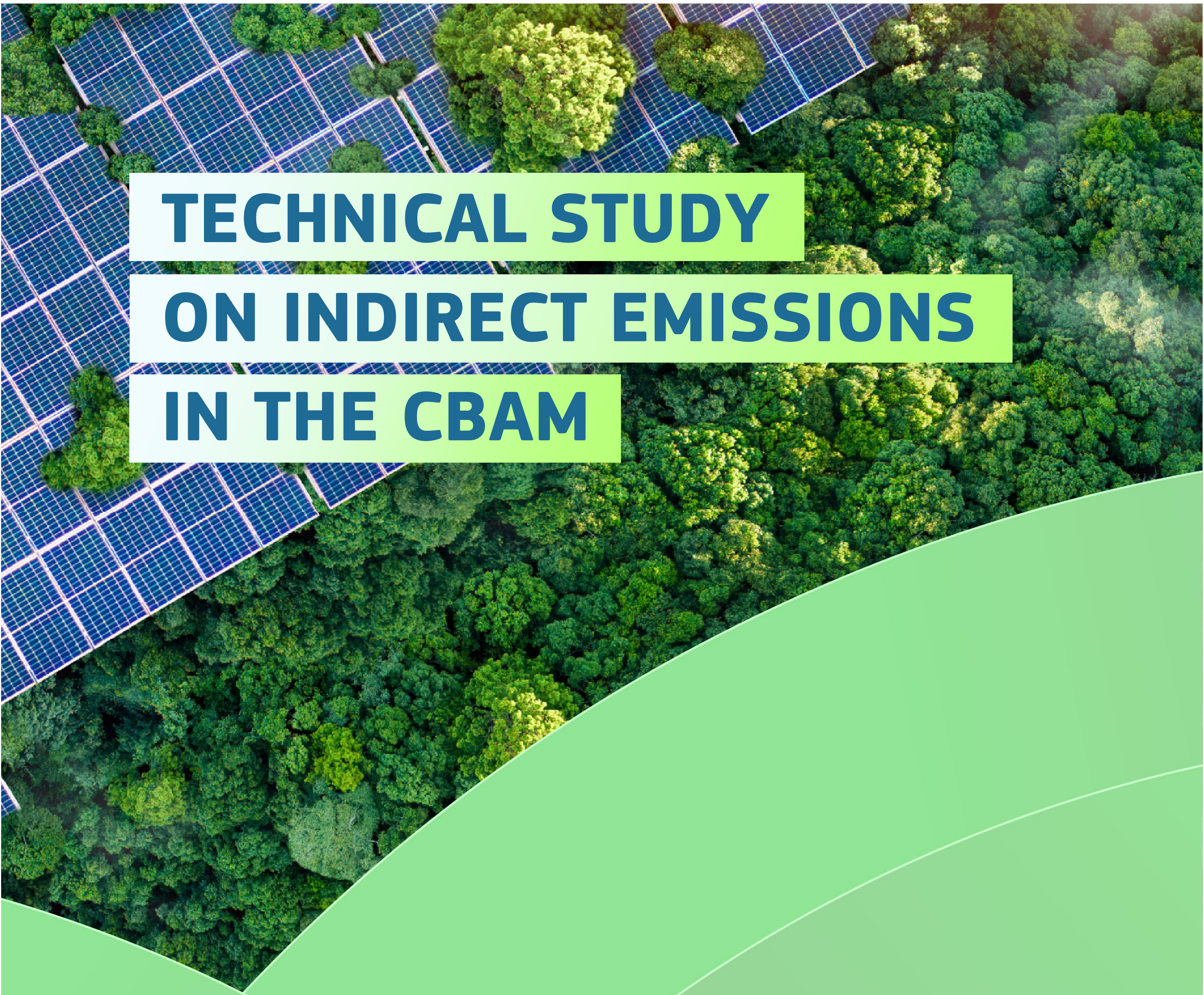
European Commission



TECHNICAL STUDY ON INDIRECT EMISSIONS IN THE CBAM

Specific Contract TAXUD/2024/AO-03 under the Multiple Service Framework Contract N° MOVE/ENER/SRD/2020/OP/0008

FINAL REPORT

EUROPEAN COMMISSION

Directorate-General for Taxation and Customs Union
Directorate C — Indirect Taxation and Tax Administration
Unit C.2 — CBAM, Energy and Green Taxation

E-mail: TAXUD-CBAM@ec.europa.eu

European Commission
B-1049 Brussels

Technical Study on Indirect Emissions in the CBAM

Contract details

Reference Number: TEC5137EU

Authors

Natalia Reyna-Bensusan, Sienna Healy, Max Robelin, Fabio Serpi, Reena Skribbe, Dominik Seebach, Ralph Harthan, Peter Gailhofer, Matthias Altmann

Quality assurance by

Long Lam

Contact person

Natalia Reyna-Bensusan

T: +44(0)7751 741253

E: natalia.reyna@ricardo.com

In association with:

RICARDO Öko-Institut e.V. Institut für angewandte Ökologie Institute for Applied Ecology LBST

Luxembourg: Publications Office of the European Union, 2026

PDF ISBN 978-92-68-40108-8 doi:10.2778/5807122 KP-01-26-026-EN-N

Table of Contents

Glossary

- **(Embedded) indirect emissions**: Emissions from the production of electricity which is consumed during the production of CBAM goods (other than electricity), irrespective of the location of the production of the consumed electricity where the electricity is generated.
- **Default values / default emission factors (for electricity)**: Commission-defined values (calculated or drawn from secondary data) that can be used to quantify embedded indirect emissions where actual indirect emissions are not applied.
- **Actual indirect emissions (for electricity)**: Indirect emissions calculated based on primary data from the production processes of electricity for a specific electricity generation source instead of default values, where the conditions in the CBAM framework to apply actual indirect emissions are met (notably via a direct technical link or a power purchase agreement).
- **Direct technical link**: A technical electrical connection between an electricity generation source and the installation producing CBAM goods (the report treats this concept as covering both “direct lines” and “private grids”, subject to appropriate metering and verification).
- **Power Purchase Agreement (PPA):** A contract under which the operator of the installation producing CBAM goods purchases an amount of electricity from a producer of electricity in a third country for an amount equivalent to the amount of electricity for which the use of actual indirect emissions is claimed (with the report distinguishing relevant contractual and electricity-specific characteristics[1] for integrity and verification).
- **Energy Attribute Certificate (EAC):** A certificate conveying electricity attributes used in some markets for accounting and claims (usually applied in a book claim approach distinct from the physical delivery of electricity).
- **Resource shuffling:** Reallocation of existing low-carbon electricity (or its attributes) to the production of CBAM goods production without a corresponding change in overall electricity generation patterns, creating risks for the environmental integrity of the CBAM.
- **Indirect Cost Compensation (ICC):** Compensation provided by Member States under State aid rules for indirect ETS-related electricity costs, relevant to the interaction between CBAM obligations and domestic carbon leakage protection for indirect costs.
- **Uncompensated share:** The share of indirect emissions not covered by ICC (used in Task 3 technical solutions to align CBAM coverage with the portion of indirect costs not addressed through ICC).
- **Environmental integrity:** The evaluation whether CBAM provides incentives for decarbonisation and prevents a net increase in global emissions. In Task 3, this is operationalised as the extent to which indirect emissions are covered by CBAM (full vs partial coverage; immediate vs phased). The extent to which emissions are covered is a key factor for determining whether CBAM provides incentives for decarbonisation in third countries and prevent a net increase in global emissions.
- **Preventing carbon leakage:** Preventing carbon leakage refers to avoiding the relocation of businesses and production from the EU to third countries due to climate policy costs, which results in a shift of emissions to outside the EU likely leading to an increase in global emissions. In Task 3, this is framed as avoiding relocation of businesses and production to regions with less stringent GHG regulations due to climate policy costs.

[1] *Electricity-specific requirements or characteristics relate to the characteristics of the electricity production rather than the technical means of delivery*

- **Even-handed approach to imports:** Whether overlap is avoided where EU producers receive Indirect Cost Compensation (ICC) while importers pay CBAM obligations for indirect emissions (i.e., avoiding double protection / overcompensation).
- **Feasibility:** Simplicity of methodology (administrative burden, MRV requirements, clarity, resource needs).
- **Ease of adaptation:** Extent of adjustment required by EU producers (ICC removal) and EU importers (new CBAM obligations for indirect emissions).

Abstract

This study provides policy analysis to support the implementation and potential evolution of the Carbon Border Adjustment Mechanism (CBAM) with respect to indirect emissions embedded in imported goods from third countries. It addresses three questions: (i) how to determine operational default emission factors for indirect emissions; (ii) under what conditions declarants should be allowed to claim actual indirect emissions, including requirements for direct technical links, power purchase agreements (PPAs), and verification; and (iii) whether and how indirect emissions coverage could be extended to additional CBAM sectors.

The analysis combines methodological assessment, analysis of the currently applicable rules under the CBAM, scenario testing, and structured stakeholder input. It evaluates trade-offs between ensuring environmental integrity (including risks of resource shuffling), carbon leakage prevention , administrative feasibility, and securing even-handed treatment between EU and non-EU producers. Particular attention is given to risks of resource shuffling, data limitations, verification complexity, as well as the need to avoid double carbon leakage protection with Indirect Cost Compensation.

The findings provide an evidence base for developing operational rules in the definitive period from 2026 and clarify the design conditions under which an expanded indirect emissions coverage would strengthen the CBAM's effectiveness while maintaining legal robustness and practical feasibility.

Abstrait

Cette étude fournit une analyse de politiques publiques visant à soutenir la mise en œuvre et l'évolution potentielle du mécanisme d'ajustement carbone aux frontières (MACF) en ce qui concerne les émissions indirectes incorporées dans les marchandises importées de pays tiers. Elle traite de trois questions principales : (i) la manière de déterminer des facteurs d'émission par défaut opérationnels pour les émissions indirectes ; (ii) les conditions dans lesquelles les déclarants devraient être autorisés à déclarer des émissions indirectes réelles, y compris les exigences relatives aux liens techniques directs, aux contrats d'achat d'électricité (power purchase agreements – PPA) et à la vérification ; et (iii) la question de savoir si, et comment, la couverture des émissions indirectes pourrait être étendue à d'autres secteurs couverts par le MACF.

L'analyse combine une évaluation méthodologique, l'examen des règles actuellement applicables dans le cadre du MACF, des tests de scénarios et une consultation structurée de parties prenantes. Elle évalue les arbitrages entre l'intégrité environnementale (y compris les risques de redistribution des ressources), la prévention des fuites de carbone , la faisabilité administrative et la garantie d'un traitement équitable entre les producteurs de l'UE et ceux des pays tiers. Une attention particulière est portée aux risques de redistribution des ressources, aux limites des données disponibles, à la complexité de la vérification, ainsi qu'à la nécessité d'éviter les interactions avec la compensation des coûts indirects.

Les résultats fournissent une base factuelle pour l'élaboration des règles opérationnelles applicables à la période définitive à partir de 2026 et précisent les conditions de conception dans lesquelles une extension de la couverture des émissions indirectes renforcerait l'efficacité du MACF tout en préservant sa robustesse juridique et sa faisabilité pratique.

Executive Summary

Introduction

This study was commissioned by the European Commission in preparation of the definitive period of the Carbon Border Adjustment Mechanism (CBAM), which aims to ensure that the costs of carbon externalities are reflected in imports on a comparable basis with the European Union (EU) Emissions Trading System (ETS). The current scope of CBAM only includes indirect emissions for some of the sectors and goods covered by the mechanism. Indirect emissions refer to the emissions from the production of electricity which is consumed during the production of goods, irrespective of the location of the production of the consumed electricity.

The work responded to the need for practical, evidence-based guidance on how the CBAM could be implemented for indirect emissions and potentially extended to cover indirect emissions of CBAM goods for which this is not yet the case. It addressed three interrelated challenges: identifying reliable default values for indirect emissions, defining conditions under which actual embedded indirect emissions could be claimed, and assessing feasible approaches to expand coverage which ensure fair treatment and coherence with existing carbon leakage protection mechanisms, such as Indirect Cost Compensation (ICC).

Objectives

The study aimed to support the Commission with the evidence, tools, and analyses necessary to implement indirect emissions obligations under the CBAM's definitive period and to inform potential future extensions. It combined economics and legal analysis, scenario-based assessment, and stakeholder input to provide an integrated view of methodological options, practical challenges, and policy trade-offs, supporting Commission decisions on operationalising the CBAM for indirect emissions while maintaining environmental ambition, even-handedness, and administrative feasibility. Specifically, it sought to:

- ✓ Support the choice of default emission factors for indirect emissions, taking account, inter alia, typical production conditions in third countries and supporting carbon leakage prevention.
- ✓ Define rules and verification requirements for claims of actual embedded indirect emissions, including guidance on technical links, power purchase agreements (PPAs), and verification.
- ✓ Assess technical solutions for possible scope extensions to additional CBAM goods and sectors, evaluating trade-offs between environmental integrity, administrative feasibility, transition management, and even-handed treatment with EU production.
- ✓ Identify key risks and design considerations, including potential double protection under ICC, data limitations, and implementation complexity, to inform policy decisions that are legally defensible and operationally feasible.

Task 1: Development of calculation methods and default values for indirect emissions linked to the manufacture of CBAM goods in third countries

Task 1 developed and evaluated a comprehensive framework for calculating default emission factors for electricity embedded in CBAM goods, addressing the dual objectives explicitly required in Annex IV of the CBAM Regulation: preventing carbon leakage and ensuring environmental integrity. The assessment systematically evaluated methodological approaches based on emission factors of all grid-connection generation, of fossil-only generation, and marginal generation, using a set of scenarios reflecting diverse electricity systems. These scenarios included high-carbon grids dominated by fossil fuel generation, medium-carbon grids with mixed production but fossil generation remaining significant at the margin, and low-carbon grids where marginal supply is often carbon-free. Data sources were rigorously screened for geographic and temporal coverage, methodological aspects, transparency, update frequency, and practical usability. National inventories, Eurostat, International Energy Agency (IEA) datasets, and other publicly available sources were screened in order to assess the sources considered as sufficiently fit for regulatory application for deriving default values across the selected countries. Key countries assessed included China, Türkiye, the United Kingdom (UK), the United States (US), and others with high exports of carbon-intensive goods to the EU and limited carbon pricing, ensuring that the analysis addressed the contexts where the CBAM was most relevant.

The assessment found that:

- Emission factors derived from fossil-only generation provide the closest alignment with the EU emission factors of the price-setting electricity source, minimising carbon leakage by ensuring CBAM obligations reflect the marginal carbon intensity faced by EU producers.
- Average emission factors based on all electricity sources provide stronger incentives for decarbonisation in third countries, as reductions in the overall grid carbon intensity lead to a direct reduction in CBAM obligations, encouraging the infra-marginal replacement from fossil fuel to renewable energy sources.
- Marginal generation approaches, while theoretically precise, face substantial limitations due to data gaps, high administrative effort, and technical infeasibility in many third-country contexts, particularly in developing countries with limited electricity data.

Expert consultations and expert feedback highlighted key considerations for implementing the methodology. The importance of transparency, replicability, and simplicity was emphasised, as overly complex approaches increased the reporting burden and risked reducing credibility. Annual updates of default values were recommended by experts to capture rapid changes in electricity generation mixes and decarbonisation trends in third countries.

Task 2: Methodologies to report actual indirect embedded emissions

Analysis under Task 2 examined the methodologies to report actual indirect embedded emissions under the CBAM. The objective of this analysis was to support the development of rules on the evidence to be provided when a declarant wishes to apply actual emissions for indirect emissions, based on section 6 of Annex IV to the CBAM Regulation.

For that, this report examined the criteria to provide evidence of a direct technical link between electricity generation and production of CBAM goods and the characteristics that should be fulfilled by PPAs. It also identified elements of evidence and specific tasks to be carried out by verifiers in respect to indirect emissions and of specific accreditation requirements for verifiers.

Main criteria to provide evidence of a direct technical link between electricity generation and production of CBAM goods include:

Technical:

- Physical Connectivity: A physical connection must be established between the electricity generation source and the production facility consuming such electricity.
- Operational Verification: Metering and monitoring systems need to be implemented at both the generation and production (consumption) sites to enable real-time tracking of electricity flows using a smart metering system.
- Network Configuration: While the infrastructure should primarily facilitate direct connectivity, it

may also allow for integration with the public grid, meaning a “direct technical link” can also be possible, even if the system is not completely isolated from the public grid in the technical sense. The system must be able to clearly monitor any electricity exchanges with the public grid.

Legal:

- It shall be ensured that internal agreements or documentation exist to formally recognise the operational and legal framework governing the electricity flow between the production and consumption units. If two different parties are involved, it shall be ensured that clear contracts exist between these two parties.
- Potential electricity-specific additional CBAM requirements for direct technical links have been assessed in view of their applicability for the CBAM, i.e.:
    - Temporal correlation: alignment in time between electricity generation and consumption.
    - Additionality: the electricity generated and supplied comes from a new or otherwise incremental renewable or low carbon energy source.
    - Geographical correlation: spatial proximity or network relationship between the production and consumption site.

Several main conclusions can be drawn regarding **claims of actual emissions based on individual PPAs** under the CBAM.

- Resource shuffling can increase the risk of carbon leakage without providing meaningful incentives for decarbonisation in third countries, potentially leading to higher global emissions. Resource shuffling is identified as the most relevant risk for maintaining CBAM’s environmental integrity.
- Although the CBAM Regulation[2] (allows claims of actual indirect emissions based on PPAs as such, further detailed specifications on contractual characteristics and electricity-related requirements are recommended. In this context, although not provided for in the Regulation, additionality criteria could help address existing shortcomings and, if properly defined and applied, could even result in positive effects by encouraging investment in new low-carbon electricity generation in third countries.
- Requirements on the temporal and geographical correlation between electricity production which is purchased via a PPA on the one hand, and the consumption of electricity used for the production of CBAM goods on the other hand, can be understood as specifications of existing rules to substantiate claims of electricity use . Additionality requirements would likely need to be justified by their importance for achieving the CBAM’s objectives and require amendments of the Regulation.
- Finally, as the relevance of indirect emissions varies significantly across sectors, the importance of detailed requirements for actual claims will increase if electricity-intensive products, such as primary aluminium, are required to cover indirect emissions under the CBAM.

Elements of evidence and specific tasks to be carried out by verifiers with respect to indirect emissions and of specific accreditation requirements for verifiers include:

- Elements of evidence of direct technical links:

[2] At the time when the analytical work for this study was completed, i.e. June 2025

    - Existence of a direct technical link: Single line diagrams, engineering designs of the direct technical link, proof of construction of the direct technical link, etc.
    - Use of a direct technical link: Proof of installed smart metering concept, relevant meter readings of smart metering installations, etc.
- Elements of evidence of PPAs:
    - Existence of a PPA: all PPAs claimed to be used must be provided to the verifier.
    - Compliance of PPAs with potential electricity-specific additional requirements (temporal correlation, additionality, geographical correlation): this depends on the types of PPAs: direct/ bilateral PPAs, indirect/ sleeved PPAs; physical PPAs, virtual PPAs.
    - Use of PPAs: The electricity amount specified in the PPA must match the amount for which the use of a specific value is claimed, based on various elements of evidence including evidence on the existence of the production installation, installed capacities, etc.
- Verification tasks related to direct technical links require expertise in electrical systems, including reading of single line diagrams, reading engineering design documents of electrical systems, and verifying electrical installations and metering systems.
- Verification tasks related to PPAs require expertise of specific contractual issues. Expertise in electrical systems is required, including reading of single line diagrams, reading engineering design documents of electrical systems, and verifying electrical installations and metering systems.
- Verification tasks related to smart metering systems require IT knowledge regarding smart metering installations both on the hardware and on the software side as well as on the correct implementation and use of smart metering systems.
- Accreditation scopes for verifiers may need to be expanded for smart metering systems and related IT systems.

Results from stakeholder engagement underlined the importance of verification needs that include technical expertise for electricity systems and smart metering, as well as the contractual requirements of PPAs. The experts stressed that rules had to be proportionate, enforceable, and designed to prevent risks such as resource shuffling, while providing accurate carbon accounting.

Task 3 Identification of technical solutions to extend indirect emissions to all the CBAM goods for the definitive period

Task 3 assessed how the CBAM could be extended to cover indirect emissions embedded in goods for which the CBAM does not yet cover indirect emissions, and what this would mean in practice. The assessment was structured around five criteria (further defined in the Task 3 section of this report): environmental integrity, prevention of carbon leakage, even-handed treatment between EU production and imports, feasibility, and ease of adaptation. The objective was to determine which design approaches would deliver robust carbon leakage protection without creating double protection through ICC, and without imposing disproportionate administrative or adjustment burdens.

The analysis confirmed that excluding indirect emissions from CBAM creates a structural inconsistency in carbon cost treatment in emission-intensive sectors. EU producers face indirect carbon costs through higher electricity prices reflecting the EU ETS, even where ICC compensates part of these costs. Third-country operators in most CBAM sectors do not face an equivalent obligation. This results in uneven carbon cost treatment across sectors in electricity-intensive value chains. From a purely environmental and carbon leakage perspective, applying CBAM to indirect emissions for all CBAM goods (except electricity) could be more effective than maintaining the selective approach.

The assessment of the different design configurations for extending CBAM coverage to indirect emissions produced the following key findings:

- **Full CBAM coverage:**

Configurations that apply full CBAM coverage to indirect emissions (i.e. for all CBAM goods except electricity) perform best on environmental integrity. They ensure that all electricity-related emissions embedded in imports are subject to a carbon price, closing sectoral gaps and strengthening the decarbonisation signal. They also perform strongly on carbon leakage prevention, as importers face a carbon cost exposure comparable in scope to that borne by EU producers. In terms of ease of implementation, from a methodological standpoint, full coverage is simple and transparent, reducing the scope for interpretation disputes or complex calculations.

- **Full CBAM coverage with unchanged ICC:**

However, if full CBAM coverage is introduced while ICC continues unchanged, the approach does not meet the even-handed treatment criterion. EU producers could continue to receive compensation for indirect carbon costs while importers are charged CBAM for the same emissions. This creates a clear risk of double protection and weakens the defensibility of the system. The practical finding was therefore that full CBAM coverage combined with unchanged ICC is environmentally strong but structurally misaligned and difficult to justify.

- **Full CBAM coverage with ICC removed:**

Fully removing ICC entirely at the moment when full CBAM coverage could be introduced resolves this overlap. In that configuration, environmental integrity remains strong, even-handedness is restored, and the system is administratively simple. From a design perspective, this is one of the most internally coherent models. However, the analysis found that it scores worst on ease of adaptation. EU producers eligible for ICC would face an immediate and significant increase in cost exposure, while importers would simultaneously face new CBAM obligations. The conclusion was that while this model is conceptually sound and logically consistent, it implies a more abrupt cost redistribution and therefore carries higher political and transition risks.

- **CBAM only applied to "uncompensated share" of indirect emissions:**

Configurations that applied CBAM only to the share of indirect emissions not compensated by ICC perform better on even-handedness. By design, importers are charged only for the portion of indirect emissions that EU producers effectively bear after ICC. This reduces the risk of overlap and improved fairness across borders. These configurations also perform well in terms of ease of adaptation, as ICC continues to operate as it did before the CBAM was introduced and as the CBAM obligation is reduced compared to full CBAM coverage. However, their performance depends heavily on how the uncompensated share was determined. Where a fixed maximum aid intensity is assumed, the method is simple and feasible but might somewhat misrepresent actual carbon cost exposure, weakening environmental integrity. Where actual ICC levels or more detailed sectoral benchmarks are used to calibrate CBAM coverage, alignment improves and carbon leakage protection strengthens relative to the simplified version. The trade-off is significantly higher data requirements and administrative complexity. The practical finding was that a calibrated "uncompensated share" approach can provide a balanced solution, but only if data availability and governance capacity is sufficient.

- **Phased CBAM introduction with ICC reduction:**

Phased approaches, in which CBAM coverage of indirect emissions is introduced gradually as ICC is reduced over time, perform well overall from a transition management perspective. Environmental integrity increases progressively, overlap is avoided if phase-out rules are clearly defined, and adjustment burdens are smoother for both EU producers and importers. As noted by experts, compared to immediate ICC removal, phased approaches are significantly less disruptive while still moving towards full border pricing. However, they require strong coordination between CBAM implementation and State aid governance to ensure that phase-out rules are applied consistently across Member States and sectors. The practical finding was that phased configurations provide a credible compromise between environmental ambition and economic manageability, but are more complex to administer than immediate, uniform solutions.

- **Sequenced approach - ICC phased out before CBAM introduction:**

A sequencing approach in which ICC is fully phased out before CBAM coverage of indirect emissions is introduced performs relatively poorly in environmental terms during the transition. Indirect emissions remain unpriced at the border for an extended period, reducing carbon leakage protection precisely while compensation is being withdrawn. Although this configuration avoids double protection and is legally straightforward, it creates a temporary misalignment between costs faced by EU producers and importers and weakens the environmental integrity. It was therefore assessed as comparatively weak overall.

- **CBAM with recalibrated ICC:**

A further configuration maintains ICC while introducing CBAM coverage of indirect emissions but adjusts ICC parameters to reflect the new border charge. In principle, this model performs strongly on environmental integrity and carbon leakage prevention while avoiding double protection. It allows EU producers to continue receiving compensation, but at recalibrated levels consistent with the carbon cost exposure of imports. The strength of this approach lays in its flexibility and its potential to maintain political acceptability. However, its effectiveness depends on the credibility of the calibration mechanism. It requires a robust and transparent method for comparing indirect carbon costs embedded in imports with those faced by EU producers and for adjusting aid intensity or eligible costs accordingly. This introduces governance and coordination challenges across Member States. The conclusion was that this model is promising but its success depends on effective administration and the reliability of the calibration mechanism.

Stakeholder feedback broadly confirmed these findings. EU producers emphasised the need to avoid abrupt removal of ICC and highlighted the importance of predictability in transition pathways. Importers stressed the need for methodological clarity and manageable reporting requirements. Member State representatives underlined the administrative implications of data-intensive solutions and the need for alignment with State aid governance. Across stakeholder groups, there was consistent recognition that the interaction between CBAM and ICC is the key factor determining the effectiveness and fairness of the overall design.

Results from stakeholder engagement also showed a divergence of views: environmental groups and public entities generally supported broader coverage to strengthen decarbonisation incentives, while industry representatives from electro-intensive sectors expressed concerns about competitiveness impacts, potential resource shuffling, and administrative complexity. Across all respondents, the use of IEA-based national grid emission factors was widely preferred for default values, while PPAs were considered reliable only if strict criteria ensured geographic and temporal correlation and additionality.

Conclusion

The study demonstrated that each option for indirect emissions under the CBAM entails different distributional, administrative, and legal consequences.

For **default emission factors (Task 1)**, grid-average electricity emission factors emerged as the most operationally defensible basis for third-country default values, provided that data quality and transparency constraints are clearly managed. More complex options (e.g. price-setting or marginal approaches) introduce methodological and implementation risks that outweighed their theoretical advantages.

For **claims of actual indirect emissions (Task 2)**, the initial regulatory framework was identified as open for interpretations that could limit the effectiveness of the policy. Specific technical criteria for direct technical links and PPAs were developed, and verification competences defined, to allow for the mitigation of resource shuffling risks and inconsistent enforcement. The analysis suggested that environmental integrity depends less on allowing actual claims per se, and more on the stringency and verifiability of the accompanying conditions.

For **potential scope extension (Task 3)**, stakeholder evidence confirmed that the limited coverage of indirect emissions is widely perceived as insufficient to address carbon leakage in electricity-intensive sectors. However, immediate full extension without careful alignment with Indirect Cost Compensation would create risks of double protection, uneven treatment, and implementation complexity. Phased or ICC-linked approaches appear more workable, though they increase administrative coordination requirements.

Résumé exécutif

Introduction

Cette étude a été commanditée par la Commission européenne en préparation de la période définitive du Mécanisme d'ajustement carbone aux frontières (MACF), qui vise à garantir que les coûts des externalités carbone soient reflétés dans les importations sur une base comparable à celle applicable à la production dans l'Union européenne (UE). Le champ d'application actuel du MACF n'inclut les émissions indirectes, associées à l'électricité consommée pour produire d'autres biens, que pour certains secteurs et produits couverts par le mécanisme.

Les travaux répondent au besoin d'orientations pratiques et fondées sur des éléments probants concernant la manière dont le MACF pourrait être appliqué aux émissions indirectes, et potentiellement étendu pour couvrir plus largement les émissions indirectes d'autres biens couverts par le MACF et qui ne sont pas encore dans le champ d'application. L'étude s'est penchée sur trois défis interdépendants : l'identification de valeurs par défaut fiables pour les émissions indirectes, la définition des conditions dans lesquelles les émissions indirectes réelles pourraient être déclarées, et l'évaluation d'approches envisageables pour étendre la couverture tout en garantissant un traitement équitable et une cohérence avec des dispositifs existants de protection contre les fuites de carbone, tels que la compensation des coûts indirects (CCI).

Objectifs

L'étude visait à fournir à la Commission les éléments probants, les outils et les analyses nécessaires pour mettre en œuvre les obligations relatives aux émissions indirectes dans la période définitive du MACF et éclairer d'éventuelles extensions futures. Elle combine une analyse économique et juridique, une évaluation fondée sur des scénarios et des contributions des parties prenantes afin d'offrir une vision intégrée des options méthodologiques, des défis pratiques et des arbitrages politiques. L'objectif est d'éclairer les décisions de la Commission concernant l'opérationnalisation du MACF pour les émissions indirectes tout en préservant l'ambition environnementale, un traitement équitable et la faisabilité administrative.

Plus précisément, l'étude visait à :

- Soutenir le choix de facteurs d'émission par défaut pour les émissions indirectes, en tenant compte notamment des conditions de production typiques dans les pays tiers et en contribuant à la prévention des fuites de carbone.
- Définir des règles et exigences de vérification pour les déclarations d'émissions indirectes réelles, y compris des recommandations concernant les liens techniques directs, les contrats d'achat d'électricité (Power Purchase Agreements – PPA) et les tâches de vérification.
- Évaluer des solutions techniques pour d'éventuelles extensions du champ d'application à d'autres biens et secteurs couverts par le MACF, en analysant les arbitrages entre intégrité environnementale, faisabilité administrative, gestion de la transition et traitement équitable avec la production dans l'UE.
- Identifier les principaux risques et considérations de conception, notamment les risques de double protection liés à la CCI, les limites des données et la complexité de mise en œuvre, afin d'éclairer des décisions politiques juridiquement défendables et opérationnellement réalisables.

Tâche 1 : Élaboration de méthodes de calcul et de valeurs par défaut pour les émissions indirectes liées à la fabrication de biens MACF dans les pays tiers

La tâche 1 a élaboré et évalué un cadre complet pour le calcul des facteurs d'émission par défaut pour l'électricité incorporée dans les biens couverts par le MACF, en répondant aux deux objectifs explicitement requis à l'annexe IV du règlement MACF : prévenir les fuites de carbone et garantir l'intégrité environnementale. L'évaluation a analysé de manière systématique différentes approches méthodologiques fondées sur des facteurs d'émission couvrant l'ensemble de la production d'électricité raccordée au réseau, la production fossile exclusivement et la production marginale, en s'appuyant sur un ensemble de scénarios reflétant des systèmes électriques diversifiés. Ces scénarios comprenaient des réseaux fortement carbonés dominés par la génération d'électricité à base de combustibles fossiles, des réseaux moyennement carbonés caractérisés par un mix énergétique diversifié mais où la production fossile demeure significative à la marge, ainsi que des réseaux faiblement carbonés où l'offre marginale est souvent décarbonée.

Les sources de données ont été examinées de manière rigoureuse au regard de leur couverture géographique et temporelle, de la transparence méthodologique, de la fréquence de mise à jour et de leur utilisabilité pratique. Les inventaires nationaux, les données d'Eurostat, les ensembles de données de l'Agence internationale de l'énergie (AIE) et d'autres sources publiques ont été examinées afin d'identifier les sources considérées comme étant suffisamment adaptées à une application réglementaire pour dériver des valeurs par défaut dans les pays étudiés. Les principaux pays analysés comprenaient la Chine, la Türkiye, le Royaume-Uni, les États-Unis et d'autres économies présentant des exportations importantes de biens intensifs en carbone vers l'UE et une tarification du carbone limitée, afin de cibler les contextes où le MACF est le plus pertinent.

L'évaluation a montré que :

- Les facteurs d'émission fondés sur la seule production fossile sont ceux qui s'alignent le plus étroitement sur la source d'électricité fixant le prix dans l'UE, ce qui minimise les fuites de carbone en garantissant que les obligations MACF reflètent l'intensité carbone marginale pertinente pour les importations.
- Les facteurs d'émission moyens fondés sur l'ensemble des sources d'électricité offrent des incitations plus fortes à la décarbonation dans les pays tiers, car les réductions de l'intensité carbone moyenne du réseau se traduisent directement par une diminution des obligations MACF, encourageant ainsi le remplacement infra-marginal des combustibles fossiles par des sources renouvelables.
- Les approches fondées sur la production marginale, bien que théoriquement précises, présentent d'importantes limitations en raison du manque de données, des efforts administratifs élevés et de la faisabilité technique limitée dans de nombreux pays tiers, en particulier dans les pays en développement disposant de données électriques restreintes.

Les consultations d'experts ainsi que leurs retours ont mis en évidence plusieurs considérations essentielles pour la mise en œuvre de la méthodologie. L'importance de la transparence, de la reproductibilité et de la simplicité de la méthodologie choisie a été soulignée, les approches trop complexes alourdissant les charges liées à la déclaration et risquant de réduire la crédibilité du système. Les experts ont également recommandé des mises à jour annuelles des valeurs par défaut afin de refléter les évolutions rapides des mix de production électrique et les tendances de décarbonation dans les pays tiers.

Tâche 2 : Analyse des méthodologies pour le rapport des émissions indirectes réelles dans le cadre du CBAM

L'analyse réalisée dans le cadre de la tâche 2 a examiné les méthodologies permettant de déclarer les émissions indirectes réelles dans le cadre du MACF. L'objectif était d'appuyer l'élaboration de règles relatives aux éléments de preuve à fournir lorsqu'un déclarant souhaite appliquer des émissions réelles pour les émissions indirectes, conformément à la section 6 de l'annexe IV du Règlement MACF.

À cette fin, le rapport a examiné les critères permettant d'établir l'existence d'un **lien technique direct** entre l'installation générant de l'électricité et l'installation produisant les biens couverts par le MACF, ainsi que les caractéristiques que doivent respecter les PPA. Il a également identifié les éléments de preuve nécessaires et les tâches spécifiques à effectuer par les vérificateurs en matière d'émissions indirectes, ainsi que les exigences spécifiques d'accréditation applicables aux vérificateurs.

Les principaux critères permettant d'établir un lien technique direct entre le générateur d'électricité et l'installation produisant les biens couverts par le MACF incluent :

- **Critères techniques**
    - Connectivité physique : Un raccordement physique doit être établi entre la source de production d'électricité et l'installation industrielle consommatrice.
    - Vérification opérationnelle : Des systèmes de comptage et de suivi doivent être mis en place, aussi bien au niveau du générateur que de l'installation consommant l'électricité, permettant le suivi en temps réel des flux d'électricité à l'aide de compteurs intelligents.
    - Configuration du réseau : Bien que la structure du réseau doive permettre avant tout le raccordement direct ce dernier peut autoriser une connexion avec le réseau public, à condition que les échanges avec celui-ci puissent être clairement mesurés. Ainsi, un « lien technique direct » est possible même lorsque le système n'est pas complètement isolé du réseau public.
    - **Critères juridiques**: Il convient de s'assurer que des accords internes ou une documentation existent afin de reconnaître formellement le cadre opérationnel et juridique régissant les flux d'électricité entre les unités de production et de consommation. Lorsque deux parties distinctes sont impliquées, il convient de s'assurer que des contrats clairs existent entre ces deux parties.
    - De potentiels critères additionnels liés à la condition d'un lien technique direct ont été évalués en vue de leur applicabilité au sein du MACF :
    - Corrélation temporelle : alignement temporel entre la production et la consommation d'électricité.
    - Additionnalité : l'électricité produite et fournie provient d'une nouvelle source d'énergie renouvelable ou bas-carbone, ou d'une source autrement additionnelle.
    - Corrélation géographique : proximité spatiale ou relation de réseau entre le site de production et le site de consommation.

Plusieurs conclusions principales ont été tirées concernant les **déclarations d'émissions réelles fondées sur des PPA individuels** dans le cadre du MACF :

- La redistribution stratégique des ressources (resource shuffling) peut accroître le risque de fuite de carbone sans fournir d'incitations significatives à la décarbonation dans les pays tiers, ce qui pourrait conduire à une augmentation des émissions mondiales. Le risque de redistribution stratégique de ressources est donc identifié comme le risque le plus pertinent pour le maintien de l'intégrité environnementale du MACF.

- Bien que le **Règlement MACF**[3] autorise les déclarations d'émissions indirectes réelles fondées sur des PPA en tant que telles, des spécifications supplémentaires plus détaillées concernant les caractéristiques contractuelles et les exigences liées à l'électricité sont recommandées. Dans ce contexte, bien que cela ne soit pas explicitement prévu dans le Règlement, des critères d'additionnalité pourraient contribuer à remédier aux lacunes existantes et, s'ils sont correctement définis et appliqués, pourraient même produire des effets positifs en encourageant l'investissement dans de nouvelles capacités de production d'électricité bas-carbone dans les pays tiers.
- Les exigences relatives à la corrélation temporelle et géographique entre, d'une part, l'électricité produite et achetée via un PPA et, d'autre part, l'électricité consommée pour la production de biens MACF peuvent être considérées comme des précisions des règles existantes permettant d'étayer les déclarations relatives à la consommation d'électricité. Les exigences d'additionnalité devraient probablement être justifiées par leur importance pour l'atteinte des objectifs du MACF et nécessiteraient un amendement du Règlement.
- Enfin, dans la mesure où l'importance des émissions indirectes varie considérablement selon les secteurs, l'importance de définir des exigences détaillées pour les déclarations d'émissions réelles augmentera si des produits fortement électro-intensifs, tels que l'aluminium primaire, sont soumis à la couverture des émissions indirectes dans le cadre du MACF.

Éléments de preuve et tâches de vérification

Les éléments de preuve et les tâches spécifiques devant être réalisés par les vérificateurs concernant les émissions indirectes, ainsi que les exigences d'accréditation associées, comprennent :

- Éléments de preuve relatifs aux liens techniques directs
  - Existence d'un lien technique direct : schémas unifilaires, plans d'ingénierie du lien technique direct, preuve de construction du lien technique direct, etc.
  - Utilisation d'un lien technique direct : preuve de l'installation d'un système de comptage intelligent, relevés de compteurs pertinents issus des installations de comptage intelligent, etc.
- Éléments de preuve relatifs aux PPA
  - Existence d'un PPA : tous les PPA dont l'utilisation est revendiquée doivent être fournis au vérificateur.
  - Conformité des PPA aux exigences supplémentaires potentielles spécifiques à l'électricité (corrélation temporelle, additionnalité, corrélation géographique) : cela dépend du type de PPA concerné, notamment PPA directs/bilatéraux, PPA indirects (« sleeved »), PPA physiques, PPA virtuels, ou certificats d'attributs énergétiques non dissociés (EAC) dans une approche « book & claim ».
  - Utilisation des PPA : la quantité d'électricité spécifiée dans le PPA doit correspondre à la quantité pour laquelle l'utilisation d'une valeur spécifique est revendiquée, sur la base de différents éléments de preuve, notamment des preuves relatives à l'existence de l'installation de production, aux capacités installées, etc.
- Les tâches de vérification liées aux liens techniques directs nécessitent une expertise dans les systèmes électriques, notamment la lecture de schémas unifilaires, l'analyse de

[3] *Au moment où le travail analytique a été effectué dans le cadre de cette étude, c'est-à-dire juin 2025*

documents d'ingénierie relatifs aux systèmes électriques et la vérification des installations électriques et des systèmes de comptage.

- Les tâches de vérification liées aux PPA nécessitent une expertise sur des questions contractuelles spécifiques. Une expertise en systèmes électriques est également requise, notamment pour la lecture de schémas unifilaires, l'analyse de documents d'ingénierie et la vérification des installations électriques et des systèmes de comptage.
- Les tâches de vérification liées aux systèmes de comptage intelligent nécessitent des compétences informatiques concernant les installations de comptage intelligent, tant du point de vue matériel que logiciel, ainsi que concernant la bonne mise en œuvre et l'utilisation correcte de ces systèmes.
- Les périmètres d'accréditation des vérificateurs pourraient devoir être élargis afin d'inclure les systèmes de comptage intelligent et les systèmes informatiques associés.

Les résultats issus de la consultation des parties prenantes ont souligné l'importance des exigences de vérification, qui doivent inclure une expertise technique concernant les systèmes électriques et les systèmes de comptage intelligent, ainsi que les exigences contractuelles associées aux PPA. Les experts ont souligné que les règles doivent être proportionnées, applicables et conçues de manière à prévenir des risques tels que la réaffectation stratégique, tout en permettant une comptabilisation précise des émissions de carbone.

Tâche 3 : Identification des solutions techniques pour étendre les émissions indirectes à l'ensemble des produits MACF pour la période définitive

La tâche 3 a évalué comment le MACF pourrait être étendu afin de couvrir les émissions indirectes intégrées dans les biens pour lesquels les émissions indirectes ne sont actuellement pas couvertes par le MACF, et ce que cela impliquerait en pratique. L'évaluation a été structurée autour de cinq critères (définis plus en détail dans la section Tâche 3 de ce rapport) : l'intégrité environnementale, la prévention des fuites de carbone, le traitement équitable entre la production de l'UE et les importations, la faisabilité et la facilité d'adaptation. L'objectif était de déterminer quelles approches de conception permettraient d'assurer une protection solide contre les fuites de carbone sans créer de double protection à travers les ICC, et sans imposer des charges administratives ou d'ajustement disproportionnées.

L'analyse a confirmé que l'exclusion des émissions indirectes du MACF crée une incohérence structurelle dans le traitement du coût du carbone dans les secteurs à forte intensité électrique. Les producteurs de l'UE supportent des coûts indirects du carbone via des prix de l'électricité plus élevés reflétant le Système d'échange de quotas d'émission (SEQE) de l'UE, même lorsque les ICC compensent une partie de ces coûts. Les importateurs, dans la plupart des secteurs MACF, ne font pas face à une obligation équivalente. Il en résulte un traitement inégal du coût du carbone entre les secteurs dans les chaînes de valeur à forte intensité électrique. D'un point de vue strictement environnemental et de prévention des fuites de carbone, l'application du MACF aux émissions indirectes à l'ensemble des biens couverts par le MACF (à l'exception de l'électricité) pourrait être plus efficace que le maintien de l'approche sélective actuelle.

L'évaluation des différentes configurations de conception pour étendre la couverture du MACF aux émissions indirectes a produit les principaux constats suivants :

- **Couverture complète du MACF :**

Les configurations appliquant une couverture complète du MACF aux émissions indirectes (c'est-à-dire à tous les biens couverts par le MACF à l'exception de l'électricité) obtiennent les meilleurs résultats en matière d'intégrité environnementale. Elles garantissent que toutes les émissions liées à l'électricité intégrées dans les importations sont soumises à un prix du carbone, comblant les lacunes sectorielles et renforçant le signal de décarbonation. Elles obtiennent également de bons résultats en matière de prévention des fuites de carbone, car les importateurs font face à une exposition au coût du carbone comparable, dans son étendue, à celle supportée par les producteurs de l'UE. En termes de facilité de mise en œuvre, d'un point de vue méthodologique, une couverture complète est simple et transparente, réduisant le risque de litiges d'interprétation ou de calculs complexes.

- **Couverture complète du MACF avec ICC inchangées :**

Cependant, si la couverture complète du MACF est introduite alors que les ICC restent inchangées, l'approche ne respecte pas le critère de traitement équitable. Les producteurs de l'UE pourraient continuer à recevoir une compensation pour les coûts indirects du carbone tandis que les importateurs seraient soumis au MACF pour les mêmes émissions. Cela crée un risque clair de double protection et affaiblit la crédibilité du système. Le constat pratique est donc que la couverture complète du MACF combinée au maintien des ICC est forte sur le plan environnemental mais structurellement désalignée et difficile à justifier.

- **Couverture complète du MACF avec suppression des ICC :**

La suppression complète des ICC au moment de l'introduction d'une couverture complète du MACF résout ce chevauchement. Dans cette configuration, l'intégrité environnementale reste forte, le traitement équitable est rétabli et le système reste administrativement simple. Du point de vue de la conception, il s'agit de l'un des modèles les plus cohérents en interne. Cependant, l'analyse a montré qu'il obtient les moins bons résultats en matière de facilité d'adaptation. Les producteurs de l'UE éligibles aux ICC seraient confrontés à une augmentation immédiate et significative de leur exposition aux coûts, tandis que les importateurs devraient simultanément faire face à de nouvelles obligations MACF. La conclusion est que, bien que ce modèle soit conceptuellement solide et logiquement cohérent, il implique une redistribution abrupte des coûts et comporte donc des risques politiques et de transition plus élevés.

- **MACF appliqué uniquement à la « part non compensée » des émissions indirectes :**

Les configurations appliquant le MACF uniquement à la part des émissions indirectes non compensée par les ICC obtiennent de meilleurs résultats en matière de traitement équitable. Par conception, les importateurs ne sont facturés que pour la part des émissions indirectes effectivement supportée par les producteurs de l'UE après compensation par les ICC. Cela réduit le risque de chevauchement et améliore l'équité entre les acteurs. Ces configurations obtiennent également de bons résultats en matière de facilité d'adaptation, car les ICC continuent de fonctionner comme avant l'introduction du MACF. Toutefois, leurs performances dépendent fortement de la manière dont la part non compensée est déterminée. Lorsqu'une intensité maximale d'aide fixe est supposée, la méthode est simple et faisable mais peut occulter l'exposition réelle aux coûts du carbone, ce qui affaiblit l'intégrité environnementale. Lorsque les niveaux réels d'ICC ou des références sectorielles plus détaillées sont utilisés pour calibrer la couverture du MACF, l'alignement s'améliore et la protection contre les fuites de carbone se renforce par rapport à la version simplifiée. Le compromis est une augmentation significative des besoins en données et de la complexité administrative. Le constat pratique est qu'une approche calibrée fondée sur la « part non compensée » peut offrir une solution équilibrée, mais uniquement si la disponibilité des données et la capacité de gouvernance sont suffisantes.

- **Introduction progressive du MACF avec réduction des ICC :**

Les approches progressives, dans lesquelles la couverture du MACF pour les émissions indirectes est introduite graduellement à mesure que les ICC sont réduites dans le temps, obtiennent globalement de bons résultats du point de vue de la gestion de la transition. L'intégrité environnementale augmente progressivement, le chevauchement est évité si les règles de suppression progressive sont clairement définies, et les charges d'ajustement sont plus lissées pour les producteurs de l'UE comme pour les importateurs. Comme l'ont souligné les experts, comparées à une suppression immédiate des ICC, les approches progressives sont nettement moins perturbatrices tout en permettant d'évoluer vers une tarification complète aux frontières. Toutefois, elles nécessitent une forte coordination entre la mise en œuvre du MACF et la gouvernance des aides d'État afin de garantir que les règles de suppression progressive soient appliquées de manière cohérente entre les États membres et les secteurs. Le constat pratique est que les configurations progressives offrent un compromis crédible entre ambition environnementale et gérabilité économique, mais qu'elles sont plus complexes à administrer que des solutions immédiates et uniformes.

- **Approche séquencée – suppression progressive des ICC avant l'introduction du MACF :**

Une approche séquencée dans laquelle les ICC sont entièrement supprimées avant l'introduction de la couverture des émissions indirectes par le MACF obtient des résultats relativement faibles sur le plan environnemental pendant la période de transition. Les émissions indirectes restent non tarifées à la frontière pendant une période prolongée, ce qui réduit la protection contre les fuites de carbone précisément au moment où la compensation est retirée. Bien que cette configuration évite la double protection et soit juridiquement simple, elle crée un désalignement temporaire entre les coûts supportés par les producteurs de l'UE et les importateurs et affaiblit le signal environnemental. Elle a donc été évaluée comme relativement faible dans l'ensemble.

- **MACF avec ICC recalibrées :**

Une autre configuration consiste à maintenir les ICC tout en introduisant la couverture du MACF pour les émissions indirectes, mais en ajustant les paramètres des ICC pour refléter la nouvelle charge carbone à la frontière. En principe, ce modèle obtient de bons résultats en matière d'intégrité environnementale et de prévention des fuites de carbone tout en évitant la double protection. Il permet aux producteurs de l'UE de continuer à recevoir une compensation, mais à des niveaux recalibrés cohérents avec l'exposition au coût du carbone des importations. La force de cette approche réside dans sa flexibilité et dans son potentiel à maintenir l'acceptabilité politique. Cependant, son efficacité dépend entièrement de la crédibilité du mécanisme de calibration. Elle nécessite une méthode robuste et transparente pour comparer les coûts indirects du carbone intégrés dans les importations avec ceux supportés par les producteurs de l'UE et pour ajuster en conséquence l'intensité de l'aide ou les coûts éligibles. Cela introduit des défis de gouvernance et de coordination entre les États membres. La conclusion est que ce modèle est prometteur, mais que sa réussite dépend d'une administration efficace et de la fiabilité du mécanisme de calibration.

Les retours des parties prenantes ont globalement confirmé ces constats. Les producteurs de l'UE ont souligné la nécessité d'éviter une suppression abrupte des ICC et ont mis en avant l'importance de la prévisibilité des trajectoires de transition. Les importateurs ont insisté sur la nécessité de clarté méthodologique et des conditions de déclaration gérables. Les représentants des États membres ont mis en avant les implications administratives des solutions intensives en données et la nécessité d'un alignement avec la gouvernance des aides d'État. Dans l'ensemble des groupes de parties prenantes, il existe une reconnaissance constante que l'interaction entre le MACF et les ICC constitue le facteur clé déterminant l'efficacité et l'équité de la conception globale.

Les résultats de l'engagement des parties prenantes ont également montré une divergence de points de vue : les groupes environnementaux et les entités publiques soutiennent généralement une couverture plus large afin de renforcer les incitations à la décarbonation, tandis que les représentants de l'industrie issus de secteurs électro-intensifs expriment des préoccupations concernant les impacts sur la compétitivité, les risques potentiels de redistribution des ressources et la complexité administrative. Parmi tous les répondants, l'utilisation de facteurs d'émission du réseau national basés sur les données de l'AIE a été largement préférée pour les valeurs par défaut, tandis que les PPA n'ont été considérés comme fiables que si des critères stricts garantissent la corrélation géographique et temporelle ainsi que l'additionnalité.

Conclusion

L'étude a montré que chaque option relative aux émissions indirectes dans le MACF entraîne des conséquences différentes en matière de répartition des coûts, d'administration et de cadre juridique.

Pour les facteurs d'émission par défaut (Tâche 1), les facteurs d'émission moyens du réseau électrique apparaissent comme la base la plus défendable sur le plan opérationnel pour les valeurs par défaut des pays tiers, à condition que les contraintes de qualité et de transparence des données soient clairement gérées. Des options plus complexes (par exemple les approches basées sur le prix marginal ou les technologies marginales) introduisent des risques méthodologiques et de mise en œuvre qui dépassent leurs avantages théoriques.

Pour les déclarations d'émissions indirectes réelles (Tâche 2), le cadre réglementaire initial a été identifié comme laissant place à des interprétations susceptibles de limiter l'efficacité de la politique. Des critères techniques spécifiques pour les liens techniques directs, ainsi que des spécifications plus strictes pour les PPA, ont été élaborés, et des compétences de vérification définies, afin de permettre la réduction des risques de redistribution des ressources et d'application incohérente. L'analyse suggère que l'intégrité environnementale dépend moins de la possibilité de déclarer des émissions réelles en tant que telle que de la rigueur et de la vérifiabilité des conditions qui l'accompagnent.

Pour l'extension potentielle du champ d'application (Tâche 3), les éléments recueillis auprès des parties prenantes confirment que la couverture limitée des émissions indirectes est largement perçue comme insuffisante pour traiter les fuites de carbone dans les secteurs à forte intensité électrique. Toutefois, une extension complète immédiate sans alignement soigneux avec la compensation des coûts indirects créerait des risques de double protection, de traitement inégal et de complexité de mise en œuvre. Des approches progressives ou liées aux ICC semblent plus opérationnelles, bien qu'elles augmentent les exigences de coordination administrative.

1. Introduction

This study was commissioned by the European Commission in the context of the European Green Deal and the EU's legally binding climate targets under the European Climate Law: a reduction of net greenhouse gas (GHG) emissions by at least 55% by 2030 (vs. 1990) and climate neutrality by 2050. Delivering these objectives has required a strengthened EU Emissions Trading System (EU ETS) and the adoption of the Fit for 55 legislative package, including the Carbon Border Adjustment Mechanism (CBAM). As the EU ETS cap tightens and the carbon price signal strengthens, concerns about carbon leakage have intensified, both through relocation of production to jurisdictions with less stringent climate policies and through the substitution of EU production by more carbon-intensive imports. Historically, carbon leakage risk under the EU ETS has been mitigated mainly via free allocation of allowances, complemented for indirect emissions costs by Member State Indirect Cost Compensation (ICC) under State aid rules. With the CBAM, the EU is progressively shifting from free allocation to a border mechanism intended to equalise carbon costs between EU production and imports, while maintaining incentives to decarbonise.

Within this policy context, the Commission requested targeted analytical and technical support to enable the implementation of the CBAM in the definitive period (from 1 January 2026) with a particular focus on embedded indirect emissions (i.e., emissions from electricity consumed in the production of the CBAM goods irrespective of where the electricity is generated). The core problems addressed by this study are threefold. First, the study explored how to best define robust and defensible default values for indirect emissions, including decisions on which electricity emission factor concept should underpin default values (e.g., grid average, price-setting sources, or an EU-wide reference), and how to operationalise these in a way that supports carbon leakage prevention and environmental integrity. Second, the study looked at options for when and how declarants may apply actual indirect emissions in place of default values, particularly in relation to direct technical links and power purchase agreements (PPAs), and the associated evidence and verification requirements. Third, this study assessed technical options to extend the CBAM's indirect emissions' scope to additional CBAM goods (including those listed in Annex II), while ensuring even-handed treatment between imports and EU production in light of ICC, Member State heterogeneity, the EU internal electricity market design, and WTO compatibility.

The study builds on the CBAM Regulation's staged introduction: a transitional period (from 1 October 2023 to 31 December 2025) in which importers report embedded emissions (including indirect emissions) without financial adjustment, followed by a definitive period (starting 1 January 2026) in which importers must surrender CBAM certificates corresponding to embedded emissions. During the definitive period, indirect emissions obligations apply only to a subset of CBAM goods (cement; fertilisers and agglomerated iron ores) while the Regulation requires the Commission to report on the possibility of extending indirect emissions coverage to additional goods before the end of the transitional period. The study therefore sits at the intersection of (i) implementing detailed methodological rules for indirect emissions, and (ii) informing policy choices on the future scope and design of the CBAM for indirect emissions, including its interaction with existing carbon leakage protection mechanisms.

1.1 General objectives of the study

In line with the Terms of Reference, the overarching objectives are:

- To support the Commission in assessing whether the current CBAM approach to indirect emissions is fit for purpose and coherent with the European Green Deal.

- To support the Commission in developing the methodology to monitor, report and verify indirect emissions of imported CBAM goods (other than electricity) for the definitive period from 2026.

These general objectives were pursued through three linked workstreams:

- **Task 1:** developing calculation methods and identifying reliable data sources to determine default values for embedded indirect emissions in third countries;
- **Task 2:** developing rules on evidence and verification requirements for applying actual indirect emissions instead of default values (including direct technical links and PPAs);
- **Task 3:** exploring technical solutions for extending the indirect emissions' coverage to all CBAM goods (and potentially additional future sectors), accounting for interaction with the EU ETS, ICC under State aid rules, EU electricity market design, and WTO compatibility.

1.2 Structure of this report

This report is structured as follows:

- **Chapter 1:** introduces the policy and regulatory context and sets out the scope and objectives of the study. Chapter 1 also introduces the methodological chapters and provides overarching considerations.
- **Chapters 2–4** present a consolidated summary of the work and findings from the three tasks:
    - **Chapter 2:** Task 1 on default values to report indirect emissions
    - **Chapter 3:** Task 2 on reporting considerations for actual emissions
    - **Chapter 4:** Task 3 on options to extend the scope of indirect emissions under the CBAM
- **Chapter 5:** Conclusions that synthesise key findings of the three tasks and the implications for implementation and policy evolution.
- **The Annexes** provide the detailed task reports and supporting evidence (including consultation materials) referenced throughout the main text.

The full task reports - setting out the detailed methodological steps, assumptions, inputs, and supporting analysis in greater detail - are provided as annexes to this final report.

The analytical work underpinning the study was carried out between June 2024 and June 2025. The task reports were therefore developed on the basis of the regulatory and technical information available until the end of that period, including the fact that certain aspects of the CBAM Regulation for the definitive period were still being finalised at the time the analysis was conducted. This is reflected in the annexed task reports (annexes 1, 2 and 3), which document the approach and findings as developed within that timeframe.

Following completion of the main analytical phase, Task 3 was updated at the Commission's request to reflect developments until January 2026. Specifically, this update (i) incorporated the Commission's amendment to the ETS State aid guidelines on fertilisers (C/2026/196)[4], and (ii) integrated an additional option for the potential extension of the CBAM scope to indirect emissions (Technical Solution 5). Technical Solution 5 was developed and added after the other technical solutions, following further

[4] *https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52026XC00196*

reflections, which is why it is assessed in a shorter format. These updates were also made to take into account the analysis presented in the CBAM review report (COM(2025)783)[5].

As the present final report was drafted in early 2026, the summaries presented in Chapters 2–4 are written in the past tense, while reflecting the work undertaken between summer 2024 and summer 2025.

1.3 Legal texts referenced throughout the document

The analysis in this report takes into account the following key legal and policy texts (cited throughout as relevant):

- **EU ETS Directive[6]:** Directive 2003/87/EC (as amended), including provisions relevant to carbon leakage protection and auctioning revenues.
- **CBAM Regulation[7]:** Regulation (EU) 2023/956 establishing a carbon border adjustment mechanism (including Annexes I, II and IV, and Article 30 reporting requirements).
- **CBAM Implementing Regulation for the transitional period[8]:** Regulation (EU) 2023/1773 implementing rules on reporting obligations during the transitional period.
- **State Aid Guidelines for ICC[9]:** Guidelines on certain State aid measures in the context of the system for greenhouse gas emission allowance trading post-2021, including relevant amendments (where applicable to the study period and Task 3 updates).

Renewable Energy Directive (RED)[10]: Directive (EU) 2023/2413 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources. In addition, other legal texts, guidance documents, Commission communications, and technical references that are specific to individual tasks are introduced and cited where relevant in the corresponding task chapters and annexes.

---

[5] *https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52025DC0783*

[6] *https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02003L0087-20240301*

[7] *https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023R0956*

[8] *https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023R1773*

[9] *https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:E2021X0415(01)*

[10] *https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=OJ:L_202302413*

2. Task 1: Development of calculation methods and default values for indirect emissions linked to the manufacture of CBAM goods in third countries

The main body of work for Task 1 was carried out between June 2024 and June 2025. Results presented in this chapter reference the CBAM Regulation and technical context available during that period. All assessments and recommendations are based on the legal and methodological information in place prior to the Commission's proposal published in December 2025.

2.1 Introduction and objectives for Task 1

Indirect emissions arise from electricity consumed during the production of CBAM goods, and electricity systems vary materially across countries. As a result, the choice of default emission factors is a central design parameter for implementation of the CBAM: it determines the strength and credibility of the carbon price signal applied to imports, influences incentives for third-country electricity decarbonisation, and affects the risk of carbon leakage.

Task 1 supported the Commission's preparation for the definitive CBAM period (from 1 January 2026) by developing and assessing approaches for setting default emission factors used to calculate embedded indirect emissions in CBAM goods imported from third countries.

Task 1 focuses on informing decision-making on the appropriate default emission factors to apply when calculating the indirect embedded emissions of CBAM goods imported from third countries into the EU. The work aimed to balance environmental integrity, carbon leakage prevention, and practical feasibility, while ensuring compliance with relevant EU policies and international commitments. It also aimed to identify default value approaches that could be implemented using data sources applied consistently across jurisdictions.

In line with Annex IV of the CBAM Regulation, Task 1 assessed the options available for determining the default emission factors for the electricity used in the production of goods other than electricity: (i) the EU average grid emission factor, (ii) the country-of-origin average grid emission factors, and (iii) the CO_2 emission factors of the price-setting sources in the country of origin. Given the interpretive and data challenges associated with the "CO_2 emission factor of the price-setting sources", the work distinguishes between a feasible proxy (average fossil-only emission factors) and a more conceptually direct but operationally demanding approach (marginal generation emission factors).

The task proceeded through a structured, transparent assessment framework: it first developed criteria and scenario-based tests to compare options at a macro level, and then specified practical calculation methods and screened data sources against coverage, quality, transparency and update frequency. This included applying candidate methodologies to a set of selected and representative trading partners with diverse electricity mixes to test feasibility and sensitivity.

A two-level assessment was developed to guide the analysis. At the first level, the suitability of each option for setting the default value was evaluated in terms of its effectiveness in preventing carbon leakage, its contribution to environmental integrity by incentivising decarbonisation in third countries, and its feasibility, considering both methodological simplicity and applicability across different contexts. At the second level, the availability and quality of data necessary to calculate the default values were assessed, ensuring that practical considerations regarding data completeness, accessibility, and reliability were taken into account. This assessment was undertaken without prejudice to the EU's international commitments.

Task 1 also addressed another implementation option envisaged in the Regulation: the possibility for third countries (or groups of countries) to request an alternative emission factor where they could demonstrate, on the basis of reliable data, that their relevant electricity emission factor was lower than the Commission default value. To support consistent and defensible decision-making, Task 1 set out criteria for assessing such requests, with a stronger emphasis on data completeness, recentness and methodological transparency than was required for the default value itself, given the need for verification and comparability. Finally, Task 1 provided technical inputs intended to support drafting of the implementing act foreseen under Article 7 of the CBAM Regulation (to be translated by the Commission into legal form), and was complemented by targeted consultation with technical experts to validate assumptions, identify practical constraints (including PPAs and Combined Heat and Power - CHP), and test the real-world implementability of proposed default value approaches.

Task 1 was organised around four linked workstreams:

- establishing criteria and assessing default value options (Subtasks 1.1–1.3)
- (ii) defining criteria for alternative emission factors (Subtask 1.4)
- (iii) providing technical drafting inputs for the implementing act (Subtask 1.5)
- (iv) supporting adoption through expert consultation (Subtasks 1.6).

Further detail on the underlying evidence, figures and country/sector-level mapping is provided in the Annex 1 of this report.

2.2 Subtask 1.1: Development of criteria for default value

2.2.1 Objectives and methodology

Subtask 1.1 developed a structured set of criteria to transparently assess the suitability of the options for setting default values for the calculation of indirect emissions embedded in goods under the CBAM Regulation. The options assessed were those outlined in Annex IV of the CBAM Regulation:

Option 1:

- Average emission factor for the EU electricity grid.

Option 2:

- Average emission factors for each country of origin (the approach used in the transitional period, calculated based on data from the International Energy Agency (IEA)).

Option 3:

- CO_2 emission factors of the price-setting sources in the country of origin of the electricity used for the production of that good.

The methodology for this subtask was structured in two main steps. The first step involved a precise definition of each option in terms of how the emission factor would be calculated. While the first two options were clearly defined in the CBAM Regulation, Option 3 required interpretation, given its reference to the "CO2 emission factor of the price-setting sources" in the country of origin. Two possible approaches for operationalising this third option were considered:

Option 3a:

- The average fossil-only emission factor of the country of origin, which can serve as a practical proxy for the marginal generation CO_2 emission factor.

Option 3b:

- The marginal generation CO_2 emission factor, representing the emissions from the plant that sets the electricity price in a liberalised market. This is typically the last plant dispatched to meet demand and is usually fossil-based.

The second step involved the development of assessment criteria that would allow a transparent evaluation of the suitability of each option. The criteria were designed to reflect both the environmental integrity of the CBAM mechanism and the feasibility of implementing each option in practice. The assessment was structured across two levels:

High-level assessment:

- Overarching criteria were applied to determine the general suitability of each option. Options failing this stage were excluded with a clear rationale, allowing the assessment to focus on the most promising approaches.

Detailed assessment:

- For options passing the macro level assessment, the availability and quality of data were considered, focusing on how practical it would be to implement the calculation of default values using publicly available information.

The assessment criteria at the macro level were developed with three main dimensions:

Prevention of carbon leakage:

- This criterion examines whether the default value discourages relocation of production outside the EU due to carbon costs, ensuring that the CBAM provides a level playing field between domestic production and imports. Carbon leakage was understood across three channels (output, investment, and energy markets), with the focus here on the relocation of production through the output and investment channels (i.e. short-term production shifts and longer-term capacity decisions).

Decarbonisation incentives for third countries:

- This criterion assesses whether the default value provides an incentive for third countries to decarbonise their electricity supply. The underlying principle is that a representative default value should encourage reductions in carbon intensity in third-country electricity generation, supporting the environmental integrity of the CBAM.

Feasibility (simplicity and applicability):

- This criterion evaluates the ease with which the methodology for setting default values can be implemented. Simplicity focuses on whether the calculation can be performed without complex modelling (e.g., avoiding the need for dispatch models), while applicability considers whether the approach can be consistently used across third countries regardless of market liberalisation.

To ensure consistency and transparency, the criteria were designed to allow scenario-based assessment of third-country electricity profiles, recognising that electricity generation mixes vary widely. Three scenarios were considered:

1. Third countries with predominantly carbon-intensive generation.
2. Third countries with a mix of fossil fuel and low-carbon generation.
3. Third countries with relatively low-carbon generation, including renewables and nuclear.

These scenarios allowed the criteria to account for different relative emission factors across countries and the potential impact on CBAM obligations.

2.2.2 Results

The output of Subtask 1.1 was the full set of criteria and their associated rationale, which provided the foundation for the subsequent macro level assessment of default value options in Subtask 1.2. Key results included:

- Clear definition of options: Options 1 and 2 were fully defined, while Option 3 was separated into two operationalisations (fossil-only average vs marginal generation factor), recognising the practical limitations of applying marginal factors in non-liberalised markets.
- Structured criteria framework: The macro level criteria were formalised along the three dimensions of environmental integrity (carbon leakage, decarbonisation incentives and feasibility) and feasibility (simplicity and applicability). These criteria provided a clear rationale for comparing options.
- Scenario-based applicability: The scenario approach was adopted to ensure that the criteria could be applied across a range of electricity system contexts, reflecting differences in carbon intensity and generation mix across third countries.
- Preparation for subsequent assessment: The criteria developed under this subtask formed the foundation for the detailed evaluation in Subtask 1.2, ensuring that options could be scored transparently and compared consistently. The detailed assessment, focusing on data availability and quality, could then be applied only to options passing the macro level suitability test.

2.3 Subtask 1.2: Assessment of the default value options at the macro level

Building on the macro-level criteria, scenario definitions, and rationale for assessing default values established in Subtask 1.1, the qualitative assessment of the default value options was undertaken as follows.

2.3.1 Objectives and methodology

The assessment focused on three core dimensions defined under Subtask 1.1 (prevention of carbon leakage, decarbonisation incentives for third countries and feasibility).

To carry out the assessment, the project team qualitatively scored each option using a structured matrix, based on predefined criteria applied consistently across all options. The results are compiled into a comparative overview table that highlighted differences in performance across scenarios and facilitated identification of the most suitable options. This approach allowed transparent consideration of the conditions under which each option would perform effectively, while recognising that further quantitative analysis may be required to confirm representativeness.

2.3.2 Results

The qualitative assessment considered the four options outlined under Subtask 1.1, for setting the default values at the macro level.

The following options were excluded from further consideration:

- **Option 3b (Marginal generation CO_2 emission factor)** was excluded from further consideration due to low feasibility. While it could provide accurate results in certain market contexts, it requires complex dispatch modelling and is generally not applicable in third countries without liberalised electricity markets.
- **Option 1 (average EU electricity emission factor)** was also deemed unsuitable. It scored negatively on all three criteria. In all scenarios the EU average emission factor is generally lower than the price-setting electricity source in the EU, the CBAM obligations would not be equivalent to the carbon costs of the electricity generated in the EU. Additionally, because it does not reflect the third country's grid emissions, it does not provide incentive for grid decarbonisation.

The remaining options are highlighted below:

- **Option 2 (average emission factor of the country of origin)** scored highest for providing decarbonisation incentives and for its feasibility. By including all electricity sources, it acknowledges the decarbonisation efforts undertaken in third countries over time. Its effectiveness in preventing carbon leakage, however, depends on the relative level of the country's average emission factor: it is most effective if the third country's factor is higher than the EU price-setting source and less so if it is lower.
- **Option 3a (average fossil-only emission factor of the country of origin)** performed best for preventing carbon leakage as it produces the highest emission factor among the options considered. While it provides a decarbonisation incentive, the incentive is more limited than Option 2 because non-fossil generation is excluded. The incentive primarily encourages fuel switching from coal to gas for electricity relevant to exports to the EU. Its effectiveness depends on the gap between the fossil-only and overall average emission factor: smaller gaps strengthen the incentive, while larger gaps reduce it.

Summary recommendation:

The qualitative assessment indicated that **Option 3a** is most suitable for preventing carbon leakage, while **Option 2** is best for providing decarbonisation incentives to third countries and in terms of feasibility (due to better data availability). Option 1 is not recommended due to its limited effectiveness, while Option 3b is not recommended due to its low feasibility. Further research is suggested to quantify the relative representativeness of the average and fossil-only emission factors in third countries compared with EU values to support final selection of default values.

2.4 Subtask 1.3: Specification of calculation methods for the default values

2.4.1 Objectives and methodology

Subtask 1.3 defined robust and consistent calculation methods for establishing default values of indirect embedded emissions in CBAM goods during the definitive period. A central aim was to identify the most suitable publicly available datasets to support different calculation approaches, and to apply these methods to calculate default values for a selection of key trading partners. Comparing results across approaches enables an assessment of feasibility, accuracy, and practical implications, forming the basis for recommending preferred calculation methods for CBAM implementation from 1 January 2026 onwards.

The approach to this Subtask comprised multiple stages. First, a comprehensive screening of potential data sources was conducted, based on criteria including data availability (i.e. geographical and temporal coverage, update frequency) and quality, (i.e. accessibility, simplicity for calculation and methodological transparency). Only publicly available datasets were considered; subscription-based sources such as certain IEA datasets were excluded due to contractual budget limitations. Several sources were found unsuitable due to limited country coverage (e.g., JRC, NAEI, eGRID), lack of electricity emission data (e.g., IPCC Guidelines, IRENA), or access restrictions.

After screening, six datasets were identified as potentially viable: UNFCCC Harmonized IFI Default Grid Factors, Ember, Statistical Review of World Energy, Eurostat, Biennial Transparency Reports (CRT files), and National Inventory Reports. Each dataset was evaluated for its advantages and limitations. For instance, the UNFCCC Harmonized IFI Default Grid Factors provide global coverage and methodological transparency but are updated only bi-annually and require complex calculations. Ember provides frequent updates and extensive country coverage but requires data cleaning due to integration of multiple sources. Additionally, its LCA-based methodology presents inherent incompatibilities with CBAM. Eurostat and the Statistical Review of World Energy provide robust historical data for the EU and other countries but have limited coverage for certain third countries. Biennial Transparency Reports and National Inventory Reports include detailed country-specific methodologies but entail high administrative effort and uneven temporal coverage.

Based on this assessment, four datasets were shortlisted for application in calculating default values:

1. **Ember Dataset** – despite its extensive coverage and frequent updates, the life-cycle assessment (LCA)-based methodology introduces misalignment with CBAM and may reduce accuracy.
2. **Eurostat Dataset** – comprehensive EU data, fully documented methodology, over 20 years of coverage, limited to EU and select other countries.
3. **Statistical Review of World Energy** – global coverage from 1965 to 2023, annual updates, transparent methodology, some aggregation limitations for certain regions.
4. **Biennial Transparency Reports (CRT files)** – broad country coverage, detailed country-specific methodologies, bi-annual updates, high administrative effort, some missing data.

Default value calculations were applied to a selected set of key trading partners: United States, European Union, Türkiye, United Kingdom, China, India, Mozambique, Costa Rica, and South Africa. These countries were selected based on their high exports of carbon-intensive goods to the EU and their diverse electricity generation profiles, such as South Africa's coal-dominated grid and Mozambique's hydroelectric system, providing a broad range of outcomes for assessment.

Electricity emission factors were calculated using either generation data by fuel type or provided emission factors. When only generation data was available, standard assumptions for plant-level emissions were applied: 350 g CO_2/kWh for natural gas, 750 g CO_2/kWh for coal, and 808 g CO_2/kWh for oil. Nuclear, hydroelectric, and renewable generation were assumed to have zero emissions. These assumptions are conservative, likely underestimating total emissions relative to actual national power plant fleets.

Two default emission factor variants were calculated:

1. **Country Average Emission Factor** – total emissions from all electricity generation sources divided by total generation.
2. **Fossil Mix Emission Factor** – emissions from fossil generation divided by fossil electricity generation only, producing higher values than the country average.

Additional methodological considerations included:

- **Power Purchase Agreements (PPAs)**: adjustments may be required for renewable electricity sourced under PPAs to avoid double-counting, although CBAM-relevant production typically represents a small share of national electricity.
- **Combined Heat and Power (CHP)**: allocation of fuel use between electricity and heat is feasible (conditional on market prices) but requires plant-specific knowledge often beyond publicly available datasets.
- **Decarbonisation Policies**: updates to default emission factors should reflect evolving electricity mixes, renewable uptake, fuel prices, and GDP growth. Annual updating of datasets is the most practical approach.

2.4.2 Results

Figure 2-1 compares the default emission factors from electricity generation (country average) for the selected key trading partners (United States, Turkey, United Kingdom, China, India, Mozambique, Costa Rica, and South Africa). For comparison, corresponding values for the EU are also included.

Figure 2-1 Comparison of default emission factors from electricity generation (country average) estimated based on different data sources for several key trading partners

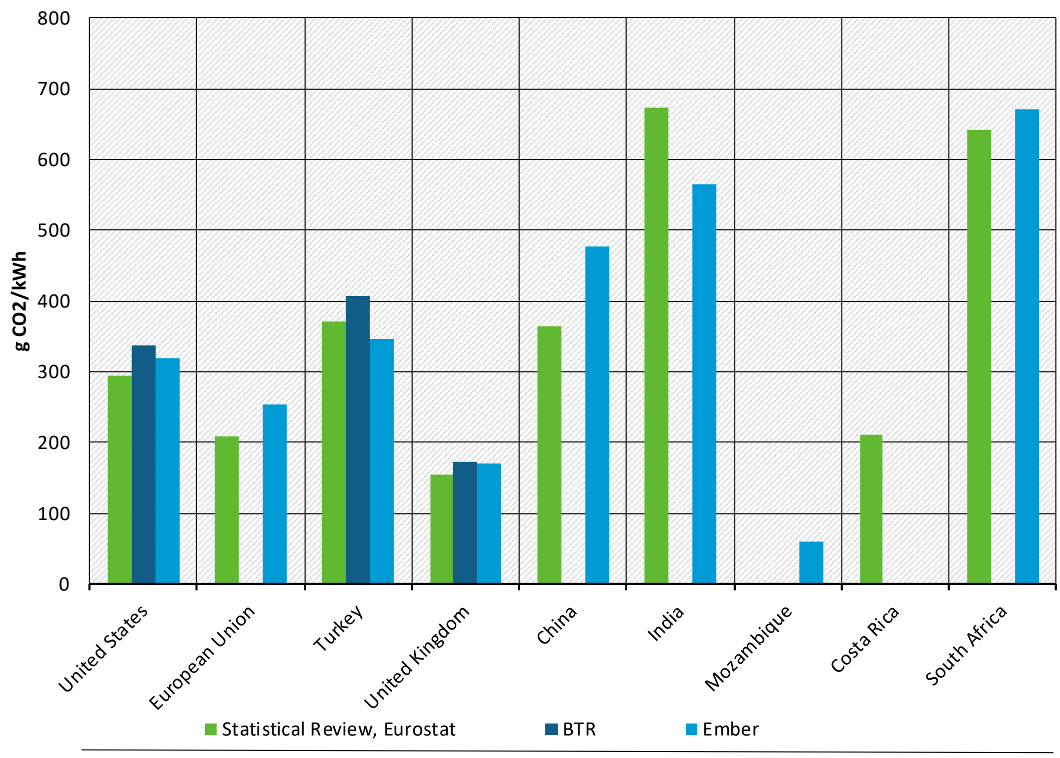
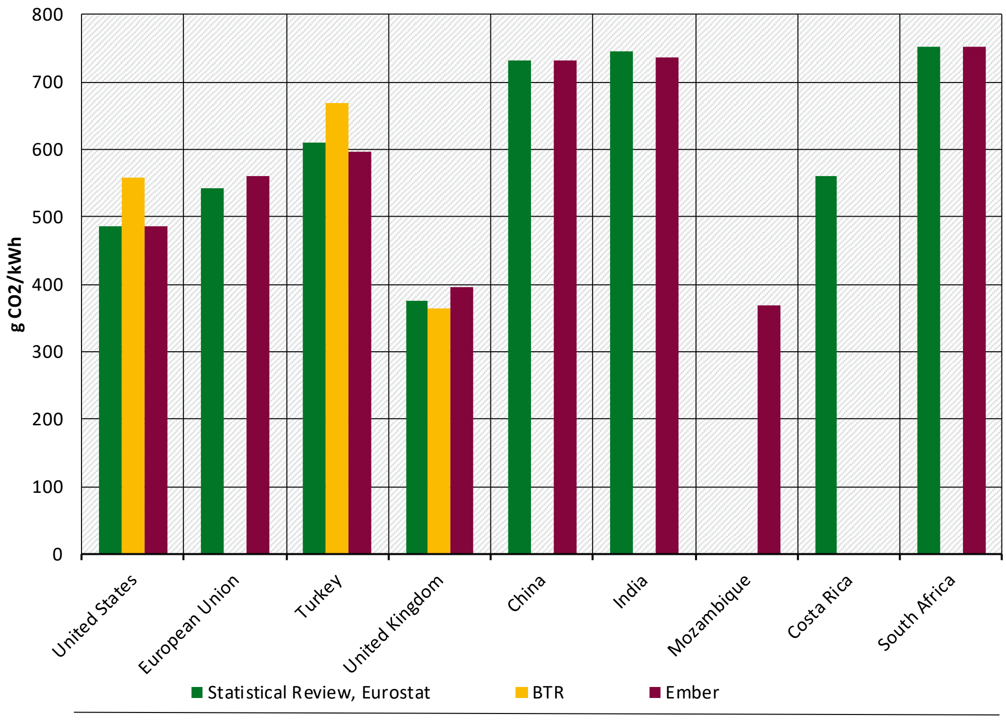


Figure 2-2 provides a comparison of default emission factors from electricity generation (fossil mix) based on the calculation with different data sources.

Figure2-2: Comparison of default emission factors from electricity generation (fossil mix) estimated based on different data sources for several key trading partners



Comparison Across Data Sources

Results were broadly consistent for the United States, EU, Türkiye, UK, and South Africa across multiple sources. Greater differences were observed for China, India, and Costa Rica, reflecting variations in source coverage, aggregation methods, and assumptions. Ember is the only dataset providing full coverage for all selected countries, making it the most flexible for global default value calculations.

Limitations and Challenges

Calculation of default values for indirect embedded emissions in CBAM goods is feasible using publicly available datasets, but careful selection of sources, conservative assumptions for missing data, and consideration of practical constraints are critical. Some countries lacked complete or timely data, limiting comparability, while aggregation in some sources prevented precise country-level calculations. Conservative methodological assumptions were therefore applied, meaning that they are likely to underestimate actual emissions. Coverage, update frequency, and methodological transparency indicate that a combination of **Eurostat** and **the Statistical Review of World Energy** provides a robust basis for EU-specific and broader default value calculations, while Biennial Transparency Reports remain valuable for detailed country-specific methodologies despite limited availability and higher administrative effort. Ember may complement these sources where global coverage is required, but its LCA approach warrants caution.

The methodology thus developed, including all assumptions and calculation steps, provides a consistent framework to derive default emission factors across key trading partners. Adjustments for PPAs and CHP are possible conceptually using methods that allocate carbon emissions consistently, but constrained by data availability and administrative complexity, and frequent updating is required to reflect evolving electricity generation mixes and decarbonisation policies. Country average and fossil mix emission factors illustrate differences in electricity generation profiles and emissions intensity, forming a robust basis for CBAM default values that balance accuracy, feasibility, and practical applicability.

2.5 Subtask 1.4: Development of criteria for the use of an alternative emission factor

Subtask 1.4 established the criteria for assessing whether a third country, or a group of third countries may calculate an alternative emission factor for indirect emissions, instead of applying the Commission's default value, when determining indirect emissions embedded in imported goods. The work built on the screening criteria defined in Subtask 1.3 but is more focused, concentrating on the reliability of a data source for a single country rather than assessing broad applicability across multiple jurisdictions. This resulted in stricter demands on data quality, completeness, and transparency.

The assessment relied on three main criteria:

- **Geographical coverage:** Geographical coverage ensures that all relevant power plants, including large utilities and smaller operators such as household or industrial generators, are represented in the data. In countries with multiple regional grids, national emission factors must account for all grids to avoid incomplete calculations.
- **Temporal coverage:** Temporal coverage evaluates whether data encompass the entire year and are updated regularly to reflect changes in the power plant fleet, including those arising from decarbonisation policies or other developments.
- **Recentness, and transparency:** Data must be recent enough to support accurate emission factor calculations, with delayed or infrequent reporting reducing reliability.

Transparency is critical for verification and reproducibility. Methodologies must clearly describe which types and sizes of power plants are included and the fuels consumed and their breakdown. All assumptions, equations, and datasets must be documented and accessible to the Commission. Specific sub-criteria included: whether PPAs are present and how they are accounted for; whether CHP plants exist and how fuel use is split between heat and electricity; and whether the data and documentation are sufficiently accessible for review.

Applying these criteria, the Commission can specify minimum requirements for the acceptability of alternative emission factors. Requirements may include comprehensive national coverage, annual updates, full methodological documentation, and verifiable datasets. Acceptability may be structured as a decision tree to ensure consistent evaluation across countries. Subtask 1.4 therefore provided the technical foundation for granting controlled flexibility while ensuring that alternative emission factors are robust, transparent, and comparable to default values, supporting both environmental integrity and consistency in CBAM reporting.

2.6 Subtask 1.5: Drafting technical proposals for the calculation approach of indirect embedded emissions

2.6.1 Overview

Subtask 1.5 supported DG TAXUD with drafting technical proposals for the calculation approach of default emission factors of indirect emissions. The work in this Subtask built on the analyses and data compiled in previous subtasks and aimed to provide technical input to the Commission to be included in the implementing act foreseen under Article 7 of the CBAM Regulation. The Subtask also provided options for decisions that were still to be taken, following the results of Task 1, ensuring that future decisions could be informed by both the technical evidence and methodological considerations.

The scope of the Subtask included defining default emission factors for electricity from the country-of-origin grid and setting the conditions under which alternative emission factors might be proposed. The work aimed to ensure that these factors were robust, transparent, and verifiable, providing sufficient methodological detail for review by the Commission. This involved a careful assessment of the data sources and methods used, as well as consideration of specific aspects of power generation in different countries, including fuel types, plant characteristics, and trade flows of electricity.

2.6.2 Technical input related to Task 1.5

The technical input set out the rules for determining the embedded indirect emissions of electricity used in the production of goods other than electricity. Default emission factors were determined based on the average emission factor of the country-of-origin electricity grid.

In addition, two approaches were proposed for determining an alternative emission factor where use of the default was not appropriate:

- Option 1: use of a fixed data source, providing a straightforward reference; or
- Option 2: assessment based on a set of defined criteria, ensuring methodological rigour and flexibility where justified.

The assessment criteria for alternative emission factors were structured into overarching and detailed categories. Overarching criteria include data availability, which ensures that comprehensive and representative data exist at least for the key trading partners, and data quality, which ensures that the data are robust, reliable, and usable for the purposes of calculating an alternative emission factor.

Detailed criteria addressed methodological transparency and technical requirements in depth. These included:

- Transparency of methodology: the submitted methodology must document all relevant details, including which types of power plants are included or excluded, their sizes, the fuels consumed (such as coal, natural gas, oil, and renewables), and the level of detail on fuel type breakdowns (e.g., hard coal versus lignite). It must also explain how electricity imports and exports are accounted for and provide the equations and basis used to calculate the alternative emission factor.
- Data timeliness: all data submitted must be available at least annually and must not be older than two to three years relative to the year of claiming the alternative factor.
- Power purchase agreements (PPAs): to avoid double counting, all PPAs relevant for the calculation of actual emissions must be considered. This includes PPAs reported under CBAM or in other contexts, such as greenhouse gas reporting, which may rely on PPAs or energy attribute certificates (EACs). A list of PPAs and their treatment in the calculation must be provided.
- Combined heat and power (CHP): if CHP plants exist, the methodology must explain how fuel consumption is allocated between electricity and heat outputs, and this approach must be available for Commission review.
- Decarbonisation policies over time: any request to use an alternative emission factor must explain how decarbonisation developments are incorporated, including growth in renewable capacity (wind, solar, hydro), fuel price evolution, and other factors such as GDP growth that

could influence electricity emissions.

Countries or groups wishing to apply an alternative emission factor must provide the estimated emission factors, the underlying datasets, and a detailed description of the methodology. They must also demonstrate compliance with all overarching and detailed criteria. This ensures that the alternative factors are verifiable, transparent, and aligned with the regulatory objectives of CBAM, allowing the Commission to assess and approve them reliably. The subtask thus established the technical and procedural foundation for consistent calculation of indirect embedded emissions, supporting both legal and operational clarity in future CBAM implementation.

2.7 Subtask 1.6: Identification of and consultation with relevant experts to seek their views on calculation methods and default values

2.7.1 Consultation process and experts identified

Subtask 1.6 gathered the views of relevant technical experts on the options for calculating default values under CBAM, including their feasibility, accuracy, and alignment with policy objectives. The consultation process was structured to ensure broad representation of expertise across methodological, technical, regulatory, and industry perspectives. To this end, four experts were consulted: members of the IPCC Task Force on National Greenhouse Gas Inventories, electricity providers, national inventory experts, and CDM verifiers. These experts were selected for their demonstrated knowledge of greenhouse gas accounting, grid-level emissions, data quality and availability, and experience with verification and compliance processes, which are all critical to developing reliable and defensible default values.

Invitations to participate were issued in written form, including semi-structured questions and a cover letter endorsed by DG TAXUD, to ensure clarity regarding the objectives and scope of the consultation. The consultation ran from June 2025 to August 2025. Four experts were asked to provide written responses, all of whom responding, enabling careful comparison and structured analysis. The semi-structured questions and the complete set of responses are included in Annex, 1 of this report, providing transparency and traceability for the consultation process.

The consultation focused on three interlinked areas: the relative merits of the different calculation options, the practical considerations associated with data sources, and the technical implementation of these methods. The consultation also allowed experts to highlight potential challenges or limitations that may arise during implementation, ensuring that both theoretical and practical dimensions were addressed. By engaging a diverse set of experts, the consultation aimed to capture a comprehensive understanding of both the technical accuracy and the operational feasibility of the proposed default value approaches.

2.7.2 Summary of responses

The responses collected during the consultation highlighted several important insights regarding the calculation of default values and the broader implications for CBAM implementation. First, the consultation clarified that the scope of Subtask 1.6 is limited to indirect emissions associated with the production of CBAM goods, excluding electricity as a CBAM good. Some industry responses discussed electricity as a CBAM good, but these contributions were treated as contextual, helping to illuminate practical considerations for data collection and methodology design without directly influencing the scope of the Task.

Feedback on the three calculation options (as outlined in Annex IV of the CBAM Regulation) was broadly consistent. Option 1, based on the EU average emission factor, was acknowledged as simple to implement, benefiting from the stability and accessibility of data sources such as ENTSO-E and EEA. However, three of the four experts highlighted that this approach would likely underestimate the carbon intensity of electricity in exporting countries, reducing decarbonisation incentives and potentially increasing the risk of carbon leakage, as the CBAM obligations would not fully reflect actual emissions in third countries.

Option 2, which relies on the average emission factor of the country of origin, was recognised by three respondents as a practical compromise. It provides a relatively robust carbon price signal applied to imports, avoids the technical complexity of marginal factor calculations, and relies on a well-established and widely used data source, the IEA emission factors, with documented QA/QC procedures. The inventory experts noted, however, that while Option 2 provides acceptable accuracy and feasibility, its incentive for decarbonisation may be weaker than Option 3, particularly in countries undergoing rapid grid transition.

Option 3, divided into 3a (average fossil-only emission factor) and 3b (marginal generation emission factor), was highlighted by all four experts as the most precise in representing embedded emissions and aligning CBAM obligations with actual carbon intensity. Three respondents noted that Option 3a offers a practical proxy for marginal emissions while maintaining reasonable feasibility, whereas Option 3b delivers the highest fidelity but poses substantial technical and data-related challenges, requiring real-time or modelled marginal generation data that may not be available across all jurisdictions. One expert suggested that targeted case studies could be useful to evaluate the practical implementation of Option 3, particularly in countries with limited data availability or partially liberalised electricity markets.

The consultation also provided detailed guidance regarding data sources for each option. ENTSO-E and EEA databases were identified for Option 1, IEA datasets for Option 2, the IEA Electricity Information Database for Option 3a, and a combination of Ember Climate, national grid operators, and other country-specific sources for Option 3b. Experts emphasised that combining multiple sources for Option 3 may be necessary to achieve adequate coverage, but it could also introduce inconsistencies and complexity. National inventory experts recommended complementing international datasets with national energy balances and regulatory reports to improve comprehensiveness, even if these data are fragmented. Electricity providers stressed that pre-agreed methodologies and datasets would reduce reporting uncertainty and enhance compliance consistency.

Key considerations for specifying calculation approaches were also identified. Two experts recommended evaluating geographical coverage, ensuring inclusion of generation by fuel type, grid mix, and associated emissions, and paying attention to update frequency to maintain relevance over time. PPAs and CHP were highlighted as critical factors, particularly in relation to allocation rules and ensuring that emissions from combined sources are accurately reflected. Two experts emphasised that historical averages may not adequately capture rapid decarbonisation trends, with marginal emission approaches better reflecting current grid conditions.

One respondent identified misalignments between CBAM criteria and existing market practices. For PPAs, it was noted that CBAM rules are overly restrictive, focusing on direct contracts while excluding virtual PPAs or other long-term instruments such as contracts for difference. Recommendations included adjusting default values to reflect fuel mix, generation location, transmission losses, temporal matching, and additionality, particularly in deregulated or complex grid markets.

Experts also provided guidance on evaluating reliability, emphasising geographical and temporal coverage, and transparency of the methodology. Questions to consider included whether emission factors represent national, regional, or plant-level generation, the treatment of off-grid or captive power, the accounting of cross-border electricity flows, frequency of updates, and documentation of assumptions and uncertainty. National inventory experts noted that while low-quality input data could present challenges, recent inventories generally provide a reliable overview of electricity sector emissions, potentially improving upon IEA data. However, introducing cross-border dimensions may reduce data completeness.

Overall, the consultation was highly valuable in confirming the technical and practical considerations relevant to the selection of default value options. Options 3a and 3b were identified as offering the highest accuracy and potential for mitigating carbon leakage and incentivising decarbonisation, while Option 2 was recognised as a feasible compromise balancing implementation simplicity and policy objectives. Respondents stressed the importance of high-quality, transparent, and up-to-date data, careful treatment of PPAs and CHP, and alignment of methodologies with market realities. These insights directly informed the development of calculation approaches and reinforced the critical objective of maintaining environmental integrity while ensuring practical feasibility for implementation.

2.8 Task 1 Conclusions

The primary objective of this summary report was to consolidate the key outputs from Task 1 to support ongoing deliberations within the Commission on the most appropriate approach for setting default emission factors for the calculation of indirect embedded emissions from 2026 onwards for goods covered by the CBAM. The aim was to ensure that the default values selected are robust, transparent, and aligned with the environmental and policy objectives of the mechanism, while also recognising practical implementation constraints.

The qualitative assessment of options for setting the default values produced the following key insights:

- **Option 3b**, based on the marginal generation CO_2 emission factor, is deemed unsuitable primarily due to feasibility constraints. While conceptually precise and potentially highly effective in capturing emissions from the price-setting electricity source, the option requires detailed real-time or modelled data that is not consistently available for all third countries, making practical implementation highly challenging.
- **Option 1**, using the EU average electricity emission factor, is also found unsuitable. While straightforward to implement and based on readily available data, this approach provides no meaningful incentive for third countries to decarbonise their electricity grids, as it relies on an EU-based value rather than reflecting actual grid emissions in the country of origin.
- **Option 3a**, which considers the average fossil-only emission factor of the country of origin, and
- **Option 2**, the average emission factor of the country of origin, are both considered suitable. The assessment highlighted a trade-off between these two options: **Option 3a** has the strongest impact in terms of carbon leakage prevention, aligning CBAM obligations more closely with the highest-emitting sources relevant for exports, whereas **Option 2** provides the most robust incentive for third countries to decarbonise their electricity sectors by reflecting overall grid emissions and thereby offering a clear pathway to reduce CBAM obligations over time while representing the most feasible option to implement due to better data availability.

Following this qualitative assessment, calculation methods are specified for the two suitable options, based on an initial screening of a long list of potential data sources. The short list of datasets identified as most promising in terms of both availability and quality included:

- **Statistical Review of World Energy (Eurostat)Biennial Transparency Reports (BTRs).** Analysis of these sources indicates that BTRs are likely the highest quality data for calculating default emission factors. BTRs provide detailed sectoral and sub-sectoral GHG data aligned with UNFCCC reporting guidelines, allowing for precise derivation of electricity sector emissions. However, limitations exist: many countries' data are not yet published or easily accessible, some data may be presented in non-standard formats, and the most recent inventory years may not be available. As a result, despite their high quality, BTRs may not be practical for comprehensive application across all relevant countries.
- **Ember Climate datasets.** Ember data offers a practical alternative, providing broad coverage across many countries, albeit at the cost of reduced precision due to assumptions required on power plant efficiency and other modelling parameters. Its global scope makes it particularly useful in operational terms, even if the underlying methodology is based on a life-cycle approach reducing its reliability for accurately determining default values under CBAM.
- **IEA data** is also potentially highly suitable, providing standardised energy balance structures and coverage for many countries. However, these datasets were not available for review during the calculation exercise and were therefore not directly assessed in this study.

Overall, the assessment highlights that both the country-of-origin average emission factor and the fossil-only average emission factor are suitable for setting default values, with the fossil-only approach offering a stronger signal for carbon leakage prevention, while the full average emission factor is comparatively easier to implement due to broader data availability and methodological simplicity. Additionally, by reflecting all sources of electricity, the full average emission factor better acknowledges decarbonisation efforts in third countries. Each data source has distinct advantages and limitations, and resulting default emission factors may vary significantly depending on the dataset used. A fully informed decision on which dataset to use for each country, and the associated reliability of the calculated emission factors, requires further research on national power plant fleets, electricity market structures, and data availability. This ensures that the default values are both accurate and implementable, supporting the overarching goals of carbon leakage prevention, environmental integrity, and feasibility within the CBAM framework.

3. Task 2: Methodologies to report actual indirect embedded emissions

The main body of work was carried out before June 2025. All recommendations made within this section are based on the relevant legal texts that were in force before June 2025.

3.1 Introduction and objectives for Task 2

During the transitional phase of CBAM, declarants could apply actual embedded emissions for the electricity consumed to produce a CBAM product instead of default values if (Section 6 of Annex IV of the CBAM Regulation as of June 2025):

- A direct technical link existed between the installation in which the imported good was produced and the electricity generation source; or
- The operator of that installation had concluded a power purchase agreement with a producer of electricity located in a third country for an amount of electricity that was equivalent to the amount for which the use of a specific value was claimed.

Implementing this option requires clear, operational rules on the evidence that must be provided and on how such evidence should be checked and verified in practice, including for both "direct technical link" and PPA-based approaches.

The aim of Task 2 of the study was to support the development of rules on the evidence to be provided when a declarant wishes to apply actual emissions for indirect emissions, based on section 6 of Annex IV to the CBAM Regulation.

The aim of this chapter is to analyse methodologies for using actual emissions in CBAM reporting for both PPAs and direct technical links that support the CBAM in its objective to reduce the risk of carbon leakage. In addition, this chapter analyses the specific elements of evidence required to verify CBAM reports based on actual emissions.

Initially, this work was intended to draw on analyses of CBAM quarterly reports collected during the transitional phase. However, due to legal constraints the data could not be made available. Instead, the desk research was complemented with additional stakeholder engagement to support a robust analysis of methodologies for reporting actual indirect emissions. Technical Annex 2.1 outlines the analysis that could have been undertaken if the data had been available, with the aim of informing future analytical work on CBAM reporting.

The results as provided in this section are based on comprehensive desk research and exchanges with the Commission and stakeholders. A stakeholder consultation process supported the collection of information, and consideration of different perspectives and expertise. Representatives from the European Commission's CBAM expert group, including NGOs, think tanks, Member States, European industry, verifiers as well as third-country industries, were interviewed to ensure that diverse stakeholder perspectives were considered.

The Task was structured along five subtasks.

- **Subtask 2.1:** Criteria to provide evidence of a direct technical link between electricity generation and production of CBAM goods
- **Subtask 2.2:** Characteristics that should be fulfilled by power purchase agreements (PPAs)
- **Subtask 2.3:** Identification of elements of evidence and specific tasks to be carried out by verifiers in respect to indirect emissions and of specific accreditation requirements for verifiers

- **Subtask 2.4:** Consultation with relevant stakeholders and experts
- **Subtask 2.5:** Support to the Commission in drafting proposals on the application of actual embedded indirect emissions, the adoption process for the relevant implementing acts and guidance materials.

3.2 Subtask 2.1 Criteria to provide evidence of a direct technical link between electricity generation and production of CBAM goods

3.2.1 Objective and methodology

The objective of this chapter is to identify suitable criteria to evidence a direct technical link between electricity generation installations and electricity consumption for the purpose of producing CBAM goods.

The CBAM Regulation and the CBAM Implementing Regulation for the transitional period do not provide any explicit additional indications that would clarify the term “direct technical link”, neither in the articles nor in the recitals. It could be assumed that no limitations to the understanding of the concept were intended. In other words, CBAM could allow for all types of physical connections between electricity production and electricity consumption for the production of CBAM goods: through the public grid (via PPAs, see chapter 3.3) on the one hand as well as through other technical connections on the other hand. As such, it could be conceived that “direct technical link” under CBAM is to cover both “direct lines” and “private grids”.

The CBAM Implementing Regulation for the transitional period, which lays down reporting obligations for the purposes of the carbon border adjustment mechanism during the transitional period from 1 October 2023 until 31 December 2025, defines in Annex III Section D.4.3.1.: “Where electricity is received from a source with a direct technical link, and where all the relevant data is available, the emission factor of that electricity shall be determined applying sections D.4.1 or D.4.2 as appropriate.”

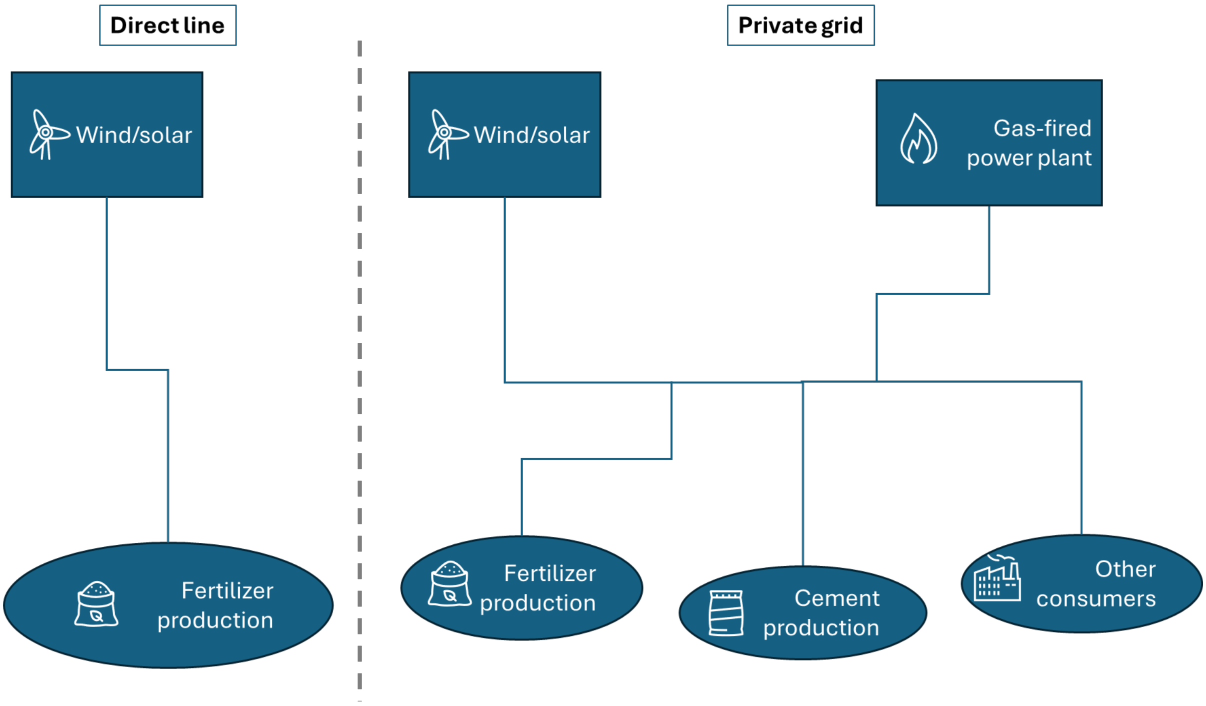
Direct line and private grid

As shown in Figure 3-1, a "direct line" explicitly refers to a unique connection between the electricity generation source and the production facility consuming electricity that is dedicated solely to the transfer of electricity and serves no other purpose, ensuring a singular, dedicated path for energy without any nodes that would connect to other producers or consumers.

In contrast, a "private grid" can encompass several connections/ nodes, with different points of electricity production and consumption being connected through interconnected lines in a defined area. For both cases, this area could be within the “battery limits” of the facility producing the CBAM goods (onsite production[11]), or could link electricity production outside the CBAM goods production facility (offsite). This distinction is important for understanding the infrastructure and operational set-ups that meet legal requirements.

[11] *Also called auto-production*

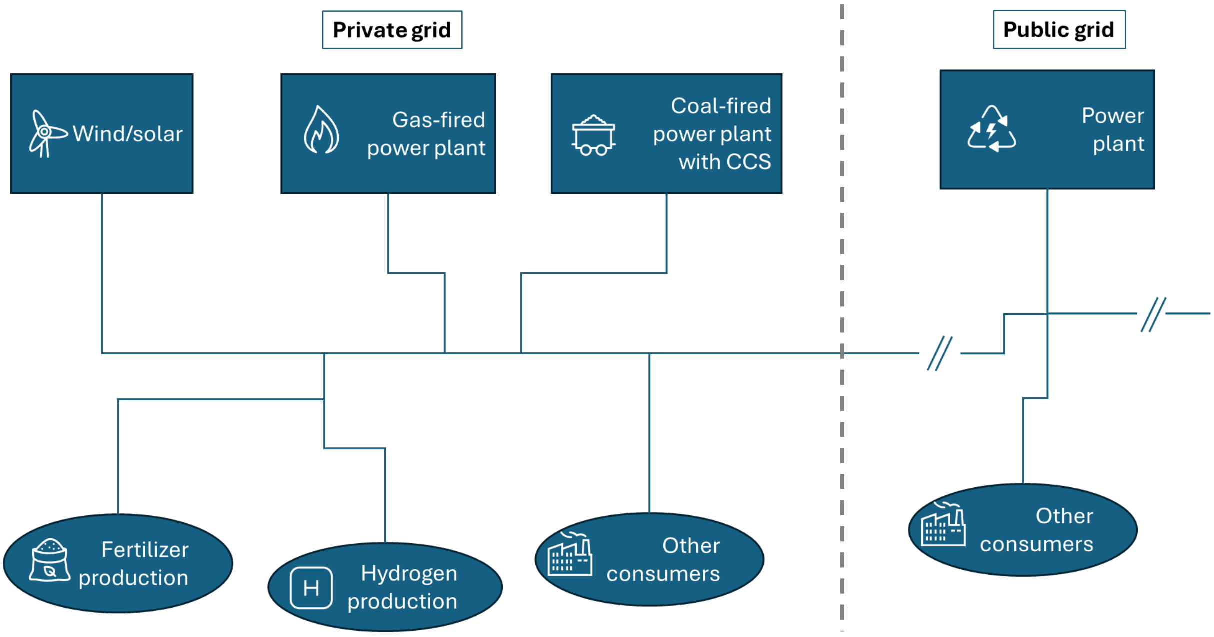
Figure 3-1 Concepts of "Direct line" vs. "Private grid"



While private grids are legally considered encapsulated systems, this does not mean that they need to be completely isolated from the public grid in a strict technical sense, as connections to the public grid are possible (see Figure 3-2) according to various definitions and applications.

Similarly, electricity production installations supplying electricity via a direct line may also be connected to the public grid.

Figure 3-2 Possible technical connection of a "Private grid" with the Public grid



The four different set-ups that could be conceived are summarised in Table 3-1. The elements of evidence and verification tasks related to the different set-ups (options) are assessed in chapter 3.4.

Table 3-1 Different options of "direct technical link" assessed for CBAM

Cases	Direct Line	Private Grid
Case 1: No other technical connection of the RE production facility	Option 1: Unique connection between the electricity generation source (onsite or offsite) and the production facility consuming electricity that is dedicated solely to the transfer of electricity and serves no other purpose	Option 2: Connection between electricity generation source (onsite or offsite) and the production facility consuming electricity that has connections/ nodes, with different points of electricity production and consumption being connected through interconnected lines in a defined area
Case 2: Additional technical connection between the generation source and a private or public grid	Option 3: Ditto, but including an additional connection to a grid	Option 4: Ditto, but including an additional connection to a grid

3.2.2 Results

Introduction

The following assessment, related to the provision of evidence of a direct technical link, concentrates on the distinction to be made between the terms "direct line" on the one hand and a "private grid" on the other hand. These terms are the two main concepts used in other current legislation.

In Annex II (1) (47), the CBAM Implementing Regulation for the transitional period defines 'reasonable assurance' as "high but not absolute level of assurance, expressed positively in the verification opinion, as to whether the operator's report subject to verification is free from material misstatement".

Part A.2 of Annex III of CBAM Implementing Regulation for the transitional period defines monitoring principles to be applied: Completeness, consistency and comparability, transparency, accuracy, integrity of methodology, optional measures, cost-effectiveness, continuous improvement.

As part of the integrity of the methodology, CBAM Implementing Regulation for the transitional period defines: "The chosen monitoring methodology shall enable reasonable assurance of the integrity of emission data to be reported." This requires the verification body to make the relevant efforts to be able to make a positive statement that a "direct technical link" actually exists and is used for producing the CBAM goods as claimed in the operator's report. As an example, this implies that the verification body verifies that:

a) a direct technical link actually exists, and
b) the direct technical link is actually used, and the electricity quantities claimed are actually transferred via the direct technical link, and

c) the electricity quantities transferred through the direct technical link have actually been produced by the linked electricity producing facility, ensuring that these quantities have not been imported to the electricity producing facility through a grid link of that facility, and
d) fuel quantities, where applicable, have actually been consumed by the electricity producing facility, and
e) possibly further issues.

In case an electricity generation source

a) supplies part of the generated electricity to a consumer, and
b) injects part of the generated electricity into the grid, and
c) additionally extracts electricity from the public (or private) grid it is additionally connected to, to supply this to the consumer, the balancing of these electricity quantities should be done on the basis of the actually consumed electricity.

An annual net balance should not be accepted as it would not reflect the actual emissions related to the electricity consumed. The **metering concept** should ensure that all electricity flows are transparent. Under RED, Commission Delegated Regulation (EU) 2023/1184 introduces the requirement of a "smart metering system" to measure all electricity flows. This way actually consumed grid electricity and actually consumed electricity produced in the electricity generation source are the basis for the emissions calculation – a "virtual storage" of clean electricity in the grid should thus not be accepted. Other options of accounting the electricity quantities and related emissions would not reflect the actual emissions of the electricity consumed, but would balance emissions out over time, and thus reduce the emissions taken into account.

An alternative could be a separate certificate or verification statement from an independent third party (certification body or verification body) of the direct technical link and the electricity provided through it. This would require the definition of criteria for what kind of certification or verification a verifier may accept. Such criteria should ensure the same level of reliability and transparency as a verification by the verification body itself. Elements of this could include accreditation requirements, and governance and quality criteria of the related certification scheme, e.g. those established under RED for renewable fuels.

Provisions defined in CBAM

The CBAM Regulation uses the term "direct technical link" only once without definition, namely in Section 6 of Annex IV.

CBAM Implementing Regulation for the transitional period defines in Annex III Section D.4.3.1.: "Where electricity is received from a source with a direct technical link, and where all the relevant data is available, the emission factor of that electricity shall be determined applying sections D.4.1 or D.4.2 as appropriate." It does not contain any provisions further qualifying what defines a "direct technical link".

Approaches in other European legislation

Criteria for what constitutes a "direct technical link" may be identified by analogy to other EU legislation. The following tables provide an overview of similar terms and concepts in other EU legislation related to certification and/ or relevant to the electricity market:

Renewable Energy Directive (RED)

Term	Direct connection
Goal	Maintain the integrity and sustainability of renewable energy sources

Key aspects	Uses the term “direct connection”, without concrete definition. Does not exclude the possibility to have a connection to the public grid at the same time; Requirement of verification of physical connection with construction plans, smart metering, and more.

Commission Delegated Regulation (EU) 2023/1184

Term	Direct line and direct connection
Goal	Counting electricity obtained directly from an installation generating renewable electricity as fully renewable
Key aspects	Provides a definition for the term “direct line” but also uses the term “direct connection”, which is not defined. Direct line is used to describe direct connection in relation to article 3 on rules for counting electricity obtained from direct connection to an installation generating renewable electricity as fully renewable but also leaves room for what can be seen as a private grid.

Directive (EU) 2019/944 on common rules for the internal market for electricity (IMED)

Term	Direct line
Goal	Promote the establishment of direct electricity supply lines between producers, electricity supply undertakings, and customers, while ensuring that these arrangements are subject to transparent regulatory processes
Key aspects	Highlights the need for a physical connection but excludes the use of the public grid for the electricity supply. However, it leaves also the room for interpretation that would include the concept of private grids.

Provisions in other EU Member States and the UK

The concept of "direct links" and “private grid” varies across the different EU Member States where such concepts could be identified in legislation, and the UK, which has historically close affinity to the EU electricity market. The objective of this overview is to provide additional basis for the assessment of the two concepts of “direct line” and “private grid”, but not to identify how national approaches differ from the applicable EU legislation.

France: Code de l'énergie: Chapitre III : Les lignes directes (Articles L343-1 à L343-6)

Term	Direct line
Goal	Permit the construction of direct lines, which are supplementary to the public transmission and distribution networks, with the primary purpose of fulfilling contracts for electricity export or supplying a producer's facilities consuming that electricity.
Key aspects	The definition and regulation of direct lines in French law highlights the need for direct lines to serve specific contractual obligations and to comply with environmental and public service considerations.

Netherlands: Electricity Act of 1998, Article 1, paragraph 1, sub-paragraph (r)

Term	Direct line
Goal	Facilitating a direct connection between electricity producers and consumers, distinguishing between isolated and network-connected configurations, and providing tailored electricity solutions, particularly for non-household consumers.
Key aspects	One or more connections used for the transport of electricity, under specific conditions: 1. A direct line is not connected to a network or any other connection for electricity transport and links an isolated electricity production plant directly to an isolated electricity consumer, other than the electricity producer. 2. Alternatively, a direct line may be connected to a network or another connection for electricity transport, linking an electricity producer's plant, through a supplier, to one or more electricity consumers, excluding household consumers, for the purpose of meeting their electricity needs.

Spain: Ley 24/2013, de 26 de diciembre, del Sector Eléctrico (Electricity Sector Law), Article 42

Term	Direct line
Goal	Facilitating direct electrical links within the same company or business group for transmitting electricity from production to consumption.
Key aspects	Direct electrical link between an electrical power production facility and a consumer where the production facility and the consumer must be the same company or part of the same business group; they cannot be accessed by third parties. However, for renewable generation plants, this requirement does not apply.

Poland: Energy Law (ustawa z dnia 10 kwietnia 1997 r. Prawo energetyczne), Article 3(11f)

Term	Direct line
Goal	Establish a legal framework for dedicated electrical connections that enable the direct supply of electricity between specific producers, consumers, or energy companies outside the public grid.
Key aspects	Poland’s definition of direct lines allows flexible, dedicated electricity connections that support both direct consumer supply and business-to-business energy transactions, aligning national practice with broader European energy market objectives.

UK: Low Carbon Hydrogen Standard

Term	Private network

Goal	Enable a clearly identifiable, traceable, and verifiable supply of low-carbon electricity directly to hydrogen production facilities – while allowing optional integration with the national grid for security of supply.
Key aspects	The UK's Low Carbon Hydrogen Standard, which is not part of the national legislation, but a basis for granting government funding, defines a "private grid" as: A local Electricity Grid connecting electricity generators and consumers, operated by an organisation other than a Distribution Network Operator, Distribution System Operator or electricity Transmission Network System Operator, that supplies electricity to a Hydrogen Production Facility. This local Electricity Grid may or may not connect to the wider national Electricity Grid.

Similarities between these countries include viewing direct lines as dedicated connections for specific supply needs, with an emphasis on regulatory compliance across all countries. Differences lie in technical definitions, with isolated connections (including to several consumers) required in the Netherlands and supplemental or exclusive connections in France and Spain. Economically and legally, approaches range from public interest considerations in France to market integration in Poland and the Netherlands. These frameworks generally reflect national strategies in electricity distribution.

In technical terms,

- France views direct lines as supplemental to the public network, fulfilling contractual obligations like electricity export or facility supply.
- The Netherlands emphasises isolated connections, either directly serving consumers or through suppliers, highlighting direct connectivity.
- In Spain, direct lines are exclusive links between production facilities and consumers, often within the same business group, especially for renewable plants. Poland's approach allows direct lines to connect generation units directly to consumers or energy companies for internal use or to supply connected consumers, focusing on direct electricity delivery.
- The UK, in its low carbon hydrogen standard, adds another dimension with its concept of private grids under the Low Carbon Hydrogen Standard. These grids are defined as local networks that connect generators directly to consumers, such as hydrogen production facilities, and can operate independently of traditional grid operators while still allowing integration with the national grid.

Economically and legally,

- France considers environmental regulations and public interest when granting authorisations, potentially refusing if public service responsibilities conflict.
- The Netherlands separate direct lines from network connections, emphasising the direct supply chain facilitated through organised and regulated trading frameworks, allowing electricity to be directly traded between producers and consumers outside of the traditional public grid. However, this includes connections of electricity generation to several consumers, thus representing also "private grids" in the wording used in this study.
- Spain requires upfront authorisations, excluding direct lines from remuneration regimes,

restricting use to authorised users.

- Poland facilitates electricity trading and supply, with legal clarity in ownership and operational scope supporting market and consumer-focused distribution, and
- the UK highlights flexibility and integration with public grids.

In view of the understanding “direct technical link” under the CBAM Regulation, the country examples show that both the “direct line” and the “private grid” concepts are covered in different countries. It may be concluded from this overview that both concepts are relevant in different countries to different degrees. It is thus worth considering in how far both may be relevant under CBAM.

Assessment of options

When defining criteria to provide evidence of a direct technical link between electricity generation and production of CBAM goods, which then have to be verified by third parties as described in chapter 3.4, two aspects need to be considered, being technical elements on the one hand and legal aspects on the other. This allows accommodating different system set-ups while ensuring compliance with CBAM requirements.

Technical aspects

1. Physical Connectivity: A physical connection must be established between the electricity generation source and the production facility consuming such electricity. This should include infrastructure such as direct lines and private grids that connect the generation source to the production site. The connection should be verifiable through documented evidence, such as single-line diagrams and construction permits.
2. Operational Verification: Metering and monitoring systems need to be implemented at both the generation and production (consumption) sites to enable real-time tracking of electricity flows using a smart metering system. This data should be logged and stored for verification purposes, providing a clear record of energy used in production processes.
3. Network Configuration: While the infrastructure should primarily facilitate direct connectivity, it may also allow for integration with the public grid, meaning a “direct technical link” can also be possible, even if the system is not completely isolated from the public grid in the technical sense. This configuration is a common set-up, and should thus be allowed under CBAM for a “direct technical link”. The system must therefore be able to clearly monitor any electricity exchanges with the public grid.

Legal aspects

From a legal point of view, an important aspect to consider is to ensure that internal agreements or documentation exist to formally recognise the operational and legal framework governing the electricity flow between the production and consumption units, both for direct lines and for private grids. In case two different parties are involved, it needs to be ensured that clear contracts exist between these two parties.

In summary, when defining the criteria to provide evidence of a "direct technical link" under the CBAM, the primary emphasis should be on establishing both the physical and operational connectivity between electricity generation and the production of CBAM goods. This technical connectivity does not need to be limited to a direct line alone, as highlighted in the IMED on common rules for the internal market for electricity. The criteria should also encompass the concept of a private grid, allowing the capability to connect multiple electricity generation sources to multiple production facilities consuming electricity while allowing for potential integration with the public grid. The set-up should always be supported by clear technical documentation and operational protocols to allow verification. Comprehensive record-keeping should underpin this framework, ensuring transparency and accountability.

Potential electricity-specific additional CBAM requirements for direct technical links

The following potential electricity-specific[12] requirements, which could be conceived in addition to the requirements discussed above (existence of physical connection, use of the physical connection) are assessed below in view of their applicability to CBAM:

- Temporal correlation (TEMP): alignment in time between electricity generation and consumption
- Additionality (ADD): electricity generated and supplied comes from a new or otherwise incremental renewable or other electricity source
- Geographical correlation (GEO): spatial proximity or network relationship between the production and consumption site

These potential additional requirements are discussed in more detail in chapter 3.3 on PPAs. It should be noted that the concrete applicability of these criteria in the context of the CBAM Regulation should also be assessed in terms of legal coherence with the existing provisions and scheme of the Regulation. A full legal assessment is not part of this analysis.

Table 3-2 provides an overview of the relevance of these criteria in the four options of direct technical links.

Table 3-2 Relevance of requirements for a direct technical link in the four options

Cases	Direct Line	Private Grid
Case 1: No other technical connection of the RE production facility	Option 1: • TEMP: o • ADD: + • GEO: o	Option 2: • TEMP: + • ADD: + • GEO: o
Case 2: Additional technical connection between the generation source and a private or public grid	Option 3: • TEMP: + • ADD: + • GEO: o • Smart metering system to measure grid electricity use	Option 4: • TEMP: + • ADD: + • GEO: o • Smart metering system to measure grid electricity use

Legend: + fully relevant; o of limited relevance

For option 1, temporal correlation is of limited relevance since the electricity cannot be sourced from elsewhere and the physical infrastructure enforces exclusivity; thus, the risk of carbon leakage is inherently low. In all other options, alternatives to the use of the direct technical link exist, which makes temporal correlation a relevant criterion.

[12] *Electricity-specific requirements or characteristics relate to the characteristics of the electricity production rather than the technical means of delivery*

Additionality plays a relevant role in all options as use of a pre-existing or repurposed electricity generation asset does not contribute to the overall reduction of GHG emissions.

Geographical correlation is of minimal to no relevance in all options as the physical connection inherently implies geographical proximity or functional integration.

3.3 Subtask 2.2 Criteria to provide evidence of power purchase agreements (PPAs) and characteristics to be fulfilled by them under the CBAM

The CBAM regulatory framework allows for the reporting of actual indirect emissions in the case that a PPA has been concluded with a producer of electricity located in a third country for an amount of electricity that is equivalent to the amount for which the use of a specific value is claimed[13].

However, the provisions made initially by the CBAM Regulation allowed for PPAs which are reported under the CBAM to differ considerably with a view to various relevant characteristics. They can be separated into two sets, with the first set of characteristics referring to the type of contract ("contractual characteristics") and the second set of characteristics referring to the characteristics of the specific electricity which is covered under the contract (electricity-specific characteristics). These characteristics include the following:

Contractual characteristics:

- Direct/bilateral PPA vs. indirect/sleeved PPA[14]
- Physical PPA vs. virtual/financial PPA[15]
- Role of energy attribute certificates (EACs)

Electricity-specific characteristics:

- Temporal correlation
- Geographical correlation
- Additionality
- Technology differentiation[16]

The extent to which such differences could create obstacles to the smooth functioning and the attainment of the objectives of the CBAM are analysed below.

---

[13] *Annex IV to the CBAM Regulation, 6. (as of June 2025): Conditions to applying actual embedded emissions for indirect emissions: "An authorised CBAM declarant may apply actual embedded emissions [...] if it can demonstrate a direct technical link between the installation in which the imported good is produced and the electricity generation source or if the operator of that installation has concluded a power purchase agreement with a producer of electricity located in a third country for an amount of electricity that is equivalent to the amount for which the use of a specific value is claimed."*

[14] *A PPA can be concluded bilaterally between the producer of electricity and the electricity-consuming offtaker (direct/bilateral PPA), or it can be concluded via a contractual intermediary (indirect/sleeved PPA). For further information see section 3.3.2.*

[15] *A PPA can relate to the actual delivery of electricity from the producer to the offtaker (physical PPA), or it can only relate to a financial relationship between both parties (virtual/financial PPA). For further information see section 3.3.2.*

[16] *This refers to the definition of technical (minimum) requirements relating to the type of energy production which is considered eligible in the respective framework. Such requirements are imposed e.g. in the RFNBO framework and for electricity as a CBAM good, relating to the generation technologies used (e.g. renewables rather than fossil), or to maximum specific actual emission factors for the generation of the claimed electricity, respectively.*

3.3.1 Objective and methodology

Therefore, this chapter aims to explore the different characteristics that should be fulfilled by PPAs to strengthen the CBAM's goal in preventing the risk of carbon leakage and supporting decarbonisation in third countries. This chapter does this by describing the applied methodology followed by a summary of the results. The detailed analysis can be found in Annex 2.

As a first step, we provided a general analysis of relevant market mechanisms (including the risk of resource shuffling and the risk of double counting) that may give rise to risks associated with the application of PPAs under the CBAM. This analysis identified factors that should be considered when assessing the applicability and effects of PPAs in the CBAM context. In a second step, we identified potential specifications related to the contractual characteristics of PPAs that could be considered eligible under the CBAM, as well as electricity-specific characteristics. We then assessed the strengths and weaknesses of these potential specifications and requirements in terms of their ability to safeguard CBAM's environmental integrity[17] and to prevent carbon leakage. The assessment was based on a set of qualitative aspects and criteria[18] outlined below:

CBAM criteria

- **Comparable carbon cost** – Does the respective requirement ensure that goods produced in third countries are subject to the same carbon price as those produced in the EU?
- **Environmental integrity** - Mitigation of resource shuffling & carbon leakage – How does the respective requirement increase or decrease the risk of resource shuffling, and the related risk of carbon leakage?
- **Promotion of decarbonisation in third countries by promotion of decarbonised power production** - Does the respective requirement contribute to the promotion of additional decarbonised power production (e.g. by stimulating new RES investments), thereby promoting general decarbonisation?
- **Promotion of decarbonisation in third countries by providing economic advantages for efficient CBAM producers** – Does the respective requirement provide economic advantages for efficient CBAM producers, thereby promoting general decarbonisation in third countries? Does the requirement e.g. lead to reduced resource shuffling potential, which makes it more attractive for CBAM producers to focus on energy efficiency rather than on claiming low-carbon electricity supply?

Criteria on legal and on practical aspects

- **Alignment with the wording of the existing CBAM Regulation** - To what extent is the respective requirement clearly in line with the wording of the existing CBAM Regulation, and to what extent does the requirement appear to be based on a specific interpretation of the wording of the existing CBAM Regulation? Or, might it be directly or indirectly conflicting?
- **Consistency with further relevant EU legislation** – To which extent is the respective requirement consistent with the definition and application of PPAs in other relevant EU legislation, namely in the context of electricity as a CBAM good, in RFNBO Regulations and in the Battery Regulation?

---

[17] For the purpose of this assessment, environmental integrity refers to evaluating whether CBAM provides incentives for decarbonisation and prevents a net increase in global emissions. Preventing carbon leakage refers to avoiding the relocation of businesses and production due to climate policy costs.

[18] It is noted that WTO compatibility is a further relevant issue that needs to be taken into account in this context, but no assessment as such is conducted as part of this study.

- **Regulatory applicability** – How does the respective requirement influence the applicability of PPA-based claims on actual emissions in different regulatory contexts, e.g. depending on the level of market liberalisation of third countries.
- **Practical feasibility / administrative effort** – How does the respective requirement influence the feasibility and administrative effort for CBAM declarants and CBAM producers to make PPA-based claims on actual emissions? Does this e.g. require special level of expertise within either one of the respective company?
- **Deliverability & supply of electricity** – How does the respective requirement influence the extent to which one can argue that the claimed electricity with its specific attributes is actually delivered and supplied[19] to the CBAM producer, and is actually being used for the production of CBAM products?
- **Ease of verification & supervision** – To which extent does the respective requirement increase or reduce the ease for the robust verification of PPA-based claims that re being made? To which extent are the requirements verifiable?

3.3.2 Results

The results section is structured in three parts. First, it outlines the risks arising from the absence of clearly defined and robust eligibility criteria for PPAs under the CBAM. Second, it presents an overview of the final assessment of different potential specifications for contractual characteristics of PPAs. Third, it provides an overview of the final assessment of different potential specifications for electricity-specific characteristics.

Analysis of potential risks deriving from the application of PPAs in the context of the CBAM

When electricity consumers are allowed to make specific claims on "actual" electricity consumption in the context of the CBAM as a climate change policy and measure, it is crucial to assess to which extent any such claim relates to an actual contribution to this climate change policy and contributes to the overall reduction of GHG emissions, or to which extent this claim is predominantly based on so-called resource shuffling. The term "resource shuffling" refers to the reallocation of existing low-carbon electricity volumes to CBAM producers within a third country towards the EU market, with no impact on the actual decarbonisation of the grid in the third country.

The extent to which such resource shuffling could materialise strongly depends on:

- The volume of available low-carbon electricity production within the permissible (geographical) accounting limits in relation to the demand for such low-carbon electricity production; and
- the flexibility of accounting systems for CBAM producers to easily claim such low-carbon electricity volumes.

Resource shuffling can encourage increased production of CBAM goods in third countries, as reporting low indirect emissions through PPAs can significantly lower CBAM obligations compared to the carbon costs faced by production in the EU.

---

[19] *Deliverability here refers to the technical possibility that a given electricity production which is fed into the grid by a specific installation can be physically delivered to a given consumer, including geographical correlation and grid connection as well as temporal correlation. Supply refers more to the contractual relationship between production and consumption in a given electricity system.*

The use of PPAs under the CBAM also aims to contribute to global emissions reductions by incentivising decarbonisation in third countries. However, if PPAs apply flexibly without additional requirements, producers can rely on existing low-carbon electricity without investing in new renewable capacity. This risks undermining the CBAM's environmental integrity unless strong national rules apply in third countries that ensure additional low-carbon electricity demand beyond volumes claimed under the CBAM. Moreover, PPAs alone cannot ensure comparable carbon costs between EU and third-country producers. Third-country producers could reduce or eliminate reported indirect emissions through PPAs, while European producers cannot, as their indirect emissions are not directly covered by the EU ETS. They implicitly pay the carbon costs for their indirect emissions through higher electricity prices. These prices are determined by the marginal power plant which is the most expensive plant needed to meet demand at a given time, which in Europe is typically a coal or gas plant. As a result, spot market electricity prices already include the carbon costs. This means that European industries cannot avoid paying a carbon price for their consumed electricity, even when relying on a PPA, unless the grid is fully decarbonised.

Although the CBAM Regulation (as of June 2025) allows the reporting of actual indirect emissions based on PPAs, our analysis identifies the need to further specify and define eligible PPAs to safeguard environmental integrity and prevent carbon leakage. While indirect emissions play a limited role in sectors covered by the CBAM, their importance is expected to increase if the CBAM expands to additional sectors or if electrification raises indirect emissions in current CBAM sectors.

Contractual characteristics of PPAs

The following section discusses how different contractual characteristics of a PPA can contribute to fulfil CBAM's objectives and to limit the risk of resource shuffling.

Direct/bilateral PPA vs. indirect/sleeved PPA

A PPA can be concluded bilaterally between the producer of electricity and the electricity-consuming offtaker (direct/bilateral PPA), or it can be concluded via a contractual intermediary (indirect/sleeved PPA). Usually, an established electricity supplier acts as intermediary in this case. This can reduce complexity for offtakers, as utilities are experienced in managing supply through the public grid, in balancing real-time differences between production and consumption. Furthermore, suppliers are already duly accredited in the electricity market thus reducing administrative hurdles to participate in that market. The following Table 3-3 provides an overview over the characteristics and pros and cons of both direct and indirect PPAs in relation to the assessment criteria defined in section 3.3.1.

Table 3-3 Differentiation of characteristics and of pros and cons of direct vs. indirect PPAs

Criterion	Direct PPA	Indirect PPA
Comparable carbon cost	A direct PPA alone does not ensure comparable carbon costs between EU and third country producers. However, if the direct PPA specifies appropriate electricity-specific characteristics, it can serve as a tool to prove that the reported renewable electricity is additional and is actually used in the production of a CBAM good. This means that only under the mentioned conditions direct PPAs can help achieve comparable carbon costs under CBAM when used for the reporting of actual indirect emissions.	There are no relevant differences between direct and indirect PPAs for this criterion. Only when specific characteristics such as additionality and temporal correlation are ensured, indirect PPAs can help achieve comparable carbon costs under CBAM, when used for the reporting of actual indirect emissions.

<table>
<thead>
<tr><th>Criterion</th><th>Direct PPA</th><th>Indirect PPA</th></tr>
</thead>
<tbody>
<tr><td rowspan="2">Environmental Integrity: Mitigation of Resource Shuffling & Carbon Leakage</td><td colspan="2">Baseline: In the relevant markets of key trading partners that do not have a comparable carbon pricing scheme in place, there might be general high risk of resource shuffling by market participants and related incentives for carbon leakage when actual claims can be made, unless suitable further requirements are defined under the CBAM.</td></tr>
<tr><td>Direct PPAs are a stronger commitment from offtakers to a single production plant and higher administrative engagement compared to an indirect PPA.
This might reduce the risk of resource shuffling and of carbon leakage to some degree, compared to indirect PPA.</td><td>Indirect PPAs can increase options for a reduced commitment from offtakers to a single production plant compared to a direct PPA.[20] This might increase the risk of resource shuffling compared to direct PPA at least to some extent.</td></tr>
<tr><td rowspan="2">Promotion of decarbonisation in 3rd countries by promotion of decarbonised power production</td><td colspan="2">Baseline: No direct promotion, as long as existing power production capacities allow for resource shuffling</td></tr>
<tr><td>The limited practical applicability of direct PPAs results in a stronger pull effect as an indirect market incentive for creating more decarbonised power generation based on direct line connections compared to indirect PPAs. This leads to earlier benefits compared to indirect PPAs, which is an advantage.</td><td>The broader potential applicability of indirect PPAs results in a reduced pull effect as an indirect market incentive for more decarbonised power production compared to direct PPAs. This leads to later benefits compared to direct PPAs (due to increased market flexibility), which is a disadvantage.

However, when appropriate further requirements are imposed particularly with a view to additionality, the related incentives for additional RES investments could be increased by the broader applicability of indirect PPAs compared to direct PPAs. This could promote the decarbonisation of 3rd countries by promoting decarbonised power production.</td></tr>
<tr><td rowspan="2">Promotion of decarbonisation in 3rd countries by providing economic advantages for efficient CBAM producers</td><td colspan="2">Baseline: No relevant advantages for efficient CBAM producers as long as existing power production capacities allow for resource shuffling.</td></tr>
<tr><td>The generally reduced potential for resource shuffling leads to some economic market advantages for efficient CBAM producers. This leads to earlier gains compared to indirect PPAs.</td><td>The generally higher potential for resource shuffling restricts economic market advantages for CBAM producers. This leads to later gains compared to indirect PPAs, which is a disadvantage of direct PPA.</td></tr>
<tr><td>Alignment with the wording of the existing CBAM Regulation</td><td>Full alignment with the wording of the CBAM Regulation.</td><td>Liberal interpretation of the wording of the CBAM Regulation, as an indirect PPA could constitute not a “direct purchase” but an indirect purchase of electricity from an electricity producer.</td></tr>
</tbody>
</table>

[20] This risk is considered to be higher for the case of back-to-back contracts by a central intermediary compared to trilateral contracts, including a specific producer, the intermediary and the offtaker.

Criterion	Direct PPA	Indirect PPA
		However, this can be addressed to some extent by imposing a more specific requirement in order to ensure that there is a direct relationship between the electricity producer and the offtaker, meaning that all three parties (producer, offtaker, intermediary) have to be contracting parties and that the contracted production plants are clearly identified.[21]
Consistency with further EU legislation	Consistency with the requirements for electricity as a CBAM good also depends on how these requirements are ultimately specified for the definitive period.; Stricter requirement compared to EU regulation on RNBO. Stricter than the respective requirements in the Battery Regulation with respect to the contractual situation.[22]	Consistency with the requirements for electricity as a CBAM good is also depending on the final specification of requirements relating to electricity as a CBAM good for the definitive period In line with Regulation on RFNBOs (where also the delegated Regulation on RFNBOs only introduces such flexible interpretation compared to the stricter definition from the Renewable Directive (where at least trilateral contracts via an intermediary are considered eligible). Stricter than the respective requirements in the Battery Regulation with respect to the contractual situation.[23]
Regulatory Applicability	Regulatory restrictions in some non-liberalised markets to conclude a direct PPA.	Particularly applicable in liberalised markets, but in principle also applicable in regulated / non-liberalised markets[24].
Practical Feasibility / Administrative effort	Feasible particularly for large offtakers with sufficient management resources to deal with the complexity of a direct PPA.	Reduces complexity and risk for the offtaker by using utilities as service providers compared to direct PPAs. This might be of particular benefit for small and medium enterprises (SMEs).
Deliverability & supply of electricity	No relevant differences.	
Ease of verification & supervision	Lower complexity for the verification of contractual specifications and the fulfilment of the contract	Increased complexity for the verification of contractual specifications and the fulfilment of the contract, due to the involved intermediary particularly if there are different back-to-back contracts rather

[21] *Cf. regulations on RFNBOs.*

[22] *However, while the Battery Regulation does not require a PPA as such, it does impose strict requirements relating to the EACs to be used as accounting instrument, which is not necessarily part of a direct or an indirect PPA.*

[23] *However, while the Battery Regulation does not require a PPA as such, it does impose strict requirements relating to the EACs to be used as accounting instrument, which is not necessarily part of direct or an indirect PPA.*

[24] *In practice, such an application of a sleeved/indirect PPA accords to the provision of a green tariff from the supplier to the consumer, being based on the supply from predefined power production plants.*

Criterion	Direct PPA	Indirect PPA
		than a single trilateral contract, and the potential increase of involved power production plants per offtaker (unless clearly restricted by appropriate regulation).

Direct PPAs offer slight advantages over indirect PPAs in terms of environmental integrity, decarbonisation incentives, and alignment with the wording of the CBAM Regulation, while indirect PPAs require a more liberal interpretation. However, these differences are minor compared to the broader risks PPAs pose for the CBAM objective (carbon leakage protection), particularly given strong financial incentives to circumvent the CBAM's intention to create a strong bilateral commitment and attribution when indirect PPAs are applicable. Concerns remain regarding the feasibility of direct PPAs for small enterprises and in non-liberalised power markets. Clarifying that an admissibility of indirect (sleeved) PPAs applies only to trilateral contracts could improve regulatory alignment, limit resource shuffling, and enhance verifiability.

Physical PPA vs virtual/financial PPA

A PPA can relate to the actual delivery of electricity from the producer to the offtaker (physical PPA), or it can only relate to a financial relationship between both parties (virtual/financial PPA). Usually, PPAs are structured like a bilateral contract for difference to settle the difference between an agreed strike price and the variable market price of electricity, thus ensuring for both the producer and the offtaker financial predictability.[25]

Table 3-4 Differentiation of characteristics and of pros and cons of physical vs. virtual PPAs

Criterion	Physical PPA	Virtual PPA (combined with EACs[26])
Comparable carbon cost	A physical PPA alone does not ensure comparable carbon costs between EU and third country producers. However, if the direct PPA ensures appropriate electricity-specific characteristics, it can serve as a tool to proof that the reported renewable electricity is actually used in the production of a CBAM good. This means that only under the mentioned conditions direct PPAs can help achieve comparable carbon costs under CBAM when used for the reporting of actual indirect emissions.	A virtual PPA (combined with EAC) alone does not lead to comparable carbon costs. In contrast to the physical PPA, a virtual PPA does not require a physical connection between the producer and the offtaker which means that renewable electricity that is claimed via a virtual PPA can be claimed without the technical requirement in place for the claimed electricity to actually flow. However, when specific characteristics such as additionality, temporal and geographical correlation are ensured, virtual PPAs can help achieve comparable carbon costs under CBAM, when used for the reporting of actual indirect emissions.
Environmental Integrity: Mitigation of	Baseline: For relevant markets general high risk of resource shuffling by market participants and related incentives for carbon leakage when actual claims can be made, unless suitable further requirements are defined under the CBAM.	

[25] https://longevity-power.com/insights/physical-and-virtual-ppas-key-differences-and-risks/

[26] *Energy Attribute Certificates are established in order to facilitate the trading and documentation of energy production attributes and the allocation of these attributes to specific consumers.*

Criterion	Physical PPA	Virtual PPA (combined with EACs[26])
Resource Shuffling & Carbon Leakage	Requiring contracting parties to manage technical complexity of electricity supply, and acknowledging that physical PPAs might not be applicable in regulated markets limits the practical potential for applying PPAs. This practically reduces this risk of resource shuffling and carbon leakage compared to virtual PPAs. The support of sustainable development and prevention of carbon leakage could be enhanced if suitable further requirements apply (e.g. RES additionality). At least, any potential influence of the CBAM on the given electricity system in the producing country would be safeguarded by the requirement of "grid-connection" with a pPPA compared to a vPPA.	By not requiring contracting parties to manage technical complexity of electricity supply, and allowing for a broader application of PPAs also in regulated markets, this risk is increased compared to physical PPAs. The support of sustainable development and prevention of carbon leakage could be enhanced if suitable further requirements apply (e.g., RES additionality).
Promotion of decarbonisation in 3rd countries by promotion of decarbonised power production	Baseline: No direct promotion, as long as existing power production capacities allow for resource shuffling.	
	The limitations on practical applicability of pPPAs result in a stronger pull effect as indirect market incentive for more decarbonised power production compared to vPPAs. This leads to earlier benefits compared to virtual PPAs, which is an advantage	The broader potential applicability of vPPAs result in a reduced pull effect as indirect market incentive for more decarbonised power production compared to pPPAs. This leads to later benefits compared to pPPAs (due to increased market flexibility and the potential application of cross-border PPAs), which is a disadvantage. However, when appropriate further requirements are imposed with a view to additionality as well as geographical and temporal correlation, the related incentives for additional RES investments could be increased by the broader applicability of vPPAs compared to pPPAs. This could strongly promote the decarbonisation of 3rd countries by promoting decarbonised power production.
Promotion of decarbonisation in 3rd countries by providing economic advantages for efficient CBAM producers	Baseline: No relevant advantages for efficient CBAM producers as long as existing power production capacities allow for resource shuffling.	
	The reduced potential for resource shuffling leads to some economic market advantages for efficient CBAM producers. This leads to earlier benefits compared to virtual PPAs, which is an advantage of physical PPAs.	The higher potential for resource shuffling restricts economic market advantages for efficient CBAM producers. This leads to later benefits compared to physical PPAs, which is a disadvantage of virtual PPAs.

Criterion	Physical PPA	Virtual PPA (combined with EACs[26])
Alignment with the wording of the existing CBAM Regulation	Full alignment with the wording of the CBAM Regulation.	The wording of the CBAM Regulation refers to the requirement that the operator of the installation for the production of CBAM goods purchases electricity directly from an electricity producer, while a vPPA does not cover the electricity itself, but only claims on the related attributes. Therefore, vPPAs appear not to be in line with the wording of the CBAM Regulation.[27]
Consistency with further EU legislation	Consistent with the requirements for electricity as a CBAM good, and for EU regulation on RFNBO. Stricter than the respective requirements in the Battery Regulation with respect to the contractual situation.[28]	More liberal than the requirements for electricity as a CBAM good[29], and more than the EU regulation on RFNBO with respect to the contractual situation.[30] Stricter than the requirements in the Battery Regulation with respect to the contractual situation.[31]
Regulatory Applicability	Applicable particularly in liberalised markets with competing electricity suppliers and free choice of supply by the consumers. In regulated markets with a single monopoly supplier, the regulatory framework may not allow for physical PPAs. Physical PPA can in principle be concluded for all types of electricity generation.	Potentially enables PPA also in non-liberalised markets; but requires the existence of a robust EAC scheme applicable both for the offtaker and the producer.[32] Furthermore, the financial regulatory framework of that region needs to support the necessary derivative contracts. EACs in many markets are only established for renewable electricity production (if at all) and thus may not be available for non-RES production for the time being.
Practical Feasibility /	Requires the offtaker and the producer to be located in the same electricity market or interconnected markets and in a	Flexibility to be applied also cross-border / in different systems.

[27] However, it should be noted that the Renewables Directive does define duly cancelled guarantees of origin being the instrument of choice for demonstrating to final consumers that a given share or volume of supplied energy is considered being of renewable origin. (cf. Article 19 (1) of the Renewables Directive

[28] However, while the Battery Regulation does not require a PPA as such, it does impose strict requirements relating to the EACs to be used as mandatory accounting instrument, which is not necessarily part of a physical PPA.

[29] This assessment is depending on the final specification of requirements relating to electricity as a CBAM good for the definitive period.

[30] However, the RFNBO regulation does not require robust EACs to be used in combination with the applicable PPA, while the use of robust EACs is assumed to be mandatory in combination with the vPPA in this discussed option for implementation under the CBAM.

[31] The Battery Regulation does not require a PPA as such, but it does impose strict requirements relating to the EACs to be used as mandatory accounting instrument. Such requirements are assumed to be likewise mandatory in the discussed option of vPPAs (combined with EACs).

[32] Virtual PPAs offer greater flexibility and can be applied across a broader range of markets, as they do not rely on the physical transfer of electricity Longevity Power (2025): https://longevity-power.com/insights/physical-and-virtual-ppas-key-differences-and-risks/ See detailed explanation on difference between market structures in Task 2 Annex.

Criterion	Physical PPA	Virtual PPA (combined with EACs[26])
Administrative effort	connected grid system in order to allow for the physical delivery of the electricity.	
	Requires contracting parties to manage logistical complexities, including the regional physical infrastructure of transmission and supply management.	Requires understanding of complex energy markets and financial regulation.
	One of the contracting parties has to balance real-time differences of electricity production and consumption	Easier application for multi-national actors by central coordination.
Deliverability & supply of electricity	As the physical PPA includes the delivery of an amount of electricity from the power producer to the offtaker, a supply of the respective volume of electricity is provided[33].	Per common understanding, a financial PPA is characterised by the fact that no electricity is supplied under that contract. Therefore, no deliverability and supply of electricity is given.
Ease of verification & supervision	Verification routines for pPPA in a comparable context are being established e.g. in the context of RFNBO certification.	No evidence for established verification routines in a comparable context for vPPA.
	Verification requires special attention to the energy-related fulfilment of the contract.	Verification requires special attention to the financial fulfilment of the contract.
	Furthermore, in order to be able to exclude double counting in case that an EAC scheme is available in the country or region of the electricity production plant, the physical PPA would have to be combined with cancelled EACs representing the contracted volume and characteristics of electricity (likewise to the discussed case of vPPAs).[34]	

The generally high risks to CBAM objectives which stem from the application of PPAs in the context of the CBAM, including carbon leakage protection and environmental integrity, remain for both physical and virtual PPAs unless further requirements are specified. These risks are higher for virtual PPAs due to greater flexibility and potential for resource shuffling. While strict conditions relating to additionally as well as to geographical and temporal correlation strengthen decarbonisation incentives, a major restriction of virtual PPAs is that these do not involve physical electricity delivery and supply of the electricity from the power producer to the offtaker, and therefore conflict with the wording of the CBAM Regulation.

Clarification of the role of energy attribute certificates (EACs)

In many regions of the world, systems for energy attribute certificates (EACs) are established to facilitate the trading and documentation of energy production attributes and the allocation of these attributes to specific consumers. In the European Union, the guarantees of origin (GOs) according to

[33] *It should be noted that the exact understanding of such deliverability is subject to specifications on temporal correlation*

[34] *If no duly cancelled EACs are required in such case, there is a risk that EACs are issued for the PPA-contracted electricity volume, and subsequently traded and used independently, thus leading to double counting. The proposed approach is also applied by Voluntary Schemes in the context of RFNBO certification, e.g. CertifHy EU RFNBO Voluntary Scheme document "GHG Emissions & Sustainability", available on www.CertifHy.eu)*

Article 19 of the Renewable Directive[35] are applicable in this respect. Similar systems for EACs have been implemented on public and on private level in several regions of the world. As such, EACs do only convey accounting attributes and are therefore distinguished from PPAs in the CBAM context. The following Table 3-5 provides an overview over the characteristics and pros and cons of EACs.

Table 3-5 Overview over characteristics and over pros and cons of EACs in a book & claim approach

Criterion	EAC (in a book & claim approach)
Comparable carbon cost	The application of EAC alone does not lead to comparable carbon costs between EU and third country producers. However, when EACs demonstrate appropriate electricity-specific characteristics such as additionality[36], temporal correlation and geographical correlation, they can help achieve comparable carbon costs under the CBAM when used for the reporting of actual indirect emissions.
Environmental Integrity: Mitigation of Resource Shuffling & Carbon Leakage	For relevant markets there is a general high risk of resource shuffling by market participants and related incentives for carbon leakage when actual claims can be made, unless suitable further requirements are defined under the CBAM. By applying EACs in a highly flexible book & claim approach the high risk of resource shuffling is not limited by any means. However, EACs can avoid double counting of low-carbon energy attributes, as they convey unique claims and allow for a proper calculation of a residual mix. Therefore, they can play a vital role as soon as there is a scarcity of relevant electricity production (or production attributes) in the market.
Promotion of decarbonisation in 3rd countries by promotion of decarbonised power production	No promotion of decarbonised power production, as long as existing power production capacities allow for resource shuffling; a pull effect as indirect market incentive for more decarbonised power production would gain relevance later compared to physical PPAs (due to increased market flexibility), which is a disadvantage. However, if appropriate further requirements are defined, EACs can support the documentation of such requirements (e.g. on additionality) in order to enhance a sustainable development and prevent carbon leakage.
Promotion of decarbonisation in 3rd countries by providing economic advantages for efficient CBAM producers	No relevant advantages for efficient CBAM producers as long as existing power production capacities allow for resource shuffling: as the applicability for resource shuffling with EACs is particularly high, such economic market advantages for efficient producers lead to later gains compared to physical PPAs, which is a disadvantage of EACs.
Alignment with the wording of the	The wording of the CBAM Regulation refers to the requirement that the operator of the installation for the production of CBAM goods purchases electricity directly from an electricity producer, while EACs do not cover the electricity itself, but only

[35] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32018L2001&from=EN,%20checked%20on%2011/20/2019

[36] *Claims based on EACs without further requirements allow third-country producers of CBAM goods to lower the overall carbon price they pay on indirect emissions while this can hardly be substantiated as appropriate, taking the high probability of resource shuffling into account. European producers cannot do the same because, they implicitly pay the carbon costs for their indirect emissions through higher electricity prices, irrespective of any individual power supply contracts. These electricity prices in the EU are determined by the marginal power plant which is the most expensive plant needed to meet demand at a given time, which in Europe is typically a coal or gas plant. As a result, spot market electricity prices already include the carbon costs. This means that European industries cannot avoid paying a carbon price for their consumed electricity, even when relying on a EACs unless the entire electricity grid is decarbonised. European producers can support grid decarbonisation by consuming additional renewable electricity for the production of their goods. Therefore, it is important that the electricity claimed by CBAM producers in third countries is also additional.*

Criterion	EAC (in a book & claim approach)
existing CBAM Regulation	claims on the related attributes. Therefore, EACs appear not to be in line with the wording of the CBAM Regulation.[37]
Consistency with further EU legislation	Wider definition than for the requirements for electricity as a CBAM good[38], and more than EU Regulation on RFNBO with respect to the contractual situation.[39] Consistent with the requirements of the Battery Regulation.
Regulatory Applicability	EACs in many markets are only established for renewable electricity production (if at all) and thus may not be available for non-RES production for the time being. However, in countries and regions where EACs are not implemented for the time being, it is assumed that these can be established with reasonable effort in the short to medium term. Still, it has to be stated that in the context of the Battery Regulation, it is found that there is no evidence that there are any extra-European EAC systems compliant with the applicable quality criteria for EACs (cf. Recital (5) the CBAM Regulation[40]). If this assessment is also applied in the context of the CBAM, no EAC-based claim would be possible for the time being.
Practical Feasibility / Administrative effort	Applicable with very low administrative effort, as the book & claim approach applies independent from technical requirements and restrictions. EACs have the potential to be applied also cross-border / in different systems, unless this is restricted by other requirements. Easy application for multi-national actors by central coordination.
Deliverability & supply of electricity	Unless restricted by a separate requirement for a “bundled” use, EACs are characterised by the fact that only attributes rather than electricity are conveyed. Therefore, no deliverability and supply of electricity is documented.
Ease of verification & supervision	EACs allow for a standardised and robust verification approach on the conveyed attributes and allow for a robust calculation of a residual mix. However, any requirement on the actual supply of electricity from the power producer to the offtaker (e.g. in the context of a bundled application) has to be verified in parallel.

A flexible use of EACs under a book-and-claim approach does not limit the high risk of resource shuffling, thereby posing a serious risk to CBAM’s objectives and overall integrity. Furthermore, EACs are not aligned with the current wording of the CBAM Regulation, which explicitly requires electricity to be purchased from the producer. While EACs therefore cannot serve as a stand-alone accounting tool, they have the potential to play an important supplementary role in a bundled approach by avoiding double counting, enabling residual mix calculations, and supporting robust verification, provided that EACs linked to PPAs under CBAM are duly cancelled and that the actual electricity supply continues to be verified through a PPA.

[37] *On the other hand, the Renewables Directive does define duly cancelled guarantees of origin being the instrument of choice for demonstrating to final consumers that a given share or volume of supplied energy is considered being of renewable origin. (cf. Article 19 (1) of the Renewables Directive*

[38] *This assessment is depending on the final specification of requirements relating to electricity as a CBAM good for the definitive period.*

[39] *However, the RFNBO regulation does not require robust EACs to be used in combination with the applicable PPA. Thus, the potential benefits of EACs particularly with a view to avoid double counting are not tapped.*

[40] *https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13877-Batteries-for-electric-vehicles-carbon-footprint-methodology_en*

Electricity-specific characteristics

Temporal correlation

PPAs can relate to different accounting periods which are applied to ensure the consistency between the **produced** volume of electricity and the **consumed** volume of electricity. This can vary between so called real-time delivery (i.e. quarterly hours) to an annual net balancing of volumes. The CBAM Regulation (as of June 2025) does not specify the level of temporal correlation required in the context of indirect emissions. However, in the context of electricity as a CBAM good an hourly delivery from the power production plant to the Union's transmission system is required. Taking this listed relationship into account, it seems advisable to limit the period for temporal correlation to the extent which can be reasonably documented by CBAM producers. This is necessary not only to comply with good accounting practice, but also to substantiate the claim that the electricity is actually used for the production of the CBAM good. This should not be seen as an additional requirement on claiming actual emissions, but as a detailing of the existing CBAM requirements on which characteristics have to be fulfilled by a PPA to be acceptable under the CBAM.

Geographical correlation

Defining the scope of geographical correlation is a fundamental requirement to be specified to have a common understanding of from where electricity for the production of a CBAM good can be sourced, commonly applicable for all CBAM declarants.

In principle, PPAs can be concluded for electricity producers and consumers located in direct vicinity, in the same region or country, the same bidding zone (or equivalent conceptual arrangement), or for those located in different regions, countries or bidding zones and thus presumably different electricity systems. For the case of virtual/financial PPAs or the unbundled application of EACs, not even a grid connection between both parties can be taken for granted. This example shows that also the specifications on acceptable accounting instruments and contractual arrangements have practical effects on the geographical correlation. When a physical PPA is required, this obviously can only be applied within interconnected grid zones. The CBAM Regulation (as of June 2025) does not appear to clearly specify the level of geographical correlation which should be applicable under the CBAM (besides the requirements for electricity as a CBAM good itself, where technical requirements address this aspect).

The analysis suggests that there are three options to be discussed for defining geographical correlation requirements under the CBAM. The first option interprets the existing CBAM wording as requiring electricity generation and use to occur within the same third country, which would be straightforward to apply but would have very different practical effects for CBAM producers depending on country size and electricity system structure. The second option builds on the EU rules for RFNBOs by requiring consistency within a bidding zone or equivalent concept in third countries, including interconnected or offshore bidding zones. This approach could rely on established procedures for documenting geographical correlation and is technically advantageous, as bidding zones best reflect the alignment of electricity production and consumption, but its legal consistency with CBAM depends on interpretation and it would not align with CBAM rules for electricity as a good. The third option applies existing CBAM requirements for electricity as a CBAM good to electricity used in the production of other CBAM goods, including conditions on grid connection, congestion, and potentially hourly temporal correlation. This option could strengthen environmental integrity and carbon leakage prevention, but its consistency with the CBAM wording again depends on interpretation and it could create inconsistencies with rules for renewable hydrogen and ammonia. However, as the practical impacts and relative restrictiveness of the different options are expected to vary across countries and regions those cannot be fully assessed within the scope of this report.

Additionality

Given the concrete risk of resource shuffling when claiming actual emissions through PPAs, specific criteria on additionality of reported (low-carbon) electricity could help safeguard CBAM's environmental integrity and ensure the achievement of its objectives. By limiting PPAs to new plants, the volume of low-carbon electricity production from existing old plants would be excluded, thereby restricting the potential for resource shuffling. Excluding supported electricity from being claimed under the CBAM would help avoid a situation in which the expected increase in renewable (and partly nuclear) production in most relevant third countries, driven by public support schemes, is used solely to supply the production of CBAM goods (at presumably little to no additional cost for the CBAM producer), which would also constitute a form of resource shuffling. Only by combining both requirements an incentive can be provided that the risk of resource shuffling is considerably reduced, thus also leading to actual incentives for investments in further low-carbon electricity production. An additionality criterion may therefore play a vital role in supporting the general objectives of the CBAM. However, the definition and application of such criteria is not foreseen by the text of the CBAM Regulation (as of June 2025). In contrast to the discussed requirements relating to temporal and geographical correlation, they can also not be justified as being a prerequisite for claiming that the produced electricity actually has been used by the CBAM producer for the production of the CBAM goods.

Conclusion

Based on the analysis of individual aspects, several main conclusions can be drawn regarding claims of actual emissions based on individual PPAs under CBAM. The prevention of resource shuffling emerges as the most relevant framework condition for maintaining CBAM's environmental integrity, as it can increase the risk of carbon leakage while failing to create meaningful decarbonisation incentives in third countries, potentially resulting in higher global emissions.

Although the CBAM Regulation (as of June 2025) allows claims of actual indirect emissions based on PPAs, further detailed specifications on contractual characteristics and electricity-related requirements are needed to safeguard CBAM's overall integrity. In this context, stringent additionality criteria could help address existing shortcomings and, if properly defined and applied, could even result in positive effects by encouraging investment in new low-carbon electricity generation in third countries. The definition of requirements for the definitive CBAM period must ensure legal applicability and consistency with both the CBAM Regulation and WTO rules, while safeguarding CBAM's objectives. Temporal and geographical correlation requirements can be understood as specifications of existing rules to substantiate electricity use claims, whereas additionality requirements would likely need to be justified by their importance for achieving CBAM's objectives. Finally, as the relevance of indirect emissions varies significantly across sectors, the importance of detailed requirements for actual claims will increase if electricity-intensive products, such as primary aluminium, are required to cover indirect emissions under CBAM.

3.4 Subtask 2.3 Identification of elements of evidence and specific tasks to be carried out by verifiers in respect to indirect emissions and of specific accreditation requirements for verifiers

3.4.1 Objective and methodology

The objective of this chapter is to identify specific tasks to be carried out by verifiers during the verification of actual indirect embedded emissions as well as specific accreditation requirements for verifiers of actual indirect emissions.

This subtask builds on a number of methodological elements, including:

- the results achieved in the two preceding subtasks,
- literature reviews of other relevant EU legislation, notably the Renewable Energy Directive (RED) and the Emission Trading System (ETS),
- experience of the expert team in verification of similar topics, and
- the CBAM provisions in general

This approach was selected to ensure robust results while limiting the verification evidence to be provided by operators, and verification tasks to be carried out by verifiers to the necessary minimum.

3.4.2 Results

The CBAM Regulation ANNEX IV 6. provides the conditions for calculating embedded emissions for the purpose of Article 7, stating that an "*authorized CBAM declarant may apply actual embedded emissions instead of default values for the calculation referred to in Article 7(4) if it can demonstrate a direct technical link between the installation in which the imported good is produced and the electricity generation source or if the operator of that installation has concluded a power purchase agreement with a producer of electricity located in a third country for an amount of electricity that is equivalent to the amount for which the use of a specific value is claimed.*" The necessary demonstration for either condition must be provided in the form of a positive verification report with criteria as outlined below. If no positive verification report can be provided, default values must be applied.

In the following, for either condition a) direct technical link, and b) power purchase agreement, the necessary elements of evidence and the verification tasks are detailed. This chapter focuses on listing the relevant elements of evidence and verification tasks that are relevant, can be made available in general and are sufficient to allow the verifier to verify the compliance with those requirements that will ultimately be defined for CBAM.

The following Table 3-6 provides a summary of the elements of evidence identified in more detail in the subsequent sub-chapters that could be conceived for the use of actual emissions.

Table 3-6 Overview of possible elements of evidence for direct technical links as well as for PPAs

	Requirement	Type of Evidence
Direct technical link	Existence of a direct technical link	Single line diagrams, engineering designs, proofs of construction, contractual electricity supply documents
	Use of a direct technical link	Smart metering concept, meter readings
PPA	Existence of a PPA	All PPAs claimed to be used
	Compliance of PPA with requirements	No additional elements of evidence required for most options. However, indirect/sleeved PPAs and virtual/financial PPAs may require additional elements; geographical correlation may require additional elements; additionality/ financial support would require catalogue of guidelines and elements of evidence

	Use of PPA	Installed capacity, existence of electricity production site, single line diagrams, smart metering and meter readings, electricity grid-feed-in from official source Option: statement from financial auditing firm on financial flows related to annual electricity quantities claimed
Potential additional requirements	Temporal correlation	Time-stamped metering data, automated matching reports, energy management system records
	Additionality	Commissioning certificates, project timelines, PPAs
	Geographical correlation	GPS coordinates or site plans, bidding zone declarations, grid operator documentation

Elements of evidence related to a direct technical link

As described in Chapter 3.2, in line with existing legislation, independent of whether the electricity production is from renewable or non-renewable sources, the four options for a direct technical link may be distinguished for the purpose of verification. Either case does not preclude the CBAM goods production site from being connected to additional electricity infrastructure through a separate inflow/outflow of electricity.

Chapter 3.2 identifies the suggested requirements related to each of the four options individually of what constitutes a direct technical link. In the following the elements of evidence are described that are to be verified for the requirements as well as the verification tasks to be carried out by the verifiers. The combination of the two aspects of suggested requirements and how to evidence and verify them define the program of the verifier for each of the four options.

Existence of a direct technical link

First, it needs to be established that a direct technical link physically exists. To that end, evidence to be provided may consist of:

a. Single line diagrams of the consumption facility, specifying where the consuming facility is connected to the direct technical link, and
b. Single line diagrams of the electricity producing facility, specifying where the producing facility is connected to the direct technical link, and
c. Engineering designs of the direct technical link and lack of connection to a grid infrastructure (where applicable), and
d. Proof of construction of the direct technical link (e.g. dated satellite photos for above-ground facilities, documentation of construction progress, etc.)
e. Verification requirements depending on the relationship between electricity producer and CBAM good producer
    i. For producers that produce both the electricity and the CBAM good, no proof of contractual relationship is required. However, some form of written document needs to be provided (e.g. term sheet) that specifies the amount of electricity that is to be transferred between the production site and the consumption site
    ii. If a separate legal entity is producing the electricity, some form of electricity procurement contract needs to be in place.

Use of a direct technical link

Second, it must be established that the **direct technical link is actually used** and that the electricity quantities claimed are actually transferred via the direct technical link. **The following evidence** to be provided for verification may consist of :

a. Proof of installed smart metering concept, i.e. electricity metering points, at the electricity production facility and the consumption facility, including software solution required[41].
b. Relevant meter readings of smart metering installations for the specified time period.

Elements of evidence related to PPAs

As outlined in Chapter 3.3, and in accordance with existing regulations, Power Purchase Agreements (PPAs) must meet specific conditions to uphold the integrity of the CBAM. To ensure the accurate determination of the origin of energy and its indirect embedded emissions, based on Annex IV (6) of the CBAM Regulation, it must be verified that the CBAM goods producer has:

1. concluded a power purchase agreement (see section “Existence of PPAs” below),
2. with a producer of electricity located in a third country (see section “Geographical correlation” below),
3. for an amount of electricity that is equivalent to the amount for which the use of a specific value is claimed (see section “Use of PPAs” below).

Existence of PPAs

One or more PPAs may be used for electricity procurement to produce CBAM goods. Thus, all PPAs claimed to be used must be provided to the verifier.

It may be pointed out that not in all countries PPA contracts may be concluded between an electricity producer and a consumer due to withstanding local legislation. In such cases, CBAM goods producers in these markets may be precluded from applying actual embedded emissions unless there is a direct technical link.

Compliance of PPAs with potential electricity-specific additional requirements

For the conclusion of a power purchase agreement, it is required, that a PPA based on the discussions in Chapter 3.3 has been concluded.

To allow verifying the requirements of additionality, temporal and geographic correlation (where applicable), the PPA must allow to clearly identify the installations that produce the amount of electricity that is used to produce the CBAM good,

The verifier may check that the PPA fulfils the requirements defined in Chapter 3.3 for the various options.

For each of the different options for requirements on PPAs as identified in Chapter 3.3, possible elements of evidence for demonstrating compliance of PPAs with potential electricity-specific additional requirements are as listed in Table 3-7:

[41] *For REDI, the Commission Delegated Regulation (EU) 2023/1184 requires “a smart metering system that measures all electricity flows”). In DIRECTIVE (EU) 2019/944, smart metering is defined as “an electronic system that is capable of measuring electricity fed into the grid or electricity consumed from the grid, providing more information than a conventional meter, and that is capable of transmitting and receiving data for information, monitoring and control purposes, using a form of electronic communication”.*

Table 3-7: Overview of possible elements of evidence relating to different optional requirements on PPAs

	Options for requirements	Related Type of Evidence
Contractual relationship of CBAM producer and electricity producer	Only direct (bilateral) PPAs	For this option, all elements of evidence identified in chapter *Elements of evidence related to potential electricity-specific additional requirements* below could be considered relevant and sufficient (for requirements selected for CBAM).
	Also allowing for indirect (sleeved) PPAs, either implemented as • Sub-option 1: only based on trilateral contracts; or as • Sub-option 2: allowing not only trilateral contracts, but possibly also two back-to-back contracts of the intermediary	Sub-option 1: only based on trilateral contract For this sub-option, all elements of evidence identified in chapter *Elements of evidence related to potential electricity-specific additional requirements* below could be considered relevant and sufficient (for requirements selected for CBAM). Sub-option 2: allowing not only trilateral contracts, but possibly also two back-to-back contracts of the intermediary For this sub-option, all elements of evidence identified in chapter *Elements of evidence related to potential electricity-specific additional requirements* below could be considered relevant (for requirements selected for CBAM), but may need to be complemented by additional elements of evidence depending on the individual contractual set-up, and require additional checks of contractual elements and of the relation between the contracts and other elements of evidence.[42]
Contractual means for fulfilment of the PPA	Only physical PPAs	For this option, all elements of evidence identified in chapter *Elements of evidence related to potential electricity-specific additional requirements* below could be considered relevant and sufficient (for requirements selected for CBAM)
	Also allowing for virtual (financial) PPAs	Under this option, additionality, temporal and geographical correlation cannot be verified. The financial fulfilment of the PPA requires statements or certificates by financial auditing firms confirming that the bookkeeping includes financial flows that underscore the transfer of annual electricity quantities claimed.
	Also allowing for the use of unbundled EACs in a book	Under this option, none of the elements of evidence related to physical electricity flows could be considered relevant. With current EACs, temporal correlation

[42] *Back-to-back contracts need to be verified to make sure they are actually "back-to-back". The contractual details in each individual case may be different, and the contracts may be of high complexity requiring legal backgrounds for verification while verifiers typically have technical expertise.*

	Options for requirements	Related Type of Evidence
	& claim approach (theoretical option)	requirements cannot be evidenced, while additionality and geographical correlation can be evidenced by the EACs in general. Once hourly EACs are available they could also be used to evidence hourly temporal correlation.
Temporal correlation	Monthly correlation until the end of 2029, hourly correlation as of beginning of 2030	For this option, all elements of evidence identified in chapter *Elements of evidence related to potential electricity-specific additional requirements* below could be considered relevant and sufficient (for requirements selected for CBAM).
	Other options, variating varying either the length of the reference period(s), or the length of the transition period for the introduction of stricter requirements	For this option, all elements of evidence identified in chapter *Elements of evidence related to potential electricity-specific additional requirements* below are relevant and sufficient (for requirements selected for CBAM).
Geographical correlation	Electricity production plant and CBAM production site being consistently located within the same country	For this option, all elements of evidence identified in chapter *Elements of evidence related to potential electricity-specific additional requirements* below could be considered relevant and sufficient (for requirements selected for CBAM).
	Electricity production plant and CBAM production site being consistently located within the same bidding zone, or equivalent concepts (according to RFNBO regulations);	For this option, all elements of evidence identified in chapter *Elements of evidence related to potential electricity-specific additional requirements* below are relevant and sufficient (for requirements selected for CBAM). However, further elements of evidence and their assessment by the verifier are required to identify the bidding zone equivalents in the relevant third country[43]
	Within the same country, additional specifications are defined relating to interconnected bidding zones or offshore bidding zones (according to RFNBO regulations)	For this option, all elements of evidence identified in chapter *Elements of evidence related to potential electricity-specific additional requirements* below are relevant and sufficient (for requirements selected for CBAM). However, further elements of evidence and their assessment by the verifier are required to identify the bidding zone equivalents in the relevant third country

[43] Identifying the bidding zone equivalents in third countries requires a thorough assessment based on the individual situation in each third country. These assessments need to be based on reliable information from official sources. The elements of evidence depend on the individual availability of such information and documents, and cannot be listed here in a general manner. It is highly recommended to ensure that the bidding zone equivalents identified for the purpose of CBAM is fully in line with the bidding zone equivalents identified by the recognized voluntary schemes for RFNBO certification. At least for hydrogen, RFNBO certification is directly applicable to CBAM. It is suggested to establish such direct applicability also for ammonia, which is a relevant RFNBO, notably in third countries, notably as a transport vector for hydrogen imports to the EU.

	Options for requirements	Related Type of Evidence
	Real-time physical delivery from the installation producing electricity to the installation producing the CBAM good (according to requirements for electricity as a CBAM good)	For this option, all elements of evidence identified in chapter *Elements of evidence related to potential electricity-specific additional requirements* below could be considered relevant and sufficient (for requirements selected for CBAM).
Additionality	Optional requirement as described in subtask 2.2 under "additionality", building on a fixed earliest date of commissioning of the installation producing electricity or building on a maximum time of the date of commissioning of the installation producing electricity relating to the start of a PPA with the CBAM producer.	For this option, all elements of evidence identified in chapter *Elements of evidence related to potential electricity-specific additional requirements* below could be considered relevant and sufficient with respect to the age of the electricity generation installation (for requirements selected for CBAM). However, excluding financial support is a very complex matter that requires an extensive catalogue of guidelines of what is considered financial support and what isn't. Furthermore, this is a topic for legal experts specialised in state aid issues, which verifiers in general are not as they typically have engineering backgrounds. Identification of elements of evidence and verification tasks for the exclusion of financial support clearly exceed the scope of this study. Elements of evidence are required based on the individual situation.
	No additionality requirements	For this option, all elements of evidence identified in chapter *Elements of evidence related to potential electricity-specific additional requirements* below could be considered relevant and sufficient (for requirements selected for CBAM), however, elements of evidence related to the commissioning date of industrial installations including power plants are not required.
Minimum technical requirements	No option proposed	-

Use of PPAs

The following evidence could be provided for verification of the use of PPAs. This also applicable where a direct technical link is used in options 3 and 4 that include an additional connection to the public grid.

The electricity amount specified in the PPA must match the amount for which the use of a specific value is claimed. To do that, several steps are needed:

First, it needs to be established that the electricity production site in the PPA exists physically and is able to provide the amount of electricity claimed based on the PPA. To that end, evidence to be provided may consist of:

a. Data on installed electricity production capacity and corresponding information to verify claimed electricity production (e.g. local wind or radiation data, fuel purchase documentation, etc.), and
b. Evidence of the existence of the identified electricity production site (e.g. GPS coordinates, dated satellite imagery, on-site visit by verifier).

Alternatively, a positive verification statement by an accredited verifier may be used to establish that the electricity production site exists physically and is able to provide the amount of electricity claimed.

Second, it must be checked whether the electricity supplied under the contract has effectively been produced. The following could be provided for verification:

a. Single line diagrams of the electricity producing facility, specifying where the producing facility is connected to the grid, and
b. Smart metering concept, i.e. electricity metering points, at the electricity producing facility (for RED, the Commission Delegated Regulation (EU) 2023/1184 requires "a smart metering system that measures all electricity flows"), and
c. Relevant meter readings of smart metering installations for the specified time period for the electricity that is being fed into the public grid, and
d. Data of the electricity feed-in into the grid from an official source, such as the (national) grid operator or the electricity market regulator, providing independent evidence of actual electricity flows.

Third, it must be established that the quantities of electricity that have been delivered to the consumption facility are equivalent to the electricity supplied under the contract to the consumption facility. The following could be provided for verification:

a. Single line diagrams of the consuming facility, specifying where the consuming facility is connected to the grid, and
b. Smart metering concept, i.e. electricity metering points, at the consuming facility, measuring all inflows and outflows to the site, and
c. Relevant meter readings of smart metering installations for the specified time period.
d. As a complementary evidence of actual electricity flows, also in commercial terms, a statement or certificate from a financial auditing firm could be requested confirming that the bookkeeping includes financial flows that underscore the transfer of annual electricity quantities claimed. In this context, the verification of accumulated data could be used as a consistency check, if the smart metering solution cannot be verified in sufficient detail.

Elements of evidence related to potential electricity-specific additional requirements

Temporal correlation

Demonstrating temporal correlation requires adequate resolution data that shows a clear match between electricity generation and the corresponding electricity consumption over defined time intervals (e.g. monthly period or hourly period). In practice, this can be achieved through digital metering infrastructure (smart metering systems) installed at both the generation and consumption points, capable of time-stamped electricity measurements. Data should be automatically collected and stored in a secure environment. To simplify verification, the system operator or a designated third party could generate automated matching reports that demonstrate compliance with the correlation rule. This is particularly important for options with access to the public grid (Options 3 and 4), where a time-based link is necessary to distinguish renewable/ low carbon from grid-sourced electricity.

Additionality

Evidence of additionality typically relates to the commissioning date and financial structure of the renewable or low carbon electricity asset. To prove that a generation facility was built as a direct response to demand from a specific consumer (e.g. an electrolyser), stakeholders can provide commissioning certificates, project timelines, signed power purchase agreements (PPAs). The key objective is to show that the capacity is "new" and would not have been built without the consumption demand. This evidence must be verifiable and auditable, ideally stored in digital form and tied to the registration or certification of the production facility. The relevance and depth of evidence required may differ depending on whether the system is fully isolated (options 1 and 2) or grid-connected (options 2 and 4), with higher scrutiny warranted in the latter cases.

Geographical correlation

Geographical correlation (where relevant) can be demonstrated through location-specific data, such as GPS coordinates, administrative boundaries, or bidding zone designations. In practice, this means providing evidence that all assets involved in the electricity supply chain, generation and consumption, are located within a defined geographical boundary, such as a single bidding zone, regulatory region, or physically integrated site. Importantly, these boundaries must be defined in a way that ensures environmental claims remain meaningful and do not enable sourcing across structurally different electricity markets.

Annex IV of the CBAM Regulation specifies that the electricity producer must be located in a third country, meaning a non-EU/EEA country. The verifier may confirm the location of the electricity production site by reviewing the contractual partner's registration through a

a. Commercial register extract of the company producing electricity, or
b. A similar official document from an official source that evidences the entity's legal status and operations, or
c. Any other official document defining the location of the electricity production plant.

Additional verification requirements for production sites of renewable energy: Use of EACs

In case of electricity supply from a renewable electricity or in some countries low-carbon source installation, the following may be considered: To protect the integrity of the CBAM, no double claiming of the renewable attribute of the renewable electricity production should be possible. To that end, it must be ensured that certificates from a national EAC system of the electricity produced and supplied to the CBAM good production site are not being sold to the market independently. In this context, the verifier shall check that facilities fulfil the conditions as described in the following:

a. In third countries where a certification system similar to the GOs in accordance with RED Art. 19 for renewable electricity exists, the related certificates need to be issued/ purchased and cancelled/ redeemed for the electricity used for production of the CBAM good. The rationale here is that a mere „non-issuing" of such EACs is not verifiable (they could still be issued and therefore double counted at a later point in time). However, the cancellation can be proven and then verified. If a PPA is concluded, the PPA should contain provisions on the transfer and cancellation of relevant EACs.
b. If no certification system similar to the definition in RED Art. 19 exists or other legal reasons stand against the issuing and cancelling of EACs as discussed above, a self-declaration may be permissible, stating that no independent monetization of the renewable attributes has

happened or will happen for the relevant amount of electricity. The self-declaration may need to contain the same information as EAC certificates.

Further, it is to be pointed out that reporting periods for different EAC systems and the reporting periods of the CBAM are not necessarily synchronised. Therefore, not all information (e.g. all EAC cancellation statements for the relevant CBAM period) may be available at the time when the CBAM declaration is to be handed in. This may possibly warrant to allow the submission of EAC cancellation statements at a later time.

Verification tasks

In Annex II (1) (47), the CBAM Implementing Regulation for the transitional period defines 'reasonable assurance' as "high but not absolute level of assurance, expressed positively in the verification opinion, as to whether the operator's report subject to verification is free from material misstatement".

In practical terms, the verifier needs to take all necessary action to be able to make a positive statement that all claims by the CBAM goods producer are free from material misstatements. This level of assurance requires much higher verification efforts than a limited level of assurance that would only allow for a negative statement of the type: "no material misstatements have been identified".

Therefore, the verifier needs to carry out the following verification tasks; in addition, the verifier needs to check whether further verification tasks need to be carried out to allow for a positive verification statement:

a. Check the elements of evidence listed in the following chapters:
    a. Check whether the evidence is complete,
    b. check consistency of evidence between all elements of evidence available
    c. check consistency of evidence against e.g. official statistics, etc.
    d. check the author of the evidence: has it been issued by a public authority, or by any other independent body, or by the CBAM producer, etc.
    e. has the evidence been verified or certified independently,
b. On-site visit by the auditor, allowing the auditor to witness the infrastructure both at the electricity production site and at the consumption facility site.
c. This could be complemented or partly replaced by remote sensing tools such as satellite images, e.g. of power plants, electricity lines, production facilities, etc.

Where PPAs or other contracts for electricity supply are verified, the verifier checks them against the basic criteria of what constitutes a valid contract:

- The contract has at least two parties to it,
- The contract is signed by all parties, with place and date clearly identified,
- The contract is in force in the time period relevant to the production of CBAM goods (validity has not ended before or during that period, or started during or after the period),
- The duties and responsibilities of each party (PPA: seller and buyer of electricity) are clearly defined,
- An exchange of value (in general in monetary terms) is defined,
- Possibly more criteria to be checked.

It is *not* the duty of the verifier to check any potential legal issues related to the validity of the contract such as, but not limited to, violation of any law, public policy or similar in the country, mistakes in the contract with material effect, etc.

Where geographical correlation requirements are defined based on the bidding zone concept, verifiers need to identify the bidding zone equivalent in the relevant third country.

Where additionality requirements are defined that include the exclusion of financial support, verifiers would have to assess all CBAM good production activities for financial support issues. This is a very complex matter that requires an extensive catalogue of guidelines of what is considered financial support and what is not. Furthermore, this is a topic for legal experts specialized in state aid issues, which verifiers in general are not as they typically have engineering backgrounds. Identification of verification tasks for the exclusion of financial support clearly exceed the scope of this study, and in general are highly project-specific.

Accreditation requirements for verifiers

A key aspect of the CBAM implementation is the verification of embedded emissions, which must be conducted by accredited verifiers to ensure accuracy, transparency, and compliance with the CBAM regulation. Therefore, the structured accreditation system ensures that the CBAM functions effectively as a tool for preventing carbon leakage. Furthermore, the European Commission is empowered to adopt further implementing and delegated acts to refine the conditions for accreditation, oversee verifiers' performance, and establish mechanisms for mutual recognition of accredited verifiers across EU Member States.

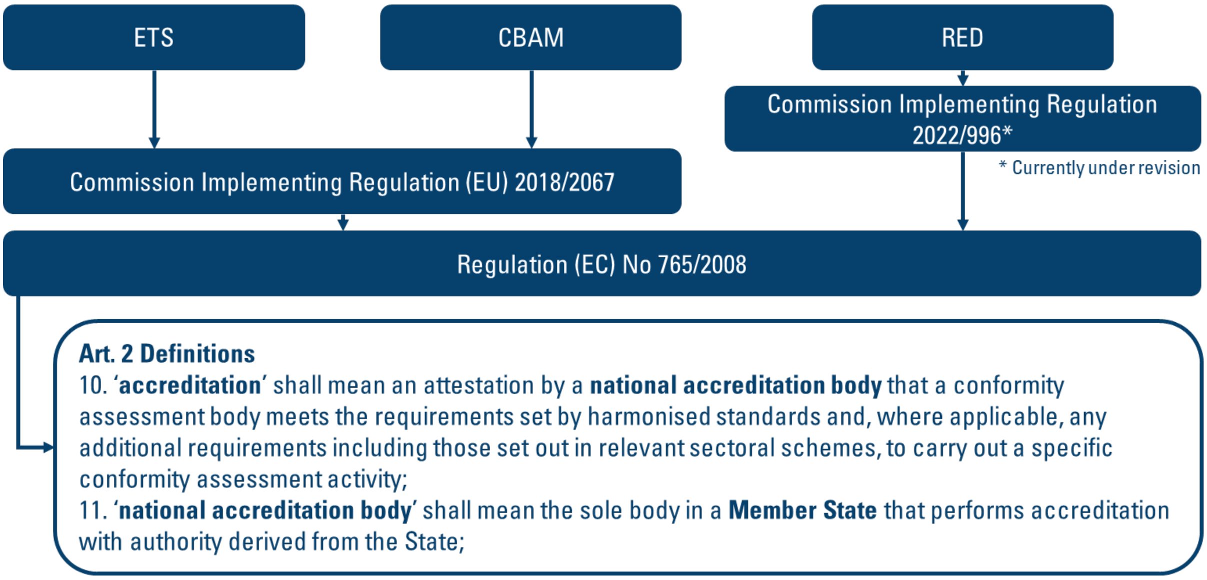
Under this framework as defined in Recital (47) and Article 18 of the CBAM Regulation, verifiers must be accredited by a national accreditation body, either in accordance with Regulation (EC) No 765/2008[44] and Commission Implementing Regulation (EU) 2018/2067[45] as shown in Figure 3-3, or based on an assessment by a national accreditation body against the verification principles referred to in Annex VI of the CBAM Regulation when performing the tasks of verification of the embedded emissions pursuant to Articles 8 and 10 of the CBAM Regulation. Explicitly, Article 18 of the CBAM Regulation states that verifiers need to be accredited for relevant activities as defined in Annex I of the Implementing Regulation (EU) 2018/2067, and article 5 of the Implementing Regulation (EU) 2018/2067 states that the relevant provisions of Regulation (EC) No 765/2008 shall apply in case no specific provisions concerning the composition of the national accreditation bodies or the activities and requirements linked to accreditation are laid down. These regulations outline the competence, independence, and procedural requirements for verifiers responsible for verifying actual embedded emissions in CBAM goods.

---

[44] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32008R0765&qid=1770987656786

[45] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32018R2067&qid=1770987690313

Figure 3-3 Relevant legislation related to accreditation for ETS, CBAM and RED



Annex I of Implementing Regulation (EU) 2018/2067 lists the scopes of accreditation for verifiers where activities 1a and 1b refer to combustion of fuels, the two activities clearly covering electricity production using combustion of fuels, while carbon capture and geological storage (CCS), which is also relevant to electricity generation, is covered in points 10 and 11. In this sense, most aspects related to electricity generation are covered by the accreditation scopes defined in Annex I. Electricity generation not based on the combustion of fuels such as solar PV, wind power, nuclear power, etc., is not covered. However, with respect to emissions accounting as for ETS or CBAM, no specific additional expertise is required for this; consequently, a specific accreditation scope for these technologies does not seem to be required.

However, the verification tasks specific to the verification of actual embedded emissions as identified in chapter Verification tasks above may require the definition of additional accreditation scopes.

Such additional accreditation scopes include most notably the verification of:

- Direct technical links
- PPAs
- Smart metering systems

In case potential additional electricity-specific requirements are selected for CBAM, the following additional accreditation scopes may be required:

- Legal expertise related to state aid/ financial support.

3.4.3 Accreditation scope related to direct technical links

Verification tasks related to direct technical links require expertise in electrical systems, including reading of single line diagrams, reading engineering design documents of electrical systems, and verifying electrical installations and metering systems.

3.4.4 Accreditation scope related to PPAs

Verification tasks related to PPAs require expertise of specific contractual issues.

As for direct technical links, expertise in electrical systems is required, including reading of single line diagrams, reading engineering design documents of electrical systems, and verifying electrical installations and metering systems.

3.4.5 Accreditation scope related to smart metering systems

Verification tasks related to smart metering systems require IT knowledge regarding smart metering installations both on the hardware and on the software side as well as on the correct implementation and use of smart metering systems. Electricity balance verification, i.e. electricity data verification, is included in scope 98 of Annex I, which in concrete terms relates to free allocation of emissions allowances under the EU ETS, but in general terms includes electricity balancing. However, this may need to be expanded for smart metering systems and related IT systems.

3.5 Subtask 2.4 Consultation with relevant stakeholders and experts

3.5.1 Overview of stakeholder approach

We conducted five stakeholder workshops with representatives from the European Commission and the CBAM Expert Group. The Expert Group brings together stakeholders from industry, non-governmental organisations (NGOs), think tanks, and Member States. We organised the workshops by stakeholder group to encourage open discussion and enable participants to share views freely within their peer groups. Specifically, we held two workshops with industry representatives, one workshop with NGOs and think tanks, and one workshop with Member State representatives. A separate workshop for European Commission officials was carried out. We complemented the workshops with targeted interviews to gather more detailed technical perspectives. We interviewed one verifier, and three industry representatives located in jurisdictions outside the EU, including South Africa, the United Arab Emirates, and Serbia.[46]

The goal of the stakeholder consultation was to gather further practical insights and evidence to inform the following areas:

- Identification of suitable criteria to provide evidence of a direct technical link;
- Identification of suitable elements that should be specified in power purchase agreements; and
- Identification of specific tasks to be carried out by verifiers in respect to indirect emissions and of specific accreditation requirements for verifiers.

The key insights from each stakeholder group are summarised in the chapter below, further details can be found in Annex 2.

3.5.2 Key Insights

Industry participants expressed broad scepticism regarding the option to report actual indirect emissions under CBAM. Many considered the current framework insufficient to ensure comparable carbon costs between EU and third-country producers and questioned whether the approach would effectively contribute to global emissions reductions. Instead, participants generally preferred relying on default emission factors.

[46] *Interview partners were approached based on the European Commission's suggestions.*

NGO and think tank representatives broadly agreed that the current framework for indirect emissions does not adequately ensure comparable carbon pricing or effectively incentivise renewable energy uptake. Several participants questioned whether PPAs represent an appropriate instrument for reporting actual indirect emissions and suggested reconsidering their role altogether.

Third-country stakeholders emphasised the need to account for local electricity market structures and regulatory conditions when designing reporting requirements. They noted that direct technical links or physical PPAs may not be feasible in certain jurisdictions due to permitting or market constraints.

Member State representatives expressed uncertainty about the overall role of PPAs in the CBAM framework and indicated that further clarity is needed before determining which instruments should be eligible, if any. The majority supported stricter rules and generally rejected virtual or financial PPAs and GOs as sufficient evidence of renewable electricity use.

The verifier emphasised the need for clear, robust, and technically verifiable criteria for demonstrating direct technical links, the use of PPAs, and the accreditation of verification bodies. They noted that definitions of direct technical links under existing frameworks, such as the Renewable Energy Directive (EU) 2018/2001 (RED I), remain broad and inconsistently applied.

4. Task 3: Identification of technical solutions to extend indirect emissions to all the CBAM goods for the definitive period

The main body of work for Task 3 was conducted between summer 2024 and summer 2025. Results presented here reference the CBAM Regulation and technical context available at that time. Following completion of the main analytical phase, Task 3 was updated in early 2026 at the Commission's request to reflect developments, including the addition of Technical Solution 5 and the latest changes to the State Aid Guidelines. All assessments and recommendations in this chapter are therefore based primarily on the pre-December 2025 legal context, with updates reflecting early 2026 adjustments.

4.1 Introduction and objectives for Task 3

Task 3 examined how the EU's current carbon leakage protection framework treated indirect emissions, and what this implied for any future extension of the CBAM's indirect emissions coverage.

CBAM currently provides only partial coverage of indirect emissions, while EU producers may also receive carbon leakage protection for indirect electricity costs through Member State Indirect Cost Compensation (ICC) under the State Aid Guidelines. Task 3 therefore focused on how indirect emissions are treated across the EU carbon leakage protection framework, what this implies for even-handed treatment between EU producers and imports, and how any extension of CBAM coverage for indirect emissions could be operationalised without creating double protection or undermining decarbonisation incentives.

Against this backdrop, Task 3 aimed to identify and assess technically robust pathways to extend CBAM coverage of indirect emissions to additional goods and sectors in the definitive period. Specifically it sought to: (i) establish a clear baseline on how indirect emissions are treated across existing EU carbon leakage protection instruments; (ii) define the policy problem, objectives, and constraints associated with scope extension; and (iii) design and compare technical solutions that could deliver scope extension while managing key constraints (notably avoiding double protection, maintaining credible decarbonisation incentives, and ensuring administrative feasibility).

Task 3 operationalised this work through a sequence of subtasks that move from baseline mapping to problem definition and solution design, and finally to assessment and stress-testing. It first mapped the existing instruments other than CBAM that address carbon leakage risk—free allocation under the EU ETS and ICC provided by Member States under the State Aid Guidelines—through a review of the evolution of the EU ETS and eligibility criteria for leakage protection, an assessment of how ICC eligibility was determined, and a compilation of evidence on ICC implementation across Member States (e.g. budgets, payments, recipients, and use of auction revenues), drawing on publicly available sources such as the State aid transparency database and national reporting.

Building on this baseline, Task 3 then defined the policy problem and objectives associated with extending CBAM obligations for indirect emissions to additional goods, taking into account core constraints. It designed and compared a set of technical solutions for scope extension—differing primarily in timing and in how they interact with ICC—and set out accompanying methods to estimate effective ICC coverage and, where relevant, calibrate phase-in or phase-out trajectories. Each solution was assessed against consistent criteria (environmental integrity, carbon leakage prevention, even-handedness, feasibility, and ease of adaptation), stress-tested under stylised implementation policy scenarios for the implementation rules on default values (Task 1) and for reporting actual emissions (Task 2), and informed by targeted stakeholder input. An additional option (Technical Solution 5) was also considered, reflecting later-stage reflections on how ICC could be adjusted alongside CBAM coverage of indirect emissions.

Task 3 was integrated by the following subtasks:

- **Subtask 3.1:** Mapping of the current carbon leakage protection measures in the EU
- **Subtask 3.2:** Problem definition and objectives setting for scope extension
- **Subtask 3.3:** Technical solutions for extending the scope of the CBAM's indirect emissions coverage
- **Subtask 3.4:** Assessment of Technical Options to expand the scope of CBAM's indirect emissions coverage
- **Subtask 3.5:** Stakeholder engagement process focused on the technical options to expand the scope of CBAM's indirect emissions.
- **Subtask 3.6:** Applicability of Technical Solutions in case of an ICC expansion of to a CBAM sector.

4.2 Subtask 3.1: Mapping of the current carbon leakage protection measures

Subtask 3.1 mapped the current carbon leakage protection measures relevant to indirect emissions by (i) setting out the policy context and evolution of measures under the EU ETS, (ii) describing the role of State Aid Guidelines in enabling Indirect Cost Compensation (ICC), and (iii) compiling evidence on how ICC is implemented in practice across Member States.

4.2.1 Overview of carbon leakage measures in place

The methodology employed to map current carbon leakage protection measures focused on two primary instruments used by the European Union to mitigate the risk of production relocating to countries with less stringent greenhouse gas (GHG) regulations: Free Allocation of Allowances and ICC.

To understand the scope and application of these measures, the approach involved a systematic review of the EU ETS evolution across its four phases, with a specific focus on the criteria for the carbon leakage list. This list is updated every five years to identify sectors at significant risk based on trade intensity and emission intensity.

The mapping of Indirect Cost Compensation was conducted by analysing the European Commission's State Aid Guidelines across two iterations (2012-2020 and the revised 2021 guidelines). The assessment of sectoral eligibility was mapped through a dual approach:

- **Quantitative Assessment**: Calculating the Indirect Carbon Leakage Indicator (ICLI), where sectors qualify if the indicator is higher than 0.15.
- **Qualitative Assessment**: Evaluating preselected sectors based on market characteristics, profit margins, abatement potential, and fuel/electricity substitutability.

The approach further involved a detailed data collection exercise across Member States to assess the application of ICC. This included gathering data on auction revenues, the total amount of aid granted, the number of recipients, and the share of auction revenues spent on indirect costs. Information was sourced from the State aid transparency database, national government websites (e.g., Germany's DEHSt), and European Commission reports.

Finally, the study mapped the interaction between existing measures and the CBAM, specifically examining the reporting obligations for indirect emissions during the transitional period (2023–2025) and payment obligations in the definitive period (starting 2026). Statistical analysis was also performed to identify potential correlations between sector size (value added and employment) and the level of compensation provided.

Further detail on the underlying evidence, figures and country/sector-level mapping is provided in the Annex 3 of this report.

4.2.2 Summary of findings on current carbon leakage protection measures

Core measures used to address carbon leakage (and how indirect emissions are treated)

Carbon leakage is addressed in the EU primarily through a combination of:

1. **Free Allocation of Allowances** (linked to the carbon leakage list), and
2. **Indirect Cost Compensation** provided by Member States via State aid to eligible electricity-intensive sectors.

The carbon leakage list is updated periodically and, for EU ETS phase 4 (2021–2030), identifies 63 sectors and sub-sectors, covering about 94% of industrial emissions; it informs access to the main protection measures. The State Aid Guidelines restrict ICC eligibility to sectors and subsectors listed in Annex I, determined via a dual approach (quantitative and qualitative), including the ICLI threshold used to identify sectors at significant risk due to indirect emission costs.

Interaction between the CBAM and indirect emissions (and why this creates complexity)

The CBAM applies a differentiated approach to indirect emissions to avoid double protection where ICC exists. During the transitional period (1 October 2023 to 31 December 2025), importers (for covered goods except electricity) reported both direct and indirect emissions; in the definitive period (starting 1 January 2026), treatment varies by sector.

In particular, iron and steel (other than agglomerated iron ore CN Code 2601 12 00), aluminium, and hydrogen are exempted from paying for indirect emissions under the CBAM (while indirect emissions reporting remains), because these sectors are eligible for ICC under the State Aid Guidelines.

By contrast, cement and fertilisers require importers to declare and pay for both direct and indirect emissions, and agglomerated iron ore is treated similarly because it does not qualify for ICC under the state aid guidelines. The report highlights that phasing out and/or aligning ICC alongside the CBAM is materially more complex than the free allocation phase-out, due to:

- Heterogeneity in ICC implementation across Member States
- Sectoral coverage differences (not all CBAM sectors are covered by ICC)
- The need to avoid double protection and associated concerns (including potential WTO compliance considerations).

Differences between Free Allocation of Allowances and ICC

Free allocation is applied consistently across the EU under harmonised rules, and focuses on direct emissions at installation boundaries, while ICC targets indirect emissions associated with electricity consumption and varies significantly across Member States (including whether a scheme exists and the level of aid granted).

The mechanisms differ in calculation (benchmarks and allocation factors for free allocation versus an ICC aid formula), and in funding (free allocation reduces allowances available for auctioning; ICC is, in principle, funded through auctioning revenues and is generally expected not to exceed 25% of those revenues without justification).

ICC implementation across the EU (coverage, scale, and key patterns)

Across the EU, ICC implementation shows substantial variation in uptake, scale, and data transparency; the key patterns identified are summarised below:

- **16 Member States** have implemented an ICC scheme for costs incurred in 2021 and subsequent years. Active schemes generally cover 2021–2030, with exceptions noted for Slovenia (ending 2024) and the Netherlands and Finland (ending 2025).[47] Member States' ICC budgets are expected, in principle, not to exceed 25% of ETS auctioning revenues, though they can be revised as market conditions change; examples include Spain increasing the total budget to EUR 8.51 billion, and Germany increasing its scheme budget to EUR 32.78 billion.
- **2022 overview (costs incurred in 2021):** total compensation was EUR 2.16 billion (down from EUR 2.38 billion in 2021), with the reduction linked (in the report) to changes in ETS guidelines (eligible sectors and emission factors) and the carbon price used for evaluation. In 2022, only two countries exceeded the 25% threshold relative to auctioning revenues (Luxembourg and Romania).
- **2023 overview (reported by 11 countries, plus Norway):** the total ICC paid out (EU countries in the table) was EUR 3.5 billion, and 1,129 installations received compensation (not fully comparable to 2022 due to different reporting coverage). The report notes a strong correlation between country economic size and total ICC granted, and it highlights that in 2023 Austria, France and Luxembourg exceeded the 25% threshold on ICC relative to auction revenues (with Luxembourg far above due to very low auction revenues in the referenced year).
- **Data fragmentation is a recurring finding.** Member States report using different channels and levels of disaggregation (e.g., State aid transparency database versus national sources), and data availability varies by year and detail, complicating cross-country comparisons.

Sector-level mapping of ICC (where support is concentrated)

Based on the sectoral mapping, the highest total ICC amounts were identified in the manufacture of basic iron and steel and of ferro-alloys, followed by manufacture of paper and paperboard, and aluminium production (with other sectors receiving lower totals; some sectors show no reported compensation).

A statistical review of potential correlations did not provide sufficient proof of a significant relationship between sector size and ICC use, with the analysis constrained by incomplete coverage, inconsistent timeframes, and inconsistent reporting methods.

Future of ICC (as framed in the mapping exercise)

The report identified several factors shaping the future of ICC, including increased resource availability linked to rising auctioning revenues, possible policy shifts and regulatory framework changes affecting the use of revenues, and potential updates to sectoral eligibility in line with future State Aid Guidelines (post-2030).

---

[47] The Netherlands extended ICC to 2027 on 3 July 2025 (https://zoek.officielebekendmakingen.nl/stcrt-2025-23428.html) and to 2028 in September 2025 (https://www.twobirds.com/en/insights/2025/netherlands/general-dutch-energy-law-updates).

At the same time, it notes that predicting the trajectory of ICC remains challenging due to variability in Member State approaches. Further detail on this mapping, including specific sectoral data, formulas for aid calibration, and detailed country-level breakdowns, can be found in Annex 3 of this report.

4.3 Subtask 3.2: Problem definition and objectives setting for scope extension

Subtask 3.2 examined the challenges associated with extending the CBAM scope to include indirect emissions for additional covered goods under the current regulation, and the potential consequences of not extending the current scope of CBAM. It situated the issue in the broader context in which the CBAM operates and explained why clear objectives are needed to assess technical solutions that aim to prevent carbon leakage and encourage emission reductions.

Further detail on this chapter can be found in Annex 3 of this report, which contains the full Task 3 report with all supporting analysis and discussion.

4.3.1 Overview of challenges and consequences

The constraints that shape (and limit) how an extension of CBAM obligations for indirect emissions could be assessed are presented below.

Nature of the problem

The challenges and consequences arising from the CBAM design and context were found to be as follows:

- **Incomplete scope of the CBAM for indirect emissions:** The CBAM's current indirect emissions coverage applied only to a portion of the sectors under the regulation, limiting the CBAM's effectiveness in comprehensively addressing carbon leakage risks and in incentivising efficiency measures in electricity consumption. The CBAM imposed financial obligations for indirect emissions on a limited set of goods (e.g., cement and fertilisers), partly to avoid "double carbon leakage protection" for sectors receiving ICC. However, this selective application reduces the CBAM's ability to prevent carbon leakage: non-EU producers in excluded sectors face weaker incentives to adopt cleaner electricity sources or invest in energy efficiency, while those EU producers in Member States with little or no ICC remain exposed to higher electricity-related carbon costs and increased vulnerability to carbon leakage risks.

- **Constraints linked to variability and controllability of indirect emissions:** Indirect emissions are heavily influenced by the carbon intensity of electricity grids, which producers cannot fully control. While producers can improve energy efficiency or shift to renewable electricity, grid decarbonisation depends on national policies and infrastructure.

- **Interaction with electrification incentives and risk of technology lock-in:** CBAM obligations projected for direct emissions during the definitive period create an incentive to decarbonise production processes, including through electrification. However, if indirect emissions are also brought under the CBAM scope alongside direct emissions, the incentive to electrify may diminish, particularly in regions where electricity is predominantly fossil-based. The report illustrates this with industrial heat supply, comparing gas boilers (direct emissions) and electric heat pumps (indirect emissions dependent on grid intensity). Under carbon-intensive electricity (e.g., coal-dominant grids), the CBAM-related costs for electricity use could make heat pumps financially less viable despite their efficiency benefits, discouraging electrification and potentially undermining broader decarbonisation efforts.

- **Variability in indirect emission costs within the EU:** A further constraint is that indirect emission costs vary significantly across Member States due to (i) variability in ICC provision, (ii) differences in electricity grid carbon intensity, and (iii) electricity price disparities. Although addressing these disparities is beyond the scope of the project, the report treats them as crucial contextual elements shaping CBAM implementation and effectiveness, and notes that technical solutions in Task 3.3 must consider how they might affect this variability (including risks of exacerbating inequities versus promoting harmonisation).

- **Broader implications for global decarbonisation (missed opportunities and risks):** Because the CBAM already discourages carbon-intensive production processes via direct emissions coverage, the report frames the currently partial indirect emissions scope as a missed opportunity to promote global decarbonisation and consistent carbon costs for electricity. It highlights that excluding indirect emissions for certain key sectors may reduce incentives for third countries to decarbonise electricity grids or promote (electric) energy efficiency (e.g., in steel and hydrogen). At the same time, it identifies risks associated with an extension, notably risk of technology lock-in and risk of resource shuffling.

Mapping of drivers

The key drivers behind the challenges of extending indirect emissions coverage are presented below:

- **Market failures - uneven global approach to carbon pricing:** A key driver is the uneven global approach to carbon pricing, particularly for electricity production. Many non-EU countries lack meaningful carbon pricing incentives for electricity, which can give industries a cost advantage over EU producers who are subject to carbon pricing for electricity. This can also discourage non-EU producers from investing in decarbonisation. The report further notes that many CBAM-covered goods are homogeneous products that compete primarily on price, making competitive outcomes especially sensitive to cost differentials.

- **Risk of resource shuffling as a market-behaviour response:** The report identifies resource shuffling as a possible challenge to the CBAM's effectiveness in promoting decarbonisation. It explains that this can occur when producers allocate lower-carbon electricity (or lower-emissions production) to EU-bound goods while maintaining higher-carbon production for other markets, potentially without reducing the overall average emissions from their production. The risk is described as particularly pronounced for electricity-related indirect emissions because electricity sources are interchangeable via grid systems. The report also describes how non-EU producers may claim renewable electricity use via power purchase agreements (PPAs), and distinguishes between virtual (financial) PPAs and physical PPAs, noting that the risk is greater in virtual PPAs due to the lack of physical linkage.

- **Constraint of "equitable treatment" relative to EU producers:** A linked driver is the concern that CBAM rules must treat importers equitably compared to EU producers while maintaining strong decarbonisation incentives. The report notes that EU producers cannot easily avoid carbon costs embedded in electricity prices due to marginal price-driven electricity markets, even with green electricity contracts (with partial exception for self-generation). This creates a potential imbalance if non-EU producers can avoid CBAM costs for indirect emissions by demonstrating renewable electricity use, which could shift production to third countries, where it could increase overall electricity demand that may then be met by additional CO_2-intensive generation. The report indicates that this may require additional rules or mechanisms to ensure non-EU producers are not unduly advantaged and to strengthen the link between CBAM and tangible global decarbonisation outcomes.

- **Regulatory challenges (including concerns about "double protection" and decentralised ICC):** The report identifies regulatory constraints associated with extending the CBAM scope, especially the risk of "double carbon leakage protection" where sectors or goods receiving ICC would also face CBAM obligations for indirect emissions, which may raise concerns. It also highlights that decentralised implementation of ICC by Member States complicates policy harmonisation, because national authorities retain discretion in scheme design and political considerations in Member States with significant electricity-intensive industries may influence the pace of progress toward a unified approach.
- **Behavioural drivers (uncertainty and delayed investment):** Uncertainty surrounding the future of the CBAM's scope and the harmonisation of indirect cost compensation can affect decision-making across industries. The report highlights behavioural inertia: EU and non-EU producers may delay investments in decarbonisation technologies due to the lack of clear and predictable regulatory signals, reinforcing carbon-intensive production, especially in sectors exempt from financial obligations for indirect emissions. It also notes that importers and downstream industries may struggle with complex reporting, and that smaller importers may lack resources to meet new compliance requirements, encouraging short-term cost management over longer-term decarbonisation strategies.
- **Interactions among drivers (constraints reinforce each other):** The report emphasises that these drivers interact: variability in ICC complicates cohesive CBAM design and can cause or reinforce internal market inequities; and uncertainty can delay investments, potentially sustaining resistance to change and slowing decarbonisation.

Impacts on different stakeholders

The impacts of a scope extension on different types of stakeholders include the following:

- **EU producers:** A scope extension could eliminate the need for ICC as a carbon leakage protection measure; the report notes that ICC can reduce incentives to transition to cleaner electricity and reduce electricity consumption, so phasing it out could strengthen incentives for efficiency measures and align with enhanced environmental effectiveness. It also notes potential exporters' challenges (CBAM does not address third country markets).
- **EU importers:** Impacts include potential planning uncertainty due to a lack of clarity about potential scope changes, supply chain adjustments (including incentivising sourcing from producers using cleaner electricity), and increased reporting requirements if indirect emissions obligations are extended to additional sectors.
- **Non-EU producers:** A scope extension would create stronger incentives to reduce electricity-related carbon intensity via energy efficiency and renewable electricity sourcing, but there can also be constraints beyond producers' control (grid decarbonisation depends on national policy). The report discusses Carbon Capture and Storage (CCS) as a potential tool for decarbonising electricity generation, while flagging practical uncertainties and barriers (e.g., costs, infrastructure needs, energy efficiency penalty, limited deployment). It also notes risks of technology lock-in (e.g., BF-BOF vs EAF in steel; SMR/coal gasification vs electrolysis in hydrogen) and describes these as cautionary scenarios.
- **EU consumers and downstream companies:** Phasing out ICC to give way for a CBAM scope extension could increase input costs and trigger supply chain adjustments. The report highlights possible cost pass-through challenges, potential competitiveness impacts for downstream industries competing with imported finished goods that use precursors produced in third countries, and a risk of carbon leakage further down the value chain.

- **EU authorities:** The transition from fragmented ICC schemes toward a more unified approach under CBAM could simplify administration and enhance policy coherence, but authorities face transition management challenges, including ensuring regulatory consistency and avoiding double protection concerns as the mechanism evolves.
- **Verifiers and accreditation bodies:** Expanding scope would increase demand for verification of electricity-related emissions to the additional sectors.

Impacts of a (non-)extension

The report concluded that if the CBAM scope is not extended to cover indirect emissions for additional sectors, several consequences are likely, limiting effectiveness in preventing carbon leakage and incentivising global decarbonisation. These include:

- **Global implications of limited decarbonisation incentives:** non-EU producers in sectors excluded from indirect emissions obligations may lack impetus to transition to cleaner electricity, limiting emissions reductions related to electricity consumption.
- **Increased carbon leakage risks:** particularly if ICC is reduced or phased out in Member States providing it, EU producers in these Member States may face higher electricity costs and lose competitiveness without the "protection" of extended CBAM obligations. In addition, producers in Member States without ICC remain exposed. The report also flags the potential under-utilisation of auction revenues if allocation to ICC crowds out decarbonisation investments eligible under the ETS Directive.
- **Continued carbon cost disparities between EU and non-EU producers:** without extension, the CBAM's objective of making carbon costs equivalent will not be achieved for electricity-related emissions; differences may grow over time as the EU accelerates electricity decarbonisation relative to trading partners, heightening carbon leakage risk.
- **Missed opportunities for policy alignment:** fragmented regulatory frameworks and underutilisation of auction revenues, with reduced ability to present a unified stance on climate action.

Any further detail on these constraints (including the full discussion of drivers, stakeholder impacts, and "no action" implications) can be found in the Annex 3 of this report.

4.3.2 Objectives setting for scope extension

This section summarised how Subtask 3.2 sets the objectives for extending the CBAM's scope to indirect emissions in more CBAM sectors. It also listed the objectives as presented in the report, which are intended to act as benchmarks for assessing and comparing technical solutions.

How the objectives were set: The report explained that the next step in the process is defining the objectives of the intervention, focusing specifically on extending the CBAM's scope to address indirect emissions in more CBAM sectors. These objectives were framed to support the assessment of technical solutions against the CBAM's intended goals within this narrower scope.

What the objectives were: The report set four objectives for scope extension, reflecting the constraints and policy needs identified in the problem definition.

1. **Driving Indirect Emission Reductions:** Extend the CBAM's scope to incentivise the use of cleaner electricity in the production of covered goods, promoting the adoption of low-carbon electricity technologies by EU and non-EU producers and achieving meaningful reductions in indirect greenhouse gas emissions.

2. **Preventing carbon leakage:** Establish mechanisms that prevent carbon leakage by imposing equivalent carbon costs for electricity-related emissions in goods produced within and outside the EU, addressing specific carbon leakage risks related to indirect emissions of imports into the EU.

3. **Avoiding concerns of double protection:** Evaluate technical solutions to avoid concerns of double protection in the context of electricity-related emissions.

4. **Minimising administrative burden:** Focus on practical solutions that expand the CBAM's coverage of indirect emissions without imposing excessive costs, complexity, or administrative challenges, ensuring implementation is efficient and manageable for stakeholders.

Any further detail on the rationale for these objectives and their link to the full problem definition (including drivers and stakeholder impacts) can be found in the Annex 3 of this report.

4.4 Subtask 3.3: Technical solutions for extending the scope of the CBAM's indirect emissions coverage

Subtask 3.3 set out four technical solutions (including sub-options) to expand the CBAM to cover indirect emissions in additional sectors and products beyond those included under the CBAM Regulation (i.e., cement, fertiliser, and iron ore within the iron and steel sector). The solutions differed mainly in how quickly the CBAM would be extended to indirect emissions and how this interacts with ICC, including whether ICC is maintained, adjusted, or phased out.

Because Technical Solutions 3 and 4 depend on the timing and pace of an ICC phase-out, Subtask 3.3 also signposted options for determining a phase-out timeline and rate, and describes methodologies that can be used to estimate ICC coverage / aid intensity more precisely (these aspects are addressed later in the chapter). The final agreed solutions were assessed in Subtask 3.4 against criteria including environmental integrity, effectiveness in preventing carbon leakage, and administrative feasibility.

Any further detail on important aspects can be found in the Annex 3 of this report.

4.4.1 Technical solutions for the scope extension

This section summarised the four Technical Solutions (TSs) presented for extending the CBAM's indirect emissions coverage, highlighting what each option does and the main design choices embedded in the sub-options.

Technical Solution 1: Immediate introduction of the CBAM

What it is: Technical Solution 1 is the most "step-change" approach: the CBAM moves from 0% to 100% coverage of indirect emissions in one step, applied simultaneously for all sectors. The solution then diverges depending on whether ICC continues.

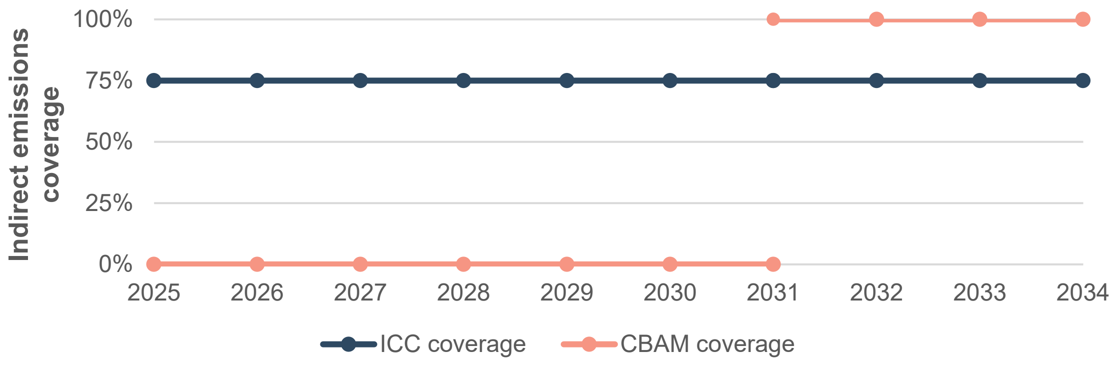
Key design choices: The central design choice is whether ICC continues alongside full CBAM coverage of indirect emissions (coexistence) or is removed immediately (clean switch).

Sub-option 1a: ICC continues (see Figure 4-1):

- The CBAM is introduced to cover **100% of indirect emissions** in one step for all sectors.
- **ICC continues**, maintaining the **current aid intensity**, which is used as a proxy for indirect emissions coverage (reflecting that the maximum aid amount also depends on efficiency benchmarks and the reduction factor).

Practical implication: this sub-option implies **coexistence** of full CBAM indirect emissions coverage with ongoing ICC.

Figure 4-1 Graphic representation of Technical Solution 1a:

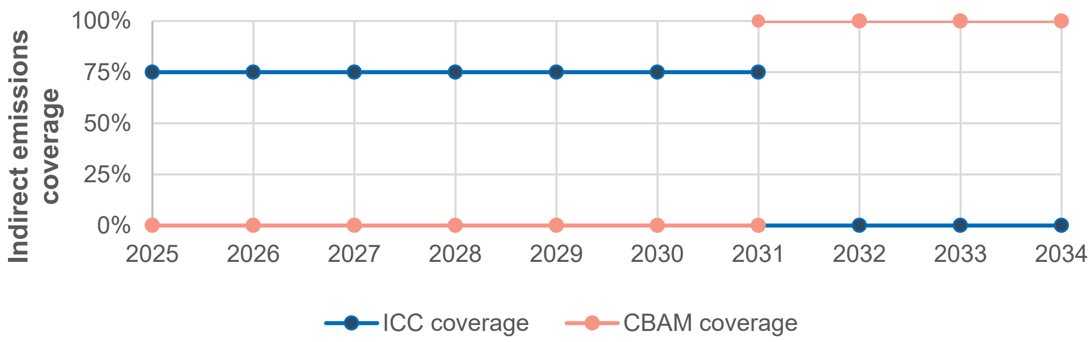


Sub-option 1b: ICC is removed (see Figure 4-2):

- The CBAM again moves to **100% indirect emissions coverage** in one step for all sectors.
- **ICC is removed immediately**: the maximum allowable aid intensity moves from its current level to **0%** in one step, occurring simultaneously with CBAM coverage reaching 100%.

Practical implication: this is a "clean switch" to CBAM coverage of indirect emissions without ICC.

Figure 4-2 Graphic representation of Technical Solution 1b:



Technical Solution 2: The CBAM phased in for the indirect emissions not covered by ICC (no changes in ICC)

What it is: Technical Solution 2 (Figure 4-3) introduces the CBAM only for the share of indirect emissions not covered by ICC, without assuming changes to the existing ICC framework. In operational terms, the CBAM is introduced at once (simultaneously across sectors) to cover the uncompensated share, using:

CBAM phase in (%) = 100 − % of emissions covered by ICC.

Key design choice: The central issue under Solution 2 is therefore *how to determine* "% of emissions covered by ICC". Three sub-options are presented:

Sub-option 2a: simplified approach using the maximum aid payable (75%):

- Uses the maximum aid payable for indirect costs (75%) as the estimate of ICC coverage.
- This implies CBAM would cover the remaining 25% of indirect emissions.

Practical implication: simplest to implement, but assumes ICC coverage is effectively at the maximum.

Sub-option 2b: more precise approach based on actual ICC paid:

- Uses a more accurate method to calculate ICC paid out in relation to indirect carbon costs, either by sector or by specific goods, depending on data availability.
- The chapter notes that ICC calculation can be done at different levels of detail (sector, subsector, product) and includes a case study elsewhere in the chapter to illustrate the approach.

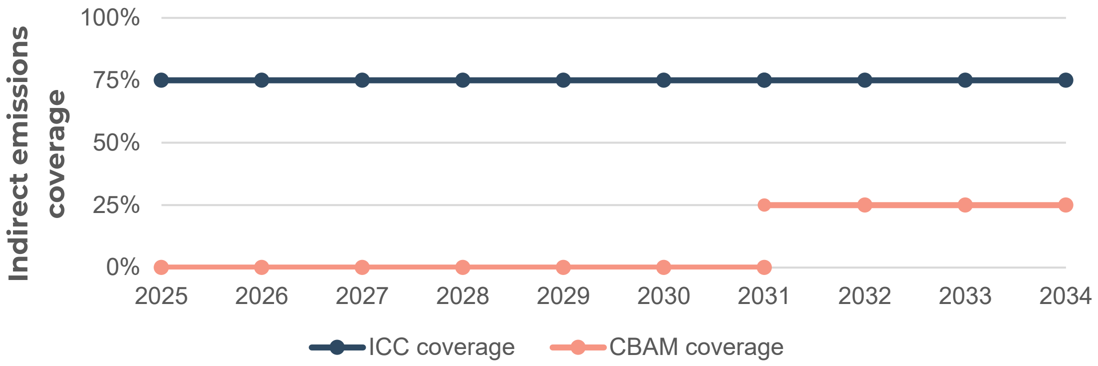
Practical implication: more accurate reflection of effective coverage, but depends on data availability and granularity.

Sub-option 2c: estimating the "real maximum aid intensity":

- Where ICC data are not feasible due to gaps, a complementary approach is proposed to estimate the real maximum aid intensity by sector.
- This provides an improved estimate of what share of *real* indirect costs can be covered by ICC compared with simply applying 75% as in 2a.

Practical implication: an intermediate approach intended to improve accuracy without relying on actual ICC paid data.

Figure 4-3 Graphic representation of Technical Solution 2



Technical Solution 3: The CBAM coverage is phased in as ICC is phased out

What it is: Technical Solution 3 starts similarly to Solution 2 by introducing the CBAM for indirect emissions not covered by ICC, but then adds a gradual phase-out of ICC, with the CBAM scope expanding correspondingly. The design intent is a progressive transition: as ICC falls, CBAM indirect emissions coverage rises, avoiding sudden changes.

Key design choices: Key choices relate to (i) how the initial "uncovered share" is estimated (e.g., using the maximum aid intensity, averages of actual compensation, or a more granular estimation approach), (ii) the phase-out timeline and rate for ICC and the corresponding phase-in trajectory for

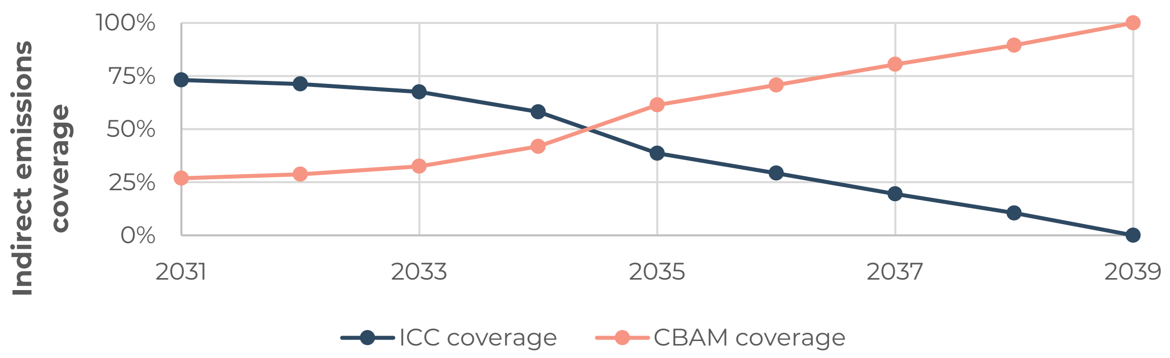
CBAM indirect emissions coverage, and (iii) whether treatment is uniform across all sectors/goods or differentiated for high-exposure sectors/goods.

Practical implications: This solution is intended to avoid discontinuities in protection by aligning a reduction in ICC with a corresponding expansion of CBAM indirect emissions coverage; however, differentiated treatment can introduce risks of double protection where ICC is retained while CBAM coverage increases, and increases data and administrative requirements.

Sub-option 3a: all goods / sectors treated equally (Figure 4-4):

- Initially, the CBAM is introduced simultaneously across all sectors for the share of indirect emissions not covered by ICC.
- After that, ICC is phased out and the CBAM's indirect emissions coverage is progressively expanded at a consistent rate across all sectors, expected to mirror the ICC phase-out rate.
- The chapter notes that the initial "uncovered share" could be calculated using an average (e.g., over three years) of actual compensation granted, and that if sufficient data are unavailable, either the 75% maximum aid intensity (implying 25% CBAM coverage initially) or a more accurate estimation approach could be used.
- Determining the phase-in rate: the CBAM phase-in rate and timeline could align with the phase-in of CBAM obligations on direct emissions, or be based on contextual factors such as anticipated EU electricity grid decarbonisation.

Figure 4-4 Graphic representation of Technical Solution 3a

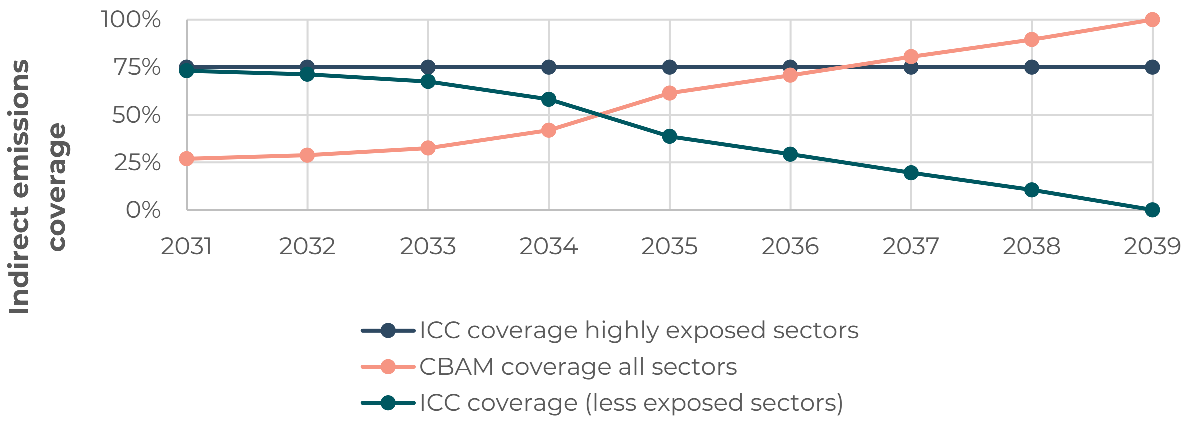


Sub-option 3b: differentiated treatment for high-exposure sectors or goods (Figure 4-5):

- Applies the same principle as 3a (CBAM phased in as ICC phased out) but includes exceptions for sectors/goods highly exposed to indirect carbon costs linked to electricity usage.
- Proposed exception types include:
    - Full exemption from ICC phase-out for high-exposure sectors/goods (retaining the current maximum aid intensity while CBAM is phased in), which would result in double protection through both ICC and CBAM.
    - Gradual ICC phase-out with a differentiated timeline (e.g., slower rate and/or different timeline) for high-exposure sectors/goods; where phase-out and phase-in remain simultaneous, there is no risk of double protection.

- The chapter notes that potential eligibility criteria could follow the methodology used in the State Aid Guidelines for 2012–2020 (quantitative and qualitative assessments such as electricity intensity, trade intensity, indirect cost impact, market structure and price sensitivity, and fuel/electricity exchangeability), while also flagging that exemptions could raise concerns regarding compliance with the EU's international obligations if they amount to double protection.
- The feasibility and practical implementation of this tiered approach are explicitly flagged as requiring further assessment.

Figure 4-5 Graphic representation of Technical Solution 3b:



Technical Solution 4: The CBAM indirect emissions scope is extended only after ICC is phased out

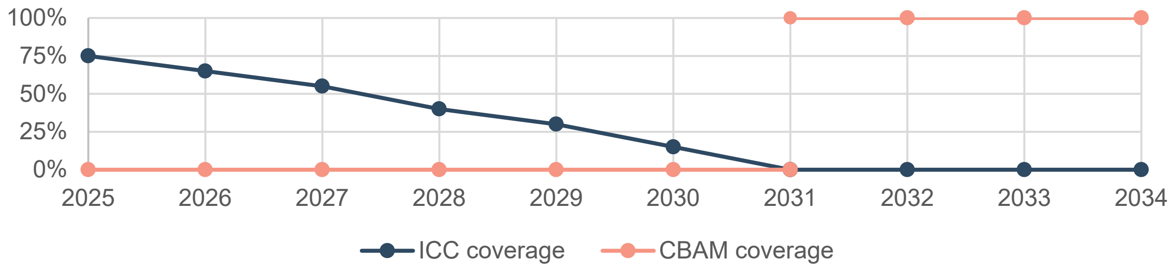
What it is: Technical Solution 4 (Figure 4-6) is included primarily for comparative purposes. It proposes that all sectors fully phase out ICC first, and only then the CBAM is extended to cover 100% of indirect emissions in a single step, simultaneously for all sectors.

Key design choices: The main design choice is the sequencing of instruments—full phase-out of ICC before any CBAM coverage of indirect emissions—and the length of the intervening period (if any) during which ICC is reduced while CBAM indirect emissions coverage remains at 0%.

Practical implications: This option creates a period of reduced carbon leakage protection for EU producers (ICC is phased out while CBAM indirect emissions coverage is not yet introduced). Because this contradicts the CBAM's core objective of preventing carbon leakage, it is unlikely to be considered a viable option and is expected to perform poorly in the Subtask 3.4 assessment.

Any further detail on important aspects (including the full presentation of each solution and sub-option) can be found in the Annex 3 of this report.

Figure 4-6 Graphic representation of Technical Solution 4:



Technical Solution 5: Adjusted ICC alongside CBAM coverage of indirect emissions

This technical solution was added at a later stage of the analysis, following further reflections during the CBAM review process. As a result, both the description and assessment of Technical Solution 5 are presented in a more concise format and do not include all the analytical steps carried out for the other Technical Solutions.

Technical Solution 5 combines the application of CBAM to indirect emissions embedded in imports with the continued use of ICC for EU producers, while adjusting the level of ICC support to account for the introduction of CBAM coverage of indirect emissions. The approach aims to price indirect emissions at the border while recalibrating domestic compensation mechanisms to reflect the interaction between the two instruments.

4.4.2 Methodological options for calculating aid intensity

This section summarised the methodological elements needed to operationalise the technical solutions, focusing on (i) how to determine an appropriate phase-out rate for ICC where required, and (ii) how to estimate aid intensity / ICC coverage to identify the uncompensated share of indirect emissions that could be covered by the CBAM. Any further detail on assumptions, formulas, examples and supporting tables/figures is provided in the Annex 3 of this report.

Determining the phase-out rate of ICC (where required by the technical solutions)

Where technical solutions require an ICC phase-out (TS 3a, TS 3b, and TS4, which link a CBAM extension to phased ICC withdrawal), three main approaches were set out:

- Linear reduction to a defined end-date: ICC is reduced at a constant rate until it reaches 0% by an agreed year.
- Alignment with the phase-out of free allocation: ICC is phased out following the same (or a coordinated) trajectory as the phase-out of free allocation for direct emissions, to support a coherent transition.
- Linking phase-out to EU electricity grid decarbonisation: ICC declines as the need for compensation reduces, using the declining fossil fuel share of electricity generation to derive a reduction factor.

The grid-decarbonisation-linked approach was illustrated using a 2025 baseline (reduction factor 1.00, corresponding to full ICC coverage (75%)) and a pathway towards 0% fossil fuel share by 2040 (reduction factor 0, implying 0% ICC). Interim values were derived based on the fossil fuel share trajectory (with illustrative milestones such as lower ICC coverage in 2030 and 2035), and linear interpolation was used between milestone years to avoid abrupt changes. The report also noted that the start date can be shifted (e.g., a later start for certain solutions), and that both the start point and curve shape are illustrative and would be finalised with the Commission.

Methodology for calculating effective aid intensity (most accurate)

This method provides the most accurate estimate because it is based on actual ICC paid out relative to actual indirect costs associated with electricity consumption. It follows three steps:

1. Estimate total indirect costs for a sector based on electricity consumption (ideally actual consumption; where unavailable, a proxy is used based on electricity intensity per tonne multiplied by output).
2. Aggregate indirect costs to EU level by summing across Member States.
3. Calculate Effective Aid Intensity (EAI) as:

EAI = actual ICC paid / total indirect costs.

An illustrative (partial) application is included in the report using Germany's aluminium sector (focusing on primary aluminium due to data constraints). The example highlights that calculated results can be sensitive to data limitations and definitional alignment (e.g., production boundaries, electricity intensity values, and whether supplementary payments are included).

Key takeaway: EAI is conceptually robust but often constrained by data availability and consistency, including limited access to actual electricity consumption, incomplete or insufficiently disaggregated production data, and difficulties mapping ICC payments to specific goods.

Methodology for calculating real maximum aid intensity (less accurate, more broadly applicable)

This method is intended for cases where **actual ICC paid** data are not available or cannot be used. It estimates the **maximum share of real indirect costs that can be compensated** under the State Aid Guidelines by comparing:

- **Eligible indirect costs** (based on efficiency benchmarks where available, or a fallback benchmark where not), and
- **Real indirect costs** (based on actual electricity intensity).

For goods with product benchmarks, the real maximum aid intensity can be expressed in simplified form as:

Real maximum aid intensity ≈ 0.75 × (benchmark efficiency / actual electricity intensity).

For goods without benchmarks, the fallback benchmark implies an upper bound around 60% (reflecting the fallback factor applied alongside the 75% ceiling). The report also notes that, in rare cases where an installation is more efficient than the benchmark, the implied maximum could exceed 75%.

This approach can be scaled from installation/product level to an EU-wide, sector-level weighted average, and can accommodate: (i) Member States that provide no ICC (aid intensity effectively zero), and (ii) Member States that apply aid intensities below the ceiling.

Key takeaway: the real maximum aid intensity approach is an intermediate option, more informative than assuming a flat 75% coverage, but less precise than EAI. It still requires reasonably robust data on production volumes and electricity intensity by product/sector, and can be limited by product-definition mismatches and insufficiently granular datasets.

4.5 Subtask 3.4: Assessment of Technical Solutions to expand the scope of CBAM's indirect emissions coverage

Subtask 3.4 provided a structured, qualitative assessment of the technical solutions developed under Subtask 3.3 to expand the CBAM's indirect emissions coverage. The chapter compared the relative strengths, weaknesses and trade-offs of each technical solution against a consistent set of criteria aligned with core CBAM policy objectives, and then tested how the solutions' performance on preventing carbon leakage might change under stylised implementation scenarios drawn from Tasks 1 and 2. Any further detail on important aspects could be found in the Annex 3 of this report.

4.5.1 Assessment criteria and methodological approach to assess technical solutions

Assessment criteria (what was assessed)

The chapter assessed technical solutions against five criteria (with associated indicators), using an ordinal scoring approach supported by a points scale:

- **A. Environmental integrity:** extent to which indirect emissions are covered by CBAM (full vs partial coverage; immediate vs phased). The extent to which emissions are covered will be a significant determinant of whether and to what degree CBAM provides incentives for decarbonisation in third countries.
- **B. Preventing carbon leakage**[48]: refers to avoiding the relocation of businesses and production to regions with less stringent GHG regulations, which could lead to a net increase in global emissions.
- **C. Even-handed approach to imports**: whether overlap is avoided where EU producers receive ICC while importers pay CBAM obligations for indirect emissions (i.e., avoiding double protection / overcompensation).
- **D. Feasibility**: simplicity of methodology (administrative burden, MRV requirements, clarity, resource needs).
- **E. Ease of adaptation**: extent of adjustment required by EU producers (ICC removal) and EU importers (new CBAM obligations for indirect emissions).

A five-step scoring scale was applied, expressed both qualitatively and numerically:

Table 4-1: Assessment scoring framework

Key: Scoring of impacts				
XX	X	O	✓	✓✓
Strongly negative	Weakly negative	No or negligible impact	Weakly positive	Strongly positive

[48] *Note: EU production for export is excluded from this project assessment (examined separately by the Commission.*

-2	-1	0	1	2

Step-by-step assessment approach (how the assessment was done)

Step 1 - Define the scope of assessed solutions. The assessment focuses on: **TS 1a, 1b, 2a, 2b, 2c, 3a, 3b, and TS 4**.

Step 2 - Apply a structured assessment matrix: An assessment matrix is used with criteria listed vertically and technical solutions horizontally. Each cell contains:

1. An ordinal score (XX, X, O, ✓, ✓✓), and
2. A short justification narrative to ensure traceability and transparency of scoring.

Step 3 - Produce solution-level summary assessments and an overall comparison: For each technical solution, results are consolidated in a matrix providing a concise summary of key pros/cons and trade-offs. It then provides an overall summary assessment to support comparison across solutions.

Step 4 - Integrate Task 1 and Task 2 implementation scenarios: This subtask recognises that performance, especially on preventing carbon leakage, depends on wider CBAM design choices from:

- **Task 1** (default emission factor setting), and
- **Task 2** (stringency of rules for claiming actual emissions, including PPA-based claims).

It defines four stylised scenarios combining:

- default values *lower vs higher* than the specific emissions of the EU's price-setting electricity source, and
- *lax vs strict* rules / eligibility for claiming actual emissions.

Step 5 - Re-assess solutions under scenarios (focused on criterion B only): The scenario analysis revisits only criterion B (preventing carbon leakage). All other criteria are not re-scored under scenarios. Under each scenario, solutions are categorised using an interpretive scale (low → high potential to mitigate relocation risk), and results are compared across scenarios and summarised in a cross-scenario overview.

Any further detail on criteria definitions, scoring logic, the assessment matrix, and scenario tables is provided in the Annex 3 of this report.

4.5.2 Summary assessment of Technical Solutions

Overall assessment by technical solution (core findings)

The table below summarises the core findings from the qualitative assessment of each Technical Solution, highlighting the main strengths and weaknesses against the common evaluation criteria (environmental integrity, carbon leakage prevention, even-handedness, feasibility, and ease of adaptation). It is intended as a quick-reference overview; the detailed rationale and supporting discussion are provided in Annex 3.

Table 4-2 Summary assessment of Technical Solutions (core strengths and weaknesses)

Technical solution	Strengths	Weaknesses / key risks

TS 1a: CBAM covers 100% indirect emissions; ICC maintained	Very strong environmental integrity (full coverage). Strong carbon leakage prevention (imports priced fully while ICC continues). Administratively simple; no disruption to EU producers.	Fails even-handedness: ICC remains while importers pay full CBAM on indirect emissions (risk of double protection/asymmetry). Abrupt change for importers.
TS 1b: CBAM covers 100% indirect emissions; ICC removed immediately	Very strong environmental integrity. Strong even-handedness (no overlap). Administratively simple.	Ease of adaptation strongly negative: abrupt change for both EU producers (ICC removed) and importers (full CBAM applied). Carbon leakage outcomes depend on relocation destinations' regulatory stringency; exports out of scope.
TS 2a: CBAM covers "uncompensated share" assuming ICC = 75% → CBAM = 25%	High feasibility (very simple). Low disruption for EU producers.	Weaker environmental integrity (limited indirect emissions coverage). Weak even-handedness: fixed 75% assumption often overstates actual ICC coverage.
TS 2b: CBAM covers "uncompensated share" using actual ICC values	Better even-handedness: alignment between importer obligations and actual ICC. Supports carbon leakage prevention relative to TS 2a.	Feasibility strongly negative: high methodological complexity and reliance on granular ICC data that may not be available.
TS 2c: CBAM covers "uncompensated share" using a more realistic estimate of ICC (not actual payments)	Middle ground between TS 2a and TS 2b. Better alignment than fixed 75% without relying on protected ICC records. Moderate feasibility.	Still partial coverage (below 100%); precision lower than TS 2b.
TS 3a: CBAM phased in as ICC phased out; uniform approach across sectors	Performs well on even-handedness (CBAM applies only to emissions not covered by ICC). Smoother adaptation via gradual change. Environmental integrity improves progressively as CBAM coverage expands.	More complex to administer (requires coordinated phase-out/phase-in).
TS 3b: TS 3a with differentiated treatment/exemptions for highly exposed sectors	Improves protection for exposed sectors. Scores strongly on carbon leakage prevention in core assessment.	High complexity (weak feasibility). Risks undermining even-handedness if exemptions create overlap/double protection.

TS 4: ICC phased out first; CBAM indirect emissions introduced only after ICC reaches zero	Allows more time for stakeholders to prepare (primarily included for comparison).	Expected to perform weakly overall: poor environmental integrity and carbon leakage prevention during transition, as indirect emissions are not priced at the border while ICC is withdrawn—creating a prolonged period of imbalance.

4.5.3 Performance under Task 1–2 policy scenarios (criterion B only: preventing carbon leakage)

Across scenarios, Task 1 default values (low vs high relative to the EU price-setting source) can significantly influence the CBAM adjustment due and its effect, and Task 2 rules (lax vs strict) determine how easily that signal can be diluted through "actual emissions" claims. This policy scenario-based stress testing was not conducted for Technical Solution 5, as it was introduced at a later stage of the analysis.

Table 4-3 Summary of performance of TSs under policy scenarios

Technical solution	Policy Scenario 1 (low defaults + lax rules)	Policy Scenario 2 (low defaults + strict rules)	Policy Scenario 3 (high defaults + lax rules)	Policy Scenario 4 (high defaults + strict rules)
TS 1a	Medium	Medium	High	High
TS 1b	Low	Medium–low	Medium	High
TS 2a	Medium	Medium	Medium–high	High
TS 2b	Medium	Medium	Medium–high	High
TS 2c	Medium	Medium	Medium–high	High
TS 3a	Low	Medium–low	Medium–high	High
TS 3b	Medium–low	Medium	High	High
TS 4	Low	Medium–low	Medium	Medium–high

Under Policy Scenario 1, CBAM deterrence is weakest because low default values and lax rules reduce the border signal; in this context, options that retain ICC tend to perform better than those that remove it. Policy Scenario 2 remains constrained by low defaults, but stricter rules improve the credibility of charges and slightly narrow differences between solutions. In Policy Scenario 3, higher default values strengthen the border signal, although lax rules still allow some circumvention, so solutions cluster around medium to high performance. Policy Scenario 4 provides the strongest overall deterrence, with most solutions scoring highly; TS 4 remains lower because CBAM coverage of indirect emissions is delayed until ICC reaches zero.

From the analysis, the following cross-cutting conclusions were drawn:

- Immediate full coverage options (especially those removing ICC) score strongest on environmental integrity, but face the sharpest adaptation challenges.
- Intermediate alignment options (TS 2) can improve balance between CBAM and ICC, but the feasibility of the more data-accurate variants depends heavily on data access and complexity.
- Transition options (TS 3) provide smoother adjustment paths, but increase administrative complexity; differentiated variants introduce added complexity and potential even-handedness risks.
- Delayed introduction (TS 4) is consistently weaker during the transition because it reduces border pricing while removing domestic protection.

Any further detail on important aspects, including the assessment matrix, solution-level justifications, scenario tables and the consolidated cross-scenario comparison, is provided in the Annex 3 of this report.

4.5.4 Technical assessment of option 5 - Adjusted ICC alongside CBAM coverage of indirect emissions

Technical Solution 5 (TS5) was presented separately from the other Technical Solutions because it was introduced at a later stage of the analysis, following additional reflections on how ICC could be adjusted alongside an extension of CBAM coverage. As a result, it was not assessed within the same structured Task 1–2 scenario-testing framework applied to the earlier solutions and is therefore discussed independently for clarity.

Technical Solution 5 extends CBAM coverage to indirect emissions while maintaining ICC for EU producers, with ICC levels adjusted to reflect the indirect emissions costs faced by imports under CBAM.

- **Strengths:** strong on environmental integrity (indirect emissions priced under CBAM) and strong on preventing carbon leakage by maintaining protection for EU producers while extending border pricing to imports.
- **Weakness:** performance on even-handed treatment depends on effective calibration of ICC adjustments; poor calibration could lead to overcompensation or residual asymmetry.
- **Implementation/adaptation:** more complex than most other options due to the need to adjust ICC parameters consistently across Member States; however, adaptation impacts are moderate, as ICC is not removed abruptly and changes for both EU producers and importers are more gradual than under TS 1b.

4.6 Subtask 3.5: CBAM Indirect Emissions T3 Stakeholder Survey Report

4.6.1 Overview of stakeholder approach

Subtask 3.5 documented the structured stakeholder survey conducted to gather targeted feedback on policy options for extending the CBAM's scope to indirect emissions. The objective was to assess the feasibility, acceptability, and perceived effectiveness of different technical solutions for expanding coverage, while identifying risks, concerns, and design preferences across diverse stakeholders.

The survey was launched on 18 April 2025 and closed on 7 May 2025. It was sent to 42 members of the CBAM Expert Group, with 30 responses received, reflecting a broad range of perspectives across the CBAM value chain. Respondents included EU-based industry representatives and trade associations (50%), EU public entities (17%), environmental groups/NGOs (13%), non-EU public entities (10%), academia/research institutions (3%), and non-EU industry (3%), with two respondents classified as "Other" (a third-country public entity and an EU national competent authority). Stakeholders were largely EU-based (87%), concentrated in Belgium due to proximity to EU institutions. Participants indicated interest across multiple sectors, with iron & steel, cement, and aluminium the most commonly cited.

The survey explored stakeholder perspectives on the effectiveness of the current CBAM treatment of indirect emissions, potential benefits and challenges of extending coverage to additional sectors, alignment with ICC, and criteria for assessing policy options. It combined quantitative and qualitative questions, allowing participants to provide detailed rationale for their views.

4.6.2 Key insights and recommendations for policy consideration

General views on extending CBAM to indirect emissions

Stakeholders broadly acknowledged the logic of extending CBAM coverage to indirect emissions in order to improve environmental integrity and address residual carbon leakage risks. Many stakeholders recognised that excluding indirect emissions for certain sectors weakens incentives for electricity decarbonisation and energy efficiency, particularly for electricity-intensive goods. At the same time, there was no consensus on the appropriate pace or design of such an extension.

Interaction with ICC and concerns about double protection

A recurring theme was the importance of avoiding double protection. Stakeholders emphasised that any CBAM extension must be carefully aligned with ICC to prevent situations where EU producers continue to receive compensation for indirect costs while importers face full CBAM obligations. Several respondents highlighted WTO-related concerns if such overlap persists, and stressed the need for transparency and defensibility in any transitional arrangements.

Preferences regarding technical solutions

Stakeholders' preferences across the technical solutions reflected a consistent trade-off between environmental ambition, even-handedness, and transition feasibility; the main views are summarised below:

- Immediate full-coverage options (TS 1a and 1b) were generally viewed as strong from an environmental perspective but risky from an adaptation and political feasibility standpoint. Stakeholders flagged abrupt cost impacts for both EU producers (if ICC is removed) and importers, and concerns about supply chain disruption.
- Partial-coverage options based on the "uncompensated share" (TS 2) were seen as conceptually attractive for even-handedness, but stakeholders raised doubts about the feasibility of accurately determining ICC coverage in practice, especially under TS 2b.
- Phased approaches linking CBAM expansion to ICC phase-out (TS 3) received comparatively more support, particularly TS 3a, as they were perceived to balance environmental ambition with smoother adaptation and reduced transition risks. However, stakeholders cautioned that these options would increase administrative complexity and require clear, predictable timelines.
- Differentiated treatment for highly exposed sectors (TS 3b) was supported by some industry representatives but raised concerns among authorities and other stakeholders about complexity, boundary issues, and the risk of undermining even-handedness.

Data availability, MRV and administrative burden

Stakeholders consistently highlighted data limitations as a key constraint, particularly for approaches relying on actual electricity consumption, product-level benchmarks, or detailed ICC payment data. Verifiers and authorities stressed the need for clear, standardised rules on acceptable data sources, treatment of PPAs, and safeguards against resource shuffling. Smaller importers were identified as being particularly sensitive to increased reporting and verification requirements.

Overall takeaway from stakeholder engagement

The engagement confirmed broad support for addressing indirect emissions under the CBAM, but also reinforced that transitional design choices are critical. Stakeholders generally favoured options that:

- Avoid abrupt shocks
- Minimise double protection
- Rely on transparent and robust methodologies
- Provide regulatory predictability

Any further detail on stakeholder groups consulted, consultation formats, and verbatim or detailed thematic feedback is provided in the Annex 3 of this report.

4.7 Subtask 3.6: Applicability of Technical Solutions in case of an ICC expansion to a CBAM sector

Subtask 3.6 assessed how the technical solutions developed under Subtask 3.3 would apply in a hypothetical scenario where ICC is expanded to cover a CBAM sector that is not yet eligible for ICC. The purpose of this analysis was to test the robustness and internal consistency of the proposed solutions under changing policy conditions, and to identify whether certain options are more resilient or adaptable than others.

The subtask did not evaluate the likelihood or desirability of ICC expansion as a policy choice. Instead, it used the scenario as a stress test to examine how different CBAM extension pathways would interact with an expanded ICC framework, and whether they would continue to meet objectives related to environmental integrity, carbon leakage prevention, and even-handed treatment.

The analysis considered how each technical solution would operate if a CBAM sector that is subject to CBAM obligations for indirect emissions were to become eligible for ICC under revised State Aid Guidelines. The assessment focused on:

- the risk of creating new overlaps between CBAM and ICC,
- implications for the calculation of CBAM coverage of indirect emissions, and
- administrative and implementation challenges arising from policy misalignment.

4.7.1 Overview of applicability of solutions in case of an ICC expansion

Technical Solution 1 - immediate full CBAM coverage

Under TS 1a, an expansion of ICC would clearly result in double protection, as importers would face full CBAM obligations for indirect emissions while EU producers receive compensation. TS 1b would avoid this issue, as ICC is removed entirely, making it inherently robust to changes in ICC eligibility. However, TS 1b remains challenging from an adaptation perspective due to its abrupt nature.

Technical Solution 2 - CBAM covers the uncompensated share

TS 2 options are sensitive to ICC expansion by design. If a sector becomes newly eligible for ICC, the CBAM coverage of indirect emissions would automatically decrease to reflect the compensated share. While this preserves even-handedness in principle, it increases reliance on accurate, timely data on ICC coverage. The analysis highlights that this sensitivity makes TS 2b and 2c particularly data-intensive and administratively demanding under an expanded ICC scenario.

Technical Solution 3 - CBAM phased in as ICC phased out

TS 3 options are assessed as relatively robust to ICC expansion, provided that the phase-out rules are applied consistently to newly eligible sectors. Under TS 3a, the inclusion of a new sector in ICC would initially reduce CBAM coverage, but the predefined phase-out pathway would ensure a gradual transition back to full CBAM coverage of indirect emissions. TS 3b introduces additional complexity if differentiated treatment is applied, as newly eligible sectors could qualify for exemptions or slower phase-out rates, increasing risks of overlap and unequal treatment.

Technical Solution 4 - CBAM extension only after ICC is phased out

TS 4 is particularly vulnerable to ICC expansion, as extending ICC to new sectors would further delay the point at which CBAM indirect emissions coverage is introduced. This reinforces the weaknesses already identified under Subtask 3.4, including prolonged periods of insufficient carbon leakage protection and reduced environmental effectiveness.

4.8 Task 3 Conclusions

An extension of CBAM obligations for indirect emissions should consider the questions of managing the interaction between CBAM and the existing (and decentralised) system of ICC, while maintaining effective carbon leakage safeguards and a credible carbon price signal. The mapping exercise carried out under Task 3 showed that, unlike free allocation, ICC differs fundamentally in its scope, funding and degree of harmonisation: it is optional, varies widely in budgets and coverage, and is implemented through MS State aid schemes. This heterogeneity is the key practical constraint for scope extension, because it creates trade-offs between even-handed treatment of imports vs EU production, administrative feasibility, and the pace at which the CBAM can expand to cover indirect emissions across all CBAM goods.

A second core conclusion was that the current CBAM treatment of indirect emissions reflects a design choice embedded in the CBAM Regulation: indirect emissions are treated differently across sectors to manage the interaction with existing carbon leakage protection for indirect costs, notably ICC. In other words, the current link between ICC eligibility and whether CBAM applies a financial charge for indirect emissions is not an inherent feature of CBAM design, but a specific regulatory configuration intended to avoid situations where EU producers can receive ICC while importers simultaneously pay a full CBAM charge for indirect emissions for the same goods. Task 3 found that, while this approach is coherent with the Regulation's current design, it also creates residual carbon leakage risks and weaker decarbonisation incentives for electricity consumption in certain electricity-intensive sectors, as some goods remain exempt from a financial CBAM obligation for indirect emissions during the definitive period (even though indirect emissions reporting continues).

The assessment of technical solutions confirms that other configurations are possible, and that "ICC vs CBAM" is not an all-or-nothing outcome but a design variable that can be managed in different ways. Immediate full-coverage options score highest on environmental integrity (because they maximise coverage quickly) but may either create overlap if ICC continues unchanged (raising concerns about asymmetry/overcompensation) or impose a significant adaptation shock if ICC is removed abruptly.

Conversely, “uncompensated share” options are explicitly designed to align CBAM indirect emissions coverage with the portion not addressed by ICC, improving even-handedness in principle; however, the most accurate variant is data - intensive and methodologically more complex, while simplified assumptions can misstate effective ICC coverage and thereby weaken alignment.

Overall, the analysis points to a central design insight: transition pathways that coordinate CBAM expansion with changes to ICC (including phase-out trajectories, calibrated coverage, or adjusted ICC parameters) could balance even-handedness with gradual adaptation, albeit at the cost of higher administrative and governance complexity. These pathways may allow policymakers to reduce or eliminate overlap through design (rather than simply avoiding coverage), while maintaining predictability for stakeholders. Stakeholder engagement reinforced this conclusion: stakeholders broadly supported addressing indirect emissions under CBAM, but emphasised predictable, transparent transition pathways and cautioned against abrupt changes or prolonged overlaps between CBAM and ICC. Task 3 also concluded that performance on carbon leakage prevention is highly sensitive to Task 1 and Task 2 design choices (default values and rules for claiming actual emissions). Consequently, choices on indirect emissions scope extension should be considered as part of the overall CBAM rather than in isolation.

Finally, Task 3 showed that the robustness of the technical solutions can vary under changing policy conditions (e.g., a potential expansion of ICC eligibility to additional CBAM sectors). Options that rely heavily on ICC levels and fragmented compensation schemes tend to be more sensitive to such changes, whereas solutions that embed a clear pathway towards full CBAM coverage of indirect emissions are more resilient to future policy adjustments.

5. Overall Conclusion

This study provided targeted analytical and technical support to inform Commission decision-making on embedded indirect emissions under the CBAM. It addressed three linked questions set out in the report's introduction: (i) how to set robust and defensible default values for indirect emissions for goods other than electricity; (ii) when and how declarants should be allowed to apply actual indirect emissions instead of default values, particularly for direct technical links and power purchase agreements (PPAs), and what evidence and verification requirements are needed; and (iii) technical options on how to extend indirect emissions' coverage to additional CBAM goods, while ensuring even-handed treatment between imports and EU production in light of Indirect Cost Compensation (ICC), Member State heterogeneity, the EU internal electricity market design, and WTO compatibility considerations.

Task 1 confirmed that the choice of default emission factor for electricity used in the production of CBAM goods is a central design parameter. It affects the strength and credibility of the carbon price signal applied to imports, the incentives for third-country electricity decarbonisation, and the risk of carbon leakage.

The macro-level assessment found that the EU average grid emission factor (Option 1) is unsuitable because it is lower than the emission factor of the EU price-setting electricity source and provides no incentive for third-country grid decarbonisation. The marginal generation CO_2 emission factor (Option 3b) was excluded due to feasibility constraints, as it requires complex dispatch modelling and is not generally applicable in third countries without liberalised electricity markets. The assessment therefore focused on the trade-off between the average emission factor of the country of origin (Option 2) and the average fossil-only emission factor of the country of origin (Option 3a). Option 3a performed best for preventing carbon leakage by aligning CBAM obligations more closely with the EU price-setting electricity source, while Option 2 provided the strongest decarbonisation incentives because reductions in overall grid carbon intensity reduce CBAM obligations over time.

Task 1 also showed that dataset choice is not trivial. Public sources differ in coverage, recency, transparency, underlying methodologies and administrative effort, and no single dataset is sufficient in all cases. Biennial Transparency Reports can provide detailed country-specific methodologies where available, but practical limitations constrain comprehensive application; broader-coverage datasets can support implementation but may require caution where methodologies are not fully aligned with CBAM calculation needs. Finally, Task 1 set out criteria for assessing requests for an alternative emission factor, with stricter requirements on data completeness, recency and transparency to support verification and comparability.

Task 2 examined the conditions under which declarants may apply actual indirect emissions instead of default values, based on section 6 of Annex IV to the CBAM Regulation (as of June 2025). It focused on the two pathways set out in the Regulation: demonstrating either a direct technical link or concluding a PPA for an equivalent amount of electricity. Furthermore, it identified the evidence and verification tasks needed to support reasonable assurance.

The analysis highlighted that the key risk for environmental integrity is resource shuffling, where low-carbon electricity (or its attributes) is allocated to CBAM production without a corresponding change in overall generation patterns. For direct technical links, Task 2 clarified that the concept can cover both "direct lines" and "private grids" and set out criteria focused on physical connectivity, temporal correlation, operational verification, and metering of electricity flows. For PPAs, Task 2 assessed contractual characteristics (direct/bilateral vs indirect/sleeved; physical vs virtual/financial; role of energy attribute certificates), operational verification metering of electricity flows, and electricity-specific characteristics (temporal correlation, geographical correlation and additionality). It concluded that, although the CBAM Regulation allows PPA-based claims, further specification of eligible arrangements and evidence is needed to reduce resource shuffling risks and support consistent verification. Temporal and geographical correlation requirements can be framed as specifications to substantiate electricity-use claims, whereas additionality requirements are not foreseen by the CBAM Regulation text as of June 2025 and would require explicit policy justification. The task highlighted that certain options (notably additionality elements linked to financial support) would be complex for verifiers and may exceed the scope of standard engineering-based verification.

Task 3 examined what the EU's current carbon leakage protection framework implies for any future extension of CBAM indirect emissions coverage. The mapping exercise showed that ICC differs fundamentally from free allocation in scope, funding and degree of harmonisation. ICC is implemented through Member States' State Aid schemes, varies widely in budgets and coverage, and data are fragmented. This heterogeneity is a key practical constraint for scope extension, because it creates trade-offs between even-handed treatment of imports versus EU production, administrative feasibility, and the pace at which indirect emissions coverage could expand across CBAM goods.

Task 3 developed and assessed technical solutions that differ primarily in timing and in how they interact with ICC. The comparative assessment showed that immediate full-coverage options score highest on environmental integrity but either create overlap if ICC continues unchanged (raising concerns about double protection) or impose abrupt adaptation impacts if ICC is removed immediately. "Uncompensated share" options are designed to align CBAM coverage with the portion not addressed through ICC, but more accurate variants depend on granular and timely data on ICC coverage and involve greater methodological and administrative complexity. Phased approaches that coordinate CBAM expansion with an ICC phase-out support smoother adaptation and improved even-handedness but require greater administrative coordination and governance complexity. Options that delay CBAM indirect emissions coverage until ICC reaches zero perform weakly during the transition because indirect emissions are not priced at the border while ICC is withdrawn, creating a prolonged period of imbalance.

Stakeholder input confirmed these trade-offs. Stakeholders broadly supported addressing indirect emissions under CBAM but emphasised the need for predictable and transparent transition pathways, cautioned against abrupt changes and prolonged overlap between CBAM and ICC, and highlighted data limitations and administrative burden as persistent constraints. The robustness analysis under a hypothetical ICC expansion confirmed that solutions relying heavily on ICC levels and fragmented compensation schemes are more sensitive to policy changes than options that embed a pathway towards full CBAM coverage of indirect emissions.

Across the study, Task 3's scenario testing illustrated how outcomes for preventing carbon leakage depend on wider CBAM design choices discussed in Tasks 1 and 2. Default values that are low relative to the EU's price-setting electricity source weaken the carbon price signal applied to imports, and lax rules for claiming actual emissions can further dilute that signal through "actual emissions" claims. This reinforces that decisions on default values, rules for applying actual indirect emissions, and any scope-extension pathway need to be considered together, because they jointly shape the strength and credibility of the carbon price signal applied to imports and the feasibility of implementation and verification.

6. Annexes

This Final Report includes six annexes that provide the full technical outputs and supporting material for the study.

Annexes 1–3 present the full final reports for each task:

- **Annex 1**: Full Final Report for **Task 1** (default values for indirect emissions)
- **Annex 2**: Full Final Report for **Task 2** (reporting actual indirect emissions and associated evidentiary requirements)
- **Annex 3**: Full Final Report for **Task 3** (technical solutions for potential scope extension and interaction with Indirect Cost Compensation)

Annexes 4–6 provide cross-cutting material that supports the overall study and explains how key inputs were generated and consolidated:

- **Annex 4** summarises the **expert support provided under Task 4**, including coordination between this study and the CBAM MRVA&FA workstream, targeted reviews of draft Implementing Act extracts related to reporting actual indirect emissions, and contributions used to inform the Commission's Article 30(2) report and verifier-facing guidance (Accreditation and Verification).
- **Annex 5** summarises **stakeholder engagement and expert outreach** undertaken across Tasks 1–3, and explains how consultation inputs were used to complement the desk-based analysis. It covers the Task 1 targeted written expert consultation (June–August 2025), the Task 2 stakeholder workshops and targeted interviews (including a verifier interview and engagement with stakeholders outside the EU), and the Task 3 targeted survey of a subset of the CBAM Expert Group (April–May 2025).
- **Annex 6** summarises the **external expert review comments** provided by the two reviewers selected by the Commission (Prof. Dr. Freya Baetens and Prof. Dr. Bert Willems), and sets out at a high level how the delivery team reflected those comments in final consolidation, including any forward-looking observations recorded as considerations for potential future work.

Annex 1: Task 1 Final Report

- **Annex 1.1:** Macro-level assessment Criteria
- **Annex 1.2:** Detailed assessment of data sources
- **Annex 1.3:** Task 1 Stakeholder Outreach

Annex 2: Task 2 Final Report

- **Annex 2.1**: Analysis of the quarterly reports where actual indirect emissions were applied including preparation of aggregated statistics
- **Annex 2.2**: Methodology and data sources for the calculation of the technical resource shuffling potential
- **Annex 2.3**: Direct and indirect GHG emission intensities as a share of the total GHG emission intensities

Annex 3: Task 3 Final Report

- **Annex 3.1:** Task 3 Stakeholder Survey

Annex 4: Task 4 Expert Support Summary

Provided in a separate file

Annex 5: Stakeholder Consultation

Provided in a separate file

Annex 6: Expert Reviews

Provided in a separate file

KP-01-26-026-EN-N

Publications Office
of the European Union

ISBN 978-92-68-40108-8