CBAM impacts on non-EU countries: the cases of least developed economies and neighbouring countries

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Abstract

The EU Carbon Border Adjustment Mechanism (CBAM) aims to reduce the risk of carbon leakage by levelling the playing field for emission-intensive, trade-exposed industries. Apart from practical implementation challenges, the degree to which the CBAM impacts industries outside the EU depends mainly on their trade exposure and their emission intensity. Since the European Commission proposed the introduction of the CBAM, in July 2021, the literature about its effects has grown exponentially but few studies in the literature have modelled the impact of CBAM on developing countries. Here we assess the impact of the CBAM on 50 countries and regions, with the EU modelled as a single region. We focus on Least Developed Countries (LDCs), a selection of other developing and emerging economies and selected EU neighbourhood partner countries. We use the JRC-GEM-E3 computable general equilibrium (CGE) model and the GTAP11 circular economy database to compare the introduction of the CBAM (including the associated phase-out of free allowances in the EU) to a baseline scenario without the CBAM, but with a continuation of other EU climate policies. Although most LDCs export only a very limited amount of CBAM goods to the EU, shifts on trade patterns are expected and the aggregate of LDCs shows a reduction on exports of 2.8% compared to the baseline by 2035. The CBAM is also expected to reduce greenhouse gases (GHG) emissions in non-EU countries with respect to exports to the EU, by reducing demand for high-emission intensity goods. We find that, compared the baseline, GHG emissions decrease the most in neighbourhood countries (– 11.4 Mt of CO2-eq) in 2035.

Introduction

The EU Carbon Border Adjustment Mechanism (CBAM) aims to reduce the risk of carbon leakage by levelling the playing field for emission-intensive, trade-exposed industries. The CBAM ensures that the carbon price of imports is equivalent to the EU carbon price, mirroring the EU ETS. By doing so, the EU puts its domestic industry, that incurs in higher production costs due to carbon pricing, on the same footing as foreign competitors that do not face the same cost increase in their jurisdictions. Importantly, while in the EU ETS the emissions accounting occurs at the installation level, the CBAM adopts a product-level methodology, focusing on emissions from energy use and industrial processes up to the point the product leaves the production facility.

Apart from practical implementation challenges (Böhringer et al., 2022), the degree to which the CBAM impacts industries outside the EU depends mainly on their trade exposure and their emission intensity. Since the European Commission proposed the introduction of the CBAM, in July 2021, the literature about its effects has grown exponentially, including country- and sector-specific assessments of the impacts within the EU and, to a lesser extent, on non-EU countries (Zhong and Pei, 2024). Nonetheless, few studies in the literature have modelled the impact of CBAM on developing countries specifically. The underlying assumptions and scope of the existing studies differ significantly, hence leading to different conclusions[1]. For example, Guepie et al. (2023) focused on the impact on Africa and found that the GDP of African countries would decrease in aggregate up to 1.12%, depending on the scenario, but assuming that the CBAM applies to all goods imported by the EU and/or that there is no phaseout of free allowances to produce CBAM goods under the EU ETS. UNCTAD (2021) modelled the impact of a CBAM-like mechanism on developing countries, but with restricted coverage of non-EU countries, and finds that real income decreases in aggregate up to USD 10.2 billion. However, the sectoral scope differs considerably from that currently legislated for in the EU's CBAM, as it includes petroleum, coal, chemicals, glass and paper – none of which are included in the EU's CBAM. Magacho et al. (2024) provide a comprehensive analysis based on trade data and Multi-Regional Input-Output (MRIO) matrices of developing economies and show that many of them could face up to a 1% impact in their production. East European economies, mainly in the Balkans, as well as Mozambique, Zimbabwe, and Cameroon in Africa, are the most exposed as far as the external dimension is concerned.

Here we assess the impact of the CBAM on 50 countries and regions, with the EU modelled as a single region. Differently from previous studies, the introduction of CBAM is not done in isolation and, therefore, is analysed jointly with the phase out of free allowances in CBAM sectors in the EU. We combine detailed emissions intensity data at country level with trade data to correct for the implied CBAM rate under the transition from one anti-leakage measure (free allowances in the EU ETS) to another (CBAM).

Methods

We use the JRC-GEM-E3 computable general equilibrium (CGE) model and the GTAP11 circular economy database[2] (Chepeliev et al., 2025) to compare the introduction of the CBAM (including the associated phase-out of free allowances in the EU) to a baseline scenario without the CBAM, but with a continuation of other EU climate policies. Our focus is on Least Developed Countries (LDCs), a selection of other developing and emerging economies and selected EU neighbourhood

[1] The World Bank's Relative CBAM Exposure Index (Chepeliev et al., 2023) and the risk index from Eicke et al. (2021) assess carbon emissions intensity and exports of CBAM products and the institutional capacities of countries, respectively, providing useful indicators for comparability across different studies.

[2] Compared to the standard GTAP 11 database, the GTAP 11 Circular Economy splits aluminium, fertilisers and cement sectors out of the more aggregate non-ferrous metals, chemicals, non-metallic minerals sectors, respectively. This dataset draws on several sources including trade statistics and thus captures differences in the input structure of these sectors as well as differences in the trade intensity.

partner countries[3]. The selection is based on the countries' availability in the GTAP database (e.g., Algeria, Egypt, Jordan, Morocco, Tunisia and Ukraine) and the geographical representation (e.g., Armenia, Azerbaijan and Georgia are aggregated as the Caucasus) in the model. Table 1 in the Appendix provides a full list of countries and regions in the model.

In the baseline, we assume the implementation of the EU's Fit-for-55 package, except the CBAM. The phaseout of free allowances in the EU's ETS is not included in the baseline but is assumed for the CBAM scenario. The scenario models CBAM as currently legislated. The introduction of the CBAM is modelled together with a phaseout of free allowances, as CBAM becomes the main EU policy instrument aimed at addressing the risk of carbon leakage in some sectors, reflecting the transition from one anti-leakage measure (free allowances) to another (CBAM). The CBAM is introduced gradually, and the analysis concentrates on 2035, when the mechanism will be fully in place for the following sectors: Aluminium, Cement, Fertilisers, and Ferrous Metals (see Table 2 in the Appendix for a full list of sectors in the model). Indirect emissions from electricity use are included in the calculation of CBAM payments for fertilizers and cement. The CBAM rate is obtained based on the carbon price differential (Equation 1).

$$\mathrm{CBAM}_{i,r,t}^{EU27} = \sum_p \left(\mathrm{EMINT}_{p,i,r,t} - \partial_{i,r,t} * \mathrm{EMINT}_{p,i,r,t}^{EU27}\right) * \mathrm{TXENV}_{p,i,r,t}^{EU27} \qquad (1)$$

where $\mathrm{CBAM}_{i,r,t}^{EU27}$ is the rate paid on the embodied emissions of the imported good *i* into the EU from region *r* in time *t*; $\mathrm{EMINT}_{p,i,r,t}$ is the emission intensity of output by pollutant *p* (CO_2 mainly, plus nitrous oxide (N_2O) for some fertiliser goods and perfluorocarbons (PFCs) for some aluminium goods), while $\mathrm{EMINT}_{p,i,r,t}^{EU27}$ is the average emission intensity of goods covered by free allowances in the EU ETS; $\mathrm{TXENV}_{p,i,r,t}^{EU27}$ is the carbon price differential for the EU ETS.

The factor $\partial_{i,r,t}$ corrects the emission intensity of JRC-GEM-E3 based on the embodied emissions of imported goods into the EU. This is used to reflect the role of free allocation in the EU ETS, so that a correction factor is applied to the emissions subject to the CBAM. The factor lowers payments for importers to the extent that EU producers enjoy free allowances during the gradual phase-in of the CBAM until 2034 (see Figure 1.A in the Appendix for the full schedule). We take data from COMEXT at product level to derive CN code specific trade flows and combine it with corresponding emission intensities from Vidovic et al. (2023). This accounts for differences in the composition of bilateral trade flows at the CN code level, which is more detailed than the sectors represented by JRC-GEM-E3. The CBAM rate is added to the export price in the JRC-GEM-E3 model to reflect the border carbon adjustment in the price of the imported good into the EU (Equation 2).

[3] Least Developed Countries (LDCs) are categorised (as of the end of 2024) as having low levels of income and facing severe structural impediments to sustainable development. The category of LDC was established by the UN General Assembly in 1971. See https://www.un.org/ohrlls/content/list-ldcs for more information and a list of LDCs. For a list of neighbouring countries, see https://economy-finance.ec.europa.eu/international-economic-relations/candidate-and-neighbouringcountries/neighbouring-countries-eu/neighbourhood-countries_en.

$$\text{Pimp}_{i,r,t}^{EU27} = \text{Pexp}_{i,r,t} + \text{CIF}_{i,r,t}^{EU27} + \text{duties}_{i,r,t}^{EU27} + \text{CBAM}_{i,r,t}^{EU27} \qquad (2)$$

where $\text{Pimp}_{i,r,t}^{EU27}$ is the price of the imported good *i* into the EU from region *r* in time *t*; $\text{Pexp}_{i,r,t}$ is the gross export price, i.e., without insurance and freight costs ($\text{CIF}_{i,r,t}^{EU27}$) and duties paid at the border ($\text{duties}_{i,r,t}^{EU27}$). Naturally, If the good is not subject to the CBAM, the rate is zero.

The rest of the world follows the reference scenario from the Global Energy and Climate Outlook 2024 (Keramidas et al., 2024), which reflects current (legislated) policies up until June 2024. This scenario assumes that third countries follow existing policies but not necessarily reach their National Determined Contributions (NDCs) under the Paris Agreement, if these targets are not backed by specific policies. The United Kingdom and the European Free Trade Association (EFTA)[4] countries are assumed to have climate policy of equal stringency in place as the EU, e.g. a carbon price that is effectively paid equal to those in the EU ETS, hence there are no CBAM payments from these countries so that Equations 1 and 2 above are also introduced for those two regions (e.g., $\text{CBAM}_{i,r,t}^{EFTA}$ and $\text{CBAM}_{i,r,t}^{UK}$).

How intense are emission intensities?

In CGE models, the value of output is typically expressed in monetary terms, hence the emission intensity of a good is commonly obtained using a monetary unit in the denominator (kg CO_2e/US$ of output) rather than a physical unit (kg CO_2e/tonne of output). If the exports contain little value added, this translates into a higher emission intensity compared to products with the same absolute emissions, but higher value added. In those cases, the emission intensity of exporters may appear high relative to the EU when comparing the broader sector as represented in the GTAP-CE database, despite having a physical emission intensity (tCO_2/t product) that is similar to that in the EU on a product-by-product basis. This implies that countries exporting goods with relatively lower value added would see higher emission intensities, hence observing larger price increases under the CBAM and, in those cases, substantial reductions in exports to the EU under the CBAM can come out as a result in CGE models.

In addition, countries exporting to the EU (also EFTA and UK) only engage in the production and exports of a subset of the products covered in the broader CBAM sector as represented in the GTAP-CE database. This influences the emission intensities that are used to calculate the CBAM rate paid at the border (in Equation 1). For example, Mozambique mainly exports to the EU unwrought aluminium, with relatively low value added, therefore the emission intensity used in a CGE model for the Aluminium sector thus is relatively high when expressed in kg CO2e/US$ compared to the EU. However, physical emissions in Mozambique are relatively low compared to other crude aluminium producers[5], and a CGE model likely overstates the negative impact on Mozambique's aluminium sector.

To assess how a different methodology for calculating emission intensities could affect the results, an alternative approach is explored with the JRC-GEM-E3 model. This approach is based

[4] Iceland, Liechtenstein, Norway and Switzerland.
[5] Wolfram et al. (2025) present a case study on Mozambique in page 16, Box 3, of the [Building a Climate Coalition: Aligning Carbon Pricing, Trade, and Development] report.

on the implied CBAM rate calculated from physical emission intensities (kg CO2e/tonne of output) instead of the emission intensities based on monetary terms (kg CO2e/US$). Besides correcting for the physical emission and trade intensities using data from Vidovic et al. (2023) and COMEXT, this approach also considers that countries whose sectors show a higher physical emission intensity than the EU would face additional costs, by absorbing potential price increases in the international market, so that their demand remains unaffected. This is equivalent to say that the price elasticity of the demand is zero, being perfectly inelastic to price changes. Therefore, the export price to the EU (import price in Eq. 2) becomes:

$$\text{Pexp}\,^{EU27}_{i,r,t} = \text{Pexp}_{i,r,t} + \text{CIF}\,^{EU27}_{i,r,t} + \text{duties}\,^{EU27}_{i,r,t} + \text{CBAM}\,^{EU27}_{i,r,t} + [\text{P}\,^{World}_{i,t} * \left(\partial_{i,r,t} - 1\right)] \qquad (3)$$

Results

The CBAM was designed with a focus on energy- and emission-intensive sectors and primarily affects more industrialised and developed economies. With the CBAM, exporting industries with relatively low emission intensity compared to the EU experience an increase in demand, whereas a higher emission intensity is reflected in a decrease in demand. This is because industries outside the EU without domestic carbon pricing face an increase in carbon costs relative to EU producers.

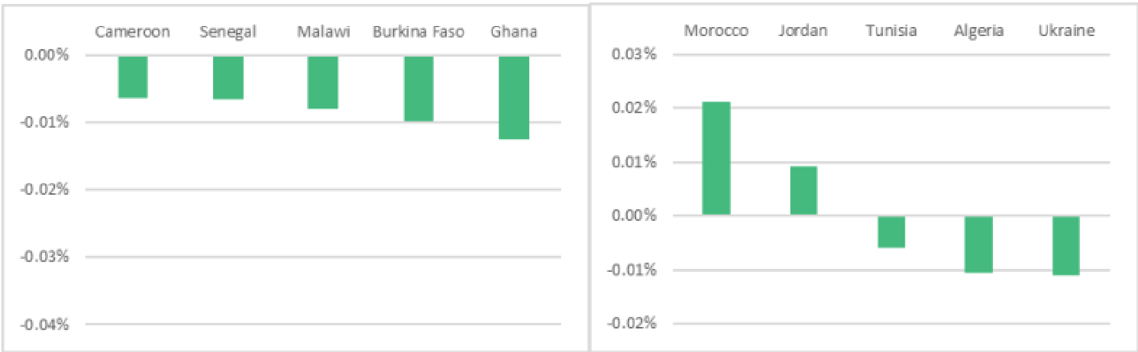
Table 1: Exports of CBAM goods to the EU (value and % share of GDP).

LDCs and Neighbouring countries (top 3 exporters)	Exports of CBAM goods to the EU in EUR billion (2024)	Exports of CBAM goods to the EU in EUR billion (2024)
Mozambique	1.20	5.50
Cambodia	0.01	0.03
Zambia	0.02	0.02
Ukraine	3.30	1.80
Egypt	1.60	0.40
Morrocco	1.00	0.70

Source: Comext (2024) for trade and World Bank data (2024) for GDP.

Countries close to the EU are among the most impacted third countries. They are typically small economies, so absolute export volumes from these countries are naturally small, but for them these exports may represent important shares. For example, North Macedonia's exports to the EU of CBAM goods amount to around 4.1% of GDP in 2024.

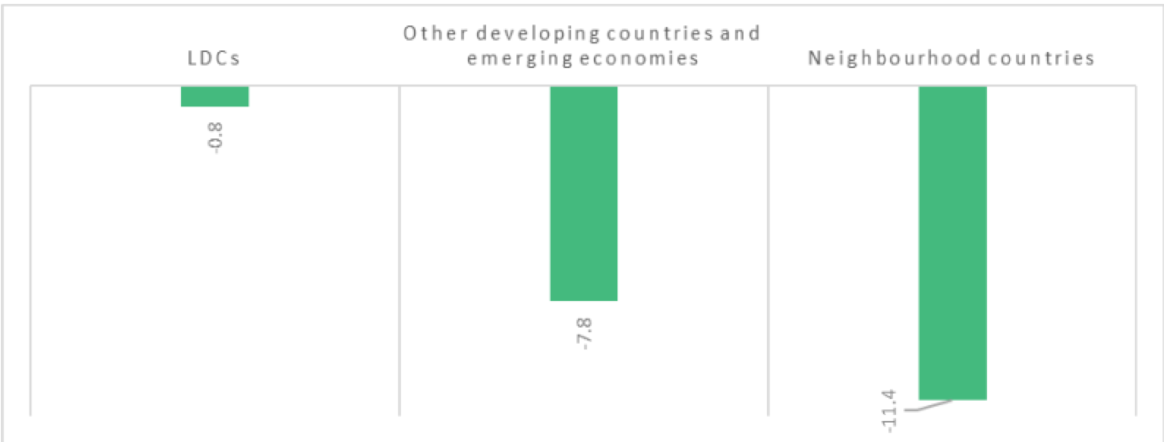
Figure 1 shows that the expected impact of the CBAM on the GDP of the aggregate of LDCs is negligible compared to the baseline, at less than 0.01% by 2035. The macroeconomic impact of the CBAM on individual countries is also negligible. Among the EU's neighbourhood countries, results show only a minor decrease compared to the baseline in GDP (0.01%) for Ukraine, Algeria and Tunisia, whereas Morocco and Jordan will see a minor increase (0.02% and 0.01% respectively). This is because the CBAM primarily affects more industrialised countries, with emission-intensive exporting sectors. Exports of CBAM goods from LDCs to the EU are rather limited, hence the impact on the GDP is small. Likewise, other developing and neighbourhood countries face aggregate small GDP impacts.



*Source: JRC-GEM-E3 model. *Includes LDCs and other developing countries. Mozambique discussed separately below.*

Figure 1: Impact of the CBAM on GDP in selected countries in 2035, % change compared to the baseline.

The CBAM is also expected to reduce greenhouse gases (GHG) emissions in non-EU countries with respect to exports to the EU, by reducing demand for high-emission intensity goods. Compared the baseline, in 2035, GHG emissions decrease the most in neighbourhood countries (− 11.4 Mt of CO_2-eq). For LDCs, the reduction in absolute emissions is more limited (− 0.8 Mt of CO_2-eq), whereas the 'other developing countries and emerging economies' aggregation shows a significant reduction in emissions (− 7.8 Mt of CO_2-eq).



Source: JRC-GEM-E3 model

Figure 2: Impact of the CBAM on GHG emissions in selected countries in 2035, % change compared to the baseline..

Sensitivity on emission intensities

In CGE models, the value of output is typically expressed in monetary terms, hence the emission intensity of a good is commonly obtained using a monetary unit in the denominator (kg CO_2e/US$ of output) rather than a physical unit (kg CO_2e/tonne of output). If the exports contain little value added, this translates into a higher emission intensity compared to products with the same absolute emissions, but higher value added. In those cases, the emission intensity of exporters may appear high relative to the EU when comparing the broader sector as represented in the GTAP-CE database, despite having a physical emission intensity (tCO_2/t product) that is similar to that in the EU on a product-by-product basis. This implies that countries exporting goods with relatively lower value added would see higher emission intensities, hence observing larger price increases under the CBAM and, in those cases, substantial reductions in exports to the EU under the CBAM can come out as a result in CGE models.

In addition, countries exporting to the EU (also EFTA and UK) only engage in the production and exports of a subset of the products covered in the broader CBAM sector as represented in the GTAP-CE database. This influences the emission intensities that are used to calculate the CBAM rate paid at the border (in Equation 1). For example, Mozambique mainly exports to the EU unwrought aluminium, with relatively low value added, therefore the emission intensity used in a CGE model for the Aluminium sector thus is relatively high when expressed in kg CO2e/US$ compared to the EU. However, physical emissions in Mozambique are relatively low compared to other crude aluminium producers[6], and a CGE model likely overstates the negative impact on Mozambique's aluminium sector.

To assess how a different methodology for calculating emission intensities could affect the results, an alternative approach is explored with the JRC-GEM-E3 model. This approach is based on the implied CBAM rate calculated from physical emission intensities (kg CO2e/tonne of output) instead of the emission intensities based on monetary terms (kg CO2e/US$). Besides correcting for the physical emission and trade intensities using data from Vidovic et al. (2023) and COMEXT, this approach also considers that countries whose sectors show a higher physical emission intensity than the EU would face additional costs, by absorbing the price increase, so that their demand remains unaffected. This is equivalent to say that the price elasticity of the demand is zero, being perfectly inelastic to price changes.

For instance, in the case of Mozambique, the trade-weighted physical emission intensity of aluminium is 1.04 times that of the EU. This would mean that a 1% price increase in the EU (from the phasing out of ETS free allowances) would be translated in the model as a 1.04% price increase for EU imports of aluminium from Mozambique under the CBAM. Therefore, the impact on the aluminium sector in Mozambique is much more limited in this approach, with aluminium output and exports from Mozambique to the EU decreasing by (− 0.4%) and (− 0.5%) compared to the baseline in 2035. This reflects the nature of this sector, with relatively low value-added per unit of emission, leading to a relatively high emission intensities compared to the EU when these are calculated only based on monetary terms. Figure 2 shows the impact of the CBAM on exports by sector in 2035 relative to the baseline.

[6] Wolfram et al. (2025) present a case study on Mozambique in page 16, Box 3, of the Building a Climate Coalition: Aligning Carbon Pricing, Trade, and Development report.

Table 2: Sectoral impact (% change in output compared to the baseline, 2035) by regions.

	Iron & Steel	Cement	Fertilizer	Aluminium
LDCs	0.10%	0.50%	3.40%	0.50%
Other developing countries and emerging economies	-0.30%	0.40%	0.80%	0.20%
Neighbourhood countries	-0.10%	1.70%	6.40%	-1.00%

Source: JRC-GEM-E3 model. Modelling for Mozambique (in LDCs) based on physical emission intensities.

Conclusions

Here we assess the impact of the CBAM on 50 countries and regions, with a focus on Least Developed Countries (LDCs), a selection of other developing and emerging economies and selected EU neighbourhood partner countries. We contribute to the existing literature on border carbon adjustments by assessing different scenarios in the JRC-GEM-E3 model, where the introduction of the CBAM in the EU is not done in isolation but assessed together with the phase out of free allowances in the sectors subject to the EU CBAM. We combine detailed emissions intensity data at country level with trade data to correct for the implied CBAM rate under the transition from one anti-leakage measure (free allowances in the EU ETS) to another (CBAM).

Although most LDCs export only a very limited amount of CBAM goods to the EU, shifts on trade patterns are expected and the aggregate of LDCs shows a reduction on exports of 2.8% compared to the baseline by 2035. Overall, the impact on LDCs, developing countries and neighbourhood countries is relatively minor in aggregate, but can be more substantial at sectoral level due to differences in emission intensities. This result is typically observed in CBAM analyses done with CGE models where the emissions intensity of output is calculated in monetary terms – countries exporting goods with relatively lower value added would see higher emission intensities, hence observing larger price increases under the CBAM. In those cases, substantial reductions in exports to the EU under the CBAM can come out as a result in CGE models. Therefore, in the paper we also explore an alternative approach to calculate the emissions intensities based on the implied CBAM rate calculated from physical emission intensities (kg CO2e/tonne of output) instead of the emission intensities based on monetary terms (kg CO2e/US$).

The alternative approach can be also seen as a lower bound for effects on countries, whereas relying on the emissions intensity based on monetary values in the CGE model may be seen as an upper bound for effects of the CBAM on exporting countries. This approach does not consider differences in the quality of products (within product groups) which would warrant a higher price in the EU market. The mark-up for product quality would imply that the relative price change from phasing out free allowances is lower in the EU compared to lower quality imports (without such a mark-up).

Overall, it is a useful approach to deal with simulations at a product-by-product level, which cannot be fully capture under a broad sectoral aggregation covering a large variety of products. For instance, in the GTAP-CE database represents three individual fertiliser sectors (Nitrous, Phosphate and Potassium fertilisers), whereas here fertilisers are represented by a single sector comprising the three different products. If a country like Morocco is specialised in the production and exports of Phosphate fertilisers, correcting for the physical emission and trade intensities proves valuable to understand the country-specific circumstances when the CBAM is in place.

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Appendix

Table 1: Regions in the JRC-GEM-E3 modelling

LDCs	
Benin	Rwanda
Burkina Faso	Senegal
Bangladesh	Togo
Ethiopia	Tanzania
Cambodia	Uganda
Madagascar	Zambia
Mozambique	Rest of Africa LDCs
Malawi	Rest of Asia LDCs
Nepal	
Other developing countries and emerging economies	
Ghana	Vietnam
Indonesia	Zimbabwe
Malaysia	South Africa
Cameroon	Rest of Africa
Thailand	Rest of Americas
Trinidad and Tobago	Rest of Asia and Pacific
Central Asian	Brazil
India	Türkiye
EU neighbourhood countries	
Morocco	Jordan
Tunisia	Ukraine
Algeria	Caucasus
Egypt	
Other	
EU 27	USA
EFTA region	Rest of Middle East and North Africa
United Kingdom	High income Asia Pacific and other
Canada	Russia and Belarus
China	Rest of Europe

Table 2: Sectors in the JRC-GEM-E3 model

Sectors in the JRC-GEM-E3 model	Power generation technologies modelled as sectors in the JRC-GEM-E3 model
Ferrous metals	Coal fired
Cement	Oil fired
Fertilizer	Gas fired
Aluminium	Nuclear
Transport equipment	Biomass
Other Equipment Goods	Hydro
Electronic products and electrical equipment	Wind
Coal	Solar
Crude oil	
Oil	
Gas	
Electricity supply	
Non-ferrous metals	
Chemical products	
Plastics	
Paper products	
Non-metallic minerals	
Consumer goods industries	
Construction	
Transport (air)	
Transport (land)	
Transport (water)	
Market services	
Non-market services	
Crops	
Livestock	
Forestry	

Note: CBAM sectors in bold. Part of the Other Equipment Goods sector is already covered under the current CBAM Regulation.

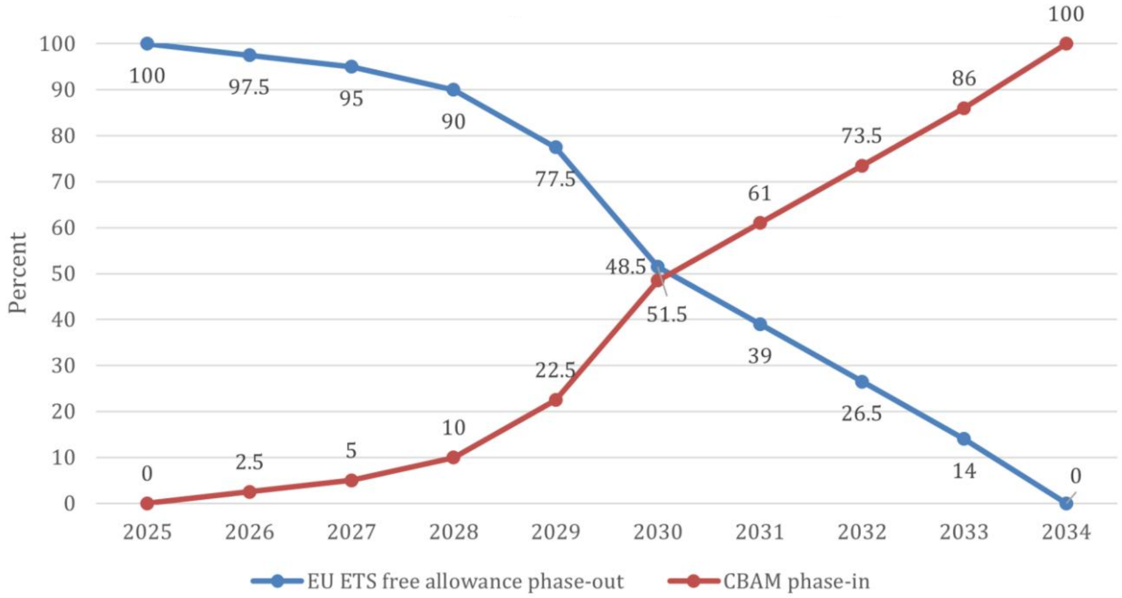

Figure 1.A: EU ETS free allowances phase-out and the CBAM phase in over 2025-2034.

Source: ICAP (2023) based on European Commission.