Plant-related carbon costs in phase IV of the EU Emissions Trading System

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Study for VIK - Verband der Industriellen Energie- und Kraftwirtschaft e.V.
(German Association of Industrial Energy Consumers)
by FutureCamp

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FutureCamp

is a Munich based consultancy established in 2001 which provides strategic and operational consulting services in the areas of climate, energy, and environment on the national and international level.

VIK – Verband der Industriellen Energie- und Kraftwirtschaft

is the German Association of Industrial Energy Consumers which, as a cross-sectoral organisation, represents the interests of and advises its member companies on all issues related to energy economy and energy policies. Founded in 1947, VIK represents 80% of the German industrial energy consumers and 90 % of the electricity producers that are independent from utility firms. The products and services of its members are of great importance for the value chains, climate change, and the German energy transition.

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Disclaimer

This study has been conducted with the greatest possible care. However, no warranty is given as to the accuracy or completeness of the information contained in this publication.
This study was financed by VIK - Verband der Industriellen Energie- und Kraftwirtschaft e. V. However, the results presented in it, the information contained in it, and the views expressed are those of FutureCamp. They are not or not necessarily those of VIK and its members.
Neither FutureCamp nor VIK adopt positions of single companies or other associations with regard to the current debate about the revision of the European Union Emissions Trading System (EU ETS) for the 2021-2030 period. Also, no conclusions regarding these positions can be drawn from this study. This is in particular the case for the assumptions on which the calculations are based.

1 Summary

This study is based on the predecessor VIK study "The financial burden for Industry arising from the revision of the EU ETS" conducted by FutureCamp in August 2016 which compared carbon costs for industry on the basis of two scenarios: first, the EU Commission's proposal for the EU ETS revision submitted in July 2015 and, second, a modified scenario which partly reflects VIK´s proposal for a dynamic EU ETS.

The aim of this follow-up study is to determine and present plant-specific CO_2 costs arising from the three proposals on the revision of the EU ETS issued by the European Commission (COM), the European Parliament (EP), and the Council of the European Union (Council). Based on these proposals the current trilogue takes place aiming at finding an agreement on the future design of the fourth trading period of the EU ETS, 2021-2030.

The selected case studies represent sectors that are considered vulnerable to carbon leakage.

Just like its predecessor, the follow-up study shows that carbon-related costs remain a serious challenge for industry in the European Union (EU): They will rise significantly until 2030, creating very different situations for particular installations. The main drivers for costs are carbon prices, benchmark updates, and the cost effect on the electricity price. The application of a cross-sectoral correction factor (CSCF) could further increase the financial burden.

Taking all three proposals for the revision of the EU ETS into consideration, the study shows that the different numerical implications deriving from the proposals deserve a closer look. This in-depth analysis allows to give recommendations on how the future EU ETS should be designed.

The proposal of the EP with an optional 5% top-up offers the largest free allocation budget. While in the understanding of FutureCamp the innovation fund is financed through the auctioning share, the free allocation budget is partly used to fund the new entrants reserve and the compensation of indirect costs of electricity prices. The Council proposal offers the second largest budget for free allocation. It would be even more effective in reducing the risk of carbon leakage (CL) if the free allocation budget was further increased.

The flexibilities that have been proposed by the EP and the Council to avoid a CSCF help reducing this risk significantly. However, the study shows that a CSCF is still not ruled out completely. Whether it applies depends upon a number of choices regarding the available budget, benchmark updates (real or flatrate), and other factors. The EP proposal would apply the CSCF only to certain sectors (tiering) and could therefore lead to deep cuts in free allocation for these sectors. To avoid a CSCF, the weighted average benchmark update within the proposed budgets would need to be ca. 0.5 (Council), 0.6 (COM), or 0.35 (EP).

The case studies show that the update of benchmarks is an issue of high importance. The updates of the fallback benchmarks, particularly for heat, have significant impacts on a broad number of sectors. Equally important is the minimum update rate for benchmarks, in particular for sectors that increasingly face physical and technological boundaries raising their efficiency. Here, the proposals of the EP and the Council clearly better address the needs of industry than the COM proposal.

Ensuring the carbon leakage status can be of vital importance for certain products or sectors. As the examples of the iron and steel industry (for sinter) and of industrial gases illustrate, this is not completely clear within the proposals at hand.

Also highly important is the compensation for indirect costs, as the example of the aluminium industry shows. For many industries indirect costs are equally or even more significant than direct costs. Therefore, it is essential to ensure that compensation of these costs is not limited, but can be provided up to the level necessary.

With calculations based on EU-wide European Union emission allowances (EUA) budgets and unified rules and case studies conducted at installation level, the results do not exclusively reflect installations in Germany but can be transferred to similar installations in other EU member states.

2 Key Findings

There are two overarching findings that can be derived from the analysis of the positions of the COM, EP, and the Council with regard to the effects on plant-related carbon costs:

1. In all three proposals for the revision of the EU ETS, the financial burdens increase for the years 2021 to 2030.
2. A rising carbon price is to be expected due to the reductions of the amount of allowances.

The findings of this study confirm the results derived from its predecessor study.

Furthermore, the following three cross-sectoral findings can be extrapolated:

1. It is important to avoid a CSCF through an adequate extension of the budget for free allocation. Unlike the COM proposal, the free allocation budget suggested by the EP and the Council would allow moderate minimum benchmark update rates without triggering a CSCF.
2. For several types of installations, state aid for indirect costs is crucial, and even more important than free allocation or direct carbon costs. The rules for future state aid still need to be finalised. It is essential that they are designed in a way that effectively reduces the risk of carbon leakage. If the degressive path is continued, as proposed by the EP, indirect costs will rise even more.
3. The adjustment of the heat benchmark is a cross-cutting issue that could cause significant additional costs for a large number of sectors.

Finally, detailed sector-specific findings are included in the case studies.

3 Introduction

Purpose

This study assesses the carbon-related costs that may result from different designs of the EU ETS for the 2021-2030 timeframe[1]. The study focuses particularly on energy-intensive industries in Europe. It assesses the costs that would potentially result from the proposals for an EU ETS revision of the COM[2], EP[3], and the Council[4].

Thematic areas

The study has two thematic areas: In the first part, EUA quantities for the different positions have been calculated. This part also includes calculations of the CSCF. In the second part, carbon-related costs for energy-intensive industries are determined at installation level. Calculations have been performed for the following sectors and types of installations:

- Chemical industry: Energy Production (steam)
- Chemical industry: Combined Heat and Power (CHP)
- Chemical industry: Steam Cracking
- Iron and steel: Steel Production
- Industrial gases: Steam Reforming
- Non-ferrous metals: Aluminium Electrolysis

The case studies illustrate different forms of cost impacts. They have been chosen to analyse different aspects like e.g. the significance of the carbon leakage status for particular sectors, the role of compensation for indirect costs, or the rules for updating benchmarks. The selection of installations and sectors, however, does not indicate that sectors or installation types that are not represented in the case study, e.g. the production of paper, glass, cement are not affected in similar ways. The cases have been selected to represent all relevant challenges and, at the same time, avoid repetitions.

Background

The results presented here are an update and further development to FutureCamp's 2016 study for VIK.[5] The following companies have taken part in the study and its 2016 predecessor:

- AIR LIQUIDE Deutschland GmbH
- BASF SE
- Covestro Deutschland AG
- Currenta GmbH & Co. OHG
- Evonik Industries AG
- Hydro Aluminium Rolled Products GmbH
- Ineos Köln GmbH

[1] Indirectly, the study also assesses indirect carbon-related costs. This requires assumptions for new State Aid Guidelines for indirect costs. These assumptions can be found in the annex.

[2] As communicated on 15 June 2015: COM(2015) 337.

[3] As agreed on 15 February 2017

[4] As agreed on 28 February 2017

[5] http://vik.de/pressemitteilung/items/vik-studie-zur-kostenbelastung-energieintensiver-industrien-durch-den-eu-emissionshandel.html

- Linde AG
- SCA GmbH
- thyssenkrupp Steel Europe AG
- TRIMET Aluminium SE
- UPM GmbH

Approach

The quantification of the different positions of the EU institutions regarding the revision of the EU ETS is based on a document analysis of the positions, empirical data, and calculations by FutureCamp. The resulting quantities have been used to calculate the CSCF for different scenarios. These calculations have been performed in a purpose-built tool that is operated by FutureCamp. They are also based on assumptions for future production volumes, specific CO_2 emissions, and specific electricity demands.

The case studies are related to existing installations in Germany. To ensure anonymity, data has been distorted. The only exceptions from this approach are the case studies for the CHP plant and for the iron and steel sector. For the latter, the sector's German association[6] has defined a virtual installation that represents a typical integrated plant.

The following table gives an overview of the most important assumptions of the study.

EUA price in 2030	30 €
Carbon Leakage status	based on current CL list and proposed criteria
Cross-sectoral correction factor	calculated for all proposals
Dynamic allocation threshold	depending on proposal
Indirect cost compensation	degression after 2021 for EP proposal, no further degression for COM, Council

Table 1: Key assumptions for the case studies.

While most assumptions are related to political choices, the carbon price is somewhat different. It is an external variable that cannot be predicted within this study. Here, the following approach has been chosen: To ensure consistency with the 2016 study, carbon prices have not been changed. They start from actual levels in 2013 through 2015 and then rise on a linear path up to 30 € in 2030. Compared to the 2016 study, the assumed 2030 price level of 30 €/EUA is regarded even more likely underlying the positions of the EP and the Council. Especially the cancellation rule for EUAs in the Market Stability Reserve (MSR) in the latter position is assumed to drive prices up as it delivers a political signal that might influence expectations of market actors.

More information on methodology and assumptions is provided in the Annex.

[6] Wirtschaftsvereinigung Stahl

4 Results

4.1 EUA quantities

The three proposals provide different quantities of available EUAs for the 4th trading period. In the following subsections, these quantities are discussed with regard to the overall number of EUAs (Cap) and the respective budgets for free allocation in 2021-2030.

4.1.1 Comparison of the EU ETS revision proposals

The EU ETS Cap

In 2013, the annual Cap was ca. 2.08bn EUA. In 2020, it will be 1.82bn EUA. For the COM and Council positions, the 2030 Cap will be reduced to 1.33bn EUA. If the LRF is increased from 2.2% p.a. to 2.4% p.a. in 2024 (EP[7]), the Cap in 2030 will be 1.30bn EUA.

The total Cap for the 8 year timeframe from 2013-2020 is 15.60bn EUA. For the 10 years period from 2021-2030, the total Cap will be 15.50bn EUA, if the LRF is 2.2% p.a.. If the LRF would be raised to 2.4% p.a. in 2024, the total Cap will be reduced by 123m EUA to 15.38bn EUA.

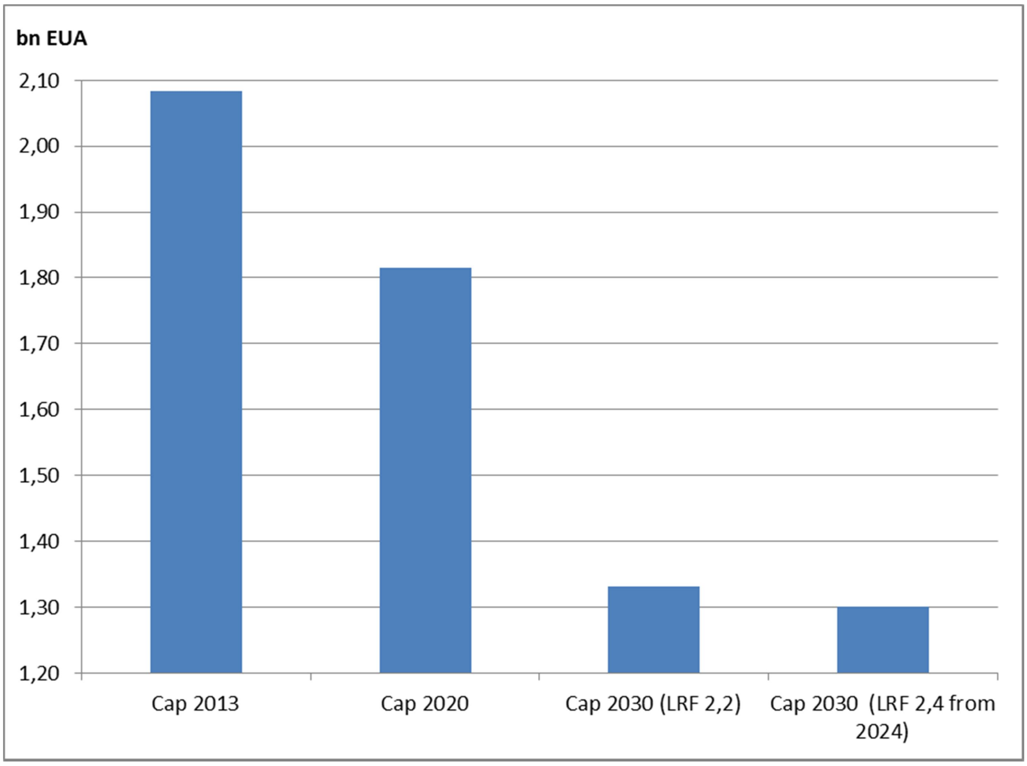


Figure 1: Comparison of Caps for EUA

[7] To adjust the LRF to 2.4% from 2024 is optional in the EP position. Here, it is assumed that the LRF will be increased from 2.2% p.a. to 2.4% p.a. in 2024.

The budget for free allocation

The actual amount of certificates available for free allocation is different for all three proposals.

In the COM proposal, a share of 40.4% of the Cap is available for free allocation. This equals ca. 6.26bn EUA over the entire fourth trading period.

The EP position contains a provision that allows extending the budget for free allocation by 5 percentage points of the Cap in order to avoid the application of the CSCF. However, two reductions from the budget for free allocation have to be taken into consideration as well:

(1) 400m EUA for the new entrants reserve (NER) do not come from the third trading period of the EU ETS[8] and the market stability reserve (MSR), but from the free allocation share 2021-30.[9]

(2) 1% of the budget for free allocation is auctioned to fund compensation of indirect costs. In the understanding of FutureCamp, the current EP position foresees the 600m EUA for the innovation fund to come from the auctioning share. In total, the budget for free allocation adds up to ca. 6.83bn EUA over the entire fourth trading period. The EP position therefore offers the largest budget for free allocation.

The Council position reserves additional 2 percentage points of the Cap for free allocation in case a CSCF would apply. With no further reductions, the overall budget for free allocation adds up to 6.57bn EUA over the entire fourth trading period.

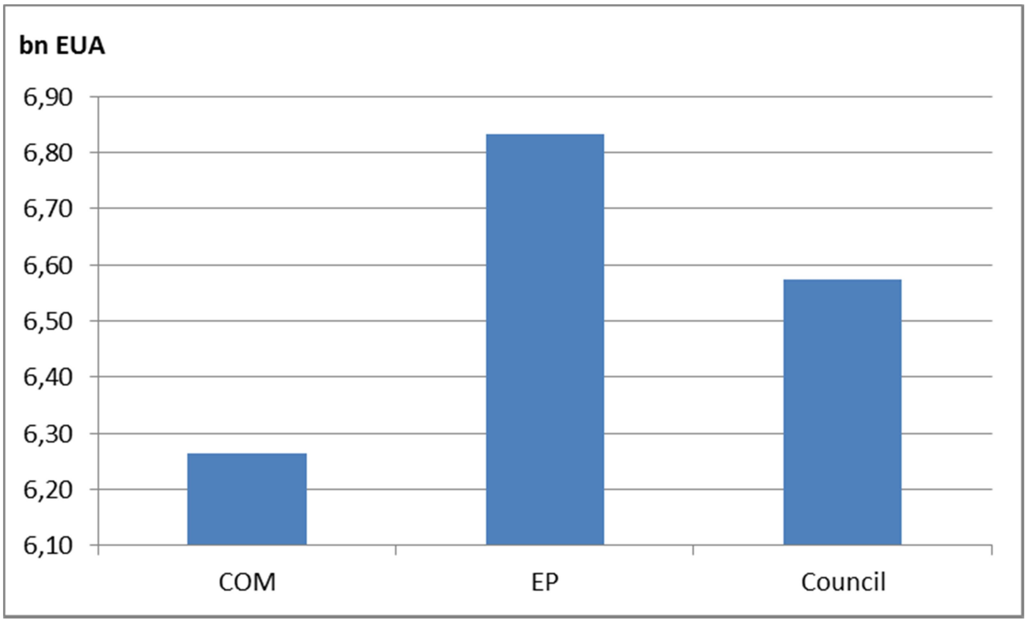


Figure 2: Overall free allocation budgets

[8] The third trading period is from 2013-2020.

[9] In the other positions, the certificates for the Innovation Fund come from the third trading period and are thus on top of the overall 2021-2030 cap.

4.1.2 Cross-sectoral correction factor

A CSCF applies, if the volume of preliminary free allocation exceeds the available budget. In contrast to the current third trading period, a number of flexibilities have been proposed to the fourth trading period to limit the risk of a CSCF. In most scenarios a CSCF does not apply. However, the complete prevention of a CSCF is not guaranteed.

The factors that determine the likelihood of a CSCF are the budget available for free allocation and the factors to calculate preliminary free allocation, namely, production levels, benchmarks, and carbon leakage status.

Calculations were carried out with the FutureCamp CSCF calculator. Key findings of these calculations are:

- Benchmarks, carbon leakage rules, and the overall budget are the most important factors with regard to design features. Among benchmarks, there are some major ones that have a high impact on the result, like heat, grey cement clinker, hot metal, refineries (complexity weighted tonne, CWT), and fuel. More than 70% of free allocation is based on these five benchmarks. If all major benchmarks are adjusted at their minimum rate, a CSCF applies for all three proposals (COM, EP, Council), with the highest cuts through a (selective) CSCF under the EP proposal.
- Specific provisions (e.g. for particular benchmarks or the discontinuation of applying the LRF for CHP as proposed by the EP) have additional impact on the CSCF.
- If, depending on the particular proposal, the overall weighted average of benchmark adjustment is between 0.35 and 0.6% p.a., a CSCF is not expected to apply.

Likeliness of a CSCF in the different proposals

<u>COM position:</u> In the COM proposal, a CSCF is not expected. The most important factor here is that the minimum update rate of 0.5% p.a. for benchmarks is the highest in all three proposals. With a weighted average benchmark update of roughly 0.6%, no CSCF would apply in this scenario.

<u>EP position:</u> In the EP scenario, it is unlikely that a CSCF applies. The minimum update rate is 0.25%. With a weighted average benchmark update of 0.35%, no CSCF would apply in this scenario. Nevertheless, it is important to note that due to a specific provision, the CSCF would only apply for certain sectors and would effectively be much stricter for them. Based on data from the current Carbon-Leakage list, among these sectors would be cement, lime and plaster, bricks and tiles, and potentially industry gases.

<u>Council position</u>: In the Council scenario, a CSCF might apply. The minimum update rate is 0.2%. With a weighted average benchmark update of roughly 0.5%, no CSCF would apply in this scenario. This, however, depends on the exact benchmark updates and it should be noted that this study is not a benchmark study.

A CSCF could apply in modified scenarios. Two very prominent aspects of the EP position that are not part of the Council position are the update of the hot metal benchmark and the application of the CSCF instead of the LRF for some installations. If these options were included in the Council scenario and particularly the budget in the Council scenario, a CSCF of 0.96 would apply for 2026-2030 (with no CSCF before). Under this assumption, a CSCF could most likely be avoided if an extra percentage point of the Cap was used for free allocation.

It must be noted that there remain a number of relevant uncertainties:

- This study is not a benchmark study and FutureCamp is well aware that in particular the update of certain benchmarks has a significant influence on the CSCF. The most important political choice is the update of the heat benchmark, the fuel benchmark, the inclusion of waste gases used for electricity production in benchmark calculation, and the provision to apply the CSCF to a limited number of sectors (EP scenario).

- The most influential general "unknowns" are future activity levels.
- Furthermore, it should be noted that in order to assess the carbon leakage status of all sectors and examples, the information included in the decision on the current CL list[10] is used. However, new data also might change the CL status of certain sectors or sub-sectors.

	COM	EP	COUNCIL
Budget for free allocation (share, %)	40.4	44.43*	42.4
Budget for free allocation (bn EUA total, 2021-2030)	6.26	6.83	6.57
Minimum benchmark update rates (%, p.a.)	0.5	0.25	0.2
Necessary weighted average benchmark update rate to avoid a CSCF until 2030 (within the proposed budget) (%, p.a., ca.)	0.6	0.35	0.5
Necessary free allocation share to avoid a CSCF until 2030 if all benchmarks are updated at the minimum rate (%, ca.)	41.4	45.19*	44.8

Table 2: Free allocation share. *The free allocation share in the EP scenario relates to a budget that is calculated based on the assumption that the LRF is adjusted to 2.4 in 2024

[10] See http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32014D0746

4.2 Case studies

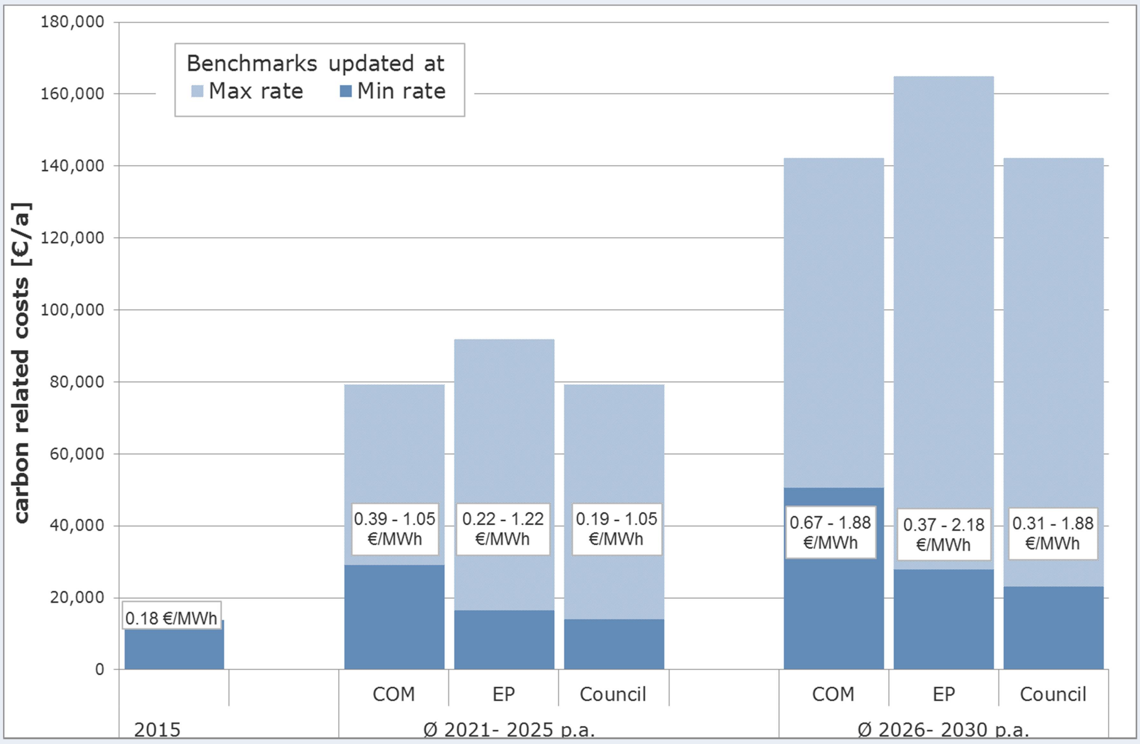
Six cases have been analysed to better understand the impacts of the different proposals for the future EU ETS design, and, furthermore, the design of the State Aid Guidelines. The case studies refer to the installation level, not the sectoral level. This allows for a precise analysis of impacts at installation level while some general conclusions can also be drawn. With calculations based on EU-wide EUA budgets and unified rules and case studies conducted at installation level, the results do not exclusively reflect installations in Germany but can be transferred to similar installations in other EU member states.

The most significant results of the calculations by FutureCamp are summarized and described in the subsequent tables and graphs. Each case study has a different focus, depending on the particular challenge of each installation. The selection of installations and sectors, however, does not indicate that sectors or installation types that are not represented through a case study are not affected in similar ways.

In the case studies presented below, a CSCF of 1 is assumed for two reasons: Firstly, to allow for the comparability of results and the isolation of relevant factors for specific installations. The aspects that were analyzed in the case studies can be compared between scenarios if the same CSCF assumption is underlying. Secondly, it is most likely that no CSCF applies in the COM and the EP scenario[11]. In the Council scenario, a CSCF might or might not apply after 2025, depending on the choices described above and other factors, e.g. the assumed activity data. As the cases where a CSCF would apply within the Council proposal require changes to the current proposal (e.g. by taking into account the full carbon content of waste gases used for electricity production), it is assumed that such changes could be linked with a slight increase in the budget. Regarding the ambivalence of a CSCF application in the Council scenario and weighing it with the methodological advantages described above, it seems reasonable to calculate the case studies assuming that no CSCF would apply in the Council scenario, too. However, FutureCamp is well aware, that the application of a CSCF cannot be ruled out completely.

[11] Plus, a CSCF in the EP scenario would not apply to the analyzed sectors due to the selective application of the CSCF.

Chemical Industry **Energy Production (heat)**



All parameters of relevance for free allocation applied here are assumptions. For example, the assumed benchmark-update rate cannot be used to draw any conclusions on technological progress achieved or expected for the (sub-)sector. Furthermore, the assumed increase of the price towards 30€/EUA in 2030 following a linear path is not a prognosis. All assumptions within this study do not allow to draw any conclusion regarding the political positions of the companies participating or their industry associations.

Remarks:

The specific carbon costs in €/MWh relate to the product steam.

The case study is based on a natural gas fuelled installation which produces steam at an efficiency close to the actual heat benchmark value. The steam is completely consumed within installations that are exposed to a risk of carbon leakage (chemical sector).

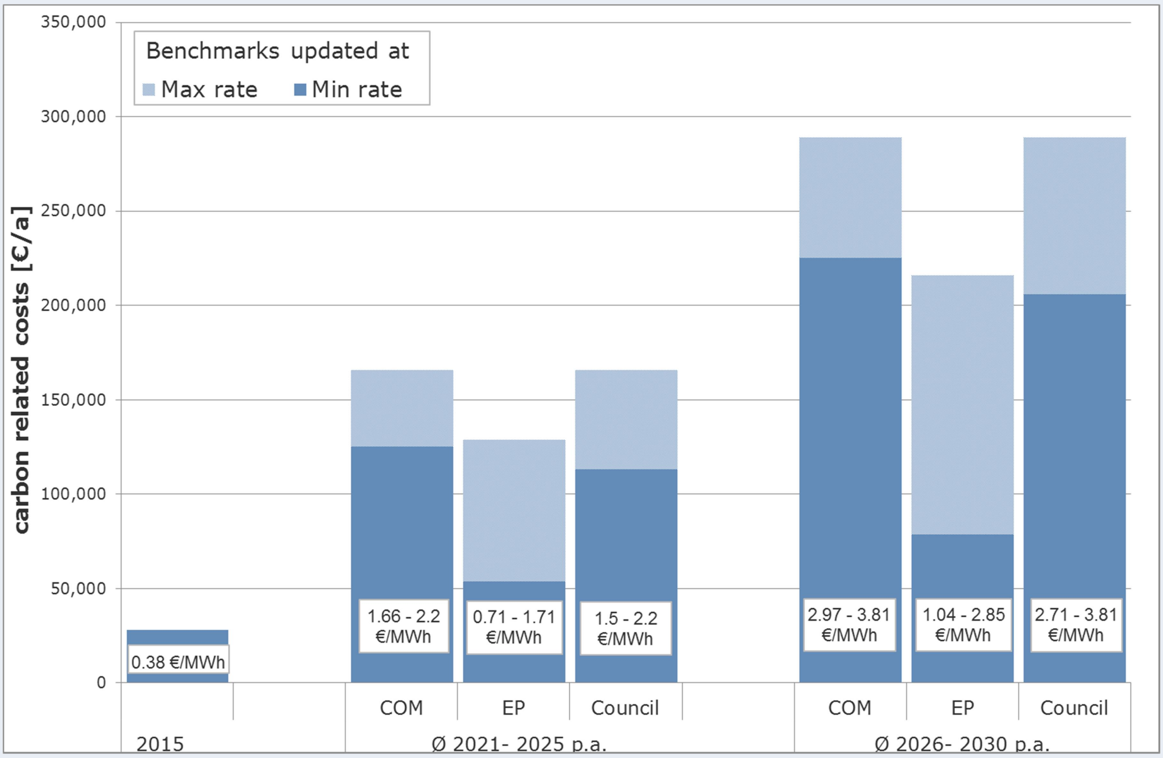
The most relevant parameter influencing future carbon costs is the update rate of the heat benchmark.

In the calculations, the CSCF of 1 is applied in all scenarios. The results show that additional costs are in a similar range in all scenarios.

The state aid for indirect emission costs is not relevant in this case because heat is not a product that is eligible for state aid according to the European guidelines on certain state aid measures.

High update rates for the heat benchmark would lead to a large increase in carbon costs even for an installation that is operated with natural gas close to the physical limit of efficiency.

Chemical Industry **Energy Production (power and heat)**



All parameters of relevance for free allocation applied here are assumptions. For example, the assumed benchmark-update rate cannot be used to draw any conclusions on technological progress achieved or expected for the (sub-)sector. Furthermore, the assumed increase of the price towards 30€/EUA in 2030 following a linear path is not a prognosis. All assumptions within this study do not allow to draw any conclusion regarding the political positions of the companies participating or their industry associations.

Remarks:

The specific carbon costs in €/MWh relate to the product steam.

The case study is based on a natural gas fuelled installation which produces steam at an efficiency close to the actual heat benchmark value. To an extent of 10%, there is also generation of electricity within the installation and, therefore, the installation is categorized as electricity producer. The steam is completely consumed within installations that are exposed to a risk of carbon leakage (chemical sector).

The most relevant parameters influencing future carbon costs are:

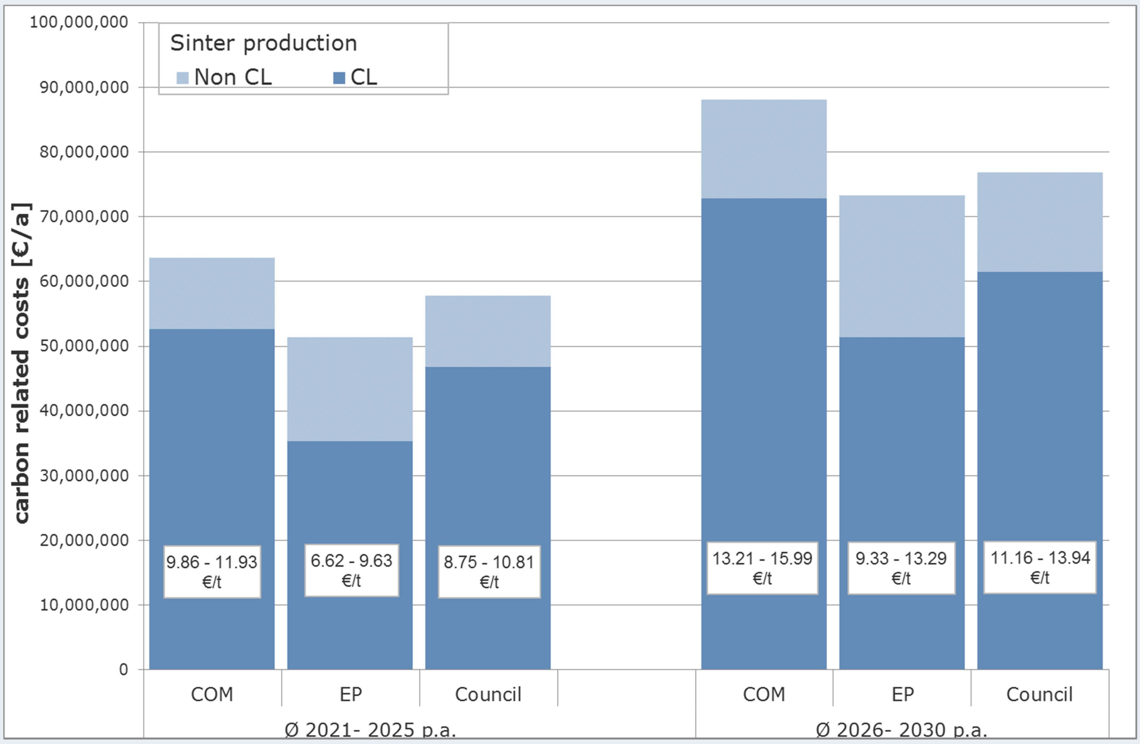
- update rate of heat benchmark
- application of LRF or CSCF for electricity producers

In our calculations the LRF is applied in the COM and Council scenarios but in the EP scenario no LRF is applied[12]. The results show that additional costs related to the application of the LRF are significantly higher in the COM and Council scenarios than in the EP scenario. Indirect costs and state aid are not considered here as the case study focuses on an energy producing installation. However, indirect emission costs might arise for installations consuming the electricity produced by the CHP.

The results show that the application of the LRF for electricity producers and high update rates for the heat benchmark would lead to a large increase in carbon costs even for an installation that is operated with natural gas close to the physical limit of efficiency.

[12]see amendment 70 in the EP position

Iron & Steel **Virtual Integrated Steel Plant**



All parameters of relevance for free allocation applied here are assumptions. For example, the assumed benchmark-update rate cannot be used to draw any conclusions on technological progress achieved or expected for the (sub-)sector. Furthermore, the assumed increase of the price towards 30€/EUA in 2030 following a linear path is not a prognosis. All assumptions within this study do not allow to draw any conclusion regarding the political positions of the companies participating or their industry associations.

Remarks:

Specific carbon costs are quantified in €/t of raw steel.

The case study is based on a virtual integrated steel plant reflecting the average of European installations. As the case study is based on a virtual installation, no calculations are performed for actual years. The virtual plant produces electricity by itself mainly using waste gases as fuel (Blast Furnace Gas 70-80%, Coke Oven Gas 20-30%, Natural Gas <1%).

The update rates of the relevant product benchmarks are assumed as follows:

- Hot metal: minimum rate as proposed (0.2% - 0.5% p.a.)
- Sinter: 0.5% p.a.
- Coke: maximum rate as proposed (1.5% - 1.75% p.a.)

It is still not clear, whether the production of sinter will be considered to be exposed to a carbon leakage risk. Therefore, calculations are performed in a CL and non-CL scenario for each position.

In the EP scenario, following assumptions are made:

- The hot metal benchmark will be reassessed to reflect the full carbon content of waste gases[13].
- The starting point for any benchmark update is defined to be 1.475 tCO_2/t hot

[13] see amendment 165 in the EP position

metal[14] in that scenario.

- At the same time, the volume of electricity produced, which is not rewarded within the compensation scheme for indirect costs, is 75% and reflects the average share of waste gas used for electricity production that receives free allocation within the hot metal benchmark. Thus, double counting through free allocation within the ETS scheme and through state aid for indirect emissions costs is excluded.
- State aid is reduced on a diminishing scale starting from 0.7% in 2021 (0.7) and resulting in 0.6% in 2030.

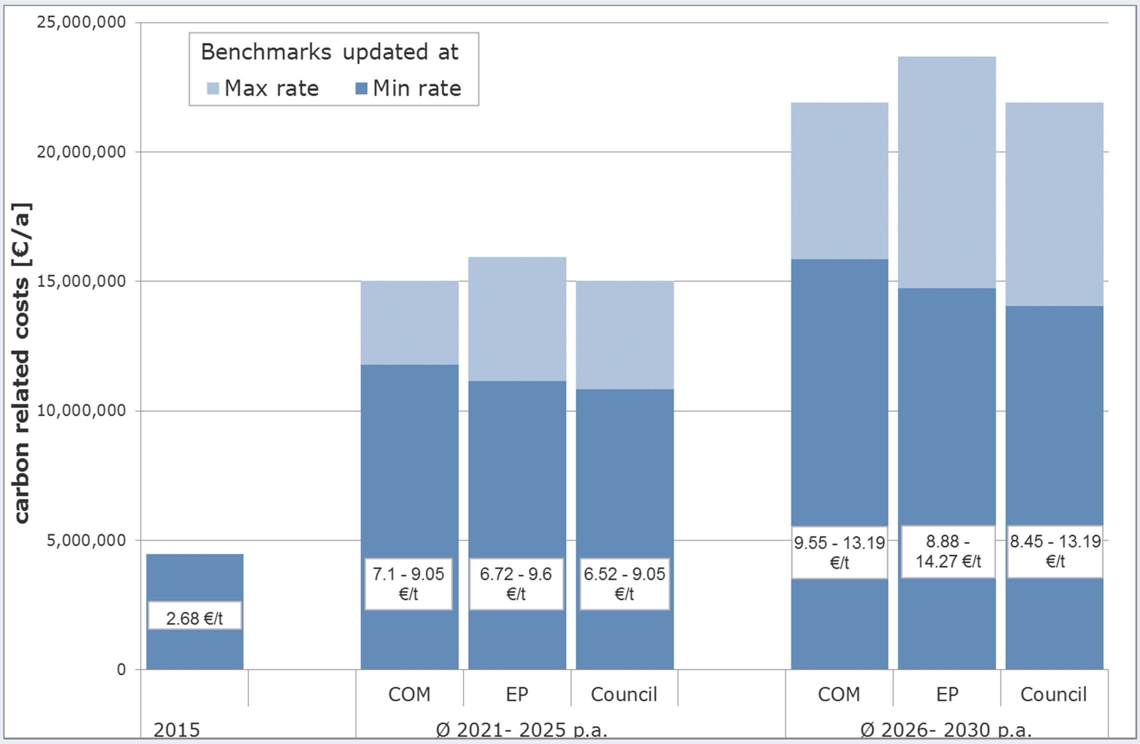
The reassessment of the hot metal benchmark is the most relevant factor influencing the carbon costs when comparing proposals, as the significantly lower costs in the EP scenario show.

The second relevant issue is whether or not sinter is considered a carbon leakage exposed sector. In the EP scenario, the consequences are even more severe as there would be no free allocation for non-CL sub-installations at all.

The third relevant issue are the diverging minimum rates for benchmark updates. Comparing the results of the COM and the Council scenarios, the minimum update rates range from 0.5 to 0.2% p.a..

[14] http://www.eurofer.org/News%26Events/Archives/Press%20releases/EUROFER%20Goes%20to%20Court%20on%20EU%20ETS.fhtml

Chemical Industry **Steam Cracking**



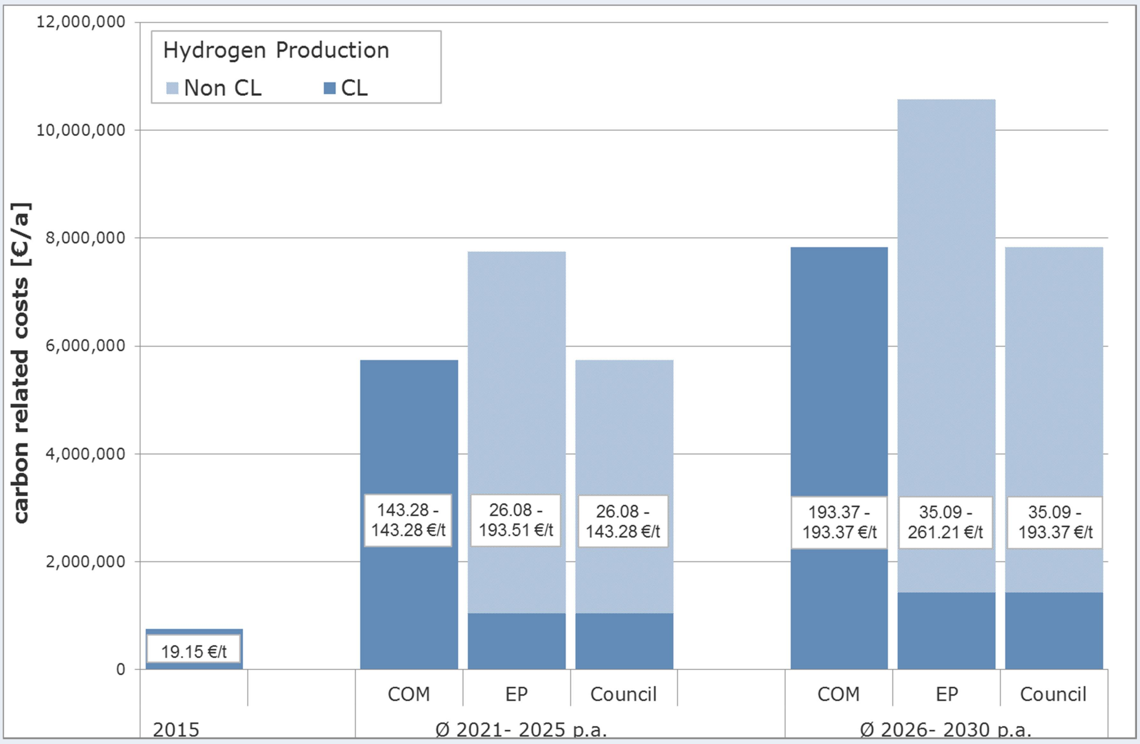
All parameters of relevance for free allocation applied here are assumptions. For example, the assumed benchmark-update rate cannot be used to draw any conclusions on technological progress achieved or expected for the (sub-)sector. Furthermore, the assumed increase of the price towards 30€/EUA in 2030 following a linear path is not a prognosis. All assumptions within this study do not allow to draw any conclusion regarding the political positions of the companies participating or their industry associations.

Remarks:

The specific carbon costs in €/t relate to the product „steam cracking (high value chemicals)" as defined for the corresponding product benchmark.

The calculation results do not vary significantly among the positions. The most relevant parameter influencing carbon costs is the update rate of the benchmarks. In case the real improvement lies within the range of 0.5% p.a. and 1.5% p.a., the results are similar for all three positions. In the EP scenario, state aid for indirect CO_2 costs is subject to further degression starting from 0.7% in 2021 and resulting in 0.6% in 2030.

Industrial Gases **Steam Reforming**



All parameters of relevance for free allocation applied here are assumptions. For example, the assumed benchmark-update rate cannot be used to draw any conclusions on technological progress achieved or expected for the (sub-)sector. Furthermore, the assumed increase of the price towards 30€/EUA in 2030 following a linear path is not a prognosis. All assumptions within this study do not allow to draw any conclusion regarding the political positions of the companies participating or their industry associations

<u>Remarks:</u>

The specific carbon costs in €/t relate to the product hydrogen as defined for the corresponding product benchmark. The case study is based on a steam reformer producing predominantly hydrogen.

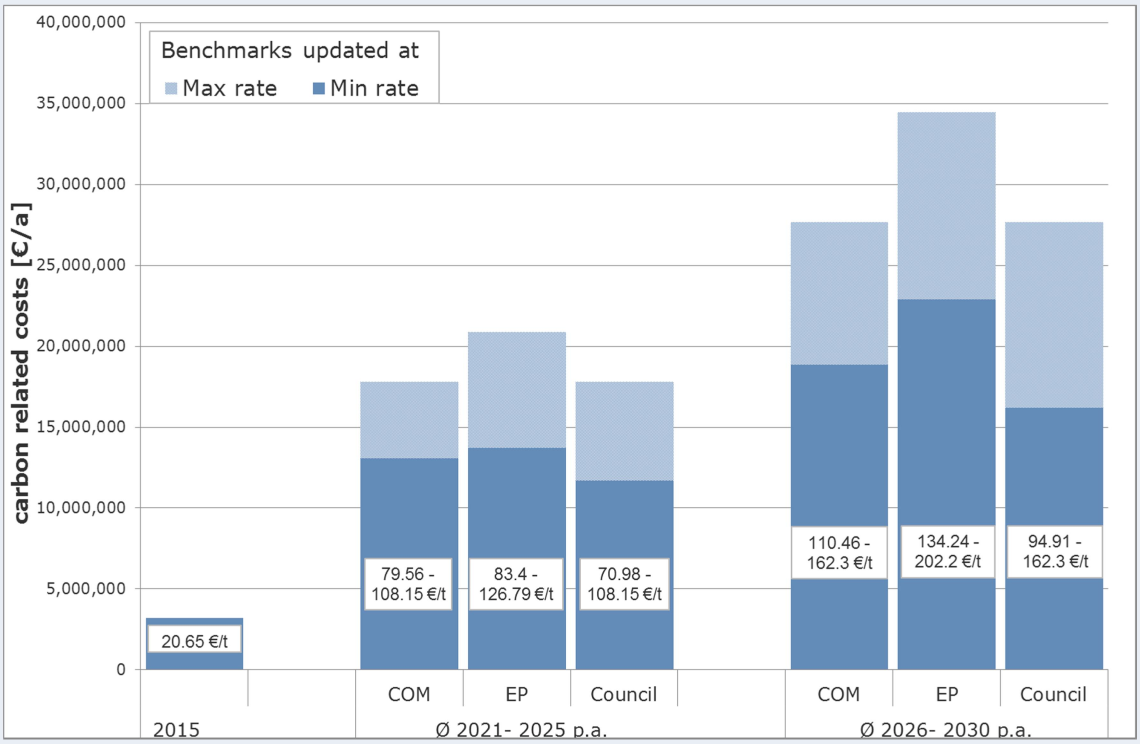
Carbon-related costs for production of hydrogen (and its by-product syngas) are particularly influenced by the question whether industrial gases will remain on the list of sectors exposed to the risk of carbon leakage. So far, neither the position of the COM nor the positions of the EP and the Council provide sufficient certainty that industrial gases will be able to meet the relevant thresholds on sector or subsector level.

This is of particular importance since hydrogen and syngas can also be produced by the refining and the chemicals sectors but in practice are very often outsourced to specialized industrial gas producers for economic and ecological benefits. Therefore, any inconsistent treatment of the identical production activity among those sectors would lead to severe market distortions – particularly for the outsourced producers. Accordingly, both the EP position and the Council position, include recitals indicating the need to harmonize not only benchmark updates but also the determination of the CL status between the sectors refineries and chemical industries[15]. However, it is not clear whether the recitals will be sufficient to maintain the level playing field between insourced and outsourced producers of hydrogen and syngas from the operator´s point of view.

Here, we do not assume a possible selective CSCF simply because the worst case under the EP proposal for this activity might lead to a CL factor of 0. In this case, a (selective) CSCF that might be applicable under the EP proposal would not lead to any additional cuts for this installation.

[15] see amendment 12 in the EP position

Non-Ferrous Metals **Aluminium Electrolysis**



All parameters of relevance for free allocation applied here are assumptions. For example, the assumed benchmark-update rate cannot be used to draw any conclusions on technological progress achieved or expected for the (sub-)sector. Furthermore, the assumed increase of the price towards 30€/EUA in 2030 following a linear path is not a prognosis. All assumptions within this study do not allow to draw any conclusion regarding the political positions of the companies participating or their industry associations.

Remarks:

The specific carbon costs in €/t relate to the product aluminium as defined for the corresponding product benchmark. More than 90% of the carbon related costs are indirect ones. In the case of aluminium, it is possible to compare these costs with the market price for aluminium set at the London Metal Exchange (LME). LME Cash Settlement Price is the global reference price for aluminium and its average within the last 2 years was USD 1637.60 per ton (23 March 2015 through 22 March 2017). Using the exchange rate as of 23 March 2017 this means 1515.00 €/t aluminium. This means that e.g. for 2021-25, carbon costs including the assumed compensation for indirect costs amount to roughly 4.7% of sales price in the assumed best case and 8.4% in the assumed worst case. For 2026-2030, these relations will rise up to 6.3% and 13.3% respectively.

The most relevant issue for this case study is the question of how compensation of indirect costs will be designed in the future. The calculation results here are based on the assumption that the general principles for the compensation of indirect costs that are currently in place will also be used for 2021-2030. It is assumed that the relevant product benchmarks will be updated to a similar extent as proposed for free allocation using the same min/max values. Therefore, the update rates also have significant influence on the results of this case study. Furthermore, consistency in state aid volumes is extremely important in this case. The same value as defined for 2020 (0.75) is assumed for the COM and the Council, although both have not mentioned state aid intensity and development. In contrast, the EP position explicitly foresees a continuation of degression. In the EP scenario the volume of state aid, thus, is reduced on a diminishing scale starting from 0.7% in 2021 to 0.6% in 2030.

Another assumption is that compensation will not be subject to any reduction factors deriving from a defined overall limit on compensation payments (e.g. expressed as percentage of auctioning revenues). If this was the case and applied here, indirect costs would increase even more depending on the additional reduction factor.

5 Annex: Assumptions

The case studies have been carried out based on the following assumptions:

Carbon price	Starting with empirical values for 2013-2015. Linear increase up to 30 €/EUA in 2030 2021-2025 average: 19.94 €/EUA 2026-2030 average: 27.13 €/EUA
Carbon leakage exposure factors	1 for CL sectors (all proposals) 0.3 for non-CL sectors (COM, Council) 0 for non-CL sectors (EP)
Cross-sectoral corrector factor	CSCF = 1 for all scenarios
Linear reduction factor	COM, Council: LRF = 2.2 EP: LRF = 2.2; from 2024: 2.4
Benchmark updates (% p.a.)	0.5/1/1.5 (COM) 0.25-1.75 (EP) 0.2-1.5 (Council)
Dynamic allocation threshold	10% (EP) 15% (Council) 50% (COM)
Assumptions for indirect carbon costs	Grid emission factor: 0.76 tCO_2/MWh Volume of state aid: - Council, COM : 0.75 (assumption; COM and Council proposals have not discussed state aid intensity and development since this is left to DG Comp) - EP: 0.7 (2021-2023), 0.65 (2024-2026), 0.6 (2027-2030) Sector-specific assumptions for future development of production levels, specific emissions, and specific electricity demand.
To calculate direct and indirect carbon-related costs, participating companies have provided the following data for the years 2013-2015	Free allocation Emissions Production levels for all sub-installations Production levels relevant for indirect costs Substitution factors (fuel-electricity) if relevant for the respective product benchmark Total electricity consumption (from grid and self-generated [covered by the ETS]) Compensation for indirect CO_2 costs

Calculations for the 2016-2030 timeframe have been performed on the basis of real data. Depending on the available data, different forecasting methods were used:

- „Input data": individual forecasts for the operator until 2030.
- „Linear specifications": a linear development from 2013-2015 average values was assumed
- „Fluctuating specifications": forecasts take the fluctuating pattern of the 2013-2015 timeframe into account. This modification has been defined to understand the effects of dynamic allocation. This would not be possible on the basis of linear growth.

The calculation of free allocation was based on the following methodology:

- 2013-2020:
  - Option 1: data according to the notification on free allocation
  - Option 2: "adjusted base period": calculations on the basis of actual activity levels for the respective years. Adjusted by variations in production since the base period of the actual trading period

- 2021-2025: calculation depending on the dynamic allocation threshold
  - If the activity level variation is below the threshold: calculation based on the median of activity levels 2013-2017
  - If the activity level variation is above the threshold: calculation based on the activity levels in the actual year
  - Definition of „dynamic allocation threshold": change of activity levels in the reporting year compared to the 2013-2017 median
- 2026-2030: calculation depending on the dynamic allocation threshold
  - If the activity level variation is below the threshold: calculation based on the median of activity levels 2018-2022
  - If the activity level variation is above the threshold: calculation based on the activity levels in the actual year
  - Definition of „dynamic allocation threshold": change of activity levels in the reporting year compared to the 2018-2022 median

For all cases, free allocation and direct carbon-related costs[16] have been calculated. The ratio of both expresses (in percent) the degree to which an operator is equipped with EUAs compared to his emissions. Using this value, real direct carbon-related costs have been calculated and expressed as absolute values and as specific values per unit of product.

Calculation of the compensation for indirect carbon costs were based on the following methodology:

- 2013-2020:
  - Calculation based on activity rate in the respective year
  - Plausibility check through comparison with real 2013/2014 data
  - For methodical reasons, no limitation of compensation volumes was assumed
- 2021-2030:
  - Calculation based on activity rate in the respective year
  - For methodical reasons, no limitation of compensation volumes was assumed

For all cases with indirect costs, the volume of state aid and indirect carbon-related costs have been calculated. The ratio of both expresses the level of compensation of indirect carbon costs. Using this value, real indirect carbon-related costs have been calculated and expressed as absolute values and as specific values per unit of product.

[16] Emissions multiplied with the actual EUA price.