162.6
Lime	9.8	1.2	-	15.8	11.1	26.8
Iron and steel	-73.9	4.1	71.0	96.9	1.2	27.1
Total*	**-21.2**	**38.5**	**265.9**	**511.1**	**283.1**	**528.3**

* Totals and subtotals can differ slightly due to rounding.

Table 32 - Top 5 companies ranked by CO_2 verified emissions (kton) and additional profits (mio EUR, constant prices of 2019), Hungary, 2008-2019

Company	Sector	KT verified	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
MOL MAGYAR OLAJ-ES GAZIPARI RT.	Refineries	17,809	-31	7	84	149	61	125
Tiszai Vegyi Kombinát NyRt.	Petrochemicals	12,452	-7	6	27	80	26	80
DUNA-DRAVA CEMENT KORLATOLT FELELOSSEGU TARSASAG	Cement	9,629	41	6	26	51	73	98
ISD Dunaferr Zrt.	Iron and steel	9,563	-75	4	68	92	-3	22
Nitrogénmûvek ZRt.	Fertilisers	5,938	-9	3	8	25	1	19

3.10 Ireland

Table 33 - Additional profits (mio EUR, constant prices of 2019), per sector, Ireland, 2008-2019

Sector	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
Extraction of crude oil and gas	-	-	-	-	-	-
Manufacture of coke oven products	-	-	-	-	-	-
Refineries	0.5	2.1	17.7	31.0	20.3	33.6
Industrial gases	-	-	-	-	-	-
Inorganic chemicals	-	-	-	-	-	-
Petrochemicals	-0.2	0.2	0.6	1.9	0.6	1.9
Fertilisers	-	-	-	-	-	-
Manufacture of plastics in primary form	-	-	-	-	-	-
Flat glass	-	-	-	-	-	-
Hollow glass	0.4	0.0	0.1	0.2	0.5	0.6
Other glass	-	-	-	-	-	-
Manufacturing of bricks	1.0	0.1	0.1	0.2	1.2	1.2
Cement	140.9	19.3	74.5	145.4	234.7	305.6
Lime	11.2	1.3	-	9.4	12.5	21.9
Iron and steel	-	-	-	-	-	-
Total*	153.7	23.1	93.1	188.0	269.9	364.8

* Totals and subtotals can differ slightly due to rounding.

Table 34 - Top 5 companies ranked by CO_2 verified emissions (kton) and additional profits (mio EUR, constant prices of 2019), Ireland, 2008-2019

Company	Sector	KT verified	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
CRH PUBLIC LIMITED COMPANY	Cement	17,329	112	15	42	89	168	215
QUINN GROUP LIMITED	Cement	8,026	28	3	21	42	52	73
LAGAN HOLDINGS LIMITED	Cement	4,660	10	3	12	23	24	35
Phillips 66 Whitegate Refinery Limited	Refineries	3,744	0	2	18	31	20	34
Gypsum Industries Limited	Lime	288	2	0	-	2	3	4

3.11 Italy

Table 35 - Additional profits (mio EUR, constant prices of 2019), per sector, Italy, 2008-2019

Sector	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
Extraction of crude oil and gas	-33.1	2.1	25.8	45.1	-5.2	14.1
Manufacture of coke oven products	-1.3	0.4	7.1	9.9	6.3	9.0
Refineries	-768.3	79.9	1,133.6	1,984.3	445.1	1,295.8
Industrial gases	-6.4	2.2	-	-	-4.2	-4.2
Inorganic chemicals	33.5	3.8	9.4	22.1	46.6	59.3
Petrochemicals	130.3	33.4	99.3	298.1	263.0	461.8
Fertilisers	-15.2	3.9	12.1	40.5	0.8	29.1
Manufacture of plastics in primary form	3.8	1.0	8.4	14.0	13.2	18.8
Flat glass	2.2	3.6	-	38.4	5.7	44.1
Hollow glass	-30.9	6.6	78.8	144.5	54.5	120.3
Other glass	3.7	0.4	2.5	5.2	6.6	9.3
Manufacturing of bricks	29.6	5.0	28.5	38.0	63.1	72.6
Cement	693.3	98.0	527.9	1,029.9	1,319.3	1,821.3
Lime	95.5	11.3	-	126.2	106.8	233.1
Iron and steel	103.5	79.9	922.8	1,258.7	1,106.1	1,442.1
Total*	240.2	331.5	2,856.2	5,054.9	3,427.9	5,626.6

* Totals and subtotals can differ slightly due to rounding.

Table 36 - Top 10 companies ranked by CO_2 verified emissions (kton) and additional profits (mio EUR, constant prices of 2019), Italy, 2008-2019

Company	Sector	KT verified	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
ILVA S.P.A.	Iron and steel	92,158	6	60	623	850	689	916
Sarlux Srl	Refineries	73,453	-527	12	344	602	-171	87
ENI SPA	Refineries*	56,115	-109	23	262	458	175	371
ITALCEMENTI S.P.A.	Cement	50,319	118	28	140	273	286	419
Buzzi Unicem S.p.A.	Cement	36,957	171	18	99	192	287	381
COLACEM SPA	Cement	36,471	128	12	96	188	237	329
Versalis S.p.A.	Inorganic chemicals	34,529	94	28	78	233	200	354
ISAB S.r.l.	Refineries	24,045	-11	7	115	201	111	197
ESSO ITALIANA S.r.L.	Refineries	22,143	-44	9	103	180	68	145
Raffineria di Milazzo S.C.p.A.	Refineries	21,714	-54	3	100	175	49	124

* Also includes 06.10 Extraction of crude oil and gas.

3.12 Netherlands

Table 37 - Additional profits (mio EUR, constant prices of 2019), per sector, Netherlands, 2008-2019

Sector	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
Extraction of crude oil and gas	-4.3	0.8	6.7	11.7	3.2	8.2
Manufacture of coke oven products	-	-	-	-	-	-
Refineries	-115.3	61.2	615.1	1,076.7	561.0	1,022.6
Industrial gases	4.6	6.1	-	-	10.7	10.7
Inorganic chemicals	-0.8	2.9	7.7	18.2	9.8	20.3
Petrochemicals	106.3	57.7	211.3	634.6	375.3	798.6
Fertilisers	-14.7	19.7	53.9	180.3	58.9	185.3
Manufacture of plastics in primary form	-1.2	2.0	21.5	35.8	22.4	36.7
Flat glass	-0.9	0.3	-	3.6	-0.6	3.0
Hollow glass	-2.0	1.3	16.5	30.2	15.8	29.5
Other glass	-0.4	0.3	3.0	6.3	2.9	6.2
Manufacturing of bricks	2.3	2.4	20.3	27.1	25.0	31.8
Cement	34.2	3.8	13.0	25.4	50.9	63.3
Lime	-1.4	0.1	-	1.2	-1.2	-0.0
Iron and steel	-47.3	35.1	498.7	680.2	486.5	668.0
Total*	**-41.0**	**193.8**	**1,467.8**	**2,731.3**	**1,620.6**	**2,884.1**

* Totals and subtotals can differ slightly due to rounding.

Table 38 – Top 10 companies ranked by CO_2 verified emissions (kton) and additional profits (mio EUR, constant prices of 2019), Netherlands, 2008-2019

Company	Sector	KT verified	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
SHELL Nederland	Refineries*	77,742	-29	43	302	598	316	612
Tata Steel Ijmuiden	Iron and steel	74,891	-48	35	496	676	482	663
Chemelot Site Permit	Petrochemicals**	47,734	-0	32	90	271	121	302
DOW Benelux B.V.	Petrochemicals***	30,752	6	12	64	191	82	209
Yara Sluiskil B.V.	Fertilisers	27,602	-9	14	37	123	42	128
Esso Nederland B.V.	Refineries	26,249	-6	13	125	218	131	225
BP Refinery B.V.	Refineries	26,077	-63	10	122	213	69	160
Zeeland Refinery N.V.	Refineries	18,382	-15	9	87	153	82	147
AIR PRODUCTS HOLDINGS B.V.	Industrial gases	7,803	-6	3	-	-	-3	-3
Kuwait foreign petroleum exploration	Refineries	5,845	-2	1	27	48	27	47

* Also includes 20.14 Petrochemicals.

** Also includes 20.15 Fertilisers and 20.16 Manufacture of plastics in primary form. This is an administrative site permit under which various chemical companies are operating (e.g. Sabic, DSM, OCI Nitrogen). We could not attribute the site permit to individual owners.

*** Also includes 20.16 Manufacture of plastics in primary form.

3.13 Poland

Table 39 - Additional profits (mio EUR, constant prices of 2019), per sector, Poland, 2008-2019

Sector	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
Extraction of crude oil and gas	-	-	-	-	-	-
Manufacture of coke oven products	94.3	15.8	120.2	166.1	230.3	276.2
Refineries	-19.2	15.7	207.0	362.4	203.5	358.9
Industrial gases	-	-	-	-	-	-
Inorganic chemicals	34.1	2.1	4.1	9.6	40.2	45.7
Petrochemicals	-10.5	8.5	40.5	121.5	38.5	119.5
Fertilisers	-127.7	24.0	72.5	242.2	-31.2	138.6
Manufacture of plastics in primary form	1.3	0.1	0.8	1.4	2.3	2.9
Flat glass	1.8	2.1	-	31.6	3.9	35.4
Hollow glass	-10.2	3.6	30.9	56.6	24.3	50.0
Other glass	-0.5	0.2	1.6	3.2	1.3	3.0
Manufacturing of bricks	10.1	2.9	20.9	27.9	34.0	40.9
Cement	-51.7	42.4	302.1	589.3	292.8	580.0
Lime	-11.9	6.8	-	116.7	-5.1	111.6
Iron and steel	-108.2	44.6	492.3	671.5	428.6	607.9
Total*	**-198.3**	**168.7**	**1,292.8**	**2,400.1**	**1,263.3**	**2,370.6**

* Totals and subtotals can differ slightly due to rounding.

Table 40 - Top 10 companies ranked by CO_2 verified emissions (kton) and additional profits (mio EUR, constant prices of 2019), Poland, 2008-2019

Company	Sector	KT verified	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
ArcelorMittal Poland S.A.	Iron and steel*	83,587	-82	52	500	701	469	671
Grupa Azoty S.A.	Fertilisers**	53,119	-140	22	76	250	-42	132
POLSKI KONCERN NAFTOWY ORLEN SA.	Refineries**	39,075	-2	17	154	297	169	312
Górażdże Cement S. A.	Cement	25,242	-13	12	67	130	66	129
Grupa Ożarów S.A.	Cement	23,550	-19	5	60	118	46	104
LAFARGE SA	Cement	23,299	3	5	57	112	65	119
CEMEX, S.A.B. DE C.V.	Cement	16,729	19	9	43	84	71	112
GRUPA LOTOS S.A.	Refineries	16,074	-13	4	70	123	61	114
CEMENTOWNIA WARTA S.A.	Cement	16,017	-34	6	38	74	11	47
Dyckerhoff Polska Sp.z o.o.	Cement	10,482	-10	2	27	53	19	45

* Also includes 19.10 Manufacture of coke oven products and 23.52 Lime.

** Also includes 20.14 Petrochemicals.

3.14 Portugal

Table 41 - Additional profits (mio EUR, constant prices of 2019), per sector, Portugal, 2008-2019

Sector	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
Extraction of crude oil and gas	-	-	-	-	-	-
Manufacture of coke oven products	-	-	-	-	-	-
Refineries	-81.5	18.4	170.9	299.1	107.9	236.1
Industrial gases	-2.0	0.2	-	-	-1.8	-1.8
Inorganic chemicals	5.0	0.3	0.7	1.6	5.9	6.8
Petrochemicals	2.3	2.6	13.7	41.1	18.6	46.0
Fertilisers	5.6	0.5	1.3	4.4	7.3	10.4
Manufacture of plastics in primary form	0.8	0.1	2.2	3.6	3.1	4.5
Flat glass	3.0	0.3	-	1.0	3.3	4.3
Hollow glass	-4.2	2.4	24.9	45.7	23.2	44.0
Other glass	-	-	-	-	-	-
Manufacturing of bricks	28.0	2.8	15.2	20.2	46.0	51.0
Cement	207.3	25.6	138.6	270.3	371.5	503.2
Lime	5.9	1.5	-	25.3	7.4	32.8
Iron and steel	17.4	1.1	13.9	19.0	32.5	37.5
Total*	**187.6**	**56.0**	**381.3**	**731.4**	**624.9**	**974.9**

* Totals and subtotals can differ slightly due to rounding.

Table 42 - Top 5 companies ranked by CO_2 verified emissions (kton) and additional profits (mio EUR, constant prices of 2019), Portugal, 2008-2019

Company	Sector	KT verified	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
Petróleos de Portugal - Petrogal S.A	Refineries	37,476	-81	18	171	299	108	236
CIMPOR-CIMENTOS DE PORTUGAL, SGPS, S. A.	Cement	31,513	144	14	80	157	238	315
SECIL	Cement	13,175	31	5	34	66	70	102
CMP - Cimentos Maceira e Pataias, S.A	Cement	9,246	35	6	25	48	66	90
REPSOL S.A.	Refineries	6,339	3	3	13	40	18	45

3.15 Slovakia

Table 43 - Additional profits (mio EUR, constant prices of 2019), per sector, Slovakia, 2008-2019

Sector	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
Extraction of crude oil and gas	-	-	-	-	-	-
Manufacture of coke oven products	-	-	-	-	-	-
Refineries	37.5	9.6	72.0	126.1	119.1	173.2
Industrial gases	-	-	-	-	-	-
Inorganic chemicals	-	-	-	-	-	-
Petrochemicals	3.2	2.9	11.0	33.1	17.2	39.3
Fertilisers	-22.2	3.0	10.4	34.7	-8.8	15.5
Manufacture of plastics in primary form	-	-	-	-	-	-
Flat glass	-	-	-	-	-	-
Hollow glass	0.6	0.4	3.8	7.1	4.9	8.1
Other glass	2.3	0.4	1.6	3.3	4.2	5.9
Manufacturing of bricks	6.0	0.6	2.4	3.2	8.9	9.7
Cement	43.6	10.8	60.8	118.6	115.2	173.0
Lime	48.7	5.3	-	51.9	53.9	105.9
Iron and steel	85.9	31.4	604.2	824.2	721.6	941.6
Total*	**205.6**	**64.5**	**766.3**	**1,202.2**	**1,036.4**	**1,472.3**

* Totals and subtotals can differ slightly due to rounding.

Table 44 - Top 5 companies ranked by CO_2 verified emissions (kton) and additional profits (mio EUR, constant prices of 2019), Slovakia, 2008-2019

Company	Sector	KT verified	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
U. S. Steel Košice, s.r.o.	Iron and steel	94,096	80	31	601	820	712	931
SLOVNAFT, a.s.	Refineries*	18,286	39	12	81	153	132	204
Holcim (Slovensko) a. s.	Cement	13,891	28	7	36	71	71	105
Duslo, a.s.	Fertilisers	7,718	-22	3	10	34	-9	15
Carmeuse Slovakia, s.r.o.	Lime	6,782	29	4	-	35	33	68

* Also includes 20.14 Petrochemicals.

3.16 Slovenia

Table 45 - Additional profits (mio EUR, constant prices of 2019), per sector, Slovenia, 2008-2019

Sector	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
Extraction of crude oil and gas	-	-	-	-	-	-
Manufacture of coke oven products	-	-	-	-	-	-
Refineries	-	-	-	-	-	-
Industrial gases	1.8	0.1	-	-	1.9	1.9
Inorganic chemicals	0.1	0.1	0.4	0.8	0.6	1.1
Petrochemicals	-	-	-	-	-	-
Fertilisers	-	-	-	-	-	-
Manufacture of plastics in primary form	0.2	0.1	0.3	0.5	0.5	0.7
Flat glass	-	-	-	-	-	-
Hollow glass	0.7	0.4	2.5	4.5	3.6	5.7
Other glass	0.2	0.1	0.2	0.5	0.5	0.8
Manufacturing of bricks	1.1	0.2	0.9	1.3	2.2	2.5
Cement	0.7	2.9	20.1	39.2	23.8	42.9
Lime	2.9	0.6	-	4.8	3.4	8.2
Iron and steel	-3.8	0.7	15.8	21.5	12.7	18.4
Total*	**3.9**	**5.1**	**40.2**	**73.2**	**49.2**	**82.2**

* Totals and subtotals can differ slightly due to rounding.

Table 46 - Top 5 companies ranked by CO_2 verified emissions (kton) and additional profits (mio EUR, constant prices of 2019), Slovenia, 2008-2019

Company	Sector	KT verified	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
SALONIT ANHOVO, D.D.	Cement	6,241	-8	2	16	32	11	26
LAFARGE SA	Cement	1,248	8	1	4	7	13	17
ACRONI, D.O.O.	Iron and steel	1,182	-1	0	8	11	7	10
METAL RAVNE, D.O.O.	Iron and steel	840	-2	0	5	7	4	5
IGM ZAGORJE, D.O.O.	Lime	819	2	0	-	4	3	7

3.17 Spain

Table 47 - Additional profits (mio EUR, constant prices of 2019), per sector, Spain, 2008-2019

Sector	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
Extraction of crude oil and gas	-	-	-	-	-	-
Manufacture of coke oven products	4.4	0.4	2.5	3.4	7.2	8.2
Refineries	-112.8	74.3	768.0	1,344.4	729.6	1,305.9
Industrial gases	-13.1	2.7	-	-	-10.4	-10.4
Inorganic chemicals	-14.0	5.1	15.8	37.1	6.9	28.3
Petrochemicals	26.8	16.6	81.9	245.9	125.2	289.3
Fertilisers	-37.4	9.2	25.8	86.1	-2.5	57.9
Manufacture of plastics in primary form	24.3	0.9	7.5	12.5	32.7	37.7
Flat glass	6.7	2.3	-	31.3	8.9	40.2
Hollow glass	-9.6	4.7	45.4	83.3	40.5	78.4
Other glass	2.2	0.4	1.9	3.9	4.5	6.5
Manufacturing of bricks	190.4	19.0	59.7	79.6	269.1	289.0
Cement	1,030.6	128.8	498.7	973.0	1,658.1	2,132.4
Lime	12.1	10.5	-	126.7	22.6	149.3
Iron and steel	253.2	42.1	569.0	776.2	864.3	1,071.4
Total*	**1,363.7**	**317.0**	**2,076.2**	**3,803.5**	**3,756.8**	**5,484.1**

* Totals and subtotals can differ slightly due to rounding.

Table 48 - Top 10 companies ranked by CO_2 verified emissions (kton) and additional profits (mio EUR, constant prices of 2019), Spain, 2008-2019

Company	Sector	KT verified	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
REPSOL S.A.	Refineries*	94,538	-92	46	413	749	367	703
ARCELORMITTAL S.A.	Iron and steel**	67,529	179	31	446	609	656	818
COMPANIA ESPANOLA DE PETROLEOS, S.A. (CEPSA)	Refineries	39,245	23	14	181	318	219	355
CEMEX, S.A.B. DE C.V.	Cement	36,351	366	38	98	192	502	595
Petróleos del Norte, SA	Refineries	26,647	-35	13	125	218	103	197
Cementos Portland Valderrivas, S.A.	Cement	24,091	166	20	68	134	254	319
Cementos Tudela Veguín SA	Cement**	22,777	51	12	42	112	104	174
HOLCIM LTD.	Cement	19,929	108	17	51	100	177	225
LAFARGE SA	Cement	19,755	129	9	53	103	190	240
Sociedad Financiera y Minera S.A	Cement	15,693	18	6	40	77	64	102

* Also includes 20.14 Petrochemicals.
** Also includes 23.52 Lime.

3.18 Sweden

Table 49 - Additional profits (mio EUR, constant prices of 2019), per sector, Sweden, 2008-2019

Sector	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
Extraction of crude oil and gas	-	-	-	-	-	-
Manufacture of coke oven products	-	-	-	-	-	-
Refineries	17.0	13.7	157.3	275.4	188.0	306.0
Industrial gases	7.4	0.4	-	-	7.8	7.8
Inorganic chemicals	5.6	0.8	1.5	3.6	7.9	10.0
Petrochemicals	21.6	2.6	18.7	56.1	43.0	80.4
Fertilisers	2.6	0.1	0.3	1.1	3.0	3.8
Manufacture of plastics in primary form	7.4	0.2	3.2	5.4	10.8	13.0
Flat glass	-0.5	0.2	-	4.7	-0.3	4.5
Hollow glass	1.5	0.5	2.7	4.9	4.7	6.9
Other glass	-0.7	0.1	0.8	1.7	0.3	1.2
Manufacturing of bricks	-0.2	0.0	0.4	0.6	0.3	0.4
Cement	-10.2	12.5	65.0	126.9	67.4	129.2
Lime	15.0	4.0	-	41.2	19.0	60.2
Iron and steel	193.6	33.3	327.8	447.1	554.7	674.1
Total*	**260.3**	**68.5**	**577.9**	**968.8**	**906.6**	**1,297.5**

* Totals and subtotals can differ slightly due to rounding.

Table 50 - Top 5 companies ranked by CO_2 verified emissions (kton) and additional profits (mio EUR, constant prices of 2019), Sweden, 2008-2019

Company	Sector	KT verified	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
SSAB AB	Iron and steel	38,806	178	30	269	366	477	575
Cementa AB	Cement	26,434	-11	13	65	127	67	129
Preem AB	Refineries	25,520	14	11	120	209	145	235
Borealis	Petrochemicals*	7,877	23	2	17	49	42	74
St1 Refinery AB	Refineries	6,060	2	2	28	50	32	53

* Also includes 20.16 Manufacture of plastics in primary form.

3.19 United Kingdom

Table 51 - Additional profits (mio EUR, constant prices of 2019), per sector, United Kingdom, 2008-2019

Sector	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
Extraction of crude oil and gas	-281.9	90.2	825.5	1,445.0	633.8	1,253.3
Manufacture of coke oven products	0.6	0.2	1.8	2.5	2.6	3.3
Refineries	-8.8	87.0	805.6	1,410.1	883.7	1,488.2
Industrial gases	-2.2	0.8	-	-	-1.4	-1.4
Inorganic chemicals	26.9	2.4	4.7	11.1	34.1	40.4
Petrochemicals	80.6	21.8	96.7	290.3	199.1	392.7
Fertilisers	7.1	5.9	18.9	63.3	31.9	76.2
Manufacture of plastics in primary form	-1.5	0.6	6.1	10.1	5.2	9.2
Flat glass	20.8	2.4	-	29.6	23.2	52.8
Hollow glass	-7.6	5.5	46.3	84.9	44.2	82.8
Other glass	8.3	1.0	3.9	8.2	13.2	17.5
Manufacturing of bricks	32.6	5.4	30.0	40.0	68.1	78.1
Cement	231.6	43.2	196.4	383.2	471.2	658.0
Lime	96.0	9.8	-	100.5	105.8	206.3
Iron and steel	-105.6	100.3	1,197.1	1,632.9	1,191.8	1,627.6
Total*	**97.1**	**376.4**	**3,233.0**	**5,511.6**	**3,706.5**	**5,985.1**

* Totals and subtotals can differ slightly due to rounding.

Table 52 - Top 10 companies ranked by CO_2 verified emissions (kton) and additional profits (mio EUR, constant prices of 2019), United Kingdom, 2008-2019

Company	Sector	KT verified	Over-allocation (a)	CERs (b)	CPT min (c)	CPT avg (d)	Tot min (a+b+c)	Tot avg (a+b+d)
Tata Steel UK Limited	Iron and steel*	164,781	-77	95	1,116	1,537	1,134	1,555
Lafarge UK	Cement*	33,837	112	16	74	170	202	299
Esso Petroleum Company Limited	Refineries	33,580	-38	18	159	279	139	258
Essar Oil UK Ltd	Refineries	29,034	-27	15	137	240	125	227
Valero Energy Ltd	Refineries	27,018	-49	7	128	224	85	182
Shell U.K. Limited	Extraction of crude oil and gas	26,232	-37	11	114	199	88	174
BP Exploration Operating Company Ltd	Extraction of crude oil and gas	23,699	-33	12	103	181	82	160
Phillips 66 Limited	Refineries	23,459	33	13	110	193	156	239
Sahaviriya Steel Industries UK Ltd	Iron and steel	20,265	-17	6	71	97	60	86
HeidelbergCement	Cement	19,127	112	15	48	94	175	221

* Also includes 23.52 Lime.

4 Outlook for Phase 4

4.1 Introduction

Chapter 2 has indicated that the companies participating in the EU ETS (in fifteen sectors in nineteen countries) received between the € 30-50 billion of additional profits from participating in the EU ETS. Most companies in the energy-intensive sectors profited from passing through (part of) the opportunity costs of freely obtained allowances into product prices. In addition to profits from cost pass-through, substantial additional profits have been obtained by some sectors and companies from overallocation, especially in the cement sector. European companies have also gained an additional € 3 billion from conversion of cheaper international credits into EUAs.

An important question is if this pattern of additional profits will continue in Phase 4 of the EU ETS and what can be done in the future to decrease the profits companies make from climate policy instruments like the EU ETS. Therefore, in this chapter, we will first, in Paragraph 4.2, discuss how additional profits can be minimised in the future from a theoretical perspective. Then we will analyse the impact of the changes in Phase 4 compared to Phase 3 on the future additional profits. In Paragraph 4.4 we will discuss how the future of the ETS may be changed in the light of Europe's ambition to step up to a reduction target of at least -55% and what needs to be done if policymakers want to limit additional profits through the EU ETS.

4.2 Two ways to limit additional profits

Of the three types of additional profits, net cost pass-through causes by far the largest profits, especially in 2018 and 2019. If policy makers want to limit these additional profits, they should change the allocation mechanism in the EU ETS. There are two ways how additional profits can be reduced:
1. By making free allocation fully in line with actual production (dynamic allocation).
2. By lowering the share of free allocation and increasing the share of auctioning of emission allowances.

Dynamic allocation

In the ETS, free allocation is based on historic activity levels (e.g. see HAL in the formula in Paragraph 2.2.1).[22] Under dynamic allocation, the allocation will be annually adjusted to actual production levels. This implies that if a producer produces more than the historic activity level, the producer is 'rewarded' with a larger amount of free allowances. This mechanism works also the other way around: if a producer produces less than the historic activity level, they will be 'penalized' by receiving less free allowances the next year. This implies that producers that pass through the carbon costs are now being faced with the chance of a reduction in output and a loss in free allowances. In economic terms this implies that there exists an opportunity cost from passing through the costs of freely obtained allowances that, under certain conditions, will exactly offset the gain in profits a

[22] If capacity is enlarged above certain thresholds, companies can also get a larger allocation through the New Entrant reserve. In addition, there was a downward activity threshold level that implies that if activity would shrink below 50%, companies free allocation would be reduced by 50%.

producer can experience from passing through the opportunity costs of freely obtained allowances into the product prices. In other words, a profit maximising company will no longer want to forward the opportunity costs of freely obtained allowances as it may result in an equiproportional loss in free allowances (Demailly and Quirrion, 2008).

In Phase 3, the cement sector experienced a situation like this where cement companies would face a cut in allocation levels if they did not increase their output above the activity level thresholds of 50% in Phase 3. Branger et al., (2015) show that for clinker installations the financial gain from increasing output to reach the threshold levels in order to safeguard free allowances did outweigh the costs for many installations, stimulating production (including exports) as well as increasing the clinker content in cement. In CE Delft and Öko Institut (2015) it was concluded that the cost pass-through rates in the cement sector was substantially below those of other sectors, which evidences that changes in allocation due to activity changes tends to lower cost pass-through substantially.

Hence dynamic allocation will imply that all sectors show much lower cost pass-through rates than presently as they will have a benefit from not passing through the costs. However, this will come at a cost. If all companies enlarge production in order to maximise their share of free allowances, total CO_2 emissions are larger than under a scheme with fixed activity levels guiding allocation as companies do not take the CO_2 costs anymore into account when expanding production. This undermines one of the purposes of the EU ETS where companies are encouraged to take into account the social costs of their carbon emissions in their production decisions. This leads to higher costs for the economy as a whole. Dynamic allocation is, from an economic perspective, a less efficient system leading to higher costs of carbon compliance. It also leads to carbon leakage. Demailly and Quirrion (2008) show, for example, that output based allocation in the industrial sectors (whereas electricity producers would fall under auctioning), result in CO_2 prices being around 25% higher resulting in additional carbon leakage. Therefore, dynamic allocation is not a proper solution to reduce additional profits.

Reducing the share of free allocation

The second option to reduce the additional profits is to reduce free allocation. In Phase 1 and 2 of the EU ETS, electricity producers obtained windfall profits by getting (the largest share of their required) emission allowances for free and putting these forward into product prices (Sijm, et al., 2006) so that consumers had to pay for the allowances companies received for free. Since the sector is subject (for the largest part) to auctioning under Phase 3, companies do no longer profit from participating in the EU ETS, but charge the consumers for the tangible costs they made from buying emission allowances.

Similarly, additional profits could be reduced if a larger share of industrial emissions were to be auctioned. Companies would still forward carbon costs into product prices, but now would have to pay for these allowances themselves as well. This scheme would put additional burden on the costs and profits of companies. Therefore it would be best if the revenues from auctions would be (partly) recycled back to subsidies for companies wanting to invest in low-carbon technologies. CE Delft (2008) showed that a regime where industrial emissions would be auctioned and recycled back in energy saving subsidies would lower costs of compliance by half for most industrial sectors.

Therefore, a combination of auctioning and subsidies to companies to invest in lower carbon emissions will be both economically efficient and reduce the additional profits. Enlarging the share of auctioning can therefore be regarded as good first step to lower additional profits.

4.3 Phase 4

4.3.1 Introduction

Phase 4, in operation since 1 January of 2021 has some important changes compared to Phase 3. However, the basis of allocation is not fundamentally changed compared to Phase 3. The most obvious changes are:
- Change in scope as the UK is out and Switzerland is in the scheme.
- Change in ambition, as the linear reduction factor increased from 1.74%/year to 2.2%/year.
- Change in free allocation rule as the free allocation basis will be periodically revised: in 2026 and every year that production changes by 15% compared to the historic activity level on which allocation is based.
- The 54 benchmark values determining the level of free allocation to each installation has been updated for the period 2021-2025 and will be updated once more for the period 2026-2030. An annual reduction rate will be determined for each benchmark, which will vary between 0.2 and 1.6%.
- Introduction of the Market Stability Reserve (MSR) which will act as a tool to reduce the number of allowances into circulation and will have a stabilising and increasing impact on the CO_2 prices.[23]

Alongside the ETS Directive, all other directives on e.g. allocation or monitoring, reporting and verification are also renewed. The final allocation to each installation is not yet known, as important pieces of information are still missing

4.3.2 Impact on additional profits

Three elements will be important in determining the impact on additional profits:
1. The CO_2 price level.
2. The number of freely allocated allowances.
3. The more frequent update of the allocation basis.

CO_2 price level

The Impact Assessment of the EC (2020) indicates that if nothing changes to the present ETS, prices will rise to € 32/tCO_2 in 2030. Presently, carbon market prices at the spot market are above that level, peaking to over €4 0/tCO_2 in recent months. However, the present market price may factor in the expectation that the EC will step up its climate ambition and hence may not be fully representative of the price development if the EU decides not to increase the ambition. An end price level of € 32/tCO_2 is in line with earlier price forecasts, like Bloomberg (2017).

The higher CO_2 price compared to the average of Phase 3 implies that additional profits will increase.

[23] The MSR was already in operation in the end of Phase 3.

Number of free allowances into circulation

In Phase 4, free allocation up to the benchmarks will be reduced significantly because the benchmarks have been updated with a historic technological improvements. This implies that the share of free allowances compared to Phase 3 will be reduced substantially in Phase 4 compared to Phase 3. Also the linear reduction factor may play a role here, although additional free allowances will come into play if the cross-sectoral correction factor needs to be applied. We do not know yet if this will be the case.

All in all, the number of free allowances in Phase 4 will be lower than in Phase 3 and this will reduce the additional profits.

More frequent updates

In Phase 4, allocation changes as a result of significant capacity changes has been changed to allocation changes as a result of significant changes in activity level and threshold levels have been reduced. As argued in Paragraph 4.2, this implies that the impetus to pass through carbon costs will be weaker. In total we will expect that this will lower the additional profits in Phase 4 compared to Phase 3.

Net impacts

The net impacts of these developments is uncertain but we expect that additional profits will remain substantial also in Phase 4 of the EU ETS, starting from the levels we observed in 2018/2019 and only slowly reducing over time. The net development will also depend on the economic development. If the Covid crisis will be translated into an economic recession that last for a longer period of time, we may expect that the activity level requirements make companies to lower cost pass-through rates to safeguard their free allowances. While this will reduce the additional profits, it may come at the price of a lack of reform in European industry effectively blocking the necessary transition towards a low-carbon economy.

4.4 Ambition to step up to 55% reduction

4.4.1 Introduction

In the European Green Deal, additional ambition on climate policy was announced: *"Achieving a climate neutral and circular economy requires the full mobilisation of industry. It takes 25 years – a generation – to transform an industrial sector and all the value chains. To be ready in 2050, decisions and actions need to be taken in the next five years."*

The document highlighted that EU industry needs to become 'climate and resource frontrunners' to develop the commercial applications of breakthrough technologies in key industrial sectors by 2030.

Against this background, a revision of the ETS design and ambition is to be expected to start in the summer of 2021. At the moment, various options are being discussed, such as increasing the Linear Reduction Factor from the present 2.2% per year to e.g. 4% per year implying that every year the number of allowances into circulation will be reduced by 4%.

Another option considered is a one-off reduction in auctioned allowances, or the combination of both an increased LRF plus a one-year reduction in allowances.

It is generally perceived that such an increased climate ambition cannot be realised without offering industry additional protection from carbon leakage. Presently (March 2021), a carbon border adjustment mechanism (CBAM) is being investigated with a proposal to be published by the summer of 2021 and intention to be implemented by 2023. Although the European Commission intended to connect a CBAM to the cancellation of free allocation, the European Parliament amended a report to include the provisions that:
- the CBAM would have to be compatible with WTO rules and EU free trade agreements;
- the CBAM would apply to energy-intensive industrial sectors like cement, steel, aluminium, oil refinery, paper, glass, chemicals and fertilisers, which continue to receive substantial free allocations.

These statements are somewhat contradictory. In earlier analysis on the legal conformity of carbon pricing as a basis for a CBAM, CE Delft (2018) concluded that the main principle of the WTO (‘non-discrimination’) will be violated if EU industry receives free allowances and non-EU industries do not. There are in general two ways forward:
- non-EU companies should, through their imports, be fully included in the ETS, or be part of a ‘notional’ ETS that calculates the average rate that applies for a certain product in the EU ETS in a transparent matter and charges the same costs to imports;
- the role of benchmarks should be improved where the EU industry would receive 100% free allowances up to the benchmarks, and the CBAM would only apply for the CO_2 emissions of imports above the benchmarks.

In the long run, additional policies may be on the table, such as consumer charges (Neuhoff, et al., 2016) or a ‘carbon added tax’ that taxes added carbon in every production step (see e.g. (CE Delft, 2015; 2018). Although such schemes would improve the efficiency of carbon reduction, they are more complicated to implement and it is unlikely that the European Commission will include them in their Fit for 55 program that is presented this summer.

4.4.2 Impact on additional profits

Three elements will be important in determining the impact on additional profits:
1. The CO_2 price level.
2. The number of sectors which will be under a CBAM.
3. The impact on free allocation.

CO_2 prices

Due to the increased ambition, CO_2 prices in the ETS are likely to rise substantially. The Impact Assessment of the European Commission (EC, 2020) states that the CO_2 prices may rise to € 44 to € 60/tCO_2 (2015 price levels) depending on the type of policies that are chosen under a -55% target and the question if the EU ETS is being expanded to other sectors or not.[24]

The higher CO_2 prices will in principle result in higher additional profits, although our cost pass-through rates derived from the literature have not really been tested in this range of

[24] There are also scenarios where the scope and coverage of the ETS remains unchanged. Under these scenarios the -55% reduction must primarily come from other sectors. The effects of this scenario are similar to the analysis described in Paragraph 4.2.

prices (see Annex A) and it is therefore not known to what extent additional profits will be augmented: the uncertainty is very high here.

CBAM

The sectors for which a CBAM will be formulated and installed will be shielded from foreign competition. This will provide a stimulus to pass through the carbon costs in those sectors as price formation will be no longer suppressed by imports and the only argument not to pass through carbon costs (maintaining market shares for oligopolistic firms) is no longer valid. However, the net impacts from a CBAM could be small: as most sectors are currently already passing through carbon costs, a CBAM will only have an impact for those sectors that currently are having problems in passing through the carbon costs.

Allocation under a CBAM

The allocation rules under a CBAM may be more decisive for the development of the additional profits. If free allocation cease for sectors under a CBAM, additional profits will cease as well. However if the CBAM is accompanied with free allocation, it could even result in a larger share of free allowances for industry. For example, when the CBAM only applies to emissions above the benchmarks, the share of free allowances to EU industry could be larger. This would result in an increase in additional profits as well.

Net impacts

The net impacts will largely depend on the question if the CBAM will be coupled with free allocation or not. If the CBAM is coupled with free allocation, additional profits are likely to increase. This development could be aggravated if, for reasons of simplicity, industry received 100% free allowances up to their benchmarks. Dynamic allocation could reduce this phenomenon but comes at a price: total CO_2 reduction under a system of dynamic allocation becomes more costly as companies do no longer take the CO_2 costs in account when taking production decisions.

The precise impacts will thus largely depend on the design of the Fit for 55 package that the Commission publishes this summer. It was concluded by the European Court of Auditors (2020) that free allocation was not targeted enough, arguing that sectors that could pass through carbon costs would not need those free allowances.[25] The report rather argues that benchmarks have been a successful mechanism for stimulating innovation and reducing emissions, but the incentive to lower emissions is reduced when allowances are given for free. The European Commission may take such statements into account when devising a new allocation mechanism in the Fit for 55 package.

[25] The report states: *Free allowances were intended to provide an exceptional method of allocating allowances in contrast to the default method (auctioning). However, during Phase 3 and the early stages of Phase 4, they continue to represent more than 40% of the total number of available allowances. We found that the number of free allowances allocated to the industry and aviation sectors in Phase 3 was not based on their ability to pass through costs and that, while carbon leakage has the potential to affect the EU carbon market and the evolution of the greenhouse gas emissions worldwide, there was limited targeting of the allocation of free allowances.*

5 Conclusions and recommendation

This study has calculated the additional profits that sectors and companies have made from the EU ETS between 2008 to 2019 for the fifteen most CO_2-intensive sectors in nineteen EU countries representing 82% of total industrial emissions in the ETS. In total, the additional profits for the fifteen sectors in the nineteen countries ranged between the € 30 to over € 50 billion in the period 2008-2019. In absolute terms, additional profits were the highest in the iron and steel sector (€ 11.9 to € 16.1 billion) followed by the cement (€ 7.1 to € 10.3 billion) and refineries (€ 5.9-11.3 billion).

The additional profits were calculated in this research from three different type of profits:

1. **Profits from overallocation of free emission allowances:** In total, industry in those countries has received 37 Mt more free allowances than they needed for covering their emissions. The excess allowances could be sold on the market resulting in additional profits estimated € 1.6 billion worth. Especially the cement sector and various building materials (bricks and lime) have profited from this resulting in around € 4 billion additional profits from simply taking part in European climate policies.

2. **Profits from using CDM/JI credits for compliance:** Companies were entitled to use a certain amount of CDM/JI credits for compliance. As the price of these credits was substantially laying below the price of an emission allowance (especially in the last few years), this has created additional profits worth of € 3 billion between 2008 and 2019. The iron and steel sector has profited most from this exchange (€ 850 million).

3. **Profits from passing through the opportunity costs of freely obtained allowances:** The design of the EU ETS with a hybrid mix between free allocation and auctioning make it likely that product prices of the products from EU industries contain CO_2 costs of marginal firms which acts as a producer surplus to other firms. There is ample empirical evidence that such producer surpluses have been stimulated by the EU ETS even though most firms do not intentionally pass through their carbon costs. In our research we have used a cautious estimate of the possibility to pass through the costs to accommodate the uncertainty that is involved in such calculations and included the loss in profits from a loss in market shares that resulted from those higher prices. Our estimates indicate that an additional profit of € 26 to € 46 billion was earned between 2008 and 2019 for the fifteen sectors in these nineteen countries. Especially the iron and steel sector has profited (€ 12-16 billion) followed by refineries (€ 7-12 billion) and cement (€ 3-7 billion). For all sectors, the additional profits from passing through carbon costs have significantly outweighed the loss in market shares that resulted from this cost pass-through.

The results should be interpreted with some care: while they give an accurate account of some of the most relevant cost and benefits associated with the EU ETS, they do not give the full picture. Abatement and administrative costs and benefits like subsidies for indirect costs or innovation are not included. Results for individual companies may also be incomplete as transfers of heat, electricity, CO_2 or waste gases (other than in the iron and steel sector) have not been covered which may result in lower or higher additional profits. However, there is no objective information available that can link such transfers to individual sectors or companies. Therefore we recommend policy makers to consider disclosing more information on the transfers of heat, electricity, waste gases or CO_2 of companies participating in the EU ETS.

For the future, several developments may results in a change in the additional profits. Table 53 shows the potential impacts on the additional profits that can be expected from various design issues.

Table 53 - ***Tentative table of potential impacts on AP***

Mechanism	Development on Additional Profits (AP)	Uncertainty
Higher CO_2 prince	Tends to result in higher CPT so higher AP	High
CBAM	If no change in free allocation, will most likely result in higher CPT so higher AP	Medium
Dynamic allocation	Will result in lower CPT, so lower AP	Medium
LRF update	Will result in less free allowances so lower AP	Low
Benchmark updates	Will result in considerably less free allowances, so lower AP	Low
International credits	No longer possible, so lower AP	Low

The total number of free allowances will be reduced in Phase 4 and this will lower the total additional profits. On the other hand, higher CO_2 prices may increase the additional profits through cost pass-through. It is difficult to predict beforehand which factor will dominate and how the additional profits actually will develop in Phase 4. However, it seems fair to suggest that it is likely that additional profits may remain dominant in Phase 4 or an eventual update for the 'Fit for 55' agenda.

The conclusions of this research should read that free allocation may not be fit for purpose in the future of European climate policies. As the costs seem to be passed through, it results in additional profits at the expense of European consumers. At the same time, free allocation may not have shielded companies from losing market shares on EU and international markets. There is a chance that free allocation has merely resulted in windfall profits without effectively preventing losses in market share. This would cast doubt on the effectiveness of free allowances to reduce carbon leakage risks. We recommend that the effectiveness of free allocation to prevent carbon leakage is investigated in future research.

Making allocation more dynamic would solve part of these problems but comes at a cost. First, individual companies may no longer factor in carbon costs in their production decisions thereby resulting in overproduction. Second, a muted carbon price signal through the value chain will reduce consumer choices for low-carbon products (Neuhoff and Ritz, 2019).

The most effective mean for reducing additional profits is to drastically reduce the number of freely issued allowances and increase the share of industrial emissions to be auctioned. Companies would still forward carbon costs into product prices, but now have to pay for these allowances themselves as well. This would have to be accompanied with targeted policies to ensure that European industries decarbonise while remaining competitive on a global playing field: either through enhanced investment subsidies, such as through the Innovation Fund, or through the instalment of Carbon Border Adjustment Mechanisms. Both solutions may be at odds with each other as an effective carbon border adjustment mechanism that is WTO compliant may also need to take into account the subsidies that had been given to European industries.

6 Literature

Alexeeva-Talebi, 2011. Cost pass-through of the European emission allowances: examining the European petroleum markets. *Energy Economics,* Volume 33, pp. 75-83.

Alexeeva-Talebi, V., 2010. Cost Pass-Through in Strategic Oligopoly: Sectoral Evidence for the EU ETS. *ZEW Discussion Paper.*

Anger, A. & Kohler, J., 2010. Including aviation emissions in the EU ETS: much ado about nothing? A review. *Transport Policy,* Volume 17, pp. 38-46.

Bloomberg, 2011. *Including Aviation in the EU ETS - The Burning Question,* s.l.: Bloomberg Research Note.

Bloomberg, 2017. *Here's What Europe's Carbon-Market Overhaul Means for Businesses.* [Online]
Available at: https://www.bloomberg.com/news/articles/2017-11-13/here-s-what-europe-s-carbon-market-overhaul-means-for-businesses
[Accessed 2021].

Capros, P., Regemorter, D. V., Paroussos, L. & Karkatsoulis, P., 2013. *GEM-E3 Model Documentation,* Luxembourg: Publications Office of the European Union.

CE Delft & Öko-Institut, 2015. *Ex-post investigation of cost pass-through in the,* Luixenbourg: Publications Office of the European Commission.

CE Delft, 2008. *Impacts on Competitiveness from EU ETS : An analysis of the Dutch industry,* Delft: CE Delft.

CE Delft, 2010. *Does the energy intensive industry obtain windfall profits through the EU ETS? ,* Delft: CE Delft.

CE Delft, 2015. *Carbon Added Tax as an alternative climate policy instrument,* Delft: CE Delft.

CE Delft, 2016. *Calculation of additional profits of sectors and firms from the EU ETS 2008-2015,* Delft: CE Delft.

CE Delft, 2018. *External Costs Charge: A policy instrument for climate change mitigation,* Delft: CE Delft.

Demailly, D. & Quirion, P., 2006. CO2 Abatement, Competitiveness and Leakage in the European Cement Industry under the EU ETS: Grandfathering versus Output-Based Allocation. *Climate Policy,* 6(1).

Demailly, D. & Quirion, P., 2008. *Changing the Allocation Rules in Quirion, Philippe and Demailly, Damien, Changing the Allocation Rules in the EU ETS: Impact on Competitiveness and Economic Efficiency FEEM Working Paper No. 89.2008,* s.l.: FEEM.

EC, 2006. *Commission SWD- Accompanying document to the Proposal for a Directive of the European Parliament and of the Council amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emission allowance,* Brussels: European Commission (EC).

EC, 2015. *Commission SWD Impact assesment Accompanying the document Communication from the Commission to the European Parliament and of the Council amending Directive 2003/87/EC to enhance cost effective Emission reductions and low carbon investments, SWD(2015)135,* Brussels: European Commission (EC).

EC, 2020. *SWD Impact assessment Accompanying the document [...]: Stepping up Europe's 2030 climate ambition, Investing in a climate-neutral future for the benefit of our people. SWD (2020) 176 final, PART 1/2,* Brussels: European Commission .

ECA, 2020. *The EU's Emissions Trading System : free allocation of allowances needed better targeting, special report,* Luxembourg: European Court of Auditors (ECA).

Ellis, J., Nachtigall, D. & Venmans, F., 2019. *Carbon Pricing and Competitiveness: Are they at Odds? – Environment,* Paris: OECD.

Forsyth, P., 2008. *The impact of climate change policy on competition in the air transport industry,* s.l.: OECD/ITF Joint Transport Research Centre Discussion Paper.

Frontier Economics, 2006. *Economic consideration of extending the EU ETS to include aviation, A Report Prepared for the European Low Fares Airline Association (ELFAA),* s.l.: Frontier Economics.

Gallaway, M., McDaniel, C. & Rivera, S., 2003. Short-run and long-run industry-level estimates. *North American Journal of Economics and Finance,* Volume 14, pp. 49-68.

Hintermann, B., Peterson, S. & Rickels, W., 2016. Price and Market Behavior in Phase II of the EU ETS: A Review of the Literature. *Review of Environmental Economics and Policy,* Volume 10, pp. 108-128.

IATA, 2008. *Air travel demand,* s.l.: IATA.

ICCT, 2020. *CO2 emissions from commercial aviation,* Berlin: International Council on Clean Transportation (ICCT).

Jereb, S., Henderson, K., Vrabic, J. & Friel, C., 2020. *The EU's Emissions Trading System: free allocation of allowances needed better targeting,* s.l.: European court of auditors.

Joltreau, E. & Sommerfield, K., 2019. Why does emissions trading under the EU Emissions Trading System (ETS). *Climate Policy,* 19(4), pp. 453-471.

Koopmans, C. & Lieshout, L., 2016. Airline cost changes: To what extent are they passed through to the. *Journal of Air Transport Management,* Volume 53, pp. 1-11.

Martin, R., de Preux, L., Muûls, M. & Wagner, U., 2013. On the Empirical Content of Carbon Leakage Criteria in the EU Emissions. *Ecological Economics,* Volume 105, pp. 78-88.

McKinsey, 2006. *EU ETS Review: December 2006. Report on International Competitiveness,* s.l.: McKinsey and Ecofys.

Neuhoff, K. et al., 2016. *Inclusion of Consumption of carbon intensive materials in emissions trading : An option for carbon pricing post-2020,* s.l.: Climate Strategies.

Neuhoff, K. & Ritz, R., 2019. Carbon Cost Pass-Through in Industrial Sectors. *Cambridge Working Paper in Economics.*

Nilsson, L., 2018. Reflections on the Economic Modelling of Free Trade Agreements. *Journal of Global Economic Analysis,* 3(1), pp. 156-186.

Oberndorfer, U., Alexeeva-Talebi, V. & Löschel, A., 2010. Understanding the Competitiveness Implications of Future Phases of EU ETS on the Industrial Sectors. *ZEW Discussion Paper*.

Sato, M. & Dechezleprêtre, A., 2015. Asymmetric industrial energy prices and international trade. *Energy Economics,,* 52(S1), pp. 130-141.

Scheelhaase, J., Grimme, W. & Schaefer, M., 2010. The inclusion of aviation into the EU emission trading scheme: impacts on competition between European and non-European network airlines. *Transportation Research Part D Transport and Environment,* Volume 15, pp. 14-25.

Sijm, J., Chen, Y. & Hobbs, B. F., 2012. The impact of power market structure on CO2 cost pass-through to electricity prices under quantity competition–A theoretical approach. *Energy Economics,* 34(4), pp. 1143-1152.

Sijm, J., Neuhoff, K. & Chen, Y., 2006. CO2 cost pass through and windfall profits in the power sector. *Climate Policy,* Volume 6, pp. 49-72.

Smale, R. et al., 2006. The impact of CO2 emissions trading on firm profits and market prices. *Climate Policy,* Volume 6, pp. 31-48.

Verde, S. F., Teixidó, J., Marcantononi, C. & Labandeira, X., 2019. Free allocation rules in the EU emissions trading. *Climate Policy,* 19(4), pp. 439-452.

Vivid Economics, 2014. *Carbon leakage prospects under Phase III of the EU ETS,* s.l.: Vivid Economics with Ecofys.

Wang, B., O'Sullivan, E., Dray, L. & Schäfer, a., 2018. Modeling Airline Cost Pass-Through within Regional Aviation Market. *Transportation Research Record Journal of the Transportation Research Board,* 2673(23).

Wang, M. & Zhou, P., 2017. Does emission permit allocation affect CO2 cost pass-through?. *Energy Economics,* Volume 66, pp. 140-146.

Warwick, P. & Ng, C., 2012. The 'Cost' of Climate Change: How Carbon Emissions Allowances are Accounted for Amongst European Union Companies. *Australian Accounting Review,* 22(1), pp. 54-67.

A Literature review cost pass-through

A.1 Introduction

Installations in the energy-intensive industry obtain the majority of their emission allowances for free. During Phase 3 of the EU ETS, 98% of industrial emissions were covered by the carbon leakage list, meaning that nearly all energy-intensive installations benefited from free allocation up to benchmark levels (Jereb, et al., 2020). In large part, the debate on cost pass-through revolves around the question to what extent companies can forward the opportunity costs of these freely obtained allowances into their product prices. Several studies have aimed to answer this question, using different methodological designs (theoretical, ex-ante, ex-post and surveys). However, the literature on cost pass-through of industrial installations within the EU ETS is still relatively sparse and for many sectors consensus estimates do not yet exist at this point. Higher EUA prices and the introduction of benchmarking have further increased the uncertainty surrounding cost pass-through rates. Here, we present an updated review of the relevant literature and show how our new results fit within the theoretical and empirical landscape. We also extend the review to incorporate research regarding cost pass-through in the European aviation sector.

A.2 Results

According to economic theory, firms produce up to the point where marginal costs equal marginal revenues. In practice, of course, production decisions are complicated by a number of other factors, yet the central notion remains valid: firms would like to increase production until it is not profitable anymore to do so. This means that firms would not necessarily use all freely obtained allowances for production; if the marginal benefit of selling allowances on carbon markets exceeds the marginal benefit of producing an additional unit, profit-maximising firms would choose to sell the allowances. Neoclassical theory thus predicts that firms will pass through allowance costs into their product prices – even if they did not pay for the allowances (Sijm, et al., 2012).

Theoretical analysis shows that the extent to which firms are able to pass through their opportunity costs depends on the shape of the demand and supply curves, as well as on the given market structure (Demailly & Quirion, 2006; Sijm, et al., 2012). In particular, assuming linear demand and supply curves, firms should theoretically be able to forward 50% to 100% of their marginal costs increase into product prices. Here, the lower bound reflects the situation under monopoly and the upper bound reflects the pass-through rate under perfect competition. Assuming non-linear demand- and supply curves, these rules of thumb no longer apply. For instance, if demand is iso-elastic, the pass-through rate may lie substantially higher than 100% (Sijm, et al., 2012). In addition to market structure and the shape of supply and demand curves, the extent of exposure to international competition could also influence the pass-through rate (Neuhoff & Ritz, 2019; Vivid Economics, 2014). To see why, note that international competitors unaffected by the given carbon legislation may effectively force affected firms to keep prices low, or lose (substantial) market shares. In practice though, this effect may be limited when carbon prices are low: as of yet, empirical research has not found that the introduction of the EU ETS had significant effects on different dimensions of competitiveness for European manufacturers (Joltreau &

Sommerfield, 2019; Ellis, et al., 2019). Finally, the pass-through rate may also depend on the precise allocation procedure by which emission allowances are distributed. Allocation procedures that are based on actual production output may lead to lower pass-through rates as there are opportunity benefits from production growth (Demailly & Quirion, 2006). This result makes intuitive sense: if allocation of free allowances is based on the actual production of the preceding year, firms may not want to lower their production in times of weak demand because doing so will decrease their future free allocation. This implicit output subsidy mitigates the rise in product prices (Neuhoff & Ritz, 2019). A similar argument based on an implicit output subsidy holds for allocation conditional on a certain activity level, as is adopted in the EU ETS. Indeed, empirical research in the cement sector (Branger et al., 2015) finds that the activity level thresholds (ALTs) in the EU ETS caused European clinker plants firms to produce 4% more clinker in 2015 than they would have without ALTs (that is, in a scenario in which the activity level was not a discrete parameter, but a continuous one).

Of course, these theoretical results do not imply that firms *in fact* pass through the opportunity costs of their freely obtained allowances. For instance, firms may not behave as economically rational agents and price their products based on accounting costs, instead of internalising the opportunity costs. A second branch of literature hence aims to determine firm behaviour under the EU ETS by asking them directly (Martin, et al., 2013). Findings from this literature indeed show that reported valuation practices vary across European firms: some firms report pricing their freely obtained allowances at market value, while others price them at nil value (Warwick & Ng, 2012).

However, as we pointed out in an earlier study, the question is not whether all firms adhere to opportunity cost pricing – rather, the question is how competitors respond when one firm raises prices because they choose to internalise opportunity costs. (CE Delft & Öko-Institut, 2015). Will other firms follow suit when a competitor raises prices or will they continue to ask a lower price in order to maximise market shares? Since the majority of firms regard themselves as price-takers instead of price-setters, it seems more likely that they too will increase their prices, and by doing so, effectively pass through their opportunity costs as well. Nevertheless, this question can only be answered conclusively using empirical methods.

A third and final branch of research thus aims to determine pass-through rates by conducting empirical ex-ante and ex-post analyses on the relation between carbon prices and product prices. Initially, empirical research on cost pass-through within the EU ETS focused predominantly on the power sector. It soon became apparent that power producers were able to pass through (nearly) all of their opportunity costs related to freely obtained allowances, resulting in large windfall profits (Hintermann, et al., 2016). Considering the wealth of literature regarding cost pass-through in the power sector, research on cost pass-through in manufacturing and aviation is still comparatively scarce (Neuhoff & Ritz, 2019; Jereb, et al., 2020).

Focusing on manufacturing first, the relative lack of empirical estimates is in part explained by inferior data quality and –availability for input and -product prices (Verde, et al., 2019). In addition, the manufacturing industry is characterised by a higher degree of product heterogeneity, resulting in distinct transportation costs, degrees of market concentration and international competition, as well as varying spare production capacity (CE Delft & Öko-Institut, 2015). Nevertheless, the literature shows that cost pass-through in the energy-intensive industry is likely, with estimates of pass-through rates varying by sector (Verde, et al., 2019).

Ex-ante studies on cost pass-through within manufacturing employ calibrated equilibrium models to simulate the effects of the introduction of a carbon price. They thus aim to merge theoretical models with real-world data. Three ex-ante analyses have been published that are relevant for our current purposes. The first was conducted by McKinsey in 2006 and finds positive, albeit relatively modest (0% to 66%), pass-through rates for the steel, paper, cement and refining sector (McKinsey, 2006). Around the same time, a study by Smale et al. estimated a cost pass-through rate of 65% for the steel industry (Smale, et al., 2006).
In 2014, a large ex-ante study by Vivid Economics determined pass-through rates for 24 different industrial sectors and found estimates of >75% for most of these sectors – a notable exception is the aluminium industry, for which a pass-through rate of less than 20% was found (Vivid Economics, 2014).

Over the years, several studies appeared that tried estimating manufacturing pass-through levels ex-post using econometric techniques – thus not relying on calibrated equilibrium models. Ex-post studies that aim to determine pass-through rates in the European manufacturing industry generally adopt one of two different methodologies:
1. The market equilibrium approach.
2. The cost-price approach.

The market equilibrium approach was introduced by CE Delft in 2010 and investigates the relation between carbon- and product prices within the EU and product prices in important trading countries that do no face European carbon regulation – in this case the US (CE Delft, 2010). The cost-price approach is more common nowadays and tries to explain product prices by conventional inputs (industry-specific materials, labour, capital, etc.) and the price of emission allowances, while controlling for potential confounders (CE Delft & Öko-Institut, 2015).

Using the cost-price approach, Alexeevi-Talebi (2010) finds that German manufacturers in the steel, cement, lime and plaster industry passed through up to 73% of their (implicit) ETS costs into their product prices during the first phase of the EU ETS (Alexeeva-Talebi, 2010). In a later study, Alexeevi-Talebi (2011) concludes that European refineries likely fully passed through the opportunity costs of their freely obtained EUAs into petrol prices (Alexeeva-Talebi, 2011). Employing the same methodology, Oberndorfer, Alexeevi-Talebi and Löschel (2010) study cost pass-through for manufacturing sectors in the UK. They find a wide scope of pass-through rates, ranging from 0% for container glass, to more than 100% for ceramics (Oberndorfer, et al., 2010). An earlier study by Walker (2006) found that cement producers that house on the periphery of the European Union tend to adopt lower pass-through rates than those in the centre of the EU. For instance, the pass-through rates for German firms was estimated at 51%-64% while the pass-through rates in Portugal and Italy were determined to be smaller than 10%. Finally, CE Delft conducted two studies that estimated pass-through rate for and extensive number of European manufacturing sectors (CE Delft, 2010; CE Delft, 2016). The first study, covering the first and second phase of the EU ETS, employed the market equilibrium approach and found that steel manufacturers and refineries passed through most – if not all – of their implicit EUA costs into product prices, while pass-through rates varied for different chemical products (CE Delft, 2010). The second study, also covering part of the third phase, used the cost-price method and extended the number of sectors investigated. Moderate to high pass-through rates (50%-100%) were found for producers of iron, steel, cement, hollow glass and petrol, while results for the petrochemical and fertiliser industry were more uncertain. All in all, we estimated that cost pass-through of freely allocated EUAs resulted in substantial additional profits for the energy-intensive industry, adding up to more than € 15 billion.

We now present an overview of the different pass-through rates found in the literature on European manufacturing, organised by sector.

Table 54 - Overview of empirically estimated pass-through rates found in the literature on manufacturing

Sector	Product	Minimum estimate	Maximum estimate	Sources
Iron and steel	Flat products	60%	100%	McKinsey (2006); Smale et al. (2006); Alexeevi-Talebi (2010); Vivid Economics (2014); CE Delft (2010); CE Delft (2015)
	Long products	66%	80%	
Cement	Portland cement, white cement	30%	100%	McKinsey (2006); Walker (2006); Alexeevi-Talebi (2010); Vivid Economics (2014); CE De;ft (2015)
	Total cement	20%	40%	
	Clinker	35%	40%	
Glass	Container glass	0%	50%	Oberndorfer et al. (2010); Alexeevi-Talebi (2010); Vivid Economics (2014); CE Delft (2015)
	Glass fibres			
	Hollow and other glass	30%	100%	
Refineries	Petrol	50%	>100%	McKinsey (2006); Oberndorfer et al. (2010); CE Delft (2010); Alexeevi-Talebi (2011); CE Delft (2015)
	Diesel	40%	>100%	
Petrochemicals	Plastics, PE, PVC, PS	25%	80%	CE Delft (2010); Alexeevi-Talebi (2010); Oberndorfer et al. (2010); CE Delft (2015)
	PE, ethylene, butadiene, etc.	0	>100%	
Fertilisers	Fertiliser and nitrogen compounds	15%	75%	Alexeevi-Talebi (2010); Oberndorfer et al. (2010); CE Delft (2015)

Note: Minimum and maximum values have been determined as the average of minimum and maximum values found in the cited studies weighted by the number of products listed in the studies and our own interpretation of the quality of the estimates and assessment of the potential range.

Aviation

Like the energy-intensive industry, the aviation sector received more than half of its allowances for free during Phase 3 of the EU ETS (Jereb, et al., 2020). In 2006, an impact assessment by the European Commission predicted that aircraft operators would be able to fully pass through the costs of these freely obtained emissions allowances onto consumers (EC, 2006). Intuitively, this makes sense as the cost increase following introduction to the EU ETS would hold for all EU flights and, in contrast to the manufacturing sector, foreign competition by airlines unaffected by the EU ETS is impossible.

To date, however, no ex-post studies on cost pass-through in the European aviation sector have been conducted and the EC's prediction has not been confirmed. As Koopmans and Lieshout (2016) write, the lack of pure empirical research may be explained by the difficulty in obtaining and analysing detailed ticket fare data (Koopmans & Lieshout, 2016). Consequently, many authors simply assume that aircraft operators fully pass through their allowance costs, based on the reasoning that the aviation sector is highly competitive (Frontier Economics, 2006; Anger & Kohler, 2010; Scheelhaase, et al., 2010). Koopmans and Lieshout question this presupposition, as most aviation markets are better described by differentiated oligopolies than by perfect competition (Koopmans & Lieshout, 2016). Under such a market structure, the authors argue that between 50% and 100% of sector-wide cost changes will be passed onto passengers.

Although ex-post studies are missing, several modelling efforts have tried estimating cost pass-through rates in the aviation sector. An ex-ante study by Vivid Economics finds that the high degree of market concentration in the European aviation sector likely leads to pass-through rates of 100%. Other studies find lower estimates: using the AIM2015 aviation model, Wang et al. (2018) estimate that within Europe, a 1% increase in marginal non-fuel costs only leads to a 0.16% increase in ticket prices (Wang, et al., 2018). A study by Bloomberg (2011) finds that the pass-through rate may increase over time as aircraft operators adept to new market conditions, for instance by no longer offering flights between certain city pairs. The authors suggest that a short-term pass-through rate of 30% is likely, while the long run pass-through rate may approach 60% (Bloomberg, 2011). In addition to market adaptation effects, Forsyth (2008) concludes that airport capacity can also influence the pass-through rate. When airlines are slot-constrained, the ticket price is determined by the balance of demand to slot capacity and airlines are unable to pass through their (implicit) allowance costs (Forsyth, 2008). Furthermore, IATA (2008) finds that price elasticities of demand tend to be higher for long-haul flights than for short-haul flights. This would make it easier for airlines to pass through costs on long-haul tickets, suggesting higher pass-through rates for long intra-EU flights.

All in all, no consensus has been reached in the literature on aviation: while significant cost pass-through seems likely, the lack of empirical estimates and the abundance of influencing factors make it hard to form reliable estimates. In this study we follow the estimation used for industrial sectors, where the minimum cost pass-through rate assumed is equal to the average of study results in de minimum range (0-50%) and the maximum cost pass-through rate is equal to the average of study results in the maximum range (50-100%). For aviation this yields 32% as a minimum value and 87% as a maximum value. Consequently, the average cost pass-through rate is assumed to be 60%.

The literature on cost pass-through in the manufacturing sector is more mature and for a range of products moderate to high pass-through rates have been predicted, as well as observed. Nevertheless, large uncertainties remain for the energy-intensive industry, not least through the uncertain effect of higher EUA prices. Since 2017, allowances prices have increased from approximately € 5 per ton CO_2 to more than € 30 per ton CO_2, and it is as of yet unclear how this price increase affects international competition from non-EU manufacturers. To our best knowledge, no new empirical estimates have been published since 2015, making it hard to foresee the effect of higher EUA prices on pass-through rates. In line with theory, one would expect to see lower rates – after all, fully passing through allowance costs comes with a higher risk of being outcompeted by non-EU manufacturers. On the other hand, this may not decrease the windfall profits earned by the energy-intensive industry: the same pass-through rate yields higher absolute profits when EUA prices are higher.

As no new empirical estimates have been published since our 2015 study, we have decided to use the same estimates for minimum and average cost pass-through in this study. Contrary to our previous study, we now also include estimates for cost pass-through values in the aviation sector. Table 55 presents an overview of the pass-through rates that were used in the main analysis.

Table 55 – Cost pass-through rates used in this study

		Minimum	Average	*Maximum*
06.10	Extraction of crude petroleum and gas	*40%*	*70%*	*100%*
19.10	Manufacture of coke oven products	*55%*	*75%*	*100%*
19.20	Refineries	40%	70%	*100%*
20.11	Industrial gases*	0%	0%	*0%*
20.13	Inorganic chemicals**	10%	24%	*37%*
20.14	Petrochemicals	15%	50%	*100%*
20.15	Fertilisers	10%	50%	*100%*
20.16	Manufacture of plastics	42%	70%	*100%*
23.11	Flat glass***	0%	40%	*80%*
23.13	Hollow glass 23.13;	30%	55%	*80%*
23.14	Other glass 23.14;	24%	50%	*80%*
23.32	Manufacture of bricks^^	*30%*	*40%*	*80%*
23.51	Cement	20%	39%	*58%^*
23.52	Lime***	0%	40%	*80%*
24.10	Iron and Steel	55%	75%	*100%*
51.10; 51.21	Aviation	32%	60%	*87%*

* Nowhere estimated in empirical work.

** Only estimated ex-post in one study for two different products.

*** Only estimated in one ex-ante study which has been taken here as max. value.

^ Maximum value calculated as average from maximum values literature review and new empirical estimates for a range of products.

^^ Only estimated in two studies with three results, as average value is now taken the mean value.

B Armington elasticities

In this annex we provide an elaborate overview of the calculations involving Armington elasticities.

B.1 Literature on Armington elasticities

As it turns out, EU level Armington elasticities are sparse in the literature, and to our best knowledge, they do not exist for industrial sectors at the four-digit NACE level. We have hence had to resort to using Armington elasticities for US industries by GTAP . As the US economy is comparable to that of the EU, these should still yield meaningful estimates.
In general, we adopted the long-term Armington Elasticities from Gallaway et al. (2003) as these better reflect the effect on demand years after the introduction of the EU ETS caused a general elevation in prices[26]. When only short-term Armington Elasticities were calculated by Gallaway et al. (2003) for a given sector, we applied the rule of thumb that the long-term elasticity is twice as large as the short term elasticity.

NACE Code	Sector	Used Armington Elasticity
06.10	Extraction of crude oil and gas	-0,30
19.10	Manufacture of coke oven products	-4,00
19.20	Refineries	-1,70
20.11	Industrial gases	-1,10
20.13	Inorganic chemicals	-1,20
20.14	Petrochemicals	-1,80
20.15	Fertilisers	-2,40
20.16	Manufacture of plastics in primary form	-4,80
23.11	Flat glass	-1,80
23.13	Hollow glass	-1,90
23.14	Other glass	-1,80
23.32	Manufacturing of bricks	-1,50
23.51	Cement	-1,50
23.52	Lime	-1,80
24.10	Iron and steel	-1,00

Statistics on imports, exports and turnover have been obtained from Eurostat. Also for the calculation of the loss of market shares, we made extensive use of Eurostat data. Specifically, sectoral turnover and profit data were taken from the 'Eurostat Annual detailed enterprise statistics for industry' and import and export data were taken from 'Eurostat EU trade since 1988 by CPA'. Note that a loss in market share is not equivalent to a loss in additional profits, as a reduction in market share also implies that companies have lower costs (variable costs are reduced in proportion to missed sales). In our calculations we assumed that 75% of the costs can be regarded as variable while 25% are regarded as fixed.

[26] We acknowledge that for sudden fluctuations in EUA prices the short-term Armington Elasticity are better suited. In general however, one can say that the introduction of the EU ETS led to cost pass-through, which in turn led to a general price elevation, the effect of which can better be modelled by a long-term elasticity.

B.2 Calculations

In order to describe how we corrected our estimates for loss in market share, we first need to define a couple of starting parameters. The following six parameters are known at the start of the calculation:

R_{cpt}	Total turnover in reference scenario
RE_{cpt}	Turnover from export in reference scenario
S_{cpt}	Total profit in reference scenario
CPT	Total gross profits from cost pass-through
I_{cpt}	Total import in reference scenario
AE	Armington elasticity

The value of the next eight parameters are not yet known at the start of the calculation, but will be calculated or assumed over time:

QD_{cpt}	Number of products sold in the EU in the reference scenario
QD_{ncpt}	Number of products sold in EU in the NO CPT scenario
QI_{cpt}	Number of products imported by the EU in the reference scenario
QI_{ncpt}	Number of products imported by the EU in the NO CPT scenario
PD_{cpt}	Price per product made in the EU in the reference scenario
PD_{ncpt}	Price per product made in the EU in the NO CPT scenario
PI_{cpt}	Price per product imported by the EU in the reference scenario
PI_{ncpt}	Price per product imported by the EU in NO CPT scenario

From these fourteen parameters, we also define a number of intermediary parameters, which will serve to improve the readability of the calculations:

$$FQ_{cpt} := \frac{QD_{cpt}}{QI_{cpt}} \tag{1}$$

$$FQ_{ncpt} := \frac{QD_{ncpt}}{QI_{ncpt}} \tag{2}$$

$$FP_{cpt} := \frac{PD_{cpt}}{PI_{cpt}} \tag{3}$$

$$FP_{ncpt} := \frac{PD_{ncpt}}{PI_{ncpt}} \tag{4}$$

$$\Delta FQ := FQ_{ncpt} - FQ_{cpt} \tag{5}$$

$$\Delta FP := FP_{ncpt} - FP_{cpt} \tag{6}$$

$$\mathrm{RD_{cpt}} := R_{cpt} - RE_{cpt} \tag{7}$$

$$\mathrm{RPI} := \frac{CPT}{R_{cpt} - CPT} \tag{8}$$

Here, $\mathrm{RD_{cpt}}$ displays the turnover from domestic consumption and the final parameter, *RPI*, displays the relative price increase as result of cost pass-through.

With these preliminaries out the way, we can properly start the calculation. Recall that by the midpoint definition of a substitution elasticity we know that:

$$\mathrm{AE} = \frac{\frac{FQ_{ncpt} - FQ_{cpt}}{(FQ_{cpt} + FQ_{ncpt})/2}}{\frac{\mathrm{FP_{ncpt}} - FP_{cpt}}{(FP_{cpt} + FP_{ncpt})/2}}$$

Note that $FQ_{ncpt} - FQ_{cpt}$ is equal to ΔFQ by definition and that $FQ_{cpt} + \Delta FQ$ is equal to FQ_{ncpt} by definition. Therefore, we can also express the equation as:

$$\mathrm{AE} = \frac{\frac{\Delta FQ}{0{,}5 * (FQ_{cpt} + FQ_{cpt} + \Delta FQ)}}{\frac{\Delta FP}{0{,}5 * (FP_{cpt} + FP_{cpt} + \Delta FP)}} \tag{9}$$

For the final results, only the relative price level between imported and domestically produced goods is relevant. We can hence scale the price parameters without loss of generality. For convenience, we assume that $PI_{ncpt} = 1$. We further assume that after a drop in European prices, the import prices do not change, such that $PI_{cpt} = 1$ as well. This implies that:

$$\Delta FP = \frac{PD_{ncpt}}{PI_{ncpt}} - \frac{PD_{cpt}}{PI_{cpt}} = \frac{PD_{ncpt}}{1} - \frac{PD_{cpt}}{1} = PD_{ncpt} - PD_{cpt} \tag{10}$$

A second simplification can be made by observing that the quotient:

$$\frac{\Delta FP}{(FP_{cpt} + FP_{cpt} + \Delta FP)/2} \tag{11}$$

is only dependent on the *relative* size of PD_{ncpt} and PD_{cpt} and not their *absolute* values. To see why, observe that from Equation 10 it follows that:

$$\frac{\Delta FP}{(FP_{cpt} + FP_{cpt} + \Delta FP)/2} = \frac{PD_{ncpt} - PD_{cpt}}{(PD_{ncpt} + P_{cpt})/2}$$

and that:

$$\frac{a * PD_{ncpt} - a * PD_{cpt}}{(a * PD_{ncpt} + a * P_{cpt})/2} = \frac{a * (PD_{ncpt} - PD_{cpt})}{a * (PD_{ncpt} + PD_{cpt})/2} = \frac{(PD_{ncpt} - PD_{cpt})}{(PD_{ncpt} + PD_{cpt})/2}.$$

We can hence assume that $PD_{ncpt} = 1$, so that $FP_{ncpt} = 1$ as well. This, in turn, entails that $PD_{cpt} = FP_{cpt} = 1 + RPI$, as the relative price increase is now equal to the absolute price increase and $PI_{cpt} = 1$.

With the expression for PD_{cpt} we can now calculate $QD_{cpt}$and QI_{cpt}:

$$QD_{cpt} = \frac{RD_{cpt}}{PD_{cpt}} = \frac{RD_{cpt}}{1 + RPI} \tag{12}$$

$$QI_{cpt} = \frac{I_{cpt}}{PI_{cpt}} = I_{cpt} \tag{13}$$

It follows that:

$$FQ_{cpt} = \frac{QD_{cpt}}{QI_{cpt}} = \frac{RD_{cpt}}{I_{cpt} * (1 + RPI)} \tag{14}$$

Substituting $FP_{cpt} = 1 + RPI$ into Equation 8 gives us:

$$\text{AE} = \frac{\dfrac{\Delta FQ}{0{,}5 * \left(FQ_{cpt} + FQ_{cpt} + \Delta FQ\right)}}{\dfrac{-\text{RPI}}{0{,}5 * (2 + RPI)}} \tag{15}$$

which can be rewritten into an expression for ΔFQ:

$$\Delta FQ = \frac{-FQ_{cpt} * AE \ * RPI}{1 + \frac{1}{2}RPI + \frac{1}{2}AE * RPI} \tag{16}$$

Remember that by definition we have: $FQ_{ncpt} = FQ_{cpt} + \Delta FQ$ and that FQ_{cpt} is known by Equation 14. We can hence find a numeric solution for FQ_{ncpt}:

$$FQ_{ncpt} = FQ_{cpt} + \frac{-FQ_{cpt} * AE \ * RPI}{1 + \frac{1}{2}RPI + \frac{1}{2}AE * RPI} \tag{17}$$

However, this solution only gives us information about the fraction between QD_{ncpt} and QI_{ncpt}, while we want to know their absolute values.

Therefore, we presuppose that:

$$QI_{ncpt} - QI_{cpt} = -\left(QUE_{ncpt} - QUE_{cpt}\right) \tag{18}$$

This assumption implies that after a rise in European prices, European customers do not buy fewer products, but rather will import a larger share of their products from outside the EU. The total number of products sold in the EU will hence remain unchanged.

After this assumption we are, conveniently, left with two equations and two unknowns:

$$QD_{ncpt} = QD_{cpt} - QI_{ncpt} + QI_{cpt} \tag{19}$$

$$QD_{ncpt} = FQ_{ncpt} * QI_{ncpt} \tag{20}$$

We can now solve for QD_{ncpt} by substituting QD_{ncpt} in Equation 20 by $QD_{cpt} - QD_{ncpt} + QI_{cpt}$ (which follows from Equation 19). This yields:

$$QD_{ncpt} = \frac{FQ_{ncpt} * \left(QI_{cpt} + QD_{cpt}\right)}{1 + FQ_{ncpt}} \tag{21}$$

From Equation 19 it also follows that:

$$QI_{ncpt} = QD_{cpt} - QD_{ncpt} + QI_{cpt} \tag{22}$$

The factor by which domestic sales increase when we move to a situation without CPT, is given by:

$$FAD \coloneqq \frac{QD_{ncpt}}{QD_{cpt}} \tag{23}$$

At this point In the analysis, we assume that the factor by which domestic sales increase is not equal to the factor by which export sales increase. Instead, the percent increase in export sales in absence of cost pass-through is assumed to be twice as high as the percent increase in domestic sales. This assumption reflects the finding that countries and supra-national regions such as the EU are less sensitive to domestic price fluctuations than to foreign price fluctuations (this is known as home bias). The factor two was inspired by, but does not follow directly from, the rule of thumb that micro Armington elasticities tend to be roughly twice as large as macro Armington elasticities (rule of two).[27]

We get that the factor by which export sales increase is given by:

$$FAE \coloneqq \frac{QE_{ncpt}}{QE_{cpt}} = 1 + 2 * (FAD - 1) \tag{23}$$

Using these two factors and the scaling result that prices equal 1 in absence of cost pass-through, we can calculate total turnover in the NO CPT scenario:

$$R_{ncpt} \coloneqq RD_{ncpt} + RE_{ncpt} = FAD * QD_{ncpt} + FAE * QE_{ncpt} \tag{24}$$

To obtain the net additional profits from cost pass-through we do not only need the turnover in the NO CPT scenario, but also the total costs. We assume a fixed costs percentage of 25% for all sectors in the reference scenario. This means that the fixed costs in the NO CPT scenario equal:

$$FC_{ncpt} = FC_{cpt} = 0{,}25 * (R_{cpt} - S_{cpt})$$

The variable costs will increase in the absence of cost pass-through as sales increase. |
The percent change in variable costs is equal to the percent change in sales, so that:

$$VC_{ncpt} \coloneqq 0{,}75 * \left(R_{cpt} - S_{cpt}\right) * \frac{R_{ncpt}}{QD_{cpt} + QE_{cpt}} \tag{25}$$

We can now calculate the profits in the NO CPT scenario:

$$S_{ncpt} = R_{ncpt} - FC_{ncpt} - VC_{ncpt} \tag{26}$$

The net additional profits from cost pass-through are given by the difference between profits in the CPT scenario and profits in the NO CPT scenario:

$$RAP = S_{cpt} - S_{ncpt} \tag{27}$$

[27] Note that we cannot directly apply the rule of two, since the non-EU country that imports European variety can have a different Armington Elasticity, as well as a different domestic consumption to import ratio.

To use this sectoral result for individual companies, or countries, we express the net additional profit as a percentage of gross additional profits from cost pass-through:

$$FRAP = \frac{RAP}{CPT} \quad (28)$$

We assume that $FRAP$ is the same for all companies and countries within a given sector.

C Calculation of additional profits

C.1 International credit conversions

In Phase 2 of the EU ETS, national Member States organised the allocation and were allowed to include international credits for compliance under the EU legislation. Since in Phase 3 CERs and ERUs are no longer directly surrendered but exchanged for allowances, it is impossible to trace how many CERs and ERUs were used in a particular compliance year. Every year, in April, the EC publishes the amounts of CERs/ERUs that have been converted into EUAs.

EU ETS participants operating stationary installations have been entitled to use international credits during the 2008-2020 period up to whichever is the highest:
- the international credit entitlement specified in the national allocation plan for the Phase 2; or
- 11% of the free allocation of EU allowances granted to them in 2008-2012;
- 4.5% of verified emissions between 2013-2020.

In our research we have only investigated the second and third option and calculated, for each installation, which would have constituted the highest number. We have subsequently assumed that every installation has used this highest number for conversion until 2019.

Our calculations are probably an underestimation, as the first criterion was not quantified (unless the total surrendered CERs/ERUs in Phase 2 were higher than the second and third options). There is an indication that this may have resulted in an underestimation of the true options to use international credits by a maximum of 20%.[28] On the other hand, our calculations assume that all of the options to use international credits were fully exploited by 2019, which is an overestimation. Therefore the precise impact of these assumptions cannot be determined without further research which falls beyond the scope of the present paper.

C.2 Waste gas allocations in the iron and steel sector

We have allocated an estimation of the free allowances given to the iron and steel sector on the basis of a preselection of installations that would produce such waste gases. The following is a list of installations that has been included in our estimates as an entity where waste gasss are being produced.

[28] In the State of the Carbon Market Reports it is stated that the total possibility to deliver international credits would be equivalent to 1.6 billion allowances. Using our criteria (2) and (3) we can calculate the total as being 1.3 billion allowances. Hence, we seem to only cover 80% of the possibilities to use these conversions.

Table 56 - Installations to which waste gases have been allocated

Country	Town of installation	Company
Austria	Donawitz/Leoben	VOEST-ALPINE AG
	Linz	VOEST-ALPINE AG
Belgium	Ghent	ArcelorMittal Belgium
Czech Republic	Ostrava	ArcelorMittal CZ
	Trinec	TŘINECKÉ ŽELEZÁRNY, a. s.
Finland	Raahe	Ruukki Metals Oy
France	Dunkerque	ARCELORMITTAL S.A.
	Fos-Sur-Mer	ARCELORMITTAL S.A.
Germany	Bremen	ARCELORMITTAL S.A.
	Dillingen	Aktien-Gesellschaft der Dillinger Hüttenwerke
	Duisburg	Hüttenwerke Krupp Mannesmann GmbH
	Eisenhüttenstadt	ARCELORMITTAL S.A.
	Salzgitter	Salzgitter Flachstahl GmbH
	Völklingen*	Saarstahl AG
Hungary	Dunauijvaros	ISD Dunaferr Zrt.
Italy	Taranto	ILVA S.P.A.
Netherlands	Ijmuiden	Tata Steel IJmuiden B.V.
Poland	Dabrowa Gornicza	ArcelorMittal Poland S.A.
	Krakow	ArcelorMittal Poland S.A.
Slovakia	Kosice	U. S. Steel Košice, s.r.o.
Spain	Aviles/Gijon	ARCELORMITTAL ESPAÑA, S.A.
Sweden	Lulea	SSAB AB
	Öxelösund	SSAB AB
United Kingdom	Port Talbot	Tata Steel UK Limited
	Scunthorpe	Tata Steel UK Limited

* *This installation may not produce waste gases, but this will have only a minor influence on the total additional profits allocated to installations.*

D Letter requesting additional information

Dear Sir/Madam,

In 2015 and 2016 we have published a calculation of the additional profits that firms and sectors obtain from participating in the EU ETS. Currently we are updating this study for the same client

The additional profits that we calculate for nineteen different sectors stem from three sources:
- overallocation of allowances;
- conversion of CERs into EUAs
- passing through opportunity costs of freely obtained allowances.

Our initial study received a fair amount of criticism, especially because of the fact that we did not correct for heat transfers or waste gas transfers other than blast furnace gas of the included industries. Within the ETS benchmark system, free allowances are allocated for the heat used, while the emissions are reported by the heat producer. Since external heat is purchased or exported at a number of companies, we would like to correct for misrepresentations in companies' calculated additional profits that result from this.

We therefore kindly ask you if you have information available of heat transfers or waste gas transfers other than blast furnace gas of the following installations:
- Port Talbot Steelworks;
- Scunthorpe Integrated Iron & Steel Works;
- Teesside Integrated Iron & Steel Works;
- Esso Petroleum Company Ltd;
- Stanlow Refinery;
- Valero Energy Ltd;
- Humber Refinery;
- Lafarge Cement UK PLC;
- Grangemouth Refining;
- Total Lindsey Oil Refinery.

Best regards,
CE Delft