EU ETS: last call before the doors close on the negotiations for the post-2020 reform

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Charlotte **Vailles**, Émilie **Alberola** (I4CE)
Cyril **Cassisa**, Jérémy **Bonnefous** (Enerdata)
Paula **Coussy**, Pierre **Marion**, Sebastian **Escagues** (IFPEN)

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Disclaimer

The authors take sole responsibility for findings or ideas presented in this report as well as any errors or omissions. This report does not reflect the opinion of any governments or private companies.

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List of acronyms

CSCF: cross-sectoral correction factor

EUAs: European Union allowances

EU ETS: European Union emissions trading system

GDP: gross domestic product

GHG: greenhouse gas

LRF: linear reduction factor

MSR: market stability reserve

POLES: prospective outlook on long-term energy systems

PCR: Price Corridor reserve

Executive summary

Introduction

Twelve years after the EU ETS was introduced as the cornerstone of EU climate policy to promote reductions of greenhouse gas (GHG) emissions in a cost-effective way, continued depressed prices are questioning its credibility. A number of economic and political factors have led to a significant surplus of EU allowances (EUAs), creating an imbalance of supply and demand, partly responsible for the depression of prices. In total, the surplus reached 1.7 billion allowances in January 2017, equivalent to one year of EU ETS emissions.

A window of opportunity to reform the EU ETS is currently open but closing soon. The EU ETS is currently being revised for its Phase IV (2021-2030): following a proposal for a revised directive by the EU Commission in July 2015, trilogue negotiations between EU institutions started on April 4, 2017, with a focus in the negotiations on the strengthening of the EU ETS and on carbon leakage. Given the divergence of opinion on a number of elements, there is still uncertainty on the possible outcome of the trilogue negotiations, probably to be reached in autumn 2017. **This reform is the last chance for the EU ETS:** with another decade of depressed prices, the EU ETS would lose what is left of its credibility and would be entirely replaced with fragmented national policies.

Following the adoption by the EU Parliament and the EU Council of their respective positions on the post-2020 EU ETS reform proposal in February 2017, I4CE, Enerdata and IFPEN provide a new **qualitative and quantitative assessment of these positions**. Two other possible evolutions of the EU ETS during its Phase IV (2021-2030) are also analyzed: the implementation of **carbon Price Corridor** on the EU ETS and an **exit of the UK** from the EU ETS. The analysis considers the EU ETS with **a long-term perspective until 2040**, considering the implementation of **other pieces of the EU Climate and Energy package**.

Key results

EU Parliament and Council reform proposals are not sufficient to create an effective ETS in Phase IV (2021-2030)

The proposals on the table today to strengthen the EU ETS fail to make it a driver of decarbonisation in energy and industry sectors over its Phase IV

The reform of the EU ETS for the post-2020 period will probably be more ambitious than with the initial proposal from the EU Commission, with the Parliament and the Council both in favor of a doubling of the Market Stability Reserve (MSR) intake rate in the first years and of a cancellation of allowances in the MSR.

However, **nor the Council proposal neither the Parliament's – even with an increase of the Linear Reduction Factor (LRF) of the cap to 2.4% in 2024 – leads to an effective EU ETS during its Phase IV**, despite the implementation of the MSR. Indeed, in Phase IV, **GHG emissions reductions notably coming from energy efficiency and renewable energy policies are sufficient to respect the EU ETS target**, under the assumption that specific policies are implemented to meet the 2030 targets for renewable energy and energy efficiency. The EU ETS is thus not a driver of abatement.

During Phase IV, the Market Stability Reserve is not sufficient to mitigate interaction effects between the EU ETS and renewable energy and energy efficiency policies

In spite of the doubling of its withdrawal rate in the first years of its functioning (until 2021 for the Parliament and 2023 for the Council), the MSR is not able to mitigate the overlapping effect of complementary policies on the EU ETS while absorbing the historical surplus of allowances. The scarcity of allowances is only restored by the end of Phase IV.

Long-term climate targets need to be anticipated for a sustainable low-carbon transition

EU long-term climate ambition should be increased to integrate the objectives of the Paris Agreement

As currently discussed in the trilogue negotiations, **the EU ETS trajectory is aligned on the low end of long-term EU climate ambition.** Furthermore, **long-term EU climate objectives and the EU ETS trajectory should now be updated to integrate the objectives of the Paris Agreement, and should aim at "net-zero" emissions by the second half of the century.**

From the early 2030s, further emissions reductions are needed to achieve the EU ETS long-term target

Even though its trajectory is aligned on the low end of EU 2050 climate ambition, **the EU ETS still requires a drastic decrease of GHG emissions in the long term.** The cost of abatements required to respect the EU ETS target (taking into account the constraint set by the cap and the surplus on the market) becomes extremely significant in the early 2030s, under the assumption that supports for renewable energy and energy efficiency decrease after 2030.

The future scarcity of allowances need to be anticipated

If the constraint is not anticipated from today, EU ETS market prices would be too low to give the right low-carbon investments during Phase IV, and on the contrary would risk becoming socially unacceptable in Phase V, leading **policy-makers to alleviate the constraint set by the EU ETS, and thus decrease its ambition**.

With a proper anticipation of the EU ETS long-term target, the need for further GHG emissions reductions would appear from today and would result in a **sustainable and politically acceptable decarbonisation pathway**. In this context, an **updated 2050 EU roadmap, integrating the objectives of the Paris Agreement,** would be necessary to give more visibility to all.

Attention should be paid to the environmental integrity of the MSR in the long run

With the Parliament proposal, even with an increase of the LRF in 2024, there are still **more than 2 billion allowances in the MSR in 2040**, which could consequently release allowances until the 2060s, jeopardizing the environmental integrity of the EU ETS in the long run. As an order of magnitude, releasing 100 million allowances in 2050 corresponds to a **27% increase in the EU ETS cap with an LRF of 2.2% from 2021 - and 41% if the LRF increased to 2.4% in 2024**.

With the Council proposal, **more than 3 billion allowances are cancelled in total, and the MSR is empty in 2044**.

An EU-wide Price Corridor on the EU ETS could be one solution to the lack of anticipation of ETS operators and would lead to earlier mitigation efforts in ETS sectors

A Price Corridor implemented through an additional reserve on the EU ETS

The implementation of a Price Corridor on the EU ETS is one of the possible solutions to the lack of anticipation of ETS operators. In this scenario, the objective is to lead the EU ETS carbon value[1] into a specific interval through the implementation of a new reserve on the EU ETS, the Price Corridor Reserve (PCR). Auctions are cancelled until the ETS carbon value reaches the floor and corresponding allowances are transferred to the PCR. Allowances are released from the PCR when the carbon value is higher than the ceiling.

The implementation of a Price Corridor leads to earlier mitigation efforts in EU ETS sectors

The implementation of a Price Corridor leads to **earlier mitigation efforts in EU ETS sectors until 2040,** and **more than half** of additional emissions reductions compared to the Parliament scenario are achieved in the power sector. A significant number of allowances are transferred in the dedicated reserve and the surplus of allowances is thus very quickly absorbed.

A possible exit of the UK from the EU ETS adds to the uncertainty of the current revision of the EU ETS directive

Uncertainties around the Brexit and the EU ETS

The possible exit of the UK from the EU ETS raises many questions, which cannot be answered through modelling. It is not known yet whether the UK is actually exiting the EU ETS, and a fortiori it is not known when this transition would take place and how the EU ETS design parameters – such as the emissions cap or the MSR withdrawal and release rates and thresholds – would be adjusted. The behavior of markets participants which hold allowances in the UK, is also an unknown, as well as the amount of allowances that may come back suddenly to the market. Finally, without the UK voice, the balance in energy and climate negotiations will probably be modified.

In case of a Brexit, careful attention should be paid to the adaptation of the emissions cap and the MSR parameters

To design a Brexit scenario, some assumptions had to be made. In this scenario, the UK is considered to be no longer part of the EU ETS from the beginning of Phase IV and the ambition in the EU ETS is assumed to remain similar as with the current emissions reduction targets. The EU ETS emissions cap is adapted consequently.

This new EU ETS emissions cap defined in the Brexit scenario corresponds to **higher mitigation efforts for the rest of the EU ETS in the period post-2020**. As a consequence, **the Brexit impacts the decrease of the surplus and the MSR functioning,** which starts releasing allowances sooner than in the Parliament scenario. Resulting ETS emissions in the Brexit scenario are **4% higher** than in the Baseline scenario **in 2040.**

The results of the Brexit scenario **cannot be dissociated from the assumptions made for the adjustment of the EU ETS parameters**. In case the UK leaves the EU-ETS,

1 One of the outputs of POLES modelling *is the carbon value in the different scenarios, which is* ***not*** *an EU ETS market price. The carbon value represents the cost of emissions reductions required to respect the constraint set by the EU ETS considering a sliding carbon budget. Please refer to the section "Estimating the cost of emissions reductions required: the carbon value" and to the annexes for more details.*

careful attention should be paid to **the adjustment of the emissions cap and MSR design parameters.**

The framework for free allocation to industrial sectors is a focal point in the negotiations on the EU ETS reform

In the trilogue, positions differ on a number of EU ETS design parameters which impact free allocation

The issue of carbon leakage and the competitiveness of EU industries is a major concern to decision-makers and is calling particular attention in the debates on the post-2020 EU ETS reform. The current approach of freely allocating allowances to industrial sectors deemed to be exposed to carbon leakage will go on. Besides, along with the EU ETS emissions cap, the free allocation cap will decrease. In this context, industries are worried that **a cross-sectoral correction factor (CSCF) might need to be triggered, to adjust the total free allocation to the free allocation cap.** Such a factor would reduce uniformly free allocation in all sectors, a concern for those most exposed to carbon leakage. The positions of the Council and the Parliament on the EU ETS reform differ on a number of elements which impact the **free allocation cap** or the calculation of the **bottom-up preliminary free allocation**.

The positions of the Council and the Parliament on the EU ETS reform will probably result in a Cross-Sectoral Correction Factor (CSCF) triggered at the end of Phase IV

With assumptions differentiated by sector on growth rates for the periods 2016-2020 and 2021-2030 and on benchmark decrease rates, we estimate that **a CSCF would be triggered in 2030 with the Parliament amendments and in 2028 with the configuration of the Council general approach**. These results should be considered with caution, as projections on free allocation are **very sensitive to assumptions on future growth rates in industry and even more to assumptions on the allowed benchmark decrease rates by sector.** It should be noted that in this study, the lowest possible benchmark decrease rates have been used in each scenario (0.25% in the Parliament scenario and 0.20% in the Council scenario) for major sectors covered by the EU ETS (refinery, cement, aluminum, steel).

Quantifying the impact of EU ETS design parameters on free allocation enables to evaluate how to avoid the CSCF, keeping in mind that free allocation should not result in windfall profits and was meant to be a transitional tool

The effects of the different design parameters on the calculation of the bottom-up preliminary free allocation balance out and **the demand for free allowances is similar in the Council and the Parliament scenarios.** On the other side, **the Parliament's position results in a higher amount of free allowances for industry than the Council's**, even if the LRF is increased to 2.4% in 2024.

The quantification of the impact of EU ETS design parameters on free allocation enables **to try and match the supply and the demand and thus avoid triggering the CSCF**. To this end, EU Council policy objectives regarding free allocation should be kept in mind – **avoiding undue carbon cost** for most efficient installations while **preserving the incentive to reduce CO_2 emissions** and **not giving rise to windfall profits and distortions.**

Around 24% of EUAs auctioning volumes would be required over Phase IV to compensate indirect costs in the main eligible sectors

With an aid intensity of 75% harmonized over the EU ETS, we find that **around 24% of EUAs auctioning volumes would be required over Phase IV to compensate indirect costs** in the main eligible sectors (aluminum, steel and ferro-alloys, chemicals, paper & pulp).

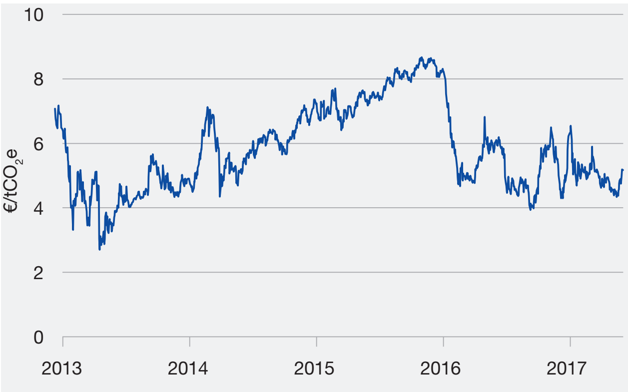
Free allocation and compensation of indirect costs were meant to be transitional tools, we should now start preparing the post-compensation period for a smooth transition.

1. Introduction

A significant surplus of allowances and continued depressed prices are undermining the credibility of the EU ETS

The EU emissions trading system (EU ETS) was introduced in 2005 as a cornerstone of the EU's policy to combat climate change with the aim of promoting reductions in greenhouse gases (GHG) emissions in a cost-effective way. Twelve years after, continued depressed prices are questioning its credibility. In 2017, the price of EU allowances (EUAs) is oscillating around 5€/tCO_2e and it has never even reached 10€/tCO_2e since the beginning of Phase III in 2013. (see **Figure 1**)

FIGURE 1. EUA SPOT PRICE – PHASE III



Source: I4CE, with data from ICE Futures Europe

A number of economic and political factors have led to a significant surplus of ETS allowances, creating an imbalance of supply and demand, partly responsible for the depression of prices. In particular, complementary climate and energy policies, such as policies for the deployment of renewable energy sources and of energy efficiency measures, have led to significant GHG emissions reductions in sectors covered by the EU ETS. In parallel, the economic downturn of 2008-2009 is also responsible for a decrease in the demand for ETS allowances, while at the same time, the supply was increased by the possibility to use international Kyoto credits[2] (*I4CE, 2015*). In total, the surplus reached 1.7 billion allowances[3] in January 2017, equivalent to one year of EU ETS emissions.

A first measure to reduce the surplus on the EU ETS was the backloading measure, voted in 2014, which consisted in postponing the auctioning of 900 million allowances over the period 2014-2016 until 2019-2020. A second step will be the implementation of the Market Stability Reserve (MSR) in 2018, with the objective of regulating the long-term surplus by applying thresholds on the total amount of allowances circulating in the market. As voted in 2015, the MSR should absorb annually 12% of the allowances in circulation, which will not be sufficient to absorb the surplus before the end of Phase IV (2021-2030) (*I4CE, 2015*).

A window of opportunity to reform the EU ETS is currently open but closing soon

The EU ETS is currently being revised for its Phase IV (2021-2030) and structural elements of reform are under discussion, such as an increase in the linear reduction factor (LRF) of the emissions cap, and a modification of the free allocation framework for sectors deemed to be exposed to carbon leakage. The EU Commission released its proposal in July 2015[4], and in February 2017, the EU Parliament and the EU Council adopted their respective positions on the post-2020 EU ETS reform[5]. The trilogue between EU institutions started on April 4, with a focus in the negotiations on the strengthening of the EU ETS and on carbon leakage. Given the divergence of opinion on a number of elements, there is still uncertainty on the possible outcome of the trilogue negotiations, probably to be reached in autumn 2017. **This reform is the last chance for the EU ETS:** with another decade of depressed prices, the EU ETS would lose what is left of its credibility and would be entirely replaced with fragmented national policies.

The EU ETS reform takes place in a fast-changing context, both at the European and international levels

Other EU climate and energy policies which interact strongly with the EU ETS are under negotiation

The other pieces of the 2030 Climate and Energy framework are also under negotiation at the EU level, following the publication of legislative proposals by the European Commission:

- In July 2016, the "**Low-carbon economy package**", including a legislative proposal for the post-2020 Effort

2 *The Kyoto protocol defined two project-based mechanisms, the Clean Development Mechanism (CDM) and the Joint Implementation (JI), which generate carbon credits from CO_2 emissions reductions linked to projects implemented respectively in non-Annex B and Annex B countries. In the EU ETS, operators are allowed to use CDM and JI carbon credits between 2008 and 2020 for their compliance under some quantitative and qualitative limits.*

3 *http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52017XC0513(01)&from=EN*

4 *http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52015PC0337*

5 *http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+TA+P8-TA-2017-0035+0+DOC+PDF+V0//EN* and *http://data.consilium.europa.eu/doc/document/ST-6841-2017-INIT/en/pdf*

Sharing Regulation, which covers GHG emissions in non-ETS sectors, such as agriculture, buildings, transport and waste as well as a legislative proposal for GHG emissions and removals from land use, land use change and forestry (LULUCF).

- In November 2016, the "**Clean Energy for all Europeans package**", with legislative proposals on energy efficiency, renewable energy sources, the organization of the electricity market and the governance of the Energy Union.

Except the proposal for the Effort Sharing Regulation, on which the Parliament voted in June 2017, all the legislative proposals are still under discussion both in the Parliament and in the Council.

Given the interactions between the different legislative pieces of the Climate and Energy framework and the impact of other policies on the demand for ETS allowances, the reform of the EU ETS cannot be analyzed without taking the rest of the Climate and Energy package into account.

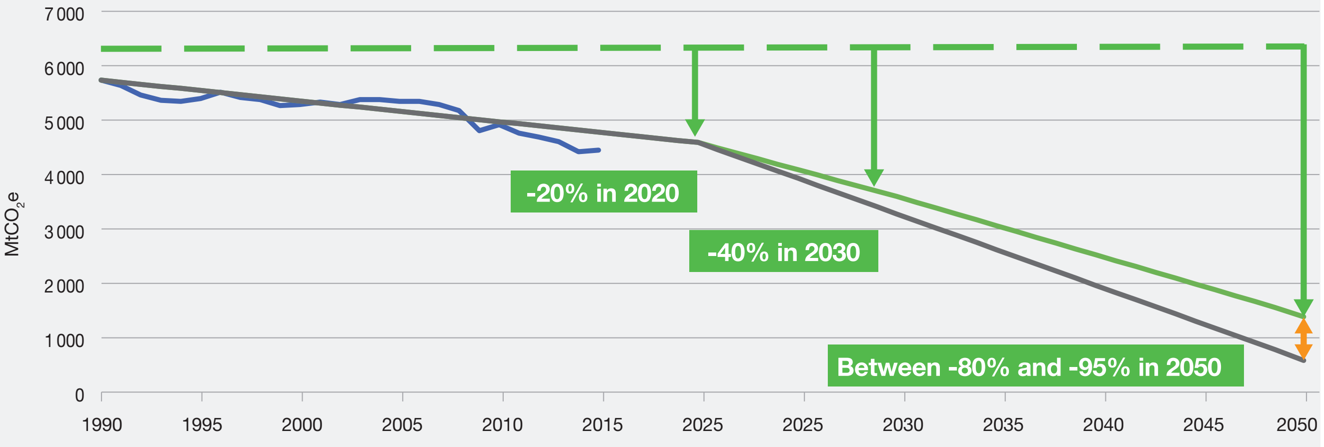
The Brexit – and the possible exit of the UK from the EU ETS – adds uncertainty to the situation

On another topic, the Brexit adds to the uncertainty of the situation. It is not known yet whether the UK is actually exiting the EU ETS, and a fortiori it is not known when this transition would take place and how the EU ETS design parameters- such as the emissions cap or the MSR withdrawal and release rates and thresholds- would be adjusted. The behavior of markets participants which hold allowances in the UK is also an unknown, as well as the amount of allowances that may come back suddenly to the market. Finally, without the UK voice, the balance in energy and climate negotiations will probably be modified.

The EU committed to pursue efforts towards a more ambitious +1.5°C target under the Paris Agreement

The Paris Agreement, entered into force in November 2016, changed deeply the international context of climate negotiations. The EU submitted as a contribution its target of reducing its GHG emissions in 2030 by at least 40% from 1990 levels. This target is on the low-end of EU long-term climate ambition, which consists of cutting emissions by 80-95% by 2050 compared to 1990 (see **Figure 2**). This 2050 objective was set by the European Council in 2011, to be aligned with necessary emissions reductions by developed countries in order to keep climate change below 2°C according to the Intergovernmental Panel on Climate Change (IPCC). Now that under the Paris Agreement the EU committed to the objective of holding global temperature increase well below 2°C and to pursuing efforts towards a more ambitious +1.5°C target, **EU 2030 and 2050 objectives should reflect this ambition.**

FIGURE 2. HISTORICAL GHG EMISSIONS AND EU 2050 GHG PATHWAYS



Source: I4CE, with data from EU Commission

2. Approach and methodology

This report was produced within the framework of the research program COPEC II (COordination of EU Policies for Energy and CO_2 by 2030) launched in April 2017 with the aim of providing a factual, independent and quantified analysis of climate and energy policies in articulation with the EU ETS and preparing policymakers for the revision of the 2030 climate and energy package. COPEC II builds on the results from the program COPEC I, which ran from September 2014 to December 2015. The program is conducted by I4CE – Institute for Climate Economics –, Enerdata and IFPEN and includes the organization of thematic workshops which bring together partners, associate experts and sponsors. The present report builds on the results from the first two workshops, respectively organized in April and June 2017 on the framework for free allocation in the EU ETS, and on the carbon price signal in the EU ETS.

Objectives and scenarios

Following the adoption by the EU Parliament and the EU Council of their respective positions on the post-2020 EU ETS reform proposal in February 2017, this report aims at providing **a qualitative and quantitative assessment of these positions and of other possible evolutions of the EU ETS during its Phase IV (2021-2030) with a long-term perspective until 2040**, considering the implementation of other pieces of the EU Climate and Energy package.

First, the report analyses the possible macro evolutions of the EU ETS in the period post-2020. On the one side, scenarios which represent possible outcomes of the trilogue negotiations on the EU ETS reform are assessed:

- **Parliament**: a scenario which represents the Parliament's amendments on the EU ETS reform;
- **LRF +**: a scenario which also represents the Parliament's amendments on the EU ETS reform but takes into account an increase of the LRF to 2.4% in 2024;
- **Council**: a scenario which represents the Council general approach on the EU ETS reform.

On the other side, the report analyses prospective scenarios which represent other possible evolutions of the EU ETS in the post-2020 period:

- **Price corridor**: a scenario in which an EU-wide Price Corridor is set on the EU ETS through the implementation of a reserve which works independently from the MSR. Auctions are cancelled until the price reaches the floor and corresponding allowances are transferred to the reserve, from which they are released when the price is higher than the ceiling;
- **Brexit**: a scenario in which the UK exits from the EU ETS at the end of Phase III.

The report looks into the macro-impacts - such as GHG emissions reductions, the functioning of the MSR and the costs of necessary abatements – of these five scenarios up to 2040.

Secondly, the report looks into the impacts of the different positions in the trilogue on the framework for free allocation in Phase IV of the EU ETS (2021-2030). Two main scenarios are analyzed:

- **Parliament**: a scenario which represents the Parliament's amendments on the framework for free allocation;
- **Council**: a scenario which represents the position of the Council general approach on the framework for free allocation.

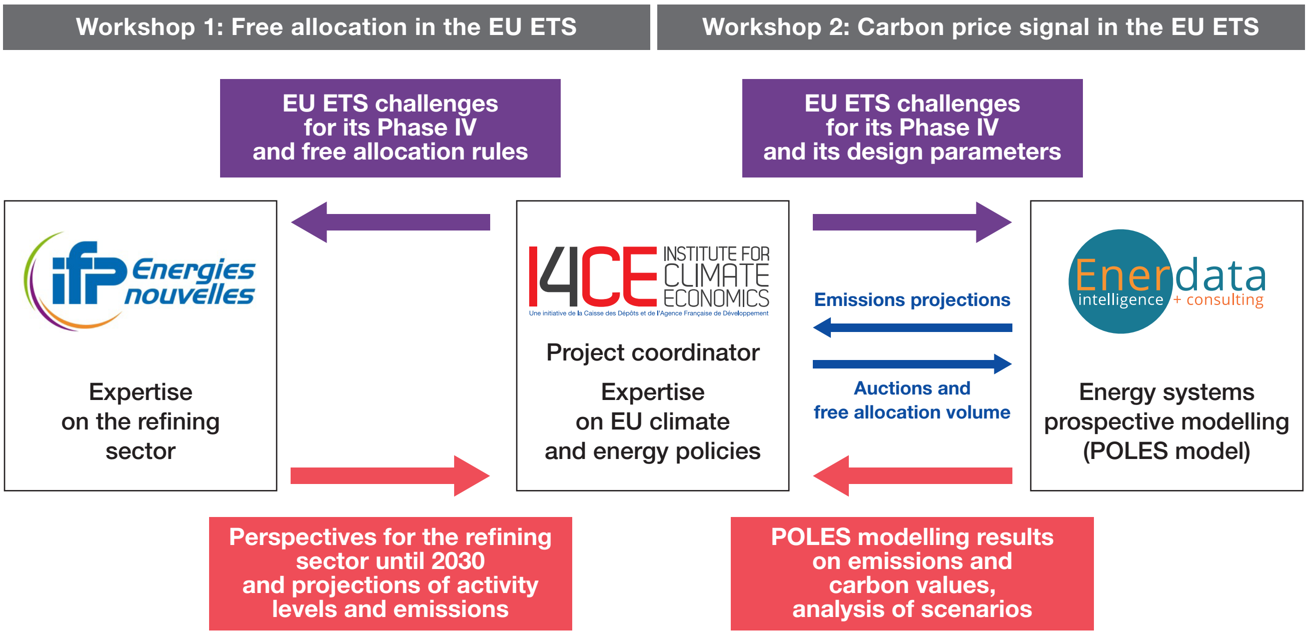
The report gives an estimation of free allocation for the main industrial sectors in these scenarios, as well as a quantification of the impact of different EU ETS design parameters on the demand and the supply of free allowances. Finally, the report gives an estimation of auctioning volumes which would be required to compensate indirect costs at EU level in the main eligible sectors.

Methodology

The report is the result of the collaboration between three entities with their specific expertise (see **Figure 3**). The analysis of the framework for free allocation was carried out with I4CE EU ETS tool, which is disaggregated at NACE code level. Assumptions for the parameters impacting free allocation are made at the sectorial level. Perspectives for the refinery sector until 2030 were developed by IFPEN, including projections of activity levels and emissions. Enerdata conducted the modelling of energy systems with the model POLES (Prospective Outlook on Long-term Energy Systems), to analyze the macro-impacts of the different scenarios.

Main assumptions used in POLES scenarios are summarized in **Box 1**. For more details on the tools and models used for this report, as well as for assumptions, please refer to the annexes.

FIGURE 3. ORGANISATION OF COPEC II PROJECT



BOX 1. MAIN ASSUMPTIONS IN POLES SCENARIOS

General assumptions

- All scenarios are modelled with POLES until 2040.
- The design parameters of the EU ETS are kept constant after 2030 in the different scenarios.
- The scenario Parliament is used as a Baseline, from which are built the other scenarios.

Assumptions for other climate and energy policies

- All scenarios take into account the targets of the EU 2020 and EU 2030 Climate & Energy Packages, and in particular, the following targets for energy efficiency and renewable energy sources:

	Energy efficiency[1]	Renewable energy sources[2]
2020	20%	20%
2030	30%	27%

1 The 2020 objective for energy efficiency corresponds to a 20% decrease in primary or final energy consumption compared to the Baseline scenario elaborated in 2007 for the Commission. The objective for 2030 corresponds to a decrease of at least 30% both in terms of primary and final energy consumption, compared to the same Baseline scenario.

2 The objectives for renewable energy sources are expressed in percentage of the gross final energy consumption.

- EU 2030 targets for Energy Efficiency and Renewable Energy are defined as proposed in the 'Clean Energy for all Europeans' package of the Commission in November 2016; the Effort Sharing Regulation for 2021-2030 is based on the Commission's proposal of July 2016.
- After 2030, support for renewable energy sources and energy efficiency measures is linearly decreasing, until being null in 2040.

Carbon budget

- Stakeholders have a 5-year sliding anticipated vision on the carbon budget.
- The surplus of EU ETS allowances is considered to be available and tradable.

Scope of the EU ETS

- Aviation with its current scope (intra-EEA flights) is considered to be within the EU ETS until 2020.
- Given the uncertainties for aviation after 2020, only fixed installations are considered in the EU ETS from the beginning of Phase IV.

Estimating the cost of emissions reductions required: the carbon value

One of the outputs of POLES modelling is the carbon value in the different scenarios, which is **not** an EU ETS market price. The carbon value represents the **cost of emissions reductions required to respect the constraint set by the EU ETS considering a sliding carbon budget**.

Please refer to the annexes for more information about the carbon value in POLES.

FIGURE 4. RELATIONSHIP BETWEEN CARBON VALUE AND EUA MARKET PRICE (ILLUSTRATIVE)

Interpretation of the graph:

Zone 1:

The EU ETS does not represent a constraint of emissions reductions. In that case, the carbon value is equal to zero. The EU ETS market price would not be driven by short-term CO2 emissions reductions requirements but by mid and long-term anticipations.

Zone 2:

Further emissions reductions are required to respect the carbon budget, defined by the supply of EU ETS allowances and the amount of allowances in circulation taking into account the action of the MSR, with a five-year anticipated vision. The carbon value, which represents the marginal cost of emissions reductions required, increases. The ETS market price would increase and tend towards the carbon value.

Zone 3:

Emissions reductions required to respect the carbon budget are significant. The carbon value becomes very high. The ETS market price would keep increasing, while also being mitigated by external factors (political decisions, complementary policies, etc.).

3. Macro evolutions of the EU ETS in the period post-2020

This chapter of the report aims at assessing possible evolutions of the EU ETS in the period post-2020. A first section of this chapter analyzes propositions to strengthen the EU ETS discussed in the trilogue negotiations, which started on April 4th 2017 between the EU Commission, the EU Parliament and the EU Council. Given the divergence of opinion on a number of elements, there is still uncertainty on the possible outcome of the trilogue negotiations, probably to be reached in autumn 2017.

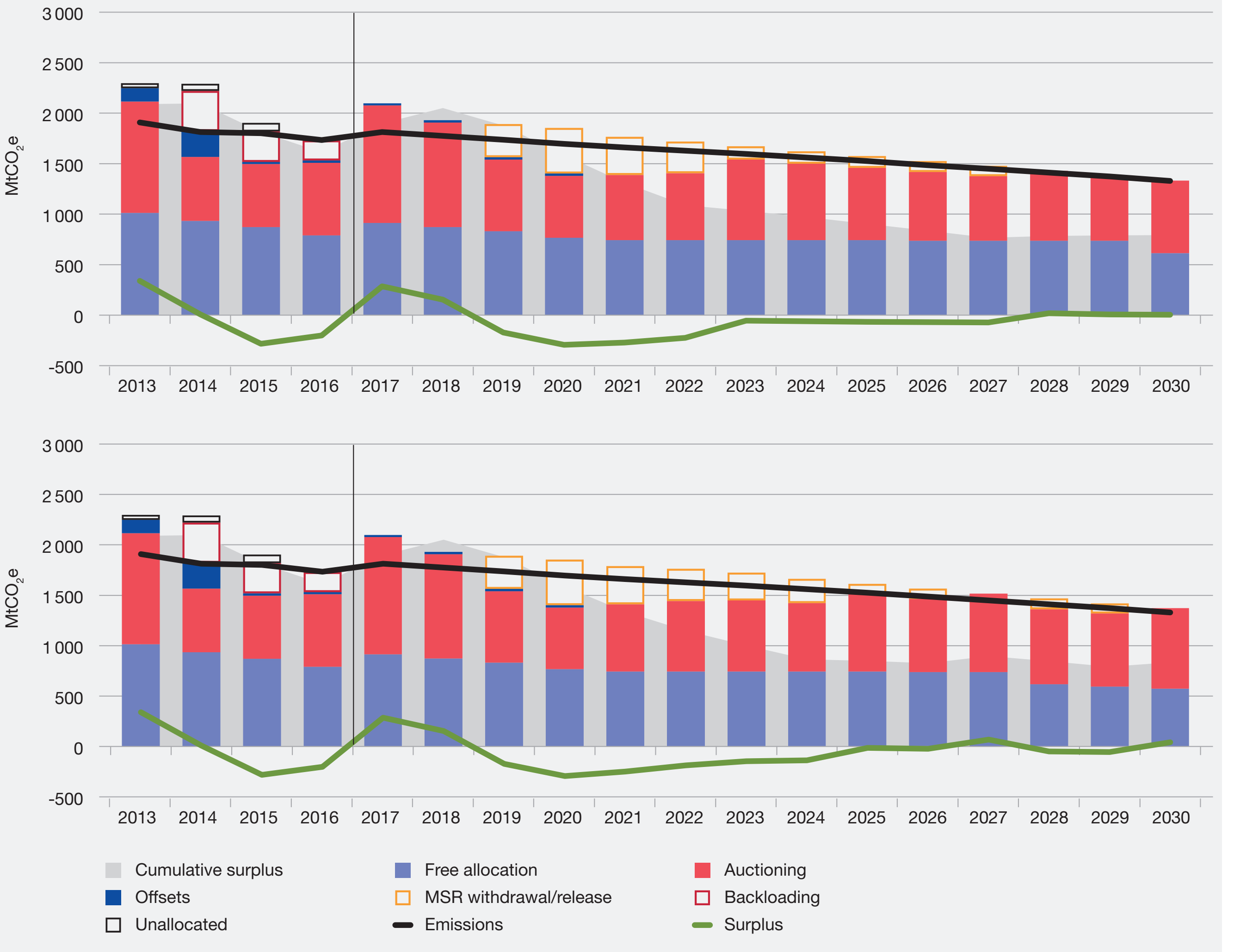
The options under negotiation would not significantly change the EU ETS outlook by 2030 (see **Figure 5**), but the devil is in the details.

A second section assesses prospective scenarios for the period post-2020 to analyze other possible evolutions of the EU ETS: first the implementation of a Price Corridor on the EU ETS, and secondly the exit of the UK from the EU ETS.

In all the scenarios, the implications on GHG emissions reductions, the functioning of the MSR and the costs of necessary abatements are analyzed.

FIGURE 5. SUPPLY-DEMAND BALANCE OF THE EU ETS BY 2030

(On the top: based on the Parliament's amendments; on the bottom: based on the Council's general approach)



Source: I4CE, with data from the European Commission, emissions projections from Enerdata

EU Parliament and EU Council's proposals to strengthen the EU ETS

The MSR will start operating in 2019 as a long-term solution to the significant surplus of allowances accumulated on the EU ETS. Both the Parliament and the Council are in favor of a doubling of its withdrawal rate in the first years of its functioning: until end of 2021 for the Parliament and end of 2023 for the Council. They also agree on the necessity to cancel a number of allowances in the MSR, but disagree on the amount to cancel. Furthermore, the faster reduction of the annual emissions cap in Phase IV compared to Phase III, proposed by the Commission and on which the Parliament and the Council agree, will also contribute to mitigate the market imbalance. (see **Table 1**)

TABLE 1. POSITIONS IN THE TRILOGUE ON OPTIONS TO STRENGTHEN THE EU ETS

	EU Commission's proposal/MSR decision	EU Parliament's amendments	EU Council General Approach
Linear Reduction Factor 2021-2030	2,20%	2,20%	2,20%
Review Linear Reduction Factor	/	Possibility to increase the LRF after 2024 to 2,4%	/
Withdrawal rate of the MSR	12%	24% until 2021 (incl.)	24% until 2023 (incl.)
Cancellation of allowances in the MSR	/	800 million in 2021	Yearly cancellation of allowances after 2024 above the number of allowances auctioned the previous year
Cancellation of allowances by Member States	/	Possibility to cancel a volume of allowances corresponding to the closure of electricity generation capacity in their territory due to national measures	/

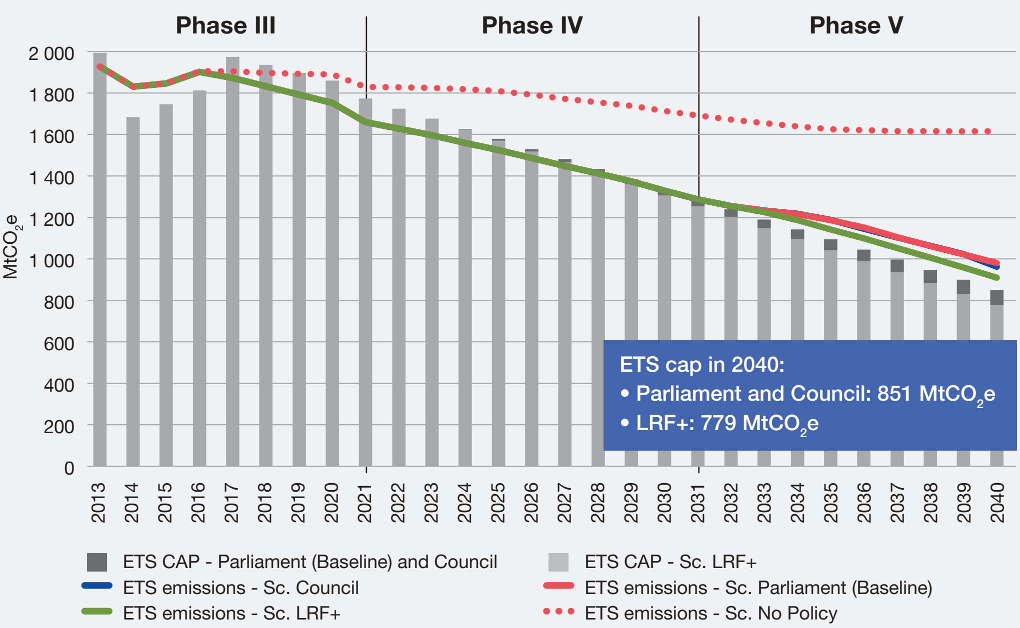
This section is based on the analysis of three scenarios modelled with POLES until 2040:

1. **Parliament (Baseline):** based on the Parliament's amendments for the EU ETS reform
2. **LRF+:** aiming to analyze the impact of an increase of the LRF to 2.4% from 2024 in the Parliament scenario
3. **Council:** representing two major elements of the Council general approach:
    - The doubling of the MSR intake rate until the end of 2023;
    - From 2024, the cancellation of the amount of allowances placed in the MSR exceeding the number of allowances auctioned the previous year.

In spite of the different design parameters proposed, the positions of the Council and the Parliament result in minor differences in EU ETS emissions reductions during its Phase IV

The Parliament, Council and LRF+ scenarios lead to similar emissions reductions during Phase IV (2021-2030). However, they have an impact on EU ETS emissions reductions required to achieve the target after 2030. (see **Figure 6**)

FIGURE 6. THE EU ETS CAP AND GHG EMISSIONS IN THE THREE SCENARIOS



Notes:
- The EU ETS cap represented in the graph does not take into account the effect of the MSR except for the transfer of backloaded allowances.
- No Policy: counter-factual scenario without any objectives for GHG emissions reductions, renewable energy sources and energy efficiency.

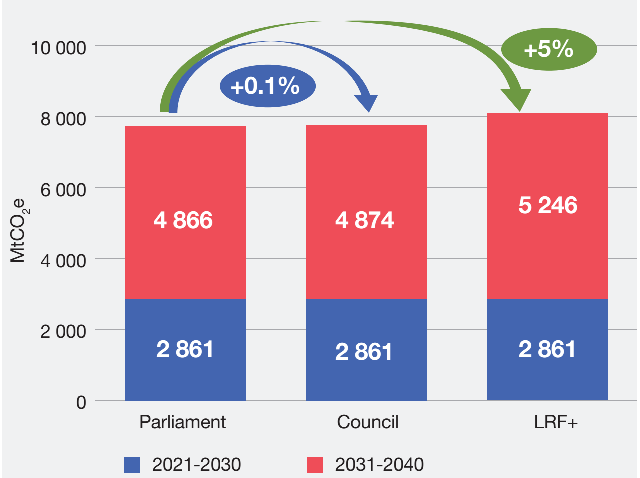
Source: Enerdata, 2017

Compared to the Parliament scenario, the doubling of the MSR withdrawal rate for two additional years and the cancellation of a higher number of allowances in the MSR in the Council scenario has a negligible impact on emissions reductions in Phase V of the EU ETS. In total until 2040, GHG emissions are additionally reduced by a cumulated 8 $MtCO_2e$.

The increase of the LRF to 2.4% in 2024 has a more significant impact on GHG emissions reductions, because the EU ETS cap becomes more constraining. It leads to a cumulated increase in emissions reductions of 379 $MtCO_2e$ compared to the Parliament scenario.

Obviously, compared to a "No-Policy scenario", i.e. without any objectives for GHG emissions reductions, renewable energy sources and energy efficiency, the three scenarios represent significant emissions reductions. In total, in each of the three scenarios, EU ETS emissions are cumulatively reduced by 2,861 $MtCO_2e$ over Phase IV compared to this counterfactual scenario. In Phase V, emissions are additionally reduced by around 5,000 $MtCO_2e$. In total, climate and energy policies save around 8 $GtCO_2e$ over the period 2017-2040. (see **Figure 7**)

FIGURE 7. CUMULATED GHG EMISSIONS REDUCTIONS COMPARED TO A "NO POLICY" SCENARIO LINKED TO CLIMATE AND ENERGY POLICIES

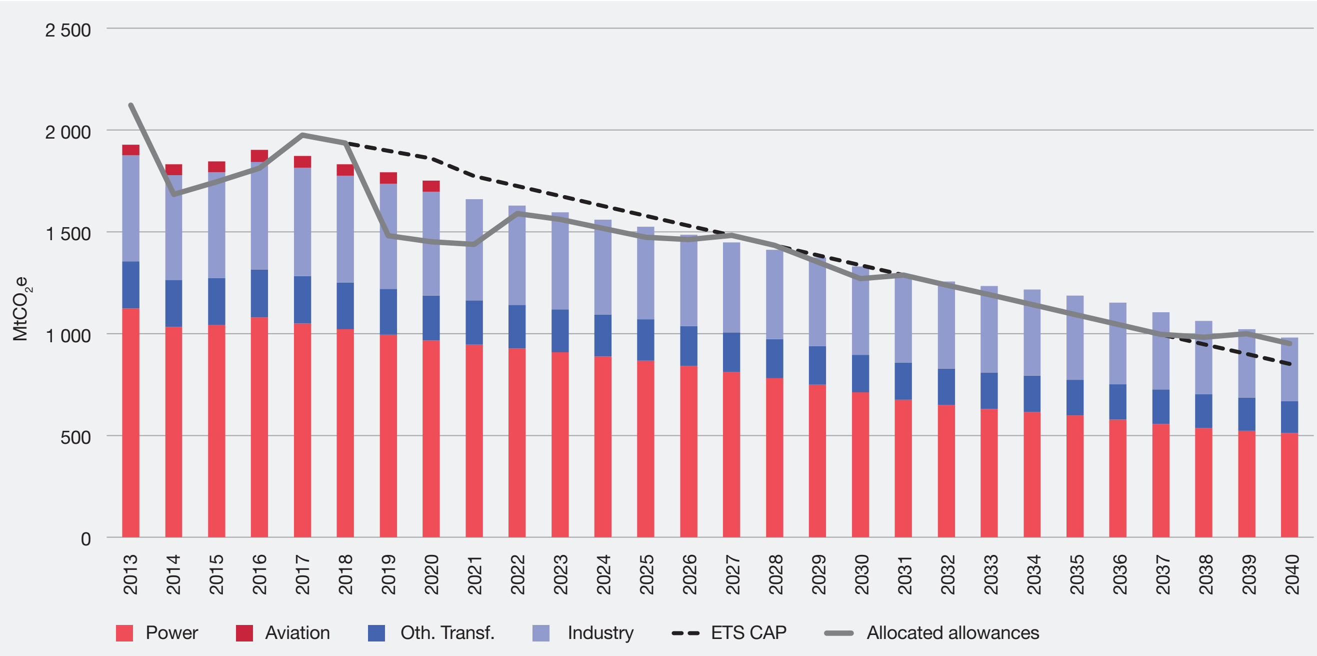


Note:
No Policy: counterfactual scenario without any objectives for GHG emissions reductions, renewable energy sources and energy efficiency.

Source: Enerdata, 2017

3. MACRO EVOLUTIONS OF THE EU ETS IN THE PERIOD POST-2020

FIGURE 8. SECTORIAL EMISSIONS UNDER THE EU ETS IN THE PARLIAMENT SCENARIO

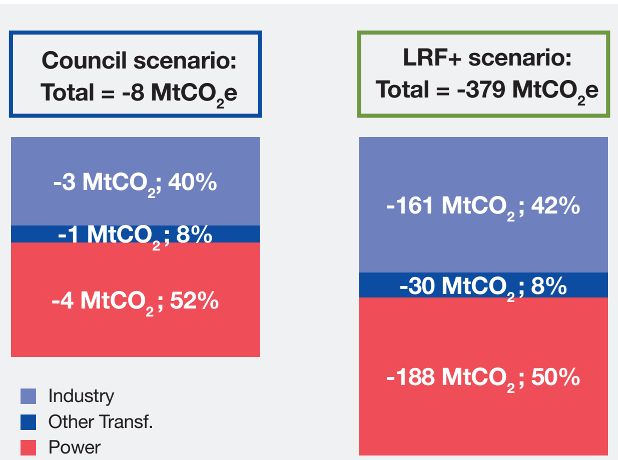


Note: Other transformation includes the refining of mineral oil and the production of coke.

Source: Enerdata, 2017

In the Parliament scenario, more than half of the additional emissions reductions between 2017 and 2040 compared to the "No-Policy scenario" are achieved in the power sector (58%). It corresponds to 4.6 $GtCO_2e$ cumulatively avoided. **Figure 8** shows sectorial emissions covered by the EU ETS in the Parliament scenario.

FIGURE 9. ADDITIONAL CUMULATED EMISSIONS COMPARED TO THE PARLIAMENT SCENARIO OVER 2017-2040 IN THE LRF+ AND THE COUNCIL SCENARIO



Source: Enerdata, 2017

The power sector contributes again to half of the additional abatement effort required in the Council and the LRF+ scenarios compared to the Parliament scenario: respectively 4 $MtCO_2e$ and 188 $MtCO_2e$. (see **Figure 9**)

EU Parliament and Council reform proposals are not sufficient to create an effective ETS in Phase IV (2021-2030)

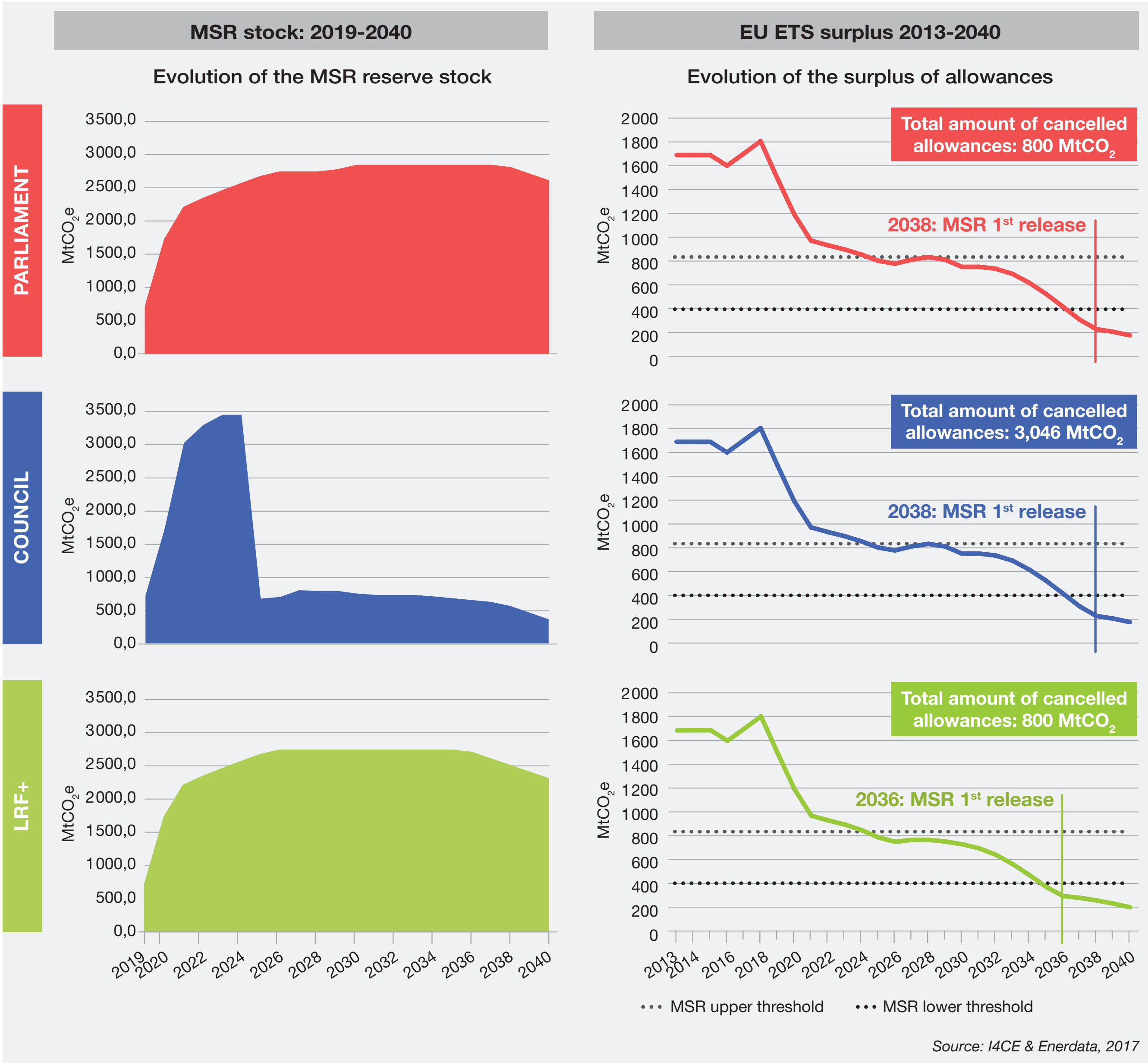
The proposals on the table today to strengthen the EU ETS fail to make it a driver of decarbonisation in energy and industry sectors over its Phase IV

In Phase IV of the EU ETS, **emissions reductions notably driven by renewable energy and energy efficiency targets and policies are sufficient to respect the EU ETS Carbon budget**, under the assumption that specific policies are implemented to meet the 2030 targets for renewable energy and energy efficiency. The carbon budget is defined by the supply of ETS allowances and the amount of allowances in circulation with a five-year vision taking into account the action of the MSR. The EU ETS does not constrain emissions reductions, and the carbon value, representing the cost of emissions reductions required to respect the EU ETS target, is thus equal to zero. (see **Figure 12**)

During Phase IV, the Market Stability Reserve is not sufficient to mitigate effects between the EU ETS and renewable energy and energy efficiency policies

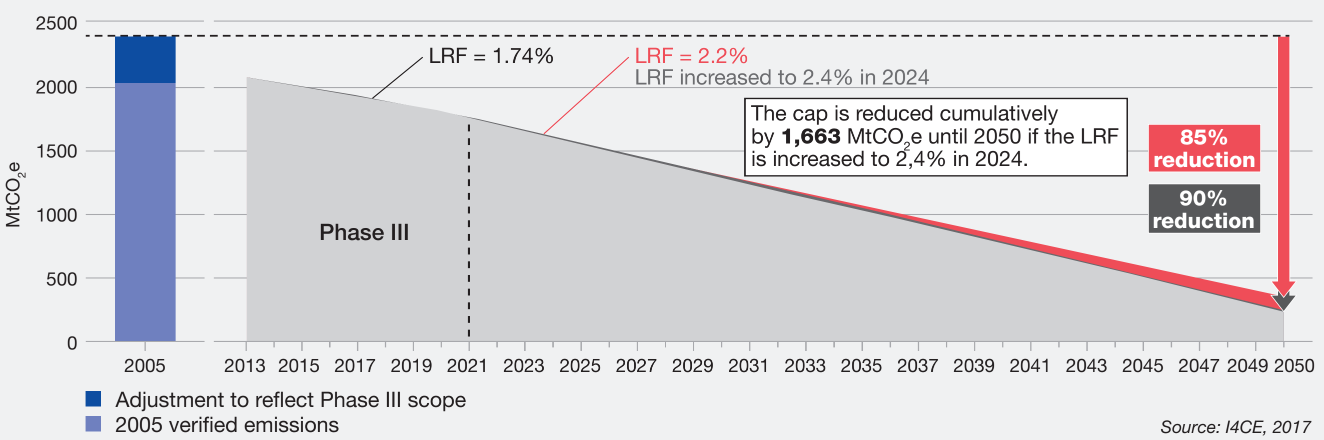
In spite of the doubling of its withdrawal rate in the first years of its functioning (until 2021 for the Parliament and 2023 for the Council), **the MSR is not able to mitigate the overlapping effect of complementary policies on the EU ETS while absorbing the historical surplus of allowances**. The scarcity of allowances is only restored by the end of Phase IV in the three scenarios. (see **Figure 10**) Furthermore, these results on the MSR do not take into account the possible implementation of national climate policies nor unexpected economic downturns or an overachievement of European renewable energy and energy efficiency objectives, which would increase the surplus of allowances. However, the MSR may have a psychological effect on the anticipations of stakeholders, which is not accounted for in the modelling.

FIGURE 10. MSR STOCK AND EU ETS SURPLUS IN THE THREE SCENARIOS



Source: I4CE & Enerdata, 2017

FIGURE 11. THE EU ETS CAP FOR FIXED INSTALLATIONS (2013-2050)



Source: I4CE, 2017

Long-term climate targets need to be anticipated for a sustainable low-carbon transition

EU long-term climate ambition should be increased to integrate the objectives of the Paris Agreement

As currently discussed in the trilogue negotiations, **the EU ETS trajectory is aligned on the low end of long-term EU climate ambition.** Indeed, a LRF of 2.2% from 2021 corresponds to an 85% reduction of GHG emissions in 2050 compared to 2005, while the *Roadmap for moving towards a competitive low carbon economy in 2050* projected an average reduction of 90% for ETS sectors[6]. **Increasing the LRF to 2.4% in 2024 would cumulatively reduce the cap by around 1,660 MtCO$_2$e** until 2050 and would be consistent with a 90% reduction in ETS emissions in 2050 compared to 2005 emissions. (**Figure 11**)

Furthermore, the Roadmap, drafted in 2011, describes a pathway only aligned with an 80% reduction in total GHG emissions in 2050 compared to 1990 levels. **Long-term EU climate objectives and the EU ETS trajectory should now be updated to integrate the objectives of the Paris Agreement, and should aim at "net-zero" emissions by the second half of the century.**

From the early 2030s, further emissions reductions are needed to achieve the EU ETS long-term target

Even if the current trajectory of the EU ETS is aligned on the low end of EU long-term climate ambition, it represents a **drastic decrease in GHG emissions in the long run**. In the early 2030s, further reductions in GHG emissions are needed to respect the EU ETS Carbon budget with a five-year anticipated vision. The cost of abatements required to respect the EU ETS target (taking into account the constraint set by the cap and the surplus on the market) becomes extremely significant in the early 2030s, under the assumption that supports for renewable energy and energy efficiency decrease after 2030. Consequently, from 2033, in both the Parliament and the Council scenarios, the carbon value starts increasing drastically. The increase of the LRF to 2.4% in 2024 brings the need for further abatements one year forward and increases the carbon value until 2040 compared to the Parliament scenario. In the Council scenario, from 2039, the carbon value is higher than in the Parliament scenario. Indeed, the cancellation of a higher number of allowances empties the MSR by 2044, which reduces the carbon budget perceived by market participants with a 5-year anticipated vision from 2039. (**Figure 12**)

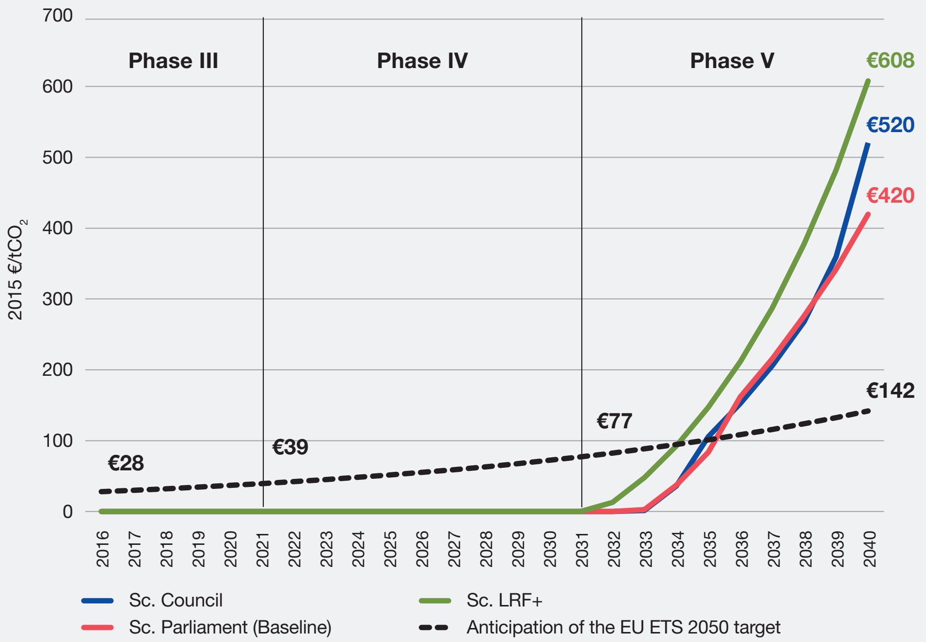
The assumption taken on the decrease of the supports for renewable energy and energy efficiency after 2030 influences these results to a considerable extent. As lower emissions reductions come from renewable energy and energy efficiency policies, the EU ETS has to drive more abatements.

The future scarcity of allowances needs to be anticipated from now

Carbon values do not represent EU ETS market prices, but when carbon values are very high and significant emissions reductions are required in ETS sectors to respect the emissions cap, market prices would also drastically increase. **If the constraint is not anticipated from today, EU ETS market prices would be too low to give the right low-carbon investment signals during Phase IV, and on the contrary would risk becoming socially unacceptable in Phase V, leading policy-makers to**

6 *http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014SC0015&from=EN, notes 55 and 122*

FIGURE 12. EU ETS CARBON VALUE IN THE DIFFERENT SCENARIOS



Notes:

- The carbon value in POLES is **not** the EU ETS market price. It represents the cost of emissions reductions required to respect the constraint set by the EU ETS considering a sliding carbon budget.
- The line « Anticipation of the EU ETS 2050 target » in the graph corresponds to a sensitivity analysis on the carbon budget. In this modelling exercise, stakeholders have a vision of the 2016-2050 carbon budget set by the EU ETS: future emissions reductions needed are perfectly anticipated.

Source: Enerdata, 2017

alleviate the constraint set by the EU ETS, and thus decrease its ambition. However, the accumulated surplus and the achievement of 2020 EU ETS target currently hide this long-term perspective, and there is no visibility on the period beyond 2030.

The modelling of a 2016-2050 carbon budget shows that long-term EU ETS targets are achievable with a sustainable and politically acceptable decarbonisation pathway, if correctly anticipated (Figure 12). In this sensitivity analysis, stakeholders perfectly anticipate emissions reductions required to respect the EU ETS target until 2050 and low-carbon investments are done in a timely manner. Carbon values start at 28€/tCO_2e in 2016 and reach 142€/tCO_2e in 2040: this trajectory enables a progressive decarbonisation of EU power and industrial sectors.

With a proper anticipation of the EU ETS long-term target, the need for further GHG emissions reductions would appear from today and would result in a **sustainable and politically acceptable decarbonisation pathway. Reducing the myopia of EU ETS stakeholders beyond 2030** is necessary for an efficient carbon price to appear from today and make the decarbonisation sustainable. In this context, an **updated 2050 EU roadmap, integrating the objectives of the Paris Agreement,** would be necessary to give more visibility to all. This roadmap would need to be elaborated in a bottom-up way to account for the different sectors' specificities and to facilitate its acceptance.

Attention should be paid to the environmental integrity of the MSR in the long run

With the Parliament proposal, even with an increase of the LRF in 2024, there are still **more than 2 billion allowances in the MSR in 2040**, which could consequently release allowances until the 2060s, jeopardizing the environmental integrity of the EU ETS in the long run.

As an order of magnitude, releasing 100 million allowances in 2050 corresponds to a **27% increase in the EU ETS cap with an LRF of 2.2% from 2021 - and 41% if the LRF increased to 2.4% in 2024**.

With the Council proposal, **more than 3 billion allowances are cancelled in total, and the MSR is empty in 2044**.

TAKEAWAYS

MACRO IMPACTS OF THE EU PARLIAMENT AND THE EU COUNCIL'S PROPOSALS TO STRENGTHEN THE EU ETS

The reform proposals from the EU Parliament and the EU Council are not sufficient to create an effective ETS in Phase IV (2021-2030).

- Indeed, GHG emissions reductions coming notably from energy efficiency and renewable energy policies are sufficient to respect **the EU ETS target, and thus the EU ETS is not a driver of decarbonisation** in industry and energy sectors over its Phase IV.
- In spite of the doubling of its withdrawal rate in the first years of its functioning (until 2021 for the Parliament and 2023 for the Council), **the Market Stability Reserve is not able to mitigate the overlapping effect of complementary policies** on the EU ETS while absorbing the historical surplus of allowances.

Long-term climate targets need to be anticipated for a sustainable low-carbon transition

- The EU ETS current trajectory is aligned with the low end of EU long-term climate ambition. **Long term EU climate objectives and the EU ETS trajectory should now be updated to integrate the objectives of the Paris Agreement**, and should aim at "net-zero" emissions by the second half of the century.
- Still, with the Parliament and Council's proposals, **from the early 2030s, further emissions reductions are needed and the cost of abatements to achieve the EU ETS target increases suddenly**, under the assumption that supports for renewable energy and energy efficiency decrease after 2030.
- With a proper anticipation of the EU ETS 2050 target, the need for further GHG emissions reductions would appear from today and would result in a **sustainable and politically acceptable decarbonisation pathway.**
- Attention should be paid to the **environmental integrity of the MSR in the long run.**

Modelling challenges and sensitive assumptions:

- The assumptions on the support for renewable energy sources and for energy efficiency after 2030
- The visibility of stakeholders on the carbon budget
- The assumption that surplus is available and tradable between ETS operators

A Price Corridor in the EU ETS in the period post-2020

Modelling a Price Corridor scenario

The analysis of the potential outcome of the negotiations on the EU ETS reform concluded that options currently discussed in the trilogue would not make the EU ETS a driver of emissions reductions in its Phase IV, unless its long-term trajectory is anticipated. The implementation of a Price Corridor on the EU ETS could be a solution to the lack of anticipation of ETS operators.

In this scenario, the objective is to lead the EU ETS carbon value into a specific interval (see **Figure 13**) through the implementation of a new reserve on the EU ETS, the Price Corridor Reserve (PCR). Auctions are cancelled until the ETS carbon value reaches the floor and corresponding allowances are transferred to the PCR. Allowances are released from the PCR when the carbon value is higher than the ceiling.

Interestingly, **the interval of values defined for the Price Corridor encompasses the carbon value resulting from the modelling of a 2016-2050 EU ETS Carbon budget perfectly anticipated by operators:** this trajectory enables a progressive decarbonisation of EU power and industrial sectors to achieve long-term EU ETS targets. (see section 1 on the outcome of the negotiations on the EU ETS reform).

The Price Corridor significantly affects the supply of ETS allowances

With the joint action of the MSR and the PCR, all auctions are cancelled in 2020, and only 30% of planned auctions take place in 2021. The surplus of ETS allowances is thus resorbed very quickly, and the MSR starts releasing allowances in 2022, while the PCR keeps on absorbing allowances until 2035.

The carbon value is at the carbon floor until 2035 and then increases to the carbon price ceiling, which is reached in 2037. (see **Figure 15**)

BOX 2. MAIN ASSUMPTIONS IN THE PRICE CORRIDOR SCENARIO

The trajectories of the price floor and the Price Corridor are based on the recommendations of the Canfin-Grandjean-Mestrallet mission report (2016)

- The price floor starts at 25€ in 2020.
- The price ceiling starts at 50 € in 2020.
- Both increase by 7% annually.

Canfin-Grandjean-Mestrallet mission report analyzes three possible way of implementing a Price Corridor:

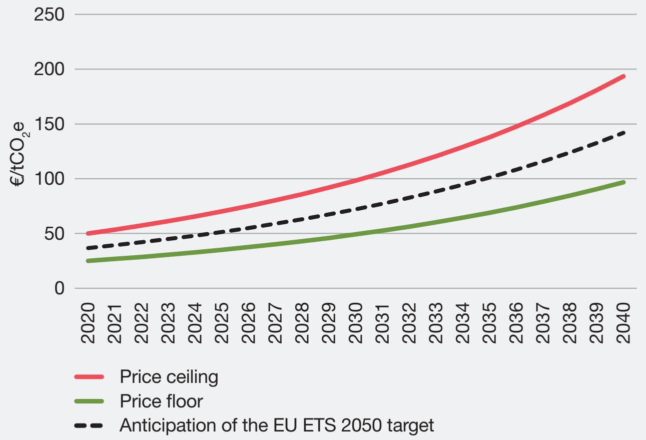
- **Option 1**: Adjustment of the supply of allowances with an auctioning reserve price (with a new reserve or by keeping allowances on the Union registry).
- **Option 2**: Establishment of an independent authority to manage the supply of allowances on the market, in the same way as central banks on money markets or public stocks on agricultural markets.
- **Option 3**: The modification of MSR parameters to adjust the supply of allowances depending on the price.

The scenario presented in this study is the option 1. It does **not** model a price-based MSR (option 3).

The MSR and the PCR work independently from each other.

While the carbon value is calculated over a 5-year budget, the PCR has a yearly functioning. It releases allowances in the year in which they would be needed, and not with an anticipation of 5 years.

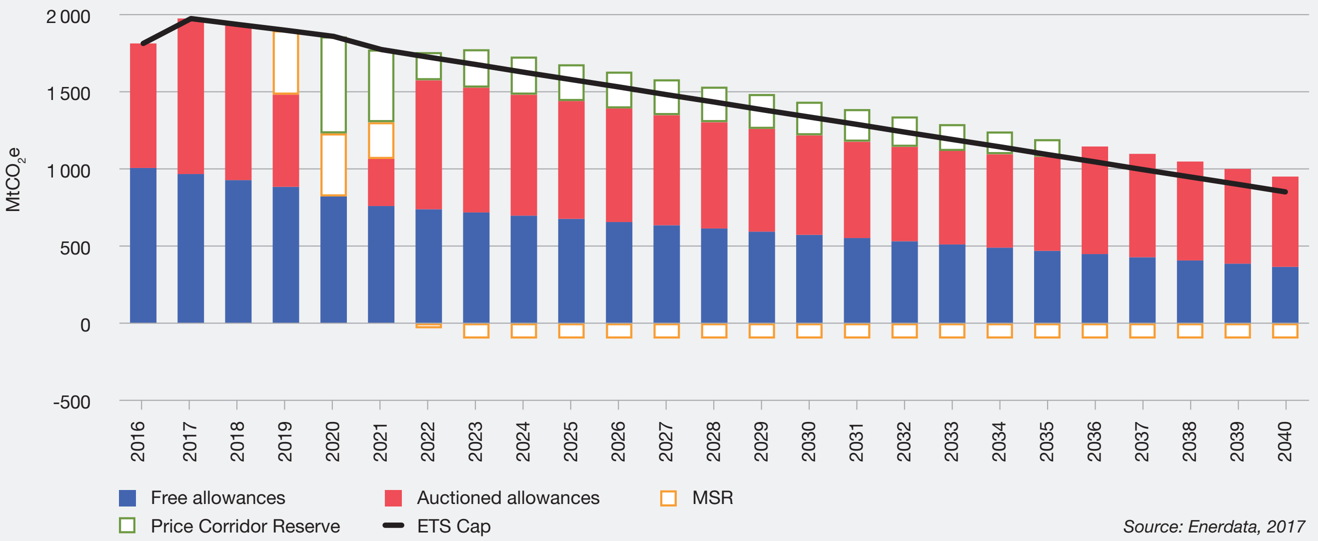
FIGURE 13. TRAJECTORY OF EU ETS CORRIDOR PRICE



Note:
The line « Anticipation of the 2050 EU ETS target » in the graph corresponds to the carbon value calculated by POLES – i.e the cost of emissions reductions required to respect the constraint set by the EU ETS – corresponding to a case when stakeholders have a vision of the 2016-2050 carbon budget set by the EU ETS: future emissions reductions needed are perfectly anticipated. (see section 1 on the outcome of the negotiations on the EU ETS reform).

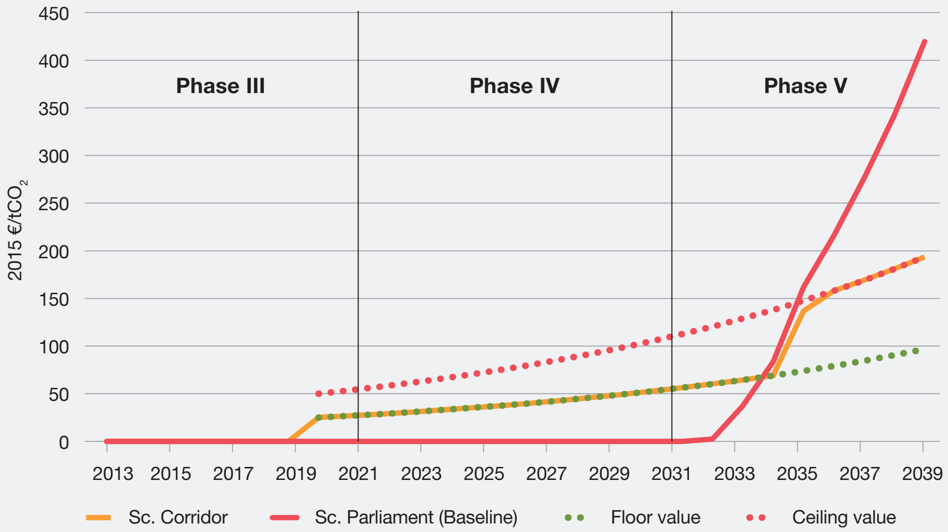
Source: I4CE and Enerdata, from Canfin P., Grandjean A., Mestrallet G. (2016)

FIGURE 14. EU ETS SUPPLY IN THE PRICE CORRIDOR SCENARIO



Source: Enerdata, 2017

FIGURE 15. CARBON VALUE IN THE PRICE CORRIDOR SCENARIO

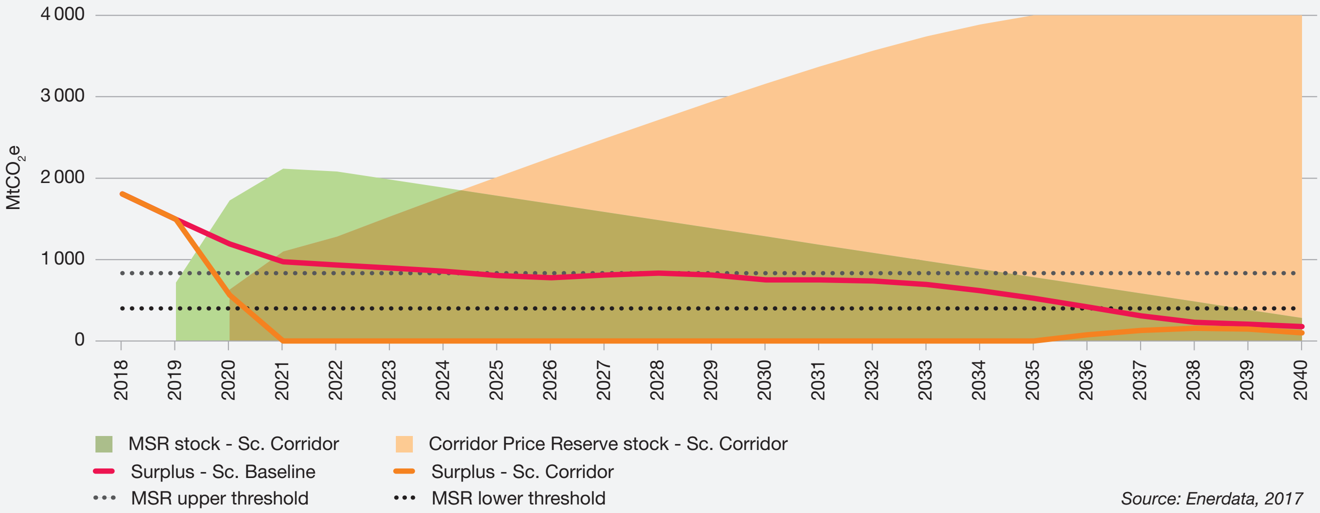


Note:
The carbon value in POLES is **not** the EU ETS market price. It represents the cost of emissions reductions required to respect the constraint set by the EU ETS considering a sliding carbon budget.

Source: Enerdata, 2017

The volume of the PCR reaches 4 billion allowances by 2035, and by 2040, it has not started yet to release allowances (which would happen in early 2040s). On the contrary, in the MSR, which started releasing allowances in 2022, there are only around 280 million allowances in 2040. (see **Figure 16**)

FIGURE 16. VOLUME OF THE MSR AND THE PCR

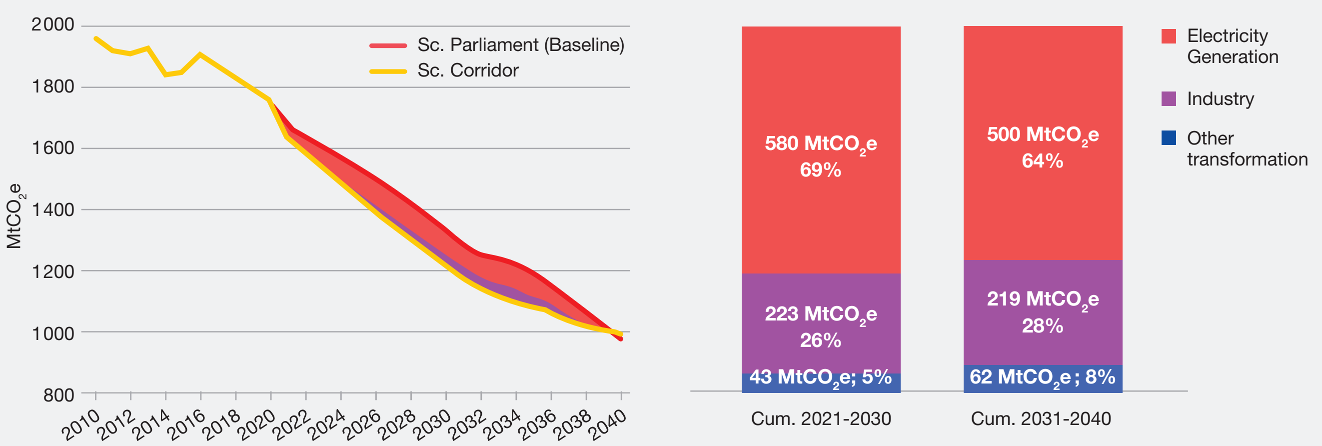


Source: Enerdata, 2017

The Price Corridor leads to earlier mitigation actions mostly in the power sector

The implementation of a Price Corridor leads to earlier mitigation actions in EU ETS sectors and reduces cumulatively emissions by 846 $MtCO_2e$ in Phase IV and by 781 $MtCO_2e$ in Phase V, compared to the Parliament scenario. More than half of these additional emissions reductions are achieved in the power sector. (**Figure 17**)

FIGURE 17. SECTORIAL EMISSIONS REDUCTIONS IN THE PRICE CORRIDOR SCENARIO COMPARED TO THE PARLIAMENT (BASELINE) SCENARIO



Note:
Other transformation includes the refining of mineral oil and the production of coke.

TAKEAWAYS

IMPACTS OF A PRICE CORRIDOR ON THE EU ETS

In this scenario, a Price Corridor is implemented through an additional reserve on the EU ETS

- The implementation of a Price Corridor on the EU ETS is one of the possible solutions to the lack of anticipation of ETS operators.
- In this scenario, the objective is to lead the EU ETS carbon value into a specific interval through the implementation of a new reserve on the EU ETS, the Price Corridor Reserve (PCR).

The implementation of a Price Corridor leads to earlier mitigation efforts in EU ETS sectors

- The implementation of a Price Corridor leads to **earlier mitigation efforts in EU ETS sectors until 2040 (over 1.6 billion in total)**, and more than half of additional emissions reductions compared to the Parliament scenario are achieved in the power sector.
- A significant number of allowances are transferred in the dedicated reserve and **the surplus of allowances is thus very quickly absorbed.**

In the same way as with the MSR, allowances stored in the PCR will have to be managed carefully, in order to ensure long-term climate targets are met.

Modelling challenges and sensitive assumptions

- The articulation of the Price Corridor Reserve with the Market Stability Reserve.

The Brexit: adding uncertainty to the current EU ETS situation

Modelling a Brexit EU ETS scenario

The possible exit of the UK from the EU ETS raises many questions, which cannot be answered through modelling. It is not known yet whether the UK is actually exiting the EU ETS, and a fortiori it is not known when this transition would take place and how the EU ETS design parameters- such as the emissions cap or the MSR withdrawal and release rates and thresholds- would be adjusted. The behavior of markets participants which hold allowances in the UK is also an unknown, as well as the amount of allowances that may come back suddenly to the market. Finally, without the UK voice, the balance in energy and climate negotiations will probably be modified.

To design a Brexit scenario, some assumptions had to be made. In this scenario, the UK is considered to be no longer part of the EU ETS from the beginning of Phase IV and the ambition in the EU ETS is assumed to remain similar as with the current emissions reduction targets. The EU ETS emissions cap is adapted consequently. (see **Figure 18**)

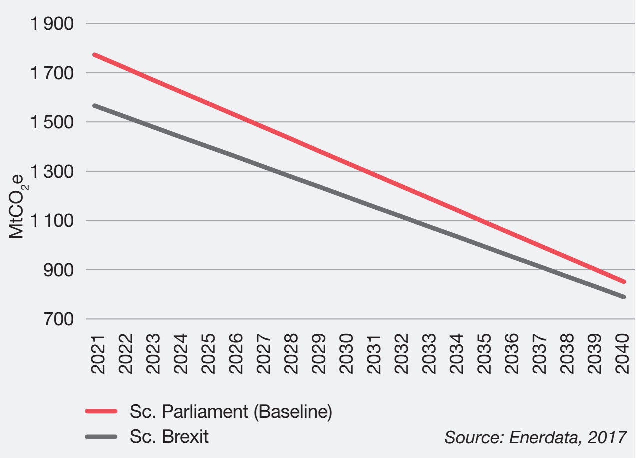
BOX 3. MAIN ASSUMPTIONS IN THE BREXIT SCENARIO

Except for the EU ETS cap, all modelling parameters are kept constant in the Brexit scenario compared to the Parliament (Baseline) scenario, such as the MSR functioning parameters, and targets for renewable energy and energy efficiency.

The ambition in the EU ETS is assumed to remain similar as with the current emissions reduction targets:

- The targets for emissions reductions are assumed to be kept for the rest of the EU ETS.
- The 2020 cap for the EU ETS corresponds to a 23,6% reduction compared to 2005 levels (taking into account the EU ETS scope in Phase III).
- The 2030 target reduction – 43% compared to 2005 levels – is applied to the rest of the EU ETS.
- Both values give the amount by which the cap is annually reduced for the EU ETS without the UK.

FIGURE 18. EU ETS EMISSIONS CAP IN THE BREXIT SCENARIO

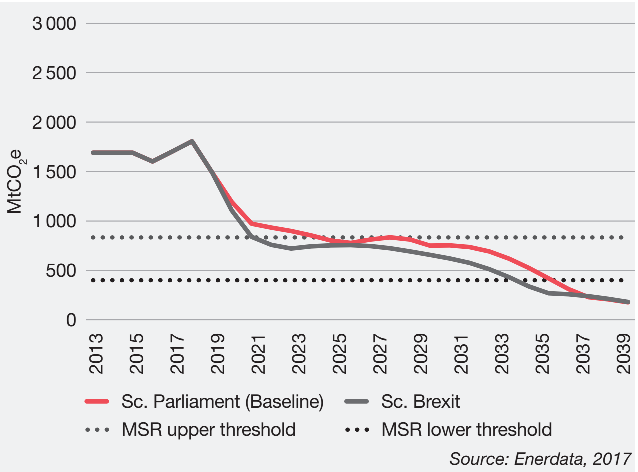


Source: Enerdata, 2017

The Brexit strongly impacts the functioning of the MSR

The new EU ETS cap, as defined in the Brexit scenario, corresponds to higher mitigation efforts for the rest of the EU ETS in the period post-2020. Indeed, GHG emissions covered by the EU ETS in the UK have decreased more than the average of the EU ETS[7]. The surplus is thus resorbed faster, and in 2022, the higher threshold of the MSR is reached, three years sooner than in the Parliament scenario. (see **Figure 19**)

FIGURE 19. EVOLUTION OF THE EU ETS SURPLUS IN THE BREXIT SCENARIO



Source: Enerdata, 2017

7 *The decrease of EU ETS emissions in the UK has been particularly sharp since 2013 in the power sector, which represents around 70% of EU ETS emissions in the UK. This decrease is probably due, at least partly, to the implementation of a carbon price floor in the power sector in 2013.*

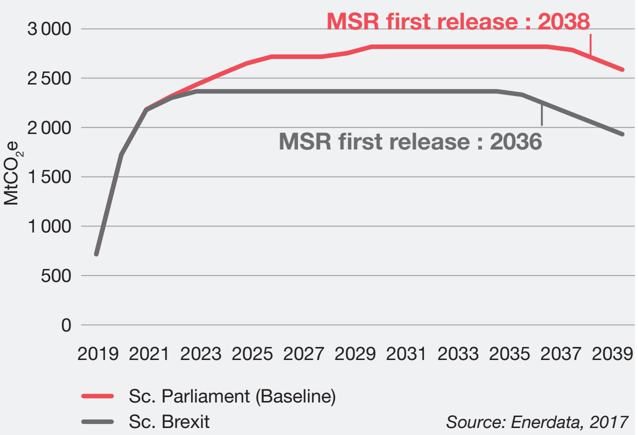
The lower threshold of the MSR is reached in 2035, and it starts releasing allowances in 2036, two years sooner than in the Parliament scenario. (see **Figure 20**)

It is assumed that in spite of the Brexit, targets for renewable energy and for energy efficiency are not modified. Consequently, they have the same effect on the demand for allowances as in the Parliament scenario, used as a Baseline. In Phase IV of the EU ETS, emissions reductions notably driven by these policies are sufficient to respect the EU ETS Carbon budget, defined by the supply of ETS allowances and the amount of allowances in circulation, taking into account the action of the MSR. The EU ETS does not constrain emissions reductions, and the carbon value, representing the cost of emissions reductions required to respect the EU ETS target, is thus equal to zero. (see **Figure 21**)

Further emissions reductions to respect the EU ETS target are required at the same time as in the Parliament scenario, in 2033. In the couple of years before the MSR starts releasing allowances, the constraint set by the EU ETS is slightly higher in the Brexit scenario, and the resulting carbon value is higher. However, as the MSR starts releasing allowances sooner in the Brexit scenario, and as the increase of the EU ETS supply by 100 $MtCO_2e$ has a more significant effect in a smaller market, the constraint set by the EU ETS becomes less stringent than in the Parliament scenario from 2036. From this date, mitigation efforts required to respect the constraint set by the EU ETS become lower in the Brexit scenario.

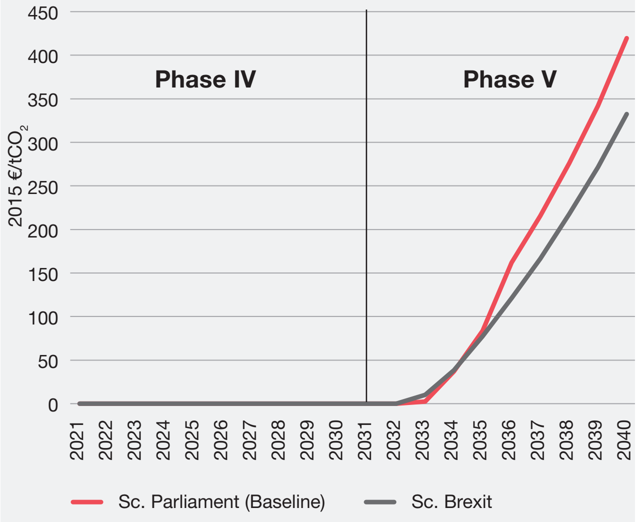
As a consequence of the earlier release of allowances from the MSR and of a lower carbon value than in the Parliament scenario from the mid-2030s, resulting emissions under the EU ETS are higher in the Brexit scenario (**Figure 22**). In total, around 93 $MtCO_2e$ are additionally emitted until 2040.

FIGURE 20. EVOLUTION OF THE VOLUME OF THE MSR IN THE BREXIT SCENARIO



Source: Enerdata, 2017

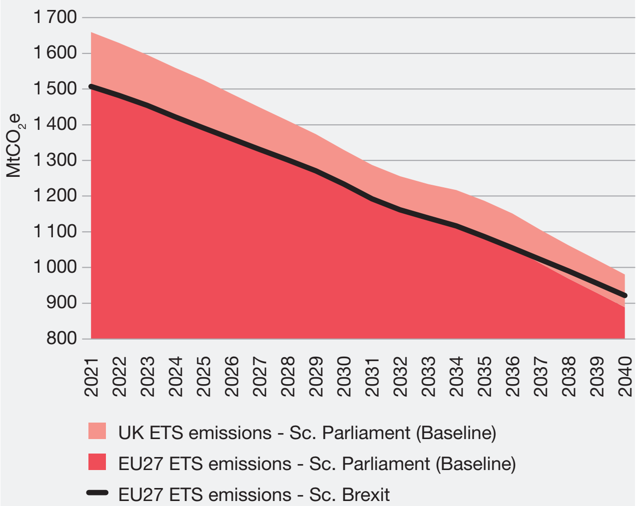
FIGURE 21. EU ETS CARBON VALUES IN THE BREXIT SCENARIO



Note: The carbon value in POLES is **not** the EU ETS market price. It represents the cost of emissions reductions required to respect the constraint set by the EU ETS considering a sliding carbon budget.

Source: Enerdata, 2017

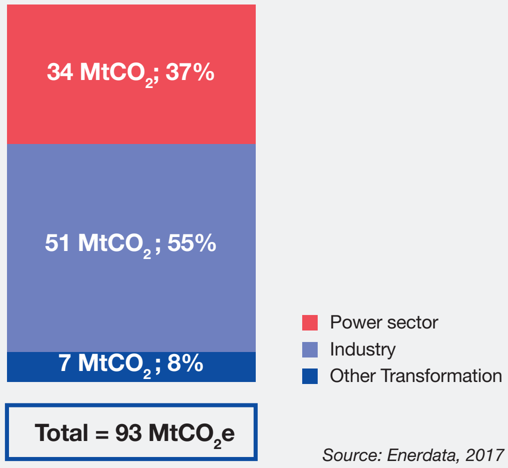
FIGURE 22. EMISSIONS UNDER THE EU ETS IN THE BREXIT SCENARIO



Source: Enerdata, 2017

More than half of additional GHG emissions in the Brexit scenario comes from in the industry and 37% comes from the power sector. (see **Figure 23**)

FIGURE 23. CUMULATED ADDITIONAL EMISSIONS IN THE BREXIT SCENARIO COMPARED TO THE PARLIAMENT SCENARIO (2017-2040)



Source: Enerdata, 2017

TAKEAWAYS

IMPACTS OF A BREXIT ON THE EU ETS

The Brexit adds to the uncertainty of the current revision of the EU ETS directive

- It is not known yet whether the UK is actually exiting the EU ETS, and a fortiori it is not known when this transition would take place and how the EU ETS design parameters would be adjusted.

In case the UK leaves the EU ETS, careful attention should be paid to the adaptation of the emissions cap and the MSR parameters (thresholds, withdrawal and release rates)

- To design a Brexit scenario, some assumptions had to be made. In this scenario, the **UK is considered to be no longer part of the EU ETS from the beginning of Phase IV and the ambition in the EU ETS is assumed to remain similar as with the current emissions reduction targets.** The EU ETS emissions cap is adapted consequently.
- This new EU ETS emissions cap defined in the Brexit scenario corresponds to **higher mitigation efforts for the rest of the EU ETS in the period post-2020.**
- As a consequence, **the Brexit impacts the decrease of the surplus and the MSR functioning**, which starts releasing allowances sooner than in the Parliament scenario.
- Resulting ETS emissions in the Brexit scenario are **4% higher** than in the Baseline scenario **in 2040**.

The results of the Brexit scenario **cannot be dissociated from the assumptions made for the adjustment of the EU ETS parameters.**

Modelling challenges and sensitive assumptions

- The definition of new EU ETS design parameters: in particular the emissions cap and the MSR thresholds and withdrawal rate.

4. Impacts of EU Parliament and Council's reform proposals on the framework for free allocation to industry

Options to reform the EU ETS currently discussed in trilogue negotiations are not likely to lead to a stringent EU ETS in Phase IV, and the emergence of a price signal will be conditioned on the anticipation of long-term perspectives. However, **the issue of carbon leakage and the competitiveness of EU industries is a major concern to decision-makers and is calling particular attention in the debates.** The current approach of freely allocating allowances to industrial sectors deemed to be exposed to carbon leakage will go on. Besides, along with the EU ETS emissions cap, the free allocation cap will decrease. In this context, industries are worried that a cross-sectoral correction factor (CSCF) might need to be triggered, to adjust the total free allocation to the free allocation cap. Such a factor would reduce uniformly free allocation in all sectors, a concern for those most exposed to carbon leakage. **A number of parameters discussed in the trilogue negotiations influence either the free allocation cap or the calculation of the bottom-up preliminary free allocation and thus determine whether a CSCF will be necessary.** Post-2020 EU ETS reform proposals from the EU Commission, the Parliament and the Council differ on a number of parameters which impact free allocation. (see **Table 2**)[8]

8 I4CE has built an online simulation tool to estimate free allocation in Phase IV depending on parameters discussed in the trilogue negotiations: https://www.i4ce.org/go_project/free-allocation-for-industries-in-phase-iv-of-the-ets-i4ces-simulation-tool/

TABLE 2. OPTIONS ON FREE ALLOCATION DISCUSSED IN THE TRILOGUE NEGOTIATIONS

	Parameters	EU Commission's proposal	EU Parliament's amendments	EU Council General Approach
Supply of free allowances	**Linear Reduction Factor (LRF) 2021-2030**	2.20%	2.20% and possibility to increase the LRF after 2024 to 2.4%	2.20%
	Funds fed with allowances from the FA share	400 million for the Innovation Fund	400 million for the New Entrants Reserve + 1% of allowances for a fund to compensate for indirect costs	400 million for the Innovation Fund
	Increase of FA share to avoid triggering CSCF	No adjustment	Reduction of up to 5 percentage points of the share of allowances to be auctioned by Member States over 2021-2030	Reduction of up to 2 percentage points of the share of allowances to be auctioned by Member States over 2021-2030
Demand for free allowances	**Proportion of benchmarked-based allocation freely allocated**	100% for sectors on CL list; 30% for sectors not on CL list	100% for sectors on CL list; 30% for district heating; 0% for others	100% for sectors on CL list; 30% for sectors not on CL list
	Annual benchmarks decrease rate (upper/lower limits)	1%/year (1.50%/0.5%)	Based on actual improvement rates (1.75%/0.25%)	Based on actual improvement rates (1.5%/0.2%)
	Free allocation for electricity generation with waste gas	/	Full carbon content of waste gas used for electricity production taken into account in benchmark calculations	/
	Eligibility to CL list (limit for qualitative assessment)	Intensity of trade* emissions intensity > 0.2 (0.18)	Intensity of trade* emissions intensity > 0.2 (0.12)	Intensity of trade* emissions intensity > 0.2 (0.16)
Other	**Application of CSCF**	To every sector	Only to sectors with an intensity of trade with third countries below 15% or a carbon intensity below 7Kg CO_2/Euro of GVA.	To every sector
	Implementation of a border carbon adjustment	/	If needed, this option will be assessed after the first review of the EU ETS	/

FA = free allocation; CL = carbon leakage; CSCF = cross-sectoral correction factor; GVA = gross value added

TABLE 3. PARAMETERS IN THE MAIN SCENARIOS ASSESSED WITH I4CE EU ETS TOOL

Parameters	Parliament scenario	Council scenario
LRF	**2.2%/year**	2.2%/year
Adjustment of free allocation share to avoid triggering CSCF	+ 5%	+ 2%
Proportion of benchmarked-based allocation freely allocated	100% for sectors on CL list; 30% for district heating; 0% for others	100% for sectors on CL list; 30% for sectors not on CL list
Application of CSCF	**Only to sectors with an intensity of trade with third countries below 15% or a carbon intensity below 7Kg CO_2/Euro GVA**	To every sector
Funds with allowances from FA share	1% of allowances for the fund to compensate indirect costs and 400 million allowances for NER	400 million allowances for Innovation Fund
Free allocation to waste gas used for electricity production	Yes	No
Eligibility to CL list	**0.2**	**0.2**
Growth rates	**Differentiated by sectors, please refer to the annexes for more details**	
Benchmark decrease rates	**Differentiated by sectors: the lowest possible rate has been used (0.25%) for major sectors covered by the EU ETS (refinery, cement, aluminum, steel) Please refer to the annexes for more details**	**Differentiated by sectors: the lowest possible rate has been used (0.20%) for major sectors covered by the EU ETS (refinery, cement, aluminum, steel) Please refer to the annexes for more details**

FA = free allocation; CL = carbon leakage; CSCF = cross-sectoral correction factor; GVA = gross value added

Sensitivity analyses have been run on parameters in bold. Please refer to the annexes for more details on the assumptions.

This chapter is based on the analysis of options discussed for free allocation in the trilogue of the EU ETS reform, carried out with I4CE EU ETS tool and based on IFPEN projections for the refining sector. The analysis considers two main scenarios as well as sensitivity analyses on some parameters. (see Table 3)

This section also looks into the issue of the compensation of indirect costs in the EU ETS and presents an estimation of the amount of allowances which would be required to compensate indirect costs in the major eligible sectors at the EU level.

Estimation of free allocation according to EU ETS design parameters discussed in the trilogue

Preliminary allocation to industrial sectors is calculated in a bottom-up way, at the level of each installation covered by the EU ETS. Phase IV will be divided in two sub-periods for the calculation of free allocation (2021-2025 and 2026-2030) and preliminary free allocation will be calculated as the product of activity levels in the relevant years for each sub-period (2013-2017 for the first sub-period and 2018-2022 for the second sub-period) multiplied by the applicable benchmarks. Benchmark values are reference values of carbon intensity (either by product, or for heat production or fuel consumption), and correspond to the average carbon intensity of the 10% most efficient installations under the EU ETS. Benchmark values were established based on 2007-2008 data and will be decreased by an annual rate in Phase IV. While the Commission proposed to decrease benchmark values by an annual default rate of 1%, with the possibility to decrease or increase it by up to 0.5% in relevant sectors, both the Parliament and the Council are in favor of using actual improvement rates in carbon intensity – within a range of possible values. (see Table 2 for more details on the respective positions on free allocation)

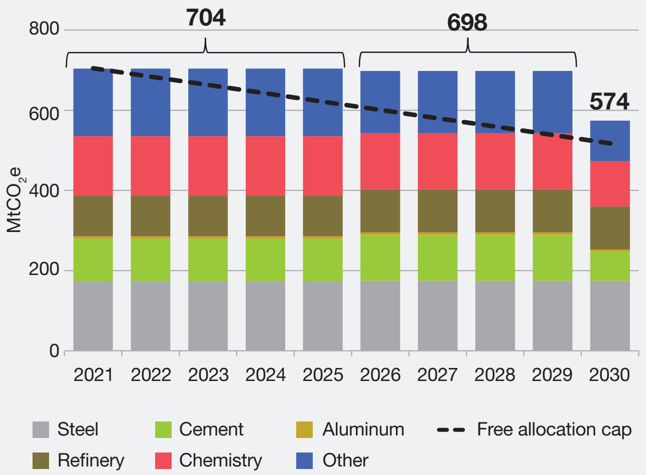
The CSCF is triggered in 2030 in the Parliament scenario

Using the parameters of the Parliament amendments on free allocation, total preliminary allocation is estimated at **704 MtCO$_2$e** in the first sub-period, and **698 MtCO$_2$e** in the second period. The possibility to increase the free allocation share by 5 percentage points as proposed in the Parliament's amendments corresponds to **775 million additional allowances to be possibly given for free**. This amount is used in totality between **2022 and 2030** to prevent triggering the CSCF.

In 2030, a CSCF of **64.2%** is triggered for all sectors which meet the applicability criterion and thus have an intensity of trade with third countries below 15% or a carbon intensity below 7kg CO$_2$/€ (see Annexes for details on the data sources). It means that preliminary allocation is reduced uniformly by 64.2% for all the installations in 2030, except for installations in the following sectors (identified by their NACE codes) (see **Figure 24**):

- **19.10** Manufacture of coke oven products;
- **19.20** Manufacture of refined petroleum products;
- **20.15** Manufacture of fertilizers and nitrogen compounds;
- **24.10** Manufacture of basic iron and steel and of ferro-alloys.

FIGURE 24. PHASE IV FINAL FREE ALLOCATION BY SECTOR IN THE PARLIAMENT SCENARIO



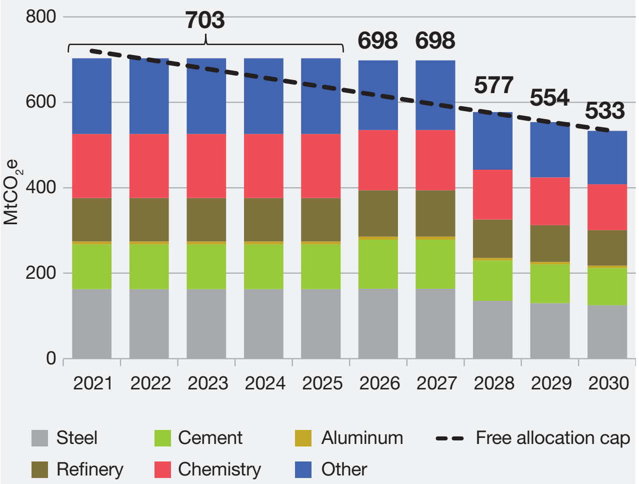
Source: I4CE, 2017

The CSCF is triggered from 2028 in the Council scenario

Using the parameters of the Council general approach on free allocation, total preliminary allocation is estimated at **703 MtCO$_2$e** in the first sub-period, and **698 MtCO$_2$e** in the second period. The possibility to increase the free allocation share by 2 percentage points as proposed in the Council's general approach corresponds to **310 million additional allowances to be possibly given for free.** This amount is used in totality between **2023 and 2028** to prevent triggering the CSCF. (see **Figure 25**)

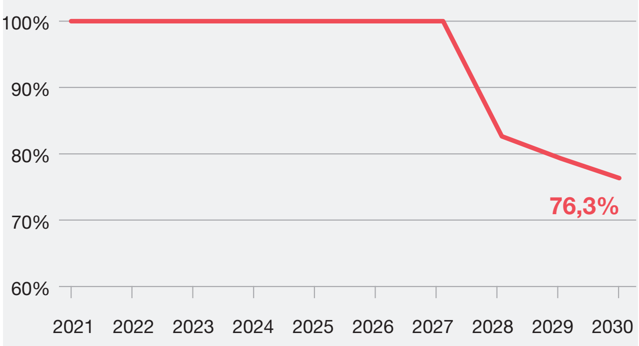
The CSCF is triggered from 2028 and is equal to 76.3% in 2030, reducing uniformly free allocation in all sectors. (see **Figure 26**)

FIGURE 25. PHASE IV FINAL FREE ALLOCATION BY SECTOR IN THE COUNCIL SCENARIO



Source: I4CE, 2017

FIGURE 26. ANNUAL CSCF IN PHASE IV IN THE COUNCIL SCENARIO



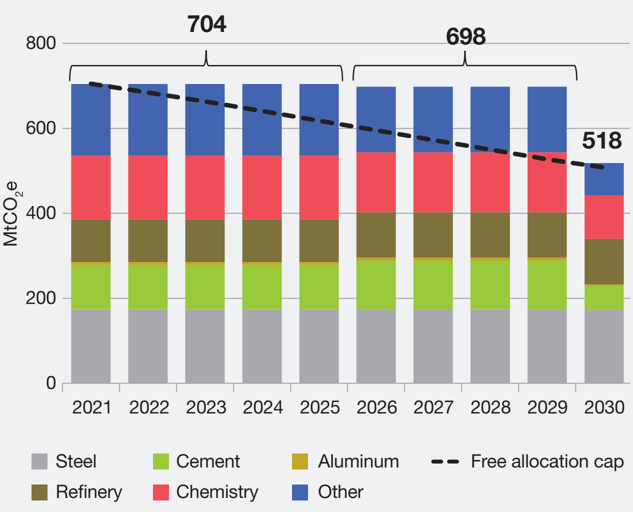
Source: I4CE, 2017

An increase of the LRF in 2024 in the Parliament scenario does not significantly impact free allocation

With an increase of the LRF to 2.4% in 2024, the possible increase of the free allocation share by 5 percentage points corresponds to 769 million EUAs. The additional allowances are used in totality between 2022 and 2030. In 2030, a CSCF of **48.1%** is triggered for all sectors which meet the applicability criterion (an intensity of trade with third countries below 15% or a carbon intensity below 7kg CO_2/€). It means that preliminary allocation is reduced uniformly by **48.1%** for all the installations in 2030, except for installations in the following sectors (identified by their NACE codes) (see **Figure 27**):

- **19.10** Manufacture of coke oven products;
- **19.20** Manufacture of refined petroleum products;
- **20.15** Manufacture of fertilizers and nitrogen compounds;
- **24.10** Manufacture of basic iron and steel and of ferro-alloys.

FIGURE 27. PHASE IV FINAL FREE ALLOCATION BY SECTOR IN THE PARLIAMENT SCENARIO WITH AN INCREASE OF THE LRF TO 2.4%



Source: I4CE, 2017

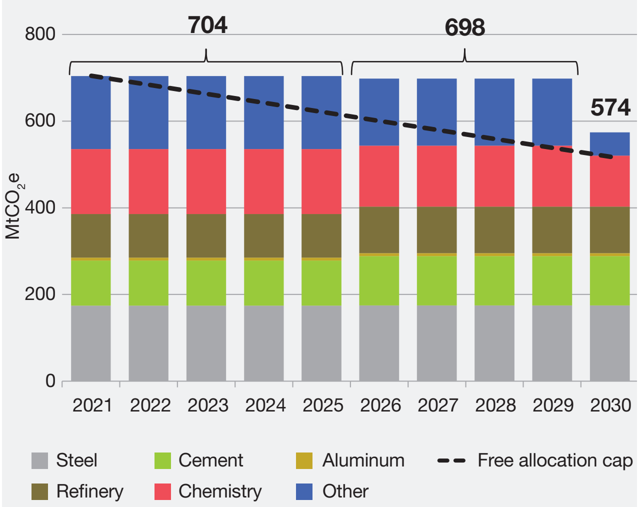
A different CSCF application criterion in the Parliament scenario modifies the list of sectors for which free allocation in reduced in 2030

In this sensitivity analysis to the Parliament scenario, the CSCF applies only to sectors for which the product of trade intensity times the carbon intensity is inferior to 1.6. It applies to all sectors but nine, including steel, refinery, cement and aluminum. Those nine sectors represent more than 70% of 2015 industrial emissions under the EU ETS.

The CSCF is triggered in **2030** and is equal to **32.1%**, reducing free allocation in sectors concerned. (see **Figure 28**)

FIGURE 28. PHASE IV FINAL FREE ALLOCATION BY SECTOR IN THE PARLIAMENT SCENARIO WITH A DIFFERENT CSCF APPLICATION CRITERION

The CSCF applies only to sectors for which the product of trade intensity times the carbon intensity is inferior to 1.6



Source: I4CE, 2017

Quantification of the impact of different parameters on free allocation

Assumptions on future growth rates and benchmark decrease rates balance each other out

For the estimation of future preliminary free allocation, it is necessary to make projections on future growth rates in the different industrial sectors, as well as on future improvements in carbon intensity, on which will be based the annual benchmark decrease rates.

Figure 29 illustrates the opposite effects of the assumptions on future growth rates and benchmark decrease rates and shows the maximum average annual activity growth rate for which no CSCF is needed, as a function of the average benchmark annual decrease rate.

The different EU ETS design parameters discussed in the trilogue impact the supply and the demand for free allowances

The Council's and the Parliament's preferred EU ETS design parameters result in a similar demand for free allowances

The demand for free allowances is more or less similar in the Parliament and Council scenarios. Indeed, on the one side, the Parliament is in favor of taking into account the full carbon content of waste gas used for electricity production in benchmark calculations, which according to our estimations increases preliminary allocation by 128 $MtCO_2e$ over Phase IV.

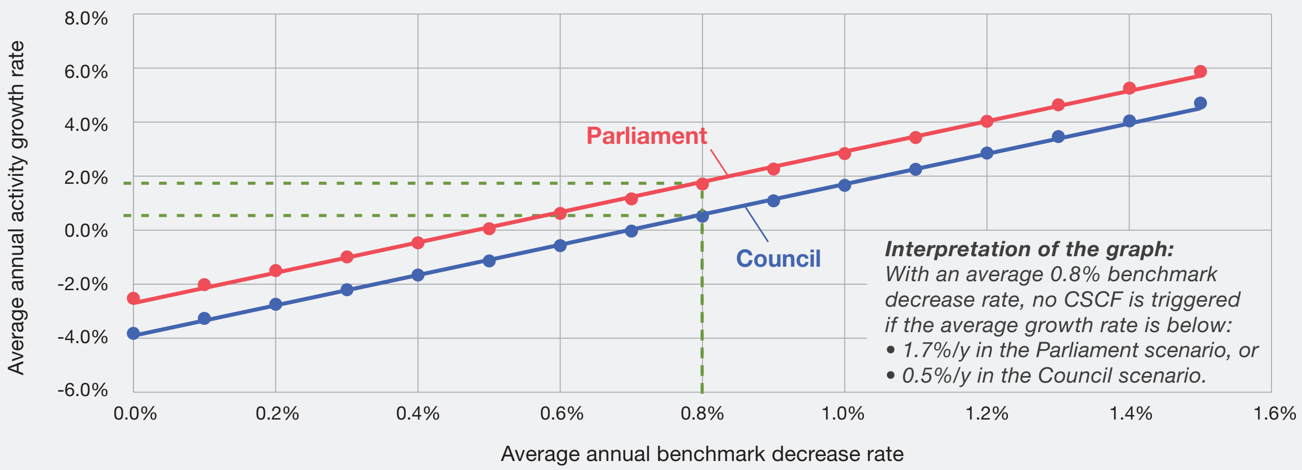
On the other, the maximum and minimum allowed values for the benchmark decrease rates are lower for the Council, and given that in our assumptions these extreme values are used for some sectors[9], it increases the preliminary allocation by 56 $MtCO_2e$ in total. Additionally, giving 30% of their preliminary allocation to installations in sectors non-exposed to carbon leakage, as supported by the Council, increases the demand for free allowances by 69 $MtCO_2e$. (see **Figure 30**)

Both the Parliament and the Council agree on setting the carbon leakage criterion – defined by the product of carbon intensity times trade intensity – at 0.2. They also both agree on giving the possibility to some sectors of applying for a qualitative assessment of their carbon leakage exposure. While the Council is in favor of limiting the eligibility to this qualitative assessment to sectors with a carbon leakage exposure factor higher than 0.16, the Parliament is inclined to open this qualitative assessment to all sectors with an exposure factor higher than 0.12.

To have an order of magnitude of the possible impact of the inclusion of some eligible sectors into the carbon leakage list, the possible additional demand coming from all eligible sectors was calculated under both configurations. Including all the sectors eligible to the qualitative assessment in the carbon leakage list increases the demand for free allowances by 11 $MtCO_2e$ in the Council scenario, and by 42 $MtCO_2e$ in the Parliament scenario.

9 *Please refer to the Annexes for the benchmark decrease rates used in each sector in the Parliament and Council scenarios.*

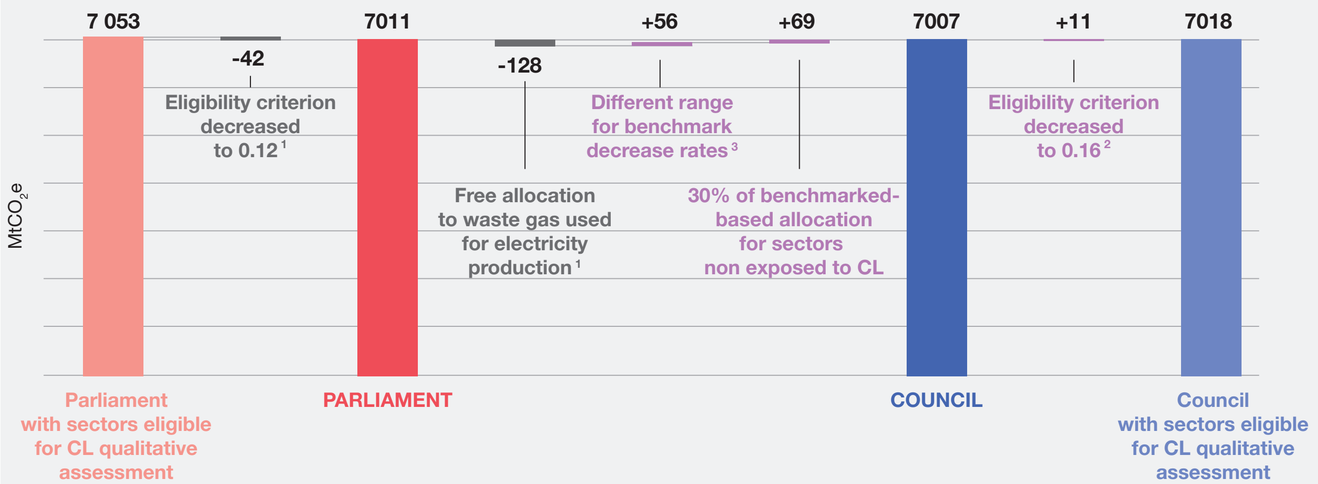
FIGURE 29. LIMIT VALUES OF THE AVERAGE ANNUAL ACTIVITY GROWTH RATE AND THE AVERAGE BENCHMARK DECREASE RATE FOR WHICH THE CSCF IS NOT TRIGGERED



Note: In this graph, benchmark decrease rates and activity growth rates are uniform across sectors.

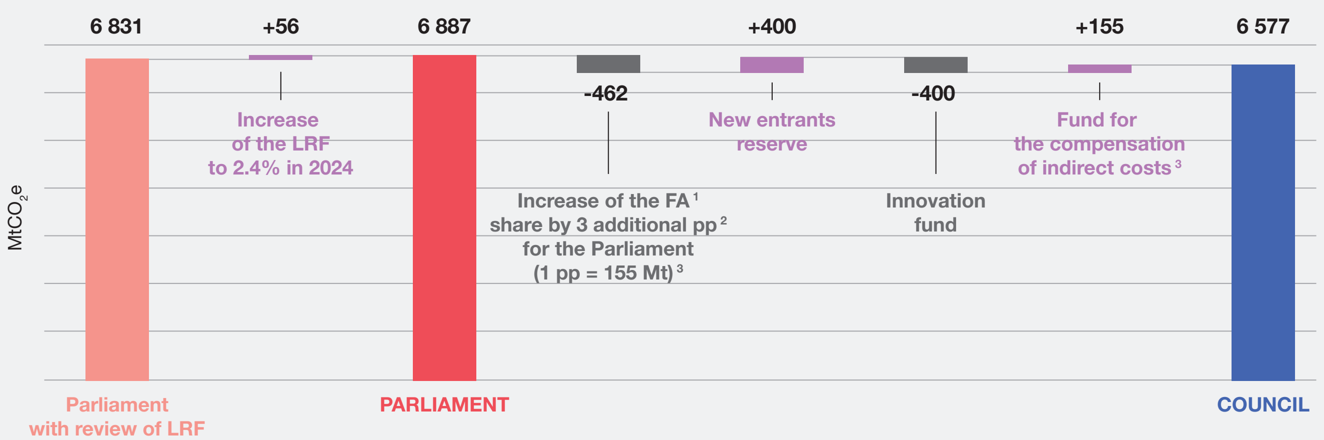
Source: I4CE, 2017

FIGURE 30. CUMULATIVE IMPACT OF EU ETS DESIGN PARAMETERS ON THE DEMAND FOR FREE ALLOWANCES (2021-2030)



Notes:
1. Under the assumptions taken for free allocation in the Parliament scenario, see the table on parameters in the scenarios and Annexes for more details.
2. Under the assumptions taken for free allocation in the Council scenario, see the table on parameters in the scenarios and Annexes for more details.
3. See Annexes for the benchmark decrease rates used in each sector in the Parliament and Council scenarios.

FIGURE 31. CUMULATIVE IMPACT OF EU ETS DESIGN PARAMETERS ON THE SUPPLY OF FREE ALLOWANCES (2021-2030)



Notes: 1. FA: Free allocaion. 2. pp: percentage points. 3. For a LRF equal to 2.2% from 2021 to 2030.

Source: I4CE, 2017

The Parliament's position on the EU ETS reform results in a larger amount of free allowances than the Council's

The Parliament is in favor of using 400 million allowances from the free allocation share to fund the New Entrants Reserve, which balances out with the fact that the Council would like to use 400 million allowances from the free allocation share for the Innovation Fund. On the one side, the Parliament is willing to create a fund for the compensation of indirect costs with 3% of the total of Phase IV allowances, 1/3 of which would come from the free allocation share. The decrease in free allowances is estimated at 155 million allowances. However, the Parliament considers a possible increase of the free allocation share by 5 percentage points to avoid triggering the CSCF. Compared to the possible increase by 2 percentage points proposed by the Council, it represents an increase of 462 million allowances in the supply of free allowances. Overall, the possible supply of free allowances is higher by more than 300 million allowances in the Parliament scenario compared to the Council scenario. (see **Figure 31**)

The supply of free allowances remains higher in the Parliament scenario even with an increase of the LRF to

2.4% in 2024. It only represents a decrease of 56 million allowances, taking into account the lower cap, fewer allowances in the Fund for the compensation of indirect costs and fewer additional allowances to be possibly given for free (the "5%" flexibility).

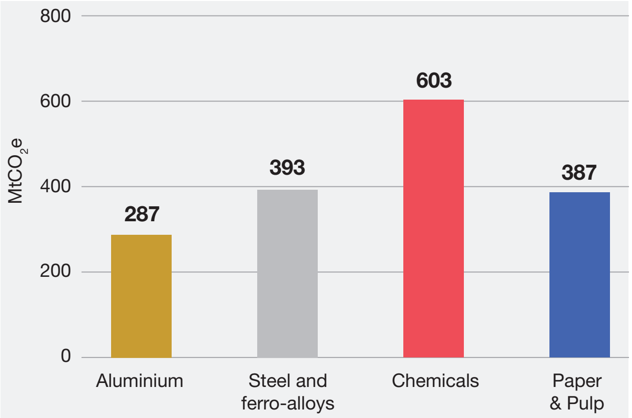
Compensation of indirect costs

A selection of electro-intensive sectors are eligible for the compensation of the increase in electricity costs they incur due to the EU ETS. In Phase III, Member States decide whether they provide a compensation for indirect costs in eligible sectors, following the applicable guidelines.

Over Phase IV, with an aid intensity of 75% harmonized over the EU ETS, **an estimated 1,670 million allowances would be required to compensate indirect costs in the main eligible sectors**. (see **Figure 32**) This estimation is based on the methodology used in the current applicable guidelines. (Please refer to the Annexes for more details on the methodology and on other assumptions).

It represents around **12% of the total allowances supply in Phase IV and 24% of auctioning volumes** - taking into account the EU ETS design parameters of the Parliament amendments.

FIGURE 32. INDIRECT GHG EMISSIONS ELIGIBLE FOR COMPENSATION BY EU ETS SECTOR (2021-2030)



Source: I4CE, 2017

TAKEAWAYS

IMPACTS OF THE EU PARLIAMENT AND THE EU COUNCIL'S PROPOSALS ON FREE ALLOCATION IN THE EU ETS

In the trilogue, positions differ on a number of EU ETS design parameters which impact free allocation

- The positions of the Council and the Parliament on the EU ETS reform differ on a number of elements which impact the free allocation cap or the calculation of the bottom-up preliminary free allocation.
- The positions of the Council and the Parliament on the EU ETS reform will probably result in a **Cross-Sectoral Correction Factor (CSCF) triggered at the end of Phase IV**, under conservative assumptions for benchmark decrease rates in major sectors covered by the EU ETS (refinery, cement, aluminum, steel).

Quantifying the impact of EU ETS design parameters on free allocation enables to evaluate how to avoid the CSCF, keeping in mind that free allocation should not result in windfall profits and was meant to be a transitional tool

- The effects of the different design parameters on the calculation of the bottom-up preliminary free allocation balance out and the **demand for free allowances is similar in the Council and the Parliament scenarios**.
- On the other side, **the Parliament's position results in a higher amount of free allowances for industry than the Council's**, even if the LRF is increased to 2.4% in 2024.
- EU Council policy objectives regarding free allocation should be kept in mind (avoiding undue carbon cost for most efficient installations while **preserving the incentive to reduce GHG emissions and not giving rise to windfall profits and distortions.**

Around 24% of auctioning volumes would be required over Phase IV to compensate indirect costs in the main eligible sectors

- With an aid intensity of 75% harmonized over the EU ETS, we find that an **estimated 1,670 million allowances** would be required over Phase IV to compensate indirect costs in the main eligible sectors.

Free allocation and compensation of indirect costs were meant to be transitional tools, we should now start preparing the post-compensation period for a smooth transition.

Modelling challenges and sensitive assumptions

- The assumptions on allowed benchmark decrease rates and future growth rates in the different industrial sectors.

Conclusion

The negotiations on the EU ETS revision for its Phase IV are taking place at the same time as the negotiations on the other pieces of the EU 2030 climate and energy framework. In particular, the EU Commission published in November 2016 legislative proposals on renewable energy, energy efficiency, the organization of the electricity market and the governance of the Energy Union which are now under discussion both in the EU Parliament and the EU Council.

This study concluded that **the revised EU ETS directive will not be sufficient to mitigate the interactions of renewable energy and energy efficiency policies with the EU ETS**, unless an unexpected proposal comes out of the trilogue negotiations.

The revision of other EU legislations thus appears as an opportunity to create a consistent policy mix and manage the overlapping effects between the different policy instruments. In particular, the Governance Regulation, which, as proposed by the EU Commission, aims at ensuring the achievement of EU targets while ensuring policy coherency, could be enhanced to specifically address overlapping policies with the EU ETS.[10]

10 The next report of the COPEC II research program will focus on the interactions between the different pieces of the 2030 climate and energy framework, and will be published in early 2018.

Annexes

Annexe.

I4CE EU ETS tool

I4CE EU ETS tool is based on two interlinked modules. The first module “Balance of the EU ETS” allows to define the EU ETS free allocation cap that is used in the second module “free allocation”. The second module allows to calculate the preliminary free allocation at NACE code level according to different parameters (benchmarks, carbon leakage list, etc..). After estimating the preliminary free allocation for all sectors and calculating the CSCF, the second module calculates the final free allocation and the forecasted GHG emissions from industrial sectors. Then these two results are used in the first module to calculate the balance of the EU ETS, taking into account the functioning of the MSR. (see **Figure 33**)

Free allocation module

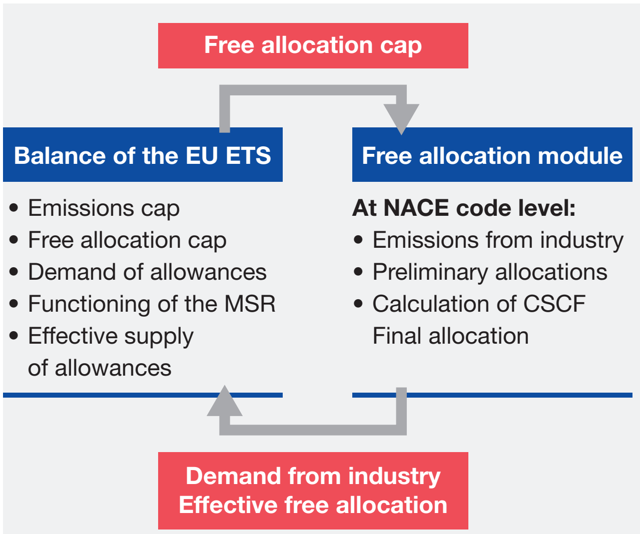
The free allocation module includes three calculation steps:

1. **Calculation of preliminary allocation**
2. **Calculation of CSCF**
3. **Calculation of final allocation**

Calculation of preliminary allocation

In Phase IV, preliminary allocation to incumbent installations which are not new entrants is calculated in a bottom-up way, at the level of each installation covered by the EU ETS. Phase IV will be divided in two sub-periods for the calculation of free allocation (2021-2025 and 2026-2030) and preliminary free allocation will be calculated as the product of activity levels in the relevant years for each sub-period (2013-2017 for the first sub-period and 2018-2022 for the second sub-period) multiplied by the applicable benchmarks. Benchmark values are reference values of carbon intensity (either by product, or for heat production or fuel consumption), and correspond to the average carbon intensity of the 10% most efficient installations under the EU ETS. Benchmark values were established based on 2007-2008 data and will be decreased by an annual rate in Phase IV. While the Commission proposed to decrease benchmark values by an annual default rate of 1%, with the possibility to decrease or increase it up to 0.5% in relevant sectors, both the Parliament and the Council are in favor of using actual improvement rates in carbon intensity – within a range of possible values.

FIGURE 33. I4CE EU ETS TOOL



Source: I4CE, 2017

TABLE 4. LIST OF SYMBOLS AND ABBREVIATIONS USED FOR THE CALCULATION OF FREE ALLOCATION

i	: sector, defined by its NACE code
k	: installation of this sector
j	: product or process defined by a fall-back approach
t	: year
$PA_{i,t}$	: primary allocation over all the installations of a sector i in a year t
$PA_{k,t}$	: primary allocation for an installation k in a year t
$FA_{i,t}$	: final allocation over all the installations of a sector i in a year t
B	: average annual reduction of benchmarks
b_j	: benchmark for the sub-installation based on 2007-2008 data (either based on a benchmark product or a fall-back approach)
$AL_{j,k,t}$	: activity levels of installation k for product or process j in a year t
$AL_{j,k,hist}$	: historical activity levels of installation k for product j, defined as the maximum between the median annual activity levels from 2005 to 2008 and from 2009 to 2010
$eff_{j,k}$	: carbon efficiency of a process j in an installation k
$em_{j,k,t}$	: emissions from a process j in an installation k a year t
$em_{i,t}$	: emissions from a sector i in a year t
β_i	: annual growth rate in a sector i for the period 2015-2030

Preliminary allocation in Phase IV will be equal to the sum of activity levels in the relevant years multiplied by the applicable benchmark over the sub-installations in each sub-period:

$$PA_{i,\ 2021–2025} = \sum_k \sum_j b_j\,(1 - 15 * B) * AL_{j,k,\ 2013–2017}$$

$$PA_{i,\ 2026–2030} = \sum_k \sum_j b_j\,(1 - 20 * B) * AL_{j,k,\ 2018–2022}$$

Preliminary allocation is aggregated over the installations of the different sectors. A few major sectors are addressed with a specific methodology:

- Refinery
- Aluminum
- Cement
- Steel

The **Table 5** summarizes the data sources and assumptions used in the estimation of benchmarks and historical activity levels for these four sectors.

For other sectors, we use 2017 EU TL data on verified emissions to estimate historical activity levels. (see **Figure 34**)

Firstly, we define $bench_i$, and eff_i, respectively an hypothetical sectoral benchmark and an hypothetical sectoral carbon efficiency, taking into account the proportion of products and processes within a sector:

$$bench_i = \frac{\sum_k \sum_j b_j * AL_{j,k,t}}{\sum_k \sum_j AL_{j,k,t}}\ ;\ eff_i = \frac{\sum_k \sum_j em_{j,k,t}}{\sum_k \sum_j AL_{j,k,t}}$$

To estimate the ratio $\frac{bench_i}{eff_i}$, we made the two following assumptions:

- The efficiency $eff_{j,k}$ of a process j in an installation k remained constant between 2007-2008 and 2015;
- Within a sector i, the proportion of products and processes remains constant over the period of projections;

Secondly, for an installation k, which was not a new entrant in Phase III, has not partially or fully ceased operations nor had a significant capacity extension or reduction, preliminary allocations in 2015 were equal to the sum of historical activity levels multiplied by the applicable benchmark over the sub-installations:

$$PA_{k,2015} = \sum_j b_j * AL_{j,k,hist}$$

Summing over a selection of installations which are not in the cases previously referred to, we have:

$$\sum_k PA_{k,2015} = \frac{\sum_k \sum_j b_j * AL_{j,k,hist}}{\sum_k \sum_j AL_{j,k,hist}} * \sum_k \sum_j AL_{j,k,hist}$$

$$= bench_i * \frac{\sum_k \sum_j em_{j,k,hist}}{eff_i}$$

Finally, preliminary allocations in 2015 can be calculated from the final allocations given in the EUTL database, using the value of the CSCF in 2015 and the carbon leakage exposure factor for the incumbent installations in 2015.

TABLE 5. DATA SOURCES AND ASSUMPTIONS USED FOR THE BENCHMARKS VALUES AND HISTORICAL ACTIVITY LEVELS IN A SELECTION OF SECTORS

Sectors	Benchmarks	Activity levels
Refinery	One benchmark: 0.0295 tCO_2/CWT	IFPen data and projections
Aluminum	Two benchmarks: **Electrolysis** 1.514 tCO_2eq/t **Anode** 0.324 tCO_2eq/t	2013 activity level from European Aluminum
Cement	Two benchmarks: **Grey clinker** 0.766 tCO_2eq/t **White clinker** 0.987 tCO_2eq/t	2014 activity levels from Cembureau
Steel	Five benchmarks: **Coke** 0.286 tCO_2eq/t **Sintered ore** 0.171 tCO_2eq/t **Hot metal** 1.328 tCO_2eq/t or 1.475 tCO_2/t to accountfor the full CO_2 content of waste gas (1) (Communication from Eurofer, 2012) **EAF carbon steel** 0.283 tCO_2eq/t **EAF high alloy steel** 0.352 tCO_2eq/t	Historical activity levels from the Commission and growth rates up to now from Eurostat

(1) Waste gases used to produce heat and which already receive free allocation are not substracted, as the downstream use of waste gases is very difficult to track

Historical CO_2 emissions from each installation are retrieved from the same database as the maximum between the median annual emissions from 2005 to 2008 and the median annual emissions from 2009 to 2010. For each sector, it is thus possible to estimate the ratio $\frac{bench_i}{eff_i}$.

Preliminary allocations in a sector i can then be estimated using this ratio:

$$PA_{i,2021\text{-}2025} = bench_i * (1 - 15 * B) \sum_k \sum_j AL_{j,k,2013\text{-}2017}$$

We assume the average value to be used for activity levels (using the median value instead has a very limited impact on the results):

$$PA_{i,2021\text{-}2025} = bench_i * (1 - 15 * B) * \frac{1}{5} \sum_k \sum_j \sum_{t=2013}^{2017} AL_{j,k,t}$$

We express activity levels as the ratio of emissions of emissions to efficiency, approximate $eff_{j,k}$ with eff_i, and project future activity levels, using a sectoral annual growth rate:

$$PA_{i,2021\text{-}2025} = \frac{bench_i}{eff_i} * (1 - 15 * B) * \frac{1}{5} \sum_k \sum_j \Big(\sum_{t=2013}^{2014} em_{j,k,t} + em_{j,k,2015} * (2 + \beta_i + (1+\beta_i)^2) \Big)$$

In the same way,

$$PA_{i,2026\text{-}2030} = \frac{bench_i}{eff_i} * (1 - 20 * B) * \frac{1}{5} * (1 + \beta_i)^3 * \frac{(1 - (1 + \beta_i)^5)}{-\beta_i} \sum_k \sum_j em_{j,k,2015}$$

Figure 34 summarizes the approach used to estimate preliminary allocation in all sectors except refinery, aluminum, cement and steel.

Calculation of CSCF

The bottom-up preliminary free allocation is then adjusted to the free allocation cap by applying a cross-sectoral correction factor (CSCF), equal to the ratio of the cap of free allocation to the sum of preliminary allocations over all industrial sectors.

$$CSCF = \frac{\textbf{Free allocation cap}}{\sum \textit{Preliminary allocation over sectors}}$$

The CSCF can either be calculated over all sectors or over sectors least exposed to carbon-leakage (such as proposed by the Parliament).

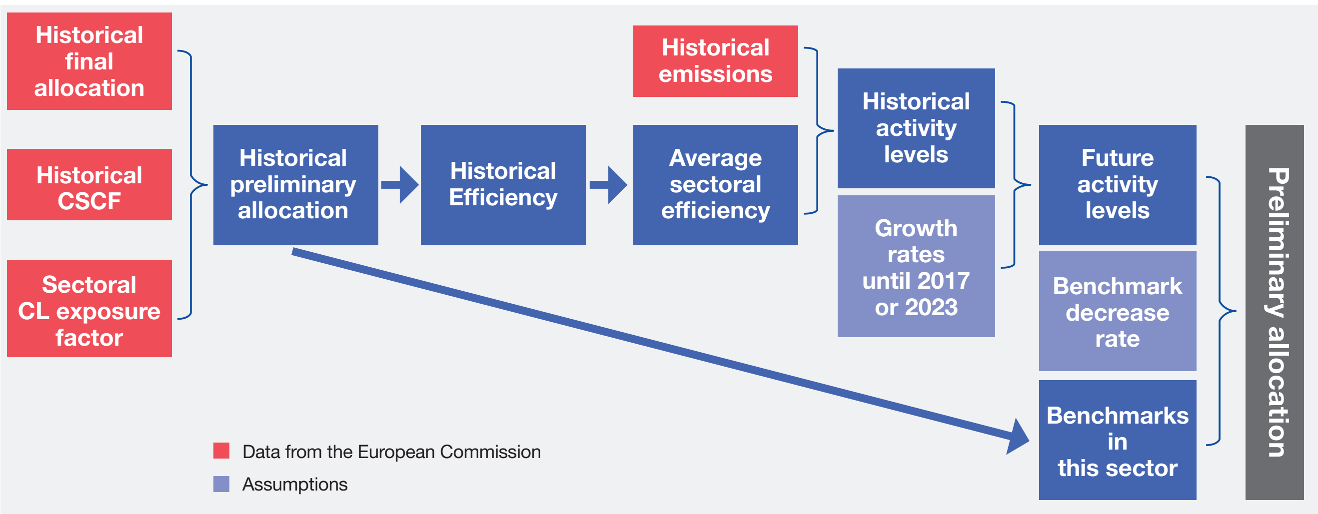
Calculation of final allocation

Finally, final allocation in each sector is given by:

$$\textit{Final allocation} = \textit{Preliminary allocation} * CSCF * \textit{Share of benchmark-based allocation to be given for free in this sector}$$

The share of benchmarked-based allocation depends on whether the sector is deemed to be exposed to carbon leakage.

FIGURE 34. APPROACH USED TO ESTIMATE PRELIMINARY ALLOCATION IN ALL SECTORS EXCEPT REFINERY, ALUMINUM, CEMENT AND STEEL



Source: I4CE, 2017

Assumptions used for free allocation

Assumptions on growth rates and benchmark decrease rates

Estimating preliminary allocation requires making assumptions on future activity growth rates in the different industrial sectors as well as on benchmark decrease rates. (see **Table 6**)

TABLE 6. ASSUMPTIONS ON GROWTH RATES AND BENCHMARK DECREASE RATES USED IN THE DIFFERENT SCENARIOS

<table>
<tr><th>Parameters</th><th>Scenario 1 - EU Parliament</th><th>Scenario 2 - EU Council</th></tr>
<tr><td>Growth rates 2016-2020 [(1)]</td><td colspan="2">• Refinery: 3.44%
• Cement: 2.00%
• Aluminum: 0.34%
• Base chemicals: 1.90%
• Other chemicals: -1.17%
• Steel: 0.34%
• Other sectors: 1.2%</td></tr>
<tr><td>Growth rates 2021-2030 [(1)]</td><td colspan="2">• Refinery: -0.64%
• Cement: 2.10%
• Aluminum: 2.10%
• Base chemicals: 1.90%
• Other chemicals: -1.66%
• Steel: 2.10%
• Other sectors: 1.5%</td></tr>
<tr><td>Benchmark decrease rate [(2)]</td><td>• Refinery: 0.25%
• Cement: 0.25%
• Aluminum: 0.25%
• Steel: 0.25%
• Heat (only district heating): 1.75%
• Other sectors: 1%</td><td>• Refinery: 0.20%
• Cement: 0.20%
• Aluminum: 0.20%
• Steel: 0.20%
• Heat (only district heating): 1.5%
• Other sectors: 1%</td></tr>
</table>

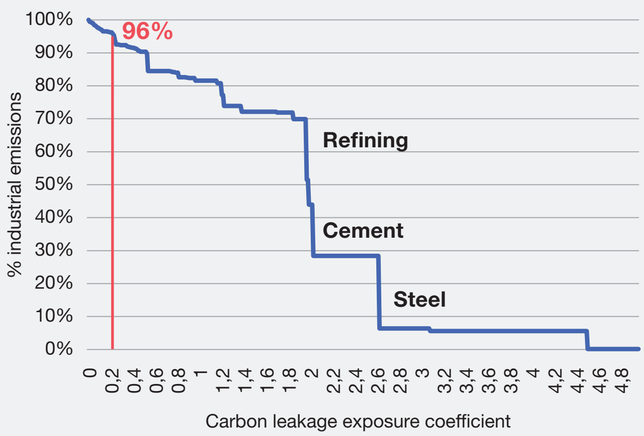
(1) Source: IFPen, BEIS based on ICIS data, EU Commission

(2) Source: for refinery, cement, aluminum and steel sectors minimum decrease rate, for district heating maximum decrease rate, and for other sectors, EU Commission default value 1%.

Assumptions used for the calculation of carbon leakage exposure

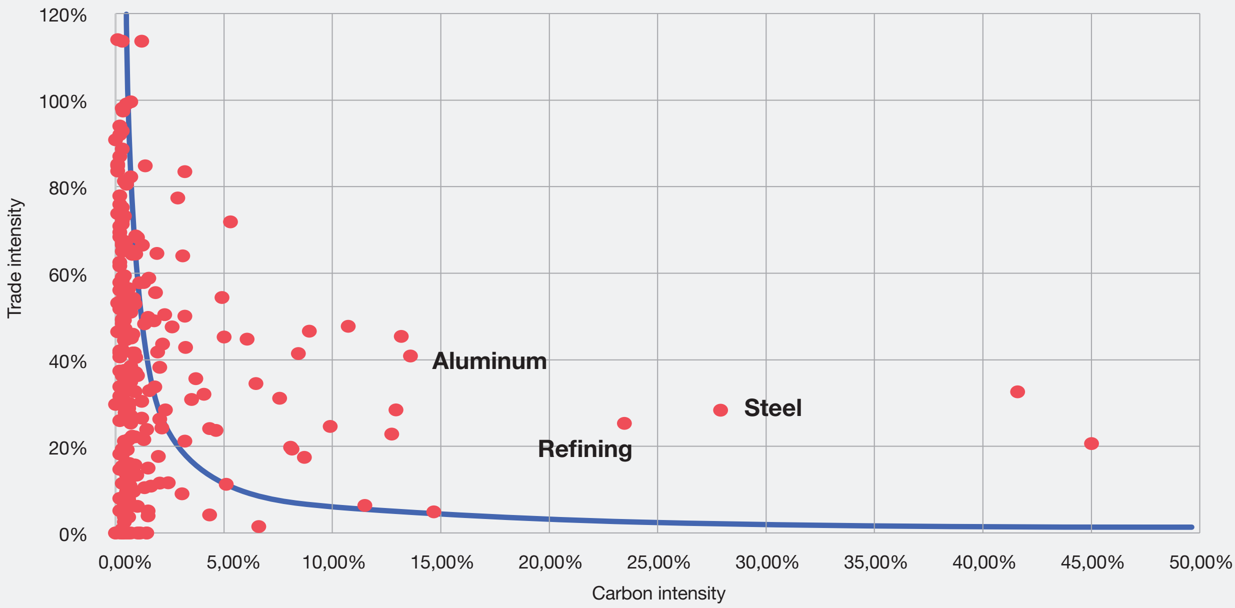
The criterion of carbon leakage exposure is based on the product of trade intensity times carbon intensity. For the carbon intensity, the data from the carbon leakage list established by the Commission in 2014 was used. Data on trade intensity was updated, using Eurostat data compiled by the Department for Business, Energy and Industrial Strategy (BEIS) of the UK government. **Figures 35** and **36** show respectively the distribution of sectors compared to the carbon leakage list frontier and industrial emissions covered by the carbon leakage list for carbon leakage factors, taking into account this updated data.

FIGURE 35. INDUSTRIAL EMISSIONS COVERED BY THE CARBON LEAKAGE LIST FOR DIFFERENT CARBON LEAKAGE FACTORS



Source: I4CE based on data from the European Commission and Eurostat (compiled par BEIS) for the trade intensity

FIGURE 36. DISTRIBUTION OF SECTORS COMPARED TO THE CARBON LEAKAGE LIST FRONTIER FOR A CARBON LEAKAGE FACTOR OF 0.2



Source: I4CE based on data from Eurostat (compiled by BEIS) and from the European Commission

IFPEN projections for the refining sector

The refining sector falls under the EU ETS and represents one of the most important industrial contributors to GHG emissions. However, refining sector activity is predicted to continue to fall in Europe as product demand weakens. Therefore, to estimate future activity levels of the refining sector and associated GHG emissions it is important to evaluate precisely the energy consumption from refinery process utility consumption and the new technologies that can be implemented to improve energy efficiency.

Complexity Weighted Tonne Methodology

To improve the analysis of free allocation under the EU ETS in Phase IV, IFP Energies nouvelles (IFPEN) has calculated projections of activity levels and GHG emissions in the refining sector until 2030. A parametric study is used to estimate activity levels and then GHG emissions up to 2030 under different regulatory and technological scenarios. Projections of refining sector activity levels and emissions to 2030 were made by utilizing the Complexity Weighted Tonne (CWT) methodology, which normalizes the activity of each process unit in a refinery so that refineries can be compared on the same basis. As a result, production is measured in terms of CWT units, which represent a level of process unit activity that generates the same amount of emissions as one tonne of crude processed in an atmospheric crude distillation unit (CDU) under "standard" conditions, i.e. at a standard level of energy performance and using a standard fuel as determined by Solomon (CONCAWE, 2012).

The primary source of data for the analysis was provided by CONCAWE (CONCAWE, 2013), including the main regulatory scenarios to 2030. Regulations included in the present study are those that have already been passed or are being prepared with a high probability of implementation in the near to medium term. No new "theoretical" regulations were envisaged in the different scenarios explored. In the same vein, all process technology improvements that were evaluated and implemented are based on actual research – on a lab bench or at pilot plant scale, or on already commercialized units and equipment that have been proven to some extent in the field. No new process technologies were modelled that would result in unfeasible and unrealistic energy efficiency gains in the period up to 2030.

A CWT calculation model is developed by IFPEN and used thereafter in CWT calculation of the different scenarios.

A Reference Case and 3 sensitivity scenarios

A Reference Case is the basis of 3 sensitivity scenarios (1, 2 and 3) elaborated by IFPEN, taking into account technological and regulatory factors.

The Reference Case

The Reference Case is based on the European refined products demand outlook to 2030 developed by CONCAWE, which does not account for any significant technology progress to improve energy efficiency in refinery process units. The Reference Case considers the International Marine Organization's (IMO) reduced sulphur specification for marine fuels to 0.5%. In 2020, 100% of the marine fuel oil produced in refineries has a 0.5% sulphur content. Therefore, this regulation will require much more hydro-treating and coking capacity to be constructed to achieve the more stringent specification.

Three scenarios

In each of the three scenarios developed, energy efficiency gains and technology improvements leading to a more realistic situation of the refining sector are implemented. Indeed, a modernisation of existing refinery utility systems is modelled by upgrading them to more efficient cogeneration systems with a condensing steam turbine. Such cogeneration systems result in a 70% overall efficiency for steam and electricity production. However, 90% of refineries in Europe that produce electricity already do so with a cogeneration system (FuelsEurope, 2014), so only 10% of refineries would realistically make such an upgrade. Furthermore, potential energy efficiencies from technological improvements are modelled, whether they consist of existing high-performing technologies being applied to a majority of refineries that do not currently incorporate them, or whether they stem from new technologies that have only recently been fully developed, tested, and commercialized. The energy efficiencies and resulting emissions reductions offered by these state-of-the-art technologies is only be applied to all new capacity installed after 2015. It was therefore assumed that no revamping of existing processing capacity would take place from now until 2030.

- **Scenario 1**: consists of an update of the Reference Case: energy efficiency gains and utility system improvements are simulated and an actualised CWT is calculated, upgrading the Reference Case to more realistic projections for the refining sector. Like in the Reference Case, **100%** of the low sulphur marine fuel oil demand at 0.5% is produced in refineries.
- **Scenario 2**: is the **main scenario** used in this report to estimate free allocation to the industry. After exchanges of view with industrials of the sector, this Scenario 2 is defined considering that **86%** of the low-sulphur marine fuel oil demand is produced in the refineries, and that the rest of low-sulphur marine fuel oil demand is produced directly on boats with scrubbers facilities. This reduces the amount of additional capacity brought online until 2030 in refineries, thereby decreases the total sector activity level and emissions compared to Scenario 1.
- **Scenario 3**: is a sensitivity scenario considering a *very low* (10%) production of the total low-sulphur marine fuel oil demand from the refineries, the rest being produced with scrubbers facilities.

Results on activity levels and emissions

Significant improvements in energy efficiency are needed, but considering the economic challenges faced by the EU refining sector it is unrealistic to expect in the future the types of large-scale investments seen in the last decade. Nevertheless, improvements can be made taking into account remaining utility system upgrade opportunities and currently available BATs that propose more energy-efficient process technologies.

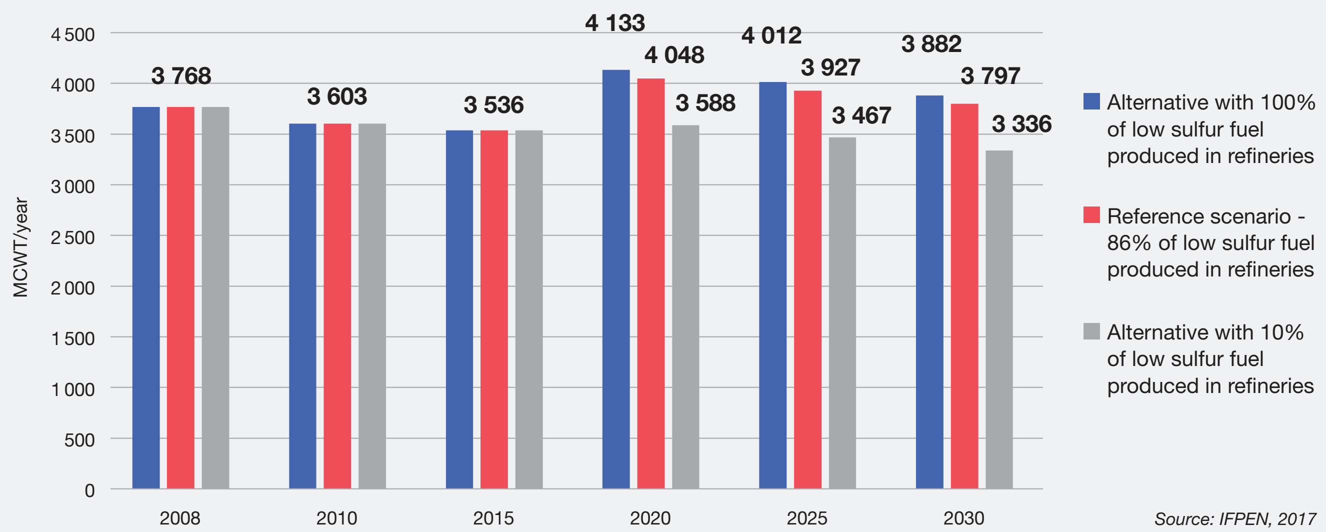
Many of the most significant emissions reductions that could be achieved with the process technology upgrades studied in the scenarios come from process units producing gasoline components, such as fluid catalytic cracking feed pre-treatment (-35%), naphtha hydro-treating (-28%), and butamer (-27%). However, the majority of the process technology upgrades are related to middle distillate as well as crude processing, which together produce over 40% of the refining sector's emissions.

The sharp increase in activity levels in 2020 in Scenario 1 (from 3536 MCWT/year to 4133 MCWT/year) is due to the implementation of the IMO low-sulphur marine fuel oil regulation and to the fact that the totality of necessary low-sulfur marine oil is produced in refineries. It will inherently require more coking and hydrotreating capacity (and thus more energy and emissions per unit of throughput).

The Scenario 2 (the main scenario used in the analysis of free allocation in this report) shows an increase in activity levels in 2020 followed by a decrease from 4048 MCWT/year in 2020 to 3797 MCWT/year in 2030.

While some emissions reductions by 2030 are possible in the refining sector, they are counterbalanced in 2030 by the implementation of the IMO regulation.

FIGURE 37. PROJECTIONS OF ACTIVITY LEVELS IN THE THREE SCENARIOS (AVERAGE EUROPEAN CORRECTED FACTOR FOR ELECTRICITY INCLUDED*)



Source: IFPEN, 2017

** The average EU electricity grid emissions factor was determined to be 465 tCO_2/GWh (CONCAWE, 2012)*

TABLE 7. CO_2 EMISSIONS ($MTCO_2$/YEAR) IN THE 3 SCENARIOS

Emissions ($MtCO_2$/year)	2008	2010	2015	2020	2025	2030
Scenario 1: 100% marine LSFO* demand produced in refineries	150	138	132	159	154	149
Scenario 2: 86% marine LSFO demand produced in refineries	150	138	132	155	151	146
Scenario 3: 10% marine LSFO demand produced in refineries	150	138	132	138	133	128

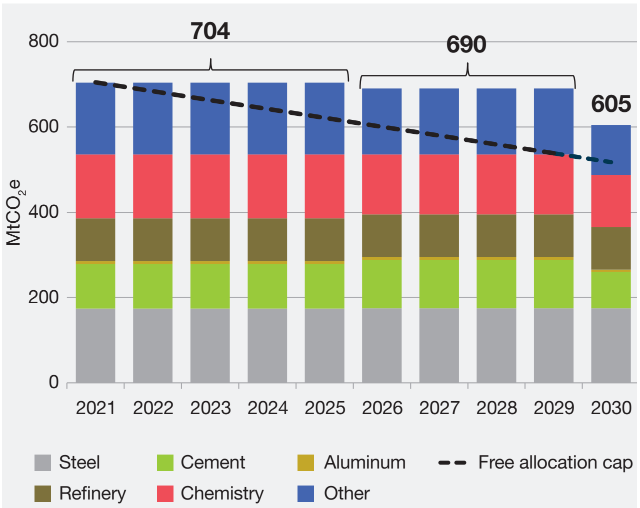
** Low Sulfur Fuel Oil*

Sensitivity analysis on refining activity levels

Impact of lower refining activity levels on the Parliament scenario

This sensitivity analysis is based on the IFPEN scenario where only 10% of demand for low sulfur marine fuel oil is produced in refineries. **Preliminary allocation in the first subperiod (based on activity levels in the years 2013-2017) does not change compared to the reference scenario**. The limitation on the sulfur content of marine fuel is not enforced yet in that period. In the second subperiod, preliminary allocation is slightly lower than in the reference scenario. In **2030**, the CSCF is triggered in sectors which meet the applicability criterion (an intensity of trade with third countries below 15% or a carbon intensity below 7kg CO_2/€) and is equal to **75.4%** (against 64.2% in the reference scenario). (see **Figure 38**)

FIGURE 38. PHASE IV FINAL FREE ALLOCATION BY EU ETS SECTOR IN THE PARLIAMENT SCENARIO WITH LOWER REFINING ACTIVITY LEVELS



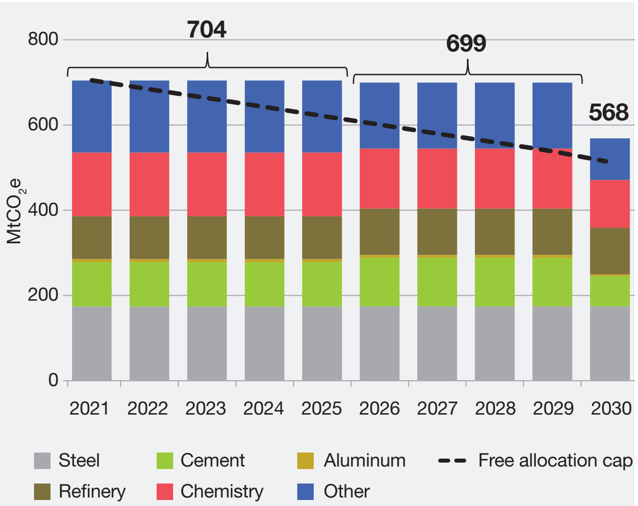
Source: I4CE, 2017

ANNEXE. I4CE EU ETS TOOL

Impact of higher refining activity on the Parliament scenario

This sensitivity analysis is based on the IFPEN scenario where 100% of demand for low sulfur marine fuel oil is produced in refineries. **Preliminary allocation in the first subperiod (based on activity levels in the years 2013-2017) does not change compared to the reference scenario**. The limitation on the sulfur content of marine fuel is not enforced yet in that period. In the second subperiod, preliminary allocation is slightly higher than in the reference scenario. In **2030**, the CSCF is triggered in sectors which meet the applicability criterion (an intensity of trade with third countries below 15% or a carbon intensity below 7kg CO_2/€) and is equal to **62.1%** (against 64.2% in the reference scenario). (see **Figure 39**)

FIGURE 39. PHASE IV FINAL FREE ALLOCATION BY EU ETS SECTOR IN THE PARLIAMENT SCENARIO WITH HIGHER REFINING ACTIVITY LEVELS



Source: I4CE, 2017

Assumptions used for the estimation of indirect costs compensation

The estimation of the amount of allowances which would be necessary to compensate indirect costs in the main eligible sectors at EU level is based on the following assumptions:

- **Aid intensity**: 75%
- **Baseline period**: 2013-2019
- **CO_2 emission factor**: Country specific maximum CO_2 emission factor from 2012 European Commission's guidelines

For the aluminum sector, the amount of emissions compensated is calculated as:

$$\text{Amount of emissions compensated} = \text{Aid intensity} * CO_2 \text{ emission factor} * \text{product specific electricity efficiency benchmark} * \text{baseline output}$$

Phase III product specific electricity benchmarks are used (electrolysis: 14.256 MWh/t and anode: 0.225 MWh/t). The baseline output is based on same growth rate assumption as free allocation (0.34% p.a. until 2021). As Eurostat production data per country was incomplete, we used EU TL verified emissions by sector for 2015 to break down activity levels per country.

For chemicals, paper & pulp, and iron & steel, the amount of emissions compensated is calculated as:

$$\text{Amount of emissions compensated} = \text{Aid intensity} * CO_2 \text{ emission factor} * \text{fall-back electricity consumption benchmark} * \text{baseline electricity consumption}$$

The fall-back electricity consumption benchmark of 80% is used. The baseline electricity consumption is based on Eurostat, scaled down to eligible NACE codes using a factor from *Ecofys, 2016*: 0.71 for Chemicals, 0.76 for Pulp and Paper and 0.81 for iron and steel. Projections are based on same growth rate assumptions as free allocation (1.9%p.a for chemicals,1.2% for pulp and paper and 0.34%p.a for iron and steel).

Annexe.

POLES-Enerdata model

Enerdata offers the world recognized POLES model to provide quantitative, scenario-based, empirical and objective analyses. As the POLES model is used by many members of the energy sector (industry, governments, European Commission, etc.), it is very well adapted to forecast the effects of different energy-related engagements (GHG emissions limitations, promotion of renewables and energy efficiency, energy security issues, etc.). In addition, with its global coverage and the endogenous calculation of demand, supply and prices of numerous energies including oil, gas, and coal, the POLES model is very relevant to capture all of the impacts of energy policies and climate change measures and to ensure that all the forecasts are coherent within the global environment.

POLES overview

POLES[11] (*Prospective Outlook on Long-term Energy Systems*) is a world energy-economy partial equilibrium simulation model of the energy sector, with complete modelling from upstream production through to final user demand and greenhouse gases emissions. The simulation process uses dynamic year-by-year recursive modelling, with endogenous international energy prices and lagged adjustments of supply and demand by world region, which allows for describing full development pathways to 2050[12].

The model provides a complete endogenous calculation from upstream activities (supply, prices of several energies incl. oil, gas and coal) to final user demand.

POLES offers a mixed approach based on:

- a "top-down" modelling for sectorial demand, which is directly related to activity, prices and technologies through econometric equations;
- and a "bottom-up" approach for the power sector (explicit representation of each type of technology as well as their costs).

11 *https://www.enerdata.net/solutions/poles-model.html*

12 *For examples of academic studies with POLES model, see Mima, S. and Criqui, P. (2015); Kitous, A. and Criqui, P. (2010).*

TABLE 8. POLES GENERAL ASSUMPTIONS

Activity Variables	**GDP**	• 2000-present: **World Bank** • Forecasts EU-28: Growth rate of **EC reference scenario (2016)** • Forecasts Rest of EU30 and other regions: **IMF** up to 2020 and then **CEPII** up to 2050 (Centre for Prospective Studies and International Information[1])
	Value Added	• 2000-present: **World Bank, OECD**
	Population	• 2000-present: **World Bank** • Forecasts EU-28: Growth rate of **EC reference scenario (2016)** • Forecasts Rest of EU30 and other regions: "2015 Revision of World Population Prospects" UN median scenario[2]
Other Activity Data	**Steel apparent consumption and production**	• 2000-present: historical data and short term outlook up to 2 years in the future from **World Steel Association**
	Transport activity and mileages	• Enerdata compiled statistics: – EU countries – **Eurostat** – Non-EU countries – **International Road Federation**
	Dwellings numbers and surfaces	• Enerdata compiled statistics: – **World Bank**
Fossil fuel & Electricity prices	**Import and end-user domestic prices (Power sector, industry, Buildings)**	• Enerdata compiled statistics: – **IEA & National sources**
	Oil price	• Spot Price of **Brent** (annual average)
	Gas market prices	• Europe/African market (spot): **Zeebrugge spot** (annual average) • Americas market: **USA pipeline** • Asian market: **Japan LNG**
	Coal market prices	• Europe/African market (spot): **Amsterdam-Rotterdam-Antwerp spot** (annual average) • Americas market: **USA** • Asian market: **Japan**
Energy Consumption	**Power, industry, buildings, agriculture and transports**	• Enerdata compiled statistics based on **IEA & national sources**

Electricity generating capacity	**All technologies**	• Enerdata compiled statistics: **IEA & national sources**, quality assured by Enerdata and Enerdata's **Power Plant Tracker database**
	Nuclear and CCS	• Capacity forecasts are exogenous taken from **PRIMES 2016 reference scenario** for EU28 since their developments are highly uncertain and follow more political decisions than competition on costs in the following decades.
Historical emissions	**CO_2-energy**	• Enerdata from **IEA**. Calculated based on energy consumption and standard emission factors per toe (single global value)
	CO_2-process	• Enerdata from **IEA**
	Non-CO_2	• **UNFCCC data** (Annex I countries), **EDGAR database** (non-Annex I countries); weighted averages on GWPs for HFCs and PFCs
	Global Warming Potentials	• **AR4**
Fossil Fuel Resources		• **IEA** (Oil, gas and coal reserves and production, gas directional trade) • **CEDIGAZ** (Gas production) • **BGR** (Bundesanstalt für Geowissenschaften und Rohstoffe, German Federal Institute for Geosciences and Natural Resources, for Ultimately recoverable resources and unconventional oil and gas reserves and production) • **Enerdata's Market Research team** (international and national databases compiled by Enerdata)
Renewable energy potentials		• Based on **World Resources Institute** (arable land surfaces and annual irradiation), **Wind Atlas** (wind speeds), **DLR** (solar irradiation)
Technology Costs and details	**Power**	• **IEA** (data used in World Energy Outlook 2016) • **TECHPOL** (produced by GAEL Energy (EDDEN) in several CNRS and European research projects)
	Transport	• **TECHPOL, IEA**, California Natural Gas Vehicle Partnership, Deutsche Bank
	Buildings	• **EURIMA, BPIE**, literature review
	Sectoral load curves	• **ENTSO-E**, literature review

1 French research institute (Centre d'Etudes Prospectives et d'Informations Internationales) providing long-term GDP forecasts based on the MaGE model.
2 United Nations website : https://esa.un.org/unpd/wpp/

TABLE 9. COPEC II BASELINE PARLIAMENT SCENARIO: EU ETS DESIGN IN POLES

			COPEC II Baseline "Parliament"	Methodology
EU-ETS	**Covered sector and emissions**		100%	• Shares by sector calculated from CITL v19 • Shares remain constant between 2014 and 2040 (except for aviation)
	Annual cap		Yes	• Phase 3: Fixed installations + Aviation • Phase 4: Fixed installations • Extension to 2040: Phase IV LRF
	5 year sliding EU carbon budget		Yes	• Actors consider the available carbon budget (allowances+surplus+MSR) with a 5-year vision ahead
	Illimited banking		Yes	• Surplus is transferable year by year, phase by phase
	International credit		No	
	LRF 2.2%/year		Yes	• Applied to the annual cap
	MSR	**Cancellation of allowances**	800 $MtCO_2$ in 2021	• Parliament proposal: - 800 $MtCO_2$ in 2021 • Backloaded allowances are directly transferred to the MSR: + 300 $MtCO_2$ in 2019 + 600 $MtCO_2$ in 2020
		Upper threshold ($MtCO_2$)	833 $MtCO_2$	
		Intake rate	24% from 2019 to 2021 (inclusive) and then 12%	• Parliament proposal: 24% for 2019 - 2021 (inclusive)
		Lower threshold ($MtCO_2$)	400 $MtCO_2$	
		Injection rate	100 $MtCO_2$	
		Price corridor	No	

Carbon Value modeling in POLES

GHG emissions reduction in POLES is modeled through the introduction of a proxy for GHG mitigation policies. The "**carbon value"** (carbon tax, price of allowances, proxy for measures intensity) is added on top of the price of energy proportional to the carbon content of the fuel, in each module where fossil fuels are combusted.

Carbon value impact in Power sector

Current costs per power plant technology are calculated for seven different annual load durations (from 730 to 8760 hours, 730 hours being 1/12 of a year's duration) and are used as a basis for the cost comparison of new capacities. Fossil fuel technologies are directly impacted by the carbon value in their Levelized Cost of Electricity (LCOE).

Carbon value impact in energy demand

The carbon value is impacting the global envelope for substitutable consumption through its implication on energy prices. It also affects the competition between new equipment that is needed to fill the energy demand gap[13].

Carbon pricing instruments in POLES like Emissions Trading Schemes are assessed through the required carbon value to achieve a given amount of GHG emissions limitation. POLES' carbon value is not the CO_2 market price (ETS).

In COPEC II, POLES provides two distinguished values:

- **ETS Carbon Value**: Carbon value needed to achieve the GHG emissions reduction target of ETS sectors which equals the marginal abatement cost of these GHG emissions reductions.
- **Non-ETS Carbon Value**: Carbon value needed to achieve the GHG emissions reduction target of Non-ETS sectors which equals the marginal abatement cost of these GHG emissions reductions.

COPEC II Baseline scenario: definition and methodology for calibration

Calibration of POLES model is necessary to define the COPEC II baseline scenario with EU climate and energy targets by 2020 and 2030 respecting the chosen policy designs.

Drivers are used to calibrate each target:

- **GHG (ETS and non-ETS):** Carbon value
- **Renewable Energy (RE):** Feed-in-tariff and premium
- **Energy Efficiency (EE):** Energy tax

Emissions Trading Scheme

The Baseline scenario for COPEC II is based on the Parliament's amendments on the revision of the EU ETS directive adopted on 15th February 2017[14].

13 The gap is the difference between new consumption and remaining scrapped capital

14 http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+TA+P8-TA-2017-0035+0+DOC+PDF+V0//EN

Shares of ETS emissions in POLES scope[15] are calculated from:

- Updated version of ETS verified emissions[16]: Shares calculated until 2014 from CITL_v19 for POLES sectors involved in ETS.
- Aviation data from European commission stats[17]: Shares intra- and extra-EEA aviation until 2014 (Shares of aviation activity within the EEA space and overseas, based on ETS verified emissions).

Shares of EU ETS emissions in the burden sharing with non-ETS emissions are assumed to remain constant from 2014 to 2040.

We choose to include covered emissions of civil and intra-EEA aviation into EU ETS from 2016 to 2020. Due to uncertainty after 2020 on Aviation participation to ETS or to other schemes, we do not include aviation for phases 4 and 5 (i.e. share of aviation under EU ETS get to 0 from 2021 to 2040).

The annual EU ETS cap from 2013 to 2030 as well as global aviation cap from 2013 to 2020 are taken from EC sources.

Comparing POLES emissions with verified EU ETS emissions from last CITL_v23[18], we are covering 100% of EU ETS emissions (including aviation) at EU aggregate level. Effort on EU ETS cap reduction from 2031 to 2040 is unchanged keeping LRF to 2.2% until 2040.

The carbon value at year N is defined by the marginal carbon value satisfying the carbon budget constraint under the following conditions:

The carbon value at year N is defined by the marginal carbon value satisfying the carbon budget constraint under the following conditions:

- Cumulated EU ETS emissions from year N to year N+5 cannot be superior to the carbon budget seen at year N.
- The carbon budget seen at year N equals the sum of the EU ETS allowances supply from year N to year N+5 taking into account the functioning of the MSR and the surplus currently on the market at year N.
- Carbon value from year N to N+5 follows an 7% annual growth rate.

POLES calculates the optimal carbon value satisfying the constraint and then repeats the process for the following year until the end of the simulation[19].

15 2016 Enerdata project for BEIS on EU ETS

16 https://www.eea.europa.eu/data-and-maps/data/european-union-emissions-trading-scheme-eu-ets-data-from-citl-7

17 http://ec.europa.eu/eurostat/fr/data/database

18 https://www.eea.europa.eu/data-and-maps/data/european-union-emissions-trading-scheme

19 If EU ETS carbon budget is higher than cumulated EU ETS emissions, then marginal carbon price is 0. No reduction effort is requested to satisfy the constraint

Time series

TABLE 10. TIME SERIES FOR FREE ALLOCATION

Parliament	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Final allocation ($MtCO_2e$)	**704**	**704**	**704**	**704**	**704**	**698**	**698**	**698**	**698**	**574**
Refinery	101	101	101	101	101	107	107	107	107	107
Chemistry	150	150	150	150	150	141	141	141	141	114
Steel	174	174	174	174	174	175	175	175	175	175
Cement	104	104	104	104	104	114	114	114	114	73
Aluminum	7	7	7	7	7	7	7	7	7	5
Other	169	169	169	169	169	155	155	155	155	101
Free allocation cap ($MtCO_2e$)	**705**	**684**	**663**	**642**	**622**	**601**	**580**	**559**	**538**	**518**

COUNCIL	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Final allocation ($MtCO_2e$)	**703**	**703**	**703**	**703**	**703**	**698**	**698**	**577**	**554**	**533**
Refinery	101	101	101	101	101	108	108	90	86	83
Chemistry	150	150	150	150	150	141	141	117	112	108
Steel	163	163	163	163	163	164	164	135	130	125
Cement	105	105	105	105	105	115	115	95	91	88
Aluminum	7	7	7	7	7	7	7	6	6	5
Other	177	177	177	177	177	163	163	135	129	125
Free allocation cap ($MtCO_2e$)	**720**	**699**	**679**	**658**	**637**	**616**	**595**	**575**	**554**	**533**

Source: I4CE, 2017

TABLE 11. TIME SERIES OF POLES SCENARIOS

PARLIAMENT	2017	2020	2025	2030	2035	2040
ETS CAP ($MtCO_2e$)	**1,974**	**1,859**	**1,579**	**1,336**	**1,094**	**851**
Total ETS Emissions ($MtCO_2e$)	1,873	1,752	1,525	1,329	1,187	980
EU ETS Surplus ($MtCO_2e$)	1,703	1,193	802	751	524	177
MSR cumulated level ($MtCO_2e$)	0	1,725	2,651	2,819	2,819	2,586
Carbon Value ETS (€/tCO_2e)	**0**	**0**	**0**	**0**	**84**	**420**

COUNCIL	2017	2020	2025	2030	2035	2040
ETS CAP ($MtCO_2e$)	**1,974**	**1,859**	**1,579**	**1,336**	**1,094**	**851**
Total ETS Emissions ($MtCO_2e$)	1,873	1,752	1,525	1,329	1,188	978
EU ETS Surplus ($MtCO_2e$)	1,703	1,193	844	758	529	191
MSR cumulated level ($MtCO_2e$)	0	1,725	671	748	677	361
Carbon Value ETS (€/tCO_2e)	**0**	**0**	**0**	**0**	**105**	**520**

LRF +	2017	2020	2025	2030	2035	2040
ETS CAP ($MtCO_2e$)	**1,974**	**1,859**	**1,570**	**1,306**	**1,042**	**779**
Total ETS Emissions ($MtCO_2e$)	1,873	1,752	1,525	1,329	1,143	909
EU ETS Surplus ($MtCO_2e$)	1,703	1,193	790	732	374	203
MSR cumulated level ($MtCO_2e$)	0	1,725	2,651	2,719	2,719	2,285
Carbon Value ETS (€/tCO_2e)	**0**	**0**	**0**	**0**	**147**	**608**

BREXIT	2017	2020	2025	2030	2035	2040
ETS CAP ($MtCO_2e$)	**1,974**	**1,773**	**1,402**	**1,198**	**994**	**789**
Total ETS Emissions ($MtCO_2e$)	1,873	1,752	1,391	1,234	1,087	922
EU ETS Surplus ($MtCO_2e$)	1,703	1,107	754	656	338	180
MSR cumulated level ($MtCO_2e$)	0	1,725	2,367	2,367	2,367	1,934
Carbon Value ETS (€/tCO_2e)	**0**	**0**	**0**	**0**	**77**	**332**

PRICE CORRIDOR	2017	2020	2025	2030	2035	2040
ETS CAP ($MtCO_2e$)	**1,974**	**1,859**	**1,579**	**1,336**	**1,094**	**851**
Total ETS Emissions ($MtCO_2e$)	1,873	1,752	1,439	1,218	1,079	997
EU ETS Surplus ($MtCO_2e$)	1,703	564	0	0	0	100
MSR cumulated level ($MtCO_2e$)	0	1,725	1,783	1,283	783	283
Carbon Value ETS (€/tCO_2e)	0	25	35	49	69	194
Corridor Price Reserve level ($MtCO_2e$)	**0**	**629**	**2,015**	**3,160**	**4,001**	**4,001**

Source: Enerdata, 2017

Presentation of I4CE, Enerdata and IFPen

I4CE – Institute for Climate Economics

I4CE – Institute for Climate Economics is an initiative of Caisse des Dépôts and Agence Française de Développement. The think tank provides independent expertise and analysis on economic issues linked to climate & energy policies in France and throughout the world. I4CE aims at helping public and private decision-makers to improve the way in which they understand, anticipate, and encourage the use of economic and financial resources to promote the transition to a low-carbon resilient economy. The Industry, Energy and Climate program of I4CE focuses on examining policies that aim to reduce greenhouse gas emissions in the industrial and energy sectors, such as carbon pricing, in Europe and worldwide. I4CE has one decade of expertise in analyzing especially the EU ETS functioning.

Team: Charlotte VAILLES and Emilie ALBEROLA

Enerdata

Enerdata is an energy intelligence and consulting company. Our experts help you tackle key energy and climate issues and make sound strategic and business decisions. We provide research, solutions, consulting and training to key energy players worldwide: oil and gas companies, electric utilities, equipment manufacturers, public authorities, policy makers, investors and consultancies. Incorporated in 1991, Enerdata leverages its experience and permanently invests in its globally recognized databases and forecasting models. Enerdata is an independent company, with headquarters in France and offices in the UK and Singapore.

Team: Cyril CASSISA and Jérémy BONNEFOUS

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IFP Energies Nouvelles is a public-sector research and training center. It has an international scope, covering the fields of energy, transport and the environment. From research to industry, technological innovation is central to all its activities. As part of the public interest mission IFPen focuses on: providing solutions to take up the challenges facing society in terms of energy and the climate, promoting the emergence of a sustainable energy mix; creating wealth and jobs by supporting French and European economic activity, and the competitiveness of related industrial sectors.

Team: Paula COUSSY, Sebastian ESCAGUES and Pierre MARION

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I4CE
24 avenue Marceau
75008 Paris

I4CE
INSTITUTE FOR CLIMATE ECONOMICS
Une initiative de la Caisse des Dépôts et de l'Agence Française de Développement

www.i4ce.org

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