The ASEAN Steel Sector: Carbon Intensity, Trade Patterns, and CBAM Exposure

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1. Introduction

Southeast Asia has emerged as one of the most dynamic steel-producing regions in the world over the past decade. Vietnam, Indonesia, and Malaysia account for the overwhelming share of ASEAN's crude steel output and together represent both the region's industrial ambitions and its vulnerabilities in the context of the European Union's Carbon Border Adjustment Mechanism (CBAM). Understanding the character of their steelmaking industries - scale, technology mix, export orientation, domestic demand patterns, and trade practices - is essential for assessing the differential impact of carbon pricing mechanisms on the region. Thailand is a net importer whose exports flow predominantly within ASEAN rather than to the EU, and its direct CBAM exposure is limited. The Philippines remains at an early stage of steelmaking development with its first integrated facility under construction. Myanmar and Singapore are minor producers at negligible scale. This analysis therefore focuses on Vietnam, Indonesia, and Malaysia.

The Carbon Border Adjustment Mechanism and Its Implications for Steel Trade

The CBAM is a trade measure adopted by the EU to prevent carbon leakage - the risk that climate regulation within the EU drives carbon-intensive production to jurisdictions with lower or absent carbon costs, from which goods are then exported back into the EU market. By placing a carbon price on imports of selected goods, CBAM ensures that imported products are subject to a cost equivalent to that borne by EU producers under the EU Emissions Trading System (ETS).

Under the CBAM regulation, importers of steel products into the EU are required to purchase CBAM certificates corresponding to the embedded CO_2 emissions of their imports, priced at the ETS allowance price – quarterly average in 2026 and weekly from 2027. The number of certificates required is determined by the verified emissions intensity of the specific production facility; where verified data are unavailable, default values set by the European Commission apply - and these defaults are calibrated punitively, creating a strong incentive for exporters to invest in emissions monitoring and verification.

CBAM entered a transitional phase in October 2023, during which importers faced reporting obligations but no financial liability. The definitive phase, with full certificate purchase requirements, began in January 2026. The EU ETS carbon price, which determines the cost of CBAM certificates, has fluctuated in recent years but is expected to face upward pressure as the ETS cap tightens through the 2030s. At carbon price levels consistent with the EU policy trajectory, the resulting CBAM charge on BF-BOF steel can represent a significant cost relative to typical steel trading margins.

Where facility-level verified emissions data are unavailable, importers must apply default emissions values set at an elevated level and augmented by a mark-up calibrated conservatively to ensure embedded emissions are not underestimated. This design is intentionally punitive, incentivising producers to verify actual emissions in line with the EU's Monitoring, Reporting and Verification (MRV) framework. The mark-ups are subject to a phased schedule and are to be revised by December 2027 at the latest, meaning the financial incentive to invest in robust MRV systems will only intensify over time.

The implications for non-EU steel exporters are strategic rather than incidental. Producers operating carbon-intensive processes - principally BF-BOF steelmaking, which accounts for the majority of global crude steel output - face a direct cost penalty on EU-bound exports. Producers lacking credible emissions verification systems face additional exposure through the application of default values. And countries whose steel sectors are expanding BF-BOF capacity risk a growing and compounding CBAM liability as the mechanism moves into its operative phase.

Southeast Asia is at the centre of this exposure. The region's three principal steelmaking economies - Vietnam, Indonesia, and Malaysia - have undergone rapid, predominantly BF-BOF-driven capacity expansion over the past decade. They are integrated into EU trade flows, and face questions around both carbon intensity and trade integrity in CBAM context.

Objective

This paper examines the carbon intensity, trade patterns, and investment trajectories of the steel sectors in the focused countries to provide an independent and analytical basis for assessing their exposure to CBAM and informing decisions on compliance, decarbonisation, and trade strategy.

Methodology

The analysis draws on a combination of publicly available statistical sources, regulatory documents, and published research. Production volumes, technology mix, and trade data are sourced primarily from the World Steel Association Steel Statistical Yearbook 2025, supplemented by national industry data where available. Capacity pipeline data are based on the Global Energy Monitor Global Iron and Steel Tracker, with authors' updates. Emissions intensity estimates are drawn from peer-reviewed literature and institutional reports, with weighted national averages calculated using the technology shares reported for 2024. CBAM liability parameters (default values and ETS benchmarks) are applied from EU implementing regulations. The paper does not present original facility-level emissions measurements; emissions estimates are indicative and intended to illustrate the analytical framework for CBAM exposure assessment rather than to serve as the basis for regulatory compliance calculations.

2. Production Scale and Growth Trajectory

The three countries started from broadly comparable positions - all three produced between 3.8 and 5.6 million tonnes (Mt) in 2015 - and have followed a similar path since: rapid capacity expansion driven predominantly by BF-BOF (Blast Furnace - Basic Oxygen Furnace) investment. What differs is not the direction of development but its pace and scale, making the comparison instructive for understanding the role of investment volume and market size rather than differences in industrial strategy.

The production expansion has occurred alongside sustained and substantial import volumes across all three countries, indicating that domestic capacity growth has not displaced import demand (Figure 1). Vietnam is the most striking case, maintaining imports of roughly 15 Mtpa even as its own output rose sharply, while also emerging as a growing exporter - reaching 11.4 Mtpa by 2024 - suggesting that capacity additions have begun to outpace domestic absorption. Indonesia followed a similar export trajectory. Malaysia, despite its comparatively smaller production base, saw the sharpest relative export growth, with outbound volumes eventually exceeding domestic output - pointing to a significant processing role rather than purely domestically-driven production.

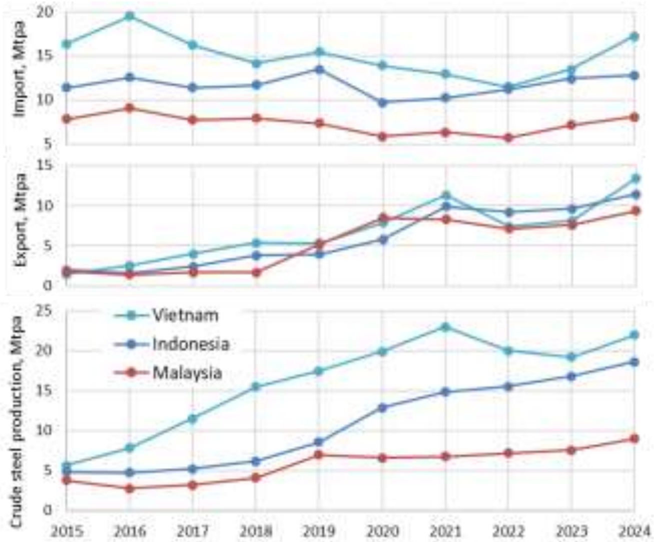

Figure 1. Steel production (crude), export and import Source: World Steel Association, Steel Statistical Yearbook 2025. [1]

As shown in Figure 2, the share of the less carbon-intensive scrap-based Electric Arc Furnace (EAF) route in total steel output has declined across all three countries over this period, with the remainder of production accounted for by BF-BOF.

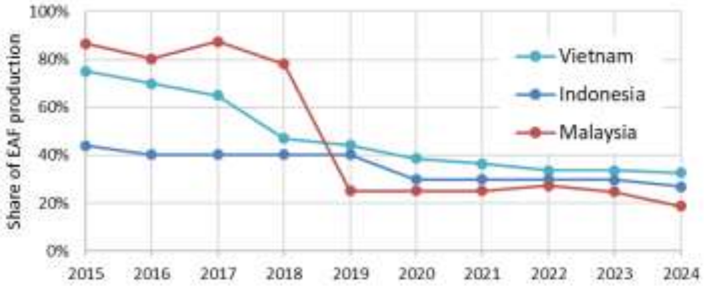

Figure 2. Share of steel produced in EAF. Source: World Steel Association, Steel Statistical Yearbook 2025.

Vietnam

Vietnam has undergone dramatic transition, with crude steel production rising from 5.6 Mt in 2015 to nearly 22 Mt in 2024, making it the largest steel producer in Southeast Asia and placing it among the top 20 globally. The dominant domestic producer is a Vietnamese-owned Hoa Phat Group, that has expanded integrated BF-BOF capacity over the past decade and now operates one of the largest blast furnace complexes in the region. A second major contributor to output growth has been Formosa Ha Tinh Steel (FHS), a Taiwanese-invested, integrated complex that began production in 2017. These two have fundamentally altered Vietnam's technological profile in steelmaking, shifting it from a predominantly EAF producer towards BOF dominance: roughly two-thirds of Vietnamese crude steel was produced via BOF by 2024.

Indonesia

Indonesia's output grew from 4.9 Mt in 2015 to 18.6 Mt by 2024, making it the region's second-largest producer. The sector's backbone remains state-owned Krakatau Steel, the country's oldest and historically largest steel enterprise, which operates an integrated BF-BOF complex in Cilegon, West Java. Alongside Krakatau Steel, a wave of primarily Chinese private investment has significantly expanded the capacity - notably at the Morowali and Weda Bay industrial parks in Sulawesi, where ferronickel, carbon steel and stainless steel are produced in adjacent facilities. This expansion has been closely tied to Indonesia's downstream ambitions in nickel processing and electric vehicle supply chains, rather than to domestic steel demand alone. The share of output produced via BF-BOF has risen sharply, from around 56% in 2015 to over 73% by 2024. Indonesia is a significant and growing producer of stainless steel, that gives it a distinctive export profile with practical relevance for EU trade flows, discussed further in Section 2.4.

Malaysia

Malaysia's crude steel output is considerably smaller, at approximately 9 Mt in 2024, and has grown more modestly from 3.8 Mt in 2015. Malaysia has shifted towards BOF-dominance, with BOF share exceeding 80% by 2024 as new Chinese-linked capacity came online - principally Alliance Steel and Eastern Steel. What distinguishes Malaysia in the regional context is not its production scale but its extraordinarily high export intensity and the questions surrounding the origins and composition of its traded steel, discussed in detail in Section 2.5.

3 Technology Mix and Carbon Intensity Implications

The technology mix is the most important determinant of carbon intensity in steelmaking and, consequently, of a CBAM liability. BOF-based production, which relies on iron ore processed in a blast furnace using coking coal, is inherently carbon-intensive. EAF-based production, which melts scrap or direct reduced iron (DRI) using electricity, can in principle achieve much lower emissions, though actual performance depends heavily on the carbon content of the local electricity grid.

Southeast Asia's low per capita steel consumption has historically limited the accumulation of end-of-life scrap, constraining the domestic feedstock base for EAF steelmaking and reinforcing the logic of BF-BOF investment. Since 2007, nominal crude steel production capacity in Southeast Asia via the BF-BOF route has grown exponentially, while EAF capacity has expanded at a broadly linear pace since the early 1960s (Figure 3). Approximately 93% of existing BOF nominal capacity and 94% of BF capacity were installed after 2007 - meaning the region's BOF fleet is, by global standards, relatively modern and likely to perform at or near benchmark emissions intensity. The opposite holds for EAF: 75% of EAF-based facilities are over 20 years old and 45% exceed 30 years of age. While EAF service life can be extended even beyond 40 years through the replacement of major components and significant reinvestment, opportunities to upgrade energy efficiency and environmental performance in ageing facilities are often constrained by the physical layout of existing structures and can be prohibitively expensive to implement, meaning that continued operation does not necessarily imply modernisation. This age profile carries significant implications for CBAM. The region's older EAF plants, while operating on a route that is inherently lower-carbon, are likely to be less energy-efficient than the EU EAF benchmark and, potentially, are less likely to have advanced data management systems needed for reliable CBAM emissions reporting. **The case for urgent modernisation therefore lies with the ageing EAF fleet rather than with the recently commissioned BF-BOF plants.**

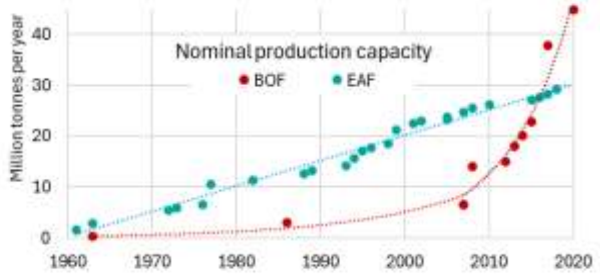

Figure 3. Development of crude steel production in Southeast Asia via BOF and EAF routes. Data include Indonesia, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam. Elaborated by authors based on Global Energy Monitor[2]

The global Worldsteel average for BF-BOF route emissions stands at 2.32 tCO_2 per tonne of crude steel (CS)[a]. All three major ASEAN producers are slightly above this global average for their BOF output - a reflection of relatively modern installed capacity, but also of limited progress on energy efficiency or fuel substitution. For the scrap-EAF route, the Worldsteel global average is 0.7 tCO_2/t CS[3], largely dependent upon grid conditions. The estimated overall CO_2 intensities in Table 1 reflect this combined technology-and-grid profile: Vietnam's weighted average of approximately 1.78 tCO_2/t is consistent with its two-thirds BOF share and a coal-intensive power grid, while Indonesia's 1.88 tCO_2/t follows a similar logic at a marginally higher BOF share. Malaysia's overall intensity of approximately 2.00 tCO_2/t is notable in that its 81% BOF share is offset, in part, by a somewhat less carbon-intensive power grid than its neighbors. **The emissions intensity values in Table 1 are reproduced as reported in the cited sources; their representativeness is the responsibility of those sources and subject to independent scrutiny. Actual emissions intensities for specific facilities, as well as national averages, may differ in practice.**

Country	BF-BOF route		Scrap (or DRI)-EAF route		Weighted average CO_2 intensity, tCO_2/t-CS
	Share	Emissions, t CO_2 /t-CS	Share	Emissions, t CO_2 /t-CS	
Vietnam	67%	2.35	33%	0.62	1.78
Indonesia	73%	2.38	27%	0.66	1.88
Malaysia	81%	N.A.	19%	N.A.	2.00

Table 1. Technology mix and CO_2 emissions (Scope 1+Scope 2)[b], 2024. N.A. - not available. Sources: Vietnam - [4]; Indonesia BOF - [5]; Indonesia EAF - [6] (combined EAF, ladle furnace and continuous caster); Malaysia - estimated as a projection from 2020 data [7].

Table 2 shows the specific direct emissions default values applicable under EU Regulation 2025/2621[8]. The values defined for carbon steel (CN[c] 7207 11 11) and stainless steel (CN 7218 99 11)billets are used as an example. Table 3 presents the EU ETS benchmarks applied under the CBAM free allocation adjustment framework (Regulation (EU) 2025/2620[9]) for the corresponding steel products and production routes.

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[a] *Crude steel is steel in its first solid form after smelting, before any further processing or finishing. It encompasses all production steps and associated emissions up to the exit from the continuous caster (or equivalent solidification stage), but excludes downstream operations such as reheating, rolling, and finishing.*

[b] *Scope 1: Direct emissions from sources owned or controlled by the facility (e.g. fuel combustion in the furnace). Scope 2: Indirect emissions from purchased electricity consumed by the facility, attributed at the point of generation.*

[c] *The Combined Nomenclature (CN) is the EU's eight-digit coding system serving the EU's common customs tariff and providing statistics for trade within the EU and between the EU and the rest of the world.*

As discussed above, to incentivise the use of actual data, the Regulation imposes escalating mark-ups on the base default value: 10% in 2026, 20% in 2027, and 30% from 2028 onwards. The base values represent the average emission intensity as determined by the Joint Research Centre.

Table 2 reflects the production structure of the region: Annex I lists BF-BOF values for Indonesia and Vietnam, and scrap-EAF values for Myanmar, the Philippines and Thailand - consistent with the dominant steelmaking route in each case. Malaysia has no country-specific entry for either route and falls back to the "Other countries and territories" values. Notably, DRI-EAF defaults are absent for all six countries, leaving a residual gap for that route. In the absence of any explicit provision, the applicable BF-BOF or scrap-EAF default - whichever is listed - would serve as the only available fallback, likely overstating embedded emissions for DRI-based producers and resulting in disproportionate CBAM certificate costs. This is expected to be addressed in the planned revision of the Default Values Regulation, due no later than December 2027. Stainless steel is an exception: Annex I assigns no production route indicator, as the Regulation treats the default value as independent of the upstream production method reflecting the variety of primary melting routes used in stainless production globally, where AOD (Argon Oxygen Decarburization) refining is widespread but upstream processes differ. Table 2 covers the principal steel-producing and trading countries in the region. Other Southeast Asian countries are omitted for brevity; they have no country-specific Annex I entries and fall back to the 'Other countries and territories' default values across all routes and products.

Indonesia's default values are among the highest in the Regulation, incentivising deployment of MRV and trade transparency.

Country	Scrap-EAF carbon crude steel t CO_2 / t				BF-BOF carbon crude steel, t CO_2 / t				Route independent stainless crude steel, tCO_2 / t			
	Default	2026 +10%	2027 +20%	2028+ +30%	Default	2026 +10%	2027 +20%	2028 +30%	Default	2026 +10%	2027 +20%	2028 +30%
Indonesia	N.D.	N.D.	N.D.	N.D.	8.230	9.053	9.876	10.699	8.670	9.537	10.404	11.271
Malaysia	N.D.	N.D.	N.D.	N.D.	*3.000**	*3.300**	*3.600**	*3.900**	*3.300**	*3.630**	*3.960**	*4.290**
Vietnam	N.D.	N.D.	N.D.	N.D.	2.350	2.585	2.820	3.055	3.440	3.784	4.128	4.472
Myanmar	0.47	0.517	0.564	0.611	N.A.	N.A.	N.A.	N.A.	3.13	3.443	3.756	4.069
Philippines	0.74	0.814	0.888	0.962	N.A.	N.A.	N.A.	N.A.	2.92	3.212	3.504	3.796
Thailand	1.92	2.111	2.303	2.495	N.A.	N.A.	N.A.	N.A.	3.390	3.729	4.068	4.407

*Table 2 – CBAM specific embedded direct emissions default values for semi-finished carbon steel and stainless steel ingots (N.D. – no data, N.A. – not applicable, * - country-specific values not listed, values listed for "Other countries and territories" apply according to the Regulations)*

For CBAM reporting purposes, Scope 2 electricity emissions must currently be disclosed but are excluded from CBAM certificate calculations for steel as of 2026[10]. This reflects the EU's decision to mirror its existing ETS framework, under which EU producers are compensated for the higher electricity costs arising from carbon pricing. This exclusion is, however, temporary: the regulation commits to incorporating indirect emissions as soon as possible, pending review. When that extension occurs, the coal-heavy power mixes of Vietnam and Indonesia will translate into a substantial additional CBAM liability for EAF-based steel producers in those countries, with the combined burden reflected in the country-level estimates in Table 1.

The benchmarks in Table 3 are set at EU best-in-class levels, reflecting the top-performing EU installations under each EU ETS product benchmark. As noted above, these values exclude Scope 2 emissions, whereas the values in Table 1 include them. Given the grid emissions intensity in the countries examined, Scope 1 emissions alone may constitute around 20% of the Table 1 figures for the scrap-EAF route, while for BF-BOF the share of Scope 1 emissions exceeds 98%, reflecting the dominance of direct emissions in that process.[11] The benchmarks are therefore calibrated such that even efficient producers will face a positive net CBAM liability. Should CBAM be extended to cover Scope 2 emissions in the future, the implications would be asymmetric: for scrap-EAF producers, whose carbon footprint is heavily grid-dependent, such an expansion would represent an additional burden and a strong incentive to shift toward renewable energy sourcing; for BF-BOF producers, whose emissions are overwhelmingly direct, the change would be of limited additional consequence.

Importantly, as Table 3 illustrates, the benchmark applied when default values are used is significantly higher than the benchmark applicable when actual verified data are declared. This reflects the design principle that the default adjustment must mirror the default emissions conditions. The practical implication for non-EU producers is that switching from defaults to verified actual data does reduce gross embedded emissions substantially, but simultaneously reduces the free allocation offset, compressing the net cost benefit of verification. For EAF producers currently forced to apply the BF-BOF default in the absence of route-specific defaults, this dynamic is particularly pronounced: the potential gain from verification is partly absorbed by the shift to a much lower benchmark offset.

EU benchmark applied	Period	Carbon steel (CN 7207 11 11)			Stainless steel (CN 7218 99 11), route independent
		scrap-EAF	DRI-EAF	BF-BOF	
When actual data is used		0.065	0.065	0.188	0.358
When default data is used	2026-2027	0.066	0.475	1.364	1.419
	2028-2030				1.381

Table 3 – EU ETS CBAM benchmarks applicable to the calculation of the free allocation adjustment (tCO_2e per tonne of product), by production route and period.

All three countries are therefore exposed to significant CBAM costs on steel exported to the EU. The critical issue is that none of them benefits from the transitional advantage that EAF producers might enjoy in a carbon-adjusted trading regime: their BOF-heavy capacity cannot be decarbonized through fuel-switching alone, and green hydrogen-based direct ironmaking remains commercially distant in the ASEAN context.

A particular note applies to Malaysia. The country operates three DRI plants that could, in principle, feed DRI-EAF production and partially offset the upward pressure on average sector emissions from the growing BF-BOF share. However, two of the three DRI facilities have been idle for years, principally due to high natural gas costs and insufficient supply of high-grade iron ore pellets suitable for direct reduction.[12,13]

4 Domestic Demand, Export Orientation, and EU Market Exposure

Apparent Steel Use Per Capita

Indonesia's apparent steel use is chronically low in per capita terms, hovering between 50–70 kg per person throughout the decade (Figure 4) - well below the global average exceeding 230 kg. Yet this does not translate into domestic supply surplus. With apparent steel use equivalent to 97% of nominal capacity presented in Table 6, domestic demand is broadly in line with installed capacity and exceeds actual output, placing Indonesia as a net importer. While reflecting demand weakness, low current per capita consumption suggests substantial development potential: for a country of 280 million people, convergence towards the global average would generate incremental domestic demand of considerable scale, providing a stable and growing demand base that could underpin long-term sector development without reliance on export markets - provided that industrial policy, public infrastructure investment and manufacturing deepening are in place to activate it.

Vietnam presents an analogous pattern: despite considerably higher per capita consumption of 277 kg in 2024, reflecting rapid urbanisation, infrastructure investment and manufacturing export growth, apparent steel use stands at 127% of actual output, confirming its position as a net importer and the fastest-growing demand market of the three. Capacity utilisation, at 62%, further indicates that even the existing installed base is not fully absorbed by domestic demand, with the shortfall met by imports rather than idle capacity serving as a buffer for future consumption growth.

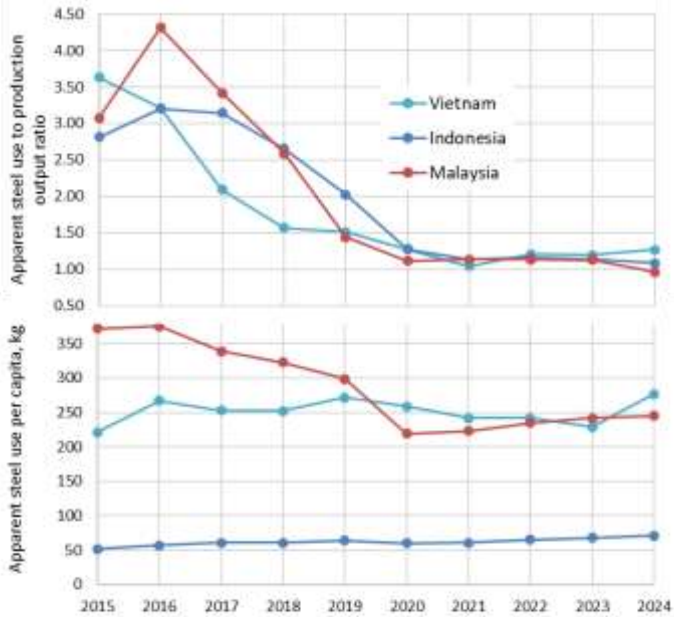

Figure 4. Apparent steel use per capita (crude steel equivalent)[d] and its ratio to steel output. Source: World Steel Association, Steel Statistical Yearbook 2025.

Malaysia presents the starkest contrast. As the most urbanised and industrialised of the three, it recorded per capita consumption of 245 kg in 2024, though this has declined notably from 2015-2016 peaks, reflecting a slowdown in construction activity. With apparent steel use at only 66% of nominal production capacity, Malaysia has by far the largest structural gap between installed capacity and domestic demand, making export markets critically important for its producers.

Figure 4 traces the ratio of apparent steel use to production output across the three countries, illustrating the rapid convergence from heavy import dependence towards domestic self-sufficiency - a transformation driven overwhelmingly by the BF-BOF capacity expansion documented above. Domestic consumption in all three countries is concentrated in construction-grade long products, consistent with the infrastructure and urbanisation investment driving demand growth, whereas exports are largely commodity-grade - billets and hot-rolled coil destined for regional markets - with stainless and alloy steel for higher-value export markets representing a notable exception, especially significant for Indonesia as discussed below.

Export and Import Intensity

Steel export volumes have grown sharply for all three producers since 2019 (Figure 5), but the pattern differs in character. Vietnam's growing exports reflect genuine domestic production surplus: its BOF capacity generates semi-finished and flat products that exceed domestic demand, channeled into regional and global markets. This is corroborated by the import-to-export ratio falling around tenfold within the decade, indicating that export growth has been driven by rising output rather than declining imports. Indonesia shows a similar pathway: an export-to-production ratio rising gradually over the decade, alongside a falling import-to-export ratio, reflects large new capacity installations producing more than the domestic market can absorb.

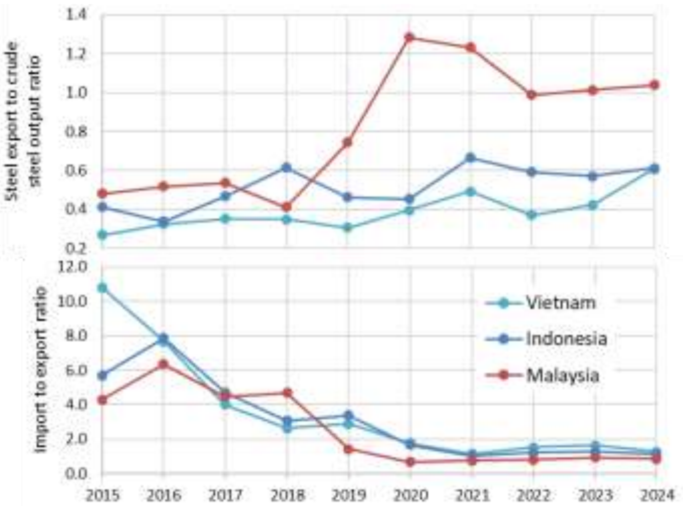

Figure 5. Steel export and its ratio to crude steel output. Source: World Steel Association, Steel Statistical Yearbook 2025.

Malaysia presents a qualitatively different and analytically more complex picture. Its exports surged above production from 2020 onwards - meaning exports have exceeded domestic crude steel output - while its imports and exports have converged. Together, these metrics point to a re-processing role, addressed in detail below.

[d] *Apparent steel use is calculated as production plus import minus export.*

Export structures differ meaningfully across the three: Indonesia's exports are led by ingots and semis (45%) and flat products (34%), reflecting its integrated and stainless-oriented capacity; Malaysia's exports are dominated by long products (55%), while Vietnam's are concentrated in flat products (61%), reflecting the flat-rolled surplus generated by its large BF-BOF installations.

Exports of Carbon Steel to the EU

In terms of direct EU market exposure for carbon steel, Vietnam is by far the most significant ASEAN exporter, having shipped 3.7 Mt to the EU in 2024, representing 10.4% of total EU carbon steel imports and 27.7% of Vietnam's own total steel exports with the total value of USD 2.7 billion. Indonesia and Malaysia are much smaller EU exporters of carbon steel with the EU share in their total export of 3.4% and 1.7%, respectively. (Table 4)

Country	Carbon steel exports to EU, 2024 million t	Share of EU carbon steel imports	Share of country's total steel exports	Value of export, USD million
Vietnam	3.700	10.4%	27.7%	2,722
Indonesia	0.385	1.1%	3.4%	254
Malaysia	0.158	0.4%	1.7%	96

Table 4. Carbon steel exports to the EU, 2024 (includes ingots/semis, long, flat and tubular products). Source: Worldbank[14]

Exports of Stainless Steel to the EU

The stainless steel trade picture is quite different, and reflects Indonesia's distinctive role as the world's top stainless steel exporter.[15] In 2024, Indonesia exported 105.9 kt of stainless steel to the EU, representing a 7.5% share of total EU stainless steel imports (Table 5). Malaysia, Vietnam and Thailand are minor EU stainless exporters (1.8%,1.5 and 1.3% share respectively). Stainless steel is subject to CBAM in the same manner as carbon steel; however, emissions accounting for it is complicated by the significant energy inputs associated with ferronickel and stainless melt shop operations, which may result in higher per-unit embedded emissions than comparable carbon steel.

Country	Stainless steel exports to EU, 2024, thousand t	Share of EU stainless steel imports	Value of export, USD million
Indonesia	106	7.5%	196
Malaysia	26	1.8%	65
Vietnam	20	1.5%	56
Thailand	19	1.3%	49

Table 5. Stainless steel exports to the EU, 2024. Source: Worldbank[14]

Indonesia's EU stainless exports were around three times higher in 2021 than in 2024, illustrating how the stainless steel dimension intersects with an active trade dispute. In October 2025, a WTO panel ruled that the EU's anti-subsidy duties on Indonesian cold-rolled stainless steel were improperly imposed - a formal finding in Indonesia's favor. In practice, however, the ruling is unlikely to translate into increased market access in the near term: the EU has appealed, and the existing duties remain in force. More fundamentally, even if the anti-subsidy duties were eventually removed, Indonesia's stainless steel sector faces a larger structural challenge from CBAM: its cost competitiveness in the pre-CBAM era rested on coal-powered nickel pig iron and rotary kiln electric furnace smelting (one of the most carbon-intensive production routes in the steel complex) - precisely the characteristics that CBAM is designed to penalise. This is reflected in assigning the Indonesian stainless steel a default emissions factor of 8.63 t-CO_2/t-CS in the CBAM framework - more than six times the EU benchmark of 1.419 t-CO_2.[10] For Indonesian exporters unable or unwilling to provide verified actual emissions data, this punitive default effectively prices their product out of the EU market regardless of the outcome of the WTO dispute. The carbon cost exposure under CBAM may even exceed the anti-subsidy duty itself. The stainless steel case thus illustrates a broader shift: the relevant competitive constraint on Indonesian steel exports to Europe is no longer primarily trade law, but carbon pricing; however, this subject deserves a dedicated discussion beyond the scope of this paper.[16]

5 Trade Integrity Concerns: Transhipment, Circumvention, and the Limits of Origin Rules

The most significant anomaly in ASEAN steel trade, and one with direct implications for CBAM enforcement, is the pattern of steel flows through Malaysia and, to a lesser extent, Vietnam that cannot be explained by those countries' domestic production alone.

The Malaysian Steel Export Anomaly

As shown in Figure 5, Malaysia's ratio of steel exports to crude steel output **exceeded 100% in 2020 and 2021 and has remained at or above 100% through 2024.** Worldsteel's data on Malaysia's imports of ingots and semis (i.e., billets and slabs) does not fully account for the discrepancy: the average difference between the total export and production of crude steel in 2021-2024 was 0.8 Mt vs average 0.2 Mt import of ingots and semis. The more plausible explanation is that Malaysia is importing large volumes of the products, classified as finished in trade statistics, and re-rolling or lightly processing them before exporting the output as Malaysian-origin products. However, a definitive assessment of the potential Malaysia's trade flows would require granular analysis of customs import statistics and product-level trade data, which falls outside the scope of this paper.

The scale of Malaysia's long products exports is particularly striking: volumes jumped from under 500 kt in 2018 to over 6 Mt in 2020–2021, a more than tenfold increase that bears no plausible relationship to any expansion of domestic long product steelmaking capacity. This pattern aligns closely with the escalation of US and EU anti-dumping and anti-circumvention duties on the steel of China and Taiwan origin, which created strong incentives to route the product through third countries with preferential market access or lower duty exposure.

Trade Investigations and Policy Precedents

Relevant governmental bodies in several countries initiated anti-circumvention inquiries into Malaysian and Vietnamese steel products on multiple occasions.[17, 18] In several cases, investigations found that the degree of processing performed in Malaysia was insufficient to confer new origin under the substantial transformation standard, and duties were extended accordingly. These findings are directly relevant to CBAM, where the question of which emissions are attributed to which origin will depend on similar origin determination frameworks.

Vietnam's Role in Regional Trade Flows

Vietnam exhibits a related but distinct pattern. Its share of ingots and semis in total steel exports has been highly variable, ranging from near-zero in 2015–2016 to nearly 50% in some years, suggesting opportunistic trading in semi-finished product rather than a stable industrial approach. Vietnam has also been the subject of circumvention investigations, particularly regarding corrosion-resistant and cold-rolled flat products manufactured using Chinese-origin input (hot-rolled coil or slab).[19]

Importantly, however, Vietnam's large integrated BOF facilities - Hoa Phat and Formosa Ha Tinh - produce steel from primary raw materials and generate verifiable, facility-level emissions data that can in principle be used for CBAM compliance. Generating facility-level data is, however, a necessary but not sufficient condition: full CBAM compliance requires adherence to the EU's Monitoring, Reporting and Verification (MRV) framework, which is unlikely to be fully in place at present and will require dedicated review and upgrades. The circumvention concern applies primarily to smaller downstream re-rollers and cold-rolling operations that purchase input coil from third countries, rather than to the dominant integrated producers.

Implications for CBAM

The transshipment and circumvention dynamics impact ASEAN amidst the implementation of CBAM, with policy interactions between EU frameworks remaining uncertain:

- **Origin and Emissions Verification:** Ensuring accurate carbon content declaration is crucial, especially when processing steel with Chinese semi-finished products elsewhere. ASEAN exporters need robust procedures that align emissions declarations with actual production conditions and account for upstream emissions from imported materials.
- **Carbon Leakage via Transshipment Hubs:** If CBAM increases costs for direct Chinese steel exports to Europe, ASEAN transshipment hubs may experience intensified routing. Effective anti-circumvention measures must be in place to prevent mere displacement of carbon leakage rather than its elimination - a concern heightened by policy uncertainties.

Key Analytical Implication

The steel sectors of Vietnam, Indonesia, and Malaysia differ not only in size and technology but in the nature of their integration into global supply chains. Vietnam's CBAM exposure is primarily a function of its large, coal-intensive integrated steelmaking base. Indonesia's is similarly driven by BOF-heavy capacity expansion, compounded by a distinct stainless steel dimension. Malaysia's exposure is further complicated by opacity in its export flows, making it both a direct CBAM liability and a potential enforcement pressure point for the European Commission's anti-circumvention agenda.

6 Sector Outlook: Investment Pipeline Deepening BF-BOF Dominance

Far from converging towards lower-carbon production routes, the investment pipeline across ASEAN confirms that BF-BOF capacity will continue dominating through the late 2020s and beyond (Table 6). The aggregate picture is stark: of the 92.4 Mt of announced crude steel capacity, 63.7 Mt (68%) is BOF-based, with a further 5.5 Mt of BOF capacity currently under construction. This is among the most consequential findings for CBAM policy: new BOF capacity being commissioned today carries a 25–30-year operational lifespan, meaning that ASEAN steelmakers risk a lock-in to high-carbon production precisely as the EU's carbon price mechanism enters full operation.

Country	Current total nominal steelmaking capacity, (Mt)	Planned capacity additions (Mt)											
		Total steel	BOF	EAF	Total iron	BF	DRI	Total steel	BOF	EAF	Total iron	BF	DRI
		Announced						Under Construction					
Cambodia	**0.0**	**3.1**	3.1	0.0	**3.1**	3.1	0.0	**0.0**	0.0	0.0	**0.0**	0.0	0.0
Indonesia	**20.8**	**21.0**	21.0	0.0	**6.0**	6.0	0.0	**0.0**	0.0	0.0	**0.0**	0.0	0.0
Malaysia	**13.2**	**17.6**	17.1	0.5	**23.6**	16.6	7.0	**5.0**	5.0	0.0	**7.5**	5.0	2.5
Myanmar	**0.2**	**4.0**	4.0	0.0	**4.0**	4.0	0.0	**0.2**	0.0	0.2	**0.5**	0.0	0.5
Philippines	**1.5**	**7.5**	0.0	7.5	**0.0**	0.0	0.0	**2.6**	0.0	2.6	**1.5**	0.0	1.5*
Singapore	**0.7**	**0.0**	0.0	0.0	**0.0**	0.0	0.0	**0.0**	0.0	0.0	**0.0**	0.0	0.0
Thailand	**9.0**	**2.5**	0.0	2.5	**2.5**	0.0	2.5	**0.0**	0.0	0.0	**0.0**	0.0	0.0
Vietnam	**36.2**	**36.7**	18.5	18.2	**12.3**	12.3	0.0	**2.5**	0.5	2.0	**0.6**	0.6	0.0
Total	**81.6**	**92.4**	**63.7**	**28.7**	**51.5**	**42.0**	**9.5**	**10.3**	**5.5**	**4.8**	**10.1**	**5.6**	**4.5**

Table 6. Nominal ASEAN steel and iron capacity pipeline by production route and project status. Source: Global Energy Monitor[12] with authors' updates. Announced includes projects at pre-construction and feasibility stages. (the exact technology mix applied at Mount Zynai Integratred Steel Mill and Smelting Plant in Philippines is not disclosed)*

Investment, Ownership, and the Carbon Lock-In Dynamic

In the CBAM context, several features of the investment landscape warrant careful consideration, particularly regarding cross-border capital flows and BOF capacity expansion:

- **Malaysia:** Malaysia's capacity pipeline is large relative to its domestic market, with 17.1 Mt of announced BF-BOF and a further 5.0 Mt under construction, implying total installed capacity well above 30 Mt and pointing to an inherently export-oriented model, with key investors including Chinese state-linked entities such as Hebei Xin Wu'an Steel and Beijing Jianlong-backed Eastern Steel. However, the announced BF-BOF pipeline should be treated with caution: in September 2025 the government has imposed a ban on new BF-BOF plants, redirecting policy toward DRI-HBI facilities as feedstock for EAFs[20], meaning much of the announced capacity may never materialise with only plants already under construction representing firm additions. Malaysia's recent natural gas discoveries[21] further suggest an emerging ambition to become a regional DRI/HBI export hub, which, if realised, would significantly alter both the carbon profile and trade character of its steel sector.
- **Indonesia** is developing an integrated steelmaking base through state and foreign investments: 21.0 Mt BOF announced pipeline is spearheaded by Dexin Steel Morowali (14 Mt via Best Grace Holdings Pte Ltd, Singapore-registered with Chinese ownership). Additionally, there's a 4.0 Mt expansion at Krakatau Steel's Cilegon plant (80% owned by the Government of Indonesia) and the 3.0 Mt KS Posco Cilegon venture (50% South Korean POSCO, 50% Krakatau Steel). These investments are broadly aligned with Indonesia's downstream industrialisation policy, which positions steel as a foundational industry supporting construction, transport, and EV manufacturing, with the strategic aim of reducing import dependence and establishing Indonesia as a net steel exporter.[22] Capacity expansion has in practice outpaced the targets set under the National Industry Development Master Plan, reflecting the pace of foreign-led investment rather than centrally managed growth. Decarbonisation remains a secondary priority: Indonesia currently lacks a unified national roadmap for steel sector emissions reduction, and the BF-BOF pipeline suggests that carbon intensity will remain high for the foreseeable future.[23]
- **Vietnam:** With a more varied investor pipeline than Indonesia or Malaysia, it splits 39.2 Mt capacity additions between BOF and EAF, reflecting varied strategies. Major BOF investors include Formosa Ha Tinh Steel (14.0 Mt, Taiwan-owned) and Vina Roma Quang Tri (4.5 Mt, Vietnamese private). On the EAF front, investments come from Siam Cement Group (Thailand) and domestic firms like Hoa Sen Phu My. This investment mix sits within a more deliberate policy framework than is evident in Indonesia or Malaysia: newly formalised Vietnam's Steel Industry Development Strategy to 2030, vision 2050 sets explicit targets to meet 80–85% of domestic demand by 2030 and reach production of 75–80 Mt by 2050[24], linking steel development closely to national infrastructure and industrial modernisation goals. Notably, the strategy also targets green and energy-saving steel products and cleaner raw materials, suggesting a greater degree of long-term decarbonisation ambition[25] than the current BOF-heavy pipeline might imply, though the gap between stated policy direction and actual investment composition remains significant.
- **Philippines and Thailand** are unique in the pipeline with zero announced BOF capacity positioning both countries as potential CBAM outliers. The Philippines focuses on EAF-based capacity, with projects like HBIS-SteelAsia, BaoSteel-SteelAsia, and SteelAsia's locally owned plant. Thailand's Meranti Green Steel (Singapore-linked, 2.5 Mt) is DRI-EAF based.
- **Cambodia and Myanmar:** These countries contribute smaller but notable BOF volumes. China Baowu's Phnom Penh plant (3.1 Mt, fully owned by Baowu Steel) represents Chinese state-owned capacity in Cambodia. In Myanmar, the Kunming Iron and Steel plant showcases a Chinese footprint. Meanwhile, the Myingyan plant (0.2 Mt EAF) is linked to the Myanmar military, posing governance and sanctions-risk challenges.
- **Governance and Incentives:** Government support is evident across these countries, with tax benefits, below-market land pricing, and debt restructuring, like that seen with Krakatau Steel. These incentives enhance the appeal of BF-BOF investments, potentially overriding CBAM developments in Europe.

A critical but uncertain variable is the future availability of low-carbon steelmaking feedstock. Domestic scrap supply remains constrained by relatively recent industrialisation: the stock embedded in buildings, infrastructure, and vehicles is still accumulating rather than reaching end-of-life at scale, and the timeline for this to change is highly sensitive to assumptions about asset lifetimes and collection infrastructure. Scrap import is an alternative but introduces price volatility and competition with other scrap-consuming economies. Where the DRI-EAF route is considered as a transition pathway, another supply constraint applies: the availability of DRI-grade iron ore with iron content over 67% is limited, accounting for around 4% of the global iron ore supply[26], adding a second layer of feedstock risk. A BOF-to-EAF route switch is therefore not simply a capital expenditure decision but depends on a feedstock transition whose commercial viability within the operational lifetime of assets being commissioned today should be treated as a key sensitivity in any techno-economic assessment of compliance pathways.

Carbon Lock-In Risk

A central question in the CBAM context is whether its price signal will effectively redirect investment toward lower-carbon pathways, or whether it will primarily cause trade diversion rather than technological change. With new BOF capacity being commissioned and expected to operate well into 2050, the 63.7 Mt in ASEAN's pipeline poses a substantial carbon liability against the EU's ETS goal for near-zero industrial emissions.

The predominance of Chinese state-owned and state-linked capital in this pipeline underscores the likelihood of trade diversion. These investments are guided by strategic and industrial-policy considerations that may not respond to CBAM price signals alone. However, the feasibility and consequences of diversion differ by country and product. For Indonesia, CBAM exposure is concentrated in stainless steel - a niche, premium product for which alternative global buyers at comparable margins may be difficult to secure at scale, implying direct margin compression rather than straightforward rerouting. For Vietnam, exposure centres on carbon steel flat products - HRC, CRC and similar commodities - which are more readily diverted to alternative markets, though alternative buyers are unlikely to pay equivalent prices for products originally specified to EU standards. Malaysia's direct EU exposure appears more limited, with ASEAN markets potentially able to absorb its long product exports; however, if Malaysia functions partly as a hub for repackaging Chinese-origin steel destined for the EU, CBAM would directly disrupt the economics of that model by attributing carbon costs to the embedded emissions regardless of the country of final processing.

These distinctions suggest that trade diversion is neither uniform nor costless, and that for Indonesia and Vietnam in particular, CBAM compliance may remain economically competitive relative to the margin penalties of market diversion, provided that robust MRV systems are established and verified facility-level emissions data are used rather than the conservative default values applied in their absence. However, only a rigorous techno-economic assessment beyond the scope of this paper can quantify this for specific product categories and facilities. Without such analysis, and without financial incentives for early conversion of high-carbon assets, the region risks a combination of stranded investment and intensified competition in non-EU markets, potentially undermining the viability of newly commissioned capacity.

Implications for CBAM Exposure Trajectory

The investment pipeline implies that the aggregate CBAM liability of ASEAN steel exporters to the EU will grow, not shrink, over the next five years. As new BOF capacity is commissioned and ramped up - particularly in Indonesia (21 Mt announced), Malaysia (21.6 Mt combined announced and under construction), and Vietnam (19 Mt BOF announced) - the volume of high-emission steel seeking export markets will increase substantially. In the absence of a credible decarbonisation pathway or a carbon pricing mechanism within ASEAN, CBAM represents an increasingly hard constraint for producers in the region.

A further consideration is the current state of domestic carbon pricing and MRV infrastructure. Though Vietnam and Indonesia have ETS frameworks at various stages of development; neither is yet operational at a scale or price level relevant to offset CBAM liability. Malaysia is introducing a carbon tax under its forthcoming Climate Change Act, with iron and steel among the first targeted industries[27], though the initial per-tonne rate is expected to be modest and to increase only gradually, meaning its near-term impact on CBAM offsetting will be limited.. Facility-level MRV systems capable of generating verified emissions data - necessary to avoid the penalty of conservative default values - remain at an early stage. The combination is consequential: without a domestic carbon price, producers receive no offsetting credit, and without verified data, they bear a substantial cost disadvantage relative to what actual emissions performance might justify. Both gaps need to be addressed simultaneously, and action is already urgent.

Illustrative calculations of CBAM cost exposure for ASEAN steel exporters under various carbon price scenarios were presented at **Navigating CBAM impacts for steel and cement producers** Ramboll webinar, available at https://c.ramboll.com/navigating-cbam-impacts-for-steel-and-cement-producers

Conclusions

1. Vietnam, Indonesia, and Malaysia have undergone rapid, predominantly BF-BOF driven capacity expansion and now account for the bulk of ASEAN's carbon steel and stainless steel exports to the EU. Their weighted average emissions intensities translate into substantial CBAM cost liabilities as the mechanism enters its definitive phase. Vietnam faces the largest absolute exposure through its integrated carbon steel exports; Indonesia's stainless steel dimension adds a distinct and potentially costlier layer; Malaysia's anomalous export-to-production ratios raise trade integrity concerns that place it at the centre of the European Commission's anti-circumvention agenda.
2. The investment pipeline offers no near-term relief: 68.7 Mt of new BF-BOF capacity is announced or under construction across the region, the majority financed by Chinese state-owned or state-linked capital whose investment logic is shaped by strategic considerations extending well beyond CBAM cost signals. Unless the mechanism is accompanied by effective origin verification and anti-circumvention enforcement, the primary effect in the short to medium term is likely to be trade diversion rather than decarbonisation.
3. A further complication for strategic planning is the counterintuitive age profile of the regional fleet: BF-BOF capacity is predominantly modern, commissioned after 2007, while the EAF sector - nominally the lower-carbon route - is largely ageing, with three-quarters of facilities over 20 years old. This weakens the assumption that a shift towards EAF would deliver an immediate emissions dividend, and complicates both the investment case for route-switching and the reliability of emissions reporting under CBAM.
4. Trade diversion is neither a uniform nor a costless response to CBAM. Compliance may remain economically competitive relative to the margin penalties of redirecting exports to alternative markets only if robust MRV systems are established and verified facility-level emissions data replace the conservative defaults applied in their absence. Without such investment in measurement infrastructure, and without financial incentives for early conversion of high-carbon assets, the region risks a combination of stranded investment and intensified competition in non-EU markets. Quantifying the compliance-versus-diversion trade-off for specific product categories and facilities requires a rigorous techno-economic assessment that this paper is intended to inform.

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