European Commission

Support for an impact assessment on measures to address the risk of carbon leakage in the light of any increase in climate ambition

Final report

Ricardo, Trinomics and Öko-Institut
September – 2021

EUROPEAN COMMISSION

Directorate-General for Climate Action
Directorate B — European and International Carbon Markets
Unit B.2 — ETS Implementation and IT

Contact: Thomas Brinkmann

E-mail: Thomas.Brinkmann@ec.europa.eu

European Commission
B-1049 Brussels

PDF	ISBN 978-92-76-42352-2	doi: 10.2834/561985	ML-01-21-345-EN-N

Luxembourg: Publications Office of the European Union, 2021

Support for an impact assessment on measures to address the risk of carbon leakage in the light of any increase in climate ambition

Final Report

Chris Green (Ricardo)

Mark Johnson (Ricardo)

Eugenia Bonifazi (Ricardo)

Sean Healy (Öko-Institut)

Verena Graichen (Öko-Institut)

Hans Bolscher (Trinomics)

Matthew Smith (Trinomics)

Contents

Abstract (EN)

This report presents analysis undertaken to support the European Commission's impact assessment for the revision of the Emissions Trading System (EU ETS), in relation to measures to address the risk of carbon leakage in the light of any increase in climate ambition. The study involved the development of a pair of spreadsheet-based tools that can be used to assess the impacts of different options for reforming the free allocation rules. These tools enabled the Commission to carry out analysis of potential options and to calculate the expected impacts in a consistent way. The report summarises the method and assumptions used to develop the tools. The report also explores potential policy options for: indirect cost compensation for electricity-intensive industries; alternative and potentially complementary approaches to mitigating carbon leakage risk; and the allocation of free allowances in relation to the definition of electricity generators, future-proofing the ETS scope and benchmarks, treatment of exchangeability of fuel and electricity and a possible green bonus for best performance.

ABSTRACT (FR)

Ce rapport présente l'analyse entreprise en vue de l'étude d'impact de la Commission Européenne pour la révision du Système d'échange de quotas d'émission (SEQE-UE), associée à des mesures permettant de répondre aux risques de fuites de carbone suite à tout resserrement des ambitions climatiques. L'étude a impliqué la création d'une paire d'outils à base de tableur pouvant être utilisés pour évaluer les conséquences des différentes options de réforme des règles d'allocation de quotas gratuits. Ces outils ont permis à la Commission d'effectuer une analyse des options potentielles et de calculer les conséquences attendues de façon cohérente. Le rapport récapitule la méthode et les hypothèses qui ont permis de développer les outils. Le rapport explore aussi des options potentielles en matière de politique pour : compensation des coûts indirects pour les industries fortes consommatrices d'électricité ; approches alternatives et potentiellement complémentaires d'atténuation du risque de fuite de carbone ; et allocation des quotas gratuits associés à la définition des producteurs d'électricité, pour assurer l'avenir de l'étendue du système SEQE et de ses mesures de référence, le traitement de l'interchangeabilité de combustible et d'électricité et un éventuel bonus vert pour les meilleures performances.

EXECUTIVE SUMMARY (EN)

Introduction to the study

The European Green Deal sets out an increased climate ambition for at least 55% net greenhouse gas emission reductions by 2030 compared with 1990 levels. The EU Emissions Trading System (EU ETS) will be revised with the aim to increase its contribution to this new climate target. This report presents the findings of a study to support the European Commission in preparing elements of the impact assessment for the amendment of the EU ETS (Directive 2003/87/EC).

The purpose of this study was to support the assessment of a range of measures to address the risk of carbon leakage in light of the increase in climate ambition. There were two main tasks: Task 1 looked at different aspects affecting carbon leakage and developed policy options, while Task 2 supported the assessment of the potential impacts of shortlisted options.

Methodology

Task 1.1 – Availability of free allowances in Phase IV

This task developed a tool to estimate the availability of free allowances in Phase IV of the EU ETS under different policy options. The following two-step approach was implemented in the tool:

1) **Calculation of preliminary free allocation**: Allocation of allowances to individual installations was estimated based upon the following free allocation formula:

   Allocation = Benchmark x Activity Level x Carbon Leakage Exposure Factor (CLEF)

   Assumptions were made for several variables including benchmark values, activity levels and a simplification of free allocation rules, in order to estimate the expected availability of free allowances in Phase IV.

2) **Calculation of final free allocation**: The preliminary free allocation was then compared with the total amount available for free allocation. This amount is determined by the ETS cap trajectory, the mandatory auction share and the amount earmarked for the Innovation Fund. If the preliminary free allocation exceeded the total amount available for free allocation in a given year, then a cross-sectoral correction factor (CSCF) is applied by which free allocation is reduced in a uniform manner across all EU ETS sectors.

The scope of the estimation of free allocation in Phase IV included all ETS countries (i.e. EU-27 and EEA, excluding the United Kingdom). The free allocation of allowances for Phase IV was modelled based on a ‘bottom-up’ approach using data from the preliminary national implementation measures (NIMs) at sub-installation level. These data had been submitted to the Commission by the competent authorities in the ETS countries by 30 September 2019.

The estimation of free allocation over Phase IV of the EU ETS was further impacted upon by the development of a range of scenarios to reflect potential reforms to the free allocation mechanism. The key variables that could be changed within the modelling exercise included:

- The selection of different **cap trajectories**;
- The selection of different **auctioning shares** for each year between 2021 and 2030;
- The introduction of **tiered approach** to free allocation from 2026 onwards based on the carbon leakage indicator value of a NACE code sector;
- The selection of **strengthened benchmarks** by increasing the maximum yearly update rate from 1.6 % to 2.5 % from 2026 onwards.

The final combination of variables was decided upon during application of the tool by the Commission.

Task 1.2 – Modification of the mechanism for indirect cost of compensation

The future need for indirect cost compensation was assessed in this task. The approach taken used the average carbon dioxide emitted within the electricity generation system to estimate the cost pass-through. Average carbon intensity is expected to halve by 2030 and become less than a third of the 2020 value by 2035. The level of cost pass-through to electricity consumers, however, is likely to be somewhat higher due to the expected higher allowance prices. Therefore, we have estimated whether the costs that sectors might incur would be significant in relation to their economic value.

To answer this question, we looked to the current eligibility criteria as set in the revised state aid guidelines. Assuming the same decarbonisation trend also for the indirect emission intensity, while keeping the trade intensity unchanged, we estimated that by 2030 seven of the fourteen sectors would still exceed the 0.2 indirect carbon leakage indicator (ICLI) threshold while the other half would not be deemed to be at risk of carbon leakage. In 2035, however, only two sectors are forecast to have an ICLI above 0.2; aluminium and leather clothes production. A third sector, industrial gases, may also have an ICLI above 0.2, depending on the generation forecast scenario used.

Finally, we looked at whether the current threshold on the amount of revenue that can be allocated for indirect cost compensation should be amended, and whether the conditionality mechanism that is being introduced with the revised state aid guidelines could be enhanced. For the former, alternative approaches were suggested, for example the inclusion of the relative standing of the Member State's electricity carbon intensity compared to the EU average in the calculation of the advisory compensation ceiling. This would allow Member States with less carbon intensive electricity, and therefore lower auction revenues, to provide comparable compensation levels as other Member States. Regarding the conditionality mechanisms, potential options are provided, which would further enhance the targeting of the aid.

Task 1.3 – New instruments and alternative ways

Approaches to mitigating carbon leakage tend to focus on policies which ensure that domestic industries are not placed at a competitive disadvantage due to incurring carbon costs not faced by producers in other jurisdictions. This section explores and identifies three alternative and potentially complementary approaches to mitigating carbon leakage risk.

1. **The use of funds:** Funds supporting technological innovation could have a significant impact on carbon leakage. By reducing the cost of breakthrough technologies, funds could reduce the cost to firms of abiding with more stringent carbon regulation /

pricing, eliminating the incentive to re-locate. Funds supporting the application of new technologies could also incentivise competitive companies to shift production back to the EU. Unlike other measures to address leakage, funding for innovation in breakthrough technologies could indirectly also lead to a reduction in non-EU emissions if those technologies are subsequently adopted in foreign markets. We argue that in order to foster innovation in the technologies that can help mitigate carbon leakage, funds will need to be targeted at the right technologies in those industries that are at risk of carbon leakage through the right public financing mechanism.

2. **Carbon Contracts for Difference (CCfD):** Literature outlines three main benefits of CCfDs as providing: (1) a hedge against uncertain future ETS prices, (2) a vehicle to subsidise innovative low-carbon industrial technologies, and (3) a signal of long-term government to innovation. CCfDs should be structured differently to target breakthrough technologies at different stages of development. By supporting early-stage breakthrough technologies, CCfDs could help the EU to gain a leading position in the industries of the future and reduce the incentive for firms to relocate to avoid more stringent EU climate policies.
3. **Minimum carbon performance standards:** Minimum carbon performance standards could help address carbon leakage by preventing the sale on EU markets of high-carbon intensity products made in other jurisdictions. The standard would address the competitive advantage importers of high-carbon products would otherwise have over EU industries when supplying EU markets. By their nature, the standards apply to the sale of goods in EU markets and thus equally apply to EU producers and importers. Therefore, there would be incumbent EU companies who could not continue to serve EU markets without making performance improvements. In addition, the standards would have no effect on exports from the EU and would therefore not address the carbon leakage risk that arises from EU ETS operators becoming less competitive against overseas producers in non-EU markets.

For each of these, we assessed how these mechanisms may be employed as part of a package of policies designed to simultaneously address the risk of carbon leakage, while promoting material efficiency and fostering innovation in breakthrough technologies. We then suggest options within each category based on real policy examples, as well as ideas put forward by other commentators (academics or industry).

Task 1.4.1 Assessment of the definition of electricity generator

The aim of this task was to assess the impacts that the European Court of Justice's interpretation of the definition of 'electricity generator' will have on the levels of free allocation for EU ETS industrial installations that produce electricity. To perform this assessment, we reviewed the NIMs data and selected those installations which become ineligible for heat benchmark-based free allocation as a consequence of their re-classification as an electricity generator. Our estimate is that total free allocations could be reduced by between 2.5% and 3.9% due to the court case decision. The analysis shows that between 17.4 and 27.0 million free allowances per year could be foregone in total from between 200 to 1000 installations.

Another consideration is that cogeneration units within an industrial installation receive a free allocation adjusted by the cross-sectoral correction factor (CSCF), whereas standalone CHP are classified as electricity generator and so the linear reduction factor (LRF) applies. During Phase 3, industrial co-generation units were disadvantaged, receiving up to 14% less compared to standalone co-generators. However, for Phase 4, up to 2025, the CSCF is 100% and so now the situation is reversed with industrial co-generators receiving up to 11% more than standalone co-generators.

Task 1.4.2 Future proofing of ETS scope and benchmark

For this task we reviewed the activity descriptions in Annex I of the ETS Directive and the benchmark definitions to assess whether they provide a disincentive to decarbonisation via electrification, use of hydrogen or bio-based fuels and feedstocks.

Following **electrification**, certain installations may no longer exceed the 20 MW thermal input capacity threshold for inclusion in ETS of several activities. For these activities, when the product benchmarks do not account for exchangeability of electricity and fuel (i.e. plaster, dried secondary gypsum), there is an incentive to electrify only to the level that 20 MW thermal capacity is retained so the installation can continue to receive the same free allocation. Similarly, if an activity does not give rise to process GHG emissions and the product benchmarks do not account for exchangeability of electricity and fuel (e.g. paper and board), electrification of all combustion activity would result in no greenhouse gases being emitted and the installation no longer being covered by the ETS. There is an incentive not to fully electrify in order to continue to receive free allocation. Whereas, allowing installations to remain in the ETS and to continue receiving free allocation for some time following electrification would provide an incentive to electrify.

Whereas, for the product benchmarks which account for the exchangeability of electricity and fuel, an increase in the use of electricity will lead to a reduction in the amount of free allocation. Also, the heat and fuel benchmarks are not applicable following switching to electricity. For these activities for which activity is defined the 20 MW input capacity (i.e. iron casting, carbon black) or which do not emit process GHG emissions (e.g. paper and board), there is incentive to electrify because ETS costs can be avoided by dropping out of the ETS.

The **substitution of fossil fuels** with non-GHG emitting fuels or feedstocks would result in no CO_2 being emitted from combustion and non-inclusion in the ETS for combustion and other Annex I activities which do not give rise to process GHG emissions. Installations may be encouraged to continue to use an amount of fossil fuels, rather than completely decarbonise, in order to remain in the ETS and receive free allowances. Continuing to provide free allocation of allowances for some time after 100% switching could provide an incentive for complete conversion.

The production of hydrogen, carbon black, hot metal, high value chemicals and aromatics may no longer be eligible for free allocation calculated via a product benchmark if, following implementation of certain decarbonisation techniques, the product benchmark definition no longer applies. Providing the modified production process continues to be in the scope of the ETS, the installation may receive free allocation calculated via fall-back benchmarks. The amount of free allocation under the fall-back benchmarks may be different to that calculated with the product benchmarks. This could provide a disincentive to adopt such techniques, unless the definitions are changed so that free allocation is continued.

Task 1.4.3 Assess the concept of exchangeability of fuel and electricity

The concept of exchangeability says that in the case of a product where both electricity and fuel can be used interchangeably in the production process, then all energy carriers that are used for the production are included in the calculation of the benchmark values and thus, indirect emissions are taken into account. However, in the final allocation, these benchmarks are multiplied with the share of the direct emissions in the total emissions to avoid free allocation for emissions related to electricity.

In this task we looked at alternative policy options and methodologies which can incentivise the electrification of industry, as the current approach is often seen as a disincentive to electrification due to the lower allowances received due to the modified allocation formula.

Eight policy options were identified, of which the following three options were suggested for further consideration:

- Recalculation of the product benchmark based on direct emissions only
- Current approach but with an updated emissions factor, both in the benchmark definition and the adjustment factor
- Introduce the use of a "frozen" direct/indirect emission ratio that could be calculated at sectoral or installation level.

As a first assessment, all three options bring incentives to electrification, either because the level of free allocations for all installations with low level of electrification will be lower or because installations that electrify will benefit from surplus free allowances.

Task 1.4.4 – Green bonus for best performers

In this task we investigated the possibility of providing a "green bonus" of additional free allocation to the best performing installations. Three options for rewarding a green bonus were considered:

- installations that are among the best 5% or 10% performing installations
- the 5% or 10% of installations that have achieved the greatest improvement in GHG efficiency over a certain time frame
- all the installations that can demonstrate an improvement on the GHG intensity above a set threshold.

The options were assessed against defined criteria, which identified some challenges for this policy option. The mechanism would add an extra layer to a system that is already set up to reward best performers. Furthermore, there are more efficient and effective options to incentivise and enable investment in green technologies.

Task 2 Development of a tool for the assessment of impacts

Task 2 aimed to provide the means to assess the effects of policy options for revisions to the EU ETS. This task identified the key economic, environmental and social impacts that should be considered in evaluating the options and developed indicators for these impacts. An Excel-based assessment tool was developed which provided quantitative outputs for many of the recommended impacts and indicators. The purpose of this tool was to facilitate assessment carried out by the Commission.

The main inputs to the tool are the results from the tool developed in Task 1.1 which provides the impact on free allocation of the key policy options. Relevant economic, social and environmental indicators are included in the tool, against which the impacts of the key policy options are assessed. The tool produces quantitative outputs for the following indicators.

Table 1: Quantitative indicators for which the task 2 tool produces outputs.

Better Regulation Impact	Selected indicator(s)
Economic	
Macroeconomic environment	[%] Potential net direct carbon costs as % of value added in sector
Competitiveness, trade and investment flows	Sector potential net direct carbon costs [EUR million NPV 2021-2030]
	[%] Potential net direct carbon costs as % of production value
	[%] Potential net direct carbon costs as % of EBITDA
Environmental impacts	
The climate	[$MtCO_2e$] Potential direct emissions not covered by free allocation 2021-2030
	[%] Potential direct emissions not covered by free allocation 2021-2030

A selection of other indicators identified as important and suitable for qualitative assessment are also included in the tool.

These tools enabled the Commission to carry out the analysis of potential options and to calculate the expected impacts in a consistent way.

Résumé analytique (FR)

Introduction à l'étude

Le pacte vert pour l'Europe présente une ambition climatique renforcée pour une réduction d'au moins 55 % des émissions nettes de gaz à effet de serre en 2030 par rapport aux niveaux de 1990. Le Système d'échange de quotas d'émission de l'UE (SEQE-UE) sera révisé dans le but d'augmenter sa contribution à cette nouvelle cible climatique. Ce rapport présente les conclusions d'une étude au service de la Commission Européenne pour la préparation des éléments de l'évaluation d'impact pour l'amendement du système SEQE-UE (Directive 2003/87/CE).

L'objectif de cette étude est de faciliter l'évaluation d'un ensemble de mesures visant à répondre au risque de fuite de carbone en vue de tout renforcement de l'ambition climatique. Il y a deux tâches principales : La Tâche 1 s'intéresse aux différents points concernant la fuite de carbone et conçoit des options de politique, alors que la Tâche 2 facilite l'évaluation des conséquences potentielles des options présélectionnées.

Méthodologie

Tâche 1.1 – Disponibilité de quotas gratuits en Phase IV

Cette tâche a conçu un outil pour estimer la disponibilité des quotas gratuits en Phase IV du système SEQE-UE avec diverses options de politique. L'outil utilise l'approche en deux étapes suivante :

3) **Calcul d'une allocation préliminaire de quotas gratuits :** Allocation de quotas aux installations individuelles estimée à partir de la formule d'allocation de quotas gratuits suivante :

   Allocation = Référence x Niveau d'activité x Facteur d'exposition aux fuites de carbone (CLEF)

   Des hypothèses ont été posées dans l'évaluation des variables suivantes de façon à estimer la disponibilité attendue de quotas gratuits en Phase IV: valeurs de référence; niveau d'activité; et simplification des règles d'allocation de quotas gratuits.

4) **Calcul d'une allocation finale de quotas gratuits :** L'allocation préliminaire de quotas gratuits a ensuite été comparée au montant total disponible pour allocation gratuite. Ce montant est défini par les trajectoires plafonds du système SEQE, le partage d'enchères obligatoire et la quantité réservée pour le Fonds d'innovation. Si l'allocation préliminaire de quotas gratuits dépassait le montant total disponible pour allocation gratuite d'une année donnée, un facteur de correction transsectoriel (CSCF) était alors appliqué par lequel l'allocation gratuite est réduite de manière uniforme dans tous les secteurs du système SEQE-UE.

L'étendue de l'estimation d'allocation gratuite en Phase IV inclut tous les pays du système SEQE (c'est-à-dire les 27 pays de l'UE et l'EEE, à l'exclusion du Royaume-Uni). L'allocation de quotas gratuits pour la Phase IV a été modélisée d'après une démarche ascendante à partir de données des mesures nationales de mise en œuvre (NIM) préliminaires au niveau inférieur à l'installation. Ces données avaient été soumises à la Commission par les autorités compétentes des pays du système SEQE le 30 septembre 2019.

L'estimation de quotas gratuits sur la Phase IV du système SEQE-UE a été de plus révisée par la création d'une gamme de scénarios permettant de refléter les réformes potentielles du mécanisme d'allocation de quotas gratuits. Les variables essentielles pouvant être modifiées dans l'exercice de modélisation étaient notamment :

- La sélection de différentes **trajectoires plafonds** ;
- La sélection de différentes **parts d'enchères** pour chaque année entre 2021 et 2030 ;
- L'introduction d'une **approche par niveau** d'allocation gratuite à partir de 2026 basée sur la valeur de l'indicateur de fuites de carbone d'un secteur de code NACE ;
- La sélection de **références renforcées** en augmentant le taux de mise à jour annuelle maximal de 1,6 % à 2,5 % à partir de 2026.

La combinaison finale de variables a été décidée lors de l'application de l'outil par la Commission.

Tâche 1.2 – Modification du mécanisme pour compensation des coûts indirects

Le besoin à venir d'une compensation de coûts indirects a été évalué dans cette tâche. L'approche choisie utilise la moyenne de dioxyde de carbone émise dans le système de production d'électricité pour estimer le transfert de coûts. On attend une réduction de moitié de l'intensité moyenne en carbone en 2030 pour descendre en 2035 à moins d'un tiers de la valeur de 2020. Cependant, le niveau de transfert des coûts vers les consommateurs d'électricité sera probablement supérieur du fait de l'augmentation attendue des prix des quotas. Nous avons donc estimé si les coûts pouvant être subis par les secteurs seraient importants par rapport à leur valeur économique.

Pour répondre à cette question, nous avons étudié les critères actuels d'éligibilité tels qu'exposés dans les directives révisées sur les aides d'état. En supposant la même tendance à la décarbonisation que pour l'intensité des émissions indirectes, tout en conservant la même intensité d'échange, nous avons estimé qu'en 2030 sept des quatorze secteurs dépasseraient encore la valeur seuil d'indicateur de fuites indirectes de carbone (ICLI) de 0,2 alors que l'autre moitié ne serait pas considérée comme présentant un risque de fuites de carbone. Cependant, en 2035, la prévision ne donne que deux secteurs avec une valeur ICLI dépassant 0,2 ; la production d'aluminium et celle de vêtements en cuir. Un troisième secteur, les gaz industriels, pourrait aussi avoir une valeur ICLI dépassant 0,2, selon le scénario de prévisions de production utilisé.

Enfin, nous regardons si le seuil actuel du montant de chiffre d'affaires donnant droit à un allocation pour compensation de coûts indirects devrait être modifié, et si le mécanisme de conditionnalité introduit avec les directives révisées d'aides d'état pourrait être amélioré. Pour le premier point, des approches de remplacement ont été suggérées, par exemple l'inclusion de la position relative de l'intensité en carbone de l'électricité de l'État membre par rapport à la moyenne de l'UE dans le calcul du plafond recommandé de compensation. Ceci permettrait aux États membres à l'électricité moins productrice de carbone et donc à chiffre d'affaires d'enchères plus bas, de fournir des niveaux de compensation comparables à ceux des autres États membres. Concernant les mécanismes de conditionnalité, on propose des options possibles, qui pourraient encore améliorer le ciblage de l'aide.

Tâche 1.3 – Nouveaux instruments et méthodes de remplacement

Les approches d'atténuation des fuites de carbone tendent à se concentrer sur des politiques qui assurent de ne pas mettre en situation concurrentielle désavantageuse les industries nationales du fait de coûts de carbone subis auxquels ne seraient pas confrontés les producteurs dans d'autres juridictions. Cette section explore et identifie trois approches de remplacement éventuellement complémentaires pour atténuer le risque de fuites de carbone.

1. **L'utilisation des fonds :** Les fonds de soutien à l'innovation technologique pourraient avoir une influence importante sur la fuite de carbone. En réduisant le coût des technologies innovantes, ces fonds pourraient réduire le coût pour les entreprises de respect de réglementations plus sévères ou de tarif plus élevé du carbone, éliminant ainsi l'incitation à la délocalisation. Les fonds de soutien à l'application de technologies nouvelles pourraient aussi inciter les sociétés concurrentielles à ramener leur production dans l'UE. Contrairement à d'autres mesures de traitement des fuites, le financement de l'innovation dans les technologies innovatrices pourrait aussi conduire indirectement à une réduction des émissions hors UE si ces technologies sont ultérieurement adoptées sur des marchés étrangers. Nous avançons l'argument que pour favoriser l'innovation dans les technologies pouvant contribuer à atténuer les fuites de carbone, les fonds devront être ciblés sur les bonnes technologies dans les industries présentant un risque de fuites de carbone grâce à un mécanisme de financement public approprié.
2. **Contrats pour la différence de carbone (CCfD) :** La littérature détaille trois avantages essentiels des CCfD comme susceptibles de fournir : (1) une couverture contre l'incertitude des prix à venir du système SEQE, (2) un véhicule permettant de subventionner des technologies industrielles innovantes à faible empreinte carbone, et (3) un signal de gouvernement à long terme en faveur de l'innovation. Les CCfD devraient être structurés différemment pour cibler les technologies innovatrices à différents stades de développement. En soutenant les technologies innovatrices dans leur première phase, les CCfD pourraient aider l'UE à acquérir une position de pointe dans les industries de l'avenir et à réduire l'incitation aux entreprises à délocaliser pour éviter des politiques climatiques plus sévères de l'UE.
3. **Normes minimales de performances carbone :** Des normes minimales de performances carbone pourraient contribuer à traiter la fuite de carbone en empêchant la vente sur les marchés de l'UE de produits à forte intensité en carbone fabriqués dans d'autres juridictions. La norme devrait cibler l'avantage concurrentiel qu'auraient autrement les importations de produits à haute intensité en carbone par rapport aux industries de l'UE pour la fourniture des marchés de l'UE. Par nature, les normes s'appliquent à la vente de marchandises sur les marchés de l'UE et s'appliquent donc également aux producteurs et importateurs de l'UE. Donc des sociétés historiques de l'UE pourraient ne pas pouvoir (sans amélioration de performances) continuer à desservir les marchés de l'UE. De plus, les normes n'auraient aucun effet sur les exportations depuis l'UE et ne répondraient donc pas au risque de fuites de carbone du fait que les opérateurs du système SEQE-UE seraient moins concurrentiels face aux producteurs étrangers sur des marchés autres que ceux de l'UE.

Pour chacun de ces points, nous évaluons la façon dont ces mécanismes pourraient être employés dans le cadre d'un ensemble de politiques conçu pour répondre simultanément au risque de fuites de carbone, tout en favorisant l'utilisation efficace des matières premières et en poussant à l'innovation dans les technologies innovatrices. Nous suggérons ensuite des options dans chaque catégorie à partir d'exemples réels de politique, ainsi que des idées proposées par d'autres commentateurs (du monde universitaire ou industriel).

Tâche 1.4.1 – Évaluation de la définition d'un producteur d'électricité

L'objectif de cette tâche était d'évaluer les conséquences de l'interprétation par la Cour de justice européenne de la définition de « producteur d'électricité » sur les niveaux d'allocation de quotas gratuits pour les installations industrielles du système SEQE-UE qui produisent de l'électricité. Pour effectuer cette évaluation, nous avons étudié les données NIM et sélectionné les installations qui deviennent inéligibles pour l'allocation gratuite basée sur les références de chaleur en conséquence de leur reclassement comme producteur d'électricité. Notre estimation est que le total des allocations de quotas gratuits pourrait être réduit de 2,5 % à 3,9 % du fait de la décision de la cour. L'analyse montre qu'entre 17,4 et 27,0 millions de quotas gratuits par an pourraient disparaître au total pour 200 à 1000 installations.

Un autre point à prendre en compte est que les centrales à cogénération dans une installation industrielle reçoivent un quota gratuit modulé par le facteur de correction transsectoriel (CSCF), alors que les installations CHP autonomes sont classées comme producteur d'électricité et se voient donc appliquer le facteur de réduction linéaire (FRL). Pendant la Phase 3, les centrales à cogénération industrielles étaient désavantagées, et recevaient jusqu'à 14 % de moins que les cogénérateurs autonomes. Mais pour la Phase 4, jusqu'en 2025, le CSCF est de 100 % et donc la situation est maintenant inversée et les cogénérateurs industriels reçoivent jusqu'à 11 % de plus que les cogénérateurs indépendants.

Tâche 1.4.2 – Assurer l'avenir de l'étendue et des références du système SEQE

Pour cette tâche nous avons évalué les descriptions d'activité de l'Annexe I de la Directive SEQE et les définitions de référence pour évaluer si elles constituent un frein à la décarbonisation par l'électrification, l'utilisation de l'hydrogène ou de biocarburants et de biomasses.

Suite à l'**électrification**, certaines installations peuvent ne plus dépasser le seuil de capacité d'entrée thermique de 20 MW pour inclusion dans le système SEQE de plusieurs activités. Pour les références de produits qui ne prennent pas en compte la possibilité d'échange entre l'électricité et le combustible, il y a donc une incitation à n'électrifier que jusqu'au niveau permettant de conserver la capacité thermique de 20 MW de façon que l'installation puisse continuer à recevoir les mêmes quotas gratuits. Les références de chaleur et de combustible ne sont pas non plus applicables après le passage à l'électricité. En conséquence, autoriser les installations à rester dans le système SEQE et à continuer à recevoir leur allocation gratuite pendant un certain temps après l'électrification serait une incitation à n'électrifier. Néanmoins, pour les références de produits prenant en compte la possibilité d'échange entre électricité et combustible, une augmentation de l'utilisation de l'électricité conduira à une réduction de l'allocation de quotas gratuits. Pour ces installations, il y a une incitation à l'électrification parce que les coûts du système SEQE peuvent être évités en sortant du système SEQE.

Pour les références de produits qui tiennent compte de l'échangeabilité de l'électricité et du combustible, une augmentation de l'utilisation de l'électricité entraînera une réduction du montant de l'allocation gratuite. En plus, les références de chaleur et combustibles ne sont pas applicables suite au passage à l'électricité. Pour ces activités pour lesquelles l'activité est définie la capacité d'entrée de 20 MW (c'est-à-dire la fonte, le noir de carbone) ou qui n'émettent pas d'émissions de GES de processus (par exemple, le papier et le carton), il y a une incitation à électrifier car les coûts du système SEQE peuvent être évités en abandonnant du système SEQE.

La **substitution de combustibles fossiles** par des combustibles non émetteurs de gaz à effet de serre ou la biomasse conduirait à ne plus émettre de CO_2 par la combustion et à la non-inclusion dans le système SEQE pour les activités de combustion et autres activités de l'Annexe I qui ne conduisent pas à un traitement des émissions de GES. Les installations peuvent être encouragées à continuer à utiliser une certaine quantité de combustibles fossiles, plutôt que de se décarboner complètement, de façon à rester dans le système SEQE et à recevoir des quotas gratuits. Continuer à fournir des quotas gratuits pendant un certain temps après basculement à 100 % pourrait être une incitation à la conversion complète.

Les productions d'hydrogène, de noir de carbone, de fonte brute, de produits chimiques à forte valeur ajoutée et aromatiques peuvent ne pas être éligibles à l'allocation de quotas gratuits si, après la mise en œuvre de certaines techniques de décarbonisation, la définition de références de produits ne s'applique plus. Tant que le processus de production modifié reste dans l'entendue du système SEQE, l'installation pourrait recevoir une allocation gratuite calculée par des références de repli. Le montant de l'allocation gratuite dans le cadre des références de repli peut être différent de celui calculé avec les références de produits. C'est parce que les définitions de référence signifient que ces références ne sont plus applicables. Ceci pourrait être un frein à l'adoption de telles techniques, à moins que les définitions ne soient modifiées de façon à poursuivre les allocations gratuites.

Tâche 1.4.3 – Évaluation de la notion de possibilité d'échange entre combustible et électricité

La notion de possibilité d'échange énonce que dans le cas d'un produit dont le procédé de production peut utiliser de façon interchangeable de l'électricité et un combustible, tous les vecteurs d'énergie utilisés pour la production sont inclus dans le calcul des valeurs de référence et que les émissions indirectes sont donc prises en compte. Mais dans l'allocation finale, ces références sont multipliées par la part des émissions directes dans les émissions totales pour éviter une allocation gratuite des émissions associées à l'électricité.

Nous nous sommes intéressés dans cette tâche aux autres options de politique et méthodologies pouvant inciter à l'électrification de l'industrie, car l'approche actuelle est souvent vue comme un frein à l'électrification du fait de la réduction des attributions de quotas reçus suite à la nouvelle formule d'allocation.

Huit options de politique ont été identifiées, dont trois ont été suggérées pour étude ultérieure :

- Recalcul de la référence à partir des seules émissions directes
- Approche actuelle mais avec un facteur d'émissions mis à jour, à la fois dans la définition de la référence et dans le facteur d'ajustement
- Introduction de l'utilisation d'un rapport d'émissions directes/indirectes « gelé » qui pourrait être calculé au niveau du secteur ou de l'installation.

En première évaluation, les trois options fournissent des incitations à l'électrification, soit parce que le niveau des allocations gratuites pour toutes les installations à faible niveau d'électrification sera inférieur, soit parce que les installations qui électrifient bénéficieront d'un surplus de quotas gratuits.

Tâche 1.4.4 – Bonus vert pour les meilleures performances

Nous avons étudié dans cette tâche la possibilité de fournir un « bonus vert » d'allocation de quotas gratuits supplémentaires pour les installations ayant les meilleures performances. Trois options de récompenses pour un bonus vert ont été pris en compte :

- installations dont les performances se situent parmi les premiers 5 % ou 10 %.
- installations des 5 % ou 10 % ayant obtenu la meilleure amélioration d'efficacité de GES sur une période particulière.
- toutes les installations pouvant démontrer une amélioration de l'intensité en GES au-dessus d'un seuil défini.

Les options ont été évaluées par rapport à des critères définis, qui ont identifié certains défis pour cette option politique. Le mécanisme ajouterait une couche supplémentaire à un système déjà mis en place pour récompenser les installations plus performantes. De plus, il existe des options plus efficientes et efficaces pour inciter et permettre l'investissement dans les technologies vertes.

Tâche 2 – Création d'un outil pour l'évaluation des impacts

La Tâche 2 visait à fournir les moyens d'évaluer les effets des options de politique pour les révisions du système SEQE-UE. Cette tâche a identifié les conséquences les plus significatives économiques, environnementales et sociales à prendre en compte pour l'évaluation des options, et a conçu des indicateurs pour ces conséquences. Un outil d'évaluation basé sur Excel a été créé pour fournir des résultats quantitatifs pour beaucoup des conséquences et indicateurs recommandés. L'objectif de cet outil était de faciliter l'évaluation assurée par la Commission.

Les valeurs d'entrée essentielles de l'outil sont les résultats de l'outil conçu dans la Tâche 1.1 qui donne les conséquences sur les allocations gratuites des principales options de politique. Les indicateurs économiques, sociaux et environnementaux pertinents sont inclus dans l'outil, ce qui permet d'évaluer les conséquences des options essentielles de politique. L'outil fournit des résultats quantitatifs pour les indicateurs suivants.

Tableau 2 : Indicateurs quantitatifs fournis en sortie de l'outil de Tâche 2.

Conséquences d'une meilleure réglementation	Indicateur(s) sélectionné(s)
Économiques	
Environnement macroéconomique	[%] coûts directs nets potentiels du carbone en % de la valeur ajoutée dans le secteur
Compétitivité, flux d'échanges et d'investissements	Coûts directs nets potentiels du carbone pour le secteur [millions EUR VAN 2021-2030]
	[%] coûts directs nets potentiels du carbone en % de la valeur de production
	[%] coûts directs nets potentiels du carbone en % de l'EBITDA
Conséquences environnementales	
Le climat	[$MtCO_2e$] Émissions directes potentielles non couvertes par les quotas gratuits 2021-2030
	[%] Émissions directes potentielles non couvertes par les quotas gratuits 2021-2030

L'outil inclut aussi une sélection d'autres indicateurs identifiés comme importants et pouvant donner lieu à une évaluation qualitative.

Ces outils ont permis à la Commission d’effectuer une analyse des options potentielles et de calculer les conséquences attendues de façon cohérente.

Introduction

The political guidelines of the European Commission (2019-2024) made the "European Green Deal" (EGD) one of the six "headline ambitions" on which the European Commission focuses its work for the period. With the objective of making Europe the world's first climate-neutral continent, the political guidance clearly identifies the fight against climate change as being a prominent political priority.

Under the EGD plan, the Commission developed an impact-assessed plan to achieve the EU's greenhouse gas net emission reductions target for 2030 of at least 55% compared with 1990 levels, which includes a review of the EU ETS finalised in June 2021. In the inception impact assessment it was highlighted that the impact assessment would explore a broad variety of options, including[1]:

- The linear reduction factor to meet the higher 2030 target of at least 55%, a one-off reduction of the cap that would put it closer to the actual emissions level, as well as the interaction with the market stability reserve (MSR).
- The parameters for the operation of the MSR, including the predefined range triggering adjustments to annual auction volumes, as well as the percentage rate applied to the total number of allowances in circulation.
- The extension of emissions trading to maritime emissions, potentially emissions from buildings and road transport or all fossil fuels combustion and waste incineration, as well as the interactions with the existing regulatory and non-regulatory framework applicable to these sectors.
- Improving support for low-carbon and carbon removal investment and innovation such as carbon contracts for difference e.g. through the existing Innovation Fund.
- The ETS' contribution to addressing specific distributional and innovation challenges related to the transition to climate neutrality and its impacts, including the use of auction revenues and the Modernisation and the Innovation Fund.
- Carbon leakage provisions, such as free allocation rules and updating emission benchmarks, coherence with a potential carbon border adjustment mechanism, indirect cost compensation.

A key issue for the EU ETS under increased ambition is what measures to address carbon leakage will be required in the future. This is the focus of this project and report.

Carbon leakage risk arises when EU businesses are exposed to carbon prices (directly or indirectly) that disadvantage them relative to competing businesses in other jurisdictions. It can lead to reduced EU investment and production, with corresponding increases in other jurisdictions, leading even to a net increase in global emissions. The purpose of this study is to support the Commission in its impact assessment of measures to address the risk of carbon leakage should the EU increase its climate ambition.

Currently, the main mitigation measure to address carbon leakage risk for direct emissions is the free allocation of emissions allowances. For Phase 4, those sectors that are deemed to be at the highest risk of carbon leakage receive 100% at benchmark level of their allocation for free,

[1] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12660-Climate-change-updating-the-EU-emissions-trading-system-ETS-_en

whereas less exposed sectors' free allocation will receive 30% at benchmark level in 2020 to 2026 and then free allocation will be phased out to 0% in 2030. The list of sectors and subsectors exposed to the risk of carbon leakage in Phase 4 has been published by the Commission, based mainly on a quantitative assessment of the carbon leakage indicator, which is the sector's intensity of trade with third countries multiplied by its emission intensity. Supplementary quantitative and qualitative assessments were used for some other sectors.

The calculated allocation is determined using 52 output-based sector and subsector benchmarks that represent the average of the top 10% performing installations in the EU ETS, together with fall-back benchmarks for heat and fuel and fall-back allocations for process emissions. These allocations are made for incumbent and new installations. They are also adjusted for certain changes in production. Under the legislation for Phase 4, the benchmark levels will be updated every five years during the phase, while allocations will more closely track production levels and will be adjusted if they increase or decrease by more than 15%.

In addition, Member States should provide compensation to electro-intensive industries, for their indirect carbon cost exposure. This is subject to Commission Guidelines on State Aid, which define *inter alia*, eligible sectors and the maximum aid intensity they can receive. The Guidelines seek to balance the need to protect vulnerable industries whilst minimising any disincentive for decarbonisation and any impact on the internal market.

This study aiming to support the Commission with the impact assessment for the revision of the ETS Directive comprises two main tasks. Task 1 is divided into five subtasks, the first four of which develop policy options and the fifth is a screening of the options. Task 2 supports the assessment of the potential impacts of the shortlisted options. Tasks 1.1 and Task 2 included the development of spreadsheet-based tools to enable the Commission to carry out its own modifications to potential options and to be able to calculate the expected impacts in a consistent way.

TASK 1.1 – AVAILABILITY OF FREE ALLOWANCES EXPECTED IN PHASE 4

In this task we have modelled modifications of the free allocation mechanism building upon the free allocation tool that was developed in the previous DG CLIMA project on carbon leakage[2] and provided additional modules that would enable the preliminary and final allocation calculated in the tool to be adjusted to take into account the different options for reforming free allocation rules.

1.1. Methodology and assumptions

To estimate the availability of free allowances in Phase 4 of the EU ETS, the following two-step approach was implemented:

1) **Calculation of preliminary free allocation:** Allocation of allowances to individual installations estimated based upon the free allocation formula (see Section 1.1.1).

2) **Calculation of final free allocation:** The preliminary free allocation was then compared with the total amount available for free allocation. This amount is determined by the ETS cap trajectory, the mandatory auction share and the amount earmarked for the Innovation Fund. If the preliminary free allocation exceeded the total amount available for free allocation in a given year, then a cross-sectoral correction factor (CSCF) was applied.

The scope of the estimation of free allocation in Phase 4 includes all ETS countries (i.e. EU-27 and EEA, excluding the United Kingdom). The free allocation of allowances for Phase 4 was modelled based on a 'bottom-up' approach using data from the preliminary national implementation measures (NIMs) at sub-installation level. These data had been submitted to the Commission by the competent authorities in the ETS countries by 30 September 2019.

The following sub-sections provide a description of the calculation of the preliminary free allocation and any subsequent adjustments to estimate the final free allocation by the sector.

1.1.1. Calculation of preliminary free allocation

The distribution of free allowances to installations was based upon a benchmarking approach. The free allocation of allowances has been estimated for Phase 4 based on the following 'bottom-up' formula using preliminary NIMs data at the sub-installation level:

Allocation = Benchmark[3] x Activity Level x Carbon Leakage Exposure Factor (CLEF)

The assumptions applied in order to estimate the preliminary free allocation for Phase 4 included:

---

2 Specific contract N 340202/2019/820554/ETU/CLIMA.B.2 – "Assessment of potential carbon leakage in the third and fourth trading phase of EU Emissions Trading System".

3 For product benchmarks that include an adjustment for the exchangeability of fuels and electricity, a factor was derived from the NIMs dataset for the period 2014 to 2018. This factor represents the weighted average ratio of direct to total emissions (weighting by activity level).

- **Benchmark values** for the period from 2021 to 2025, the updated benchmark values from the Commission Implementing Regulation[4] were used. For the period from 2026 to 2030, the benchmark values were estimated using the same annual update rates that were used to determine the revised benchmark values for the period from 2021 to 2025. For example, annual update rates of 0.2%, 0.9% and 1.6% thus meant that the benchmark values for the period from 2026 to 2030 would decrease by 4%, 18% and 32%, respectively, compared to the benchmark values used in Phase 3. The latter values reflect the 20-year period between 2007/2008, the reference year for the benchmarks used in Phase 3, and 2027/2028. Therefore, the model assumed a continued improvement in the performance of the best installations.[5]

- **Activity levels** were estimated based upon historic information extrapolated using annual growth rates by NACE 4-digit sector (informed by PRIMES modelling, see Annex A2) for the time period 2019-25 and 2026-30. The calculated rates took into consideration the 2020 drop in activity levels due to the COVID-19 crisis. For refineries, no activity level data were obtained from PRIMES modelling. For this sector, a constant production was assumed. For the year 2019, the annual growth rate for the 2019-25 time period was initially multiplied by the historical average activity rate for 2017-18. In each subsequent year, the activity rate was determined by multiplying the relevant annual growth rate by the activity level of the previous year up until 2030.

- **Simplification of free allocation rules** have been applied in the model for Phase 4. Following Regulation (EU) 2019/1842, the historic activity level of an installation for the purposes of free allocation was adjusted when the rolling average of the activity levels of two consecutive years differed by more than 15% compared to the historical activity level of the period 2014 to 2018. The implementation of this rule adjusted the preliminary allocation within the modelling for some installations in the period from 2021 to 2025 allocation. This resulted in an overall increase in preliminary allocation to reflect an increase in production over the time period compared to the historical activity level in the period from 2014 to 2018. However, there was no adjustment of the preliminary allocation in the period from 2026 to 2030 for any installation, as the updated historical activity level for the period from 2019 to 2023 was estimated based on the annual growth rates from PRIMES that did not exceed 2%.

1.1.2. Calculation of final free allocation

The preliminary free allocation was then multiplied by the CLEF and the CSCF in order to determine the final allocation for the different sectors. If a sector is deemed to be at risk of carbon leakage in Phase 4, then the sub-installations belonging to the sector will receive allowances equivalent to 100 % of the relevant benchmark for free (corresponding to a CLEF

---

4 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R0447&qid=1621868213497&from=en

5 The free allocation for process emissions not covered by product benchmarks was set at 0.97 EUAs/t CO_2 equivalents.

of 1). The CSCF is triggered if allocation based on the allocation rules would exceed the budget available for free allocation which depends on the ETS cap scenario.

1.2. Scenarios

The estimation of free allocation over Phase 4 of the EU ETS was then adjusted in a range of scenarios to reflect potential reforms to the free allocation mechanism. The key variables that could be changed within the modelling exercise included:

- The selection of different **cap trajectories**;
- The selection of different **auctioning shares** for each year between 2021 and 2030;
- The introduction of **tiered approach** to free allocation from 2026 onwards based on the carbon leakage indicator value of a NACE code sector (only sectors with a CL indicator value above 2 would receive 100 % of free allocation up to benchmark level);
- The selection of **strengthened benchmarks** by increasing the maximum yearly update rate from 1.6 % to 2.5 % from 2026 onwards;
- The modification of the free allocation budget that is earmarked for the innovation fund.

All of the above variables could be selected within the modelling exercise and the final combination of variables selected and specific conditions applied in the developed scenarios were decided upon by the Commission.

TASK 1.2 – MODIFICATION OF THE MECHANISMS FOR INDIRECT COST OF COMPENSATION

1.3. Future need for indirect cost compensation

Article 10(a)6 of the ETS Directive states that Member States should adopt financial measures in favour of sectors or subsectors which are exposed to a genuine risk of carbon leakage due to significant indirect costs that are actually incurred from greenhouse gas emission costs passed on in electricity prices (commonly referred to as 'pass-through costs'), provided that such financial measures are in accordance with State aid rules, and in particular do not cause undue distortions of competition in the internal market. Over the 27 EU Members, only 10 decided to introduce compensation for indirect costs until 2018 (Belgium, Finland, France, Germany, Greece, Lithuania, Luxembourg, the Netherlands, Slovakia and Spain). Poland and Romania granted indirect cost compensation for the first time in 2020 for costs incurred in 2019[6].

To understand whether there will be a future need for indirect cost compensation, considering the on-going decarbonisation of electricity production, it is necessary to consider the projected grid emission intensity in Europe.

Instead of modelling projected peak plant categories and allowance cost pass-through to different manufacturing consumer classes in all the regional electricity markets, we use the average carbon dioxide emitted within the electricity generation system to estimate allowance cost pass-through. It is acknowledged that this is a proxy that might lead to an underestimation of cost pass-through, if the marginal plants that determine the electricity price throughout the year are more often based on fossil fuel combustion (e.g. coal combustion) than what represents their share in the fuel mix.

Based on the PRIMES data received (see Figure 1), both in the REG and CPRICE scenarios, the CO_2 emissions associated with power production become negligible in 2040 and the *average* role of fossil fuels in electricity price setting *over the year* is expected to be very minor.

[6] Italy and Czechia have also recently announced the introduction of a compensation scheme, however these were not implemented yet to the time of writing

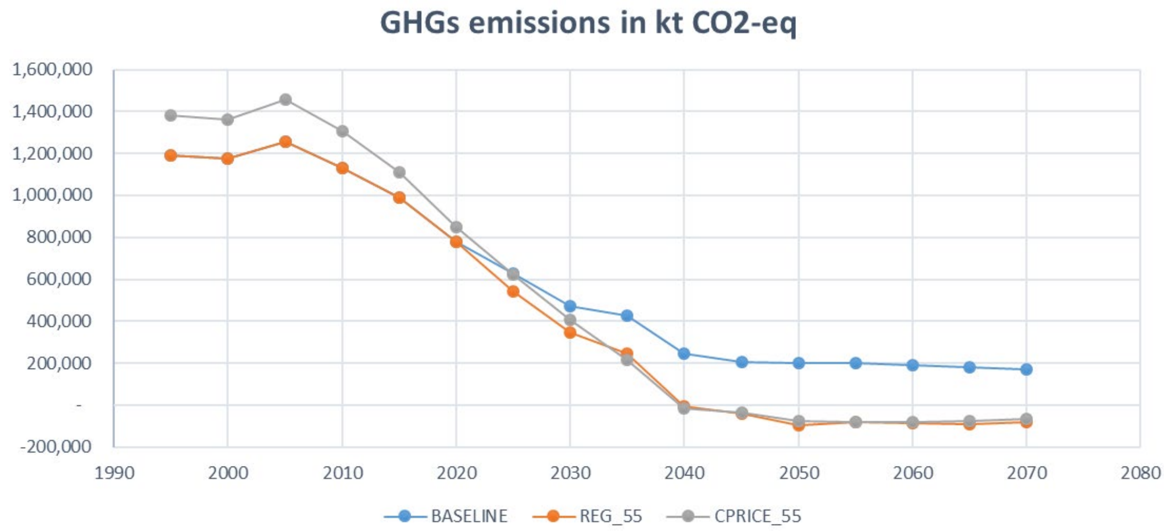


Figure 1: Absolute GHG emissions associated with power production under the three considered scenarios. By 2040 the emissions in the REG and CPRICE scenarios tend to zero.

However, to better understand the need for indirect cost compensation further, it is necessary to consider in more detail the evolution of carbon intensity of electricity generation. The current indirect cost compensation justification uses the average carbon intensity of the fossil fuel mix. As the electricity sector decarbonises, a metric that captures the role of zero carbon electricity will become more relevant. Historically, the cost of supply of the marginal plant has played a central role in determining wholesale electricity prices. Forecasts for the marginal plant were not available for this assessment. Therefore, in the context of the analysis below, average overall carbon intensity of electricity production is used as a proxy. Figure 2 shows the average electricity emissions factor and projections under the three PRIMES scenarios. The value has been obtained by dividing the above absolute values of total GHGs emissions from power generation by the gross electricity production in the relevant scenario. The following can be said:

- The electricity emission factor is expected to continue declining significantly in every scenario. In the baseline, the 2030 value is projected to be 57% of the 2020 figure, while this value becomes 42% and 49% (thus less than half) of the 2020 value in the REG and CPRICE scenario respectively.
- Similarly, in 2035 the emission factor in the baseline scenario is expected to halve compared to 2020 while in the REG and CPRICE scenarios, the expected emission factors will decrease by 79% and 75% compared to 2020 levels.
- In 2040, as mentioned above, the emission factors associated to power production are close to zero in the REG and CPRICE scenarios.

Box 1: Definition of the considered scenarios

The mentioned scenarios are the ones developed for the IA "Stepping up Europe's 2030 climate ambition, investing in a climate-neutral future for the benefit of our people" which are assessed with the PRIMES-GAINS-GLOBIOM modelling suites.

- **BSL**, the baseline scenario, achieving the existing 2030 GHG, RES and EE EU targets;
- **REG,** a regulatory-based measures scenario that achieves around 55% GHG reductions. It assumes high increase of the ambition of energy efficiency, renewables and transport policies, while keeping the EU ETS scope unchanged. This scenario thus does not expand carbon pricing and relies mostly on other policies;
- **CPRICE**, a carbon-pricing based scenario that achieves around 55% GHG reductions. It assumes strengthening and further expanding of carbon pricing, be it via EU ETS or other carbon pricing instruments, to the transport and buildings sectors, combined with low intensification of transport policies while not intensifying energy efficiency, renewables policies;

We consider the average electricity emission factor as a proxy for the shrinking role of fossil fuels and we use this to understand how the cost pass-through would work at low levels of carbon intensity/high proportion of renewables, when reserve costs and system charges may be a bigger part of the wholesale price. Average carbon intensity is expected to halve by 2030 and become less than a third of the 2020 value by 2035 under the REG and CPRICE scenario. The level of cost pass-through to electricity consumers is likely to be somewhat higher due to the higher allowance prices.

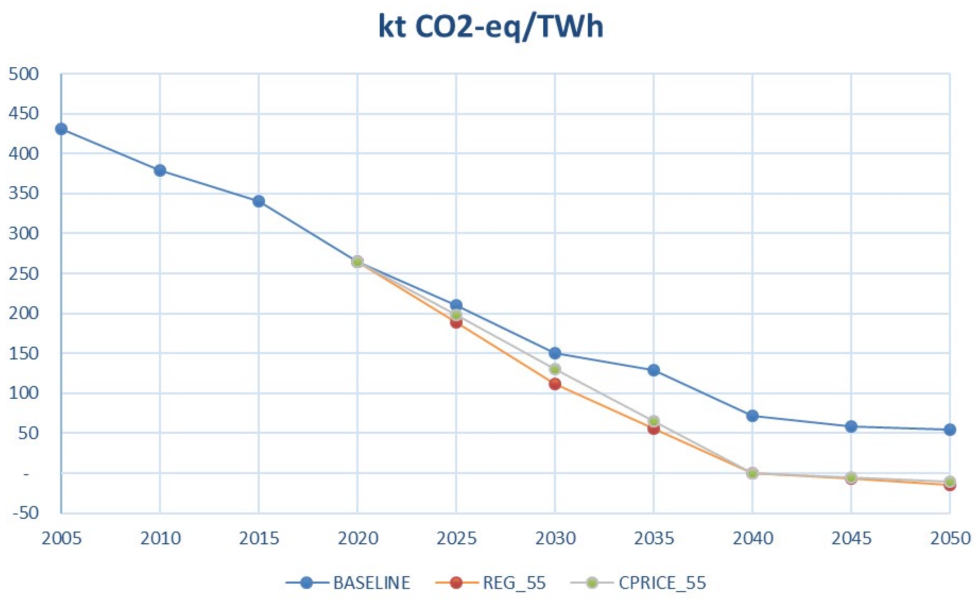


Figure 2: Average electricity emissions factor and projections under the three PRIMES scenarios

Having established the possible future decline in the emission factor, and the downward trend that this will likely also mean for cost pass-through, using a proxy approach of the average emissions intensity, it's then necessary to consider whether the residual indirect costs are likely to be significant enough to require compensation, i.e. whether the costs that sectors might incur would be significant in relation to their economic value. In addition, it might be useful to consider if the administrative costs of operating such a system would be justified.

To answer this question, we have looked to the current eligibility criteria as set in the revised state aid guidelines. The methodology to determine eligibility of sectors is based on the methodology used to establish the Carbon Leakage List 2021-2030 and sectors deemed to be exposed to a genuine risk of carbon leakage due to indirect emission costs.

Currently, sectors considered eligible for indirect cost compensation, must fulfil the following criteria:

- a trade intensity[7] of at least 20%
- an indirect emission intensity[8] of at least 1 kg CO_2/EUR GVA

and in addition, present an "indirect carbon leakage indicator" (ICLI)[9] above 0.2.

In the Impact Assessment accompanying the Guidelines on certain State aid measures in the context of the system for greenhouse gas emission allowance trading post 2021, the "indirect carbon leakage indicators" are calculated for all the sectors, and Annex I of the guidance contains the sectors deemed to be exposed to a genuine risk of carbon leakage due to indirect emission costs (Figure 3 provides a visual summary of the sectors deemed at need of indirect cost compensation and the calculated ICLI).

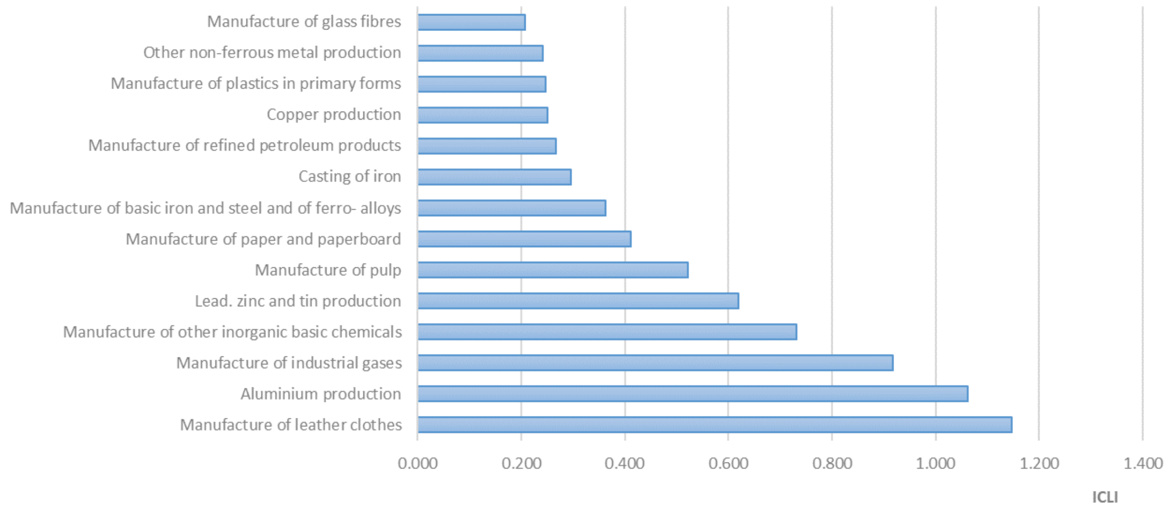


Figure 3: Indirect carbon leakage indicator value for sectors eligible to receive state aid for indirect cost of compensation according to the 2020 revised State Aid Guidance.

Assuming that the current 0.2 ICLI threshold will still be applied in the future as a measure of the need for compensation, to assess the future sectors' exposure and see if sectors fail to meet the threshold receiving compensation, we have assessed how the ICLI value changes, assuming

[7] Trade intensity = (Imports + Exports) / (Turnover + Imports)

[8] Indirect emission intensity = Indirect emissions / GVA

[9] Indirect Carbon Leakage Indicator = Trade Intensity * Indirect emission intensity

that the indirect emission intensity will decrease in line with the average grid emission factor. As described above, the average grid emission factor is decreasing in all scenarios, thus, assuming the same trend also for the indirect emission intensity, while keeping the trade intensity unchanged, the following graphs have been calculated[10].

However, in the CPRICE scenario, a higher carbon price is foreseen, i.e. 60EUR /tonne in 2030. A higher carbon price is expected to bring higher indirect costs and therefore an increased carbon leakage risk. On the other hand, the carbon price is not considered in the sectoral ICLI definition, but was considered in relation to the 0.2 ICLI threshold for indirect compensation eligibility. Thus, it can be concluded that, in the CPRICE scenario, a different threshold for eligibility should be used, which would better represent the actual carbon price. For example, if the carbon price used in the definition of the 0.2 ICLI was 30EUR /tonne, it could be expected that the eligibility threshold in the CPRICE scenario would be halved, due to a doubled carbon price.

For the purpose of this analysis, we have assumed a constant energy efficiency of the installations and of the sectors. While energy efficiency will reduce the electricity demand per product, and therefore the indirect costs per unit of product, the impacts of variations in energy efficiency will be smaller compared to impacts due to changes in the grid mix and carbon prices. We have therefore decided to ignore this parameter, as, not considering it, delivers a more conservative analysis, and a possible overestimate of an indirect compensation need.

Both graphs show the same sectors and variables, one describes the expected situation in 2030, while the second one shows the expected situation in 2035.

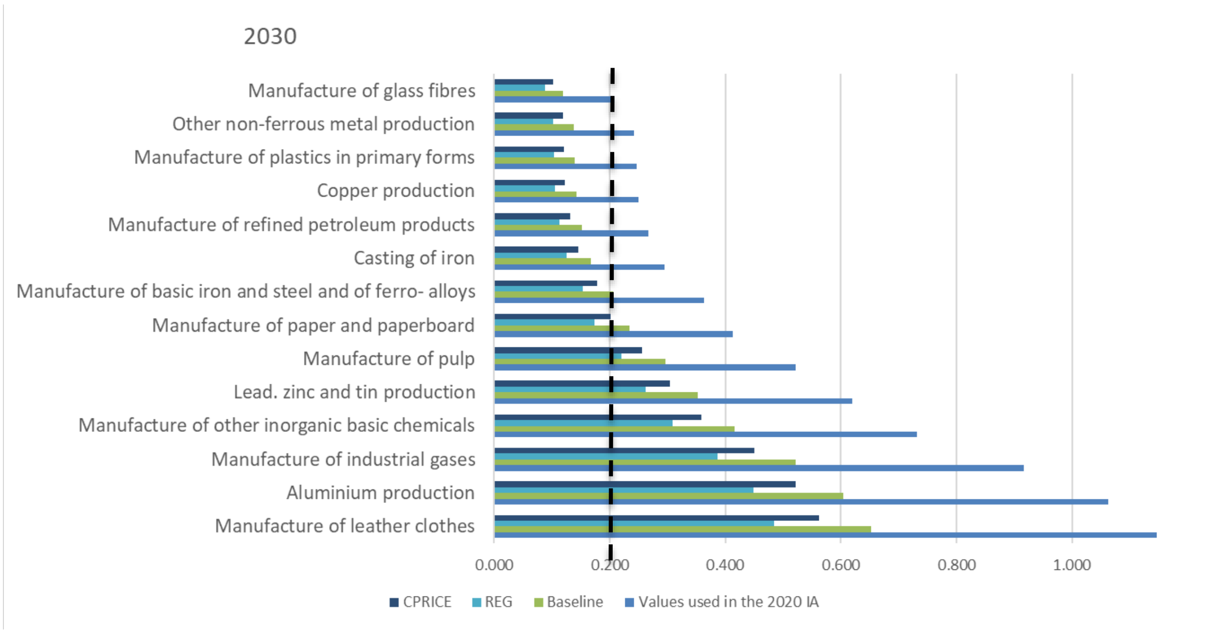


Figure 4: Estimated 2030 indirect carbon leakage indicator for the currently eligible sectors. The dotted line represents the 0.2 ICLI threshold which defines eligibility.

[10] Note: only certain subsector of Manufacture of industrial gases, Manufacture of plastics in primary forms and Manufacture of glass fibres are currently eligible.

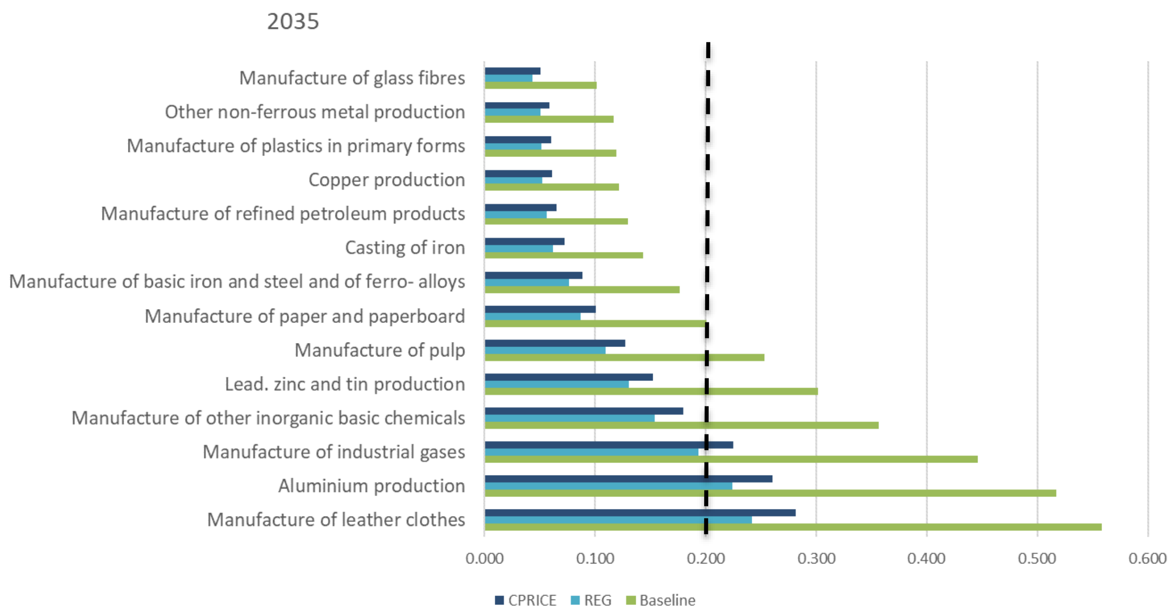


Figure 5:Estimated 2035 indirect carbon leakage indicator for the currently eligible sectors. The dotted line represents the 0.2 ICLI threshold.

By 2030, in both the REG and CPRICE scenario, seven of the 14 sectors/subsectors would still exceed the 0.2 ICLI threshold, these are:

- 14.11 Manufacture of leather clothes
- 24.42 Aluminium production
- 20.11 Manufacture of industrial gases
- 20.13 Manufacture of other inorganic basic chemicals
- 24.43 Lead. zinc and tin production
- 17.11 Manufacture of pulp
- 17.12 Manufacture of paper and paperboard

Under the baseline scenario, these same seven sectors plus one more sector would exceed the 0.2 ICLI threshold, i.e. the manufacture of basic iron and steel and of ferro alloys. This is explained by the fact that the baseline scenario has a slower decarbonisation of the grid network and it is not set to meet the new, more ambitious, 2030 GHG reduction targets.

In 2035, the results across the scenarios are as follows: the baseline scenario sees a larger number of eligible sectors (i.e. 7 sectors), On the other hand, under the CPRICE scenario only three sectors will have an ICLI above 0.2, these are industrial gases, aluminium and leather clothes production, while in the REG scenario only aluminium production and manufacture of leather clothes are eligible.

After 2035 there will be decreasing need for indirect cost compensation, and this need is expected to cease by 2040 when all the sectors under the CPRICE and REG scenario will have an ICLI which reaches zero according to the analysis based on carbon intensity proxy. .

Having estimated that, at least until 2035 there will be sectors with ICLI above 0.2 and therefore eligible for indirect cost compensation, it is necessary to consider the scale of these sectors, to understand the cost effectiveness of allowing compensation arrangements. Therefore, to understand the size and need of the compensation by 2035 we assessed the size of the sectors which remain eligible. Production levels can be considered a good indicator of the size of each sector/subsector in each country, however, production levels are not always available in the PRODCOM database, thus as a proxy for production level, the GVA of the sector in the period 2013 - 2015 has been used.

Figure 6 provides an analysis of the GVA dataset received from DG CLIMA which is used as a proxy for the size of the sectors. The dataset provided has been obtained following a gap-filling exercise carried out by the Commission; however, the dataset still represents some gaps and contains values for 17 of the 27 EU Member States[11].

The plotted value has been obtained considering the average over 3 years (2013-2015). To visualise differences among Member States, the Member States applying an indirect cost compensation mechanism have been shown in blue while the Member States in yellow do not apply such a mechanism. The red dots represent the electricity prices in Euro/kWh obtained from Eurostat[12].

---

[11] MS included are: Belgium, Bulgaria, Croatia, France, Germany, Latvia, Lithuania, Luxembourg, Norway, Poland, Portugal, Slovakia, Spain, Slovenia, Finland, Sweden, Austria and Denmark.

[12] Electricity prices for non-household consumers - bi-annual data (from 2007 onwards) [NRG_PC_205__custom_219671] - All taxes and levies included [I_TAX] - Band IF : 70 000 MWh < Consumption < 150 000 MWh [4162906]

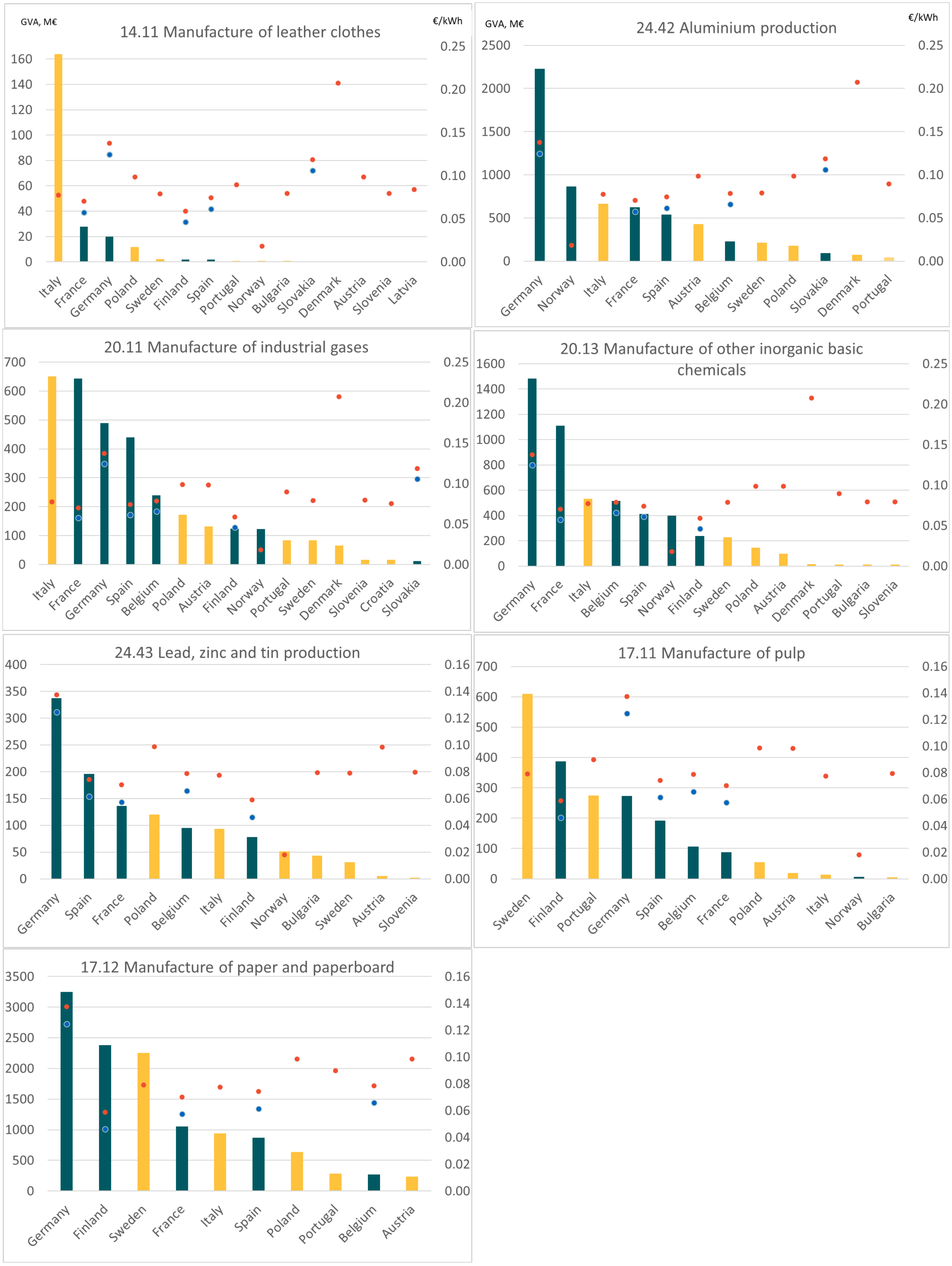


Figure 6: Analysis the GVA dataset received from DG CLIMA.

The graphs show the GVA in million Euro as a proxy for the size of the sectors. Member States in blue apply an indirect costs compensation mechanism while the Member States in yellow do not have such a mechanism. The red dots represent the electricity price in the Member State while the blue dots represent the equivalent electricity price when the indirect cost compensation is taken into consideration.

The figures above show that compensation is applied in a context of highly variable electricity prices.

Moreover, the recent study on energy prices, costs and subsidies and their impact on industry in the EU[13] shows that IEA and Eurostat electricity price databases vary considerably given the different survey approaches (e.g. data reported by the government or individual companies), further illustrating the heterogeneity of electricity prices to energy-intensive industries both within and across Member States.

Finally, the total size of the sectors and the ICLI values used in the 2020 impact assessment are given in Figure 7.

14.11 Manufacture of leather clothes
24.42 Aluminium production
20.11 Manufacture of industrial gases
20.13 Manufacture of other inorganic basic chemicals
24.43 Lead. zinc and tin production
17.11 Manufacture of pulp
17.12 Manufacture of paper and paperboard

Figure 7: Sector size in GVA million euro and indirect carbon leakage indicator as used in the 2020 impact assessment

The analysis shows that the sectors vary considerably in size, with "17.12-Manufacture of paper and paperboard" representing the biggest sector, while having the lowest ICLI value. The sector with the lowest GVA value is "14.11 Manufacture of leather clothes" and this is also the sector with the highest ICLI value.

[13] Study on energy prices, costs and subsidies and their impact on industry and households - Publications Office of the EU (europa.eu)

Based on the above findings, the three sectors still eligible in 2035 (i.e. 14.11, 24.42 and 20.11) account for a total of around EUR 3.6 billion GVA. The design and benefits versus administrative cost burden aspects of the future compensation mechanism needs to be considered in a context of potentially limited and declining number of sectors to which indirect compensation will apply to.

Need for harmonisation

Additional considerations could be made by analysing the differences within a sector as shown in Figure 6. In every sector, there are Member States where the compensation mechanism is implemented and Member States where such a mechanism has not been introduced. This reflects a range of issues including:

- The wider public finance decision-making context. For example, the 2017 report on the use of auction revenues shows that most MS have used a large proportion of auction revenues for climate and energy purposes, however some MS, e.g. Belgium, Hungary, Italy, Poland and Romania directed these to other public finance purposes
- Interaction with channelling of other funds, e.g. European Structural funds such as the European Regional Development Fund and Cohesion Fund where these are used to support energy efficiency in relevant industrial sectors.

Often, Member States where the state aid is not provided, hold a leading position in the sector, representing one of the biggest players. This raises two questions: is there a need for harmonisation across Member States and is the compensation mechanism really necessary? For example, in the manufacture of leather clothes, which is the sector with the highest ICLI value, Italy has the highest GVA, seven folds higher compared to the second Member State. However, Italy does not have an indirect cost of compensation mechanism in place[14], which raises question on the need of compensation, as the biggest player does not receive state aid. It could be pointed out that Italy might hold a "market advantage" in this sector, as the country is probably able to sell "Made in Italy" leather products for a higher GVA. This could constitute an example of a sector that is able to pass through additional costs to final consumers due to the strength of its brand and does not show vulnerability to added electricity costs, at least in the short term.

In addition, other issues could also be taken into consideration, for example, while for the leather sector the proportion of electricity cost could be small compared to the GVA, particularly for the Italian producers, this is not the case for the aluminium sector, where the product is a uniform commodity, meaning price is set internationally and electricity costs constitute a high percentage of total costs.

Similarly, in the pulp sector and in the paper and paperboard sector, a very mixed situation can be observed. The country with the highest GVA in the pulp sector is Sweden followed by Finland while for the manufacturing of paper and paperboard it is Germany also followed by Finland and then Sweden. While Germany compensates installations within the sector, Finland has recently stopped compensating and Sweden never had a mechanism in place, but at the

[14] However, Italy is in the process to introduce a compensation scheme as states in the Gazzetta Ufficiale n. 257 (2nd November 2019) transposing the D.L. n. 101/2019, art. 13. It not clear when the scheme will start.

same time has maintained a leading position for GVA in sector 17.11 and a close third place in sector 17.12.

Another variable which shall be considered when evaluating the need of indirect cost compensation is the electricity price. Electricity prices across Member States can vary considerably and will also change based on the size of the electricity consumer. In Figure 6 we have displayed the electricity price for industry for the band IF (i.e. 70 000 MWh < Consumption < 150 000 MWh) which, based on our analysis, is the average installation electricity consumption when analysing the NIMs data. The graphs do not show a clear correlation between electricity prices and cost compensation, although there are other considerations such as reductions in taxes and levies from which industrial consumers can benefit.

Finally, to evaluate the impact of the disparity of compensation among Member States we have assessed the maximum value that could be compensated per kWh. Considering the formula to calculate the maximum aid payable per installation and assuming an aid intensity of 0.75; a CO_2 emission factor of 0.284 tCO_2/MWh[15] and a EUA price of 60 EUR/tCO_2, as used in the CPRICE scenario, it can be estimated that the compensation per MWh is 12.78 Euro. The blue dots in the graphs show the equivalent electricity prices in Member States that apply the scheme, when the compensation is taken into consideration. However, the difference between the highest price (Denmark 207.5 EUR/MWh) and the lowest price (Finland 58.9 EUR/MWh) is 147 EUR/MWh, thus the market distortion which is generated by the state aid, is probably lower than the one introduced by the electricity prices variability.

Given the analysis performed and the findings discussed above, it is difficult to estimate the impact of market distortion due to a patchy uptake of compensation for indirect costs, particularly when this is compared to the electricity price.

A recent study carried out by the JRC[16] suggests that "*the aid has not had a significant effect on average relative competitiveness, measured in terms of turnover per worker and the value of total assets per employees. However, there is evidence of beneficiaries performing worse than firms operating in non-funded countries when turnover, value of total assets and number of employees are considered as outcomes. This applies to the sample of all firms operating in the sectors eligible to compensation and, to a lesser extent, to businesses active in the aluminium sector alone. These results point to a reduction in performance of aided firms, which might then be subject to a higher risk of carbon leakage*."

The study also recommend that high quality data should be collected to allow a more accurate and solid evaluation of the policy impact.

1.3.1. 25% threshold for indirect cost compensation

Lastly, we have assessed whether the 'soft' provision of the EU ETS Directive which states that a Member State shall set out the reasons when the amount used for indirect cost compensation exceeds 25 % of the revenues generated from the auctioning of allowances is

---

[15] EU electricity intensity factor 2018 - https://www.eea.europa.eu/data-and-maps/daviz/sds/co2-emission-intensity-from-electricity-generation-3/@@view

[16] JRC, 2020, Technical Report – "The Effects of EU ETS Indirect Cost Compensation on Firms Outcomes" - https://publications.jrc.ec.europa.eu/repository/bitstream/JRC119837/jrc119837_ferraragiua2020_ets_jrctechnicalreport.pdf

appropriate. Table 3 summarises the percentage of auction revenues spent on indirect cost compensation in 2017, 2018 and 2019 as reported by Member States.

Table 3: Percentage of auction revenues spent on indirect cost compensation in 2017 and in 2018 in each Member State. Member States which have surpassed the 25% threshold are highlighted in red.

Member State	Duration of the scheme	Percentage of auction revenues spent on indirect cost compensation 2017	Percentage of auction revenues spent on indirect cost compensation 2018	Percentage of auction revenues spent on indirect cost compensation 2019
UK	2013 - 2020	4.60%	3.70%	3.7%
DE	2013 - 2020	34.10%	17.60%	8.5%
BE (FL) BE (WL)	2013 - 2020 2017 - 2020	43.60%	27.30%	11.4%
NL	2013 - 2020	37%	19.50%	8.0%
EL	2013 - 2020	8.40%	8.50%	3.2%
LT	2014 - 2020	4.80%	0.80%	0.3%
SK	2014 - 2020	15.40%	11.40%	2.6%
FR	2015 - 2020	60.00%	31.80%	12.4%
FI	2016 - 2020	40.00%	28.20%	11.6%
ES	2013 - 2015	23%	1.20%	13.3%
LU	2018-2020		50%	23.2%

One of the transparency provisions in the revised EU ETS Directive determines that Member States that have spent more than 25% of their auction revenues on indirect cost compensation in any year have to publish a report setting out the reasons why this amount was exceeded. The table below summarises the reasonings given by Member States in their 2017 reports for Belgium (Flanders), Finland, Germany and the Netherlands, while the 2018 report has been used for France. None of the Member States surpassed the 25% threshold in 2019.

Table 4: Reasons given by Member States in their Carbon Market Reports to justify an expenditure higher than 25% of their auction revenues on indirect cost compensation

Member State	Reasoning
Belgium (FL)	In 2017, the revenues from the Belgian auction amounted to EUR 143,523,215, with an average price of EUR 5.75 / tonne CO_2. In 2017, the total expenditure for compensation for indirect emission costs amounted to 46.75 million euros, fully paid by the Flemish government. The amount spent on compensation for indirect issuance costs amounts to 33% of the Belgian auction revenues received in 2017. There are some explanations for exceeding the 25% threshold. A first element is the **difference between the criteria concerning the distribution of auction between the Member States** on the one hand and the support for indirect compensation on the other. The auction revenues are mainly distributed among the Member States according to the historical emissions of ETS installations, both in industry and in the electricity sector. Where in **Belgium the electricity sector has limited CO_2 emissions, the auction revenues that Belgium receives are relatively limited compared to other Member States**. On the other hand, Belgium has a large energy-intensive industrial cluster, with relatively high electricity consumption. It follows that a relatively large amount of electricity consumption is also eligible for compensation for the indirect emission costs of companies with high energy consumption. Concretely, according to Eurostat 2016 data, Belgium uses 3.7% of industrial electricity consumption in the EU 28, while Belgium receives 2.47% of EU 28 revenue. This means that the 25% threshold is exceeded more quickly than in other Member States. A **second explanation lies in the relevant prices of emission allowances for the payment of compensation for indirect emission costs on the one hand and auction revenues on the other.** The issue costs paid in 2017 are based, in accordance with the guidelines, on the simple average of the closing selling prices of EUAs for December 2016, as observed from January 1, 2015 to December 31, 2015 on a platform of EU carbon exchange given. This price was EUR 7.8 / tonne of CO_2, while the relevant price for auction revenue for 2017 was lower and amounted to EUR 5.75.
Finland	Grounds for the amount of compensatory aid paid in 2017 The Act on Compensation for Indirect Costs entered into force on 1 June 2017. The amendment to the Emissions Trading Directive, which set a 25% recommendation on the maximum amount of compensatory aid, did not enter into force until later, on 8 April 2018. The Finnish compensatory aid scheme strictly complies with the requirements of the European Commission's State Aid Guidelines however, the aid intensity applied is half that of the maximum allowable level. According to

Member State	Reasoning
	the guidelines, a maximum of 80% of the indirect costs of emissions trading can be offset in 2016-2018. **In accordance with the aid intensities set out in the Compensatory Aid Act, aid will be paid in those years at 40% of the approved indirect costs.** The aid scheme has been notified to and approved by the Commission on 4 April 2017. The ratio between compensatory aid and auctioning revenues can vary considerably from year to year due to their different formation mechanisms. The auction proceeds **are determined on the basis of the settlement price of each allowance auction and Finland's share of the allowances in that auction**. The average price of allowances in the auctions held in 2017 was EUR 5.75. The compensatory aid, on the other hand, is retroactive aid, and in 2017 the aid was paid for the reference year 2016. The forward price of the 2016 allowances used to determine the amount of support was EUR 7.72, which was formed in December 2015 on the basis of the average prices of derivative contracts for the following year. Therefore, the forward price is determined on a different time than the auctioning proceeds of the aid payment year. According to the ETS State Aid the amount of aid is calculated annually on the basis of the same reference period. The amount of compensatory aid to be paid therefore varies each year only on the basis of the aid intensity and the forward price of the allowances to be determined. The amount of compensatory aid granted in 2017 is also partly explained by the structure of Finnish industry. **Finland's largest industrial companies operate in sectors that are at risk of carbon leakage and are eligible for compensatory aid.** In addition, the manufacturing of these companies' products is energy-intensive. Although in Finland only 55 plants were covered by the compensatory aid in 2017, these plants used more than 50% of the electricity consumed in industry as a whole.
France	Reasons for exceeding the threshold of 25% of allowances auction revenues The emission allowance auction revenues (including aviation) for France were EUR 312,401,500 in 2017 The amounts necessary for compensation indirect costs therefore represent 31.5% of auction revenues for 2017. This indicator can fluctuate significantly from one year to the next because: **- the price of CO_2 used to offset indirect costs is not that of the current year that determines auction revenues (but that of the previous year)** - the auction volume may be reduced due to market regulation mechanisms (backloading, then the stability reserve of the market) This level is above 25% because **France receives relatively few auctions compared to its energy and industrial activity**. Indeed, the distribution between Member States of the auctions is based on the historical verified

Member State	Reasoning
	emissions of the first years of the EU ETS, which are comparatively lower for France due to its low carbon electricity production.
Germany	The amount of annual aid disbursed mainly depends on two factors: firstly, **the aid intensity**, which was highest in 2013-2015 with 85 percent of the volume of electricity eligible for compensation, then 80 percent for 2016 to 2018 and it will drop to 75 percent in 2019 and 2020. Secondly, **the relevant EUA price**. For electricity price compensation, this is determined based on the respective previous year average of the daily settlement prices of the exchange-traded reference contract for European emission allowances. For all accounting years, this was the futures contract traded on the ICE in London with delivery in December of the following year. Thus, the maturity of the reference contract corresponds to the accounting year of the electricity price compensation. **EPC price and auction price are clearly drifting apart.** The relevant calculation price for electricity compensation is determined from the average of the future price in the previous year, so that **there is a one-year delay between the pricing for electricity price compensation and auction proceeds.** Certain developments are thus not yet reflected in the price relevant to aid calculation. If the prices for aid calculation and auctions were identical, the share of the aid in the German auction proceeds would be between 19 and 31 percent in the 2013–2018 period. If one were to take hypothetical account of the EUA quantities not auctioned in the years 2014 to 2016 due to backloading, the share would be between 18 and 23 percent. By default, this calculation approach also includes the reductions of the auction quantities at the beginning of 2019 in the withdrawn volume of the market stability reserve.
Netherlands	Since the total amount of compensation amounts to more than 25% of the Dutch annual auction revenues, the reporting obligation in paragraph 2 of Article 10a (6) also applies to the Netherlands to state the reasons for exceeding this percentage. The total Dutch auction proceeds held in 2016 amounted to EUR 145.5 million (2016 National Budget, annual report, Infrastructure & Environment budget, art. 19). This means that the expenditure of the subsidy scheme for indirect costs ETS 2017 (for the year 2016) amounted to approximately 37% of the auction revenues in the same year. The Netherlands thus spent more than 25% of the proceeds from auctions on the subsidy scheme for indirect costs ETS. These expenses can be explained as follows. The Dutch subsidy scheme for indirect costs ETS is the result of agreements with social parties in the Energy Agreement (2013). In the Energy Agreement (2013) it was agreed that the **government would compensate companies that are sensitive to carbon**

Member State	Reasoning
	leakage and that participate in a covenant to promote energy efficiency for the period from 2013 to 2020 for the indirect emission costs as a result of the EU Emissions Trading System (EU ETS). The scheme is also in line with the European state aid measures in the context of the emission allowance trading scheme. The obligation to participate in a covenant to promote energy efficiency also shows that there is indeed attention in the Netherlands for measures other than indirect cost compensation to sustainably reduce indirect CO_2 costs in the long term. In 2017, the cabinet conducted an evaluation of the subsidy scheme for indirect emission costs ETS. The evaluation concluded that the scheme is being implemented effectively and efficiently and is generally functioning well. The evaluation does, however, make a number of recommendations with regard to possible adjustments to the scheme**, including the suggestion to focus the scheme more on companies where the indirect electricity costs as a result of the ETS are most likely to adversely affect international competitive position**. In the light of the agreements made with the parties to the Energy Agreement that have been made for the entire period from 2013 to 2020, the cabinet has decided to maintain the scheme in its current form. If continued, these recommendations could be included in the evaluation. It has not yet been decided on a possible continuation of the scheme from the year 2021.

Based on the reasons given by Member States, perhaps, capping the level of compensation to an amount of auction revenues, might not be the most appropriate approach:

- **The level of allowances and compensation budget is not aligned with the industrial electricity consumption amounts**. A Member State could pass the 25% threshold because it received lower auction revenues compared with the electricity usage by their industry. For example, the electricity sector has limited CO_2 emissions (e.g. Belgium and France), however, the Member State might have a large cluster of industries which are eligible for indirect cost compensation, therefore is more likely to go above the 25% threshold.
- **The carbon price used to set the budget and distribute the budget is different**. The discrepancy between the price of CO_2 used to offset indirect costs and the one that determines auction revenues introduces an artificial increase (or decrease) of the calculated percentage value.

Based on this assessment, alternative approaches such as

- The inclusion of the relative standing of the MS electricity carbon intensity compared to the EU average in the calculation of the advisory compensation ceiling, therefore allowing MS with less carbon intensive electricity and therefore lower auction revenues to provide comparable compensation levels to other MS, or
- The removal of the advisory 25% auction revenue ceiling altogether, therefore allowing the total maximum compensation cap to equal the sum of the limits imposed at the installation level by the State Aid Guidelines for Indirect Cost Compensation based on 75% of the product of the relevant emission factor, electricity use benchmark and actual output levels.

1.3.2. Can the conditionality mechanism that is being introduced with the revised state aid guidelines be enhanced?

In the revised state aid guidelines, additional conditions are considered (see box below), and the revision of the EU ETS would allow for exploring more options and conditions to be imposed for indirect cost compensations.

> Conditionality rules in the Guidelines on certain State aid measures in the context of the system for greenhouse gas emission allowance trading post 2021, published September 2020:
>
> 55. Member States also commit to monitoring that beneficiaries covered by the obligation to conduct an energy audit under Article 8(4) of Directive 2012/27/EU will:
>
> **(a) implement recommendations of the audit report**, to the extent that the payback time for the relevant investments does not exceed 3 years and that the costs of their investments is proportionate; or alternatively
>
> **(b) reduce the carbon footprint of their electricity consumption,** so as to cover at least 30% of their electricity consumption from carbon-free sources; or alternatively
>
> **(c) invest a significant share of at least 50% of the aid amount in projects that lead to substantial reductions of the installation's greenhouse gas emissions** and well below the applicable benchmark used for free allocation in the EU Emissions Trading System.

The ETS Guidelines have been criticised in the past as they can be perceived as handouts of public resources to polluting industries which, as a consequence, put a lower effort in reducing GHGs emissions. The new impact assessment study released by the European Commission suggests that hard evidence of carbon leakage had not been identified up to 2015, but that this could change further to a significant increase in carbon prices.[17] However, JRC-GEM-E3 modelling supporting the Green Deal IA shows a decrease in both output and employment for non-ferrous metals under the fragmented action scenario compared to the global action scenario. This is an indication of carbon leakage risk that is not empirically measurable from indirect emission costs.

The policy options below consider and build on the IA to support the latest *Guidelines on certain State aid measures in the context of the system for greenhouse gas emission allowance trading post 2021*. They are framed within the objectives of the State Aid for indirect cost compensation, which are to avoid or reduce carbon leakage in a proportional manner, i.e. the minimum level of aid should be disbursed to achieve the environmental protection sought.

In terms of conditionality, the IA document stipulates a focus on the beneficiaries' performance as regards energy efficiency. Among other conclusions, the assessment determined that the most efficient options are those that are most targeted.

With a view to improving targeting, a potential option would be to link the stringency of the payback limit on investments in condition (a) to the performance of the installation against the

---

[17] https://ec.europa.eu/competition/consultations/2020_ets_stateaid_guidelines/consultance_report.pdf

electricity consumption benchmark. This would preclude the risk of continued compensation to underperforming installations.

The increase in EU ETS ambition will lead to higher allowance prices and a decrease in fossil-fuel based electricity generation. As the change in carbon prices resulting from increased ambition[18] is captured in the indirect compensation formula, the conditionality rules only require an adjustment with regards to the percentage of carbon-free electricity in the grid. Whereas stakeholders have disputed the feasibility of the requirement to purchase 50% carbon free electricity[19], a lower role of fossil-fuelled generation will eventually transform the current 30% figure into a non-binding constraint. Suggested options are to index the percentage of carbon free electricity to the relevant regional electricity market fuel mix or to increase the 30% figure in absolute terms.

Removing the choice between conditions a) and b) would further enhance the targeting of the aid.

Current formulation	Suggested change: Option stringency	Suggested change: Targeting
(a) implement recommendations of the audit report, to the extent that the payback time for the relevant investments does not exceed 3 years and that the costs of their investments is proportionate;	Increase payback time duration	Link payback time duration to installation performance against the relevant electricity consumption benchmark.
(b) reduce the carbon footprint of their electricity consumption, so as to cover at least 30% of their electricity consumption from carbon-free sources;	1. Increase percentage of carbon-free electricity sources, e.g. 35%-40%. 2. Index the percentage of carbon-free electricity sources to the average for the relevant regional electricity market, as a minimum.	

[18] The increase in carbon prices would lead to increased distortions caused by differentiated State Aid application at MS level

[19] This option was discarded as part of the IA process.

Current formulation	Suggested change: Option stringency	Suggested change: Targeting
Choice between a), b) and c). *Evaluation of impacts depends on options above.*	Remove the choice between a) and b).	

The options above do not reduce potential intra-EU distortions, other than through limiting provisions. Without undertaking EU-wide indirection cost compensation, intra-EU discrepancies can be addressed outside the specific definition on conditionality through:

- Requiring proof that the electricity prices the installation is subject to do not exceed average EU electricity prices for the relevant consumer size category.
- Either remove the advisory indirect compensation ceiling (25% of auction revenue), allowing the ceiling to equal the sum of the compensation limits at the individual installation level or link the compensation ceiling to the relative emission factor of the MS electricity system.
- At the end of the spectrum of change from latest indirect compensation provision, the creation of an EU-wide mechanism that allows access to funding to all qualifying installations in the EU.

In addition to these, the options of no change to current conditionality provisions and removing them altogether can also be considered.

TASK 1.3 – NEW INSTRUMENTS AND ALTERNATIVE WAYS

A key issue for the EU ETS under increased ambition is what measures to address carbon leakage will be envisaged in the future. Carbon leakage risk arises when products are substituted by imported products not subject to equivalent carbon costs. It can lead to reduced EU investment and production, with corresponding emission increases in other jurisdictions, leading potentially to a net increase in global emissions.

Literature tends to focus on three main ways of mitigating carbon leakage associated with emissions pricing policies:

1. **Exempting the industries that are most exposed to foreign trade**. This approach negates the risk of carbon leakage but removes incentives to reduce emissions.

2. **Output-based rebating or 'benchmarking' the allocation of emissions allowances**. This approach allocates emission allowances to firms up to a benchmark for each unit of production. The benchmarks set tangible goals that each industry can reasonably achieve. Firms are then required to pay emissions allowances in excess of the benchmark. If firms emit fewer emissions per unit of production than the benchmark, then they can trade their allowances in the ETS.

3. **Border adjustments**. This approach levies tariffs on the embodied carbon of imported products, and potentially refunds the carbon price paid on exported goods. It retains the price incentive to reduce emissions while creating an equal playing field for domestically produced and imported goods.

These policies aim to ensure that domestic industries are not placed at a competitive disadvantage relative to foreign ones with less stringent climate policies.[20]

A growing body of literature suggests that carbon pricing and (if implemented) border carbon adjustments (BCA) alone will not be enough to induce the deep decarbonisation required to hit the EU's ambitious climate targets. In industries where carbon-intensive technologies and processes have an established competitive advantage, the level of carbon pricing required to induce a technological shift to zero or near-zero carbon options may be unacceptably high.[21] Moreover, aggressive carbon pricing policies risk reducing cash flows that could otherwise be invested in research and development of cleaner technologies.[22]

Benchmarking the allocation of emission allowances addresses some of these concerns by not overly burdening firms with carbon costs that cannot be reduced, while retaining a market

---

[20] Carbon Trust. (2010). *Sector-specific solutiuons for a world of unequal carbon prices.* London.

[21] Acemoglu, D., Aghion, P., Bursztyn, L., & Hemous, D. (2012). The Environment and Directed Technical Change. *American Economic Review, 102*(1), 131-166.

[22] Fischer, C. (2019). *Market-Based Clean Performance Standards as Building Blocks for Carbon Pricing.* Washington, DC: The Hamilton Project, Brookings.

incentive to beat the benchmark.[23] However, benchmarking is unlikely to drive deep decarbonisation in production processes. Acemoglu et al. (2012)[24] argues that optimal environmental policy involves a combination of carbon pricing to control emissions and subsidies to influence the direction of research and development of clean technologies.

Meeting the EU's ambitious climate targets will require deep decarbonisation across the economy. For emission-intensive industries, like cement, steel, and chemicals, deep decarbonisation will require much more than incremental improvements to production methods. Instead, it will require product redesign leading to enhanced material efficiency, a scaling-up in the re-use and recycling of emission-intensive materials (circular economy), and substantial innovation and investment in new decarbonised industrial technologies and processes.[25]

This section will explore and identify three alternative and potentially complementary approaches to mitigating carbon leakage risk:

- **The use of funds**, where the support to low-carbon technologies is more aligned with mitigating carbon leakage exposure

- **Carbon Contracts for Difference (CCfD)** to incentivise investment in low-carbon production and the application of abatement technologies by reducing the uncertainty around carbon prices and provide an additional incentive beyond expected future carbon prices.

- **Minimum CO_2 standards** that are applied equally to EU-produced and imported products would protect compliant EU industry from being undercut by cheaper, higher carbon–intensive products from jurisdictions without carbon policies.

For each of these mechanisms, we review relevant literature to assess how these mechanisms may be employed as part of a package of policies designed to simultaneously address the risk of carbon leakage, while promoting material efficiency and fostering innovation in breakthrough technologies.

We then suggest options within each category based on real policy examples in other settings, as well as ideas put forward by other commentators (academics or industry). The set of policy options include specific existing models applied in an EU ETS context as well as new approaches that draw on good features of other systems.

---

[23] Fischer, C. (2019). *Market-Based Clean Performance Standards as Building Blocks for Carbon Pricing.* Washington, DC: The Hamilton Project, Brookings.

[24] Acemoglu, D., Aghion, P., Bursztyn, L., & Hemous, D. (2012). The Environment and Directed Technical Change. *American Economic Review, 102*(1), 131-166.

[25] Bataille, C. (2020). Physical and policy pathways to net-zero emissions industry. *WIREs Climate Change, 11*, 1-20.

Section 3.4 presents a final set of options to take forward into Task 1.5, at which point they will be screened alongside candidate approaches from other subtasks to determine the options that will be assessed in Task 2.

1.4. The use of funds

Many jurisdictions have policies and funds in place to foster technological innovation. Yet surprisingly little literature has explored the impact that funding for low-carbon production or innovation could have on carbon leakage.

Instead, most literature examining climate funds focuses on how they can be used to drive low-carbon innovation. The debate is less about protecting losers, and more about fostering innovation to help the EU develop a leading position in industries of the future.[26] This section will explore how EU public funds, through existing vehicles or others, could be targeted in a way that directly aims to reduce carbon leakage.

In theory, the impact of innovation policy and funds on leakage could be significant:

1 Reductions in the cost of breakthrough technologies could reduce a firm's costs associated with abiding with more stringent carbon regulation / pricing, eliminating the incentive to re-locate.

2 Funds supporting the application of new technologies could incentivise competitive companies to shift production home, giving the EU an early mover advantage in technologies that will play a key role in the future.

3 Unlike other measures to address carbon leakage, funding for innovation in breakthrough technologies could lead to a reduction in non-EU emissions if the breakthrough technologies developed at home are subsequently adopted in foreign markets.[27]

In order to foster innovation in the technologies that can help mitigate carbon leakage, funds will need to be targeting the right technologies in those industries that are at risk of carbon leakage through the right public financing mechanism (PFMs).

Sectors at risk of carbon leakage are those that are carbon- or energy-intensive, so face substantial additional costs due to the implementation of abatement policies, and at the same time are highly exposed to international trade. Trade-exposed companies are less capable of passing the additional costs onto consumers without losing market share. In the EU ETS, the sectors at risk of carbon leakage receive a higher share of emissions allowances for free to safeguard their competitiveness. The sectors and sub-sectors at risk of carbon leakage for the

---

[26] Görlach, B., & Zelljadt, E. (2018). *Forms and Channels of Carbon Leakage.* Berlin: German Environment Agency.

[27] Fischer, C., Greaker, M., & Rosendahl, K. E. (2017). Robust technology policy against emission leakage: The case of upstream subsidies. *Journal of Environmental Economics and Management*, 44-61.

period from 2021 to 2030 were determined through Commission Delegated Decision (EU) 2019/708.[28]

Emissions in the iron and steel, cement, and chemicals sectors are particularly difficult to abate due to their high-temperature processes and/or chemical process emissions. Nevertheless, recent publications have identified emerging zero or near-zero technology options to decarbonise the production of basic materials.[29] [30] [31] In general, emerging technological options are based on widespread electrification with carbon free electricity generation, decarbonised heat sources (such as electricity, biomass, renewable-based hydrocarbons or hydrogen), carbon capture and storage (CCS) or utilisation (CCU), and alternative cement chemistries. If these early-stage breakthrough technologies can be deployed at a competitive cost, it would address carbon leakage by eliminating the incentive for firms to re-locate to take advantage of more lax regulations / pricing.

Even with carbon pricing and border tax adjustments, industrial firms will tend to underinvest in early stage breakthrough technologies for a variety of reasons – capital costs are high, profit margins low, and given that industrial producers tend to be price takers, they cannot pass through costs to consumers without losing market share and competitiveness.[30] Without government support, breakthrough technologies that could help address carbon leakage will not make it to the market. Many of the strongest examples of growth-driving innovation – from IT to biotech to renewable electricity generation – required significant public investment in innovation at the outset.[32]

A substantial body of research has examined the optimal design of subsidies and other public financing mechanisms (PFMs) to guide technological development. It shows that governments have an important role to play in supporting early stage R&D, but also in helping nascent low-carbon innovations bridge the so-called 'valley of death' by helping bring them to commercial viability. Bataille (2020)[30] outlines how technology readiness level (TRL) provides a measure of different industrial technologies stage of development: "'*Near-commercial' technologies (TRL 8–9) are defined as those that are well developed but current relative energy prices (e.g., for electricity, natural gas, petroleum products, and coal) make them too expensive (e.g., electric boilers), or regulations limit or prevent their use (e.g., substitution of up to 40% of clinker with calcined clays and limestone fillers or pozzolanic cementious materials in cement). 'Emerging" technologies' (TRL 1–7) are defined as those that work at the lab bench level but*

---

[28]https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2019.120.01.0020.01.ENG&toc=OJ%3AL%3A2019%3A120%3AFULL

[29] Material Economics. (2019). *Industrial transformation 2050 industrial transformation 2050: Pathways to net-zero emisisons from EU heavy.* Cambridge: University of Cambridge Institute for Sustainable Leadership.

[30] Bataille, C. (2020). Physical and policy pathways to net-zero emissions industry. *WIREs Climate Change, 11*, 1-20.

[31] IEA. (2019). *The fugure of hydrogen.* Paris: International Energy Agency.

[32] Mazzucato, M. (2013). *The Entrepreneurial State: Debunking Public vs. Private Myths.* London: Anthem Press.

need development to scale-up and become commercially available (e.g., directly electrolyzed or hydrogen-based virgin steel)."

Figure 8 shows how government funds and policy can target each of different stages of technological development to unlock investment throughout the innovation chain. The following sections explore how funds can be used to support low-carbon industrial technologies in each of these different stages of development and assesses whether the existing EU funding architecture is sufficient at each of these stages within the sectors at risk of carbon leakage.

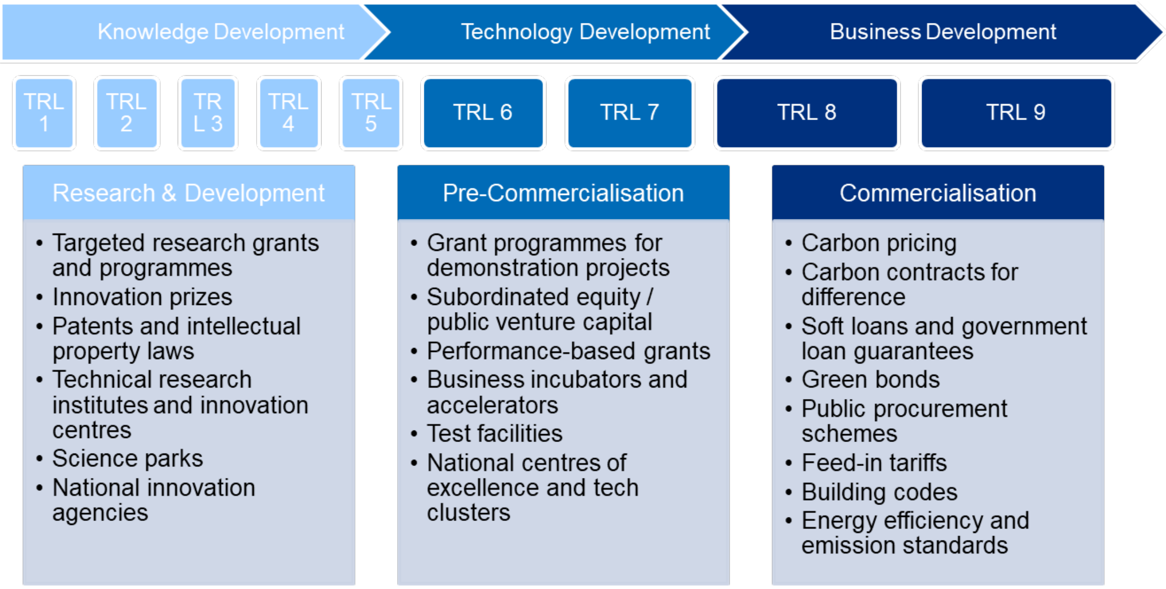


Figure 8. Public support for different stages of technology development and risk-profiles

1.4.1. Funds for Research & Development

1.4.1.1. PFMs needed to support R&D

The riskiest point to invest in a technology is the research and development (R&D) stage. Given that the risk profile of technologies at the R&D stage is often too high for traditional investors, funding tends to be dependent on public support.

Technology push policies are required in the R&D stage to develop a pipeline of innovations and bring down their cost. PFMs effective at this stage are grants and contingent grants, the latter of which are loaned to project developers without interest or repayment until business is viable. Funds may also need to be invested in the delivery of non-financial support to help develop the networks and technical capacities in science and engineering that are required for R&D.

Innovation prizes offer another cost-effective tool to direct private R&D towards ground-breaking discoveries. Payments are made to project developers only after they achieve a pre-determined goal. Innovation competitions could be established for commercially viable technological innovations in carbon capture and storage, electrolysis derived hydrogen, zero-carbon cement, etc. Innovation prizes are only awarded when an inventor is successful, and because the prize money is less than the amount the government would need to spend to develop the same technology, innovation prizes are a 'no lose' strategy. Innovation prizes leverage not only the private investment and technical expertise of the winners of the competition, but also of numerous other participants. Private investors are frequently keen to support the viable innovations that come forth.

Despite the benefits, innovation prizes do not provide predictability in funding and therefore cannot replace other PFMs. However, they are a useful supplement that could spur private initiatives and produce unexpected gains.

1.4.1.2. EU support vehicles for R&D

The **Horizon Europe** framework programme is the EU's proposed EUR 100 billion research programme for the years 2021-2027, which will succeed Horizon 2020. The Commission is currently engaged in public consultations on the structure and strategic plan for Horizon Europe. The second pillar of the strategic plan – Global Challenges and European Industrial Competitiveness – aligns directly with the objective of fostering cost-effective zero-carbon industrial technologies, mitigating the risk of carbon leakage.

Another relevant EU vehicle for research funding is the **Research Fund for Coal and Steel (RFCS)**, which provides around EUR 40 million in research funding annually to universities, research centres and private companies. Among other topics, the RFCS provides funding for research into emission reductions from steel production. One ongoing example is the project Green Steel for Europe (GREENSTEEL), which aims to develop a technology roadmap and define mid- and long-term pathways for the decarbonisation of the steel industry. GREENSTEEL was funded through a EUR 1.2 million research grant and includes a consortium of 10 partners, coordinated by the Centre for European Policy Studies (CEPS).

1.4.2. Funds for Pre-Commercialisation

1.4.2.1. PFMs needed to support pre-commercialisation

Businesses often encounter frequent difficulties in raising funds for the initial deployment of a new technology. This so-called pre-commercialisation stage involves capital-intensive activities such as large-scale demonstration and repeated testing of commercial viability. At the same time, the risk profile remains too high for many private investors.

The main types of private investment at the pre-commercialisation stage are corporate RD&D (Research, Development & Demonstration) spending and venture capital. The IEA (2020)[33] found that corporate spending is the largest single source of funding for RD&D in the energy sector. However, unlike governments, large companies allocate very little funding to new technologies, and instead focus RD&D spending on incremental improvements of existing technologies and product development.

Venture capitalists specialise in high-risk equity investments in companies that other investors deem too risky. Venture capital will only be forthcoming where projects forecast potentially

---

[33] IEA. (2020). *Energy Technology RD&D*. Paris: International Energy Agency. Retrieved from https://www.iea.org/reports/energy-technology-rdd-budgets-2020

high returns. Technologies that offer lower potential returns will struggle to secure private investment, even if they could achieve significant gains in terms of GHG emissions reduction. Moreover, given the high returns that venture capitalists expect from a successful business, their involvement in a pilot will drive up the break-even ETS price, i.e. the price at which the breakthrough technology's higher costs could be entirely covered through savings on carbon costs or the sale of emissions allowances.

As a result of these challenges, many potentially viable technologies and business models fail to commercialise for lack of funds. The 'valley of death' refers to the gap between government funding for R&D and the point at which private capital is willing to take on the risks associated with a new technology. Frequently, firms aiming to commercialise new technology will require government funds to bridge this gap.

Government funding for demonstration of pre-commercialisation technologies (TRL 6-7) can go a long way in overcoming perceived technological risks by showing that it is willing to get its own 'skin in the game.' An important example is the Swedish Industrial Leap programme's support for the pilot HYBRIT Development (Box 1), which attracted co-investment from a series of companies that stand to benefit from the new technology.

Box 1. Swedish Industrial Leap and HYBRIT Development

The Swedish Industrial Leap programme, run by the Swedish Energy Agency, provides financial support for research, feasibility studies, pilot and demonstration projects and full-scale investments to support Swedish industry to reduce process-related emissions. The Industrial Leap programme began in 2018 and will run until 2040, with funding of SEK 300 million (EUR 29.4 million) per year. Industries, universities and research institutes are all eligible for funding.

The first funding awarded by the Industrial Leap programme was to Hydrogen Breakthrough Ironmaking Technology (HYBRIT) Development. HYBRIT Development is a joint venture between the steel manufacturer SSAB, the mining company LKAB and the energy company Vattenfall. The objective is to develop the first fossil-free, primary steelmaking process by using fossil-free electricity and hydrogen in steelmaking, instead of coke and coal. HYBRIT Development began in 2016 and aims to have the technology in place by 2035, which it estimates could reduce Sweden's emissions by 10 percent (Pei, Petäjäniemi, Regnell, & Wijk, 2020).

The estimated total cost of the pilot phase will be SEK 1.4 billion (EUR 136 million), with SEK 528 million (EUR 51 million) from the Swedish Energy Agency and the balance from SSAB, LKAB and Vattenfall.[34]

For more advanced pre-commercialisation technologies, PFMs such as public venture capital, subordinated equity, loan guarantees and concessional loans can also be used to crowd-in

[34] Bioenergy International. (2018, June 18). Swedish Energy Agency awards record funding to HYBRIT. Retrieved from https://bioenergyinternational.com/research-development/swedish-energy-agency-awards-record-funding-to-hybrit

private investment. By crowding-in, rather than crowding-out private capital, government funds will achieve more value for money for public resources.

When providing public funding for higher risk technologies and companies, it must be accepted that not all investments will succeed. Some companies will go bankrupt, and some technologies will fail to commercialise. Failed investments are likely to create political backlash due to the perception of wasted public funds. Nonetheless, it is important that public financing schemes for pre-commercialisation are evaluated based on the performance of the entire portfolio rather than based on individual investments. As illustrated in Box 2 on the American Recovery Act, public financing programmes can be instrumental in fostering new breakthrough technologies. Provided that transparent procedures to evaluate applications and monitor investments are in place, they can even turn into a profit. The example of the American Recovery Act illustrates the values and perils of a high-risk, high return approach to financing innovation. Although the programme was a strong success by all financial measures, it also came under fire for the failure of one of its investments taken in isolation, showing that even when effective, there are political challenges to conveying the public policy benefits of this approach.

Box 2. The American Recovery Act's Clean Energy Package

The American Recovery and Reinvestment Act was launched in 2009 during the worst recession the US had seen since 1930. It injected US$787 billion (EUR 670.2 billion) in fiscal stimulus into the American economy, equivalent to 5.5% of the GDP. The massive investment aimed, first and foremost, to save and create jobs and prevent further economic deterioration. However, a secondary aim of the Recovery Act was to promote the deployment of low-carbon energy technologies. In total, US$90 billion (EUR 76.6 billion) in public spending and tax exemptions were provided to clean energy technologies.[35]

The Department of Energy (DOE) was allocated over US$35 billion, more than triple its 2009 appropriation for civilian energy activities. Given that the primary purpose of the Act was economic stimulus, it was necessary for the funds to be spent quickly. The DOE was required to expand its traditional focus on science, applied research, and demonstration to include the scaling up of commercial technology deployment.[35]

As a stimulus package, the performance of the clean energy portfolio of the Recovery Act was mixed.[36] As a clean energy investment portfolio, however, the Recovery Act was an undeniable success. The US$46 billion invested in clean energy leveraged more than US$200 billion in private sector and non-federal government spending on clean energy, more than 37% of the co-investment secured by the Recovery Act as a whole.[37] Rebate programs helped to diffuse over one million ENERGY STAR-labelled energy efficiency appliances in a very short period.[36] Through tax credits, grants, and loan guarantees the Recovery Act

[35] Aldy, J. E. (2013). A Preliminary Assessment of the American Recovery and Reinvestment Act's Clean Energy Package. *Review of Environmental Economics and Policy, 7*(1), 136-155.

[36] C2ES. (2013). U.S. Department of Energy's Recovery Act Investments: Center for Cliamte and Energy Solutions.

[37] Council of Economic Advisors. (2010). *The economic impact of the American Recovery and Reinvestment Act of 2009. Fourth quarterly report.*

caused investment in wind power in 2009-10 to be triple the amount projected in the Energy Information Administration's (EIA) business-as-usual scenario.[38] Between 2008 and 2009, wind generating capacity increased 60%, and solar photovoltaic capacity grew almost 300%.[39] [40]

Despite this success, it was the DOE's investment in renewable energy that generated some of the most high-profile controversy around the Recovery Act. Most notably, when a solar company, Solyndra, defaulted on a US$535 million loan guarantee in 2011, it was portrayed in the media as a national scandal. However, the DOE loan programme, as a whole, has a default rate of less than 2.28%, a level that any financial institution would deem a success. When the interest collected on the programme's loans is factored in, the programme is operating in the black – this despite the fact that in the programme's inception, Congress did not anticipate that it would generate an income, and even set aside US$10 billion to cover its losses.[41]

The loan guarantees provided under the stimulus package ended in September 2011. However, by helping commercial providers and private investors gain experience with utility-scale solar plants, the initial investments provided by the DOE laid the foundation for a rapidly growing industry that by 2014 was entirely commercially financed, and delivering 57 times the installed utility-scale PV solar than the EIA had projected just seven years prior.[42]

1.4.2.2. EU support vehicles for pre-commercialisation

The EU has a number of support vehicles for demonstration of innovative low-carbon technologies and processes. A number of the funds supporting R&D, including the RFCS, also support demonstration and pre-commercialisation. **The LIFE Programme**, which is managed by DG ENV, DG CLIMA and the Executive Agency for Small and Medium-sized Enterprises (EASME) provides grants to, among other things, company-led 'close-to-market projects' that aim to launch innovative, demonstrative solutions that offer clear environmental and/or climate benefits. The LIFE Programme will fund up to 55% of each project to help with the commercialisation of innovative solutions. It has supported several projects in industrial sectors including the ongoing LIFE CO_2 TO FUEL project led by the Spanish steel producer Celsa. The project aims to build and test a pilot plant able to capture 800 tonnes of CO_2 generated by the steel production process and transform it into hydrocarbons that can be re-used in the

---

[38] EIA. (2009). *An updated annual energy outlook 2009 reference case reflecting provisions of the American Recovery and Reinvestment Act and recent changes in the economic outlook.* Energy Information Administration.

[39] Aldy, J. E. (2013). A Preliminary Assessment of the American Recovery and Reinvestment Act's Clean Energy Package. *Review of Environmental Economics and Policy, 7*(1), 136-155.

[40] Solar Energy Association. (2011). *U.S. soalr market insight: 1st quarter 2011.*

[41] Brady, J. (2014). *After Solyndra Loss, U.S. Loan Program Turning a Profit.* NPR. Retrieved from http://www.npr.org/2014/11/13/363572151/after-solyndra-loss-u-s-energy-loan-program-turning-a-profit

[42] DOE. (2015). *Powering new markets: Utility-scale photovoltaic solar.* Washington, DC: U.S. Department of Energy.

production chain. The project has a total budget of EUR 2.1 million, of which the EU is contributing EUR 1.78 million.

The **Innovation Fund** is an EU funding programme for demonstration of innovative low-carbon technologies and processes.

It is capitalised through revenues from auctions of emissions allowances under the EU ETS as well as unspent funds from its predecessor, the NER300 programme. The European Investment Bank (EIB) is responsible for monetisation of the Innovation Fund allowances and providing project development assistance to promising but immature projects, while the programme is implemented by the European Commission via the Executive Agency for Innovation and Networks (INEA). For the period 2020-2030, the Innovation Fund is expected to amount to about EUR 20 billion, depending on the carbon price. Targets for funding include:

- Innovative low-carbon technologies and processes in energy-intensive industries, including products substituting carbon intensive ones
- Carbon capture and utilisation (CCU)
- Construction and operation of carbon capture and storage (CCS)
- Innovative renewable energy generation
- Energy storage

The Innovation Fund will support up to 60% of the additional capital and operational costs linked to innovation. These will be disbursed in a flexible way based on project needs. Up to 40% of the grants can be given based on pre-defined milestones before the whole project is fully up and running. The first call for proposals for large-scale demonstration projects, defined as those above EUR 7.5 million in capital costs, closed in October 2020. Of the 311 applications received, 14 were for CCUS projects and 204 were for projects in energy-intensive industries, including 56 hydrogen projects.

Sartor (2020)[43] outlines three limitations of the Innovation Fund:

- At EUR 8-11 billion it will be too limited in size to cover the costs of low-carbon innovation across the whole system.
- The fund will only cover 60% of the additional capital and operating costs linked to innovation.
- Although the Innovation Fund can cover 60% of the additional operating costs, this support is limited to a maximum of 10 years.

[43] Sartor, O. (2020). *Enabling investments for a climate-neutral heavy industry in the EU - Introduction to Carbon Contracts for Difference.* Agora Energiewende.

It will be possible to co-finance Innovation Fund projects through other government support programmes, including aid provided by centrally managed EU programmes or State aid. In these cases, the rules governing State aid must be considered (see Box 3).

A final EU vehicle for supporting pre-commercial technologies is **InnoEnergy**, which is financially supported by the European Institute of Innovation and Technology (EIT). EIT InnoEnergy invests in innovative products that have already been proven in a lab (TRL5 or higher). Beyond funding, it provides intellectual property protection service, market knowledge and support with validation, certification, approvals and geographic expansion. While EIT InnoEnergy is a profit-oriented company whose shareholders include universities and private energy companies, it has a “not for dividend” financial strategy, reinvesting all its profits back into the organisation’s activities. EIT InnoEnergy has invested over EUR 560 million in over 380 start-ups. Several of the technologies supported are directly relevant to decarbonising heavy industry. For example, Imperial and Nobilis power plants are modular micro-power plants that transform waste products from wood, dried bio-waste and solid refuse fuel into heat and electricity for use in industrial processes. However, InnoEnergy’s thematic fields[44] do not include breakthrough technologies for CCUS or process emissions from cement and steel production, etc.

Box 3. EU State aid rules

State aid refers to financial support granted by the national government or public authorities either in the form of subsidies or any other transfer of state resources such as tax breaks and interest-free loans. Aid provided by centrally-managed EU funds is not classified as State aid, so is exempt from State aid rules.

The Treaty on the Functioning of the European Union (TFEU) forbids State aid as it distorts the competition in the internal market, except in certain circumstances. Those circumstances relevant to this project are discussed below:

- The Framework for State aid for Research and Development and Innovation (RDIF) allows Member States to provide funding for R&D projects up to experimental development and innovation clusters.

- The Guidelines on State Aid for **Environmental Protection and Energy (EEAG)** allow Member States to finance projects with environmental or energy benefits without adversely affecting trading conditions. State aid may support renewable energy electricity generation, combined heat and power (CHP), renewable fuels, biogas production, energy infrastructure, CCUS, aid for going beyond Union standards, making use of industrial products, etc. In EEAG projects, funding can only be provided for the extra investment costs (only CAPEX) directly linked to the achievement of the environmental protection objective. For some types of projects, such as CCS, EEAG aid can cover 100% of the eligible costs.

- The Guidelines for State Aid to promote **Important Projects of Common European Interest (IPCEI)** allow Member States to fund projects providing an

[44] Energy efficiency, nuclear instrumentation, renewable energy, smart and efficient buildings and cities, smart electric grids, energy storage, energy for circular economy and energy for transport an industry.

important contribution to the EU's objectives. IPCEI projects normally involve more than one Member State and require approval at the EU level. Funding can be provided for first industrial deployment of a new product or service with high research and innovation content and for upscaling, but not for mass production or commercialisation. IPCEI allows aid for a broader set of costs than EEAG. It covers the CAPEX and OPEX costs without which the project's realisation would be impossible. If justified, the aid intensity could reach up to 100% of the eligible costs. An IPCEI on hydrogen is currently being prepared, but as of yet, no decision has been made.

1.4.3. Funds for Commercialisation

1.4.3.1. PFMs needed to support commercialisation

At the commercialisation stage, a technology has been proven and is ready for widespread deployment. Private investment in green technologies and businesses will generally be more forthcoming than in previous stages. Nonetheless, several barriers may continue to hinder diffusion such as externalities that remain unpriced or inadequately priced by carbon markets, volatile markets and lack of awareness and perceived risks associated with new technologies. If a bank has little practice in lending to, for example, a carbon capture and storage project, the cost of evaluating the economic viability of the project tends to be high. Bank loans for new technologies will often come with stringent terms, such as high down payment, high interest rates, and a long approval process. These types of barriers may still justify government support.

As technologies become more competitive, governments need to avoid competing with and driving out private capital. There is a risk that government funds will lead to excessive windfall profits for private companies that are able to gain intellectual property and an early mover advantage with new technologies and industries. Government funds should aim to complement and guide the allocation of private resources towards innovative low-carbon technologies by bearing the risks that the private sector is ill-equipped to handle.

For example, governments can bear the risk of volatile markets facing the technology through, for example, feed-in tariffs or carbon contracts for difference (CCfDs – see Section 3.2). Public procurement schemes, such as government programmes to purchase low-carbon materials for public building projects, can further build a product's track record and can create a niche market for technologies while innovative companies build skills, supply chains and track record of success.

Attracting private investment during the commercialisation stage is about ensuring that the risk/return profile of low-carbon technologies is appealing and meets the needs of investors. PFMs such as loan guarantees and concessional loans can buy down many of the risks facing innovative technologies – be they perceived or real risks. Government loans for commercial-stage low-carbon technologies can also be securitised as green bonds which will enable greater liquidity in financing the deployment of low-carbon technologies.

Crowding in private investment will require public funds to be delivered through PFMs that are more complex than grants, which are employed by the Innovation Fund. The creation of dedicated green banks (either at the Member State or EU level) or hosting funds for low-carbon industry within existing international finance institutions (IFIs), like EIB and EBRD, could prove to be effective institutional arrangements for leveraging private funds. The UK Green Investment Bank, discussed in Box 4, offers a useful model. **The EIB's InnovFin Energy Demonstration Projects** (EDP) is another example. It provides a loan, loan guarantees or equity financing between EUR 7.5 to 75 million to innovative demonstration projects helping them to bridge the gap from demonstration to commercialisation. Eligible projects help to contribute to the energy transition, particularly in the following fields:

- renewable energy technologies
- smart energy systems
- energy storage
- carbon capture and storage
- carbon capture and use

Projects are expected to generate sufficient revenues to have the potential to become bankable. InnovFin was established as part of the Horizon 2020 programme. In 2019, the Commission decided to reinvest unspent funds from the NER300 programme to support further low-carbon innovation projects under InnovFin EDP. One of the successful projects was STEELANOL, an industrial-scale demonstration plant owned by steelmaker ArcelorMittal that will capture waste gases from a blast furnace and biologically convert them into ethanol. In 2014, the STEELANOL project received a EUR 10 million grant through the Horizon 2020 Research and Innovation Programme. In May 2020, the EIB approved a EUR 75 million loan to ArcelorMittal, part of which will be used to scale up the STEELANOL technology

Such institutions enable financial and technical expertise to be established in a single organisation, rather than expecting existing institutions to rapidly change professional expertise. This expertise would allow for more complex and riskier fund-raising techniques, such as bond issuances. Finally, green banks and IFIs would be more capable of deploying a diverse set of public financing mechanisms.

Box 4: UK Green Investment Bank

The Green Investment Bank (GIB) was established by the UK government in 2012 to 'accelerate the UK's transition to a greener, stronger economy' by investing in wind, biomass, other green infrastructure projects and non-domestic energy efficiency projects. The UK government had concluded that a separate financial institution was best placed to understand and address market failures that caused these projects to struggle to gain funding because their risk profile was too high for private investors (Green Investment Bank).

The GIB's objectives was to attract co-investment from private investors in low-carbon projects while generating a financial return. The government implemented sound oversight and governance arrangements but allowed GIB sufficient operational autonomy to deliver its objectives.

From 2012-2017, the bank invested £3.4 billion (EUR 4 billion) in 100 green infrastructure projects spanning each of its priority sectors. The projects had a total transaction value of £12.0 billion (EUR 14.1 billion). The GIB attracted an additional £8.6 billion (EUR 10.1 billion) from private sources, equating to around £2.50 for every £1 invested. The GIB's projected rate of return was 10% at the end of March 2017, demonstrating that green banks could offer good value for money.[45]

The majority of GIB's capital was invested in offshore wind (46%) as well as waste and bioenergy (34%). The remainder was invested in non-domestic energy efficiency (14%) and onshore renewables (6%). Between 2012-2017 the GIB estimated that it was involved in between 43% and 64% of the transactions in the UK offshore wind and waste and biomass sectors. An evaluation found clear evidence that in these sectors the bank achieved its objective of addressing market failures. In other sectors, such as non-domestic energy efficiency and onshore renewables, it was less clear whether this objective had been met.[45]

The GIB invested through four different channels:

- Direct equity and debt investments as the principal investor.

- Fund of funds, as a limited partner of funds managed by third party managers, which enabled GIB to invest in higher volume smaller assets (such as energy efficiency projects).

- Fund management, as a fund manager and partner in a fund that included third-party capital, such as GIB's Offshore Wind Fund.

- International projects, as a participant in a joint venture with the UK government in green infrastructure projects outside the UK.

The majority of the GIB's capital was deployed through direct equity (57%) and direct debt (23%).[45]

The GIB's investments were limited by EU State aid rules. The European Commission's initial State aid approval allowed GIB to invest in a range of sectors including offshore wind power generation, waste infrastructure, non-domestic energy efficiency, biofuels for transport, biomass power, carbon capture and storage, marine energy and renewable heat. To comply with State aid rules, the GIB was required to invest in line with several key principles:

- GIB must encourage others to invest

- GIB must not crowd out other investors

- GIB must invest on terms acceptable to commercial investors, or on other terms supported by an expert.

In 2015, the UK government decided that it would sell the GIB to a private buyer, partly to clear its balance sheet from the associated liabilities during a period of austerity, and partly to allow the GIB to raise its own debt or equity through private capital. The government also

[45] National Audit Office. (2017). *The Green Investment Bank.* London.

concluded that insufficient capital liquidity was no longer the main barrier to green infrastructure investment and that continued public investment in the GIB could risk competing directly with private capital. Privatising the bank offered the government a solution to questions of State aid approval. The sale to the Australian financial group Macquarie was completed in August 2017.[46]

Three years on, the UK government is now planning to launch a new publicly-owned Green Investment Bank 2.0 to help fund the technologies and infrastructure needed to reach the UK's legally binding 2050 net zero emissions target, a testament to the original GIB's success.[47]

1.4.3.2. EU support vehicles for commercialisation

The European Green Deal Investment Plan will aim to mobilise at least EUR 1 trillion in sustainable investments over the next decade. This funding will come from a variety of different sources, many of them relevant for enterprises that deploy commercial stage technologies, be it through public-private partnerships or private instalments.

The **InvestEU Fund** will aim to leverage around EUR 279 billion of private and public climate and environment related investments over the period 2021-2030. It will provide an EU budget guarantee to allow the EIB Group and other implementing partners to invest in more and higher-risk projects, crowding in private investors.

The EU's **Just Transition Fund (JTF)**, a EUR 40 billion fund that supports regions most affected by the green transition, provides another potential vehicle for funding for market-ready industrial technologies. The JTF will be complemented with resources from cohesion policy funds and national co-financing. Significant questions remain concerning how these resources will be deployed, but investments in new low-carbon activities will be eligible as well as those aimed at transforming existing carbon-intensive installations if they would take the installations' emissions to 'substantially below benchmarks'. The Fund will be part of a Just Transition Mechanism, which also includes resources under InvestEU and a public-sector loan facility. The Commission expects total funding mobilised under the mechanism to reach at least EUR 100 billion over the period 2021-2027.

The EIB-managed **Modernisation Fund** will support the 10 lower-income EU Member States modernise their energy systems and improve energy efficiency. The eligible Member States are Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania and Slovakia. The Modernisation Fund is capitalised through revenues from the auctioning of 2% of the total allowances for 2021-30 under the EU ETS. Five beneficiary Member States – Croatia, Czechia, Lithuania, Romania and Slovakia – have transferred additional allowances to the Modernisation Fund. The Modernisation Fund is expected to amount to EUR 14 billion in 2021-30, depending on the ETS allowance price. The beneficiary Member States will propose specific projects to be supported in their countries and the form of support: grants,

[46] National Audit Office. (2017). *The Green Investment Bank.* London.

[47] Thomas, N., & Pickard, J. (2020, July 15). UK ministers plan 'Green Investment Bank 2.0'. *Financial Times*.

premium, guarantee instruments, loans or capital injections. Co-financing from private and public entities is permitted as long as it is in compliance with State aid rules.

The Modernisation Fund will support investments in:

- Generation and use of energy from renewable sources
- Energy efficiency
- Energy storage
- Modernisation of energy networks, including district heating, pipelines and grids
- Just transition in carbon-dependent regions: redeployment, re-skilling and upskilling of workers, education, job-seeking initiatives and start-ups

These areas are of central importance to the decarbonisation of industrial sectors. However, other important areas, such as low-carbon carbon capture and storage or clinker substitution for cement, do not appear to be covered. The Modernisation Fund is therefore restricted in both scope and geography.

1.4.4. Proposed options for using funds to mitigate carbon leakage

This section provides a long-list of proposed options to mitigate carbon leakage by using government funds to foster innovation in breakthrough industrial technologies. The proposed options aim to align and complement existing EU funds and institutions. The options are listed in Table 1, which categorises them based on different stages of technological development.

Table 5. Proposed options to mitigate carbon leakage through funds

Stage	Option
R&D	**Option 1:** Horizon Europe – through its pillar Global Challenges and European Industrial Competitiveness – could allocate funding to R&D in early-stage (TRL 1-5) deep decarbonisation technologies in industries that are at high risk of carbon leakage .
Pre-commercialisation	**Option 2:** A portion of the Innovation Fund could be earmarked for demonstration of pre-commercial low-carbon technologies (TRL 6-7) in industries that are at high risk of carbon leakage. This would ensure that regardless of whether the Fund's capital is too limited to drive innovation across the whole energy system, funding will be available for those industries at the highest risk of carbon leakage.
	Option 3: Modify the Innovation Fund to allow it to provide higher levels of support, beyond 60% of the additional capital and operational costs linked to innovation in sectors that are at risk of carbon leakage.
	Option 4: Approve the pending IPCEIs on Hydrogen and consider IPCEIs for other deep decarbonisation technologies in industries at high risk of carbon leakage to

Stage	Option
	ensure that demonstration and deployment of these strategic technologies is not hindered by State aid rules.
Commercialisatio	**Option 5:** Modify Innovation Fund to allow it to provide alternative public financing mechanisms beyond grants for deployment of market-ready breakthrough technologies (TRL 8-9) in industries that are at high risk of carbon leakage.

Our analysis leads to several conclusions regarding the preferred options for using funds to foster technological innovation and address carbon leakage:

- **Government funding for breakthrough industrial technologies can help mitigate carbon leakage**. Government support throughout the innovation chain can drive reductions in the cost of breakthrough technologies, reduce a firm's costs associated with abiding with more stringent carbon regulation / pricing, eliminating the incentive to re-locate.

- **Support for R&D is critical, but its impact on carbon leakage is not possible to forecast.** Support for early-stage deep decarbonisation technologies (Option 1) could have a significant impact on carbon leakage by allowing European industries to meet their long-term emission reduction targets without facing a competitive disadvantage and by giving the EU a leading position in the industries of the future. Competitive research grants and/or innovation prizes could be awarded to developers that produce scalable and transformative technologies like high temperature heat pumps; electrolytic smelting and electric virgin steel production; alternative zero-carbon cement chemistries; or direct air capture CO_2 and net zero synthetic fuels. However, given the unpredictably of pathways and speeds of innovation in the early stages, the impact of R&D on carbon leakage would not be possible to forecast.

- **Funding for demonstration of breakthrough industrial technologies can give the EU a leading position in the industries of the future.** To meet its ambitious climate targets while ensuring its industries remain competitive, the EU will need to support breakthrough industrial technologies to overcome the 'valley of death' (Options 2-4). Key pre-commercialisation technologies include CCUS for combustion emissions produced during process heating, CCUS of post-combustion CO_2 diluted in nitrogen and $CaCO_3$ calcination during cement production. Combined with sunset retirement regulations for polluting technologies, support for demonstration of these technologies could send strong market signals on the direction of technological change. However, during the pre-commercialisation stage, innovative technologies only capture a narrow sliver of the market. The impact that support measures during this stage will have on carbon leakage will not be felt until the technologies achieve more widespread diffusion.

- **Government financing for the diffusion of market-ready breakthrough technologies can have an immediate impact on carbon leakage**. Several key technologies for decarbonisation of industrial sectors are market-ready or will become market-ready in the coming decade. A non-exhaustive list of the technologies that are available today is provided in Table 2. Government financing for diffusion of these and other market-ready technologies could lead to cost-reductions through learning effects and economies of scale. These effects would help mitigate carbon leakage in the near term by reducing the incentive for firms to relocate to avoid stringent carbon regulations / pricing. The EU already has numerous vehicles and substantial finance available for supporting the deployment of market-ready technologies.

- **A combination of PFMs, tailored to the technologies' stages of development, is required to guide the transition to a decarbonised industry**. Governments will need to take on higher levels of risk in the early stages of R&D and demonstration. As technologies mature, government support can gradually be phased out and targeted through mechanisms that aim to optimise market signals. Where diffusion of technologies is specifically inhibited by a low and unpredictable ETS price, it would likely be cost-effective to combine government finance for technologies with high capital and operating costs, with CCfDs, discussed in the following section, which would provide a secure revenue stream.

Table 6. Market ready or near commercial technologies

Technology	GHG reduction	TRL	Breakeven Est. ($/tonne CO_2e)
CCUS of concentrated CO_2	99%	9	<$40/tonne (EUR 34/tonne)
Hydrogen production: Alkaline or polymer electrolyte membrane (PEM) electrolysis	99%	9	~$50/tonne (EUR 42/tonne) or <$20-30/MWh (EUR 17-25/MWh)
Biogas or liquid replacement hydrocarbons	60-99%	9	>$50/tonne (EUR 42/tonne),uncertain
Partial clinker substitution (e.g., limestone + calcined clays) in cement	<40%	9	Near zero
Alternative lower GHG fuels (e.g. some waste types) for cement production	40%	9	Cost of alternative fuels
Production of pulp and paper using full biomass firing, including lime kilns	90-99%	9	$50/tonne (EUR 42/tonne)

Source: (Bataille, 2020)

1.5. Carbon Contracts for Difference

A Contract for Difference (CfD) is a contract that allows two parties to hedge against market fluctuations in the price of a financial instrument. If the final trade price is higher than the price agreed in the CfD, then the seller will pay the buyer the difference. If the opposite is true, then the seller will benefit from the difference.

Carbon Contracts for Difference (CCfDs) are proposed as a mechanism to strengthen the commercial case for investments in early stage emission reduction technologies and materials. CCfDs are increasingly being seen as an important mechanism for deploying deep decarbonisation technology. Germany, for example, has announced that it plans to deploy a pilot programme of CCfDs, first to support its national hydrogen strategy.[48]

The literature outlines three main benefits of CCfDs:

1. Hedge against uncertain future ETS prices
2. Vehicle to subsidise innovative low-carbon industrial technologies
3. Signal of long-term government to innovation

This section will consider each of these benefits, drawing on both the literature on CCfDs and case studies from the application of CfDs in the renewable energy market. It will then consider the role that CCfDs can play as part of a package of policies that reduces carbon leakage while fostering innovation in low-carbon technologies and materials.

1.5.1. Benefits of CCfDs

1.5.1.1. CCfDs as a hedge against uncertain ETS prices and mechanism to unlock finance

A characteristic of many abatement technologies is that they have relatively high capital costs. Renewable electricity technologies, for example, have significant higher upfront costs than thermal generation. Their competitiveness derives from their low operating costs. Unlike thermal generation, renewables do not require a continuous supply of fuel.

Similarly, technologies that deliver more efficient use of a carbon-intensive input through highly technical, engineered solutions – such as district heating, smart buildings, and industrial heat pumps – will tend to require more capital outlay upfront than their carbon intensive alternatives. Likewise, carbon sequestration technologies like carbon capture and storage (CCS) will involve substantial upfront investment in return for long-term savings under an emissions tax or trading system or revenue through the sale of emission reductions or allowances.

Abatement technologies with higher capital face more risk at the outset of a project and do not generate profit until a much later point in their life. Even where these technologies

[48] Flasbarth, J. (2020, October 13). Keynote speech at CEMBUREAU Summit. *CEMBUREAU: The Euroepean Cement Association*. Retrieved from https://cembureau.eu/library/press-releases/keynote-speech-of-jochen-flasbarth-at-cembureau-summit/

are cost competitive, market uncertainty and the high cost of finance can create barriers to investment.

Given the high capital costs of abatement technology, the availability and affordability of finance affects their economic attractiveness. Renewable power plants, for example, are often built through project finance, which allows a large portion of the upfront costs (~85%) to be covered by low-cost debt.[49] However, finance is only available and affordable when revenues are secure and predictable.

Uncertainty in market prices – be it electricity markets or EU ETS markets – undermines investors ability to forecast revenue and secure finance. A recent study by the European Court of Auditors (2018)[50] found that the highly volatile and lower than expected market price under EU ETS was a central reason why six CCS demonstration projects that had received grants through the European Energy Programme for Recovery (EEPR) remained unable to reach financial close. A review of their financing plan submitted in 2009 showed that they expected the carbon price to range between EUR 20 and 40 per tonne of CO_2 during the construction and demonstration phases.

CCfDs could help producers hedge against this price risk. A producer and government would agree on a 'strike price' at the outset of the contract. If the market price for emissions allowances is lower than the strike price, then the government will pay the producer the difference. If the market price is higher than the strike price, than the producer will need to return the additional revenue to the buyer. Figure 9 illustrates how they could work.

[49] Project finance involves setting up a new 'project company' that receives capital from shareholders in the form of equity and from creditors in the form of debt. Debt is cheaper than equity (the interest rate is lower than the required rate of return on equity). Because lenders' potential return is capped, they require high levels of confidence that the debt will be paid back with interest. As a result, project finance only works if the project's income can be confidently forecast through robust long-term contracts.

[50] European Court of Auditors. (2018). *Special Report: Demonstrating carbon capture and storage and innovative renewables at commercial scale in the EU: intended progress not achieved in the past decade.* Luxemburg: European Court of Auditors. Retrieved from https://www.eca.europa.eu/Lists/ECADocuments/SR18_24/SR_CCS_EN.pdf

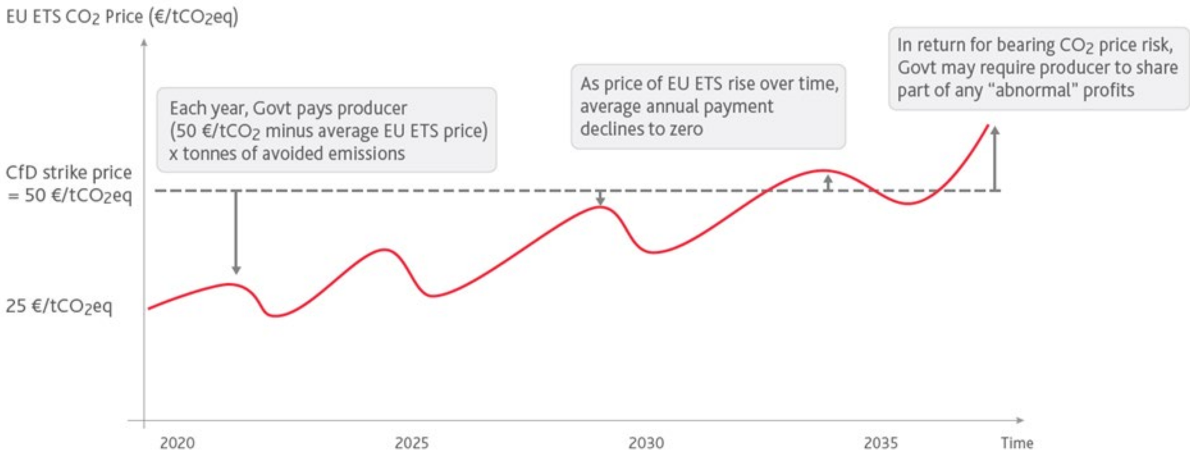


Figure 9. Example of how a CCfD could work to support commercial-scale investment in a first-of-a-kind decarbonisation materials production

Source: (Sartor & Bataille, 2019)

CfDs or a similar policy, sliding feed-in premiums, are already used in numerous countries to provide price certainty for renewable energy generators. In 2014, the UK shifted its main mechanism for supporting low-carbon electricity generation from a quota-based tradeable green certificate (TGC) market to a CfD scheme. Other countries, including Portugal and Romania, have also adopted or are considering adopting CfDs to accelerate clean energy uptake. Numerous EU countries, including Germany, Italy and Spain, run sliding FIP schemes.

Policies like CfDs that create price certainty for investors can be effective for lowering the cost of finance.[51] Evidence from renewable energy CfD schemes suggests that the price stability provided by CCfDs can be critical in reducing the cost of finance for abatement technologies

The lowered cost of financing enabled through greater price certainty can have a significant impact on the overall cost. In the case of renewable energy technology, May & Neuhoff (2017)[51] found that the greater price certainty enabled by CfDs/FIPs was associated with a lower cost of wind power at EUR 50 per MWh, relative to EUR 65 MWh under quota-based mechanisms (See Box 5).

Box 5: The effectiveness of CfDs relative to quota-based instruments in reducing price risk and the cost of finance

[51] May, N., & Neuhoff, K. (2017). *Financing Power: Impacts of Energy Policies in Changing Regulatory Environments.* Berlin: DIW Berlin.

May & Neuhoff (2017)[52] analysed the effectiveness of three different policies that are used around the world to help create markets for renewable electricity: fixed feed-in tariffs (FiTs); CfDs or sliding feed-in premiums (FIP)[53]; and tradable green certificates (TGCs).

FITs guarantee that an electricity generator will be able to sell the electricity produced at a given price, removing all uncertainty on the income they will receive per kWh.

CfDs and sliding FiPs have a similar effect as FiTs in that they create long-term price certainty for renewable electricity generators. However, the renewable generators' income will come from two different sources:

1. Revenue from electricity sales: Generators will sell electricity to private off takers at the going rate.

2. Revenue from CfD or sliding FIP: Generators will receive an additional premium equal to the difference between the average price for electricity and the agreed 'strike price' in the CFD / FIP contract.

The main difference between CfDs and sliding FIPs is that the contractual obligation under a CfD goes both ways. Under a sliding FiP, if the electricity price is above the strike price the top up payment would be zero. Under a CfD, if the electricity price is above the strike price, the premium would be negative, allowing the buyer to share in the profits generated from higher prices.[52]

Tradable green certificates differ from the other two instruments in that they are a quantity-based instrument. Generators will sell electricity to private off takers at the going rate, and further receive TGCs relative to their output. Electricity retailers are mandated to purchase green certificates to meet renewable energy quotas, creating a market for them. Like CfDs/FiPs, renewable generators income will come from two different sources: the sale of electricity and the sale of TGCs. However, in the case of TGCs, there remains significant uncertainty around the price that they will fetch.

May & Neuhoff (2017)[52] analysed wind power financing costs in 23 European countries with different support mechanisms. The study found that FITs and CfDs/FIPs lead to similar financing costs, but the higher risks associated with TGCs leading to 30% higher renewable energy costs.

Whereas CfDs in electricity markets provide a hedge for the entire revenue stream or renewable generators, the hedge provided by CCfDs will not cover the entirety of the revenue or savings generated by most industrial technologies. Low-carbon cement producers, for example, will also need to worry about the price of cement, not just the price of carbon. Governments may

[52] May, N., & Neuhoff, K. (2017). *Financing Power: Impacts of Energy Policies in Changing Regulatory Environments.* Berlin: DIW Berlin.

[53] There are two main varieties of feed-in premiums: (1) **fixed FIPs** provide a fixed top up above the wholesale electricity price so that the level of payment per kWh increases and decreases with the market; (2) **sliding FiPs** provide a variable top up that consisted of the difference between the average market electricity rate and the agreed strike price so that the rate of payment per kWh remains more or less constant. Where they are sliding, such as in Germany, Italy and Spain, feed-in premiums have a similar effect as CfDs.

consider this to be a desirable aspect of CCfDs, in that they will not create an unfair advantage to some producers by locking in a price guaranteed price for their product. Nevertheless, because carbon prices tend to play a smaller role in the economic viability of industrial producers than electricity prices do for electricity generators, CCfDs may not be as effective at unlocking finance for low-carbon industrial technologies as CfDs are for renewable generators.

Even with a more limited hedge than that provided by renewable energy CfDs, CCfDs could be instrumental in unlocking affordable finance. Neuhoff et al. (2019) provides a useful illustration of how CCfDs could lower the cost of finance for low-carbon technology. Figure 10 compares three new investment choices:

- A conventional technology
- A clean 'breakthrough' technology financed without CCfD that has 30% higher capital investment costs and 30% higher variable operating costs
- The same clean 'breakthrough technology financed with a CCfD

Each of these investment choices is compared against an expected revenue scenario and lower-bound revenue scenario. These scenarios cover revenue from both the sale of the product and, in the case of the low-carbon technology, the sale of emissions allowances/reductions on an emissions trading scheme. In the expected revenue scenario, the ETS price is equal to the break-even price for the break-through technology, meaning that its higher capital and operating costs could be entirely covered by through CO_2 revenue. In the lower-bound scenario, the CO_2 revenue is insufficient to cover these costs.

As with many renewable power plants, our illustrative technologies are financed through project finance, and the return on each project is partly determined by the portion financed through cheap debt rather than equity (which holds greater risk but demands a higher return).

The conventional technology is profitable under the expected revenue scenarios and can meet its debt obligations and variable costs in the lower-bound revenue scenario. Equity is needed to cover the uncertain part of the revenue.

The breakthrough' technology financed without CCfD faces significant uncertainty around CO_2 revenues. The amount of cheap debt that would be available would only be that which could be serviced by the guaranteed revenue in the lower-bound scenario. Without CCfD, a much greater portion of the project would need to be covered by equity, and a higher ETS price would be required to meet the high rate of return demanded by the equity investors.

A CCfD would reduce the uncertainty related to CO_2 revenue. For each emission allowance/reduction sold on an ETS, the project would receive a top up to the 'strike price' through the CCfD. This greater revenue certainty would allow the project to service a greater amount of debt, reducing the equity required to secure the investment to the same level as the conventional technology. As a result, the expected ETS price required to realise the project would be lower (in this scenario, 35% lower).

Neuhoff et al. (2019)[54] argues that the effects of CCfDs on financing structures and 'break-even' ETS prices depend on the relative share of operational costs to capital costs in a project. The hedge provided by CCfDs is likely to be more beneficial for financing capital-intensive projects with a high loan to value ratio, rather than material production technologies that are more OPEX intensive, because the reduced cost of finance will greater for more capital intensive projects. That said, CCfDs can also play an important role as a vehicle for subsidising the cost-difference between low- and high-carbon technologies, and these benefits would equally apply to OPEX intensive technologies. The following section discusses the role of CCfDs as a vehicle for subsidising low-carbon technology and materials.

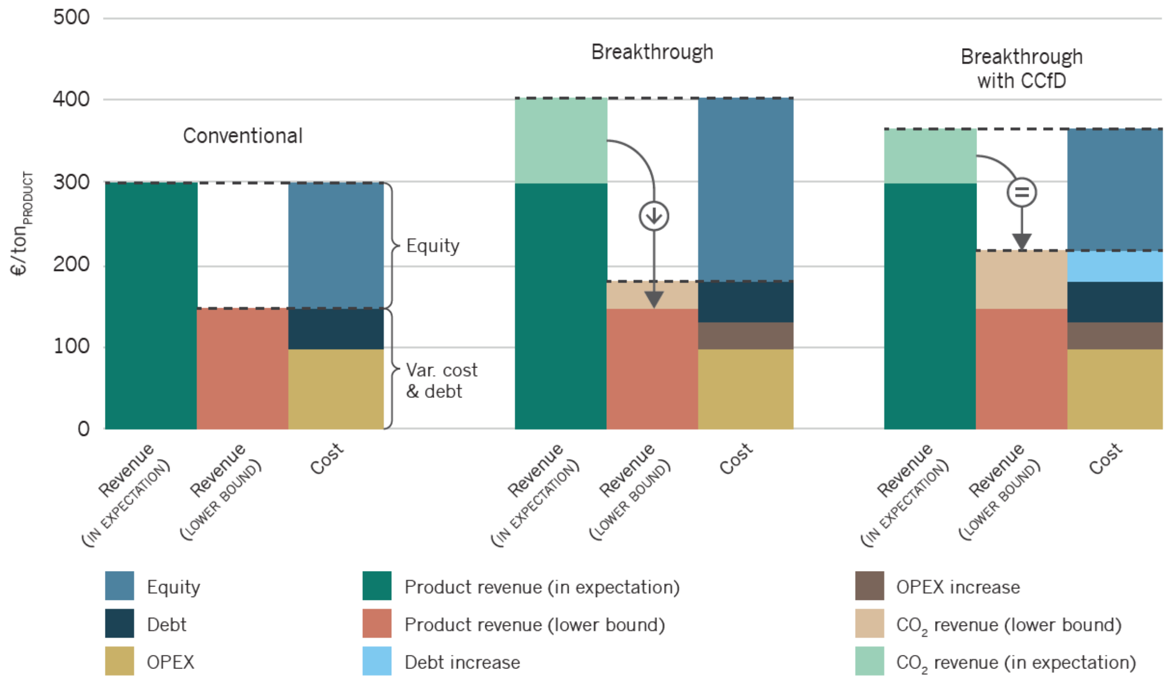


Figure 10. Effect of CCfD on financing structure and total cost of production

Source: (Neuhoff, et al., 2019)[54]

1.5.1.2. CCfDs as a vehicle for subsidising low-carbon technology and materials

The previous section exclusively discussed the effectiveness of CCfDs in hedge against market uncertainty, and therefore reducing the cost of abatement technologies by reducing the cost of finance. For the benefits described above, the CCfD 'strike price' would be set at a rate equivalent to the expected ETS price.

[54] Neuhoff, K., Chiappinelli, O., Gerres, T., Haussner, M., Ismer, R., May, N., . . . Richstein, J. (2019). *Building blocks for a climate-neutral European industrial sector.* Climate Strategies.

CCfDs can also act as a vehicle for additional support for innovative low-carbon industrial technologies. An implicit subsidy can be provided by setting the 'strike price' higher than the expected market rate.[55] This additional support could be used to plug the gap between the ETS price and the break-even price for breakthrough technologies. This type of support may be appropriate in sectors where investments in commercial-scale breakthrough decarbonisation technologies face a significant cost gap relative to conventional technologies, despite the existing ETS price.[56]

Before 2030, several low-carbon industrial technologies are expected to have a break-even ETS price below EUR 70/t CO_2.[57] Sartor & Bataille (2019)[58] find that promising carbon neutral technologies for cement have a break-even ETS price of EUR 50. The break-even price of electrolysis-derived hydrogen for steel depends on the price of electricity but would likely be at least EUR 60 (see Figure 11). Bataille (2020)[57] identifies similarly promising zero or near zero emissions technologies in the iron and steel, aluminium, pulp & paper, chemicals and other manufacturing sectors

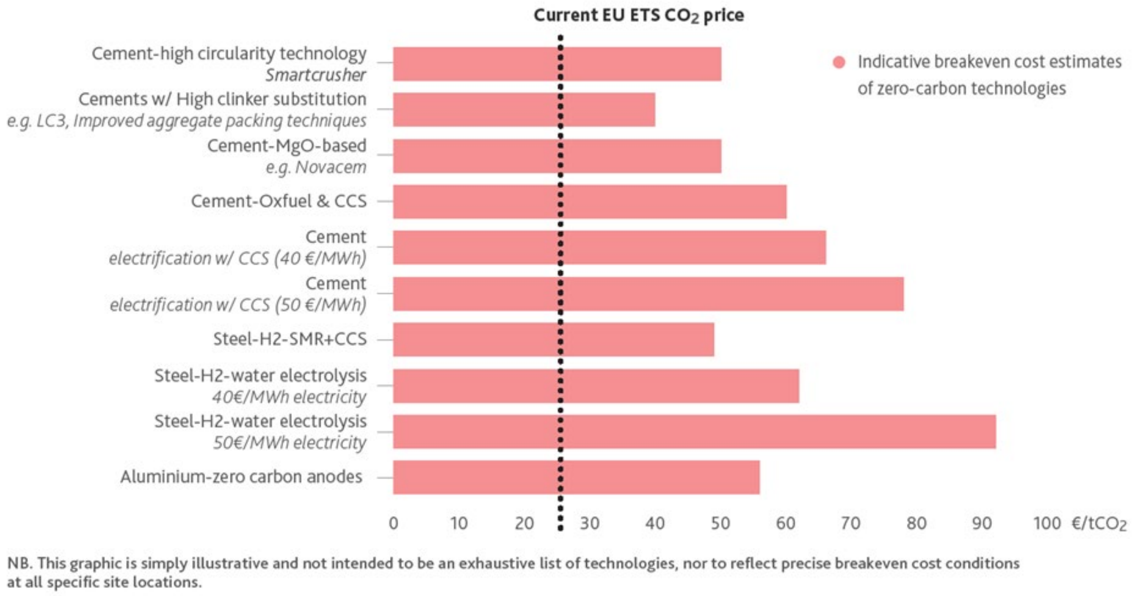


Figure 11. Breakeven cost estimates of low-carbon cement, primary steel and primary aluminium tech

---

[55] Gerres, T., & Linares, P. (2020). *Carbon Contracts for Differences: their role in European industrial decarbonization.* Madrid: IIT, Universdad Pontificia Comillas.

[56] Sartor, O. (2020). *Enabling investments for a climate-neutral heavy industry in the EU - Introduction to Carbon Contracts for Difference.* Agora Energiewende.

[57] Bataille, C. (2020). Physical and policy pathways to net-zero emissions industry. *WIREs Climate Change, 11*, 1-20.

[58] Sartor, O., & Bataille, C. (2019). *Decarbonising basic materials in Europe: How Carbon Contracts-for-Difference could help bring breakthrough technologies to market.* Paris: IDDRI, SciencesPo.

Source: (Sartor & Bataille, 2019)[58]

A CCfD 'strike price' set high enough to cover an abatement technology's incremental costs relative to its carbon-intensive alternative could theoretically ensure that deployment of these technologies would be commercially viable within the next 5-10 years, rather than decades down the line. To ensure that they are targeting zero or near zero emissions technologies and not just incremental improvements, a low-carbon performance threshold could be set defining eligibility.

This approach to subsidising abatement technologies through CCfDs with 'strike prices' higher than the expected ETS price would not be a cost-effective approach to rolling out deployment of an abatement technology across the whole sector.

However, CCfD contracts that are set higher than the expected ETS price could be a cost-effective approach to pilots of near zero or zero carbon technology, and involve a relatively low burden on public resources.[59] As these CCfDs with high strike prices would only be offered to first-of-a-kind pilots of industrial technology, the government would not subsidise the technologies' deployment across the whole sector. The treasury would also not pay the entire 'strike price' of the CCfD, just the difference between the 'strike price' and the ETS price. If the ETS price increases over time, then the subsidy would be reduced, and if it increases to a level higher than the 'strike price' than the CCfD could mandate that the company would need to pay back the difference (which would help to avoid windfall profits).

Task 2 of this project will deliver analysis on the cost-effectiveness of different approaches that are shortlisted in Task 1. One potential area to be analysed would be the cost-effectiveness of the different uses of CCfDs to subsidise pilots of new technologies or provide market-ready technologies with a hedge against ETS prices to stimulate widespread deployment.

Very early commercial scale projects may still encounter a high degree of risk aversion form industry, given that CCfDs tend not provide a hedge for a project's entire revenue stream, just the CO_2 revenue. In these cases, developers may demand an overly high strike price to reduce uncertainty, and it may be more cost effective to support the project through a package of mechanisms – for example, a lower CCfD that covers the project incremental operating costs relative to its carbon-intensive alternative, combined with grants or concessional loans to cover its higher capital costs. Another option would be to motivate the sector to take on additional risks by combining support mechanisms for low-carbon technologies with *technology sunset clauses,* which signal that minimum CO_2 standards will be adopted in the coming years effectively phasing out conventional technology.[59] Likely the most effective option for reducing the level of the strike price will be to issue CCfDs through competitive auctions. These are discussed further below.

[59] Sartor, O., & Bataille, C. (2019). *Decarbonising basic materials in Europe: How Carbon Contracts-for-Difference could help bring breakthrough technologies to market.* Paris: IDDRI, SciencesPo.

1.5.1.3. Signal of long-term government to innovation

Beyond lowering the cost of finance by providing price certainty, CCfDs can also act as a device to signal long-term government commitment to innovation. Gerres & Linares (2020)[60] argue, "Without contracts, governments have a clear incentive to expropriate the rents of innovation in low-carbon technologies, by lowering carbon prices ex-post, once the innovation has taken place. A similar effect is created when investments in lower carbon technologies result in lower carbon market prices. This in turn results in an underinvestment in innovative technologies, since firms anticipate this behaviour." With CCfDs, governments will have an incentive to keep carbon market prices high so that they are not liable for excessive CCfD payments.

1.5.2. Potential design, governance and funding of CCfD scheme

CCfDs can be issued via direct negotiation with a developer, at a standard rate or by reverse auction / competitive tender. Most sliding feed-in premium schemes offer a standard rate, sometimes differentiated by technology, so that the overall benefit for renewable generators equates to a feed-in tariff.

Like FiTs, CCfDs issued at a standard rate can create an explicit subsidy for nascent technologies by setting the standard 'strike price' at a higher level than the expected market ETS price. A drawback of this approach is that it would not place downward pressure on prices, which is particularly important in procuring technologies with rapidly declining technology costs, such as wind and solar PV. There are numerous examples (notably Spain and Ontario, Canada) of where high feed-in tariffs led to windfall profits for solar generators at the expense of electricity consumers or taxpayers.

Competitive tenders enable more rapid price discovery, preventing utilities or governments from locking themselves into long-term over-priced contracts. In the case of reverse auctions for renewable energy, suppliers bid to supply a pre-determined quantity of electricity at the lowest tariffs, and the winner is awarded a long-term power purchase agreement (PPA). Auctions are also the primary mechanism through which Spain and the UK award FIPs/CfDs. These examples could provide a template for running auctions, for example, for CCfDs for zero-carbon cement, steel or aluminium.

Auctions are complex, contingent on sufficient competition and relatively expensive and time-consuming to run. Experience from large-scale renewables auctions has shown that the benefits of auctions (cheaper prices, more transparency, and a high portion of projects reaching completion) tend to outweigh the costs.[61] Large-scale renewable energy auctions can also provide important lessons on design decisions that are applicable to the design of auctions for CCfDs. Important auction design features to consider include the following[62]:

---

[60] Gerres, T., & Linares, P. (2020). *Carbon Contracts for Differences: their role in European industrial decarbonization.* Madrid: IIT, Universdad Pontificia Comillas.

[61] Eberhard, A., & Kruger, W. (2018). *EEG Energy Insight: Best practice in renewable energy auctions desig and implementation - a global review.* Oxford, UK: Energy and Economic Growth.

[62] RENAC. (2020). *Policy frameworks for renewable power generation.* Berlin: Renewables Academy.

- **Procurement schedule**: Generally, auction programmes are more effective if they have multiple rounds held in a predictable schedule. Developing proposals can be expensive, and without a predictable market, it is difficult for developers to allocate resources to project preparation effectively.

- **Technology neutral vs technology specific auctions**: Just as different renewable energy technologies have different costs per kWh, different abatement technologies have different costs per tonne of GHG mitigated. Many jurisdictions have opted to host technology specific renewable energy technologies in order to ensure that nascent technologies are not competing against more established ones. On the other hand, technology neutral auctions can, in theory, yield a more cost-effective outcome for any single auction round by targeting the least cost options. Rather than focusing on technology in renewable energy auctions, some jurisdictions such as California have focused on defining the required characteristics of bidders, such as the ability to provide baseload power. An analogous approach for CCfDs would be to hold auctions not for a specific type of technology, but rather for materials with specific performance parameters and a maximum CO_2 continent. This would help ensure that the auctions are targeting only breakthrough technologies.

- **Penalties for non-compliance**: One common problem with auctions is that bidders often submit unrealistically low price offers, and then pull out later on leaving the project unfinished. To avoid this pitfall, many renewable energy auctions now include penalties for non-delivery or bid bonds, in which bidders provide a financial guarantee at the outset that they will see their proposal through to completion. Such policies place additional risks on bidders, which may exclude some project developers from participating.

- **Pre-qualifications**: To participate in auctions, bidders tend to need to fulfil pre-defined criteria, such as demonstrated financial strength, track-record, contracts for any necessary equipment or land, etc. Such criteria has been demonstrated to lead to a higher project realisation rate in renewable energy auctions, but also reduces the pool of potential bidders, which can reduce competition and increase prices.

- **Selection criteria:** Apart from securing the lowest price for the CCfD, regulators may opt to pursue other objectives including adequate geographical spread of successful projects, domestic industry development or mitigation of carbon leakage.

A further element to consider is whether CCfDs should be issued at the European or member-state level. As explained by Gerres (2020)[63], each approach has advantages and disadvantages:

- A European CCfD scheme would prevent distortions in the internal market by treating all national industries equally and independent of the level of state resources available. This would also avoid any considerations about whether CCfDs should be considered

[63] Gerres, T., & Linares, P. (2020). *Carbon Contracts for Differences: their role in European industrial decarbonization.* Madrid: IIT, Universdad Pontificia Comillas.

state aid. However, an EU CCfD scheme would require new sources of EU-specific funding. An EU scheme could align directly with other EU support mechanism, like the Innovation Funds.

National CCfDs schemes may be more coordinated with national industrial policies and may be more politically palatable to Member States. National governments may also have an easier time securing and allocating revenue for CCfDs, but then the question of how CCfDs should be treated under State aid would need to be resolved. Sartor (2020) proposes that CCfDs be hosted under the ETS Innovation Fund. The two mechanisms would certainly be complementary. However, legislation for the Innovation Fund allows it to cover operating costs for a period of ten years, so it may be unable to sign long-term contracts spanning more than a decade. This issue would likely only be relevant for projects with very high capital costs that require a long-time period to become profitable and could be overcome through higher strike prices that ensure profitability within a decade. Based on the experience of the UK LCCC (see Box 6), an alternative option would be to create a dedicated institution to manage the scheme, with the necessary financial and technical skill sets under one roof. Critically, whichever institution is administering the CCfDs scheme, it would need to have access to adequate capital to be a creditworthy counterparty to the contracts.

Box 6: UK Low Carbon Contracts Company

The UK has created the Low Carbon Contracts Company (LCCC), a government-owned company to deliver its CfD scheme for low-carbon electricity generators. LCCC manages the auctions, acts as the counterpart to the 15-year CfDs and administers the Supplier Obligation Levy that funds CfD payments.

Since its inception, LCCC has held 3 auctions, or allocation rounds, which have yielded 72 live CfDs to date, totalling roughly 18 MW installed capacity. The auctions have included a range of different technologies competing against each other. The majority of CfDs have gone to offshore and onshore wind, however biomass conversion, waste-to-energy with combined heat and power (CHP) and solar PV projects have also won contracts.

The LCC is a private company with operational independence, but its sole shareholder is the UK Department of Business, Energy & Industrial Strategy (BEIS). It operates at an arm's length from the government, which provides investors with confidence that there will be no political meddling in CfD markets.

As previously discussed, CCfDs are particularly compatible with support mechanisms, like the Innovation Fund, that help cover the capital costs of pre-commercial technologies. Sartor (2020)[64] shows that CCfDs are also compatible with additional measures established to address carbon leakage, such as free allocation of emissions allowances or a BCA (Scenarios 1 and 2 in Figure 12, respectively).

---

[64] Sartor, O. (2020). *Enabling investments for a climate-neutral heavy industry in the EU - Introduction to Carbon Contracts for Difference.* Agora Energiewende.

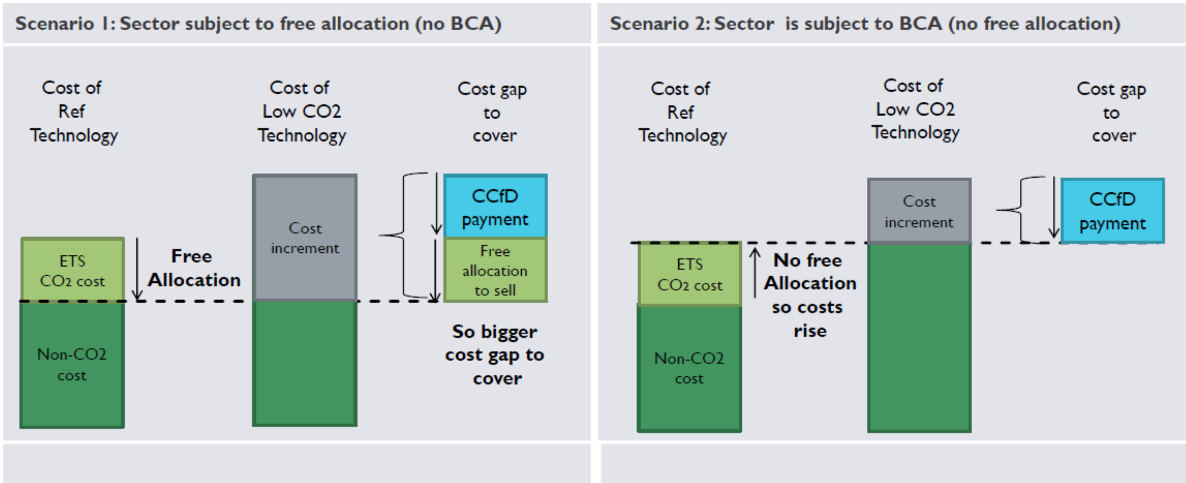


Figure 12. CCfD compatibility with free allocation and border carbon adjustments

Source: (Sartor, 2020)[65]

1.5.3. Proposed options for using CCfDs to mitigate carbon leakage

CCfDs could play an important role in fostering technological innovation and mitigating carbon leakage. As stated by Jochen Flasbarth (2020)[66], State Secretary at the Ministry for Environment, Nature Conservation and Nuclear Safety, "Only if we succeed in giving energy-intensive industries the prospect of greenhouse gas neutrality in Germany and Europe will we be able to retain the value added they generate and achieve broader decarbonisation throughout the world"

Table 3 provides a long-list of proposed options pertaining to the CCfD strike price and deployment approach.

Several conclusions can be drawn from our analysis:

- **CCfDs with strike prices near to the expected ETS price and at the break-even price will be suitable for breakthrough technologies at different stages of development**. CCfDs set near the expected ETS price (Option 1) would provide companies that adopt breakthrough technologies with predictable carbon revenue and/or savings on carbon pricing. This revenue security could help them secure the finance necessary for breakthrough technologies with high capital costs. It could also support operational costs that are higher than those of the conventional technology. CCfDs with negotiated strike prices set higher than the expected ETS price (Option 3) would act as a vehicle to provide additional support to early-stage breakthrough

[65] Sartor, O. (2020). *Enabling investments for a climate-neutral heavy industry in the EU - Introduction to Carbon Contracts for Difference.* Agora Energiewende.

[66] Flasbarth, J. (2020, October 13). Keynote speech at CEMBUREAU Summit. *CEMBUREAU: The Euroepean Cement Association*. Retrieved from https://cembureau.eu/library/press-releases/keynote-speech-of-jochen-flasbarth-at-cembureau-summit/

technologies, which could make them more competitive in EU and global markets. This could give adopters of breakthrough technologies an early mover advantage and allow the EU to gain a leading position in the industries of the future. Each of these benefits would reduce the incentive for firms to relocate to avoid more stringent EU climate policies.

- **Auctions are preferable for issuing large-scale CCfDs for low-carbon industries despite their higher administrative costs.** CCfDs issued through auctions (Option 2) place downward pressure leading to more rapid price realisation and preventing windfall profits. CCfDs issued at standard rates (Option 1), akin to feed-in tariffs, would reduce administrative costs allowing the scheme to more easily reach numerous small-scale producers. CCfDs with directly negotiated strike prices can take into account the project specific needs, for example, of demonstration projects (Option 3).

Table 7. Proposed primary options to mitigate carbon leakage through CCfDs

	Options
Strike price and deployment	**Option 1:** Widespread deployment of CCfDs at standard rate, akin to feed-in tariffs, to reduce operational costs and reach numerous producers. Standard strike price set near expected EU ETS price, to support widespread deployment of market-ready low-carbon technologies in industries at risk of carbon leakage.
	Option 2: Auctions of CCfDs for large-scale breakthrough technologies to create downward pressure on prices and reduce risk of windfall profits.
	Option 3: Direct negotiation of CCfDs taking into account project-specific financing needs Strike price set at 'break even' EU ETS price to subsidise demonstration of pre-commercial technology.

Beyond the primary options related to strike price and deployment, other secondary options relate to the institutional arrangements and sources of revenue for a CCfD scheme (Table 4):

- **A dedicated institution to administer the CCfD scheme and act as a contractual counterparty would likely offer the most effective institutional relationship.** At the EU-level the counterparty to CCfDs could be the Innovation Fund or a new dedicated institution, similar to the UK LCCC. At the Member State level, governments could design their own approach tailored to national circumstances.

- **Additional revenues will be required to ensure that the counterparty to the CCfDs is creditworthy**. Sartor (2020)[67] proposes that CCfDs be funded through a share of revenues from an ETS expansion or BCA implementation, or from an EU-wide climate surcharge on final products with high levels of energy-intensive basic materials.

[67] Sartor, O. (2020). *Enabling investments for a climate-neutral heavy industry in the EU - Introduction to Carbon Contracts for Difference.* Agora Energiewende.

Revenues could also come from increasing the share of emissions allowances that are auctioned and/or higher auction prices, or they could be drawn from the existing budget of the Innovation Fund, although this may already be too limited. For those proposed policy options taken forward, part of Task 2 will be to investigate the amount of revenue required to deploy breakthrough technologies that replace, for example, 5-10% of steel, cement and/or basic chemicals in the EU market.

Regardless of the options selected, CCfDs are highly compatible with other measures to foster innovation and mitigate carbon leakage, such as CBAs and funds for breakthrough technologies.

Table 8. Proposed institutional options for a CCfD scheme

	Options
Institution	**Institutional option 1:** House implementation of CCfDs within the Innovation Fund.
	Institutional option 2: Create new institution at the EU-level that will act as an administrator and counterparty to CCfDs.
	Institutional option 3: Promote CCfD schemes at the Member State level and issue guidance on CCfD compliance with State aid rules.

1.6. Minimum carbon performance standards

Minimum carbon performance standards could help address some aspects of carbon leakage by preventing the sale on EU markets of high-carbon products made in other jurisdictions. Products subject to the standard would be covered by a certification system to demonstrate that the performance requirements are met. The standard would address the competitiveness advantage importers of high-carbon products would otherwise have over EU industries when supplying EU markets.

A substantial limitation to the approach in the short to medium term, however, is that for those producers that perform better than the standard, the companies based in the EU would still be subject to a carbon price that those in other jurisdictions may not face, and thus still suffer a competitive disadvantage. Therefore, whilst minimum carbon standards might go some way to addressing carbon leakage concerns, there would be limits to their effectiveness. It may be necessary to consider the use of standards in tandem with other carbon leakage mitigation measures, including free allowance allocation or carbon border adjustment mechanisms. In the longer term, if standards were to become sufficiently high performing that they support the achievement of the EU's climate objectives, then the standards system, could replace the EU ETS.

Two further features need to be taken into account when considering minimum carbon performance standard options. First, by their nature, the standards apply to the sale of goods to EU markets and thus equally apply to EU producers and importers. Therefore, there would be incumbent EU companies who could not (without performance improvements) continue to serve EU markets. Second, the standards would have no effect on exports from the EU and would therefore not address the carbon leakage risk that arises from EU ETS operators becoming less competitive against overseas producers in supplying those third-party export markets.

Of the options considered in Task 1, minimum carbon performance standards have some of the strongest similarities with a possible Carbon Border Adjustment Mechanism. In particular, both would require the determination of the carbon performance of certain products entering the EU and the application of a constraint at that point of entry (a charge in relation to the carbon performance for CBAM or simply that sale is only permitted in the EU when above the performance standard). Similar considerations will apply in terms of the identification of suitable sectors and products that would be covered by each option and how the mechanism would be governed.

To explore the options for carbon performance standards this section is arranged as follows:

- Section 3.3.1 provides a description of the most relevant literature on the subject. In doing so the main design aspects and choices are highlighted.
- Section 3.3.2 contains a review of other relevant EU standards, to identify examples relevant to the design and functioning of carbon performance standards.
- Section 3.3.3 introduces a set of possible policy options, which will be taken forward into the Task 1.5 screening stage.

1.6.1. Literature relevant to minimum carbon performance standards

There is a modest body of literature concerning the issues around carbon performance standards, with many studies not concentrating on minimum standards but instead on variants that could serve as alternative policies to carbon pricing. Nevertheless, the literature does provide some relevant perspectives on the main issues concerning minimum carbon performance standards, especially the benefits that they can provide, type of standards mechanism, the point in the supply chain at which they can be deployed and the setting of standard levels. These four aspects are central to the design of possible policy options and are considered below in turn.

1.6.1.1. The benefits of performance standards

Minimum carbon performance standards are considered here primarily from the perspective that they could limit the carbon leakage risk. More broadly, however, the use of standards is widely promoted in the context of the direct environmental impact that they can lead to and the certainty that they can provide for investors in low carbon technologies. Walter & Freed (2019)[68] elaborate these benefits in their analysis of the possible role of performance standards to help the US achieve net zero emissions by 2050. In particular, they envision:

[68] Walter, L., & Freed, J. (2019). *Setting the Standards: How Performance Standards Can Get the US to 0x50.* Third Way.

- Performance standards that set goals as far as 30 years into the future to provide long-term policy and market certainty.

- The establishment of demand for clean energy technologies, creating the environment for investment in them, with the result that companies have a stake in the continuation of the policy.

- The reduced risk that those companies supplying the market with cleaner products could lose out to cheaper and less clean alternatives (essentially the argument in favour of using standards to protect against carbon leakage).

Similarly, Gerres et al. (2019)[69] propounds the benefits of longer-term clarity around performance standards (Product Carbon Requirements (PCRs)), suggesting a 10-20 year timescale would help businesses plan and develop strategies for deep decarbonisation (the study seeks to develop policy approaches to enable drastic reductions in GHG emissions from basic materials as part of a push towards climate neutrality).

The possible role of carbon performance standards in conjunction with carbon pricing, as an approach towards achieving deep decarbonisation, is touched on by Tvinnereim and Mehling (2018).[70] They note that although performance and technology standards have been criticised for their economic costs, they can realise effective environmental outcomes and have been shown to result in greater abatement effects than carbon pricing, when applied alongside one another. Gerres et al. (2019)[71] elaborates an aspect of this synergy, highlighting that PCRs can sit alongside both carbon pricing (to internalise the full carbon price) and innovation funding

Implications for policy options. The points raised by the literature mentioned above suggest the following are considered in the design of options for minimum carbon performance standards:

- Standards set over an extended period to give more certainty to investors
- A pathway for future standards set taking into account potential technological developments
- Design of standards to drive environmental benefits as a priority including carbon leakage mitigation

to support the technological development needed to meet the target intensity levels in the longer term.

---

[69] Gerres, T., Haussner, M., Neuhoff, K., & Pirlot, A. (2019). *Can Government Ban Materials with Large Carbon Footprint?*

[70] Tvinnereim, E., & Mehling, M. (2018). Carbon pricing and deep decarbonisation. *Energy Policy*, 185-189. Retrieved from https://doi.org/10.1016/j.enpol.2018.06.020

[71] Gerres, T., Haussner, M., Neuhoff, K., & Pirlot, A. (2019). *Can Government Ban Materials with Large Carbon Footprint?*

1.6.1.2. Type of standards mechanism

The potential for PCRs is examined in Acworth et al. (2020)[72], which considers policy options to further support deep carbonisation in the EU, citing Gerres et al. (2019)[73] as the most extensive proposal to date. The study focuses on measures that support technological innovation and deployment, whilst addressing carbon leakage risk. It presents PCRs as an initiative that would begin with emission intensity labelling standards for certain industrial products on a voluntary basis and which would fall under longer term targets that give a strong signal to the market for the technological change required. The reasoning given for an initial voluntary phase is that it would be a more gradual implementation of a system that would subsequently develop into mandatory labelling for all products within the covered groups (i.e. the voluntary nature supports a phased approach rather than being a desirable end feature in itself). This approach to transparency and labelling would be designed to empower consumers to make choices for low-carbon products and thereby shift the market towards further decarbonisation. Acworth et al. (2020)[72] presents this argument in the context of policies aimed at industrial materials, but to be effective it would require that the performance level for these materials is somehow reflected within information made available for final consumer goods.

A further dimension to the decision whether to implement a mandatory or voluntary system is what it might mean for the potential stringency of the standards, and in this respect the existing EU product policy environment provides a good example. For products, the EU often starts with ecolabels, which represent a high level of performance but which are voluntary and by design only benefit the high performing products. Ecodesign, on the other hand, sets minimum standards at a less stringent level and must be complied with by all products placed on the market. A third relevant example of energy labelling provides a further model, in which it is mandatory that products in scope have an energy label, but that label represents a scale of performance and producers can choose where on that scale to pitch their products. A decision to introduce performance standards for EU ETS related products needs to take account of which model is most desirable for the sectors concerned.

Acworth et al. (2020)[72] and Gerres et al. (2019)[73] envisage the system to eventually become mandatory but expects that only to take place once there is industrial capacity to produce the low-carbon materials required. This argument is reasonable from the perspective of standards necessary to drive deep decarbonisation, but it does not rule out the introduction of more modest and gradually tightening standards with the aim of mitigating carbon leakage, where the capacity to meet that standard (within the EU and elsewhere) were to already exist. Nevertheless, a phased approach, possibly with a voluntary initial period, might be desirable.

Acworth et al. (2020)[72] makes a further suggestion to enhance the environmental effectiveness of PCRs, which is to apply the standards to exporters as well. Whilst this may deliver environmental benefits, it would not immediately help to protect against carbon leakage. Acworth et al. (2020)[72] notes that the idea would be more feasible if done on a

---

[72] Acworth, W., Kardish, C., & Kellner, K. (2020). *Carbon Leakage and Deep Decarbonization: Future-proofing Carbon Leakage Protection.* Berlin: International Climate Action Partnership (ICAP).

[73] Gerres, T., Haussner, M., Neuhoff, K., & Pirlot, A. (2019). *Can Government Ban Materials with Large Carbon Footprint?*

multijurisdictional basis with coordination of the standards involved. This could be a longer-term aim for an EU carbon performance standards approach.

Fischer (2019)[74] provides a detailed description of clean performance standards, as a policy proposal aimed at the US. The paper proposes a market-based baseline and credit-type system, which provides a reward to those companies that perform better than the standard. This is relevant to the consideration of minimum carbon performance levels in the EU, since a single minimum level would not preferentially reward good performers. It may be possible to design standards with both a minimum level and a tiered labelling system to create a softer market incentive for good performers. This would be most effective for products that serve final consumers (for example in some textiles, food and drink, glass or ceramics subsector) rather than intermediary products.

The effectiveness of labelling in influencing consumer behaviour has been studied for energy labels[75], which found that labels in themselves have a negative correlation with green purchasing behaviour and for effective purchasing decisions it is necessary that consumers understood, trust and value such labels as a tool, implying that complementary awareness programmes are part of the policy package required. The effectiveness of types of energy labels have been studied,[76] using experiments in a range of EU Member States. It was found that consumer choice can be influenced by different types of label (with alphabetic scales being more effective than numerical ones), but also that where energy efficiency is of low importance for consumers, then choice of label design has a greater influence than the use of scales to convey performance, again indicating that labelling systems without wider consumer awareness could have limited value.

A further angle to be considered is the role of green public procurement in helping to create a market for new low carbon products. This is a subject explored by Baron, OECD (2016)[77], which notes that benefits arise from the aggregation of public sector demand to create a larger market and by providing a reputational boost to the product or company, thereby delivering multiplier benefits. The paper also suggests that public procurement of innovative technologies

[74] Fischer, C. (2019). *Market-Based Clean Performance Standards as Building Blocks for Carbon Pricing.* Washington, DC: The Hamilton Project, Brookings.

[75] Zainudin, N., Siwar, C., Choy, E. A., & Chamhuri, N. (2014). Evaluating the Role or Energy Efficiency Label on Consumers' Purchasing Behaviour. *ICESD*.

[76] LSE, & IPSOS. (2014). *Study on the impact of the energy label - and potential changes to it - on consumer understanding and on purchase decisions.* for DG ENER.

[77]https://www.oecd.org/sdroundtable/papersandpublications/The%20Role%20of%20Public%20Procurement%20in%20Low-carbon%20Innovation.pdf

can offer a more cost-effective approach than more expensive direct support measures, and

> **Implications for policy options.** The points raised by the literature mentioned above suggest the following approaches are considered in the design of options for minimum carbon performance standards:
>
> - Voluntary GHG standards for high performing products, akin to the current Ecolabel regime
> - Mandatory labelling of product GHG performance, similar to current energy labelling
> - Mandatory minimum product GHG standards for products, akin to current Ecodesign requirements
>
> As noted in the discussion above, mandatory approaches could be phased in after a voluntary trial period. These standards could also form the basis for green public procurement policies to further stimulate the market for low carbon products

therefore is a better use of public funds.

1.6.1.3. Products subject to standards

The premise of this study is that minimum product standards could help address carbon leakage, and therefore would focus on some or all of the products from sectors within the carbon leakage list. The literature focusses on product selection from the perspective of environmental benefits, but nevertheless provides views on what might be practicable options.

Acworth et al. (2020)[78] discusses PCRs applied to industrial materials and suggests that they focus on the outputs of industrial facilities rather than end user products. Gerres et al. (2019)[79] provides a more detailed proposal for PCRs on basic materials and highlights those that are carbon-intensive such as steel, cement, plastics and aluminium.

Garicano (2020)[80] proposes the design of a Carbon Border Adjustment Mechanism (CBAM) and although a different type of measure, the discussion on coverage is relevant to carbon performance standards. It is argued that a broad scope should be sought, because of the benefits that the mechanism can bring to industries at risk of carbon leakage. To enable this practicably, Garicano (2020)[80] outlines an approach in which the direct emissions associated with each

---

[78] Acworth, W., Kardish, C., & Kellner, K. (2020). *Carbon Leakage and Deep Decarbonization: Future-proofing Carbon Leakage Protection.* Berlin: International Climate Action Partnership (ICAP).

[79] Gerres, T., Haussner, M., Neuhoff, K., & Pirlot, A. (2019). *Can Government Ban Materials with Large Carbon Footprint?*

[80] Garicano, L. (2020). *A proposal for the design of a European Carbon Border Adjustment Mechanism.* Brussels: Submitted to the European Parliament.

basic material used in a final product are determined by multiplying the weight of that material by a relevant carbon intensity factor. This factor could be a default value, possibly a world average, or it could be specific to the country of origin or production technology.

The above approach, it seems, is intended to enable a wider coverage of products based on their basic material inputs, rather than confine the system to the basic materials themselves. To limit the administrative complexity and reduce the risk of challenge to aspects that would be uncertain, Garicano (2020)[81] proposes that emissions associated with product transformation, logistical movements and indirect emission are not accounted for. This last point contrasts with Gerres et al. (2019)[82], which proposes that indirect emissions would be covered.

Implications for policy options. The points raised by the literature mentioned above suggest the following are considered in the design of options for minimum carbon performance standards:

- Coverage focused on basic industrial materials where the accounting aspects would be more straightforward, yet the policy gains could be substantial
- A phased approach to extension to other products as the policy becomes more established/proven

1.6.1.4. Setting the standard levels

Much of the literature on the use of carbon performance standards discusses the concept in the context of deep decarbonisation and the achievement of near-zero emissions. There is therefore emphasis on the achievement of substantial performance achievements over an extended period of time. There is no discussion on the setting of standard levels to best address an immediate risk of carbon leakage, which requires a balance between significantly limiting the possibility of high-carbon imports on the one hand, and minimising the impact for higher carbon intensity EU producers and EU consumers on the other. Nevertheless, it is helpful to draw the main points from the literature in respect of standard setting as they relate to the creation of a regulatory environment that supports low-carbon investment, which will be an important element of an EU system.

Gerres et al. (2019)[82] frames PCRs as underpinning long-term technological change. This introduces a challenge: standards must improve at a fast-enough rate to achieve climate change targets, yet must not move so fast as to be technologically unachievable. To reconcile this, the announcement of a long-term unambiguous vision for the standards or even specific long-term targets would reinforce incentives for businesses to focus their strategies and investments towards the achievement of the required carbon performance.

---

[81] Garicano, L. (2020). *A proposal for the design of a European Carbon Border Adjustment Mechanism.* Brussels: Submitted to the European Parliament.

[82] Gerres, T., Haussner, M., Neuhoff, K., & Pirlot, A. (2019). *Can Government Ban Materials with Large Carbon Footprint?*

Walter and Freed (2019)[83] recognise the same points, but discuss the balance between certainty and adaptability. Gradual and consistent tightening of performance standards enables firms to better manage investment risks and anticipate more predicable returns on those investments. On the other hand, it is argued that the policy should have a feedback mechanism in which the rate of improvement is re-evaluated based on changes in technologies and market conditions.

The possibility of technology-based performance standards applied to EU ETS installations could draw upon the sector Best Available Techniques (BAT) Reference documents (BREFs) established under the Industrial Emissions Directive. For each sector/subsector, general and system specific techniques are described for a wide range of environmental impacts, for which the most relevant to GHG emissions is energy efficiency. These energy efficiency techniques could form the basis for defining carbon performance reference levels. Specific energy consumption levels (per tonne of products) are defined for current installations based on the use of BAT. The emphasis on energy efficiency techniques and associated levels varies between the BREFs. GHG emission standards are rarely set, and if so, it is for GHGs not covered by Annex I to the ETS Directive. Nevertheless, such standards could be developed in the future.

Implications for policy options. The points raised by the literature mentioned above suggest the following are considered in the options for setting minimum carbon performance standards:

- The standard levels could recognise the opportunities for technological improvements. This aspect is emphasised in the literature in the context of standards driving deep decarbonisation, rather than to mitigate carbon leakage.
- The setting of standards against a long-term vision will help to underpin investment by companies in reducing their carbon intensity.
- Balancing the need for certainty, there are advantages in having some flexibility to adjust the standards in recognition of changing technological or market conditions.

1.6.2. Existing relevant standards

The overarching concept of minimum performance standards for products is to prevent products that do not meet the required standard, for example in terms of energy efficiency or GHG emissions, from being placed on the EU market in order to achieve positive environmental outcomes (Ecodesign).

In addition to minimum performance standards, other standards are used to inform consumers on the environmental performance of products and inform purchasing decisions. For example, certifications, such as the EU Ecolabel (voluntary for producers), provide consumers with information on the best performing products on the market, and energy labelling identifies the different spectrum of performance of products.

[83] Walter, L., & Freed, J. (2019). *Setting the Standards: How Performance Standards Can Get the US to 0x50.* Third Way.

While the use of performance standards (both minimum standards and other standards) is an established concept in some policy areas, including energy efficiency of products or emission limits of vehicles, it has not been explored within the context of ETS sectors and as an approach to addressing carbon leakage.

To understand the key issues and considerations when setting carbon performance standards for products within the context of ETS sectors and carbon leakage, it is useful to have an overview of how existing approaches to product policy and standards are undertaken and developed.

Figure 7 shows how the key policy instruments of Ecodesign, Energy labelling, Green Public Procurement and Ecolabel complement each other and work together across the market at different stages relative to the sustainability of products.

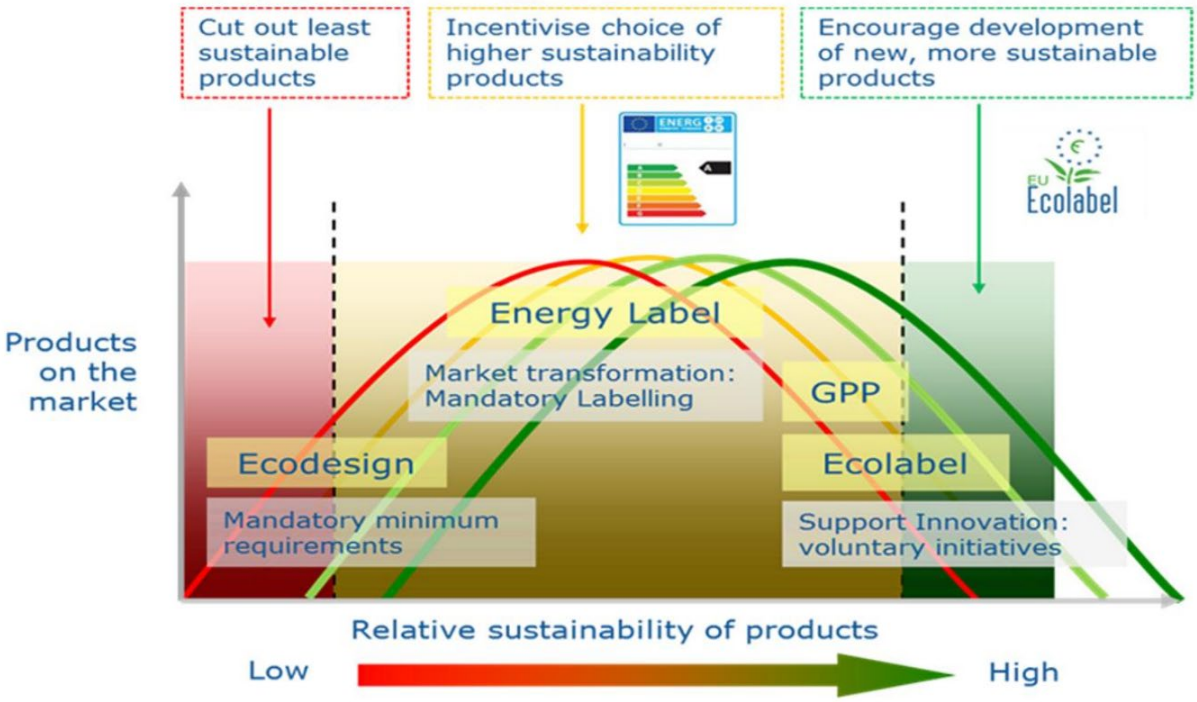


Figure 13. Complementarity of Ecodesign, Energy labelling, Green Public Procurement and Ecolabel

Source: (Vidal-Abarca, Dodd, & Wolf, 2020)[84]

It can be seen that the systems operate at different points in the market. Ecodesign aims to eliminate poor performing products and thus is the system that most closely aligns with the aims of minimum carbon performance standards to help address carbon leakage. Next in terms of relevance is energy labelling, which seeks to transform the market towards better energy

[84] Vidal-Abarca, C., Dodd, N., & Wolf, O. (2020). *Revision of EU Ecolabel Criteria for Electroci Displays (previously Televisions), JRC Science for Policy Report.* Luxembourg: Publications Office of the European Union.

performance products through performance disclosure, such that manufactures gain a commercial advantage from moving to a higher tier performance level. At the high-performance end, Ecolabel promotes innovation in product design and is awarded only to the top performing products.

Energy labelling is developed as part of the above Ecodesign process where applicable, whereas Ecolabel and GPP criteria are developed separately, but using a similar methodology in terms of the evidence base to reduce duplication of effort where possible.

The relationship between Ecodesign and energy labelling can be further illustrated in Figure 8 below, from the European Commission press material on the systems. This has similarities with the concepts discussed in the literature described above, that a carbon performance standards system could comprise both a minimum level to push the market and a graded labelling system to provide market pull.

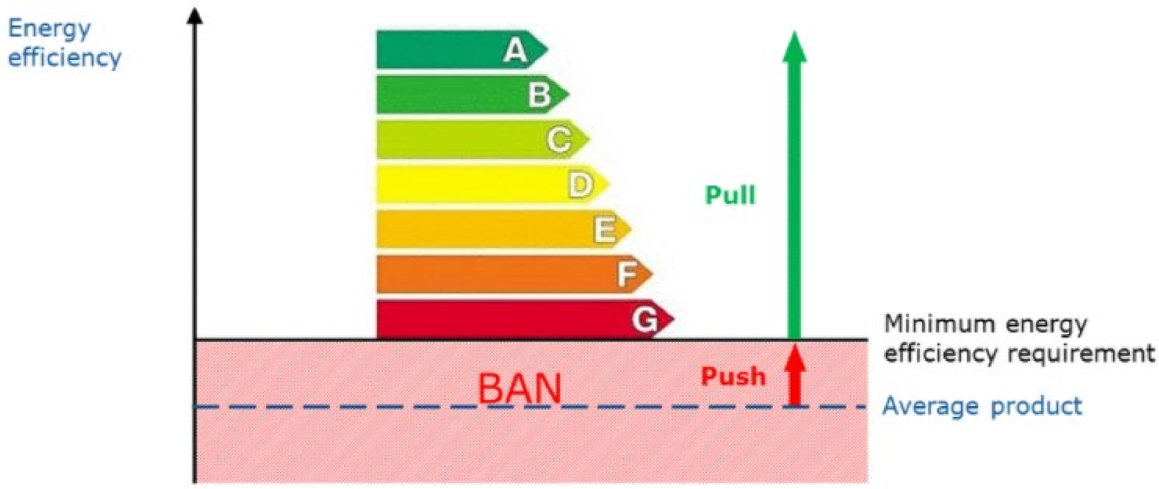


Figure 14. Relationship between Ecodesign and energy labelling

Source: European Commission[85]

Valuable points can be taken from these systems concerning the governance process involved in setting standards. This is because the product groups themselves are mostly down-stream or end-user products, which are less relevant to an EU ETS minimum carbon performance standard that will likely focus on basic industrial materials.[86] Alternative and possibly more suitable governance regimes could include that under the Industrial Emissions Directive for setting BAT levels.

[85] https://ec.europa.eu/commission/presscorner/detail/en/QANDA_19_5889

[86] As of October 2019 there were 10 ecodesign implementing regulations covering the following product groups: refrigerators, washing machines, dishwashers, electronic displays (including televisions), light sources and separate control gears, external power suppliers, electric motors, refrigerators with a direct sales function (e.g. fridges in supermarkets, vending machines for cold drinks), power transformers and welding equipment.

The framework used by the Ecodesign and Energy labelling to set mandatory minimum performance standards and energy labelling (where appropriate) for energy-related products, comprises a series of key stages that are followed before standards are introduced by the European Commission[87]:

- Step1 – A review of product groups is made to identify those that should be prioritised based on the potential for cost-effective reduction of greenhouse gas emissions, which result in working plans that indicate the priorities for the development of implementing measures.

- Step 2 – A detailed preparatory study (following MEErP methodology[88]) is undertaken for a given product group, which follows a defined methodology and includes the following tasks:

    - Scope (definitions, standards and legislation)

    - Markets (volumes and prices)

    - Users (product demand side)

    - Technologies (product supply side, includes both BAT and BNAT)

    - Environment & Economics (base case LCA & LCC)

    - Design options

    - Scenarios (Policy, scenario, impact and sensitivity analysis)

  This is done in consultation with relevant stakeholders, including industry, and includes detailed technical discussions.

- Step 3 – The Commission prepares first drafts of the ecodesign and energy labelling measures, which are discussed within a Consultation Forum involving Member States and other stakeholder representatives. There may be an open public consultation and the Commission will develop the approach through impact assessment and inter-service consultation procedures.

- Step 4 – Draft implementation measures are published, and WTO is notified of these. The process involves a four-week feedback mechanism.

- Step 5 – Two separate paths are then followed to achieve the necessary technical approvals. Draft Ecodesign measures are submitted for voting by a regulatory committee. Draft Energy Labelling Delegated Acts are not voted on, but consensus is sought from a Member State expert group

---

[87] European Commission. (2019). *The new ecodesign measures explained.* Brussels. Retrieved from file:///C:/Users/rh45/Downloads/The_new_ecodesign_measures_explained.pdf

[88] Methodology for ecodesign of energy-related products

- Step 6 – Measures are scrutinised by the European Parliament and Council and, if no objection is received, published in the official journal and entered into force.

These stages are summarised in Figure 9.

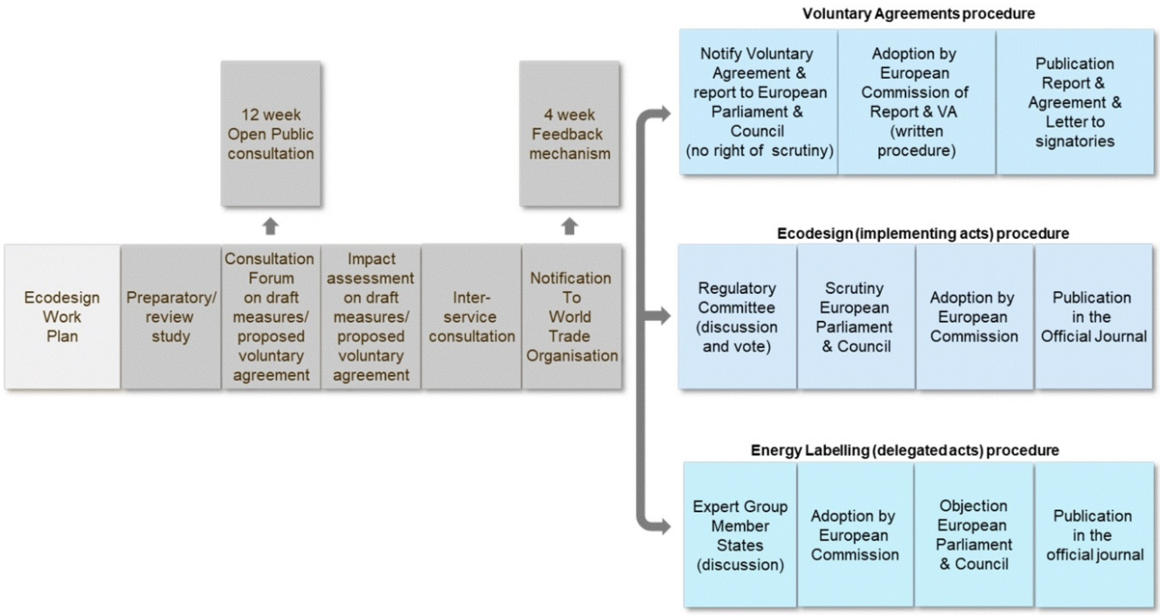


Figure 15. Key stages used by Ecodesign and Energy labelling to set mandatory minimum performance standards and energy labelling

There are other examples of standards systems discussed in the literature. Gerres et al. (2019)[89] provides descriptions of CE-Marking, the Ecodesign Directive, road vehicle emission requirements, the Environmental Management and Audit Scheme (EMAS), Biofuels Certification, Forestry Law Enforcement Governance and Trade Voluntary Partnership Agreements (FLEGT VPAs) and the EU Timber Regulation. It notes that across these policies there is a long history of the EU imposing standards that apply to importers, and that it is the importer or distributor that places a product on the EU market who is responsible for demonstrating product conformity. Such an approach is likely to be required for EU ETS minimum carbon performance standards.

A key challenge with product performance standards such as eco-design/ecolabelling is that they concern products available on the market and hence tend to lead to incremental improvements rather than encouraging transformations that would be needed to achieve net zero greenhouse gas emissions. It would be necessary to devise an approach that overcomes this to encourage deeper decarbonisation over long timescales. Longer term trajectories for performance improvement, as has been implemented for vehicle emission standards, could be a way forward, although the risk is that the approach locks in targets that are either unachievable or not sufficiently ambitious.

---

[89] Gerres, T., Haussner, M., Neuhoff, K., & Pirlot, A. (2019). *Can Government Ban Materials with Large Carbon Footprint?*

Implications for policy options. The points raised by the policy examples mentioned above highlight the following points to consider in the options for setting minimum carbon performance standards:

- The Ecodesign and ecolabel framework provides a model for an integrated approach to minimum carbon performance standards together with a graded labelling system, to provide a mix of push and pull incentives to the market.
- The Ecodesign and ecolabel framework provides a model for technology informed standard setting. The preparatory study process provides a systematic method for assessing technology and market issues to inform standard development, as part of a wider process in which Member States and other stakeholders are widely consulted.
- This approach would be the most relevant to an EU ETS minimum carbon standard that aims to change technology expectations over the long-term, but would be less relevant to one that mechanistically derives standards from installation carbon intensity performance data (in the same way that benchmark trajectories are determined).

1.6.3. Options for EU ETS minimum carbon performance standards

In this section we present a set of options to be considered further in the shortlisting stage of this project, for which the most promising will be assessed further in Task 2. Following the structure of the previous discussion, the options can be characterised by the following main elements:

- The design of the standards system
- The products to be covered
- The level of the standards to be applied, and how they would be developed over time

1.6.3.1. Design of standards system

The literature highlights the possibility of a phased approach to the introduction of carbon performance standards, in which the first phase is voluntary. The main driver for this is to provide a signal to the market whilst simultaneously allowing industries time to adjust so that they can meet the upcoming mandatory performance levels. The key premise of this approach is that performance standards will be stringent, since most of the literature considers the approach as a mechanism to drive deep decarbonisation towards near or net zero emissions. It may be that when viewed from a carbon leakage mitigation perspective this aspect is less critical, because there is an immediate need for carbon leakage protection measures and because the standard levels may not be so stringent initially. However, we consider that such phasing-in could be a valuable element of the design.

The intent behind considering new carbon leakage protection measures is that they could apply in the second half of EU ETS Phase 4 (i.e. 2025-2030), during which time there is a planned but declining role for free allocation, but that it will also apply in the longer term, during a realm of even deeper decarbonisation and limited, if any, free allocation. Consequently, the most logical options regarding phasing-in and a voluntary period would be:

- Voluntary standards established for the start of 2026, becoming mandatory in 2031. It should be noted that the intent of this initially voluntary approach is to introduce the system gradually and allow time for businesses to adjust. It is not intended that the standards be sufficiently robust that they need to be voluntary (following the eco-label model) since the voluntary phase would later be replaced by a mandatory system.

- Mandatory standards introduced in 2026

The means by which the standards would apply could dictate timescales. Since the standards would relate to the production process, not the products themselves, they could take the form of emission limit values under the Industrial Emissions Directive (IED). However, since IED does not currently apply to GHG emissions that are covered under the EU ETS Directive, it would take some time to develop. Potentially longer than indicated above due not only to the time that would be needed for this to be reflected in revision of the IED but also because of the timings of the cycle of updating of the BREFs under which the standards would be determined.

There is also a strong argument in favour of supplementing minimum carbon performance standards with a graded labelling system. This would provide a market pull, which would be most effective for products where environmental performance is a factor in consumer choice. The suitability of such an approach therefore depends on product inclusion (discussed below), but the options in principle are simply:

- Introduce only minimum carbon performance standards

- Supplement minimum carbon performance standards with a graded labelling system for some or all of the products covered.

1.6.3.2. The products to be covered

The choice of products[90] to include will involve balancing the benefits of applying the standard to those products in sectors or subsectors with a high carbon leakage risk with the practical burden of including complex (downstream) products for which the process of accounting for carbon performance will be more complex. The literature on carbon performance standards puts emphasis on covering basic materials, yet suggests that over time the system could become more comprehensive. Examples such as Ecodesign and energy labelling show it is possible to apply standards for energy use by complex products, but these do not relate to emissions from the production that would be necessary to consider if standards are to be applied for EU ETS

[90] The term “product” is used here but in practice the performance standard would cover the emissions associated with the processes within the corresponding sector or subsector, potentially aggregated across stages within the supply chain.

sectors (potentially also including emissions at upstream stages, which would be very complex).

From an EU ETS perspective, some distinct options emerge, because of the various product grouping already identified within the policy regime. The starting point for minimum carbon performance option development is that it can help to address carbon leakage. Thus, one option to be considered is that all products from sectors and subsectors on the carbon leakage list[91] would be included.

Further options are then subsets of these products. The reasons for limiting the list would be to ensure relevance and cost effectiveness by excluding complex products of those for which there is less trade; and policy coherence by choosing products subject to existing benchmarks or those that are direct products of only EU ETS installations. The important aspects are as follows:

- The carbon leakage list mostly defines sectors and subsectors at NACE-4 level, which is a high-level grouping of activities that each produce a wide range of products. Within a single NACE code will be products of significantly different specificity and extra-EU trade volume/value. The cost effectiveness of including more complex, heterogenous and/or lower extra-EU traded product groups may not be justified, and a subset selected based on these criteria may be better.

- The carbon leakage list covers sectors that extend beyond the EU ETS installations, either because there will be producers that are below the thresholds in the EU ETS Directive Annex I (for instance with smaller combustion capacity) or because the sector includes downstream processing that is not done at EU ETS installations. It will be more complex and administratively costly to apply standards to sectors or subsectors in this grouping. Therefore, a simplified coverage may be preferable based on the larger sectors whose activities are concentrated in EU ETS installations.

- The minimum carbon performance standards would either complement existing free allocation-based carbon leakage mitigation or replace it (possibly in conjunction with other measures). The standards would need to be set with an expectation of how EU producers would perform against the intensity levels and be affected, and it would also be desirable to set a long-term trajectory for the standards. The minimum carbon performance standards could align with EU ETS product benchmarks. For example, they could be defined using the installation intensity data that is gathered for installations within the current regime – in essence, they could be derived using benchmark curves and updated according to intensity trends in a similar way. These aspects point towards an option of applying minimum carbon performance standards to EU ETS output benchmark products.

In summary, we have four main options for product coverage:

- All products from sectors and subsectors covered by the carbon leakage list

[91] Found at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2019:120:FULL&from=EN

- A subset of carbon leakage list products focussing on those that have the highest extra-EU trade value.

- A subset of carbon leakage list products focussing on those that are the main outputs from EU ETS installations.

- A list comprising some or all of the EU ETS output benchmark products.

Some could be applied in combination: for example, a list based on EU ETS benchmark products could be shortlisted to those products with the greatest extra-EU trade value.

In practice, the elaboration of these options involves a more detailed assessment of the product groups within each NACE-4 category and consideration of which of these are primarily and substantially the outputs of EU ETS installations. Annex A1 provides a preliminary assessment of these aspects.

1.6.3.3. The level of the standards to be applied

The stringency of any minimum standards directly relates to the objective of addressing carbon leakage, since standards would prevent materials being sold on the EU market if produced below a threshold. Thus, there is a direct relationship between the standard level and the proportion of EU and non-EU producers that might be prevented from participating in the market. In turn, there is a relationship with EU consumer prices, as a more stringent standard limits supply and raises the costs of supply. These are points that arise when we consider the supply market to be static, however. A longer-term perspective involves manufacturers adjusting to the standards, so that they invest to improve their carbon efficiency to be able to serve the EU market. As the literature shows, this long-term adjustment is enhanced if the standards are set over a long term or set regularly against the backdrop of a long-term aim. We therefore have options for the basis for setting the standard and the period over which they are set.

The basis for the standards can be an assessment of the current state of play, i.e. carbon intensity of producers in the sector or subsector, or an assessment of the available technology. The former is a data driven exercise that is transparent and objective (can be based on ex-post verified data), possibly with an annual improvement rate built in. The latter allows for a future standards trajectory to be set based upon what performance improvements are possible and is more consistent with an approach in which standards are part of the policy mix for deep decarbonisation, as opposed to just mitigating an immediate carbon leakage risk. The literature favours the latter approach, as does experience with systems like Ecodesign, but that is because they are focussed on the environmental outcome. In these cases, governance arrangements like that for Ecodesign would be relevant to the EU ETS carbon standards. Broadly speaking, the options for standard setting are:

- Sector/subsector/product-specific technology-informed standards.

- Standards based upon current performance levels with stringency factors applied. The method would be common across all sector/subsector/product groups and involve stringency levels based on, for instance, average, decile or quartile performance levels. Sector averages would be the most practicable if the method were to be based upon a peer group that extended beyond the EU ETS and for which individual producer data would be difficult to obtain. The standards could be based upon:

- o Worldwide peers
- o EU peers
- o EU ETS peers

The period over which standards are set is important for the signal it provides to the market, with longer term clarity providing lower risks for investors in low-carbon technologies. Flexibility in the system, however, also allows for adaptations to changing markets and technology circumstances. The way in which standards could be set over the long term, and updated, depends on how they are set. More specifically, if they are technology informed, then they could be set based on long-term technology expectations, but updated well in advance. If they are based on actual peer data (for instance the EU ETS installation intensity data), then it is necessary to define the frequency with which that would be updated and possibly, as with EU ETS benchmarks, a trajectory of percentage improvement that would apply.

As noted above, the intent behind considering new carbon leakage protection measures is that they could apply in the second half of EU ETS Phase 4 (i.e. 2025-2030), and potentially in the longer term. The main options for standard updating could be:

- Minimum performance standards set well in advance on a 5-year basis (i.e. set for intervals of 2026-2031, 2031-2036, etc., well in advance of those periods).

- Minimum performance standards set well in advance on a 10-year basis (i.e. set for intervals of 2026-2036, etc., well in advance of those periods).

1.6.3.4. Summary of options

The main options presented here have been informed by the literature on carbon performance standards and wider experiences of similar policies with the EU. The main design choices concern the type of standards mechanism, the products involved and the basis for setting the standards. To some degree, these are independent of each other and therefore a large number of permutations can be envisaged. These are represented in the following table.

Table 9. Proposed options and permutations for carbon performance standards

<table>
<tr><th>Design - phasing</th><th>Design - grading</th><th>Products</th><th>Standard setting - basis</th><th>Standard setting - stringency</th><th>Standard setting - timescales</th></tr>
<tr><td rowspan="4">Voluntary in 2026 and mandatory from 2031

or

Mandatory from 2026</td><td rowspan="4">Single minimum level per product

or

Minimum level per product and graded labelling</td><td>All carbon leakage list sectors/ subsectors</td><td rowspan="2">Worldwide peers

or

EU peers</td><td rowspan="4">Technology informed

or

Data informed (average, performance quartile, decile etc)</td><td rowspan="4">5-yearly

or

10 yearly

In each case set well in advance</td></tr>
<tr><td>Carbon leakage list sectors/ subsectors –high value imports</td></tr>
<tr><td>Carbon leakage list sectors/ subsectors – EU ETS installation outputs</td><td rowspan="2">EU ETS peers</td></tr>
<tr><td>EU ETS installation benchmark products</td></tr>
</table>

1.7. Evaluation of final options

This section presents a final list of options across all three measures – funds, CCfDs and standards. Table 6 presents a refined list of diverse options with the greatest relevance to the problem of carbon leakage. The selection of options was based on the preceding analysis, and a preliminary judgement of how each will fare against defined scoring criteria.[92] The third column provides the rationale behind the selection of each option / permutation.

Table . Proposed options to mitigate carbon leakage through funds

Stage	Option	Rationale
Funds	**Option 3.1:** Earmark a portion of the Innovation Fund for demonstration of pre-commercial low-carbon technologies (TRL 6-7) in industries that are at high risk of carbon leakage. This would ensure that regardless of whether the Fund's capital is too limited to drive innovation across the whole energy system, grant funding will be available for demonstration projects in those industries.	• Aligns with existing EU funding mechanism, the Innovation Fund • Funding for demonstration of pre-commercial breakthrough technologies can give the EU a leading position in the low-carbon industries of the future.
	Option 3.2: Approve the pending IPCEIs on Hydrogen and consider IPCEIs for other deep decarbonisation technologies in industries at high risk of carbon leakage to ensure that demonstration and deployment of these strategic technologies is not hindered by State aid rules.	• IPCEIs focus Member State resources on projects of strategic significance to the EU and clarify rules on State aid. • IPCEIs do not necessarily require EU resources, although EU funds can help support them.
Carbon contracts for difference	**Option 3.3:** Hold auctions for CCfDs for pilot projects of breakthrough technologies. Auction will set downward pressure on strike prices, but the winning strike price will be at the technology's 'break even' EU ETS price (rather than the expected ETS price) to provide additional support to early-stage breakthrough technologies. Pilot projects from sectors at risk of carbon leakage that successfully receive Innovation Fund grants	• Strike prices at the 'break-even' ETS price will act as a vehicle to subsidise early-stage technologies, allowing the EU to gain a leading position in the low-carbon industries of the future. • Pre-qualification of Innovation Fund grant-

[92] The priorities for the screening process are in alignment with the Better Regulation Guidelines, we have screened options against the primary criteria outlined in Toolbox 17: relevance, legal feasibility, previous policy choices, technical feasibility, coherence with other EU policy objectives, effectiveness and efficiency, proportionality, and political feasibility. In addition, we developed a set of sub-criteria specific to the challenge of carbon leakage.

	will pre-qualify for a CCfD. This pilot CCfD scheme will be exclusively for pilot projects. It could be administered and funded through the Innovation Fund.	winners could enable piloted early stage technologies to bridge the valley of death.
	Option 3.4: Host auctions for CCfDs in sectors at risk of carbon leakage to provide companies that adopt market-ready technologies breakthrough technologies with predictable carbon revenue and/or savings on carbon pricing. This revenue security could help them secure the finance necessary for breakthrough technologies with high capital costs. Auctions will place downward pressure on strike prices leading to more rapid price realisation and preventing windfall profits. This CCfD scheme will be larger scale. A dedicated arms-length EU institution could be established to administer it and act as a contractual counterparty.	• CCfDs will provide a hedge against volatile EU ETS prices, helping to unlock the finance necessary for breakthrough technologies with high capital costs. • A dedicated institution will have the technical expertise, long-term mandate, financial security and governance structure to administer the scheme. • Widespread deployment of technologies could have a near-term impact on carbon leakage.
	Option 3.5: Establish technology-informed minimum carbon performance standards for a subset of carbon leakage list products focussing on those that have the highest extra-EU trade value. These standards will set at a single minimum performance level per product for companies to be eligible to trade within the EU. The standards will also include a graded labelling system indicating to consumers which performance decile the product falls into. A future trajectory of the minimum standards based on expected technological performance improvements will send market signals to industries to focus on deep decarbonisation. Given the higher ambition of technology-informed standards, these should be introduced on a voluntary basis in 2026 and made mandatory in 2031. The evolving minimum level should be transparently forecast through long-term (10-year) timescales to allow industry time to adjust to increasingly ambitious targets.	• Standards align with long-term technology pathways towards decarbonisation • Broader choice of sectors/subsectors/products can deliver greater environmental benefit • Complementary labelling system helps deliver market pull.
Standards	**Option 3.6:** Establish minimum carbon performance standards based on the range of performance levels of EU ETS installation benchmark products. These standards would	• Close alignment with existing benchmark system

	be data-informed and derived using the existing benchmark curves. They would include a minimum performance level per product for companies to be eligible to trade within the EU. As these standards will be more conservatively based on actual peer data, they should be made mandatory from 2026. A trajectory will indicate the percentage improvements that will be applied to the minimum standards in five-year intervals, which is the frequency in which the underlying data is gathered.	in choice of products and underpinning data • Simpler and technically more feasible option • Approach prioritises carbon leakage protection over longer term environmental outcome.

TASK 1.4 – ADDITIONAL TOPICS

1.8. Task 1.4.1 – Assessment of the definition of electricity generator

The aim of this task is to assess the impacts that the definition of 'electricity generator' and its interpretation from the European Court of Justice (ECJ) will have on the levels of free allocation for EU ETS industrial installations that have sold electricity in the past. According to Article 10a(3) of the ETS Directive, no free allocation shall be given to electricity generators (subject to provisions in Articles 10a(4) and 10a(8) explained below). The definition of electricity generator is contained in ETS Directive Article 3(u), which states that:

> *'electricity generator' means an installation that, on or after 1 January 2005, has produced electricity for sale to third parties, and in which no activity listed in Annex I is carried out other than the 'combustion of fuels'.*

With reference to the court case, the installation at issue, i.e. ExxonMobil site in Steyerberg (Germany), operated a natural gas processing installation. The only Annex I activity carried out on site was the combustion of fuel. The installation consisted of natural gas desulphurisation and dehydration facilities, sulphur recovery facilities, called 'Claus-process' facilities, waste gas purification facilities and ancillary facilities. The ancillary facilities included a steam boiler, a gas engine facility, emergency flaring facilities and a condensing power station. The power station was connected to the public electricity network, with small amounts of electricity being continuously released into the network in order to ensure continuity of electricity supply for the installation. During some of the baseline years, the installation consumed more electricity than it produced.

The key elements of the ECJ interpretation are repeated below.

The judgement in Case C 682/17 ruled that "an installation, such as that at issue in the main proceedings, which produces, within the framework of its activity of 'combustion of fuels in installations with a total rated thermal input exceeding 20 MW', referred to in Annex I to that directive, electricity intended essentially to be used for its own needs, must be regarded as an 'electricity generator', within the meaning of that provision, where that installation,

- first, carries out simultaneously an activity for producing a product which does not fall within that annex and,
- second, continuously feeds, for consideration, even a small part of the electricity produced into the public electricity network, to which that installation must be permanently connected for technical reasons".

And "an installation such as that at issue in the main proceedings must be regarded as an 'electricity generator', within the meaning of Article 3(u) of Directive 2003/87, it is not entitled to be allocated free emission allowances in respect of the heat produced within the framework of its activity of 'combustion of fuels in installations with a total rated thermal input exceeding 20 MW', referred to in Annex I to that directive, where that heat is used for purposes other than the production of electricity, since such an installation does not fulfil the conditions laid down in Article 10a(4) and (8) of the directive."

This definition of electricity generator and its interpretation by the ECJ could lead to a very different amount of free allocations received by similar installations solely based on the fact that one installation has exported, at any point in time during the baseline period, a small amount of electricity and it is therefore considered an electricity generator.

It is necessary to determine which installations would not be eligible for free allocation because of the interpretation of the electricity generator clause, and to calculate the free allocation that they would forego as a result. The installations for which this judgement is relevant will be those that:

- Have produced and exported electricity to the public electricity network or another operator at any time since 2005. They will be classified as an electricity generator irrespective of the amount of electricity exported in this way, the length of time over which the exports occurred, and irrespective of the amount of electricity they have generated and consumed themselves, or which they have imported from the public network, and
- Do not carry out any activity in Annex I of the ETS Directive other than "*combustion of fuels in installations with a total rated thermal input exceeding 20 MW'"*. This means that any installation that does carry out one or more of those product-based activities will not be an electricity generator and is excluded from the analysis.

Installations as defined above are not eligible for free allocation, unless they are covered by ETS Directive Articles 10a(4) and (8). The ECJ was asked to rule on whether the installation in question should receive free allocation for the heat produced using the heat benchmark and decided that it should not. The analysis presented below therefore assesses the extent to which industrial installations become ineligible for heat benchmark allocations as a consequence of their classification as an electricity generator. To identify the potentially affected installations we have reviewed the NIMs data and applied a series of filters:

- **Activities according to Annex I of the EU ETS Directive**: The installation must have listed as only Annex I activity the "*combustion of fuels in installations with a total rated thermal input exceeding 20 MW"*. Only these installations would be considered "electricity generator" and no allowances would be allocated to them. The Annex I classification based on the NIMs data has not been checked against any other sources and so is assumed to be correct.
- **Installations that produce electricity:** Selected installations must have been labelled "TRUE" in the corresponding field of the NIMs data, as the court ruling and the electricity generator definition only apply to installations that produce electricity.
- **Total electricity exported to the grid or to other installations**[93]**:** only installations which have exported electricity can be considered "electricity generators"; if the electricity is produced and consumed within the boundaries of the installation then

[93] The data in the NIMs template are provided as "Total electricity exported to the grid or to other installations"

the definition would not apply. Therefore, selected installations must have reported a positive export value in at least one of the baseline years. With the available information, we cannot confirm if the installation is permanently connected to the public network or another operator to allow for electricity export, although this is probably true if the installation has exported electricity.

- **Heat eligible for heat benchmark sub-installation**: installations, to be impacted, must have a positive value of heat eligible for allocation in the baseline period, as, based on the court decision, if the above conditions are satisfied, and the installation is considered an electricity generator, the free allowances allocated through the fall-back heat benchmark would not be permitted.
- **Installations should not fulfil the conditions laid down in Article 10a(4) and (8) of the directive**. Article 10a(4) states that free allocation can be given to district heating as well as to high efficiency cogeneration in respect of the production of heating or cooling, while Article 10a(8) refers to the allowances allocated to support innovation in low carbon technologies and processes in sectors listed in Annex I. District heating installations and the relevant heat generated have been identified and removed.
- **Based on the NIMs data we have performed an additional analysis to exclude high efficiency co-generators**. Due to data gaps in the NIMs this analysis is presented as an additional filter in Table 10
- **Finally, installations should have a positive preliminary allocation.** This is an extra filter used to avoid the selection of electricity producers or power plants[94].

Thus, we have reviewed the data and, by applying the above criteria, we have selected the cohort of installations that is relevant for this analysis. In total we have found 1086 installations that could be impacted,

For each installation we have calculated what percentage of electricity produced is exported in the baseline period, as:

$$\%exported\ electricity = \frac{Total\ electricity\ exported}{(Net\ electricity\ produced\ from\ fuels\ +\ Other\ electricity\ produced)}.$$

Where the used value are the totals over the reported years.

The results are shown in Figure 16. Overall, it can be concluded that a large proportion of the installations export a substantial share of the electricity that they generate, a smaller but still considerable number export very little, and the remainder are distributed evenly across the medium range of export percentages:

- around 10% of the installations export less than 5% of the produced electricity,
- almost 4% of the considered installations export between 5-10% of the generated electricity,
- 6.5% of the installations export between 10% and 35% of the generated electricity,
- less than 5% of the installations export between 35% and 65% of the generated electricity,

[94] It should be pointed out that, in the NIMs data received, German installations do not have a value in the field, "Preliminary allocation" although information on heat and electricity generation is provided. For this MS we have still selected all the suitable installations.

- 25% of the installations export more than 65% but less than 95% of the generated electricity,
- and around 38% export between 95% and 100%.

We have also noted that almost 12% of the considered installations export more electricity than is generated on site. This could be because the installation exports electricity which itself is imported or be due to a possible error in the dataset.

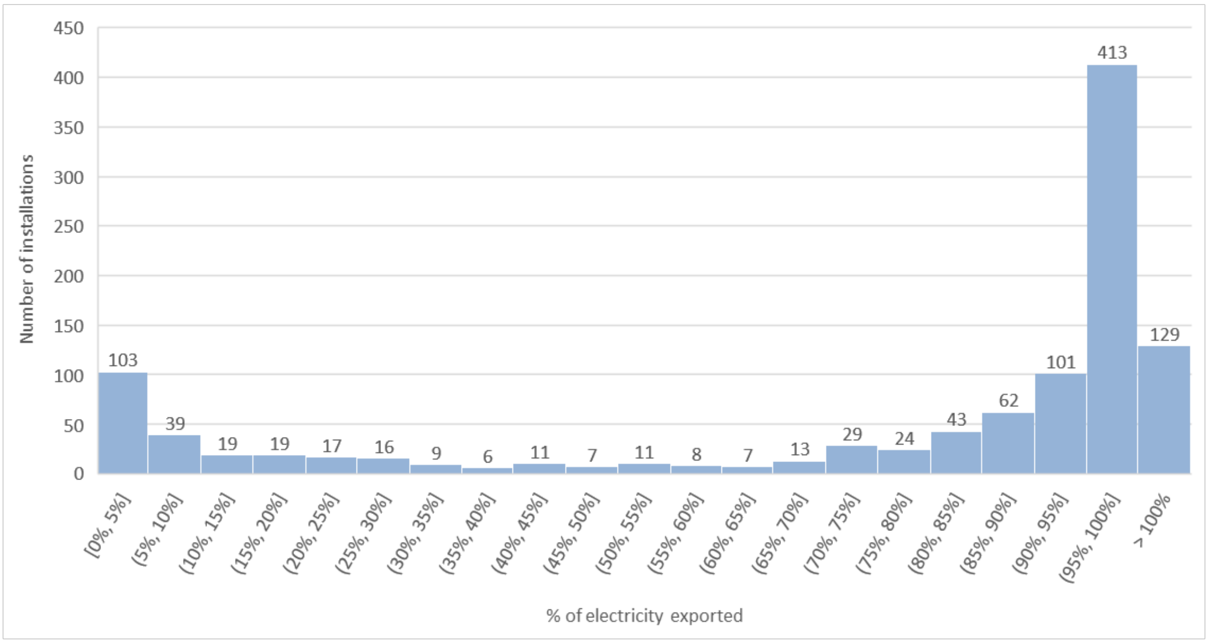


Figure 16: Installations grouped by value of exported electricity over produced electricity. District heating installations have been removed.

To better understand the distribution of the installations and how these could be affected by the definition of electricity generator, we have plotted, for each installation, two variables:

- On the x axis: the percentage of electricity exported compared to the total electricity generated
- On the y axis: the annual average foregone heat allowances.

For the purposes of this exercise, the foregone heat allowances have been calculated by multiplying the average amount of the heat that would be otherwise eligible for the heat benchmark with the heat benchmark value. Of particular interest are installations with high foregone allowances and low percentages of electricity export, as they would be treated as an "electricity generator" and even though their electricity export is only a small percentage of the generated electricity, they would forego a high level of free allocation as a result. For the purposes of this exercise, the possible heat allowances have been calculated by multiplying the average amount of heat eligible[95] for heat benchmark[96] with the heat benchmark value[97].

From the average heat amount we have then subtracted the average amount of heat from the district heating sub-installation. A further analysis looking at highly efficient CHP has been done in the next section. If the average heat from district heating is the same as the average amount of heat eligible for heat benchmark, the installation has been removed from the cohort as the only activity carried out is the generation of heat through district heating, and therefore the installation would fall under article 10a(4). For other installations the calculation has reduced the value of "eligible heat" used to calculate the allowances, as the heat associated with district heating has been removed from the total heat.

If the installation does not belong to a sector at significant risk of carbon leakage, the value has been multiplied by the carbon leakage factor for 2020 (i.e. 0.3):

*Foregone allocation = Average amount of heat otherwise-eligible for heat benchmark * Heat BM * CL factor*

It should be noted that this value is an overestimate of the number of allowances that installations could receive as it does not take into consideration the cross-sectoral correction factor (CSCF). On the other hand, we are applying the 2020 carbon leakage factor which compensates the overestimate, as the analysis is compared against the 2018 total allowances value.

Filtering out installations which exported more than 100%[98] of produced electricity, the graph in Figure 17 can be visualised. The majority of installations tend to fall below a level of 100,000 allowances, however, some installations have high allowances values together with a low percentage of electricity export; these will probably be mainly impacted by the electricity generator definition. The red dots represent the installations in the cohort which fall under the NACE code 35.30 (steam and air conditioning supply). These are analysed in more detail in the following section.

---

[95] "Eligible heat" is the heat classified as "eligible" according to the NIMs data

[96] The average value has been obtained by averaging the value "Amount of heat attributable to heat benchmark sub-installations" over the 5 years baseline period

[97] We have used the Phase 3 benchmark value as this allows for a comparison with the final free allocation given in 2018. For Phase 4 the allocation amounts would be lower because of heat benchmark tightening

[98] Mainly for presentational reasons, the installations are included in the following analysis

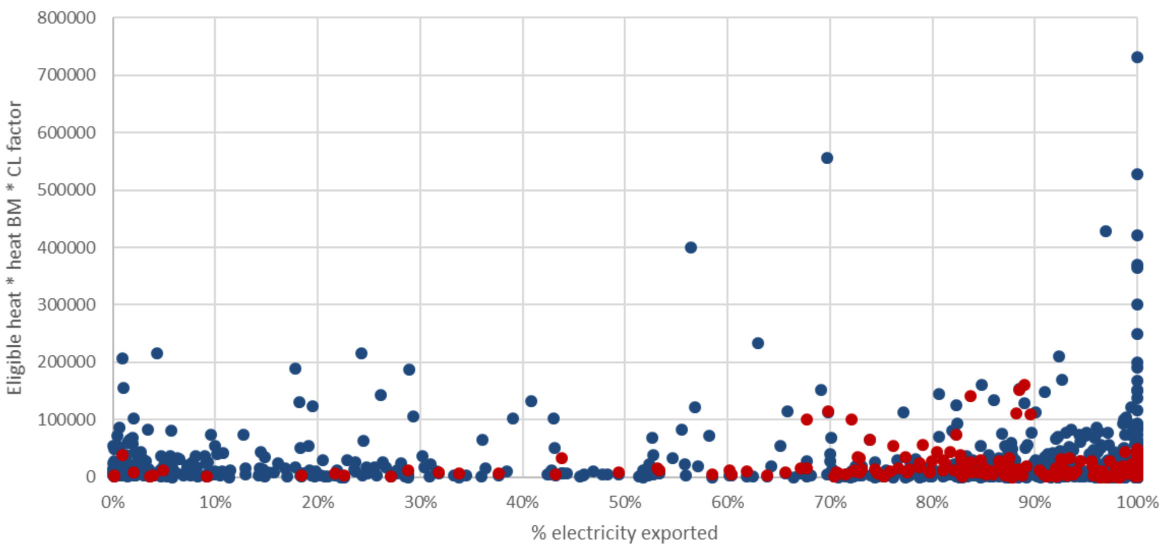


Figure 17: Percentage of electricity exported vs foregone allowances for each installation, after removing district heating installations. Red dots represent installations falling under NACE code 35.30.

Finally, to obtain a sense of the size of the problem, we have compared the maximum number of allowances, calculated as described above, with the total value of free allocation that was given to industry and heat production in 2018. The cohort used to perform this exercise is the one where the district heating installations, and the district heating heat has been removed.

The final allocation that was given to industry and heat production in 2018 is[99]:

$$Final\ Allocation\ 2018 = \boldsymbol{688.42\ million\ allowances}$$

The table below shows the average total heat allowances to installations included in the analysed cohort as an absolute value and as a percentage of the total 2018 free allocation.

In addition, by using the NIMs data we have analysed how much heat, and therefore foregone allowances, can be attributed to high-efficient co-generators. In fact, this heat would fall under article 10a(4) and, based on the court ruling, still be eligible for heat allocation.

However, the NIMs data related to CHP production and efficiency presents some gaps and uncertainties. For example, no information on heat and electricity generation has been provided for all the German installations and in some cases, the provided data does not appear robust (e.g. some CHP installation seem to achieve efficiency over 50%, and even 90%, which is unrealistic).

[99] https://www.eea.europa.eu/data-and-maps/dashboards/emissions-trading-viewer-1

Following the methodology for determining the efficiency of the cogeneration process as defined by the Energy Efficiency Directive, we have calculated the primary energy saving for each CHP installation:

$$PES = \left(1 - \frac{1}{\frac{CHP_{H_\eta}}{REF_{H_\eta}} + \frac{CHP_{E_\eta}}{REF_{E_\eta}}} \right)$$

Where:

- CHP_{H_η} is the heat efficiency of the cogeneration production defined as annual useful heat output divided by the fuel input used to produce the sum of useful heat output and electricity from co-generation.
- REF_{H_η} is the efficiency reference value for separate heat production, which depends on the fuel input
- CHP_{E_η} is the electrical efficiency of the cogeneration production defined as annual electricity from cogeneration divided by the fuel input used to produce the sum of useful heat output and electricity from cogeneration.
- REF_{E_η} is the efficiency reference value for separate electrical production, which depends on the fuel input

As defined by the EED, cogeneration units shall provide primary energy savings (PES) of at least 10% to be considered high-efficient co-generators.

Based on our analysis, the following has been found:

- Out of the 1086 installations which have been selected in the cohort, 488 appear to be high-efficient co-generators
- A further 245 installations do not exceed the 10% PES value
- The remaining 353 installations either do not have a CHP or present gaps in the dataset and the PSE value cannot be estimated, e.g. all the German installations[100].

Therefore, for the purpose of this analysis we have considered only the first category as not within the electricity generator category but assumed that all installations in the second two categories are potentially electricity generators not subject to art 10a(4).Based on this analysis, for the 488 high-efficient co-generators, we have identified the average heat generated by the CHP and calculated the amount of foregone allowances. The total value of allowances, calculated as described above, i.e. *heat * Heat BM * CL factor* is provided in Table 10.

In addition, due to data limitations in identifying high-efficient co-generators, we have performed a second analysis looking at installations' NACE codes. This is, we looked what the value would be if all the installations belonging to the NACE code 35, i.e. "electricity, gas, steam and air conditioning supply" are excluded from the cohort. For example, NACE

[100] It should be noted that fore these installations there is still enough data for us to calculate the foregone allowances. In other words, they have gaps that prevent us knowing if they are high efficiency, but not gaps to calculate allocations.

code 35.30 “steam and air conditioning supply” accounts for 271 installations in the cohort. Similarly, installations under NACE code 35.11 “production of electricity” which have been included in our cohort, as they fulfil all the filters, including having eligible heat receiving allowance, might still be eligible for free allocation as there might be other articles, such as 10a(8)[101], which would apply. Again, this might not be the case, but, as a sensitivity analysis, we have assessed what the impact of including or removing these installations would be on the size of the issue. In conclusion, this approach underestimates the number of foregone allocations and gives a conservative estimate of the issue. On the other hand, mainly due to data uncertainty and limitation, the high-efficient co-generator approach is probably overestimating the issue. Thus, these values provide an upper and lower range value.

Table 10: average yearly foregone allowance and percentage of final allocation given to installation in 2021 according to the NIMs data

Considered Cohort	Average yearly foregone allowances	% of free 2018 allocation
Removing highly efficient co-generators		
Whole cohort (total of 1086 installations)	26.95 million	3.91%
Total allowances from high-efficient co-generators (488 installations)	2.94 million	
Whole cohort minus heat from HE co-generators	24.01 million	3.49%
Alternative analysis based on NACE codes		
Whole cohort (total of 1086 installations)	26.95 million	3.91%
Excluding NACE 35.30 (271 installations removed)	24.56 million	3.57%
Excluding NACE 35.30 and 35.11 (additional 297 installations removed)	17.61 million	2.56%
Excluding all NACE 35.xx (additional 291 installations removed)	17.43 million	2.53%

In conclusion, when the whole cohort is considered, our estimate is that up to 3.91% of the total free allocations could be lost by installations due to the court case decision. When the heat generated by HE co-generators is excluded, the value decreases to 3.49%.

[101] i.e. received through the Innovation Fund

When installations belonging to NACE code 35.30 are excluded, the percentage decreases to 3.57% and further down to 2.53% if the whole NACE code 35 sector is excluded. Therefore, we believe that the true value is between these extremes.

As mentioned above, the method used to calculate the number of allowances that installations could receive does not take into consideration the cross-sectoral correction factor (CSCF) or the linear reduction factor (LRF) in case of electricity generators. However, currently there is unequal treatment between standalone CHP and CHP that are within industrial sites. The standalone CHP is classed as an electricity generator and, in this case, the LRF is applied. The industrial CHP is classed by industrial activity and the CSCF is applied. In Phase 3, this gave an advantage to standalone CHP (electricity generators) but in 2021-2025, as the CSCF will be 100%, the advantage is moved to industry CHP.

In our analysis we have estimated, based on the available data, that, in 2016, 2.94 million foregone allowances would be from HE co-generators and 3.08 million would come from district heating. Therefore, a total of 6.02 million allowances were removed from our cohort because the installations would still receive the allocation even with the new court ruling.

When the CSCF is taken into account, this the 6.02 million in 2016, become 5.38 (i.e. 6.02 multiply by the 2016 CSCF, which is 89%). Appling the CSCF going forward (as showed in table below) the millions of allowances reduce to 4.96 in 2020. From 2021, the updated heat benchmark [102] on the 2016 allowances value has been applied, thus, the number of allowances to district heating and HE co-generators becomes 4.57 (i.e. 6.02 multiplied by the ratio of phase 4 and phase 3 heat benchmark value). The same approach has been used to calculate the allowances when the LRF is considered. In this case the following approach has been used:

- 2016 million allowances with LRF = 6.02 * (1-1.74%)
- 2019 million allowances with LRF = 6.02 * (1- ((2019-2016)*1.74%))

The table below shows the impact of the new CSCF and LRF values on the number of allowances.

Table 11: evaluation of million allowances allocated to generators when using the CSCF or the LRF

	CSCF	LRF	Million allowances with CSCF	Million allowances with LRF	% difference CSCF vs LRF
2013	94%	1.74%	5.67	6.47	-14.01%
2014	93%	1.74%	5.58	6.35	-13.90%
2015	91%	1.74%	5.48	6.24	-13.88%
2016	89%	1.74%	5.38	5.91	-10.03%
2017	88%	1.74%	5.27	5.81	-10.17%
2018	86%	1.74%	5.17	5.71	-10.33%
2019	84%	1.74%	5.07	5.60	-10.53%
2020	82%	1.74%	4.96	5.50	-10.75%
2021	100%	2.20%	4.570	4.469	2.20%

[102] The heat benchmark value for the period 2021 – 2025 is 47.3 allowances/TJ - https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R0447&qid=1621868213497&from=en

2022	100%	2.20%	4.570	4.369	4.40%
2023	100%	2.20%	4.570	4.268	6.60%
2024	100%	2.20%	4.570	4.168	8.80%
2025	100%	2.20%	4.570	4.067	11.00%

The calculation shows that in the period 2013 – 2020 a CHP classed by industrial activity will receive less allowances than an equivalent CHP classed as standalone CHP. The difference ranges between 14% and 11%, however, starting in 2021, the situation is the opposite. Due to a CSCF of 100%, CHP classed by industrial activity will this time receive higher allowances, although the difference, particularly in the first few years, is less marked.

To understand which are the Member States which might be highly impacted by the court ruling, we have plotted the millions of allowances allocated to the selected cohort, based on the eligible heat as discussed above. The Member State which would see the highest number of allowances (over 11 million i.e. 7.5% of free allocation received in 2018) not allocated to their installations is Germany, which is also the Member States with the highest number of installations (Figure 18). Poland follows with 2.8 million (i.e. 3.5% compared to free allocation in 2018), followed by Spain (1.96 million, i.e. 3.4% compared to 2018), Italy (1.7 million, i.e. 2.5% compared to 2018) and the Netherlands with 1.5 million (i.e. 3.4 compared to 2018 free allocation) .

Figure 18:Total number of allowances (in Million) which will not be distributed to "electricity generators" according to the court ruling.

Finally, we have looked at the geographical distribution of the installations falling in our selected cohort. The graph shows all the installations which have been identified through our analysis. The five Member States with the higher number of installations left, and therefore likely to be impacted, are Germany (295 out of 1831. i.e. 16%), Italy (138 out of 1068, i.e.

13%), Spain (116 out of 739, i.e. 15%), Poland (111 out of 637, i.e. 17%) and Denmark (59 out of 327, i.e. 18%).

1.9. Task 1.4.2 – Future proofing of ETS scope and benchmark

1.9.1. Context

A concern of the current EU ETS scope and benchmark definitions is that they appear to protect the status quo and provide a low level of incentive for industry to decarbonise, particularly in the case of electrification. For example, a paper mill that fully switches to biomass and hydrogen fuel would no longer emit CO_2 and therefore would no longer be covered by the ETS and would not be eligible to receive free allocation. On the other hand, if the paper mill only partially switches fuel and continues to use a small amount of fossil fuels it will continue to be covered by the ETS and receive allocation via the relevant paper product benchmarks. The latter scenario is advantageous to the operator because the surplus allowances can be used to offset the investment cost in fuel switching, however this scenario has less CO_2 reduction.

For this task we have reviewed the activity descriptions under Annex I to the ETS Directive (2003/87/EC and amendments) as well as the 52 product and the 2 fall-back fuel and heat benchmarks defined by the Free Allocation Regulation (FAR) ((EU) 2019/331) to assess whether they are “future-proof”. That is, to consider whether or not they provide an incentive to decarbonisation. Of particular interest are the definitions of product, production process, system boundary and the treatment of indirect emissions.

This assessment is in the context of Article 10a of the Directive which states:

The measures referred to in the first subparagraph shall, to the extent feasible, determine Union-wide ex-ante benchmarks so as to ensure that ***allocation takes place in a manner that provides incentives for reductions in greenhouse gas emissions*** *and energy efficient techniques, by taking account of the most efficient techniques, substitutes, alternative production processes, high efficiency cogeneration, efficient energy recovery of waste gases, use of biomass and capture and storage of* CO_2*, where such facilities are available, and shall not provide incentives to increase emissions.*

Furthermore, the FAR states the purposes of free allocation are to provide protection against the risk of carbon leakage and to incentivise emissions reductions:

(30) Article 191(2) of the Treaty on the Functioning of the European Union requires that the Union policy on the environment be based on the principle that the polluter should pay and, on this basis, Directive 2003/87/EC provides for a transition to full auctioning over time. Avoiding carbon leakage justifies temporarily postponing full auctioning, and targeted free allocation of allowances to industry is justified in order to address genuine risks of increases in greenhouse gas emissions in third countries where industry is not subject to comparable carbon constraints, as long as comparable climate policy measures are not undertaken by other major economies. Furthermore, ***free allocation rules should incentivise emission reductions*** *in line with the Union's commitment to reduce the overall greenhouse gas emissions by at least 40% below 1990 levels by 2030. Incentives for emission reductions for activities that produce the same product should be enhanced.*

The description of Annex I activities as well as the definitions of products, processes and emissions covered by the benchmarks were assessed in light of potential future technology developments such as electrification and use of hydrogen.

The potential for low-carbon technologies and products in 2030, considered under the recent sectoral assessments of carbon leakage,[103] served as a starting point to identify what future technology developments are likely to be available for which activities and product benchmarks. To supplement this, a literature review was undertaken to extend the research to the period from 2030 up to 2050 and to cover all benchmarked products. Decarbonisation options were identified using scientific literature, sector roadmaps, pilot studies and other publicly available literature.

We considered two main approaches to electrification: exchangeability with fuels or full electrification. Exchangeability is understood as when there is partial replacement of fossil fuel use with electricity in a current production process. Full electrification is understood as an option that would involve full replacement of fossil fuel use in the production process. Full electrification may consist of replacing the energy source in the same production process or it may be associated with a significant change to the production route itself such as production via electrolysis.

The exchangeability of fuel and electricity is already common in certain production processes and was therefore accounted for in the development of 14 of the product benchmarks. For these, the benchmark was determined including the indirect emissions associated with the electricity consumed. For the calculation of free allocation, an adjustment is made to exclude indirect emissions so that free allocation is not given for emissions associated with electricity production. These benchmarks are indicated in Table 12 and the adjustment calculation is further described in Section 1.10.1.1.

We performed a high-level assessment of all 52 product benchmarks to identify those where electrification is unlikely to be feasible by 2030 and/or by 2050. The findings showed that there are only a small number of benchmarks for which no electrification options could be identified in the literature. These products are coke, pre-bake anodes, adipic acid and phenol/acetone. Further consideration of the production processes for these products identified that in all cases there is consumption of heat or steam. Therefore, there may in principle be potential for full or partial replacement of fuel combustion with electricity use for production of heat. However, the likelihood or timeframe for switching to electricity is uncertain given the lack of evidence in the identified literature.

As a next step we identified the benchmarks for which electrification appears to be feasible by 2050 but not by 2030. This included considering pilot studies of technologies and assessing the market readiness of these technologies, as well as industry expectation of the penetration of these technologies. The benchmarks identified were **grey cement clinker** and **white cement clinker**, for which electrification through plasma generators and radiation energy is at a very early development stage. Similarly, **vinyl chloride monomer (VCM), S-PVC** and **E-PVC** for which full electrification is at a very early development stage, although the production and use of steam/heat means there is potential for earlier exchangeability for some fuel use.

---

[103] Oko-Institute, Ricardo, Trinomics and Adelphi (2020 unpublished) *Assessment of potential carbon leakage in the 3rd and 4th phase of the EU Emissions Trading System* contract for DG CLIMA

The following table summarises whether the current benchmark already reflects exchangeability of fuel and electricity or if this may become relevant in future.

Table 12: Potential for electrification in the production of benchmarked products

Product benchmark	Exchangeability is reflected in the benchmark	Electrification/ exchangeability possible by 2030	Electrification/ exchangeability possible by 2050
Coke	No	Uncertain: high heat demand implies possibility for partial exchangeability of fuels for electricity. Production of coke oven gas as a by-product and being available for use as a fuel, and the high temperatures required, may mean full electrification is improbable.	
Sintered ore	No	Electrification	Electrification
Hot metal	No	Electrification	Electrification
Pre-bake anode	No	Uncertain: high heat demand implies possibility for partial exchangeability of fuels for electricity. The high temperatures required may mean full electrification is improbable.	
Aluminium	No	Production is via electrolysis so is already a predominantly electrified process. Minor potential for further electrification where the melting furnace has supplementary heating from fuel combustion.	
Grey cement clinker	No	No	Electrification
White cement clinker	No	No	Electrification
Lime	No	Exchangeability	Exchangeability
Dolime	No	Exchangeability	Exchangeability
Sintered dolime	No	Exchangeability	Exchangeability
Float glass	No	Exchangeability	Exchangeability
Bottles and jars of colourless glass	No	Exchangeability	Exchangeability
Bottles and jars of coloured glass	No	Exchangeability	Exchangeability
Continuous filament glass fibre products	No	Exchangeability	Exchangeability
Facing bricks	No	Exchangeability	Exchangeability
Pavers	No	Exchangeability	Exchangeability
Roof tiles	No	Exchangeability	Exchangeability
Spray dried powder	No	Exchangeability	Exchangeability

Product benchmark	Exchangeability is reflected in the benchmark	Electrification/ exchangeability possible by 2030	Electrification/ exchangeability possible by 2050
Plaster	No	Exchangeability	Exchangeability
Dried secondary gypsum	No	Exchangeability	Exchangeability
Short fibre kraft pulp	No	Exchangeability	Exchangeability
Long fibre kraft pulp	No	Exchangeability	Exchangeability
Sulphite pulp, thermo-mechanical and mechanical pulp	No	Exchangeability	Exchangeability
Recovered paper pulp	No	Exchangeability	Exchangeability
Newsprint	No	Exchangeability	Exchangeability
Uncoated fine paper	No	Exchangeability	Exchangeability
Coated fine paper	No	Exchangeability	Exchangeability
Tissue	No	Exchangeability	Exchangeability
Testliner and fluting	No	Exchangeability	Exchangeability
Uncoated carton board	No	Exchangeability	Exchangeability
Coated carton board	No	Exchangeability	Exchangeability
Nitric acid	No	Electrification	Electrification
Adipic acid	No	Uncertain: demand for moderate temperature heat implies possibility for partial exchangeability of fuels for electricity. Fuel combustion in N_2O abatement units may still be necessary.	
Vinyl chloride monomer (VCM)*	No	Exchangeability	Electrification
Phenol/acetone*	No	Uncertain: demand for moderate temperature heat implies possibility for electrification.	
S-PVC*	No	Exchangeability	Electrification
E-PVC*	No	Exchangeability	Electrification
Soda ash	No	Electrification	Electrification
Refinery products	Yes	Exchangeability	Exchangeability
EAF carbon steel	Yes	Electrification	Electrification
EAF high alloy steel	Yes	Electrification	Electrification

Product benchmark	Exchangeability is reflected in the benchmark	Electrification/ exchangeability possible by 2030	Electrification/ exchangeability possible by 2050
Iron casting	Yes	Electrification (potential – timeline uncertain)	Electrification
Mineral wool	Yes	Exchangeability	Exchangeability
Plasterboard	Yes	Exchangeability	Exchangeability
Carbon black	Yes	Exchangeability/ Electrification	Exchangeability/ Electrification
Ammonia	Yes	Electrification	Electrification
Steam cracking (high value chemicals)*	Yes	Electrification	Electrification
Aromatics*	Yes	Uncertain: high heat demand implies possibility for exchangeability of fuels for electricity.	
Styrene*	Yes	Uncertain: high heat demand implies possibility for exchangeability of fuels for electricity.	
Hydrogen	Yes	Electrification	Electrification
Synthesis gas (syngas)	Yes	Electrification	Electrification
Ethylene oxide/ethylene glycols*	Yes	Electrification (potential – timeline uncertain)	Electrification

*Research also considered replacement of hydrocarbon feedstocks with biomass feedstocks for the products indicated.

The use of electricity for the generation of measurable heat, direct heat or mechanical energy also has potential to increase in 2030 and 2050 to partially or fully replace fossil fuels. This will affect free allocation calculated via the heat or fuel benchmarks.

Fuel switching to hydrogen would potentially be possible to partially or fully replace fossil fuel use for combustion in the production of any benchmarked products. Uptake will primarily be influenced by availability of sustainable “green” hydrogen and the relative price compared to switching to electricity.

1.9.2. Review of ETS scope (Annex I)

1.9.2.1. Replacement of fossil fuels with electricity

The review of literature on potential decarbonisation developments in ETS sectors indicates potential for partial electrification of heat production across the majority of the benchmarked products. For a smaller number of products, full electrification of all combustion activities or replacement by an electrified process such as electrolysis may be possible.

Inclusion of several activities under the ETS is defined under Annex I of the Directive by a threshold of 20 MW thermal input capacity, as presented in the following table.

Table 13: ETS Annex I activities defined with a thermal input capacity threshold[104]

Combustion of fuels in installations with a total rated thermal input exceeding 20 MW (except in installations for the incineration of hazardous or municipal waste)
Production or processing of **ferrous metals** (including ferro-alloys) where combustion units with a total rated thermal input exceeding 20 MW are operated . Processing includes, inter alia, rolling mills, re-heaters, annealing furnaces, smitheries, foundries, coating and pickling
Production of **secondary aluminium** where combustion units with a total rated thermal input exceeding 20 MW are operated
Production or processing of **non-ferrous metals**, including production of alloys, refining, foundry casting, etc., where combustion units with a total rated thermal input (including fuels used as reducing agents) exceeding 20 MW are operated
Drying or calcination of **gypsum** or production of **plaster** boards and other gypsum products, where combustion units with a total rated thermal input exceeding 20 MW are operated
Production of **carbon black** involving the carbonisation of organic substances such as oils, tars, cracker and distillation residues, where combustion units with a total rated thermal input exceeding 20 MW are operated

Following complete, or even partial, replacement of combustion activities with electricity, these installations may no longer exceed this 20 MW thermal input capacity threshold and would then no longer be covered by the ETS. Therefore, following extensive electrification the installation would no longer be eligible to receive free allocation.

For these activities, where the product benchmarks account for the exchangeability of electricity and fuel (i.e. iron casting, carbon black), and for the heat and fuel benchmarks, an increase in the use of electricity will lead to a reduction in the amount of free allocation. It will also result in lower emissions and similarly a reduction in the number of allowances to be surrendered. For many of these installations there will be a saving due to avoided ETS costs of electrifying and dropping out of the ETS. Only the installations that receive a surplus of free allowances, for example the best performing benchmarked installations (e.g. due to using biomass fuels), would benefit from remaining in the ETS and may therefore be disincentivised from switching to electricity.

For these activities, when covered by product benchmarks developed without accounting for exchangeability of electricity and fuel (i.e. plaster, dried secondary gypsum), there is an incentive to electrify up to the level at which the 20 MW thermal capacity would be retained.

[104] Annex I (3): When the total rated thermal input of an installation is calculated in order to decide upon its inclusion in the EU ETS, the rated thermal inputs of all technical units which are part of it, in which fuels are combusted within the installation, are added together. These units could include all types of boilers, burners, turbines, heaters, furnaces, incinerators, calciners, kilns, ovens, dryers, engines, fuel cells, chemical looping combustion units, flares, and thermal or catalytic post-combustion units. Units with a rated thermal input under 3 MW and units which use exclusively biomass shall not be taken into account for the purposes of this calculation. 'Units using exclusively biomass' includes units which use fossil fuels only during start- up or shut-down of the unit.

This would enable the installation to remain in the ETS[105] and continue to receive the same amount of free allocation calculated via the product benchmark. There would be a reduction in emissions and the number of allowances to be surrendered, and therefore a net surplus in allowances which could be sold to offset the cost of electrifying.

For all Annex 1 activities, the inclusion of installations in the ETS may be affected following complete electrification due to no longer emitting the greenhouse gases listed in Annex I. Therefore, for any activities without process emission that are covered by product benchmarks developed without accounting for exchangeability of electricity and fuel (i.e. paper and board, and possibly some instances for pulp and ceramics production), there is an incentive not to fully electrify so that greenhouse gases continue to be emitted. This would enable the installation to remain in the ETS and receive free allocation calculated with the product benchmark.

Continuing to allow installations to remain within the ETS in order to receive free allocation of allowances following full or partial electrification could provide an additional incentive for installations to electrify. It would lead to a surplus in the free allocation to the installations compared to actual emissions. This surplus could be sold to provide revenue to compensate for the conversion costs. This provision of free allocation could also be regarded as protection against the risk of carbon leakage, as it can compensate the installation for the additional costs incurred for the capital investment needed for electrification and the additional energy cost of electricity compared to fuel[106]. Those costs may otherwise need to be passed through into product prices making the continued operation uncompetitive. This compensation may be considered to be separate from the indirect cost compensation for electricity consumers, for which the compensation specifically covers the carbon cost element within the electricity price, rather than compensating for the cost of using electricity relative to using fuels.

The following policy options have been considered as possible approaches to remove barriers and /or provide an incentive to electrification via free allocation.

Table 14: What could be changed to overcome this issue: policy options relating to Annex I

	Policy options	Should it be further assessed	Rationale / comments
0	**Continue with the current scope of ETS.**		Installations will fall out of the ETS if electrification results in no longer

[105] Art. 27 allowing for opt-out of small installations emitting less than 25 ktCO2e and a rated thermal input below 35 MW and Art 27a allowing for exclusion for small installations emitting less than 2.5 ktCO2e are optional.

[106] This will depend on the relative cost of electricity (including indirect costs of ETS incurred by fossil fuel fired electricity generators unless receiving indirect cost compensation) compared to the cost of the fossil fuels to be replaced and the amount of free allowances that would be received.

	Policy options	Should it be further assessed	Rationale / comments
			meeting the 20 MW thermal input capacity threshold. This would result in the installation no longer receiving free allocation, but the installation would also no longer incur direct CO_2 costs or ETS monitoring, reporting and verification (MRV) costs. This is the baseline scenario so will be used as the point of comparison.
S. 1	**Redefine the Annex I threshold of 20 MW thermal input capacity in terms of thermal output capacity.** • This would require such information to be available from the technical specification of the combustion unit or for default combustion efficiency factors to be defined for each type of combustion unit, in order for continued inclusion of current combustion activities in the ETS. • This would also require an equivalent output capacity to be available in technical specification of electrical equipment available to replace these activities, either in terms of thermal, power or other metric depending on the type of unit.	**No**	This would result in some installations that already use electricity and are not currently covered by ETS being brought in to ETS. Introduces additional complexity as the range of different types of combustion unit covered by the current definition will require various output thresholds and metrics (thermal, electrical, mechanical etc.).
S. 2	**Redefine the threshold in terms of production capacity or processing**	**Yes**	Feasibility of defining appropriate metrics and thresholds for these

	Policy options	Should it be further assessed	Rationale / comments
	capacity for ferrous metals, secondary aluminium, non-ferrous metals, gypsum and carbon black, and retain 20 MW thermal input capacity only for combustion activities that are not linked to specific activities.		activities would require further investigation. Only provides a partial solution as combustion activities without specification of activities would continue to have the 20 MW thermal input capacity threshold. Introducing specification of more activities which are currently covered only by the fuel combustion activity (e.g. sugar production) would reduce this effect; however, there are a very large number of diverse activities that fall under this ETS category so this would be a considerable task and there will continue to be heat only producers (e.g. district heating suppliers).
S. 3	**Allow Member States to opt-in installations following partial or complete electrification,** on the basis that the Annex I scope was met and the installation granted a GHG permit during a defined baseline period.	**Yes**	This would enable the installation to continue to receive free allocation, the installation would not incur CO_2 costs but would incur ETS MRV costs. This is similar to using Article 24 or Art 24a of the ETS Directive. An equivalent approach may be needed to allow for equal treatment of new entrants that were not operating during the baseline period, in order to avoid competitive distortion if only providing free allocation for retrofitting of incumbent installations.
S.4	**Revision of Article 4 to remove "resulting in emissions specified in relation to that activity".**	**Yes**	Results in inclusion of installations undertaking Annex I activities without emitting GHGs. Enables installations to continue to receive free allocation after

	Policy options	Should it be further assessed	Rationale / comments
			switching away from fossil fuels. The installation would not incur CO_2 costs but would incur ETS MRV costs. Provides a harmonised EU approach. Avoids inconsistency between incumbents and new entrants. Retaining the list of GHGs in Annex I will avoid extending the scope of ETS to cover all Annex II GHGs for all activities. This would result in some installations that already use electricity and are not currently covered by ETS being brought in to ETS.

1.9.2.2. Substitution of fossil fuels with alternative fuels

The Annex I definitions only consider fuel type in the case of biomass. Combustion units using only biomass are not included in the consideration of the thermal input capacity threshold, nor are units for the incineration of hazardous or municipal waste. If a combustion unit is fuelled by hydrogen, ammonia or other non-GHG emitting fuels then it will be included in the calculation of the thermal input capacity of the installation against the Annex I thresholds.

Articles 4 and 5, along with Annex I, of the Directive, make reference to emissions of specified GHGs in determining the inclusion of installations in the ETS. The substitution of fossil fuels with 100% non-GHG emitting fuels would result in no CO_2 being emitted from combustion. This would affect the inclusion of installations in the ETS under the combustion activities scope and potentially certain activities that are defined in reference to the product produced but for which there are no process emissions, such as the production of paper and board (and possibly some instances for pulp and ceramics production).

For Annex I activities defined by production or manufacturing activities, there may be process emissions of the specified GHGs that would continue to be emitted irrespective of the fuel type used. Most of the benchmarked products give rise to process emissions of greenhouse gases and installations undertaking these activities will continue therefore to fall under the EU ETS. In these cases, installations would continue to fall within the scope of the ETS following conversion to non-GHG emitting fuel and therefore would still be eligible to receive a free allocation of allowances following the fuel switch

For the combustion activity and other Annex I activities which do not give rise to process emissions of the specified GHG, the inclusion of installations in the ETS would be affected by a 100% switch to biomass or non-GHG emitting fuels. Installations producing paper only, for example, or undertaking activities covered only by the fallback heat and / or fuel benchmarks, would no longer emit GHG emissions following a switch to non-GHG emitting fuels and therefore would no longer be covered by the ETS or eligible for free allocation. Similarly, such installations switching exclusively to biomass fuel would no longer meet the 20 MW thermal input capacity threshold for inclusion. In such a case, installations may have an incentive not to invest in fully converting to biomass or non-GHG emitting fuels given there would no longer be free allocation to compensate for the cost of the conversion. Installations may be encouraged to co-fire with fossil fuels in order to meet the 20 MW threshold and to continue emitting small amounts of GHG emissions and remain in the ETS[107] to receive free allocation of allowances. Continuing to allow for free allocation of allowances in such a situation could provide an incentive for complete fuel switching and also protect against the risk of carbon leakage, given the additional costs the installation is likely to incur in reducing emissions through fuel substitution.

The following policy options have been considered as possible approaches to remove barriers and /or provide an incentive to switching to non-GHG emitting fuels via free allocation.

Table 15: What could be changed to overcome this issue: policy options relating to Annex I

	Policy options	Should it be further assessed	Rationale / comments
0	**Continue with the current scope of ETS.**		Installations will fall out of the ETS if converting to 100% biomass or non-GHG emitting fuel or technology. This would result in the installation no longer receiving free allocation, but the installation would also no longer incur direct CO_2 costs or ETS MRV costs. This is the baseline scenario so will be used as the point of comparison.
S. 5	**Allow Member States to opt-in installations following conversion to biomass or non-**	**Yes**	This would enable the installation to continue to receive free allocation, the installation would

[107] Art. 27 allowing for opt-out of small installations emitting less than 25 ktCO2e and a rated thermal input below 35 MW and Art 27a allowing for exclusion for small installations emitting less than 2.5 ktCO2e are optional.

	Policy options	Should it be further assessed	Rationale / comments
	GHG emitting fuels, on the basis that the Annex I scope was met and the installation granted a GHG permit during a defined baseline period.		not incur CO_2 costs but would incur ETS MRV costs. This is similar to using Article 24 or Art 24a of the ETS Directive. An equivalent approach may be needed to allow for equal treatment of new entrants that were not operating during the baseline period, in order to avoid competitive distortion if only providing free allocation for retrofitting of incumbent installations.
S.6	**Revision of Article 4 to remove "resulting in emissions specified in relation to that activity" and of Annex I to remove the exclusion of "units which use exclusively biomass".**	**Yes**	Results in inclusion of installations undertaking Annex I activities without emitting GHGs or using exclusively biomass. Enables installations to continue to receive free allocation after switching away from fossil fuels. The installation would not incur CO_2 costs but would incur ETS MRV costs. Provides a harmonised EU approach. Avoids inconsistency between incumbents and new entrants. Retaining the list of GHGs in Annex I will avoid extending the scope of ETS to cover all Annex II GHGs for all activities. This would result in some installations that already exclusively use biomass, or do not meet the 20 MW threshold due to having some biomass only fuelled units, and are not currently covered by ETS being brought in to ETS.

1.9.3. Review of benchmark definitions

1.9.3.1. Product benchmarks

The Phase 4 rules already require the benchmark values determining the level of free allocation to be updated periodically to reflect technological progress. Therefore, the deployment of decarbonisation technologies will be reflected in the free allocation, providing these changes in the process continue to meet the definition of the benchmark.

For all benchmarks, we examined the definitions of the products, processes and emissions covered to identify if any of the identified electrification or fuel switching options is not covered by the existing definitions of the product benchmarks. The product benchmark definitions and system boundaries make no reference to fossil fuels and therefore the substitution of the fuel does not affect the applicability of the product benchmarks. Similarly, the fallback heat and fuel benchmarks are determined by the relevant measure of the energy produced or consumed, without reference to the fuel type used. The heat benchmark does however exclude the production of heat from electricity (discussed in Section 1.9.4).

For many of the product benchmarks, the benchmark product and system boundaries definitions would remain applicable following implementation of decarbonisation techniques. The following exceptions are identified:

- The production processes defined for the **hydrogen** benchmark specifically refers to hydrocarbon feedstock(s) and therefore does not capture hydrogen production through electrolysis of water[108].
- The **carbon black** product definition and system boundaries refer to furnace carbon black, and therefore production of carbon black via electrolysis of hydrocarbons (using plasma[109]) is not captured.
- The system boundary of the **hot metal** benchmark for the production of liquid iron refers to the blast furnace (BF) and basic oxygen furnace (BOF). Alternative production routes for primary iron may therefore not be covered. This may also be the case because ETS Annex I refers to pig iron.

These product benchmarks can be deemed not to be "future proof".

Under the current scope of the ETS (not accounting for alternative options presented in Sections 1.9.2.1 and 1.9.2.2), installations producing hydrogen via electrolysis of water would receive no free allocation as the hydrogen product benchmark would not be applicable and the fallbacks are unlikely to be relevant. Additionally, the installation would most likely not be covered by the ETS.

[108] Production of hydrogen or syngas from the electrolysis of hydrocarbons does meet the definitions of the product benchmarks.

[109] https://www.pbl.nl/sites/default/files/downloads/pbl-2020-decarbonistation-options-for-the-dutch-carbon-black-industry_3884_0.pdf

Similarly, installations producing carbon black via electrolysis of hydrocarbons would no longer receive free allocation via the fall back benchmarks, if heat production for product drying is also electrified. However, there would also be no CO_2 emissions so the installation would also likely not be covered by the ETS.

A variety of different options for lower GHG intensity primary "green steel" production are under research and development for potential application in the EU by 2030 or 2050. Substitution of coke for alternative reducing agents such as biomass, plastic or hydrogen in a blast furnace will be covered by the current hot metal benchmark definition. The production of directly reduced iron (DRI) or hot briquetted iron (HBI), which may use natural gas or hydrogen fuel as a lower GHG intensive option to coal, is not covered by the current product benchmarks. There was already one DRI plant in the EU ETS when the benchmarks were developed[110]. Additional DRI plants are now under construction or being planned, however, by 2030 take up is forecast to still be relatively low[111]. Other techniques such as plasma or direct electrolysis appear unlikely to be commercially viable until well after 2030. An operator switching production from the BF-BOF route to the DRI-EAF route would no longer receive allocation via a hot metal benchmark and would instead be eligible for allocation via an EAF benchmark and the fall back benchmarks for heat, fuel and process emissions for the DRI production steps. Alternative production routes may also fall outside the ETS Annex I scope because it refers to pig iron. For example, the DRI route produces sponge iron.As indicated in Table 12, there is on-going research and development for the replacement of hydrocarbon feedstocks with biomass feedstocks for organic chemicals. The change in feedstock itself does not affect the relevance of the benchmark definitions. However, for some products the production steps may also change, in which case the definitions of the system boundaries may no longer be applicable.

- Separate production of **high value chemicals** using biomass feedstocks, such as bio-ethylene, can follow a different production route[112] and would not be covered by the **steam cracking** product benchmark definition or system boundaries. However, bio-based feedstocks can be used in a steam cracker in which case the benchmark could continue to be applicable[113] if the product mix definition is met.
- Production of **aromatics** using biomass feedstocks, such as bio-benzene, can follow a different production route[113, 114] and would not be covered by the **aromatics** product benchmark definition of system boundaries.
- If bio-based cumene is produced from bio-benzene and bio-propylene then used for co-production of **phenol/acetone** this would continue to meet the current

---

[110] Ecofys, Fraunhofer ISI and Oko-Institute, 2009, Methodology for the free allocation of emission allowances in the EU ETS post 2012: Sector report for the iron and steel industry

[111] Derived from ICF and Fraunhofer ISI (2019) in Oko-Institute, Ricardo, Trinomics and Adelphi (2020 unpublished) *Assessment of potential carbon leakage in the 3rd and 4th phase of the EU Emissions Trading System* contract for DG CLIMA

[112] https://www.pbl.nl/sites/default/files/downloads/pbl-2021-decarbonisation-options-for-the-dutch-polyolefins-industry_4236.pdf

[113] https://www.pbl.nl/sites/default/files/downloads/pbl-2021-decarbonisation-options-for-large-volume-organic-chemicals-production-lyondellbasell-rotterdam.pdf

[114] https://www.pbl.nl/sites/default/files/downloads/pbl-2020-decarbonisation-options-for-exxonmobil-chemicals-rotterdam-4230.pdf

benchmark definitions. Various production routes to separately produce phenol and acetone already exist and are not covered by the product benchmark, and therefore the separate production of phenol and acetone from biomass feedstocks is consistent with this current situation.

- The **styrene** product definition and system boundaries do not specify the feedstock or process and therefore would continue to apply for bio-based feedstocks.
- The **ethylene oxide (EO)/ethylene glycols (EG)** system boundary indicates all processes linked with EO production, EO purification and glycol section are covered by the benchmark so any changes to the feedstock and production route will continue to be covered by the benchmark.
- For production of **VCM** and **PVC** bio-ethylene feedstock can be directly substituted without process changes[115] so the benchmarks continue to apply. In any case the definitions of E-PVC and S-PVC do not specify the feedstock or process.

An operator switching production to bio-based high value chemicals (not via steam cracker), aromatics or separate production of phenol or acetone would no longer receive allocation via a product benchmark and may instead be eligible for allocation via the fall back benchmarks for heat, fuel and/or process emissions. Detailed assessment of each product has not been undertaken, however, overall, the take up by 2030 of biomass based chemicals is forecast to still be relatively low[111].

The following policy options have been considered as possible approaches to future proof the product benchmarks in order to remove barriers and /or provide an incentive to electrification via free allocation.

Table 16: What could be changed to overcome this issue: policy options relating to benchmarks

	Policy options	Should it be further assessed	Rationale / comment
0	**Retain current benchmark definitions.**		Installations producing hydrogen or carbon black with electrified processes would lose their free allocation. DRI production would continue to be covered by the fall back benchmarks. Certain production routes of bio-based high value chemicals (not via steam cracking) or aromatics would receive allocation via the fall back

[115] https://www.pbl.nl/sites/default/files/downloads/pbl-2020-decarbonisation-options-for-the-dutch-pvc-industry_3717.pdf

	Policy options	Should it be further assessed	Rationale / comment
			benchmarks rather than the product benchmarks. This is the baseline scenario so will be used as the point of comparison.
B. 1	**Revise the benchmark definitions for these products: hydrogen; carbon black**, to remove reference to specific feedstock or production processes so that the current benchmarks will be applicable for alternative production routes.	**Yes**	Aligns with the principle of "one product, one benchmark"
B.2	**Introduce product benchmarks for DRI and separate chemicals products not produced via steam cracking, aromatics or phenol/acetone co-production.**	**No**	Scale of production is anticipated to be low by 2030 and production may be covered by the fall back benchmarks, consistent with production of other low volume products. There is inconsistency with the "one product, one benchmark" principle whether or not this option is adopted. However, given the high complexity and significant differences between the production routes it may not be practicable to replace the current coke, sinter, hot metal, with a single primary iron benchmark, or for separate product benchmarks for the chemicals produced via the prevalent co-production routes.

Consideration has also been given to identify which benchmarks may become redundant due to a change in the production process of the final product, including if the benchmark is for an intermediate product for which there would no longer be demand.

Pre-bake anodes are currently in use for aluminium production. Complete replacement of use of these carbon-based anodes with inert anodes would mean there is no longer demand for pre-bake anodes which would make the benchmark redundant. Inert anodes avoid CO_2 emissions being emitted from decomposition of the carbon anodes during use.

Coke and sintered ore are intermediary products associated with primary steel production via the BF-BOF route. If iron ore pellets, DRI or HBI produced using hydrogen (or natural gas) is used in the BF, this may be as a substitute for the use of coke or sinter (or otherwise may be used in place of scrap metal). Iron ore pellets, DRI or HBI may alternatively be used in electric arc furnaces (EAF) as a means of increasing the electrification of steel production. Demand for coke and sinter would subsequently reduce or cease. There is currently no product benchmark for iron ore pellets and therefore free allocation for production of this intermediary product would be based on the fall-back benchmarks. If hydrogen is used as the reducing agent in the production of hot metal (iron) instead of carbon monoxide from coke, demand for coke would reduce or cease. Production of hydrogen is already covered by a product benchmark.

Replacing the coke, sinter, hot metal and EAF steel product benchmarks with a single steel product benchmark that represents the average of the 10% lowest intensity steel producers would result in a steel benchmark that reflects the EAF production route (i.e. this would effectively be the same as retaining the two current benchmarks for EAF steels). This would lead to a significant short fall in free allocation to the blast furnace production route, which would send a signal to encourage uptake of lower GHG emissions intensive production routes. However, it would expose this sector to the risk of carbon leakage and may not be feasible for demand to be met given the finite availability of scrap steel and early stage of development of alternative low carbon steel production techniques. While steel may be considered to be a single homogeneous product, there are speciality grades which industry claims can only be produced via the BF-BOF route due to limitations introduced by quality of scrap used in EAF. So having multi product benchmarks reflects this product differentiation, even though currently there is likely to be considerable overlap in the steel grades produced via the different routes. Furthermore, as coke and sinter are traded as intermediary products there would be challenges in applying a single system boundary covering all steps and alternative routes for steel production. The options for low GHG intensity steel production are still at an early stage of development and have not been commercially deployed in the EU. The benchmark level would therefore not be achievable for a significant proportion of EU steel production by 2030. Significant replacement of the current production routes with the alternative production routes is not expected to have occurred by 2030 and therefore the current benchmarks will remain relevant for a significant proportion of production.

Therefore, it is not proposed for any of the product benchmarks to be removed as all will remain relevant by 2030.

1.9.4. Fall back benchmarks

The Free Allocation Regulation ((EU) 2019/331) Article 2 (3) definition of the heat benchmark excludes heat produced from electricity. The fuel benchmark applies when there is combustion of fuel. Therefore, these fall back benchmarks no longer apply following electrification. This potentially presents a disincentive to electrification of production process that receive free allocation via these fallback benchmarks.

The following policy options have been considered as possible approaches to future proof the heat and fuel benchmarks in order to remove barriers and /or provide an incentive to electrification via free allocation.

Table 17: What could be changed to overcome this issue: policy options relating to benchmarks

	Policy options	Should it be further assessed	Rationale
0	**Retain current benchmark definitions.**		Allocation will be lower than the allocation that would be received for continued production of the same amount of product via the conventional techniques as there is no allocation for electricity consumption via the fall back benchmarks. This is the baseline scenario so will be used as the point of comparison.
B. 2	**Revise the heat benchmark definition**, to include heat produced from electricity.	**Yes**	This would mean giving free allocation associated with electricity which is not aligned with the free allocation rules and would re-open discussion on this issue. Improves consistency with activities covered by a product benchmark which does not include adjustment of exchangeability of fuels and electricity, for which partial replacement of fuel with electricity will result in a surplus of allowances given actual emissions will reduce whilst allocation is not reduced. Similarly, improves consistency with a heat benchmarked process that switches to hydrogen, for which partial replacement of fuel with electricity will result in a surplus of allowances given actual emissions will reduce whilst allocation is not reduced.
B. 3	**Revise the allocation rules to allow the installation to continue to receive free**	**No**	This would enable the installation to continue to receive free allocation, the installation would not incur CO_2

	Policy options	Should it be further assessed	Rationale
	allocation via the heat or fuel benchmark following switching to electricity, on the basis that there was consumption of heat or fuels during a defined baseline period .		costs but would incur ETS MRV costs. This would be consistent with continued free allocation of other decarbonisation options such as switching to biomass or investment in efficiency improvements. But it means giving free allocation associated with electricity which is not aligned with the free allocation rules and would re-open discussion on this issue. An equivalent approach may be needed to allow for equal treatment of new entrants that were not operating during the baseline period, in order to avoid competitive distortion if only providing free allocation for retrofitting of incumbent installations. Creates inconsistent treatment with early movers to electrification, which would not receive the allocation. More complex variant of option B.3 without additional benefit.

1.10. Task 1.4.3 – Assess the concept of exchangeability of fuel and electricity

1.10.1. The concept of exchangeability

The concept of exchangeability of fuel and electricity is set out in Article 22 of Regulation (EU) 2019/331. The article recognises that in some processes, direct emissions (i.e. emissions eligible for free allocations) and indirect emissions (i.e. due to electricity consumption and not eligible for free allocation) can be interchangeable. An example of such a process is the use of electric vs fuel-based furnaces.

Therefore, if a benchmark for a product where both electricity and fuel can be used interchangeably in the production process were based only on direct emissions, then the benchmark values would be dominated by electricity intensive processes (as electrified installations would probably fall within the 10% most efficient sites) with low direct emission. It was therefore considered, at the time of the development of the benchmarks, that the choice of energy carrier should not influence the determination of the benchmark value and that it would not be fair to benchmark only one of the energy carriers (fuels), because this could result in the calculation of extremely low energy consumption when another energy carrier (electricity) is used.

1.10.1.1. Why was the concept introduced?

To avoid unrepresentatively low emissions for product benchmarks where the exchangeability of heat and fuel is applicable, a different approach for the calculation of the benchmark was introduced. At the beginning of Phase 3, for selected sectors it was proposed to define a benchmark including the indirect emissions. The first sectors considered[116] were mineral wool, refineries (where indirect emissions are an integral part of the approach) and aluminium (casting and secondary aluminium). Prior to the start of Phase 3, fourteen product benchmarks were defined considering the exchangeability of fuel and electricity.

In these instances, all energy carriers that are used for the production are included in the calculation of the benchmark values and thus, indirect emissions are taken into account. Therefore, the benchmark value is higher compared to a situation where those indirect emissions would not have been considered. However, in the final allocation, these benchmarks need to be multiplied with the share of the direct emissions in the total emissions to avoid free allocation for emissions related to electricity. This means that rather than using the normal allocation formula, used for all other product benchmarks:

$$F_{p,k} = BM_p \text{ X } HAL_p \text{ X } CLEF_{p,k}$$

a modified allocation formula is used which takes into consideration the ratio between direct and indirect emissions:

$$F_{p,k} = \frac{Em_{direct} + Em_{NetHeatImport}}{Em_{direct} + Em_{NetHeatImport} + Em_{Elec}} \times BM_p \times HAL_p \times CLEF_{p,k}$$

---

116 https://ec.europa.eu/clima/sites/clima/files/ets/allowances/docs/bm_study-project_approach_and_general_issues_en.pdf

The emissions from electricity consumption are calculated in the same way irrespectively of where and how the electricity is produced, meaning that a common emission factor of 0,376 t CO_2 equivalents/MWh is used.

Because of the modified allocation formula, the installation will receive an adjusted amount of free allocation, to avoid free allowances being awarded for indirect emissions. A high denominator in the fraction, i.e. a high electricity consumption in the process, means a lower value for the ratio, therefore a likely lower value of free allocation received. For example, direct emissions will decrease if the electricity is used to replace a fuel that is not carbon neutral, however indirect emissions will increase and therefore the ratio will be smaller, and the free allocation is lower.

A review of future decarbonisation options and the potential for electrification has identified that there are many more products for which the exchangeability of electricity and fuels has the potential to become relevant in the future than is currently accounted for in the existing product benchmarks (see Table 12). Under this task we therefore consider not only the impacts on changes to the approach for exchangeability of electricity and fuels for the products where it is included in the benchmarks, but also for benchmarks for which there is currently no inclusion of indirect emissions for which this is likely to become relevant in future.

1.10.1.2. Problems will the current approach

The current approach described above has often been criticized by industry, stating that it fails to bring incentives to decarbonisation and electrification and that it protects the status quo. In fact, installations covered by a product benchmark with consideration of exchangeability of fuel and electricity would see their amount of free allocation reduced when partly or fully substituting fuel by electricity as energy source (i.e. when electrifying the process). We have listed below the main shortfalls of the current approach:

- **Adaptation of free allocation.** The current annual preliminary allocation is calculated at the beginning of Phase 4 using the baseline period 2014-2018 and at the mid-point of the phase using baseline data from the period 2019-2023, however if activity levels change considerably, adjustments could happen within the trading period. This means that an installation which has fully or partially electrified within the production process will see the number of free allocations reduced either in the current period or in the following period. This is, if an activity level (i.e. one of the values used in the ratio to calculate the allowances) changes by more than 15% than the average of two consecutive year than the adjustment is performed within the trading period, otherwise the calculation of allowance is performed at the beginning of the new period. Thus, installations are disincentivised to electrify as any benefit from a reduced direct emission will be lost due to the updated direct/indirect ratio. The only exception would be when a small partial electrification reduces direct emissions without exceeding the 15% threshold. In this case, the installation will keep the same amount of free allocation until the next trading period.
- **The use of a fixed and relatively high grid electricity emission factor disincentives electrification**. Free allocation decreases more than direct emissions if the emission factor of electricity (i.e. 0,376 t/MWh = 104.4 t/TJ) is higher than the

emission factor of the fuels associated with direct emissions. This is the case except when very emission-intensive fuels such as coke or lignite are used.

- **There is no incentive to reduce direct emissions.** The introduction of direct emissions within the allocation formula as part of the numerator, jeopardises the incentive to reduce direct emissions. This is, if an installation reduces the direct emissions through other means than electrification, and indirect emissions remain unchanged, the free allocations will decrease, bringing a disincentive to decarbonisation. This disincentive becomes apparent particularly when free allocation is newly assigned during a period, or when direct emissions are reduced so that the factor changes by more than 15%.

Based on the above considerations and taking into account that the current policy option and methodology does not appear to incentivise the electrification of industry, we have suggested and qualitatively evaluated a number of policy options. Table 12 provides an initial long list of policy options and how they address the issues identified above. Following an initial assessment, a shortened list is provided.

Table 18: Matrix of suggested policy options and how they address the three issues identified above

Policy option	Electrification support	Grid emission factor	Reduction of direct emissions
1. Current situation	Fails to incentivise electrification	Only substitution of very emission intensive fuels such as coke or lignite with electricity will bring a benefit on allocation levels.	The introduction of direct emissions within the allocation formula as part of the numerator, jeopardise the incentive to reduce direct emissions.
2. Recalculation of benchmark based on direct emissions only.	Electrification is rewarded as the free allocation is not impacted by the ratio of direct/indirect emissions	It is not used in the allocation formula	The ratio direct/indirect emissions is not used, thus the issue is not relevant.
3. Benchmark including indirect emissions, but allocation formula is not modified	Electrification is rewarded as the free allocation is not impacted by the ratio of direct/indirect emissions	It is not used in the allocation formula	High benchmark and high free allocation value will provide lower incentive to decarbonise
4. Current approach but with updated emission factor for both the benchmark value and the allocation formula	Will provide only a slightly better incentive, issues will remain as approach is the same .However an updated grid emissions factor could incentivise shift to lower carbon intensity fuels	Higher incentive to phase out very intensive fuels.	No change in the issues, as the ratio remains.
5. Current approach but with updated emission factor for the allocation formula	Fails to provide an incentive. The number of allowances will maximise simply through grid decarbonisation.	Tackles this issue, but does not solve the problem	Fails to provide an incentive. The number of allowances will maximise simply through grid decarbonisation.
6 to 8 Direct/Indirect ratio frozen at sectoral level considering all installations or frozen at installation level	It incentivises electrification and installation receives benefits of electrification also in future phases.	The value is fixed at the start, so the issue is less relevant.	The value is fixed at the start, so the issue is less relevant.

What could be changed to overcome this issue: policy options description An updated, forward looking emission factor is used in the allocation formula, which will increase the number of free allowances. The approach does not reward electrification, as, the higher the ratio of indirect emissions to direct emissions the lower the allowances allocated. However, by using a lower electricity emission factor, the ratio of the allocation formula will maximize to one. However, this would just reflect the decarbonisation of the grid and not necessarily an improvement in efficiency of the installation.

1. **Direct/Indirect ratio frozen at sectoral level considering all installations**

   A frozen ratio value used in the calculation of free allocation will incentivise electrification. Three approaches to define the ratio have been suggested

   Freezing the ratio of direct and total emissions used in the allocation formula at sectoral level. The same approach currently applied is maintained, however the ratio used to calculate allowances is frozen at a baseline sectoral value. The sectoral value is calculated as the average of **all installations** in the sector.

   However, the use of an average value calculated using data from all the installations will not necessarily bring a strong incentive at installation level. This approach will provide a ratio which is higher, due to the expected low uptake of electrification in the baseline period, and therefore, in comparison to other approaches, a higher value of free allowances. Nevertheless, the approach still rewards installations that electrified in the past, while providing less allowances to those who have not electrified. However, the use of the whole cohort of installations does not align with the approach used to define the benchmarks and might be challenged by some industries.

2. **Direct/Indirect ratio frozen at sectoral level considering best performant installations**

   Freezing the ratio of direct and total emissions used in the allocation formula at sectoral level. The same approach currently applied is maintained, however the ratio used to calculate allowances is frozen at baseline sectoral value. The sectoral value is calculated as the average of the 10% **best performing installations**, i.e. the same used to calculate the benchmark value, which are probably also the ones at higher level of electrification.

   The use of the 10% best performing (lowest GHG intensity) installations will probably select installations which have a high uptake of electricity; thus, the ratio will be low as well as the level of free allocation. On one hand, using the ratio of the installations that have most electrified could mean quite some loss of free allocation for those installations that have not electrified, on the other hand, this will provide a stronger incentive to electrification, because the frozen ratio will ensure that the company is rewarded.

3. **Direct/Indirect ratio frozen at installation level**

   Freezing the ratio of direct and total emissions used in the allocation formula at installation level. The same approach currently applied is maintained, however the value of the ratio used in the allocation formula is calculated using the baseline data **at installation level** and is kept constant throughout the Phase.

Calculating the ratio at installation level and freezing this at the baseline value will provide strong incentives to installations with a small degree of electrification, but installations with a high degree of electrification will not benefit from past electrification actions. This approach will also ensure that installations which fully electrify continue to receive free allocation for energy consumption, providing the reference baseline does not change over time

For the above options 6 to 8, the choice of the baseline period used to freeze the ratio could be either the 2007-2008 period, which would align with the period used to determine the benchmark, or the 2014-2018 baseline period used at the beginning of Phase 4. Using the 2007-2008 period would ensure that installations that have electrified in the meantime would still see a benefit in future phases. On the other hand, if the most recent year period is used there would be an inherent assumption that to date there has not been any electrification driven by ETS, which could be the case due to the issues with the exchangeability rule as described above

In summary, the suggested policy options listed above will treat the benchmark definition and free allocation formula as summarised below in Table 19.

Table 19: Summary of policy options

Policy option	Indirect emissions in the benchmark definition	Free allocation	
		Formula	Adjustment for the share of direct emissions
1	Included	Modified	Yes
2	Not included	Normal	No
3	Included	Normal	No
4	Included with updated emission factor in the benchmark definition	Modified	Yes, with new grid electricity EF
5	Included	Modified	Yes, with new grid electricity EF update twice during Phase 4
6	Included	Modified	Yes, with ratio kept constant at sectoral level considering average of all installations
7	Included	Modified	Yes, with ratio kept constant at sectoral level considering average of 10% best performing installations

Policy option	Indirect emissions in the benchmark definition	Free allocation	
		Formula	Adjustment for the share of direct emissions
8	Included	Modified	Yes, with ratio kept constant at installation level

1.10.2. Which policy options should be further considered?

In the table below we have selected a sub-section of policy option which could be considered for further analysis and we have provided . a rationale for each policy option.

Table 20: Qualitative assessment of policy options

Policy option	Should it be further assessed?
1	**Current situation** **No,** this is the current approach, due to the ratio used in the allocation formula installations which electrify will receive fewer allowances. This is the baseline scenario so will be used as the point of comparison
2	**Recalculation of benchmark based on direct emissions only.** **Yes**, electrification is rewarded as the free allocation is not impacted by the ratio of direct/indirect emissions.
3	**Benchmark includes indirect emissions, but allocation formula is not modified through direct/indirect ratio.** Yes, it would require substantial changes to the directive as indirect emissions will receive free allocation.
4	**Current approach but with updated emissions factor** **Yes**, the use of revised values would bring incentive to switch from natural gas to electricity. Currently, the incentive is only to switch from lignite to electricity. An updated heat benchmark value would also mean that direct emissions from the use of all fossil fuels including natural gas decrease more than free allocation decreases. So overall, there is a surplus
5	**Current approach but allocation formula uses an updated emission factor** **No**, the issues linked to the use of the ratio would remain and the decarbonisation of the grid would bring benefits to the installations even if they do not electrify. In addition, changing the emission factor in the allocation

Policy option	Should it be further assessed?
	formula but not in the benchmark would be inconsistency and might be challenged by industries.
6 – 7 -8	**Direct/Indirect ratio is frozen** **Yes**, it would be interesting to further investigate these approaches as the use of a frozen ratio could provide better reward for installations which have electrified some or part of the process and overall would provide a stronger signal.

In conclusion three options have been selected for further analysis:

- Option 2: Recalculation of benchmark based on direct emissions only
- Option 4: Current approach but with updated emissions factor, both in the benchmark definition and the adjustment factor
- Options 6 to 8 which introduce the use of a "frozen" direct/indirect emission ratio which could be calculated at sectoral or installation level.

As a first assessment, option 2 gives a reward to those who electrify, because the level of free allocations would be calculated using a low benchmark value therefore all installations with low level of electrification will have to surrender allowances. It then becomes a choice of whether it's cheaper to electrify or to buy allowances which follow the same principle on whether companies invest in energy efficiency improvements to reduce emissions, or not.

On the other hand, options 6-7-8 incentivise companies to electrify by rewarding them with indirect subsidy, i.e. they receive free allowances which they would not need for compliance once they have electrified, so they can sell those allowances and use the revenue to offset their increased costs and reduce the risk of carbon leakage.

1.11. Task 1.4.4 – Green bonus for best performers

Recent discussions in DG CLIMA have raised the possibility of providing a "green bonus" of additional free allocation to the best performing installations.

The concept of a "green bonus" mechanism has not been elaborated and DG CLIMA is interested in investigating possible options and implications, on a qualitative basis. The bonus would have the purpose of providing incentives for using green technology across all installations. Given this initial stage of thinking on the design and purpose, to perform our assessment, we have firstly described the three different potential models of the green bonus and important considerations regarding their implementation. We then assessed these options against defined criteria, in line with the matrix developed and used under Task 1.5.

1.11.1. Definition of the option

The considered options are to reward additional free allowances to the best performing or most improved installations.

- **Model 1**: Reward a green bonus of additional free allocation to installations that are among the best 5% or 10% performing installations.
- **Model 2**: Reward a green bonus of additional free allocation to the 5% or 10% of installations that have achieved the greatest improvement in GHG efficiency over a certain time frame, e.g. from the start to the phase to mid-phase when the selection is redone.
- **Model 3**: Reward a green bonus of additional free allocation to all the installations that can demonstrate an improvement on the GHG intensity above a set threshold (e.g. 30% from the start to the Phase to mid-phase).

The following issues should be taken into consideration when assessing each option:

- **Data collection**. Benchmarks have been originally defined as the average value of the 10% most greenhouse gas efficient installations. The identification of these installations was supported by an extensive data collection exercise that was carried out prior to the start of Phase 3. In Phase 4, the benchmarks will be updated, twice during the Phase, based on a linear reduction trend as observed at sector level, although there could also be the possibility to update the values to reflect the GHG intensities of the 10% best performing installations. Either ways, data has been recently collected within the NIMs to include production and emissions associated to specific benchmarked products. Therefore, it would be possible to identify the best performing installations based on the newly collected NIMs data covering the baseline period 2014-2018.
- **Selection of installations**. The system should be carefully designed to ensure that early movers should not be penalised. This means that the frequency, timing and methods to select installations must reward installations which have implemented GHG reduction technologies before the start of the phase, but at the same time ensure that new improvers are also incentivised, therefore the applied method is critical. The identification of installations should be based on robust and recent evidence and updated regularly to ensure that investments in energy and emission reduction technologies are rewarded and incentivised. The system should also be set up to ensure that it achieves the final aim, and, if this is to reduce the risk of carbon leakage, it should be implemented so that installations at a genuine risk are selected. Alternatively, if the main aim is to provide an incentive for green technologies the bonus should be carefully sized and distributed to avoid large overlap with the free allocation mechanism.
- **Timing** is important, it is necessary to use updated data to reflect the current situation and ensure that installations which are currently best performing are selected. If the selection is based on newly collected data, then it should be considered whether "best performers" should be defined only once at the start of the phase, each year taking into account yearly improvements or somewhere in between, for example at mid-phase like currently done for the update of the benchmarks. Various considerations should be made, firstly the **feasibility of data collection**. Identifying best performing installations is not straight forward and requires production and emissions data associated with the specific product. While currently installations are used to report activity level data for each product annually for compliance purposes, they are not used to report emissions at this granularity with a yearly frequency. Emissions are in fact reported only at installation level. Under the current data arrangements, benchmark baseline data which is suitable for the

identification of best performing installations is submitted every five years (at mid-point) so a more frequent update would not be possible. Asking installations to report yearly emissions split at sub-installation/product level would introduce a considerable administrative burden on them as well as on competent authorities of the Member States and the Commission.

- **Size of the bonus**. It is important to consider how the bonus will be calculated to ensure that it provides the right balance between overcompensation and incentive to investments in innovative green technologies. Options could be to allocate the "green bonus" as a number of allowances equivalent to a fixed share of the project costs or as a share of the proved emission intensity improvement per unit of product multiplied by the production.
- **The origin of the distributed allowances.** In the following assessment it has been assumed that allowances would be taken from the existing cap. However, this shall be evaluated. If a large amount of allowances are carved out from the free allocation budget then the system becomes a penalty for poorer performers, as these will receive fewer allowances as there is a larger possibility that the overall free allocation budget is exhausted and the cross-sectoral correction factor is applied., However, the best performing installation would gain the vast majority of the free allowances. Consequently, the level of acceptance will drastically decrease. On the other hand, if the budget comes from allowances to be auctioned then this implies less revenues for Member States and/or less revenues for instruments like the innovation fund. Removing available funds from an existing mechanism would just be shifting the incentive from one mechanism to another. However, the innovation fund is not only targeting best performing installations, but is accessible to any installation that wants to implement innovative GHG reduction technologies.
- **Product and fall-back benchmarks**. The approach described and analysed below can be applied both to product and fall-back benchmarks.

1.11.2. Assessment of the option

Using the criteria defined under Task 1.5, the following considerations can be made:

*1.11.2.1. **Relevance** – "Options should target carbon leakage, specifically in sectors that have significant carbon costs and leakage risks exposure."*

A green bonus for the best or most improved installations, as currently defined, does not target carbon leakage risk, rather it incentivises a shift to greener technologies or investment in more efficient processes and technologies without recognition of the carbon leakage risk associated with the sector and/or installation.

If the intention is to make this option coherent with the idea of targeting carbon leakage risk, the selection of installations should be better tailored to only provide the green bonus to sectors which are at genuine risk of carbon leakage. For example, the bonus should be limited to the 10 - 5% most greenhouse gas efficient installations only in sectors at risk of carbon leakage.

1.11.2.2. ***Legal feasibility*** *– "Options should respect obligations arising from the EU Treaties (and relevant international agreements), including State aid and World Trade Organisation regulations."*

The EU management and distribution of free allowances is not subject to state aid control and the distribution of extra allowances to reward best performing installations at risk of carbon leakage would not impact WTO regulations.

A legal challenge, however, would be if the bonus were to allow the system to possibly allocate free allowances above sector's need. Phase 4 allocation rules have been modified to closely monitor the production and avoid overallocation. Therefore, the introduction of a bonus system might be challenged by industry if its distribution does not provide the right incentives and leads to overallocation for certain installations. For example, a bonus system which provides allocation mainly to installations that are already below benchmark value would not provide the right incentive to green technology as these installations will probably have lower abatement opportunities.

1.11.2.3. ***Technical feasibility*** *– "Options should be administratively and practically feasible. They should overcome technological and technical constraints that do not allow their implementation, monitoring or enforcement."*

The option does not bring significant changes to the administrative procedures of the current situation; however, the following barriers and challenges should be considered:

- **Data collection**. The need to identify best GHG performing installations, or the installations that have significantly improved their GHG intensity, which will then receive the green bonus, requires emission and production data at product level, which installations have reported at the start of Phase 3 and 4, and are expected to provide also at mid phase. Although this has been collected at the beginning of each Phase, i.e. every 8 years, companies have not been used to monitor and report emissions at product level and this could increase the data collection and administrative burden on installations. On the other hand, a way to limit this burden could be to set up the "green bonus" mechanisms like the new entrants reserve, so that installations must apply to obtain it. In this way, only installations that are interested and think they will receive it will spend time and effort to collect the required data.
- **Some additional analysis required** to assess collected data. The distribution of a "green bonus" and the identification of the best performing installations will require additional effort from Member States and the Commission to ensure the correctness of the data.
- **Legal challenges** could also be raised by installations considering themselves to be among the best but not receiving the green bonus.
- **Timing and frequency** of the selection of installations should be carefully considered. This could align with the start of the phase and at mid-point, as currently set up for benchmark review and NIMs collection exercise. This will mean that installations which are highly performing or have made significant investment in abatement technologies and considerable progress in GHG intensity will receive a bonus until the next review.
- **The size of the total budget allocated to the "green bonus" should be evaluated based on the criteria used to select installations as well as on how the bonus will be allocated.** It is assumed that the pot of allowances allocated to the green bonus

will be taken from the total value of allowances, and not added later on. Therefore, it is important to estimate what the size of the "green bonus" will be, to ensure that enough allowances are set aside. For example, a system that rewards all installations that can prove an improvement in GHG intensity higher than a certain threshold (Model 3) will reduce uncertainty for companies regarding their carbon costs and revenues, it will, at the same time, create uncertainty in the size of the required budget. It will not be possible to know in advance how many installations will be eligible, thus the number of needed allowances cannot be robustly estimated. On the other hand, a system that only select the top 5-10% best performing or most improved installations (Models 1 and 2, respectively) would enable easier estimation of the total budget.

1.11.2.4. ***Coherence with other EU policy objectives – "****Options should be coherent with other general EU policy objectives."*

The creation of a "green bonus" with the EU ETS is in line with the ETS objectives and would be directly compatible with the European Green Deal's objective to invest in environmentally-friendly technologies. Overall, it is not introducing anything different to the system, as the ETS is already set up to incentivise the best performing installations. The use of highly efficient benchmarks to distribute free allowances provide an incentive to industries to reduce their GHG intensity, as those that are closest to the benchmark value have lower net carbon costs.

On the other hand, the mechanisms could significantly overlap with the Innovation Fund and could co-fund IPCEIs along with Member States, and the projects would not be subject to the 60% cap on support for additional opex and capex of low-carbon tech.

1.11.2.5. ***Effectiveness and efficiency*** *– "Options should lead to the achievements of the objectives identified. They should be resilient to shocks and carbon price perturbations and suitable for supporting long-term investment. Options should achieve a reasonable cost-benefit balance. They should not be overly costly to businesses and avoid the risk of over-subsidy."*

The EU ETS and carbon market is already set up to incentivise efficiency improvements, by creating a cost to inefficient production. Providing an extra bonus to the efficient installations is a way of modifying the ETS system to amplify an incentive that already exists. If the aim is to provide a stronger incentive to decarbonisation, this could also be achieved by lowering the benchmark or reducing the number of free allocation allowances, which will effectively increase the carbon price and therefore increase the incentive for industry to invest in GHG reduction technologies.

Model 1, which selects the top 5-10% best performing installations for bonuses, will increase uncertainty for companies regarding their carbon costs, because companies will not know for certain whether they will fall within the 5-10% best performing installations to receive the reward.

This uncertainty would be counterproductive for companies considering the commercial case for investments in early stage emission reduction technologies and materials. A way to mitigate this uncertainty would be to distribute the bonus with a tiered approach, so that companies received a free allowance amount proportional to their position among the best performing installations. For example, if the installation does not fall within the top 5%, it would still receive a bonus as long as it falls within the top 10%.

Model 2, which rewards 5-10% of installations that achieve the most improvement in GHG efficiency over a certain time frame, would likely have a greater effect in reducing emissions overall, because the companies that are most capable of achieving significant improvements in GHG efficiency are likely to currently be the most polluting.

A system that provides extra free allowances to companies that realise the greatest efficiency gains over a period of time, however, will likely penalize the current best performers whom have little room for improvement. Moreover, the uncertainty around the reward will continue to reduce the commercial case for decarbonisation.

Model 3, which rewards a green bonus to all the installations that can demonstrate a pre-determined level of improvement in GHG intensity, would provide a clearer signal to investment in emission reduction technologies, because it would provide companies with more certainty around the benefits of doing so. However, it would continue to disadvantage the current best performers, which have less room for improvement than their higher polluting competitors.

There are likely more efficient and effective options to incentivise and enable green technologies. Regardless of the model selected, the bonus will be rewarded retroactively, so will not be as effective to support installations to fund the high upfront costs that characterise innovative abatement technology. Where diffusion of abatement technology is hindered by high upfront costs, the availability and affordability of finance affects their economic attractiveness. Models 1 and 2 do not provide companies with certainty that part of the costs of emission reduction technology or materials will be covered through a higher free allowance allocation. As a result, companies will face more difficulty in accessing financing for these investments than they would through other options discussed in this paper, including CCfDs and public financing for green technologies in industry.

1.11.2.6. ***Proportionality*** *– "Options should meet the proportionality principle. They should not restrict the scope for national decision-making over and above what is required to achieve the objective."*

Whichever model is employed, it will be important to consider the size of the bonus to ensure that it does not provide an overcompensation to a sector but is large enough to incentivise investment in innovative green technologies. Similarly, the methodology applied to calculate the size of the bonus will be important. If the bonus will be proportional to the investment made, then there might be a need to define a cap on the total investment covered, while if the bonus is proportional to the improvement made on GHG intensity times the production, it might be easier to predict the maximum budget needed.

1.11.2.7. ***Political feasibility and previous policy choices*** *– "Options should have sufficient political acceptability for legislative adoption and implementation. Options should seek parity of treatment across member states and similar sectors. Certain options might have been ruled out by previous policy choices"*

The mechanism appears to add an extra layer to a system that is already set up to reward best performers. The same objective could be achieved by lowering the benchmarks or reducing the amount of free allocation. These steps would increase the carbon price, which would lead to the same signal and reward for companies that achieve greater GHG efficiency. Therefore, it is unlikely that this proposed change in legislation will receive a high level of acceptance.

TASK 1.5 – SCREENING AND COMBINATIONS

The aim of this subtask was to bring together the most promising of policy options developed within earlier Task 1 subtasks to determine a definite set of options to take forward into Task 2. This consisted of two steps:

- **Screening.** A simple qualitative assessment was used to determine how well each option could address the problem of mitigating carbon leakage under increased ambition scenarios.
- **Combinations.** In addition, a review whether the shortlisted options could be introduced in combination.

The following section outlines our approach to each of these steps.

Due to the timeframe of this study, the screening and shortlisting of options was done through collaborative discussion with Commission staff. The final selection of options and assessment was undertaken by the Commission team using the tools developed under this project and as described in this report.

Screening

The priorities for the screening process were agreed during the inception phase. In alignment with the Better Regulation Guidelines, we have screened options against the primary criteria outlined in Toolbox 17: relevance, legal feasibility, previous policy choices, technical feasibility, coherence with other EU policy objectives, effectiveness and efficiency, proportionality, and political feasibility. In our proposal and Inception Report, we outlined an additional set of sub-criteria specific to the challenge of carbon leakage. Table 1 shows how these sub-criteria (in red) align with the primary criteria of the Better Regulations Guidelines.

Table 21. Criteria and sub-criteria used to screen policy options

Criteria	Sub-criteria
Relevance	*Options should target carbon leakage, specifically in sectors that have significant leakage risks exposure.*
Legal feasibility	*Options should respect obligations arising from the EU Treaties (and relevant international agreements), including State Aid and World Trade Organisation regulations.*
Technical feasibility	*Options should be administratively and practically feasible. They should overcome technological and technical constraints that do not allow their implementation, monitoring or enforcement.*
Previous policy choices	*Certain options might have been ruled out by previous policy choices.*

Criteria	Sub-criteria
Coherence with other EU policy objectives	*Options should be coherent with other general EU policy objectives.*
Effectiveness and efficiency	*Options should lead to the achievements of the objectives identified. They should be resilient to shocks and carbon price perturbations and suitable for supporting long-term investment. Options should achieve a reasonable cost-benefit balance. They should not be overly costly to businesses and should avoid the risk of over-subsidy.*
Proportionality	*Options should meet the proportionality principle. They should not restrict the scope for national decision-making over and above what is required to achieve the objective.*
Political feasibility	*Options should have sufficient political acceptability for legislative adoption and implementation. Options should seek parity of treatment across member states and similar sectors.*

Combinations

Beyond screening the options against the selection criteria, we reviewed whether the shortlisted options could be introduced in combination. This was done by breaking down their applicability by sector and carbon emissions (e.g. direct, indirect and whether covered by product or fall-back allocations) to avoid double coverage. We also reviewed the rationale of each measure in terms of the nature of support they provide. For instance, some policies were considered to be aligned with innovation or with maximising deployment of existing technologies, others were purely compensatory and aligned with actual carbon cost exposure.

Taking these factors into account, we generated illustrative packages of options that best meet the needs of the widest variety of sectors regarding cost exposure and the need to encourage innovation and deployment of low-carbon technologies.

Assessment

Based on this shortlisting and after discussions with the Commission, none of the options developed as part of Tasks 1.2, 1.3 and 1.4 were selected for further assessment of the potential impacts. Options from Task 1.1 were taken forward. *The final development of the specific options and scenarios was undertaken by the Commission using the tools developed in this project, and details of these are not available for presentation within this report.*

Directorate-General for Climate Action
[Name of the Programme/Activity]
2021 EUR [number] EN

TASK 2 DEVELOPMENT OF A TOOL FOR THE ASSESSMENT OF IMPACTS

Task 2 aimed to provide the means to assess the effects of policy options for revisions to the EU ETS. This task identified the key economic, environmental, and social impacts that should be considered in evaluating the options and developed indicators for these impacts. An Excel-based assessment tool was developed in this task which provided quantitative outputs for many of the recommended impacts and indicators. The purpose of this tool was to support the Impact Assessment carried out by Commission Services.

The outputs of task 1.1 were one of the major data inputs for the assessment tool, data was also taken from Eurostat's Structural Business Statistics (SBS) and EMBER [117].

The tool produces outputs at sector level for 10 of the highest emitting industry sectors (Iron and Steel, Cement, Refineries, Chemicals, Lime, Fertilizers, Pulp and Paper, Ceramics, Non-ferrous metals and Glass sectors); as well as at an aggregate level for these 10 sectors. The further work and outputs presented in the Impact Assessment were produced by Commission Services using the tool to test different policy option settings.

The following subsections describe the methodology and key assumptions used in this task, with a focus on the selection of impacts to be assessed, the indicators used for their assessment and how these indicators are calculated in the tool.

1.12. Methodology and approach

It was agreed for this part of the work to have four main outputs:

1. Electronic spreadsheets developed at the sector level and aggregated for all concerned sectors, providing outcomes to support the impact assessment of policy options, analysing the impact of each policy option on efficiency and effectiveness, incentives for innovation and transitioning to low-carbon industry, practical feasibility and on the economy. This represents the Excel-based assessment tool produced as part of this task.
2. A user guide manual for the Excel spreadsheets
3. Training on using the Excel spreadsheet and the user guide manual
4. A synthesis report (this report), highlighting the methodology and the main outputs of the tool developed for Task 2 and the key underlying assumptions and inputs to it, and the outputs produced to support the impact assessment.

The first three outputs have been provided separately, this section presents the fourth output on the list.

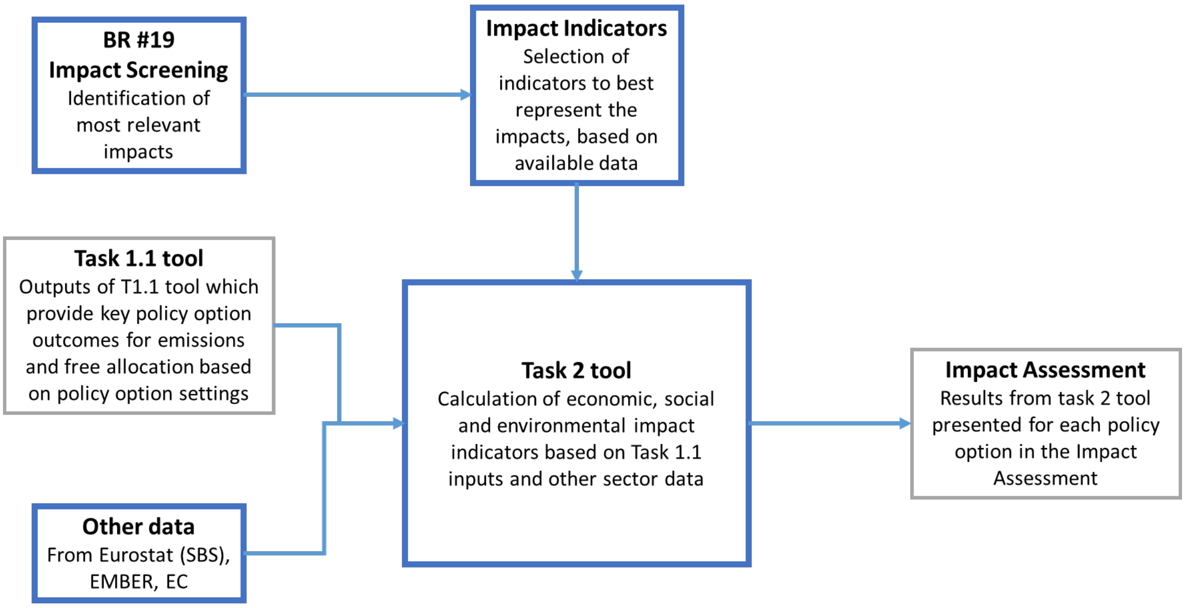
1.12.1. Approach

Figure 0-1 describes our methodology in implementing task 2. The approach started by screening the impacts to be assessed, based on the Better Regulation toolbox (Tool #19) which provides a list of all potentially relevant impacts that could be assessed. Afterwards, we selected the most appropriate indicators to describe such impacts (quantitatively and qualitatively) and the sources of data that could be used to estimate/describe such impacts. This served as the framework for the data assessment tool. The tool used outputs from task

[117] EMBER is an independent climate website that tracks EU-ETS EUA prices - https://ember-climate.org/data/carbon-price-viewer/

1.1 as input data, and was supplemented by SBS and other ETS EUA price data to enable calculation of the indicators. The tool was used in a final step by the Commission services, who populated the tool with outputs from the tool developed under task 1.1 in which scenarios for different allocation approaches were developed by the Commission. From this, the tool calculated the quantitative impact indicators that were used in the Impact Assessment.

Figure 0-1 Approach to task 2



1.12.2. Key assumptions

The tool produced in this task required additional data and also for some key assumptions to be made for the calculations; these are detailed in this section.

Data from Eurostat's Structural Business Statistics (SBS), EMBER, and Task 1 was used. The key characteristics of the data are shown in Table 1 1. The SBS data covers the period 2009-2018.

Table 22. Data sources for key variables

Source	Variable(s)	Dimensions	Unit
Eurostat SBS data	Value added at factor costs, production value, personnel costs	Per year, sector, country	Million EUR (nominal)
EMBER	ETS price (historic – see following section for projected price assumptions)	Per week	EUR /tonne CO_2 (nominal)
Task 1 tool	Sector emissions, final free allocation	Per year, sector	Mt CO_2-eq.

The following assumptions were made:

- **Prices**:
  - Net present value calculation: Future prices and costs were estimated using the net present value (NPV) for all costs to be incurred between 2021 and 2030. A discount rate of 4% was used.
  - Deflation: All costs were expressed in 2015 Euros. Data expressed in other monetary units were converted to 2015 Euros, using the indices shown in Table 23.

Table 23. Deflation indices used for the modelling of carbon costs

Year	Deflation index
2015	1
2016	0.991
2017	0.980
2018	0.967
2019	0.950
2020	0.936

Source: Trinomics, calculated based on gross domestic product (GDP) deflators of the European Central Bank for the Eurozone.

Table 24. shows the EUA prices assumed in the tool. The Commission had the ability to alter the carbon prices used in the model and for the final analysis performed by Commission services.

Table 24. EUA prices used for the modelling of carbon costs

Year	EUA price in the given year (in EUR)	
	Baseline (-43% overall ambition)	Strengthened cap (-55% overall ambition)
2021	26.0	33.0
2022	26.0	34.0
2023	26.5	35.0
2024	27.0	36.0
2025	27.0	37.0
2026	28.0	40.0
2027	28.5	42.5
2028	29.5	45.0
2029	30.0	47.5
2030	31.0	50.0

- **Geographical coverage**: The calculations in the tool include data from all ETS countries (EU27 + Iceland, Liechtenstein and Norway).

1.13. Output indicators

The following table, Table 25. , summarises the impacts and indicators selected for presentation within the tool following the impact screening[118],[119] and the calculation approach used. This represents only the quantitative indicators that could be calculated.

[118] Based on the Better Regulation toolbox (Tool #19)
[119] https://ec.europa.eu/info/sites/info/files/file_import/better-regulation-toolbox-19_en_0.pdf

Table 25. Summary of impacts included, indicators used and calculation approach for the assessment tool

Better Regulation Impact	Relevance	Selected indicator(s)	Calculation approach
Economic			
Macroeconomic environment	Carbon leakage measures can have a significant effect on industries and with knock-on effects for the overall economic environment through direct, indirect and induced effects and (may) require large governmental budgets, as such, the macro economic impact is an important element.	[%] Potential net direct carbon costs as % of value added in sector	– Net direct carbon costs used for this indicator are the annualised net direct carbon costs for each sector (see the next row for how the net direct costs are calculated, an annual average of the aggregate total is then used. – The value added at factor cost per sector is obtained from SBS data and is averaged for years 2016 - 2018[120]
Competitiveness, trade and investment flows	Carbon leakage measures aim aim to safeguard competitiveness of European industries to avoid that emissions move to countries with laxer emissions constraints, which could lead to an	Sector potential net direct carbon costs [EUR million NPV 2021-2030]	– Potential net direct carbon costs are calculated as the difference between the **gross direct carbon costs** and the **free allocation value** per sector. – *Gross direct carbon costs* are calculated as the NPV of the projected emissions (tCO_{2e})[121] multiplied by the forecasted ETS EUA price[122] (EUR/ tCO_2) for the period between 2021 –

[120] Source: SBS data
[121] Source: Output of Task 1
[122] Source: Table 0.3

	increase in total (global) emissions. Impacts on competitiveness are quantitatively assessed based on the measurement of emissions intensity and trade intensity (which compose the carbon leakage formula), as well as the calculation of changes in firms' revenues and costs		2030. The calculation is done annually (to take into account increasing EUA prices each year), at sector level, before being aggregated. – *Free allocation value* is calculated as the NPV of the projected free allowances (tCO_{2e})[123] multiplied by the forecasted ETS EUA price (EUR/ tCO_2) for the period between 2021 – 2030. The calculation is done annually, at sector level, before being aggregated.
		[%] Potential net direct carbon costs as % of production value	– Potential net direct carbon costs used for this indicator are the annualized net direct carbon costs of each sector (distributed over 10 years' time span between 2021 - 2030). – The production value per sector is obtained from SBS data and is averaged for years 2016 - 2018[124]
		[%] Potential net direct carbon costs as % of EBITDA	– Potential net direct carbon costs used for this indicator are the annualized net direct carbon costs of each sector (distributed over 10 years' time span between 2021 - 2030) – EBITDA is calculated as the difference between the GVA at factor cost and the

[123] Source: Output of Task 1
[124] Source: SBS data

			personnel costs (both obtained from SBS data) – EBITDA value used for the estimation of this indicator is averaged for years 2016 – 2018.
Environmental impacts			
The climate	This is a very relevant indicator to understand the impact of implementing the proposed policy options on the shortage of free allowances per sector, and hence, the exposure of each sector to carbon leakage.	[$MtCO_2e$] Potential direct emissions not covered by free allocation 2021-2030	– This indicator represents the shortage in free allowances per sector and is calculated as the difference between sector's total direct emissions[125] and the total free allocation of allowances[126] for the period between 2021 – 2030.
		[%] Potential direct emissions not covered by free allocation 2021-2030	– Calculated as the ratio between the shortage in free allowances (calculated in the previous row) and the total direct emissions per sector

[125] Source: Output of task 1.1.
[126] ibid

Other impacts were also identified as potentially relevant, for possible qualitative assessment, these are listed in Table 26. below.

Table 26. Impacts for which qualitative indicators were used

Better Regulation Impact	Relevance	Selected indicator(s)
Economic		
Macroeconomic environment	As mentioned previously, carbon leakage measures can have a significant effect on industries, with effects on the overall economic environment. In addition to the quantitative assessment, there are other factors that can have an impact on the wider economy that include indirect impacts throughout the value chain (such as reduction in production/closures, sourcing of raw materials and downstream effects on consumers) and the abatement potential per sector.	(+/-) Macroeconomic impact
Competitiveness, trade and investment flows	Carbon leakage measures aim to safeguard the competitiveness of European industries to avoid that emissions move to countries with laxer emissions constraints, which could lead to an increase in total (global) emissions. . In addition to the quantitative assessment, there are other important factors that influence the competitiveness of the sector including the ability of each sector to pass through carbon costs, the market situation with regards to international competition per sector, and if international competitors have equivalent or any form of carbon pricing policies.	(+/-) Impact on EU sector competitiveness
Regulatory burdens on business	The measures may result in new obligations on business, therefore important to include.	(+/-) Impact on regulatory burdens
Increased innovation and research	In changing the carbon costs incurred by firms, carbon leakage mitigation measures are likely to have an impact on innovation and R&D. Depending on the form and policy settings it is also possible that an option is designed to	(+/-) Impact on innovation

	directly channel greater funds to innovation activities.	
Public authorities (and budgets)	Revenues generated from auctioning of EUAs would be directed to member states public budgets. Such revenues are greatly influenced by the change in direct carbon costs. Accordingly, reduction of free allowances as a result of policy implementation would therefore have a positive impact on national public budgets for member states.	(+/-) Impact on public budgets
Social impacts		
Employment	Since the policy options may likely influence competitiveness, they may also have a similar impact on employment, since labour-intensive industries would be more vulnerable to negative competitiveness, macroeconomic environment, and climate impacts.	(+/-) Employment impact Contextual indicators on labour intensity of each sector are provided in the tool.
Environmental impacts		
The climate	Assesses the exposure of the sector to carbon leakage risks. The more feasible the abatement measures are (per sector) and the less shortage in free allocation, the less the sector is exposed to carbon leakage risk.	(+/-) Abatement price signal (+/-) Carbon leakage risk
Cross-cutting		
Economic and social cohesion	Relevant to capture main economic and social distributional effects which may vary significantly across the EU and/or sectors.	[+/-] Extent of distributional effects

The practical feasibility of the policy options that can be assessed using the Task 1.1 tool has been considered and variants of these scenarios have been determined to have no material impact on existing functional requirements of the ETS actors; with regards to the following:

- Data requirements and data flows.
- Verification or audit functions.
- Public authority administration and oversight functions.
- Systems needs.

It was also noted that there would be several uncertainties and limitations to the impact assessment, due to:

- The net direct carbon cost representing a maximum potential cost under the given price assumptions and and the emissions abatement assumptions incorporated in the Task 1.1 outputs. The costs of emissions abatement detailed in Task 1.1 are not accounted in the options, as these are assumed to be accounted already in the baseline, i.e. they are not additional to the baseline. The net direct carbon costs do not account for further (or less) emissions abatement on top of the Task 1.1 assumptions as estimating an industry abatement response to the policy scenario and price changes is too uncertain, given the multiple uncertain variables.
- Changes in indirect carbon costs are not included, nor modelled, so the full financial impact on sectors is not examined.
- The role of the market stability reserve (MSR) in the auctioning of EUAs, which has an impact on the revenues as a result of the shortage in free allowances, and accordingly, impact on the national budgets of member states.
- Other market conditions that could have impact on competitiveness (potentially with a greater impact than that which occurs due to carbon costs).
- Economic feasibility and business decision making for investing in abatement measures per sector, which impacts the carbon leakage risk.

ANNEX A1 ASSESSMENT OF PRODCOM DATA TO UNDERSTAND TRADE RELATIONS FOR SECTORS DEEMED AT RISK OF CARBON LEAKAGE

Table 0-1 shows the values of imports and exports in EUR millions for 2018. The purpose of this is to provide some context to which would be the priority products that could be covered by a minimum carbon performance standard if the starting point for those products were the carbon leakage list. The values of exports and imports shown in the table indicate strong candidates for such a list, based on NACE 4 digit codes. Analysis subsequent to the table considers examples of a more granular approach with products defined at PRODCOM 8 digit code.

Table 0-1: Value of imports and exports for all NACE codes listed as being at risk of carbon leakage (in EUR million)

			Value in EUR million (EU27 – 2018)	
	NACE Code	NACE Description	Exports	Imports
Mining and extraction	0510	Mining of hard coal	-	-
	0610	Extraction of crude petroleum	-	-
	0710	Mining of iron ores	EUR 984	EUR 7,392
	0729	Mining of other non-ferrous metal ores	EUR 2,436	EUR 13,474
	0891	Mining of chemical and fertiliser minerals	EUR 429	EUR 939
	0893	Extraction of salt	EUR 174	EUR 142
	0899	Other mining and quarrying n.e.c.	EUR ,9524	EUR 9,658
Food	1041	Manufacture of oils and fats	EUR 6,223	EUR 15,433

	1062	Manufacture of starches and starch products	EUR 1,981	EUR 463
	1081	Manufacture of sugar	EUR 1,366	EUR 1,140
	1106	Manufacture of malt	EUR 948	EUR 28
Textiles	1310	Preparation and spinning of textile fibres	EUR 1,806	EUR 3,228
	1330	Finishing of textiles	EUR 0	EUR 0
	1395	Manufacture of non-wovens and articles made from non-wovens, except apparel	EUR 2,069	EUR 1,221
	1411	Manufacture of leather clothes	EUR 574	EUR 670
	1621	Manufacture of veneer sheets and wood-based panels	EUR 4,002	EUR 2,729
Pulp and paper	1711	Manufacture of pulp	EUR 3,433	EUR 5,527
	1712	Manufacture of paper and paperboard	EUR 18,907	EUR 4,692
Coke	1910	Manufacture of coke oven products	EUR 129	EUR 38
Refineries	1920	Manufacture of refined petroleum products	-	-
Chemicals	2011	Manufacture of industrial gases	EUR 281	EUR 299

	2012	Manufacture of dyes and pigments	EUR 4,388	EUR 4,816
	2013	Manufacture of other inorganic basic chemicals	EUR 6,598	EUR 7,352
	2014	Manufacture of other organic basic chemicals	EUR 41,567	EUR 45,152
Fertilisers	2015	Manufacture of fertilisers and nitrogen compounds	EUR 3,525	EUR 5,212
Plastics and rubber	2016	Manufacture of plastics in primary forms	EUR 28,791	EUR 20,212
	2017	Manufacture of synthetic rubber in primary forms	EUR 1,961	EUR 2,463
Man-made fibres	2060	Manufacture of man-made fibres	EUR 1,716	EUR 3,201
Pharmaceuticals	2110	Manufacture of basic pharmaceutical products	EUR 24,192	EUR 21,665
Glass	2311	Manufacture of flat glass	EUR 640	EUR 301
	2313	Manufacture of hollow glass	EUR 2,515	EUR 1,391
	2314	Manufacture of glass fibres	EUR 758	EUR 1,227
	2319	Manufacture and processing of other glass, including technical glassware	EUR 1,586	EUR 994

Ceramics	2320	Manufacture of refractory products	EUR 1,938	EUR 681
	2331	Manufacture of ceramic tiles and flags	EUR 4,038	EUR 467
	2332	Manufacture of bricks, tiles and construction products, in baked clay	EUR 339	EUR 53
	2341	Manufacture of ceramic household and ornamental articles	EUR 785	EUR 1,269
	2342	Manufacture of ceramic sanitary fixtures	EUR 526	EUR 541
Cement	2351	Manufacture of cement	EUR 996	EUR 248
Lime and Plaster	2352	Manufacture of lime and plaster	EUR 156	EUR 80
Minerals	2399	Manufacture of other non-metallic mineral products n.e.c.	EUR 3,029	EUR 2,341
Iron and Steel	2410	Manufacture of basic iron and steel and of ferro-alloys	EUR 39,760	EUR 50,178
	2420	Manufacture of tubes, pipes, hollow profiles and related fittings, of steel	EUR 9,538	EUR 4,511
	2431	Cold drawing of bars	EUR 1,548	EUR 987

NFM	2442	Aluminium production	EUR 9,730	EUR 20,019
	2443	Lead, zinc and tin production	EUR 1,762	EUR 2,322
	2444	Copper production	EUR 9,154	EUR 9,063
	2445	Other non-ferrous metal production	EUR 3,396	EUR 8,596
Nuclear Fuel	2446	Processing of nuclear fuel	-	-
Iron and Steel	2451	Casting of iron	EUR 304	EUR 262

The above table shows the value of imports and exports for all sectors deemed at risk of carbon leakage as defined by the Annex of Commission Delegated Decision (EU) 2019/708. Data was retrieved from the PRODCOM database DS 066341 for the year 2018 (the last year available) at the EU27 level. It shows the value (in EUR million) of the imports and exports of all products from sectors on the carbon leakage list grouped at the 4-digit NACE code level.

There are 4 exceptions that do not have associated PRODCOM codes, and therefore data could not be collected. These are as follows (noting that only mineral oil refining under 1920 corresponds to an EU ETS Directive Annex I sector category and installations in the other sectors listed would only be included if they were above the Annex I 20MW thermal capacity threshold):

- Mining of hard coal (0510)
- Extraction of crude petroleum (0610)
- Manufacture of refined petroleum products (1920)
- Processing of nuclear fuel (2446)

There are two key limitations to the numbers produced.

1. Each NACE code is made up of several PRODCOM codes. Where no data was available for PRODCOM codes, they were removed from the data processing. However, the processing algorithm did not distinguish between data that could not be provided due to confidentiality reasons and where no trade happened for that PRODCOM code. The values reported therefore, in some cases, represent an undercount of the true value of imports/exports.
2. The analysis only looks at the value of imports and exports for the products from sectors listed in the carbon leakage list. It does not take into account derivatives of these products that are made within the internal market and then exported. This, more detailed, analysis, could be conducted through assessment of CM8 trade data which can be matched to PRODCOM codes. It would however take considerably more time and is not conducted here.

> This is particularly relevant given that previous studies have shown that the EU conducts an outsized amount of 'end product' high value production and limited raw material production[127].

If a more detailed approach was to be developed for options that were considered favourable, then it would be necessary to take a more refined approach to the data. This is illustrated as follows for hollow glass (NACE code 2313).

If the full carbon leakage list was to be covered, then it would correspond to the table below for which it is evident that there is a diverse range of products. Therefore, clearly this would be a more substantial initiative to introduce a comprehensive standard covering all of the PRODCOM codes. More practically, it would be better to select only those PRODCOM codes that correspond to high-value traded products which are likely to be more homogenous in their carbon characteristics; the high-value sectors (over EUR 100 million) are shown in bold. However, in practice, it appears that it may only be bottles of coloured and colourless glass for which it is possible to define minimum carbon standards. These broadly correspond to the two container glass benchmarks and therefore the option to base the standards on benchmarks may be more suitable.

However, there are other sectors where the benchmarks do not so clearly correspond to specific PRODCOM codes, such as the cement sector where the two benchmarks could both refer to PRODCOM code 23511100 ('Cement clinker') and the other two PRODCOM codes Portland cement and 'other hydraulic cements that are not represented by benchmarks.

Table 0-2: PRODCOM codes associated with the NACE code 2313 (hollow glass) and the value of imports and exports for 2018.

	Export (EUR)	Import (EUR)
Glass preserving jars, stoppers, lids and other closures (including stoppers and closures of any material presented with the containers for which they are intended)	44,131,400	69,557,390
Containers made from tubing of glass (excluding preserving jars)	42,558,630	11,181,110
Glass containers of a nominal capacity >=2,5 litres (excluding preserving jars)	8,420,990	12,838,830
Bottles of colourless glass of a nominal capacity <2,5 litres, for beverages and foodstuffs (excluding bottles covered with leather or composition leather, infant feeding bottles)	**281,655,380**	**170,183,820**

[127] Öko-Institute, Ricardo, Trinomics and Adelphi (2020 unpublished) Assessment of potential carbon leakage in the 3rd and 4th phase of the EU Emissions Trading System contract for DG CLIMA

	Export (EUR)	Import (EUR)
Bottles of coloured glass of a nominal capacity <2,5 litres, for beverages and foodstuffs (excluding bottles covered with leather or composition leather, infant feeding bottles)	**232,031,440**	**162,653,260**
Glass containers for beverages and foodstuffs of a nominal capacity <2,5 litres (excluding bottles, flasks covered with leather or composition leather, domestic glassware, vacuum flasks and vessels)	55,668,350	28,490,430
Glass containers for pharmaceutical products of a nominal capacity <2,5 litres	250,248,990	37,063,750
Glass containers of a nominal capacity <2,5 litres for the conveyance or packing of goods (excluding for beverages and foodstuffs, for pharmaceutical products, containers made from glass tubing)	**216,361,810**	**146,387,980**
Drinking glasses (including stemware drinking glasses), other than of glass ceramics, of lead crystal, gathered by hand	44,583,240	1,034,570
Drinking glasses (including stemware drinking glasses), other than of glass ceramics, of lead crystal, gathered mechanically	16,189,270	6,869,450
Drinking glasses (excluding stemware drinking glasses and products of glass ceramics or lead crystal), of toughened glass	47,957,170	15,539,530
Other drinking glasses	**531,269,470**	**167,908,530**
Table or kitchen glassware of lead crystal gathered by hand (excluding of glass-ceramics, of toughened glass, drinking glasses)	98,114,180	3,665,740
Table or kitchen glassware of lead crystal gathered mechanically (excluding of glass ceramics, of toughened glass, drinking glasses)	42,066,080	9,303,570
Table/kitchen glassware with linear coefficient of expansion <=5 x 10-6/K, temperature range of 0°C to 300°C excluding of glass-ceramics, lead crystal/toughened glass, drinking glasses	84,654,170	23,291,230
Glass-ceramic table, kitchen, toilet, office, indoor decoration or similar purpose glassware	32,077,660	13,903,440

	Export (EUR)	Import (EUR)
Table/kitchen glassware (excluding drinking), toughened glass	**484,294,880**	**504,132,990**
Glass inners for vacuum flasks or for other vacuum vessels (including unfinished and finished)	2,992,010	7,143,090

ANNEX A2 DERIVATION OF GROWTH FACTORS FROM PRIMES FORECASTS

The projection of emissions from industry is based on growth rates for activities based on PRIMES modelling forecasts. Activity forecasts are used rather than GVA forecasts for the following reasons:

- Comparing 2014-2018 trends from the NIMs activity data and the modelling data showed better correlation with the activity forecasts than the GVA forecasts.
- GVA is also affected by additional economic factors, whereas emissions are more closely associated to production activity.
- The sector disaggregation in the activity forecast is more detailed and better aligned with the priority sectors studied.

The sector categorisation in PRIMES does not align exactly with the NACE sector categorisation used in this study. Therefore, a mapping to match the most relevant categories was undertaken. The table below gives an overview of this sector attribution. For the other industry sectors that are not individually covered in the assessment, an average growth rate is based on the average for the remaining PRIMES industrial sectors. A median value was used to minimise the influence of the textiles sector that was an outlier and represents only a small contribution to ETS emissions.

The PRIMES activity forecasts do not cover the energy sectors so an alternative approach was taken for these. For district heating the GVA growth rate of the energy sector is applied. This rate is for the whole energy sector not only district heating, however, further disaggregated projections were not available. It is suitable to apply an energy sector growth rate for district heating, rather than the other industry growth rate, as a significant part of district heating supply is to households and services not industry. The energy sector projections reflect economic growth that would be reflected in energy demand in services and households as well as industry. The refinery sector is included in the energy sector projections. Considering that demand for refinery products from road transport will decline, despite demand for petrochemical feedstocks and aviation and maritime fuels increasing, a growing activity rate for this sector is unlikely to be realistic. Therefore, 0% growth was assumed for the refinery sector (NACE 1920).

	NACE sector	**PRIMEs industrial activity projection sector**
23 51	Manufacture of cement	Cement
23 52	Manufacture of lime and plaster	Other non-metallic minerals
24 10	Manufacture of basic iron and steel and of ferro-alloys	Integrated steelworks *PRIMES distinguishes activity growth for EAF (secondary) steel from integrated (primary) steelworks. The rate for integrated steel only is used for the single iron and steel NACE code, because the growth is used to calculate the growth in emissions and the large majority of emissions come from*

		integrated steel works compared to EAF.
2441	Precious metals production	Other non-ferrous products
2442	Aluminium production	Primary aluminium & Secondary aluminium *(average of two PRIMES sectors, weighted by production)*
2443	Lead, zinc and tin production	Zinc & Lead *(average of two PRIMES sectors, weighted by production) (PRIMES does not disaggregate tin production)*
2444	Copper production	Copper
2445	Other non-ferrous metal production	Other non-ferrous products
2011	Manufacture of industrial gases	Basic chemicals
2012	Manufacture of dyes and pigments	Other chemical products
2013	Manufacture of other inorganic basic chemicals	Basic chemicals
2014	Manufacture of other organic basic chemicals	Basic chemicals
2016	Manufacture of plastics in primary forms	Other chemical products
2017	Manufacture of synthetic rubber in primary forms	Other chemical products
1920	Manufacture of refined petroleum products	*Assumption*
2015	Manufacture of fertilisers and nitrogen compounds	Basic chemicals
2311	Manufacture of flat glass	Glass (basic and recycled glass)
2312	Shaping and processing of flat glass	Glass (basic and recycled glass)
2313	Manufacture of hollow glass	Glass (basic and recycled glass)
2314	Manufacture of glass fibres	Glass (basic and recycled glass)

23 19	Manufacture and processing of other glass	Glass (basic and recycled glass)
23 31	Manufacture of ceramics tiles and flags	Ceramics
17 11	Manufacture of pulp	Pulp
17 12	Manufacture of paper and paperboard	Paper
	other industry (non-priority sectors)	*Median of the remaining PRIMES industry sectors not mapped against specific NACE activities in this table.*
35 00	Electricity and heat	Energy Sector **(*GVA growth*)**

The projected activity data was reported as either kilotonnes of activity or a volume indicator. The same units are used for the PRIMES sectors which have been combined to reflect a NACE sector. Activity data is collated at the EU27 level. Historic activity data was available for the period 2010-2019 and projections were available for 2020, 2025 and 2030.

The provided activity data was used to calculate the growth factors by looking at the percentage change between reporting years. Where consecutive years were not available (i.e. between 2020 and 2025 and 2025 and 2030) the percentage change was divided by the year gap to calculate an annual percentage change (i.e. divided by five). The annual factor is applied in the reporting year (i.e. 2015, 2020, 2025 and 2030) and a growth factor the intermediary years is calculated by linearly interpolating between these five-year intervals. Once annual growth factors are calculated, the growth factor was then calculated for the appraisal period of 2019-2025 and 2025-2030 by taking the median of these annual values for these years. The effect of this approach is to give stronger weighting to the growth forecast for nearer years, which tend to have less uncertainty than longer term projections. This does lead to a small discrepancy (up to +/-5% in 2030 activity, varying depending on the sector) against the PRIMES activity values when recalculating the activity value using these derived growth factors. For the energy sector projections, growth is provided annually and the median value has been taken over the appraisal periods for 2019-2025 and 2025-2030.

HOW TO OBTAIN EU PUBLICATIONS

Free publications:

- one copy:
  via EU Bookshop (http://bookshop.europa.eu);

- more than one copy or posters/maps:
  from the European Union's representations (http://ec.europa.eu/represent_en.htm);
  from the delegations in non-EU countries (http://eeas.europa.eu/delegations/index_en.htm);
  by contacting the Europe Direct service (http://europa.eu/europedirect/index_en.htm) or calling 00 800 6 7 8 9 10 11 (freephone number from anywhere in the EU) (*).

  (*) The information given is free, as are most calls (though some operators, phone boxes or hotels may charge you).

Priced publications:

- via EU Bookshop (http://bookshop.europa.eu).

[Catalogue num

Publications Office

doi:[number]

ISBN [number]

GETTING IN TOUCH WITH THE EU

In person

All over the European Union there are hundreds of Europe Direct information centres. You can find the address of the centre nearest you at: https://europa.eu/european-union/contact_en

On the phone or by email

Europe Direct is a service that answers your questions about the European Union. You can contact this service:

– by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),

– at the following standard number: +32 22999696, or

– by email via: https://europa.eu/european-union/contact_en

FINDING INFORMATION ABOUT THE EU

Online

Information about the European Union in all the official languages of the EU is available on the Europa website at: https://europa.eu/european-union/index_en

EU publications

You can download or order free and priced EU publications from: https://op.europa.eu/en/publications. Multiple copies of free publications may be obtained by contacting Europe Direct or your local information centre (see https://europa.eu/european-union/contact_en).

EU law and related documents

For access to legal information from the EU, including all EU law since 1952 in all the official language versions, go to EUR-Lex at: http://eur-lex.europa.eu

Open data from the EU

The EU Open Data Portal (http://data.europa.eu/euodp/en) provides access to datasets from the EU. Data can be downloaded and reused for free, for both commercial and non-commercial purposes.