

6. SAE International. (2021). Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles. P. 3-12; 20-27.
7. UNECE. (2021). Regulation No. 157. Uniform provisions concerning the approval of vehicles with regard to Automated Lane Keeping Systems. Geneva. P. 2-15; 30-36.

**DOI 10.70286/ISU-17.12.2025.008**

## **STRATEGIES FOR ADAPTING UKRAINIAN INDUSTRY TO THE CBAM MECHANISM AND INCREASING COMPETITIVENESS IN THE EU MARKET**

**Butenko Olena**

Candidate of economics, Associate Professor

**Kot Olena**

Candidate of economics, Associate Professor

**Kozub Viktoria**

Candidate of economics, Associate Professor

Semen Kuznets Kharkiv National University of Economics, Ukraine

In the current context of global economic transformation, the decarbonization of production is becoming a key factor in enhancing the competitiveness of enterprises. As part of the Fit for 55 legislative package and the European Green Deal, the European Union has introduced the Carbon Border Adjustment Mechanism (CBAM), which requires exporters to pay carbon fees in proportion to their greenhouse gas (GHG) emissions. CBAM aims to encourage emission reductions in production and to create a level playing field in the EU market, as well as to combat carbon leakage to countries with weaker regulatory frameworks [2].

For Ukraine, as a country with a highly export-oriented industrial sector, CBAM has a direct economic impact. In 2021, Ukrainian exports to the EU amounted to USD 27.5 billion, of which approximately USD 5.8 billion was accounted for by goods subject to CBAM regulation. The most vulnerable sectors include metallurgy, chemicals, cement, aluminum, and electricity, where a significant share of production is highly carbon- and energy-intensive [2]. According to analysts' estimates, the additional costs of CBAM for Ukrainian exporters may range from €5–15 per tonne in the chemical industry to €20–40 per tonne in metallurgy, highlighting the need for strategic decarbonization planning [2]. At the same time, the implementation of emission reduction measures opens up new opportunities, including the development of low-carbon electric arc steel production, the expansion of renewable energy generation, improvements in energy efficiency in cement and aluminum enterprises, as well as access to green financing and market premiums for low-emission products.

Thus, studying the benefits and costs of decarbonisation of Ukrainian enterprises in the context of CBAM allows not only for an assessment of the potential economic

effect, but also for the identification of priority areas for investment and modernisation of production, which is critical for maintaining the competitiveness of Ukrainian exports in the European market and minimising the negative environmental impact of military activities [3].

With the gradual introduction of the Carbon Border Adjustment Mechanism (CBAM), Ukrainian exporters need to assess both the direct and indirect costs associated with the production of goods characterised by high greenhouse gas emissions. The main objective of this study is to determine the potential economic impact of CBAM on key sectors of the Ukrainian economy, in particular metallurgy, the chemical sector, the cement industry, aluminium production, and the energy sector.

To analyse the economic impact of CBAM on Ukrainian enterprises, the direct costs of CBAM certificates for key industries have been calculated. These direct costs are determined as the product of export volumes, specific CO<sub>2</sub> emissions per unit of output, and the projected price of a CBAM certificate (1).

$$\text{Direct costs of CBAM (\text{€ million})} = \text{Export volume (t)} \times \text{Specific CO}_2 \text{ emissions (t/t)} \times \text{CBAM price (\text{€/t})} \quad (1)$$

This approach enables a quantitative assessment of the financial pressure on enterprises and facilitates comparison across different sectors of the economy. Table 1 presents export figures and estimated direct CBAM costs for key greenhouse gas-intensive industries in the Ukrainian economy.

Table 1. Direct costs of CBAM for Ukrainian exporters in 2024 by industry

CN Code / Industry	Export volume. 2024	Export volume. 2024	Fugitive CO <sub>2</sub> emissions (t/t)	CBAM price (\text{€/ton CO}_2)	Direct costs of CBAM (million \text{€})
1	2	3	4	5	6
Aluminum (7603–7609)	172.05	23.88	1.80	30	1.29
Metallurgy (72. 7301–7311)	78	21.35	1.85	30	1.18
Chemistry (2808. 2814. 3102)	56.46	8.28	0.90	10	0
Cement (2523)	1.12	0.18	0.75	12	0.002
Energy (2716)	68.0	11	0.55	30	0.18

Source: compiled from [4]

The highest direct CBAM costs are borne by sectors with high emission intensity and significant export volumes, in particular the aluminum and metallurgical industries. The chemical and cement sectors incur relatively low costs due to lower export volumes or lower emission intensity. The energy sector shows moderate costs despite its significant export value, which is explained by its lower specific emission intensity, especially in the case of renewable energy sources. Figure 1 illustrates the priorities for production modernization and decarbonization by indicating which industries are expected to bear the highest costs.

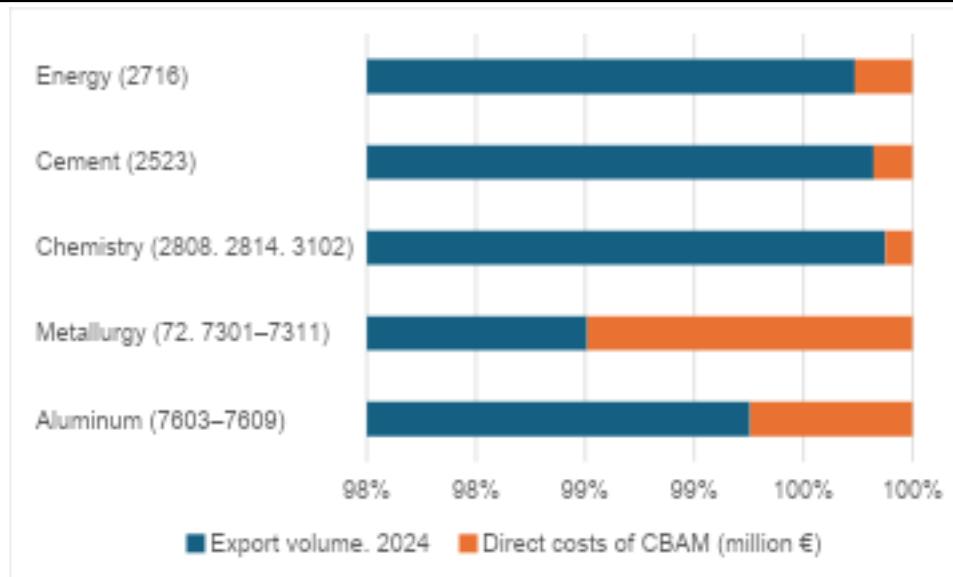


Fig. 1. Direct costs of Ukrainian exporters to CBAM in 2024 by sector, million €

Source: compiled from [4]

The implementation of CBAM for Ukrainian exporters creates new challenges while simultaneously opening strategic opportunities for industrial modernization and enhanced competitiveness in the EU market. To assess the potential economic impact, this analysis considers three key dimensions: technological, financial, and market-related.

Technological aspect. The carbon intensity of Ukrainian production varies significantly across sectors. Metallurgy is characterized by high specific CO<sub>2</sub> emissions (exceeding 1.8 tonnes per tonne of output), whereas the cement industry and the electricity sector exhibit moderate emission levels of 0.55–0.75 tonnes per tonne. Chemical production, including nitrogen fertilizer manufacturing, remains heavily dependent on natural gas, resulting in additional emissions. In this context, three technological transformation pathways appear particularly promising: the transition to low-carbon energy sources (renewable energy, nuclear power, and green hydrogen), the deployment of carbon capture, utilization, and storage (CCUS) technologies, and the modernization of production processes, notably the development of direct reduced iron (DRI) technologies in metallurgy. The adoption of these solutions not only reduces emissions but also lowers long-term operating costs, thereby making technological modernization economically viable.

Financial aspect. The potential burden on exporters is determined by a combination of export volumes and the price of CBAM certificates. At an average cost of €30 per tonne of CO<sub>2</sub>, the direct costs for the metallurgical and aluminum sectors could exceed €1 billion per year if export volumes remain unchanged. To mitigate this pressure, companies may rely on various decarbonisation financing mechanisms, including government support programmes, international financial instruments (international financial institution loans, green bonds, and climate fund grants), and public–private partnership models. Optimal investment planning requires ensuring that capital expenditures are lower than the cumulative future operating costs associated with the purchase of CBAM certificates, thereby making modernization financially viable.

Market aspect. As CBAM alters the structure of competitiveness in the European market, Ukrainian manufacturers face the need to strengthen their market positions. Companies capable of demonstrating a low carbon footprint of their products will gain access to premium market segments and reduce the risk of losing market share due to higher export costs. Key instruments for building a sustainable market position include the adoption of Product Environmental Footprint (PEF) certification, the development of “green” industrial clusters, and the rebranding of products to reflect their reduced environmental impact. These measures will facilitate deeper integration into European value chains and stimulate further innovation.

To summarize the strategies for adapting industries to CBAM requirements, a comparative table is presented that highlights the key areas of modernization across technological, financial, and market dimensions. This approach enables a clear systematization of decarbonization instruments and identifies the solutions most relevant for each sector. The summarized results are presented in Table 2.

Table 2. Strategies for adapting key sectors of the Ukrainian economy to CBAM requirements in technological, financial, and market dimensions

Sector	Technology (Decarbonization)	Finance (Investment)	Market
Metallurgy	DRI, CCS, RES	Decarbonization Fund, Green Bonds	PEF certification, green clusters
Aluminum	CCS, RES, modernization	PPP, international grants	Rebranding products as "green"
Chemistry	CCS, modernization	Green bonds	PEF certification
Cement	CCS, modernization	Decarbonization fund	Green industrial clusters
Energy	RES, hydrogen	PPP, IFIs	Access to markets with high demand for green electricity

Based on the analysis above, several key patterns can be identified.

First, all sectors exhibit substantial technological potential for reducing carbon intensity; however, the dominant solutions differ significantly. The metallurgical and cement industries primarily focus on carbon capture and storage (CCS) and process modernization, whereas the energy sector has the greatest potential for rapid transformation through the scaling-up of renewable energy sources (RES) and the use of hydrogen. This highlights uneven technological readiness across sectors, which should be taken into account when designing state support measures.

Second, the structure of financial mechanisms reflects different capital-raising models. Capital-intensive industries, such as metallurgy and cement, mainly rely on the Decarbonisation Fund and green bonds, while the energy and aluminium industries largely depend on public-private partnership instruments and resources from international financial institutions. This indicates that effective decarbonisation requires a differentiated financing model tailored to sector-specific characteristics.

Third, market strategies form the basis for strengthening competitive advantages under CBAM. Industries with high export potential, such as metallurgy and aluminum, focus on carbon footprint certification and the development of green industrial clusters, which allow them to strengthen their positions in premium market segments. The

energy sector, by contrast, focuses on expanding access to markets with growing demand for green electricity, thereby creating opportunities for deeper integration into European supply chains.

In summary, the successful adaptation to CBAM requires a комплексний approach based on the following principles:

- technological innovations must be combined with clear and effective financial mechanisms;
- market strategies should amplify the economic benefits of decarbonization;
- sectoral differences require flexible government and corporate policies.

Overall, an integrated approach combining technological, financial, and market-based measures is essential to minimize CBAM-related costs and enhance the long-term competitiveness of Ukrainian exporters.

The study finds that the implementation of CBAM for Ukrainian exporters creates both additional economic risks and strategic opportunities for industrial modernization and enhanced competitiveness in the EU market. The technological analysis indicates that the adoption of low-carbon energy sources, carbon capture, utilization, and storage (CCUS) technologies, and the modernization of production processes in the metallurgical, chemical, and cement industries can significantly reduce specific CO<sub>2</sub> emissions as well as long-term operating costs. The financial analysis demonstrates that the use of state support programmes, international financial assistance, and public-private partnership mechanisms makes capital investments in decarbonization economically viable by ensuring their payback relative to the cumulative costs of purchasing CBAM certificates. Market analysis further shows that compliance with CBAM requirements and the implementation of green positioning strategies facilitate access to premium segments of the EU market, enhance the relative competitiveness of Ukrainian products, and support deeper integration into European value chains. Thus, the results confirm that a coordinated technological, financial, and market-oriented response to CBAM is essential for reducing compliance costs while fostering long-term competitiveness and sustainable growth of Ukrainian industry.

### References

1. Belousova K. V. Ukraine's carbon emissions have increased by a quarter due to the war. EcoPolitics. URL: <https://ecopolitic.com.ua/ua/news/v-ukraini-cherez-vijnu-kilkist-vikidiv-vuglecju-zrosla-na-chvert/> (accessed on 03.12.2025).
2. Kitura, A., Panov, V. Carbon tax could cost Ukraine \$300 million. Which manufacturers will be hit hardest? EY calculations. Forbes Ukraine magazine. 2023. URL: <https://forbes.ua/money/vugletseviy-podatok-mozhe-koshtuvati-ukraini-300-mln-po-yakikh-virobnikakh-vin-vdarit-naysilnishe-rozrakhunki-ey-22032023-12550>.
3. Mosorko, A. In Ukraine, CO<sub>2</sub> emissions reached 180 million tons due to hostilities. This is the annual level of one of the EU countries. Ukrainian Truth. Life. URL: <https://life.pravda.com.ua/society/vikidi-co2-vnaslidok-boyovih-diy-v-ukrajini-dosyagli-180-mln-tonn-mindovkillya-301594/> (accessed on 03.12.2025).
4. UN Comtrade. UN Comtrade. URL: <https://comtradeplus.un.org/TradeFlow> (date of access: 06.12.2025).