

Carbon Border Adjustment at the Definitive Stage: Exposure Channels, Domestic Carbon Pricing and Green Finance Architecture in Azerbaijan

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Abstract

The European Union's Carbon Border Adjustment Mechanism (CBAM) entered its definitive phase on 1 January 2026, converting an instrument of climate policy into an operative condition of market access. This paper examines what that transition means for a small, hydrocarbon-dependent open economy that is simultaneously attempting to diversify its industrial exports and to position itself as a supplier of renewable electricity to the European market. Using documentary analysis of the CBAM legal framework together with scenario-based sensitivity estimates, the study maps Azerbaijan's exposure across four transmission channels: products already within scope (aluminium, iron and steel, fertilisers), electricity exports planned through the Black Sea submarine interconnector, transit and supply-chain effects associated with the Trans-Caspian corridor, and the prospective downstream extension of the mechanism from 2028. Three findings emerge. First, the financial burden of 2026 is negligible because only 2.5 per cent of embedded emissions attract a certificate obligation in the first year; the binding constraint is instead the absence of verified installation-level emissions data, which triggers conservative country-specific default values carrying a mark-up that rises from 10 per cent in 2026 to 30 per cent in 2028. Second, because a documented domestic carbon price is deductible from the CBAM liability, the policy question is not whether the carbon cost is paid but to whose budget it accrues; the paper shows, however, that this rent-capture logic only becomes fiscally advantageous once the phase-in factor is high, and quantifies the threshold. Third, drawing on recent panel evidence, the paper argues that the binding constraint on green investment in Azerbaijan is the architecture of green finance rather than the volume of fiscal expenditure. An eight-point policy framework and a sequencing timetable are proposed.

1.0 INTRODUCTION

For most of its history the debate on carbon pricing has been a debate about domestic environmental policy. On 1 January 2026 that framing became obsolete. On that date the European Union's Carbon Border Adjustment Mechanism (CBAM) left the

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transitional regime, under which importers were required only to report the emissions embedded in covered goods, and entered the definitive regime, under which those emissions generate a financial obligation [21]. The change is not merely procedural. For roughly three decades international trade law and climate policy developed as largely separate fields; CBAM closes that separation and converts the emissions intensity of production into a condition of market access.

The implications for Azerbaijan are more immediate than the country's modest share in European industrial imports would suggest. Three circumstances converge. First, having hosted COP29 in Baku in November 2024, Azerbaijan submitted an updated Nationally Determined Contribution in November 2025 committing to a 40 per cent reduction in net greenhouse gas emissions by 2035 relative to 1990, equivalent to a fall from 85 to 51 MtCO₂e, conditional on international financial and technological support [35], [36]. Second, the country's industrial base contains three of the six product groups currently within CBAM's scope — aluminium, iron and steel, and fertilisers — and access to the European market for the first of these is being actively prepared [37]. Third, and least discussed in the literature, CBAM covers electricity, while Azerbaijan's principal green-energy export project is a submarine cable delivering power directly into the European grid [41].

Against these commitments stands a structural gap: Azerbaijan operates no carbon pricing instrument. Recent panel evidence covering thirty-three countries over 2010–2021 treats the country as an illustrative case and identifies a triple deficit — environmental expenditure well below the sample average, no carbon price, and an institutional quality score below zero — a combination that helps explain why measured green investment lags stated ambition [1].

This paper assesses CBAM's implications for Azerbaijan on the basis of the mechanism's operative parameters: the phase-in factor, the treatment of default values, the verification regime, and the rule permitting deduction of a carbon price paid in the country of origin. Four questions organise the analysis. What obligations does the definitive regime create, and how do they evolve? Through which channels, and at what magnitude, is Azerbaijan exposed? Does a domestic carbon price represent a net cost or a net gain for the national budget? And is the binding constraint on the required investment fiscal capacity or financial architecture?

The paper proceeds as follows. Section 2 reviews the relevant literature and sets out the conceptual framework. Section 3 describes the data and method. Section 4 presents the results, covering the design of the definitive regime, the exposure channels, the scenario estimates, and the arithmetic of domestic carbon pricing. Section 5 discusses the findings, including their trade-law dimension, and derives a policy framework. Section 6 concludes and Section 7 states the limitations.

2.0 LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 Carbon leakage and the logic of border adjustment

The theoretical foundation of CBAM is the problem of carbon leakage. Where one jurisdiction prices emissions and another does not, carbon-intensive production has an incentive to relocate to the unregulated jurisdiction. Global emissions then do not fall; they change address, while the regulating jurisdiction loses industrial capacity. The conventional remedy — allocating free allowances to domestic producers — mitigates leakage but simultaneously weakens the price signal that the system exists to transmit.

The European approach escapes this dilemma by coupling the two sides: free allocation is withdrawn on a fixed schedule while imports are brought under an equivalent obligation at the same pace [22]. In principle the mechanism is therefore not a protective tariff but the extraterritorial extension of an internal carbon price; in practice the distinction is less clean, and for exporting countries the functional consequence resembles a tariff.

Evidence on the underlying instrument is reasonably strong. Dechezleprêtre, Nachtigall and Venmans [20] find that the EU Emissions Trading System reduced emissions without measurable damage to economic performance, which matters for CBAM's legitimacy: the mechanism extends a system that demonstrably works. Analysis of the transitional phase nevertheless indicates that the trade effect will be uneven, with estimated reductions in EU imports of covered goods ranging from about 4 per cent for aluminium to about 26 per cent for fertilisers [32]. For a small open economy this dispersion is the operative signal: the impact is product-specific rather than uniform.

2.2 Fiscal expenditure, carbon pricing and the complementarity hypothesis

The proposition that fiscal expenditure and carbon pricing are complementary is intuitive: spending lowers the cost of green projects while pricing raises the cost of carbon-intensive ones. The empirical record is more equivocal. Abdulhasanova et al. [1], estimating a two-way fixed-effects model on an unbalanced panel of thirty-three countries over 2010–2021, find that government environmental expenditure alone does not significantly predict green investment. The interaction with carbon pricing is positive but does not reach conventional significance, and the authors state explicitly that the data do not reject the complementarity hypothesis but do not confirm it either.

This caution is analytically consequential and is adopted here. Recommending a domestic carbon price on the grounds that it will amplify fiscal spending would overstate what the evidence supports. The argument advanced in Section 4.4 rests instead on the deduction rule inside CBAM itself, which is a matter of institutional design rather than of estimated elasticities.

A second and statistically more robust result from the same study is directly relevant. Mediation analysis shows that government environmental expenditure significantly deepens financial markets — a one-percentage-point increase in expenditure is associated with roughly a forty-seven-point rise in the ratio of domestic credit to GDP — but that this deepening does not translate into green capital allocation. The gap is therefore not between fiscal ambition and fiscal capacity but between financial depth and green financial capacity [1]. Section 4.5 develops this point for the Azerbaijani case.

2.3 Energy transition, supply chains and corridor economics

The economic case for the transition itself is grounded. Aliyev et al. [3], comparing Azerbaijan and Iceland, establish a positive relationship between renewable energy consumption and economic growth, which supports treating decarbonisation as growth policy rather than solely as environmental compliance.

On the supply-chain side, Abdulhasanova, Ahmadova and Alasgarova [4] propose a six-pillar analytical framework integrating decarbonisation strategies with closed-loop supply chain design. The framework maps closely onto CBAM's requirements for complex goods, which oblige producers to transmit precursor-level emissions data along the chain. Ahmadova, Alasgarova and Ibrahimov [10] examine public-private partnership models for sustainable logistics infrastructure, while Ahmadova and Mammadov [11] analyse the contribution of Industry 4.0 and digitalisation to sustainable economic structure. Institutional design and digitalisation — the two strands — correspond precisely to the practical requirements of CBAM compliance.

Azerbaijan's transit function enters indirectly but materially. Abdulhasanova and Abdulhasanov [7] assess the Middle Corridor and the Zangezur Corridor in global supply chains, while Abdulhasanova et al. [6] examine customs efficiency and logistics performance. The latter acquires new significance under CBAM, since the mechanism operates through codes declared at customs clearance [21], turning customs administration into an instrument of climate regulation. Mammadov, Ahmadova and Ibrahimov [8], [9] extend this to smart logistics ecosystems and to the corridor's contribution to the Sustainable Development Goals.

2.4 The gap addressed by this paper

Three gaps are identifiable. First, the CBAM literature concentrates on large exporters — China, India, Türkiye, the Russian Federation, South Africa — and offers little on small open economies that export hydrocarbons while attempting industrial diversification. Second, the electricity channel is almost entirely unexamined, even though several countries pursuing renewable electricity exports to the European Union face an obligation on precisely that product. Third, CBAM adaptation is generally framed as a compliance cost, whereas the deduction rule makes it, for the exporting state, a question of public finance. This paper addresses all three in the Azerbaijani case.

3.0 DATA AND METHODS

The study combines documentary analysis of the legal framework with scenario-based sensitivity estimation. The choice is dictated by data availability: verified installation-level emissions data for Azerbaijani producers are not in the public domain, so no reliable basis exists for econometric estimation. Under such conditions a transparent scenario analysis with explicitly stated assumptions is the more honest instrument.

The legal and regulatory corpus comprises Regulation (EU) 2023/956, the CBAM Omnibus Regulation adopted on 8 October 2025 and in force from 20 October 2025 [23], and the package of implementing and delegated acts published on 17 December

2025, including the acts governing default values and the free-allocation adjustment [24], [25], [26], [28]. Statistical and institutional sources include the World Bank's State and Trends of Carbon Pricing 2025 [33], Azerbaijan's NDC 3.0 as submitted to the UNFCCC [35], statements of the Ministry of Energy and the Renewable Energy Agency [42], [43], [44], and specialist market analysis [31].

Scenario estimates in Section 4.3 apply the following identity:

$$Liability = Volume (t) \times Emissions\ intensity (tCO_2e/t) \times CBAM\ factor (\%) \times Certificate\ price (€/tCO_2e)$$

Four assumptions are stated explicitly. (i) The deduction available in respect of the free-allocation benchmark is not applied, so the figures are gross and should be read as upper bounds. (ii) Export volume is set at 50,000 tonnes per year, a figure consistent with the historically reported output range of the Ganja aluminium complex [50]; it is an assumption about scale, not a statement about current output. (iii) Emissions intensity is presented under two cases, a direct-emissions case of 2.0 tCO₂e per tonne and a combined direct-and-indirect case of 14 tCO₂e per tonne, the latter drawn from the range of 13–15 tonnes reported for aluminium production inclusive of the electricity input [37]. (iv) The certificate price is held at €75.36 per tCO₂e, the reference value published for the first quarter of 2026 [30], with no escalation, so the estimates isolate the effect of the phase-in factor rather than of price movement.

The scenarios are a sensitivity exercise, not a forecast. Their purpose is to establish the order of magnitude of the exposure and the direction of its movement over time.

4.0 RESULTS

4.1 The architecture of the definitive regime

The transitional phase ran from 1 October 2023 to 31 December 2025, during which importers filed quarterly reports without financial consequence. From 1 January 2026 reporting moved to an annual declaration, emissions data became subject to mandatory third-party verification, and a financial obligation arose [27]. The Omnibus Regulation introduced a set of simplifications, of which the most significant is an annual mass threshold of fifty tonnes per importer for iron and steel, aluminium and fertiliser categories, below which no obligation applies; the earlier €150 value threshold was removed and the certificate surrender obligation deferred to 2027 [23].

Table 1. Implementation timetable of the definitive CBAM regime

Date	Event
1 Oct 2023 – 31 Dec 2025	Transitional phase; quarterly reporting only, no payment

Date	Event
1 Jan 2026	Definitive regime begins; CBAM codes required on EU import declarations
31 Mar 2026	Deadline for applications for authorised CBAM declarant status
1 Feb 2027	Sale of CBAM certificates begins
30 Sep 2027	First annual declaration and certificate surrender for 2026 imports
1 Jan 2028	Proposed extension to downstream goods with high steel or aluminium content
2034	Free allocation fully withdrawn; CBAM factor reaches 100%

Sources: compiled by the authors from [21], [23], [24], [25], [26], [27].

The price of a CBAM certificate is linked to EU ETS auction prices, computed as a quarterly average during 2026 and moving to a weekly average from 2027 [28]. The published reference value for the first quarter of 2026 was €75.36 per tCO₂e [30]. That headline figure is nevertheless a poor guide to the actual burden in the early years, because the obligation is phased in at the same rate at which free allocation is withdrawn.

Table 2. CBAM factor and residual free allocation, 2026–2034

Year	CBAM factor	Free allocation	Illustrative cost, 1 t of aluminium at 14 tCO ₂ e/t and €75.36
2026	2.5%	97.5%	€26
2027	5.0%	95.0%	€53
2028	10.0%	90.0%	€106
2029	22.5%	77.5%	€238

Year	CBAM factor	Free allocation	Illustrative cost, 1 t of aluminium at 14 tCO ₂ e/t and €75.36
2030	48.5%	51.5%	€512
2031	61.0%	39.0%	€644
2032	73.5%	26.5%	€776
2033	86.0%	14.0%	€908
2034	100.0%	0%	€1,055

Sources: phase-in schedule from [22] and [28]; cost column calculated by the authors, gross of the free-allocation benchmark deduction.

Table 2 clarifies a point frequently lost in public discussion. The year 2026 is financially close to immaterial but institutionally decisive: the reporting and verification practice established now determines the cost structure of the 2030s, when the same physical volume attracts forty times the charge.

4.2 Verification, default values and the data asymmetry

The most demanding component of the definitive regime for exporters is not price but data. Actual emissions figures may be used only if verified by an accredited third party; where verification is absent or fails, country-specific default values apply [21]. Default values are deliberately conservative, and a mark-up is added to encourage the use of actual data, rising for most goods from 10 per cent in 2026 to 30 per cent in 2028 [29].

An exporter unable to document its emissions is therefore penalised twice: once through the conservative default value and again through the escalating mark-up. The corollary is that investment in verification converts directly into financial saving, and that this saving grows as the mechanism strengthens. For Azerbaijan the practical implication is that the construction of an installation-level monitoring, reporting and verification (MRV) system is a trade-policy priority rather than an environmental one.

4.3 Exposure channels and scenario estimates

Channel I: aluminium. Aluminium is classified as the highest-risk commodity within the CBAM system because of the energy intensity of primary smelting. Reported figures place total emissions, inclusive of the electricity input, at 13–15 tonnes of CO₂ per tonne of metal [37]. The distinction between direct and indirect emissions is not a technical footnote but the principal source of risk. CBAM presently captures direct emissions for aluminium; market analysis indicates that bringing indirect emissions into scope could

raise the sector's aggregate liability from roughly €1 billion to about €4.7 billion [31]. Given that Azerbaijani electricity generation remains predominantly gas-fired, such an extension would materially alter the competitive position of the country's aluminium exports.

Industry has begun to respond. In May 2026 it was reported that Azeraluminium LLC is working to obtain a carbon certificate for the European market and that the use of renewable energy sources to reduce the product's carbon footprint is expected to support competitiveness under CBAM requirements [37]. The company plans to raise annual export value to approximately 340 million manats — about USD 200 million — by 2030, from roughly 80 million manats at present [38].

Table 3. Scenario estimates of gross CBAM liability, aluminium, 50,000 t/year at €75.36/tCO₂e

Year (CBAM factor)	Direct emissions only (2.0 tCO ₂ e/t)	Direct and indirect (14 tCO ₂ e/t)
2026 (2.5%)	≈ €0.19 m	≈ €1.32 m
2030 (48.5%)	≈ €3.65 m	≈ €25.58 m
2034 (100%)	≈ €7.54 m	≈ €52.75 m

Authors' calculations. Figures are gross of the free-allocation benchmark deduction and therefore constitute upper bounds. See Section 3 for the full set of assumptions.

Set against the company's stated 2030 export target, the comparison is instructive. Converting 340 million manats at the prevailing peg of 1.70 AZN to the US dollar and at approximately 1.15 USD to the euro yields roughly €174 million. On that basis the 2030 liability under the combined-emissions case would represent about 14 per cent of export value — a burden that cannot be absorbed within normal margins. The exchange-rate assumption should be treated as indicative; the conclusion is robust to reasonable variation in it, since the direct-emissions case yields approximately 2 per cent and the combined case remains in double figures across plausible rates.

The same arithmetic reads in the opposite direction as well. If smelting is supplied from renewable generation, the indirect component approaches zero and the identical product acquires a structural advantage in the European market. CBAM thus attaches a measurable commercial return to renewable energy investment, altering the financial model of projects that have conventionally been justified on environmental grounds alone.

Channel II: iron, steel and fertilisers. Market modelling attributes roughly 75 per cent of potential CBAM liabilities to the iron and steel sector and identifies a wide dispersion

in emissions intensity within it, which creates both risk and opportunity depending on the production route [31]. Azerbaijani steel production is based predominantly on the electric arc furnace route with scrap input, which carries substantially lower emissions intensity than the blast furnace–basic oxygen furnace route. This is in principle an advantage — but only if it can be evidenced. Absent verification, a default value applies and the technological advantage remains economically invisible. Fertilisers present a different profile: for fertilisers and cement, CBAM captures indirect as well as direct emissions, and Azerbaijani urea production is gas-based with an emissions-intensive ammonia synthesis stage.

Channel III: electricity and the green-export paradox. This channel is the least examined and, strategically, the most important. Electricity is within CBAM's scope, and Azerbaijan intends to export electricity into the European Union through the Black Sea submarine cable. The intergovernmental agreement was signed in December 2022 between Azerbaijan, Georgia, Romania and Hungary; reported cable length ranges from 1,155 to 1,195 km and transmission capacity from 1,000 to 1,300 MW, and the project obtained EU Project of Mutual Interest status in December 2025 [41]. Public sources diverge on the completion date, citing 2029 in some cases and 2032 in others — a discrepancy that is itself indicative of the project's planning risk.

The decisive point is that the carbon content of exported electricity is assessed by reference to the exporting country's grid. Should power transmitted from Azerbaijan not qualify as renewable, it will generate a CBAM obligation and the commercial logic of the project will be weakened. A functioning guarantee-of-origin system, together with a mechanism linking exports to dedicated renewable generation, is therefore not an administrative detail but a condition of the project's commercial viability.

Azerbaijan's renewable targets require reassessment in this light. The official objective is to raise the share of renewables in installed generating capacity to 30 per cent by 2030 [42]. More ambitious figures have since been stated by officials: in June 2025 the President announced a target of 6.5 GW of installed renewable capacity by 2030, representing more than 35 per cent of the grid [43], and in June 2026 a Deputy Minister of Energy indicated shares of 39 per cent by 2030 and 43 per cent by 2035 [44]. The upward drift reflects political ambition, but it also signals that planning documents require formal updating if the targets are to carry regulatory weight.

Channel IV: corridor and indirect effects. The fourth channel is systemic rather than direct. Freight along the Middle Corridor rose by roughly 62 per cent in 2024 to about 4.5 million tonnes and reached approximately 5.2 million tonnes in 2025, against a target of 10 million tonnes by 2027 [45]; World Bank modelling suggests that, with the requisite investment and reform, volumes could approach 11 million tonnes by 2030 [34]. Supporting infrastructure has expanded accordingly, with the annual freight capacity of the Baku–Tbilisi–Kars railway raised from 1 to 5 million tonnes following modernisation and the capacity of the Baku International Sea Trade Port at Alat scheduled to rise from 15 to 25 million tonnes [46].

A portion of the Central Asian goods moving along this corridor towards the European Union falls within CBAM categories. Two requirements follow for Azerbaijan: precise documentation of origin, in view of the strengthened anti-circumvention framework proposed in December 2025 [24], and the capacity to account for the emissions of the transport stage, in view of the proposed downstream extension from 2028. Customs administration is thereby recast: under CBAM it functions not only as a fiscal and control authority but as a transmission node for climate data, which gives the findings of Abdulhasanova et al. [6] on customs efficiency an operational dimension.

4.4 The arithmetic of a domestic carbon price

One of the least discussed but economically most consequential provisions of the CBAM Regulation is the deduction rule: a carbon price demonstrably paid in the country of origin in respect of the goods concerned is deducted from the CBAM obligation [52]. The consequence is straightforward. If Azerbaijan levies no domestic carbon price, payment in respect of the emissions embodied in its exports will still be made — it will simply accrue to the European system. The policy choice is not whether to pay but to whom.

The magnitudes can be stated. In the aluminium scenario above, combined emissions amount to 700,000 tCO_{2e} per year. At the full 2034 factor and a certificate price of €75.36, this implies a gross obligation of approximately €52.8 million. A domestic carbon price of €30 per tonne applied to the same goods would retain roughly €21 million within the national budget while reducing the CBAM obligation correspondingly. The total burden on the exporter is unchanged; only the destination of the revenue differs.

This argument requires an important qualification that is frequently omitted. The deduction cannot reduce the certificate obligation below zero, and the obligation itself is scaled by the phase-in factor. In 2026, at a factor of 2.5 per cent, the CBAM liability on the same volume is approximately €1.32 million, whereas a domestic price of €30 per tonne would collect roughly €21 million. In that year the domestic tax is overwhelmingly a net cost to the exporter rather than a substitution for a payment that would otherwise be made abroad. The two converge only as the factor rises. Setting the deductible fraction equal to the domestic rate, a domestic price of €30 against a certificate price of €75.36 is fully absorbed once the CBAM factor exceeds roughly 40 per cent, which the schedule reaches between 2029 and 2030.

Table 4. Domestic carbon price of €30/tCO₂e against CBAM liability, 700,000 tCO₂e

Year	CBAM liability at €75.36	Domestic revenue at €30	Share of domestic tax offset by deduction
2026 (2.5%)	€1.32 m	€21.0 m	≈ 6%
2028 (10%)	€5.28 m	€21.0 m	≈ 25%
2030 (48.5%)	€25.58 m	€21.0 m	100%
2034 (100%)	€52.75 m	€21.0 m	100%

Authors' calculations. The final column expresses the proportion of domestic carbon tax revenue that displaces a payment the exporter would otherwise make to the EU system.

The sequencing implication is precise. A domestic carbon price introduced late captures no rent; introduced too early and at too high a rate, it imposes a cost without a corresponding offset. The design horizon that reconciles the two is a phased instrument whose rate rises broadly in step with the CBAM factor, which points to introduction in the second half of the present decade with a low initial rate.

On design, the World Bank has advised that, should the government decide to adopt a carbon pricing instrument, it would be appropriate to begin with an upstream carbon tax levied on the carbon content of fuels as they enter the economy, using the existing excise system. Such a tax was estimated to cover approximately 60 per cent of national emissions, with scope for later expansion and eventual transition to an emissions trading system, and with part of the revenue directed to low-income households through cash transfers [39]. A critical caveat applies: to be deductible under CBAM, the carbon price must be explicit, documented and verifiable. Indirect taxes, energy excises and subsidy reform do not automatically satisfy this requirement, so compatibility with EU methodology must be designed in from the outset rather than retrofitted.

Institutional preparation is under way. A draft Law on Climate submitted for public consultation by the Ministry of Ecology and Natural Resources provides for systematic monitoring of the carbon market, covering the issuance, transfer, use and cancellation of carbon units, analysis of transactions in a National Carbon Registry, compliance oversight and the identification of market risks; it also sets criteria for the registration of carbon projects, including additionality, measurability, verifiability, avoidance of double counting, leakage management and social and environmental safeguards [40]. This is registry infrastructure rather than a pricing mechanism, but the sequence is

correct: neither a carbon tax nor an emissions trading system can be administered without it.

A parallel track concerns international carbon markets. In January 2026 it was reported that Japan and Azerbaijan were close to finalising a bilateral agreement under Article 6.2 of the Paris Agreement, with credits to be generated by a project decarbonising the country's largest oil and gas terminal [49]. A conceptual distinction must be preserved here: Article 6 credits do not offset a CBAM obligation, which recognises only an explicit carbon price actually paid. The two mechanisms serve different purposes and should not be treated as substitutes in policy documents. The wider context is that eighty carbon pricing instruments were in operation worldwide in 2024, covering approximately 28 per cent of global greenhouse gas emissions and mobilising more than USD 100 billion for public budgets [33]. Carbon pricing is no longer a marginal practice, and remaining outside it increasingly entails relative disadvantage.

4.5 The green finance constraint

Adaptation requires capital: renewable generation, energy efficiency, process modernisation, measurement equipment. The question is where that capital originates.

Abdulhasanova [2] documents what may be termed a green financing paradox in Azerbaijan: the banking sector holds substantial liquidity while green projects receive a negligible share of domestic credit, with the annual green investment gap estimated at approximately USD 2.3 billion. This is consistent with the cross-country mediation result reported above. Where banks lack green lending units, green risk assessment tools, a taxonomy for classifying eligible projects and the capacity to issue long-maturity instruments, additional liquidity simply produces more conventional lending [1].

The comparative figures locate Azerbaijan's position. In the same panel, environmental expenditure averages approximately 0.16 per cent of GDP against a sample mean of 0.58 per cent; the institutional quality score averages -0.58 against a sample mean of $+0.81$; and the renewable share of installed capacity rose from 15.6 per cent in 2010 to 20.3 per cent in 2023 without narrowing the gap to the sample mean of 39.7 per cent [1].

External finance will not close this gap on its own. The New Collective Quantified Goal adopted at COP29 sets a floor of at least USD 300 billion per year by 2035 for developing countries, alongside an aspirational figure of USD 1.3 trillion from all sources [47]. Analysis cited by Carbon Brief nevertheless suggests that, on current trajectories, the sources potentially covered by the goal may reach only around USD 427 billion a year by 2035, less than a third of the aspiration [48]. A strategy premised on external climate finance is therefore insufficient; domestic financial architecture must be built.

Two adjacent literatures reinforce the point. Ahmadova and Seyidzada [15] examine methods for assessing financial stability in commercial banks, an agenda that intersects directly with the integration of climate transition risk into capital adequacy assessment

— and CBAM is a concrete instance of such risk, since the quality of credit extended to carbon-intensive exporters will change as the mechanism strengthens. Ahmedova [16] emphasises the economic weight of institutions and societal values, which is consistent with the institutional quality findings above: building a green financial system is a matter of regulatory and administrative culture as much as of technical rule-making. Ahmadova et al. [5] address the prioritisation of investment for ecological sustainability, and CBAM supplies a new and measurable prioritisation criterion — which investments best protect market access.

4.6 Digital MRV as enabling infrastructure

The technical core of adaptation is the MRV system. The data required are at installation and process level: the specific production route, the origin of precursor materials, the CN code, the country of origin, whether default values were used, and verification particulars [51]. This differs qualitatively from conventional environmental reporting.

Here the Azerbaijani research on blockchain and customs logistics acquires applied relevance. Ahmadova et al. [12] examine blockchain applications in customs logistics and their effect on transparency; Ahmadova and Mammadov [13], [14] analyse the technology's potential to reduce risk in multichannel logistics systems and its impact on supply chain management. The connection to CBAM is direct, since the verification regime requires immutability of recorded emissions data, traceability along the chain at precursor level, and a single source of truth shared between producer, verifier, customs authority and EU importer.

Technological enthusiasm should nevertheless be tempered. Distributed ledgers secure the immutability of data, not their accuracy; an erroneous or falsified initial measurement remains erroneous once recorded. The correct sequence is therefore physical measurement and accounting systems first, accreditation infrastructure second, distributed ledger solutions third. Inverting that order — deploying the technology ahead of the underlying accounting system — is a common and expensive error.

A broader caution follows from Abdulhasanova et al. [17], who show that a proliferation of digital tools does not automatically raise productivity. Applied to MRV, this yields a specific recommendation: a single data entry principle rather than an accumulation of parallel reporting systems. The observation of Abdulhasanova and Aliyeva [18] applies equally — under CBAM, competitive advantage is determined not only by cost structure but by data quality.

5.0 DISCUSSION

5.1 The trade-law dimension

Any assessment of CBAM must acknowledge that its compatibility with multilateral trade rules remains contested. Proponents argue that the mechanism is a legitimate internal measure applied at the border under Article III:2 of the General Agreement on Tariffs and Trade, since it extends to imports a charge already borne by domestic

production, and that in any event it could be justified under the environmental exceptions of Article XX. Critics contend that the calculation methodology, the treatment of default values and the recognition of foreign carbon prices may operate in a discriminatory manner in practice, and several developing-country members have raised the matter in WTO committees. This paper takes no position on the legal question. Its relevance here is practical: the possibility of future modification is a source of planning risk, and it argues for adaptation measures that retain value regardless of the mechanism's legal fate. An MRV system and lower-carbon production are valuable under any plausible outcome; a strategy calibrated solely to the current text of the Regulation is not.

5.2 Three scenarios

Scenario A, passive adaptation, involves no systematic state-level action, with firms pursuing verification individually; the consequence is widespread application of default values with escalating mark-ups and complete transfer of carbon rent to the EU budget. Scenario B, data-centred preparation, establishes MRV and accreditation infrastructure without a carbon price: firms can then use actual emissions data and avoid default values, generating measurable savings, but rent transfer continues. Scenario C, integrated adaptation, builds MRV infrastructure, an explicit domestic carbon price phased in line with the CBAM factor, and green financial architecture in parallel, while linking renewable generation to industrial decarbonisation.

On the analysis presented here, Scenario B is the minimum rational threshold and Scenario C the optimum. Scenario A produces an apparent short-term saving while accumulating a growing liability for the period 2029–2034.

5.3 A policy framework

Eight measures follow from the analysis. First, a national MRV system covering the sectors within CBAM's scope, at installation level and methodologically compatible with EU requirements; this is the highest priority because every other measure presupposes it. Second, a national accreditation body, since without accredited verifiers actual data cannot be used and dependence on foreign verifiers is both costly and capacity-constrained. Third, an explicit carbon price, beginning as the World Bank recommends with an upstream levy on the carbon content of fuels, designed from the outset to satisfy EU documentation standards, phased in step with the CBAM factor, and with part of the revenue directed to low-income households. Fourth, a guarantee-of-origin system, designed as an integral component of the Black Sea cable's commercial model rather than added after commissioning. Fifth, green financial architecture — a national taxonomy, climate risk disclosure requirements for banks, and a sovereign green bond framework — justified directly by the finding that liquidity alone is insufficient [1]. Sixth, legal provision for direct power purchase agreements between industrial consumers and renewable generators, since the aluminium scenario shows the indirect emissions component to be the single largest lever. Seventh, integration of carbon data into customs systems on a single data entry basis, which also

serves the corridor function. Eighth, a just transition component, since structural adjustment in carbon-intensive sectors will affect employment and may influence migration flows, for which the existing research framework on migration management [19] provides a basis for ex ante assessment.

5.4 Timing

The available window is narrower than it appears. The CBAM factor is 2.5 per cent in 2026 but reaches 22.5 per cent in 2029 and 48.5 per cent in 2030. Establishing an MRV system, building accreditation capacity and preparing the legislative framework typically require three to five years. Work begun in 2026 will therefore become fully operational around 2030 — precisely when the mechanism becomes materially expensive. Delay implies entering the costliest phase unprepared.

6.0 CONCLUSION

This paper has assessed the implications of CBAM's transition to its definitive phase for Azerbaijan on the basis of the mechanism's operative legal parameters. Three conclusions follow.

First, the near-term financial impact is limited, but this is a warning rather than a reassurance. The 2.5 per cent starting factor opens a preparation window that closes in 2029–2030. The mechanism's real test occurs four to five years hence, and work not undertaken now cannot be performed retrospectively.

Second, the critical gap is informational rather than financial. Without verified emissions data the genuine technological advantages of Azerbaijani producers — electric arc furnace steel being the clearest example — remain economically invisible and default values apply. This is a net loss arising from purely administrative causes.

Third, domestic carbon pricing should be framed not as a cost but as a question of where revenue accrues. The deduction rule means that the issue is not whether a carbon charge is paid but whether it remains within the national budget. The analysis nevertheless qualifies this: the rent-capture logic holds only once the phase-in factor is high, which argues for a phased instrument introduced in the second half of the decade rather than an immediate high rate.

Empirical caution is warranted alongside these conclusions. The evidence in [1] indicates that the complementarity between carbon pricing and fiscal expenditure is theoretically well grounded but not yet statistically established. The more robust finding concerns financial architecture: public expenditure deepens financial markets without automatically producing green capital allocation. The highest-return policy direction for Azerbaijan is therefore neither fiscal expansion nor regulatory tightening in isolation, but the construction of green financial infrastructure.

CBAM is simultaneously a risk and an opportunity. The risk is that an unprepared country loses part of its export market while transferring carbon rent abroad. The opportunity is that the mechanism raises, in measurable and commercial terms, the

return on renewable energy investment, and thereby supplies a business case for green transition targets that have hitherto rested largely on environmental argument. Which outcome materialises will be determined by the institutional work undertaken between 2026 and 2030.

7.0 LIMITATIONS AND DIRECTIONS FOR FURTHER RESEARCH

Three limitations should be noted. First, verified installation-level emissions data for Azerbaijani producers are not publicly available, so the estimates in Section 4.3 are scenarios and must not be read as forecasts; emissions intensities are drawn from reported ranges, and the omission of the free-allocation benchmark deduction biases the figures upward. Second, the precise composition of Azerbaijan's exports to the European Union within CBAM categories at CN code level was not obtained within the scope of this study; detailed analysis of customs statistics is a priority for further work. Third, the legal framework is in active evolution: the proposed downstream extension has not been adopted, the treatment of indirect emissions for aluminium remains open, and default values and benchmarks are scheduled for revision in 2026–2027.

Four directions for further research follow: construction of a product-level exposure index from customs data; assessment of a domestic carbon tax within a computable general equilibrium framework with revenue recycling scenarios; a technical and economic feasibility study of a guarantee-of-origin system for electricity exports; and comparative analysis of CBAM readiness across the South Caucasus and Central Asia.

List of Abbreviations

AZN — Azerbaijani manat; CBAM — Carbon Border Adjustment Mechanism; CN — Combined Nomenclature; CO_{2e} — carbon dioxide equivalent; COP — Conference of the Parties; ETS — Emissions Trading System; EUA — European Union Allowance; GDP — gross domestic product; GW — gigawatt; MRV — monitoring, reporting and verification; MW — megawatt; Mt — million tonnes; NDC — Nationally Determined Contribution; PMI — Project of Mutual Interest; UNFCCC — United Nations Framework Convention on Climate Change; WTO — World Trade Organization.

Declarations

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Data availability. All data supporting the analysis are drawn from the publicly available sources listed in the References. The scenario calculations reported in Tables 2, 3 and 4 are reproducible from the assumptions stated in Section 3 and are available from the corresponding author on request.

Use of generative artificial intelligence. During the preparation of this work the authors used an AI-based language tool for translation, language editing and the structuring of source material. The authors reviewed and edited all output, verified every

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