Carbon costs for the steel sector in Europe post-2020

Impact assessment of the proposed ETS revision

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Executive summary

In July 2015, the European Commission (EC) launched its proposal for a revised European Emissions Trading System (EU ETS) for the period after 2020. The resulting carbon costs to energy-intensive sectors, like the steel sector, are still poorly understood. As the carbon costs impact the competitiveness, the European steel sector is interested to get a better quantification of the carbon cost impact in the period 2021-2030. Commissioned by Eurofer, Ecofys developed the Ecofys' EU ETS Carbon Cost Calculator (E3C3) to assess future carbon costs under different scenarios. An important design criteria was to have all sources and assumptions as transparent as possible. With this model Ecofys provides the first transparent impact assessment of EU Commission proposal for ETS revision post-2020

Based on our interpretation of the EC proposal, we found that the steel industry will face an annual shortage of allowances for direct emissions increasing from 31% in 2021 to 48% in 2030 (on average 38% over the period 2021-2030). Using carbon price projections of Thomson Reuters Point Carbon, this shortage can be expressed in net carbon cost of about €1.4 billion in 2021 and €4.6 billion in 2030. Cumulatively, the net direct carbon costs is calculated to be €26.1 billion for the period 2021-2030.

The sector is also highly exposed to indirect carbon costs passed through in electricity prices. Member States have the possibility to compensate companies for these costs. It was found that 24% of the indirect carbon costs would be covered by financial compensation over the whole decade, assuming that Member States that are granting compensation today will continue to do so in Phase 4. For the whole sector net carbon costs for indirect emissions would be €8.2 billion for Phase 4.

The total net carbon costs (for direct and indirect emissions) for the steel sector in the period 2021 – 2030 are projected to amount to €34.2 billion. This translates into €10/t crude steel in 2021 to €28/t crude steel in 2030.

1 Introduction

In July 2015, the European Commission (EC) launched its proposal for a revised European Emissions Trading System (EU ETS) for the period after 2020 (see Box 1). This marks the third step to structurally improve the functioning of the EU ETS after "backloading" and the introduction of the market stability reserve, which were adopted in previous years. As a result of these structural changes, market analysts expect carbon prices to rise significantly towards 2030, while the availability of free allowances for sectors exposed to risks of carbon leakage gets more limited, according to the ETS proposal.

The resulting carbon costs to energy-intensive sectors, like the steel sector, are still poorly understood: the European Commission's impact assessment accompanying their proposal is not completely transparent on this question and, more importantly, various options to distribute free allowances are still being discussed by the EU legislators, including a tiered carbon leakage approach. As the carbon cost impact the competitiveness, the European steel sector is interested to get insight in the following central question:

Based on the proposal by the Commission for a revised ETS, what carbon costs can the steel sector expect in the period 2021-2030?

In its proposal to revise the EU ETS for the period after 2020 the Commission proposes to continue current measures to compensate sectors at risk of carbon leakage. The most important features not changing compared to current rules are:

- free allocation is based on benchmarks for direct carbon costs and compensation for indirect carbon costs is to be granted via state aid from Member States;
- the total amount of free allocation is capped and will therefore require the existence of a cross-sectoral correction factor;
- a binary carbon leakage list is used, where sectors are "in" or "out".

The Commission also proposes several changes, the ones mostly affecting carbon costs are:

- benchmark values will be updated every 5 years based on a flat rate reduction factor between -0.5%/a and -1.5%/a;
- the carbon leakage status will be based on a combination of trade intensity and emissions intensity;
- activity levels will be updated every 5 years.

Box 1: The primary features of the Commission proposal for a revised ETS post-2020 affecting carbon costs

Ecofys was mandated by EUROFER to quantitatively research this question. Ecofys performed this assessment in order to create more transparency in the understanding of expected cost impacts, which we deem necessary for all stakeholders to make informed strategic and political decisions.

Disclaimer - *Ecofys took great care in validating all data that are used in the model. However, data that stem from EUROFER sources and from the BCG / VDEh Steel Roadmap could not be validated with the same rigidity as applied to the data from open sources. The validity of these data remains therefore the responsibility of EUROFER. In the Annex it is clearly indicated which data are from which sources.*

2 Key findings

The steel sector will face carbon costs as a result of two sources: 1) a shortage of allowances for direct emissions; and 2) from indirect costs passed through in electricity prices, for which no compensation is provided.

Figure 1 shows an annual breakdown for the direct CO_2 emissions and the amount of free allowances for the steel sector, based on the proposal by the European Commission. Emissions increase slightly because the efficiency increase (-0.12% / a) does not outweigh the increase in emissions stemming

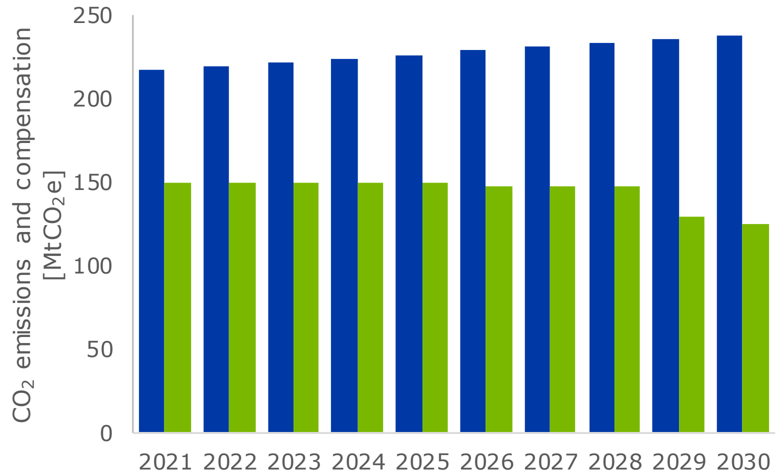

Figure 1: Projected total direct emissions (blue) and free allocation (green) for the steel sector

from the expected recovery of EU steel production after the economic crisis (+1.15% / a growth in production).

The difference between emissions and free allocation represents the annual shortage, which increases from 31% in 2021 to 48% in 2030 (on average 38% over the period 2021-2030). Such shortage is mainly caused by a combination of reduced benchmark values (linear reduction of 1%/year, i.e. -17.5% on average over the period 2021-2030) and the cross-sectoral correction factor, which is expected to be applied – in this scenario - in the last two years of the fourth trading period.

The shortage of free allowances leads to direct carbon costs (compliance cost for direct CO_2 emissions) for the steel sectors, which can be estimated using carbon price projections. This cost figure is based on a nominal carbon price of €20.1/t in 2021 progressively increasing to €40.7/t in 2030.[1]

Figure 2 shows the gross direct carbon costs and the value of free allowances for the steel industry. The increasing gross carbon costs is due to the increasing direct emissions of the sector and the projected increasing carbon price. The relative flat level of the value of free allocated allowances over the second part of Phase 4 is due to the combination of decreasing free allocation with increasing carbon price. The difference between the gross carbon cost and the value of free allowances represents the net direct carbon cost resulting from the emissions that are not covered by free allocation (shortage). The direct (net) carbon cost will be about €1.4 billion in 2021 and €4.6 billion in 2030. Cumulatively, the net direct carbon costs amount to €26.1 billion for the period 2021-2030.

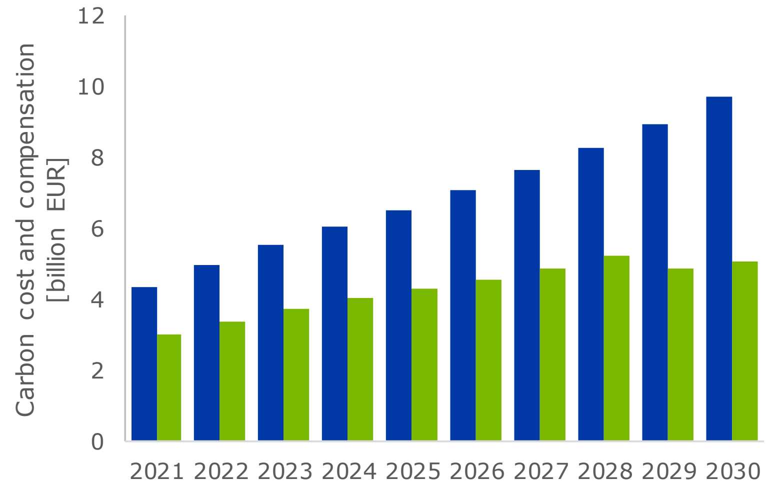

Figure 2: Gross direct carbon cost (bleu) and value of free allowances (green) for the steel sector. The difference between the bars represents the net carbon costs.

Steelmaking is also electro-intensive, particularly the manufacture of recycled steel via Electric Arc Furnaces. This means that the sector is also highly exposed to indirect carbon costs passed through in electricity prices. Figure 3

[1] Source: Thomson Reuters Point Carbon (2015)

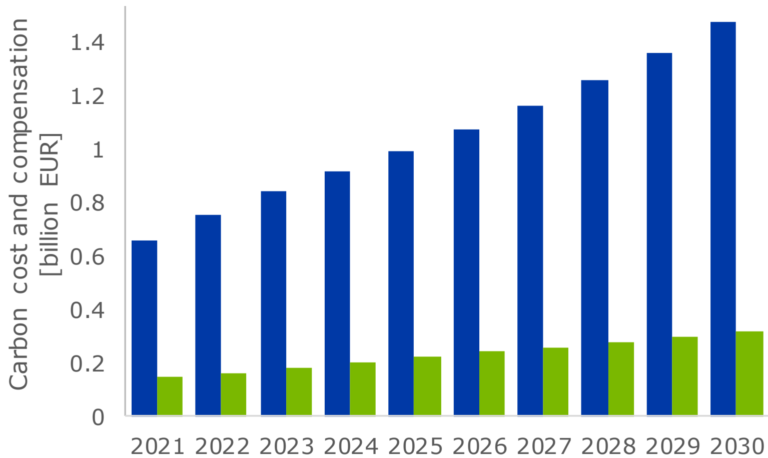

Figure 3: Projected indirect carbon cost (blue) and financial compensations (green) for the steel sector

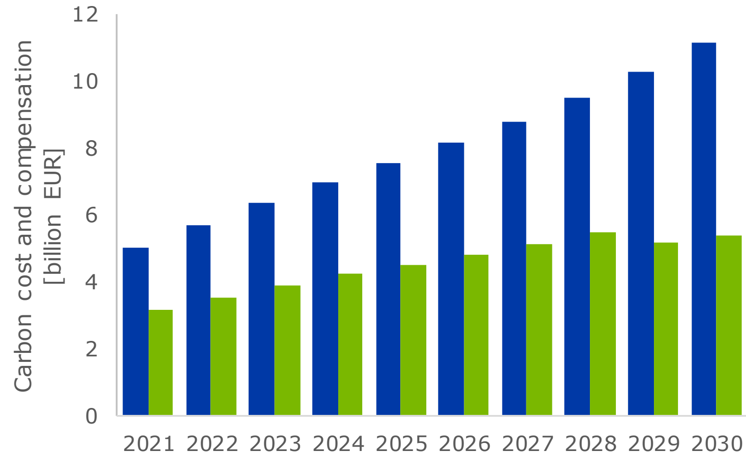

Figure 4: Projected total gross carbon costs (blue) and compensations (including free allocation for direct emissions and financial compensation for indirect costs) (green) for the steel sector

shows the comparison between indirect carbon costs from electricity consumption and the financial compensation of these indirect costs if Member States that are granting compensation today are assumed to continue to do so after 2020. In this scenario, the study finds that 24% of the indirect carbon costs would be covered by financial compensation over the whole decade.

Figure 4 shows the sum of the direct and indirect carbon costs of the steel sector. In the first year of the trading period (2021) about one-third of the carbon costs is not compensated (through free allocation for direct costs as well as financial compensation for indirect costs); in 2030 about half the carbon costs are not compensated. On average about 43% of gross carbon costs are not covered by free allocation and/or financial compensation over the whole decade.

The total net carbon costs for the steel sector in the period 2021 – 2030 are expected to amount to €34.2 billion, as summarized in Figure 5. The gross

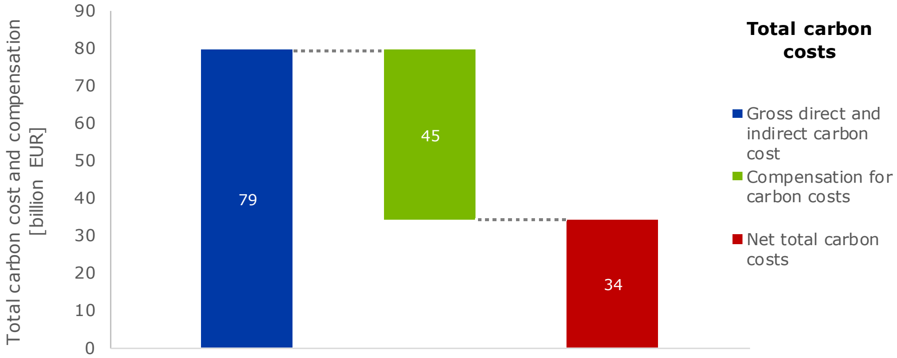

Figure 5: Total cumulative carbon costs for the steel sector in 2021 - 2030

direct and indirect carbon costs of €79.5 billion consist of €69.0 billion direct and €10.5 billion indirect costs. The compensation granted of €45.3 billion consists of €43.0 billion of free allocation and €2.3 billion of financial compensation (based on current Member States continuing support).

The amount of carbon costs for the steel sector is robust for different updates of the benchmark values. If one assumes a lower benchmark reduction factor (0.5% for all energy-intensive sectors), the model shows that the cross-sectoral correction factor would apply already in the first years of the trading period (2023) and reach the level of about 0.75 in 2030 (i.e. a 25% cut). However, the shortage in free allocation and the overall costs for the steel industry would be similar to the previous scenario as the more stringent cross sectoral correction factor would compensate the lower benchmark reduction ratio.

In order to have a better understanding of the relevance of such costs, the study analyses the impact of net carbon costs per tonne of crude steel. Figure 6 shows the evolution of net direct and indirect carbon costs in €/t crude steel over the period 2021 to 2030. The study finds that the steel industry will be faced with carbon costs from €10 / t crude steel in 2021 up to €28 /t crude steel by 2030 (average: €18 / t crude steel).

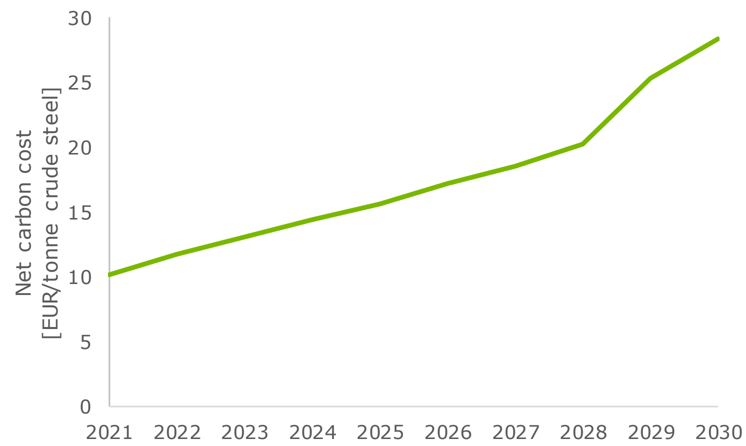

Figure 6: Projected total direct emissions (blue) and free allocation (green) for the steel sector

3 Our approach

To answer the question at hand, Ecofys developed the *Ecofys' EU ETS Carbon Cost Calculator* (E3C3) which compares future emissions with compensation levels for different sets of compensation scenarios. The model consists of different building blocks to determine direct and indirect carbon costs[2] (see Figure 7). The modular approach allows to flexibly change input parameters, if needed, and to toggle easily between scenarios.

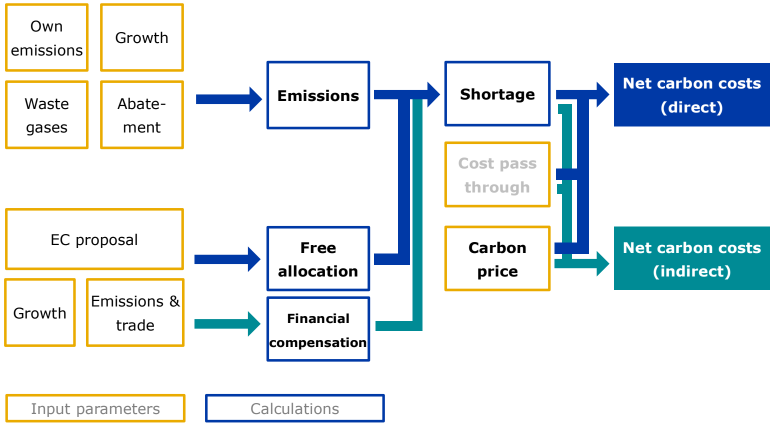

Figure 7: Schematic overview of Ecofys' E3C3 model to determine carbon costs

Under the assumption of zero cost pass-through[3], net carbon costs are defined as the difference between total emissions and compensation levels (free

[2] Direct carbon costs come from the obligation to cover GHG emissions (either on-site or exported in waste gases) with corresponding allowances, indirect carbon costs stem from carbon costs passed through in electricity prices.

[3] The cost pass-through ability has not been assessed in this study. Nevertheless, an assumption of zero cost pass-through is taken to show the net carbon cost exposure to sectors.

allocation and/or financial compensation) multiplied by the carbon price. We will now zoom into the first two elements.

Emissions

Direct emissions in the steel sector have been forecasted by taking emissions in a baseline year (2014) and applying an annual production growth rate and abatement rate, both taken from the Steel low-carbon roadmap developed by BCG/VDEh[4].

For **direct emissions** Ecofys took verified emissions as reported in the public European Transaction Log (EUTL) database for ETS installations that were identified as belonging to the steel sector (see Box 2) for a definition of the sectoral scope). In addition, emissions from the combustion of recovered waste gases for electricity production outside the steel industry were added, as steel plants pay for these downstream emissions by means of allowances and/or higher electricity prices. Due to data sensitivities not all companies could reveal the split between direct and indirect emissions in waste gas emissions and therefore they were all accounted as direct emissions. To avoid double counting, indirect carbon costs in the corresponding steel production process (the blast furnace route) are excluded from the analysis.

The **scope of the steel sector** has been defined as a list of 437 ETS-installations performing relevant steel sector activities. The list was derived from a long list of 620 installations selected by combining installations that report under steel-related ETS activities (3, 4, 5, 22, 23, 24, and 25 in EUTL) and relevant NACE codes (07.10, 19.10, 24.10 and 24.20). From this long list 112 installations were excluded by EUROFER as they were not recognized as part of the steel sector (i.e. forges, foundries, and installations producing non-ferrous metals, chemicals, or ferroalloys), and 71 installations were found to be closed.

Box 2: Scope of the steel sector

The calculation of **indirect carbon costs** is slightly more detailed, as it relies on two production routes within Electric Arc Furnaces (EAF carbon steel and EAF high alloy steel) and should be differentiated per country. We used verified values of the average electricity intensities of EAF carbon steel and EAF high alloy steel and multiplied this with the production forecast for each of these

[4] Boston Consulting Group and the Steel Institute VDEh (2013). Steel's contribution to a low-carbon Europe 2050.

routes. In addition, electricity use from downstream processes (rolling) were added based on the electricity intensity derived from BREF documents.

The **production growth rate** of the steel sector until 2030 has been set at 1.15%/year where the 2030 production volume corresponds to the one from the Steel low-carbon roadmap[5]. This growth rate has been used to project direct emissions. For indirect carbon costs, a more specific EAF steel growth rate per country has been derived, based on the assumptions that the EAF share in the total steel production increases by 0.18% per year[6], the EAF share per country stays constant and the split between EAF carbon steel and EAF high alloy steel also stays constant.

The **abatement rate** of the steel sector has been set at -0.12%/year for specific direct emissions and -0.26%/year for specific electricity consumption, based on the Steel Low-carbon Roadmap. The value for the direct emissions includes the impact of a shift between the EAF and BF/BOF steel production, energy efficiency improvements, fuel mix changes, and production growth and excludes the impact of the grid emission intensity improvement on the annual carbon efficiency improvement rate.

Free allocation

The amount of free allocation can in principle be determined in quite a straightforward way as depicted in below equation.

Free allocation =

Benchmark x Historical activity level x CL factor x Cross sectoral correction factor

However, as activity levels are not available for the relevant steel benchmarks, and to stay consistent with the approach for emissions, allocation is determined by taking allocation in a baseline year (2014) and project this towards the future using forecasted production growth. This approach is applied to each steel production route separately. As reference years we use the median of the production in 2013 – 2017 and 2018 – 2022, respectively, for the two allocation periods after 2020 as suggested by the European Commission.

The **carbon leakage list** and related compensation factors are derived from the Impact Assessment from the European Commission. For the steel sector NACE codes, a compensation factor of 100% is assumed.

[5] The projections from BCG and VDEh estimate that the crude steel production in the EU27 (173 Mt in 2010) will grow to 204 Mt in 2030, but will still remain below pre-crisis levels (211 Mt in 2007).

[6] The increase of the EAF share of 0.18% per year is in line with the projections of BCG and VDEh that estimate an EAF share of 41% in 2010 progressively increasing to 44% in 2050.

The **cross-sectoral correction factor** follows from a detailed analysis at sectoral level. The correction factor kicks in if the bottom-up free allocation to all industrial ETS installations exceeds a top-down cap on free allocation. The cap on free allocation is 6,267 million allowances for the period 2021 -2030. The bottom-up allocation demand is the sum of the allocation need for steel, cement, refineries, basic chemicals and other industries and depends on three factors: activity levels (based on historical data from public sources and forecasts derived from PRIMES data), updated benchmark levels (variable input parameter), and the carbon leakage compensation factor per NACE sector. In our default scenario, the latter two parameters are based on the EC Impact Assessment complemented with Ecofys analysis.

Financial compensation

The European Commission has not indicated how the maximum compensation for indirect carbon costs should be calculated after 2020. The current compensation guidelines heavily build on the rules for free allocation for direct emissions, with the only main difference being the production baseline calculation methodology. Given that the EU is aiming for increased harmonisation of rules, Ecofys assumes that the calculation methodology for the production baseline and benchmark update will be in line with the free allocation approach. The model assumes that member states currently granting financial compensation[7] will continue after 2020 with a state aid intensity at 75%. Marginal emission factors are assumed to have decreased by about 8 – 12% based on PRIMES.

[7] Germany, the Netherlands, the UK, Flanders (Belgium), and to some extent Spain.

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Overview of input parameters, values and assumptions

General E3C3 model parameters

Parameter	Value chosen	Source
Benchmarks [tCO_2/tonne]	Hot metal: 1.328 Coke: 0.286 Sintered ore: 0.171 EAF carbon steel: 0.283 EAF high alloy: 0.352	EC Decision 2011/278/EU
Benchmark heat phase 3: [tCO_2/TJ]	62.3	EC Decision 2011/278/EU
Benchmark basic oxygen steel [MWh/t product]	0.036	EC Communication 2012/C 387/06
Fallback benchmark for indirect carbon cost compensation [%]	80%	EC Communication 2012/C 387/06
Benchmark fuel [tCO_2/GJ]	0.561	EC Decision 2011/278/EU
Heat-electricity exchangeability factor [%]	EAF carbon steel: 28% EAF high alloy: 25%	EUROFER data
Heat benchmark phase 4 [tCO_2/TJ]	53.0	EC SWD(2015) 135 final, p.191
Marginal electricity grid factor [tCO_2/MWh]	Series (2008-2030) per country	2008-2020: EC Communication 2012/C 158/04 2021-2030: Ecofys calculations based on PRIMES data, 2021-2030 average of linear converging marginal grid factors (starting from EC Communication 2012/C 158/04) from 2021 onwards to 2050.
Average electricity grid factor [tCO_2/MWh]	0.465	EC Decision 2011/278/EU
Cross sectoral correction factor [%]	Series (2013-2020)	EC Decision 2013/448/EU
Linear reduction factor	Series (2013-2020)	EC Directive 2003/87/EC
Carbon leakage exposure factor	Series (2013-2020)	EC Decision 2011/278/EU
Industry allocation cap 2013 [EUA]	809,315,756	EC Decision 2011/278/EU
Final allocation heat production 2013 [EUA]	104,326,872	EC Decision 2013/448/EU
CL share in allocation for heat production	27%	Ecofys calculations based on PRIMES data
Total ETS cap excl. aviation [$MtCO_2e$]	Series (2021-2030)	EC Decision 2010/634/EU
Auctioning share in cap [%]	57%	EC Communication COM/2015/0337
Innovation fund (NER400) [million EUA]	400	EC Communication COM/2015/0337
Degree of compensation for indirect carbon costs granted [%]	Series (2013-2020) and for Phase 4 per country	Ecofys analysis
Maximum state aid intensity [%]	75%	Ecofys assumption
Carbon price [€/tCO2]	Series (2012-2030)	ThomsonReuters Point Carbon, EU ETS Phase 4 Proposal: learning to share, p. 7

Parameters specific to the steel sector

Parameter	Value chosen	Source
Baseline year for projections	2014	The latest year for which all production, emissions and allocation data is available
Crude steel production [thousand tonnes crude steel]	Series (2005-2014) per country	Worldsteel - Steel statistical yearbook 2014 (Tables 7-9), Monthly crude steel production Jan-Jul 2015 vs 2014
Annual production growth rate [%]	1.15%	BCG/VDEh - Steel's contribution to a low-carbon Europe 2050, p. 32.
BF/BOF steel conversion factors [tonne per tonne BF/BOF steel] Downstream fuel consumption in [GJ per tonne BF/BOF steel]	Hot metal to BF/BOF: 0.901 Coke to BF/BOF: 0.344 Sintered ore to BF/BOF: 1.44 Downstream fuel: 1.8	EUROFER, based on investigation of BREF documents
EAF steel production [thousand tonnes crude steel]	Series (2005-2014) per country	For 2005-2013: Worldsteel - Steel statistical yearbook 2014 (Table 8). For 2014: World Steel in Figures 2015 Crude Steel Production by process 2014
EEA-wide EAF share projection [%]	From 41% in 2010 to 44% in 2050	BCG/VDEh - Steel's contribution to a low-carbon Europe 2050, p. 16.
Share of EAF carbon and high alloy steel [%]	EAF carbon: 80.67% EAF high alloy share: 19.33%	EUROFER - 2015 edition European Steel in Figures, page 6. Average 2012-2014
Annual carbon efficiency improvement rate [%]	-0.12%	Interpolation based on BCG/VDEh - Steel's contribution to a low-carbon Europe 2050, p. 15
Electro-intensity [kWh/tonne]	EAF carbon: 569.7 EAF high alloy: 703.3 Downstream: 137.2	EAF: EUROFER data Downstream: EUROFER findings in the BREF documents
Annual electro-intensity improvement rate, baseline year	-0.26% starting from 2008	BCG/EUROFER data
Emissions of steel plants [$MtCO_2e$]	Series (2008-2014); 160.9 $MtCO_2$ in 2014	EUTL (Ecofys download June 2015), based on selection of 437 installations by EUROFER
Emissions of waste gas plants [$MtCO_2e$]	Series (2008-2014); 41.1 $MtCO_2$ in 2014	EUTL (Ecofys download June 2015), based on selection of 28 installations by EUROFER
Allocation to steel plants [MtCO2e]	Series (2008-2020); 189.8 MtCO2 in 2014	EUTL (Ecofys download June 2015), based on selection of 437 installations by EUROFER

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Parameters related to carbon leakage

Description	Value chosen	Source
Compensation factors EC proposal, July 2015	Very high: 1 Low: 0.3	EC Communication COM/2015/0337, July 2015
Compensation factors EC IA, "Limited changes" package, July 2015	Very high: 1 High: 0.8 Medium: 0.6 Low: 0.3	EC SWD(2015) 135 final (Impact Assessment), July 2015
Compensation factors EC IA, "Targeted" package, July 2015	Very high: 1 High: 0.8 Medium: 0.6 Low: 0.3	EC SWD(2015) 135 final (Impact Assessment), July 2015
CL tier thresholds EC proposal, July 2015 (emission intensity x trade intensity)	Very high: 0.2 Low: 0	EC Communication COM/2015/0337, July 2015
CL tier thresholds EC IA, "Limited changes" package, July 2015	Emissions intensity => Very high: 9, High=2, Medium: 0.2, Low:0 Trade intensity => Very high: 0.2, High=0.1, Medium: 0, Low:0	EC SWD(2015) 135 final (Impact Assessment), July 2015
CL tier thresholds EC IA, "Targeted" package, July 2015 (emission intensity x trade intensity)	Very high: 2.5 High: 1 Medium: 0.2 Low: 0	EC SWD(2015) 135 final (Impact Assessment), July 2015
Emission intensity and trade intensity per NACE sector [%]	Series	EC, Detailed data on direct and indirect costs, and trade, for all assessed sectors. 22 May 2014 + Ecofys analysis

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Parameters related to the cross-sectoral correction factor

Description	Default value chosen	Source
Annual improvement factor benchmark	Cement (2021-2025): -0.5% Cement (2026-2030): -0.5%	EU Commission, impact assessment July 2015 proposal, p.142 and p.176
Annual improvement factor benchmark	Refineries (2021-2025): -1% Refineries (2026-2030): -1% Basic chemicals, incl. fertilizers (2021-2025): -1.5% Basic chemicals, incl. fertilizers (2026-2030): -1.5%	EU Commission, impact assessment July 2015 proposal, p.142 and p.177
Annual improvement factor benchmark	Other industry (2021-2025): -1% Other industry (2026-2030): -1%	EU Commission, impact assessment July 2015 proposal, p.142 and p.178
Allocation phase 3	Cement: 1,110,105,321 tCO_2 Refineries: 878,402,084 tCO_2 Basic chemical, incl. fertilizers: 998,567,590 tCO_2	EU Commission, Questions and Answers on the Commission's decision on national implementation measures (NIMs)
Annual production growth rate (2015-2030)	Cement: 1.28% Basic chemical, incl. fertilizers: 1.42%	Based on PRIMES EU28 data, average 2010-30 annual growth rate sector value added
Annual production growth rate (2015-2030)	Refineries: -0.70%	PRIMES EU28 data on fuel input into refineries
Production growth rate (2015-2030)	Other industry: 1.10%	Ecofys estimate. Based on PRIMES EU28 data, average 2010-30 annual growth rate sector value added excluding the sectors evaluated separately
Production index other industry	Series (2005-2014)	Eurostat, production in industry – monthly data
Production index cement	Series (2005-2013)	GNR Project, Total production volumes of clinker, http://www.wbcsdcement.org/GNR-2013/EU28/GNR-Indicator_8TG-EU28.html
Production index refineries	Series (2005-2014)	BP Statistical review of World Energy 2015
Production index basic chemicals	Series (2005-2013)	CEFIC Facts and Figures 2014, chart 3.4
Production index non-ETS heat	Series (2005-2013)	Eurostat Energy Statistics