Getting the Transition to CBAM Right: Finding pragmatic solutions to key implementation questions

IMPULSE

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With acknowledgements to:
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Dear reader,

As part of its July 2021 package in support of a 55 percent reduction in greenhouse gas emissions by 2030, the European Commission proposed a Carbon Border Adjustment Mechanism (CBAM). The purpose of the mechanism is to prevent the risk of carbon leakage while free allowances to manufacturing industries are gradually phased out under the revised EU ETS.

The CBAM is controversial. It represents a massive shift in the system of carbon leakage protection. However, if designed correctly, and complemented with a robust package of supporting policies, CBAM could be a key enabler of the industrial transition to low-carbon technologies and a more circular economy.

However, for the CBAM to play this role, we need pragmatic solutions to key design issues. In particular, important issues regarding exporter protection, possibilities of carbon leakage related to resource shuffling, use of revenues, and the transition from free allowances to auctioning. This impulse paper analyses these issues and offers pragmatic and actionable suggestions on how to solve key implementation design questions. It also tries to map out possible interactions between "climate clubs" and CBAM.

I wish you a pleasant read!

Yours,

Frank Peter
Director, Agora Industry

Key findings:

1 Under the EU's higher climate ambition, the current system of free CO_2 allowances is no longer sustainable to protect against carbon leakage. The EU will need to start phasing in an alternative system to protect EU energy intensive industries before 2030, though not in all sectors. This new system must protect against leakage and also incentivise industry to start decarbonisation during the coming decade.

2 A CBAM is the most credible alternative to free allocation. The proposed "climate club" may have value *as a complement* to a CBAM, but it is not a credible stand-alone option. Similarly, consumption charges also raise numerous practical and political difficulties that are difficult to resolve, discounting them as a viable alternative to a CBAM.

3 A cautious and gradual phase-in of a CBAM would accelerate industrial decarbonisation provided that it is accompanied by support for key low-carbon technologies. It would promote carbon cost pass-through along the value chain, incentivising recycling and the move to lower-carbon materials; it would allow the EU to raise vital funds to finance Carbon Contracts for Difference; and it would help to incentivise cooperative climate action on carbon leakage internationally.

4 An effective CBAM must also give adequate protection for exporters. We suggest a two-step approach to this question, including a slightly slower phase-in rate for auctioning prior to 2030, coupled with the prioritisation of decarbonisation support for abatement. This could be followed by a review of the risks to exporters in 2029 based on emerging international action. In a worst-case scenario, a freeze in the phase-down of free allocation to exported production could be considered once CBAM was well established as a policy and risks of retaliation have reduced.

Contents

Introduction

In July 2021, the European Commission proposed a Regulation for a Carbon Border Adjustment Mechanism along with a broader package of reforms to boost the EU's climate ambition (known as the "Fit for 55 Package"). The "CBAM" is intended to provide a long-term solution to the problem of carbon leakage for energy-intensive industries subject to increasingly high carbon prices not faced by trading partners.

While many EU industrials have supported the CBAM in principle, some key design elements are controversial, in particular the handling of exports, the inclusion of indirect emissions, and the timing of the phase-down of the free allocation system. This paper acknowledges the legitimacy of certain aspects of these concerns while describing solutions through modifications in the CBAM design and phase-in.

We argue that the shift from free allocation to a CBAM and allowance auctioning is not only inevitable: it is an essential component of a successful transition to climate-neutral industry. There are three reasons for this.

First, CBAM sectors in Europe face a major investment cycle to prolong the lives of existing assets over the next 10 years. By 2030, between 30 and 50 percent of European cement and steel plants are expected to require major investments in refurbishment. Guiding these investments into technologies compatible with climate neutrality is crucial to avoid locking in high-carbon technologies until the 2040s and 2050s. Carbon pricing must begin to be passed along the value chain so that downstream manufacturers and consumers pay the green premiums associated with low-carbon technologies and high rates of closed loop recycling – driving material efficiency in production. Policy settings that promise a simple continuation of unsustainable levels of free allowances send the wrong signal and provide a false sense of security.

Second, kickstarting the transition to climate-neutral industry prior to 2030 will require significant amounts of public funding. By Agora's estimates, several tens of billions of euros in funding will need to be made available between 2025 and 2035 to support the deployment of (more expensive) low-carbon industrial breakthrough technologies – using, for example, EU-level funding mechanisms such as carbon contracts for difference (CCfD). European-level funding mechanisms will be critical to limiting distortions in the EU's internal market. In this context, CBAM introduction allows for free allocations to begin to be sold via the ETS Innovation Fund, raising significant new funds for CCfDs and industrial decarbonisation. Thus, without CBAM, tens of billions of euros will disappear into the free allocation pie, allowing only a few higher income member states to support their national industries, as the rest look on in frustration.

Third, the introduction of a CBAM would complement – but not replace – efforts to promote global cooperation on industrial decarbonisation via "climate clubs" and other cooperative undertakings. Indeed, there is value in the EU pursuing closer cooperation on industrial product requirements with other willing nations. In practice, however, it is highly unlikely that the EU's key international partners will agree on a uniform global carbon price by 2030. The EU will also be in a stronger position to elicit meaningful cooperation from trading partners if it has the credible alternative of a CBAM in place. While a CBAM should not be a threat, it will take emerging national policies to incentivise key countries to negotiate meaningful coordinated alternatives for the future.

Hence the key question for the EU legislator is how to make a CBAM work as effectively as possible, despite its complications.

This paper is structured as follows. Section 1 begins by clarifying the current status of the transition to climate-neutral industry in the EU. It seeks to explain what industry could do by 2030 to decarbonise and the policy conditions that need to be in place. Section 2 explains how the CBAM and revisions to the EU ETS Directive and Innovation Fund Regulation, as proposed by the Commission, would support this transition. Section 3 focuses on particularly controversial issues: the risk of resource shuffling, the phase-down of free allocation, protection for exports, and the re-use of border revenues. In each case, we explain the issue, clarify the scale and nature of the potential risks and suggest practical and balanced solutions. We conclude that pragmatic solutions can be found to the main CBAM design issues raised in the debate.

1 CBAM in the context of the EU's green industrial transition

1.1 The 2020s: A make-or-break decade for decarbonising industry

The sectors to be covered by the CBAM – i.e., steel, cement, fertilisers and aluminium – face major reinvestment cycles during the coming 10 years. Estimates by Agora Energiewende and Wuppertal Institute suggest that roughly 53 percent of the primary steelmaking blast furnaces, 30 percent of cement kilns and around 48 percent of steam crackers will require major reinvestments by 2030 (Agora Energiewende, 2020). Once made, such investments are typically long-lived, lasting as long as 20–30 years. Locking in conventional carbon intensive technologies until the 2040s is obviously not a viable strategy for European industrial companies if the EU's climate goals are to be met. Together, cement, steel, aluminium and chemicals account for approximately 70 percent of the EU's industrial emissions, or 14 percent of the total annual emissions of the EU (Eurostat, n.d.). It is therefore essential that the transition to climate- neutral technologies begin at a large scale during the 2020s and early 2030s.

In this context, some companies in CBAM sectors have announced their intention to shift to decarbonised production processes. Figure 1 provides the example of European steel products and shows the potential capacities of low-carbon steelmaking by 2030 if the announced plans become final investment decisions. (See the Global Steel Tracker Database.) In the ammonia and fertilisers sector, major companies, including BASF[1] and Yara[2], have developed strategies to begin a shift from grey to green hydrogen-based ammonia by 2030. In the aluminium sector, Alcoa Alcan, the owner of numerous aluminium smelters in Southern Europe, have announced the commercial scale readiness of inert anodes – a new zero-emission smelting technology – by 2024.[3] In the cement sector, a variety of low-carbon breakthrough innovations have also begun to be piloted[4] and a first-of-a-kind cement CCS project has been announced by Norcem at the Brevik site in Norway.[5] Hence, companies in the CBAM sectors have the technical potential to kickstart a major shift to low-carbon production in Europe before 2030.

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[1] See https://www.basf.com/global/en/media/news-re-leases/2021/03/p-21-166.html

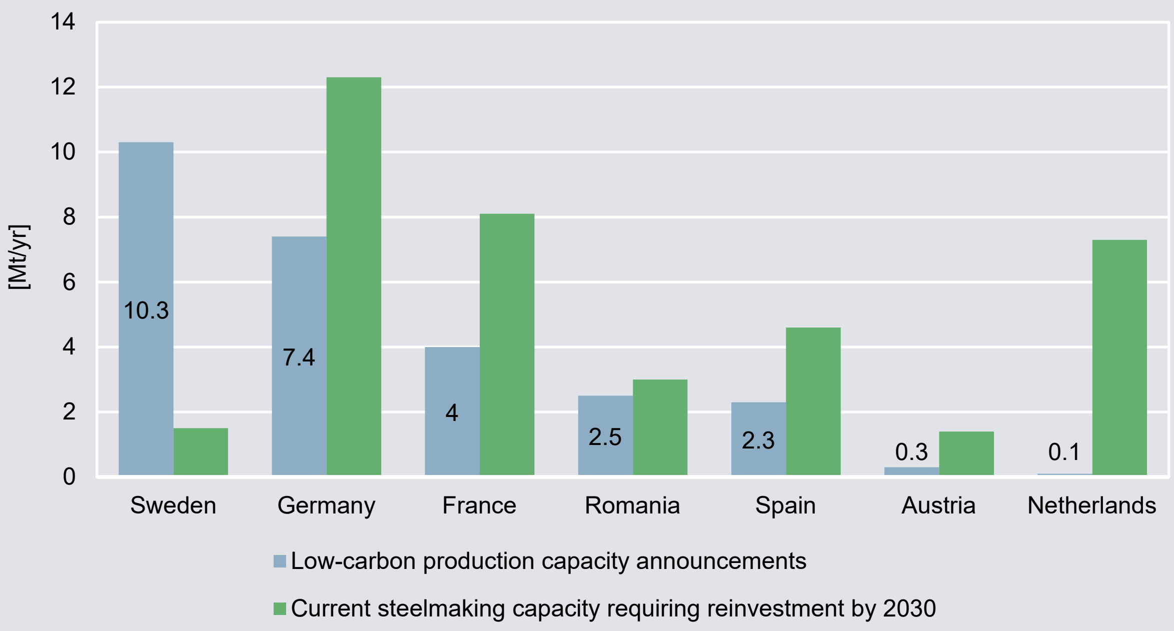
[2] See https://www.yara.com/this-is-yara/yara-clean-ammonia/

[3] See https://elysis.com/en/start-of-construction-of-commercial-scale-inert-anode-cells

[4] For a list, see https://www.globalcement.com/news/itemlist/tag/LC3

[5] See https://www.norcem.no/en/CCS%20at%20Brevik ; https://www.globalcement.com/news/item/11741-nor-wegian-parliament-approves-norcem-s-brevik-car-bon-capture-and-storage-plans

Figure 1: Low-carbon capacity announcements (awaiting final investment decision) by EU Steel producers



Agora Industry (2021)

However, investments in low-carbon technologies require a viable business case vis-à-vis higher-carbon alternatives. One of the key challenges is the generally higher cost of low-carbon technologies relative to conventional carbon-intensive processes. Figure 2 below shows that the expected break-even CO_2 abatement costs per unit of low-carbon steel, cement and green hydrogen is significantly higher than what would be incentivised by current carbon prices.

We can expect some of these costs to decrease over time, in some cases significantly.[6] But in the critical decade ahead, the costs of many low-carbon technologies will probably continue to exceed the costs of carbon experienced by the EU's energy-intensive industries. And even if they do not, investments that depend on high carbon prices will need to be insulated from future downward price fluctuations.

Thus, to create robust investment in low-carbon and circular technologies, three changes to the existing policy incentives are needed:

→ First, carbon prices must be passed onto the price of conventional steel, aluminium, cement, hydrogen and ammonia products. This means that the volume of free allowances must be phased down and ultimately phased out.

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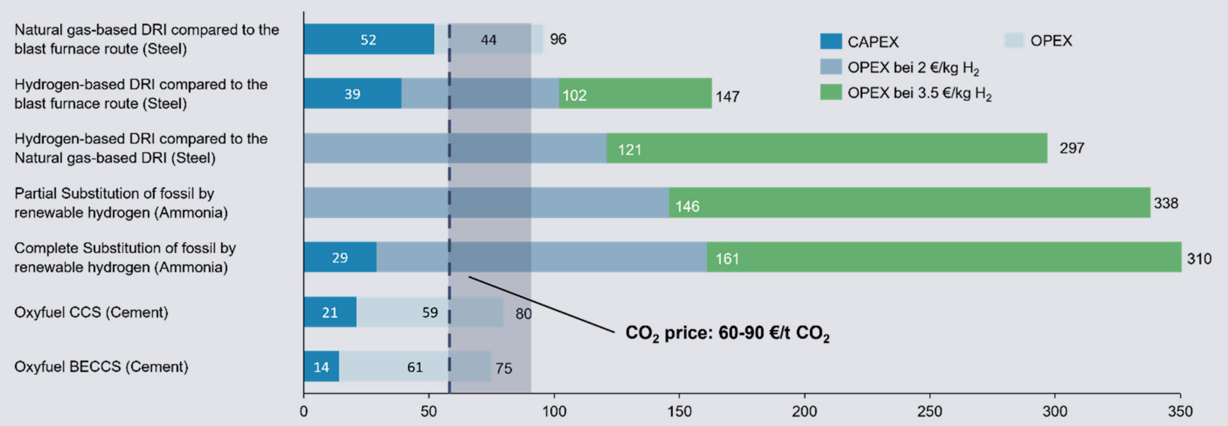
[6] See https://irena.org/-/media/Files/IRENA/Agency/Publication/2020/Dec/IRENA_Green_hydrogen_cost_2020.pdf

Figure 2: CO_2 reduction costs of climate-friendly technologies compared to the expected CO_2 market price



Agora Energiewende, FutureCamp, Wuppertal Institut und Ecologic Institut (2021). Actual costs will vary depending on site specifics and energy prices.

- → Second, additional "top-up" or "difference" payments must be able to be paid to cover the additional incremental costs of key low-carbon technologies (beyond the carbon price).
- → Third, the large-scale deployment of industrial sites must be de-risked from possible downward fluctuations in the carbon price.

For carbon cost pass-through to occur, there needs to be a levelling of carbon regulations at the EU's border (either in the form of a CBAM or a CO_2 product requirement). To tackle the latter two challenges, the European Commission has adopted Carbon Contracts for Difference as part of its EU ETS Revision (European Commission 2021b). However, rough estimates by Agora suggest that financial resources in the order of several tens of billions of euros may be required over the 2025–2035 period. This assumes that a 20–30 percent share of the assets due for reinvestment relies on CCfDs. The question is where to find the funding.

1.2 Free allocation is unsustainable under higher EU climate ambition

The EU Climate Law obliges the EU and the member states to reduce net domestic greenhouse gas emissions in Europe by at least 55 percent by 2030 relative to 1990 levels. In this context, the current system of free allocation is not a sustainable solution to protect EU energy-intensive industries from carbon leakage.

First, under the more ambitious linear reduction factor proposed as part of the Commission's EU ETS revision in July 2021, the amount of free allowances currently given to energy-intensive industries would need to decline precipitously by the latter half of the 2020s. Figure 3 below shows that if the current rules are kept, then Agora estimates that industrial installations operating at the future best performance benchmark could expect to be short by as much as 28 percent of their allowance requirements in 2030, and even more so in the years after 2030. It may seem that a solution to this concern would be to abandon the Cross-Sectoral Correction Factor (CSCF)

Figure 3: EU ETS free allocation scenarios vs. the revised ETS cap (scenarios with and without cross-sectoral correction factor)

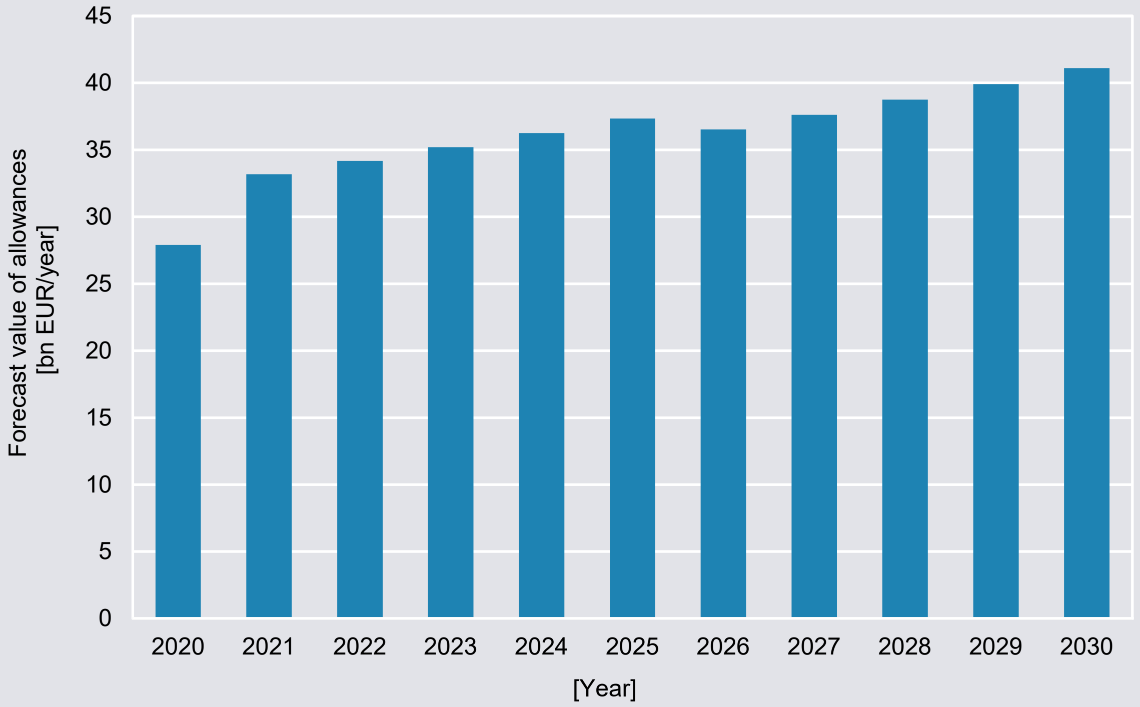
Agora Industry, based on Commission data and new legislative proposals for ETS reform (2021)
Note: ETS benchmarks are assumed to be further tightened by 7% on average in 2026. it is assumed that domestic shipping is included in the cap as proposed by the ETS Directive revision proposal of July 2021.

and allow industry to receive 100 percent of the benchmark free allowance level. However, if the CSCF were abandoned then this would quickly create challenges for the carbon market. Even if the current benchmarks were to be further tightened at the current rate of improvement (7 percent on average) during the next 5 years, then in 2030, 2033 and 2036 energy-intensive industries would receive approximately 65 percent, 78 percent and 91 percent of the entire annual ETS cap for free allowances, respectively. (Currently, the industry is allowed to receive no more than 46 percent of the ETS cap in free allocations.) It should be clear that this situation is likely to be neither economically nor politically sustainable, nor conducive to a well-functioning carbon market.

The current benchmark-based system for free industrial allowances is also unsustainable for the transition to climate neutrality to the extent that it creates distortionary incentives that unfortunately work against the goal of deep decarbonisation. To cite just one example, the cement sector's free allocation benchmark is a set of clinker benchmarks, and the free allocation level is based on historical clinker production. This works against the creation of incentives to reduce the level of clinker used per unit of cement and the amount of cement used per unit of concrete. More generally, incentives for recycling, material efficiency and market-based payments for the higher cost of low-carbon production processes are stifled when there is no carbon cost pass-through (which free allocation enables).

A third reason why the current system of free allocation is unsustainable beyond 2030 is that, at higher carbon prices, it becomes prohibitively expensive. Figure 4 shows the author's estimates of the possible cumulative costs of free allocation between 2020 and 2036. We assume that free allocation is reduced every five years by ongoing reductions in the best performance benchmarks but

Figure 4: The monetary value of free allocation under higher carbon prices (conservative estimates)



Agora Industry estimates (2021)
Note: Figures assume carbon prices begin at 60 EUR/tCO_2 in 2021 and rise by a conservative 2% per annum on average out to a price of 80EUR/tCO_2 in 2036. Note that current CO_2 prices have surged well above the levels assumed in this calculation. If such price levels were sustained these estimates would be significantly higher than those estimated in this graphic.

assume no cross-sectoral correction factor under this scenario. (See the discussion above.) Under this scenario, between 33 and 41 billion euros worth of allowances would be allocated annually to industry and a total value of 611 billion euros worth of allowances would be allocated between 2021–2036. In a context of restricted national budgets – not to mention efforts under the European Green Deal to make consumers pay for the cost of carbon in the buildings and transport sectors – one can question the political and economic sustainability of this level of free allocation to ETS industries.

1.3 Climate clubs and CBAM – substitutes or complements?

There has been a spate of recent proposals for international cooperation on carbon pricing, or carbon clubs, from the OECD,[7] the IMF,[8] the World Trade Organisation (WTO),[9] the German Ministry of Finance[10] and others. Many of the cooperative programmes, known as "carbon clubs", are driven by a desire to avoid the unilateral application of a CBAM. As the IMF's proposal for an international carbon price floor (ICPF) notes, "An ICPF would likely circumvent pressure for unilateral border carbon adjustments." However, it is important to critically assess how such arrangements might work in combination with a CBAM, or whether they might be viable and effective alternatives to a CBAM in the pursuit of its primary objective: avoiding the risk of leakage in the context of rising EU climate ambition.

The climate club concept comprises many different possible regimes and intents. Some proposals are focused on incentivising climate action more generally and, as under the original Nordhaus-style climate club,[11] imply penalties for non-members and incentives for members[12] such as a flat tax on all imports. However, it is not necessarily clear that such proposals actually reduce the differences in real CO_2 prices paid by members, let alone the price differences between members and non-members. It is not clear, therefore, that such 'transformational' kinds of climate clubs obviate the need for a CBAM.

Alternatively, under some proposals, the intent is to remove the need for an EU CBAM. If a climate club is to remove the need for a CBAM, it must presumably do so by garnering wide enough agreement from the key countries on a level of ambition that, because everyone adheres to it, reduces the risk of leakage to acceptable levels. However, this is quite a high bar to achieve – at least in the short to medium term.

For instance, if the club focuses only on explicit carbon pricing, then the key problem is simply getting adequate buy-in from national governments. Carbon pricing at the national level is inevitably difficult to enact and implement, as evidenced by the experiences of those few national governments that have done it. Adding a layer of international monitoring and assessment of adequacy would add to the complexity.

A further complication is how countries would ensure that carbon prices were equalised enough to mitigate the risk of carbon leakage? The EU, after all, has a floating carbon price, and does not have the legal authority to implement carbon taxes under the EU treaties. Linking of carbon markets between major economies would pose very substantial challenges, even if we assumed that all relevant countries designed broadly compatible carbon markets.

But perhaps most importantly, if international cooperation on common carbon prices did not achieve critical mass of global markets for CBAM products, it would be ineffective at preventing leakage without adding a CBAM. Figure 5 illustrates the kind of gaps that would exist in the steel sector if, say, China (50 percent of global steel production), or India (10 percent), declined to sign on to such an agreement. How realistic is it that such countries

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[7] See Fleming and Giles (2021).

[8] See Parry and Black (2021).

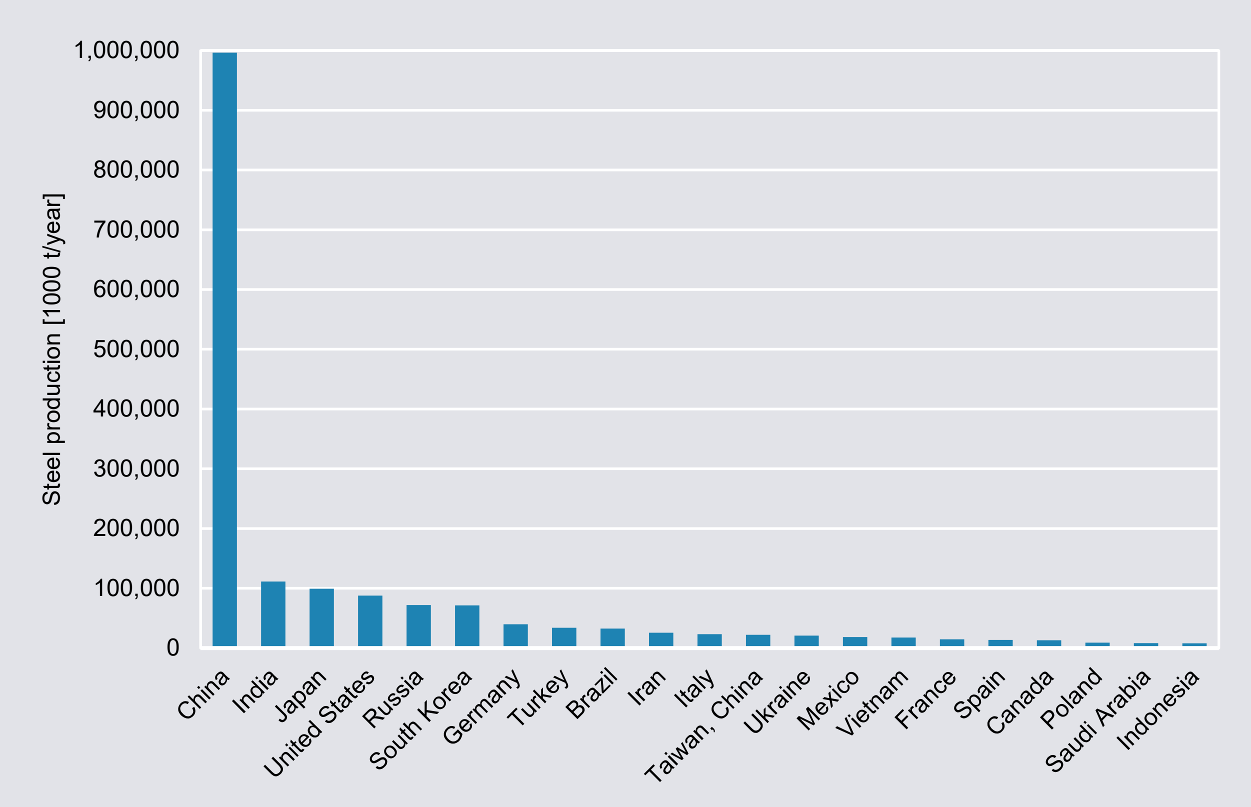
[9] See Okonjo-Iweala (2021).

[10] See German Finance Ministry (2021) Schritte zu einer Allianz für Klima, Wettbewerbsfähigkeit und Industrie - Eckpunkte eines kooperativen und offenen Klimaclubs https://www.bundesfinanzministerium.de/Content/DE/Downloads/eckpunkte-internationaler-klimaclub.pdf?__blob=publicationFile&v=3

[11] See Nordhaus (2015).

[12] In the taxonomy proposed by Faulkner et al. (2021), the clubs are transformational.

Figure 5: Global steel production by country (top 20 producers) in thousands of tonnes per year (2019 data)



Agora Industry based on data from WorldSteel.org (2021)

would adopt the EU's 60–100 EUR/tCO_2 carbon prices by 2030, let alone agree to link them to each other's levels?

Even in this unlikely scenario, therefore, some form of common border carbon adjustment would probably be needed to prevent leakage. This would obviously be true between club and non-club members. However, it would quite likely also be the case between members within the club if common carbon prices are not achieved. Thus, the EU CBAM would presumably still have a role to play under such a club.

Alternatively, it has been argued that clubs might be defined to allow for members achieving equivalent climate ambition either via price or non-carbon price policies (See both the IMF's ICPF and the OECD's proposals.) Once again, however, such approaches face significant methodological challenges. First, translating certain types of climate policies into a common measure such as an equivalent carbon price is no simple matter. For instance, both real and shadow carbon prices tend to fluctuate over time – as a function of market forces in emissions trading schemes or due to changes in relative energy costs. Key issues such as offsets, relative purchasing power, exchange rates, etc. would complicate matters. A key challenge would once again be the inclusion of key developing countries. But defining "equivalent levels of ambition" to avoid punishment via a CBAM between developed and developing countries is likely to be a very difficult exercise, both politically and technically.

Second, it is not obvious which policies should be included in such a regime. Air pollution and health policies, for example, have climate change impacts, but do they count as climate change policies? How about strict requirements for environmental and social impact assessment of projects? If the exporting country decides, the list will be long, and if the importing country decides, the decision might be disputed as an intrusion on national sovereignty. Once again, an internationally agreed methodology would be needed involving many key developed and developing countries. This represents a very significant challenge.

A more plausible approach might be for clubs or international agreements to seek to align CO_2 product requirements on CBAM products over time. This would at least reduce the complexities of translating price and non-price policies into common metrics. However, it will also require significant time and political capital to be achieved. Once again, a critical mass of large economies would have to agree on shared, and sufficiently ambitious standards for such requirements. It is far from certain whether, in the near future, countries such as China, India or even the United States will be open to adopting EU-level climate ambition in the definition of such standards.

If, in light of the arguments above, we set aside penalties/incentives, the recognition of non-price-based climate policies, and the intent to replace CBAM, what is left is a useful set of cooperative activities – activities that are appropriate subjects of international cooperation. Indeed, a number of these ideas are elaborated in the German proposal, including:

- → agreement on common metrics for GHG intensity of products, so producers need only certify one standard.
- → creation of joint lead markets.
- → joint R&D in decarbonisation of key materials, processes.
- → agreement on common principles regarding the implementation of anti-leakage policies.
- → agreement on common principles regarding subsidisation of clean technologies.
- → the progressive implementation of future CO_2 product requirements.

Cooperation around these topics could be a practicable way forward in the short and medium term. In this case, CBAM would remain a complement to international cooperation, until such time as international CO_2 product requirements might be phased in, and the relevant industries removed from the EU ETS.

Obviously, such a climate poses important questions of governance. While neither the UNFCCC nor WTO are likely to be workable venues, it is nevertheless critically important that climate clubs are inclusive, address both developed and developing country concerns even-handedly, and are not hijacked by protectionist interests. Indeed, this concern has been raised regarding some versions of the climate club idea, such as the language contained in the EU-US Aluminium and Steel Agreement signed at COP26.[13]

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[13] See https://ielp.worldtradelaw.net/2021/12/guest-post-the-worst-of-two-worlds-why-the-us-blueprint-for-a-transatlantic-climate-club-authored-by.html

1.4 Consumption charges don't address carbon leakage

Another alternative proposal to the CBAM put forth by researchers in has been the idea of an ETS-linked consumption charge, or a "climate contribution", on energy-intensive products exposed to carbon leakage risk (Neuhoff et al, 2020; Climate Strategies, 2021). Under this proposal, free allocation would continue to ETS installations at the full benchmark level, but moved to an output-based allocation system in which free EUAs are allocated to EU producers proportional to their current output (instead of historical output) multiplied by the CO_2 benchmark (Quirion, 2009).

Unlike the CBAM proposal, this system effectively maintains free allocation. To restore some form of carbon price along the value chain, a materials consumption charge would be added on pproducts as they left the installation and passed on down the value chain – not unlike a Value Added Tax (VAT) charge – until ultimately paid by the consumer.

The consumption charge would be based on the weight of material in the product multiplied by a benchmark CO_2 intensity level per unit of product. For instance, a steel producer (or importer) would pay nothing, but would see a charge added to its products once they left the factory gate. This charge would be equivalent to the prevailing CO_2 price multiplied by the historical CO_2 content of EU steel multiplied by the amount of steel sold. Importantly, this weight-based "CO_2" charge would not be updated or adjusted for recycled or low-carbon products. Doing so would add enormous complexity since each and every EU steel producer (and importer) would need to report their steel CO_2 intensity and their consumers would need to pay a different charge. This would effectively require turning the system into a classic CBAM, defeating the simplifying objective.

The consumption charge would also apply to imports and, as with VAT, could be legally rebated to exports at the border under WTO rules.[14]

The fact that this approach maintains free allocation at the full benchmark for longer than the CBAM while offering the option of an export rebate has made it attractive to some parts of industry.

If one digs deeper into the detail, however, it becomes clear that the "consumption charge" approach has several major technical and political difficulties that would make it even harder to implement than the CBAM.

A first key problem is that it does not resolve the fundamental problem that CBAM is designed to solve: unlike a CBAM, a consumption charge does not actually mitigate against carbon leakage. After all, simply applying a consumption charge downstream does not change the fact that EU ETS installations are still in the EU ETS and thus must surrender ETS allowances while their foreign competitors do not. For this reason, the consumption charge option is always proposed alongside a continuation of 100 percent free allocation to upstream ETS installations.

As noted above, however, free allocation is not sustainable at the full benchmark level beyond 2030. Proponents of the consumption charge typically struggle to provide a clear and compelling story of how the lack of available free allocation would be dealt with beyond 2030.

One response given to the authors of this paper is that perhaps the revenues from the consumption

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[14] See note 1, Agreement on Subsidies and Countervailing Measures, WTO (n.d.): "In accordance with the provisions of Article XVI of GATT 1994 (Note to Article XVI) and the provisions of Annexes I through III of this Agreement, the exemption of an exported product from duties or taxes borne by the like product when destined for domestic consumption, or the remission of such duties or taxes in amounts not in excess of those which have accrued, shall not be deemed to be a subsidy."

charge could be used by national governments to enter the carbon market and buy up industry's allowance requirements from the rest of the EU ETS market, and return them to the installations. However, this raises several new questions:

First, is it desirable that a system that prevents virtually all actual CO_2 costs from being borne by EU ETS installations be continued indefinitely?

Second, it is unclear how it would be possible for member states to purchase ETS allowances for their industrial installations in the required amounts. As noted above, by 2035, the amount of free allowances required by industry would represent approximately 90 percent of the total ETS cap. Member states buying up such large shares of allowances would not seem to be consistent with a functioning ETS market.

Third, how would the money collected from the consumption charge that member states collected be recycled back to the original location of the producing industrial installations in order to allow for such purchases? In practice, geographical imbalances between the location of production and consumption of materials within the EU would imply the need for an entirely new system of intra-European revenue transfers. It is hard to see how member states would be able to agree on such a system, or to see how the European Council would achieve unanimity (as some experts argue would be required for such a European fiscal measure).

When pressed on these criticisms, proponents of the consumption charge approach have suggested that free allocation might be made conditional on industrial commitments to reduce emissions over time. However, this solution too creates significant problems:

First, how would carbon leakage be protected against if free allocation were phased out? What would follow the phase-down of free allocation (if not a CBAM)? The only plausible alternative to a CBAM is the recycling of consumption charge revenues to pay the full incremental costs of adopting low carbon production technologies. But recycling consumption charge revenues to pay all the abatement costs of EU ETS industry would mean, in effect, that state aid funding would be granted to practically *every single* EU ETS installation based on a government-endorsed plan. Leaving aside the question of coordinating such plans between member states, this approach would lead to an entirely planned and state-financed transition of EU industry. It is not hard to see how this could go seriously wrong. It is one thing to propose carbon contracts for difference to kick start initial deployment projects. But a subsidy-dependent approach to the *entire* transition would be extremely expensive for national budgets (on the order of 40–50 billion EUR/year) and prone to regulatory capture by special interests. The unfavourable political economy would tend to:

- promote overcapacity rather than asset rationalisation or relocalisation where necessary.
- promote primary production technologies at all costs to protect existing assets, rather than recycling; and
- disadvantage innovative new entrants in the relevant product markets.

Above all, a system recycling tens of billions of euros to industry every year would be difficult to remove once in place.

A further concern with the consumption charge proposal is that, to avoid becoming legally and technically equivalent to a CBAM, charges would have to be *weight-based*. They would thus not reward recycled products or new low-carbon production processes by giving them a lower consumption charge. As such, they would not help to incentivise the circular economy. Weight-based charges also do not incentivise any form of lower carbon production since these products would not be rewarded by more favourable downstream price signals because they too would pay the same charge as high-carbon products.

Since the charge is not based on actual CO_2 content, from an international perspective, an EU consumption charge would also do little to encourage third countries to decarbonisee their industrial production to maintain access to the EU's market. It is highly likely that such an arrangementbe antagonistic to foreign producers selling in the EU. Unlike a CBAM, however, importers could not reduce the charge they face by reducing their emissions or adopting carbon pricing. As such, while the uncalibrated charge is sold by its proponents as less discriminatory, it might ultimately create more adverse rulings in WTO dispute settlements, because it would not be meaningfully linked to the stated environmental objective. Moreover, it is far from certain that a consumption charge would remove the risks of retaliation attached to a CBAM, while it would do less to promote decarbonisation abroad.

A final and very important concern with a consumption charge is that, as an arguably fiscal measure in nature, there is an argument that it would require a unanimous decision in the European Council for its adoption and design. If so, this poses significant risks that the ultimate agreement could be misused in practice. It could be watered down by any member state seeking to gain some advantage. Or certain member states could be held hostage on this policy or other related policy goals (e.g. the ambition of ETS reform) in order to gain unanimous agreement. While legal experts could debate about whether unanimity is technically required, the argument that it should be required would undoubtedly be made by certain member states – potentially leading to a situation where it would be required de facto.

A consumption charge option was explored as part of the Commission's impact assessment on the CBAM, but it was ultimately rejected in favour of a fully-fledged CBAM. The impact assessment judged that the consumption charge system would be likely to be less effective at preventing carbon leakage due to its dependence on continued (output-based) free allocation. The Commission found that the system would not be fully consistent with the EU Emissions Trading Scheme, which sets a declining cap on emissions in the industry sector (something that is not easily resolved by the consumption charge and output-based free allocation).[15]

Based on the above considerations, we conclude that the consumption charge approach is likely to be an unworkable alternative to a CBAM.

2 CBAM as an enabler of the industry transition

Given the nature of the challenge just outlined, it is clear that a CBAM, coupled with a phase-down of free allocation, would help to support the deployment of key low-carbon technologies in European industry. While a CBAM is only one of the tools necessary to support that transition, it can do at least three important things.

First, by imposing a charge based on the embedded carbon in covered products, the CBAM will raise the costs of those goods relative to the costs of goods produced in less GHG-intensive ways. This is in line with the fundamental objective of the ETS, the carbon pricing scheme that the CBAM is designed to accompany. Pricing carbon changes market conditions to make low-carbon goods more competitive, and

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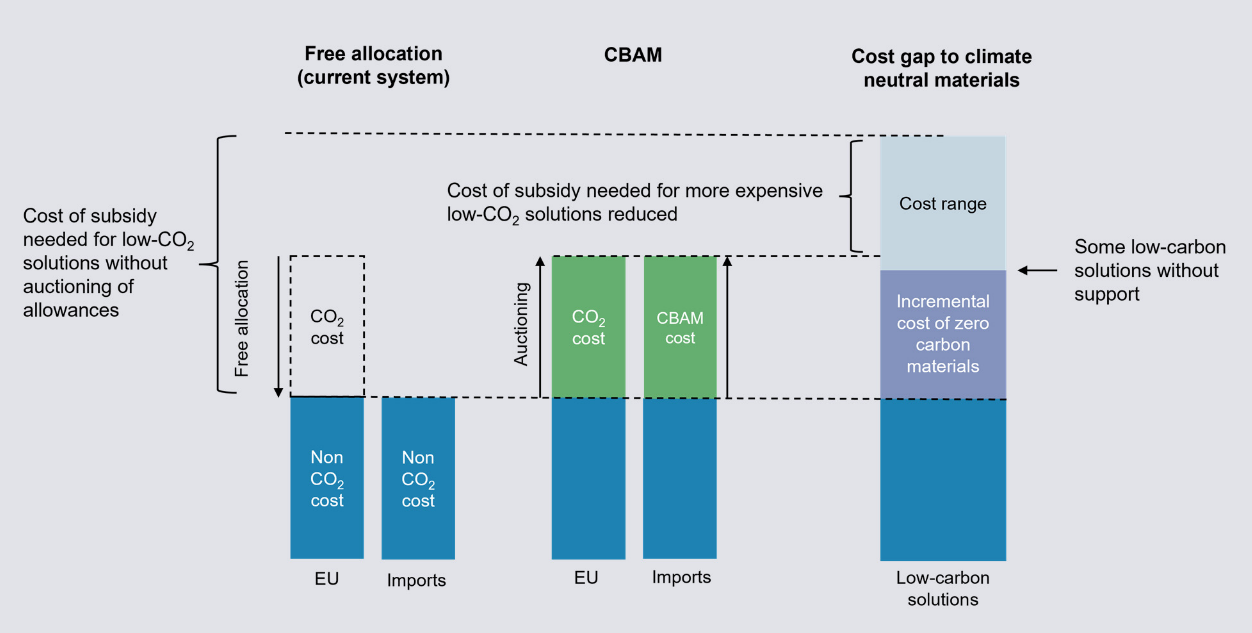
[15] See p. 80–88 of EC (2021b) (Impact Assessment on the CBAM Regulation).

Figure 6: How a switch from free allocation to auctioning of allowances facilitates investment in low-carbon solutions



Agora Industry (2021)

thus incentivises investments in low-carbon technologies while encouraging consumers to substitute away from high-carbon goods.

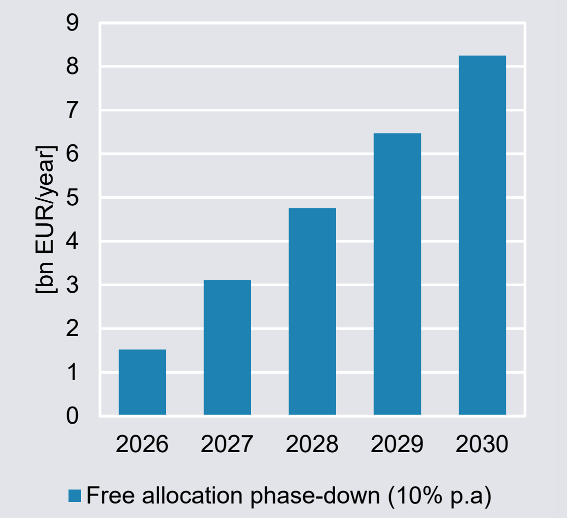
For some low-carbon producers, whose costs of production are low enough, the carbon price may render them competitive in an unsubsidised environment. Figure 6 shows that the incremental costs of some zero-carbon materials are lower than the cost of carbon-intensive materials plus carbon charges (levied either by the ETS or by CBAM).

For others, the costs of production are still higher than those of conventional materials even with carbon costs added. As shown in Figure 2 above, this is currently the case for many industrial technologies even though costs are falling. Here there is a case for subsidies and other policies to bridge this gap. Figure 6 shows that the cost of such measures to the EU will be lower where auctioning and the CBAM have raised the costs of conventional high-carbon production.

Second, a CBAM allows for a phase down of free allocation of ETS allowances by addressing the risk of leakage and competitiveness impacts. As such, it indirectly contributes to a significant source of revenue – auctioning of allowances – that can be channeled to support decarbonisation as discussed above. Figure 7 shows this dynamic. If we assume a phase down at 10 percent per annum starting in 2026, per the Commission proposal, and a carbon price of €66/tonne of CO_2, rising by 2 percent per annum, with a constant level of free allowances at 230 million, average annual revenues from auction between 2026 and 2030 are approximately 4.8 billion EUR, or 24 billion over five years. This is a significant source of funds that could be devoted to supporting a low-carbon transition in the EU.

Third, the CBAM is likely to accelerate action to decarbonise industry in other parts of the world. "Encouraging producers in third countries who export to the EU to adopt low carbon technologies" is one of the specific objectives cited for the CBAM by the

Figure 7: Potential auction revenues from the sale of allowances to CBAM sectors (2026-2030)



Agora Industry (2021)
Note: Assumes carbon price of 66 EUR/tCO_2 in 2026, rising by 2% per annum. Free allocation pot of 230 million allowances assumed constant as the basis for calculating the share entering the ETS Innovation Fund.

European Commission (European Commission, 2021a: 100). And one of the CBAM's anticipated ancillary effects noted by the Commission is "Strengthening the joint climate action needed by all Parties of the Paris Agreement."

This could play out in several ways. Countries *directly* affected by the CBAM might implement carbon pricing to effectively tax their own exports rather than allowing CBAM revenues to be transferred to the EU. For instance, a source close to the government of Russia, which has the greatest exposure to the proposed CBAM by trade volume, has said that the country is considering implementing its own carbon tax in response to the CBAM. "Neither the government nor business," the source observed, "is interested in the EU collecting payments from Russian exporters at its discretion" (Korsunskaya and Marrow, 2021).

However, carbon pricing has benefits beyond simply avoiding transfers to the EU by exporters, and those will also be considered by the EU's trade partners. For those countries that are serious about achieving their Paris Agreement commitments and are pursuing a low-carbon transformation, carbon pricing represents an important tool, and a signal to the global community of their seriousness. The EU's CBAM is simply one more reason to move toward carbon pricing. Moreover, for many countries the EU's CBAM is a harbinger of a broader trend: the counting of carbon embedded in internationally traded goods, whether by governments—and the EU is not the only jurisdiction in the process of doing so—or by buyers and final consumers. In that sense, the CBAM can serve as a wake-up call to the realities of future global markets for energy-intensive commodities. The CBAM proposal has at any rate sparked a flurry of proposals and discussions on global carbon pricing.[16]

3 Making sure CBAM is fit for purpose

3.1 Resource shuffling and carbon leakage risks for electro-intensive products

Resource shuffling is the phenomenon whereby foreign producers are advantaged by the combination of domestic carbon pricing and border protection such as CBAM, because their existing production patterns allow for a shift in trade patterns to divert existing clean production to the carbon pricing jurisdiction. For CBAM-covered producers, the risk is that existing foreign producers with high GHG intensities will divert their exports elsewhere, and foreign producers with GHG intensities lower than EU

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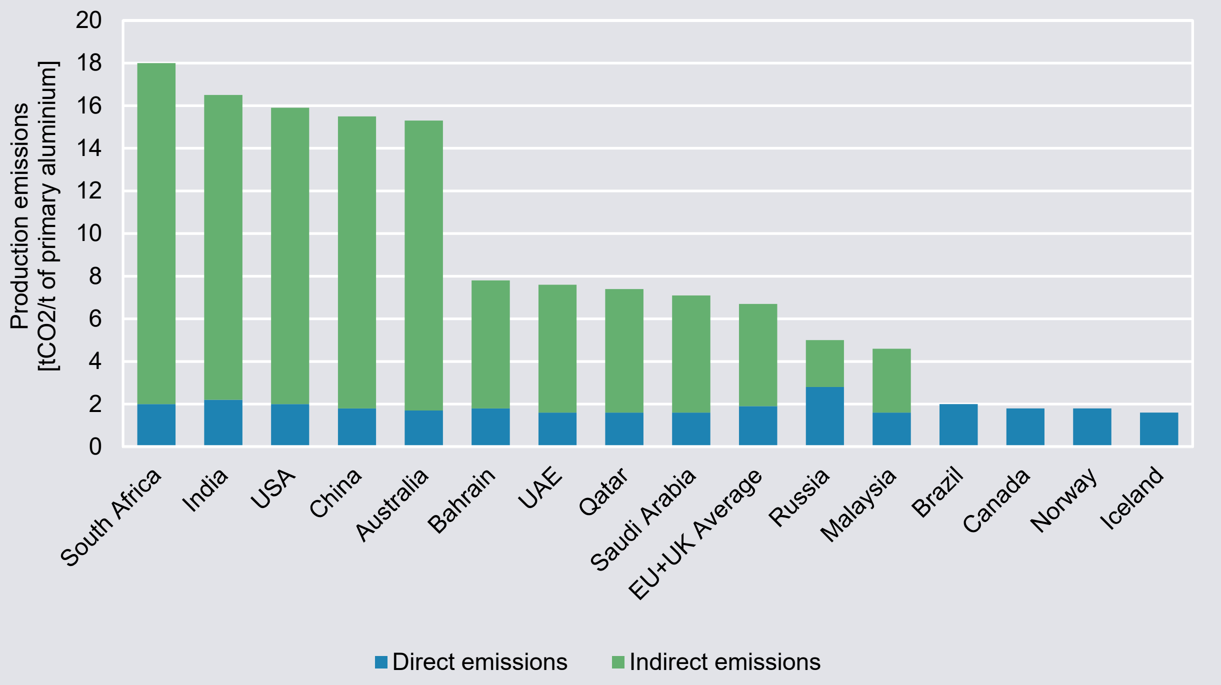
[16] See the discussion in section 1.3. Proposals for global carbon pricing include those from the OECD (Fleming and Giles, 2021), the IMF (Parry and Black, 2021) and the WTO (Okonjo-Iweala, 2021). All are explicitly motivated by the prospect of an EU CBAM.

Figure 8: Scope 1 and 2 emissions in global aluminium production



Eurometaux (2021)

producers will shift their exports toward the EU. The result would be EU producers losing domestic market share, but no overall change in global GHG emissions.

In the context of CBAM, resource shuffling largely remains an electricity problem. Scope 1 (i.e., direct onsite) emissions in the candidate sectors are much more homogeneous than are scope 2 (i.e. indirect emissions related to electricity consumption). Figure 8 shows this in the context of aluminium production. The section that follows shows that, in the context of scope 1 emissions, EU emissions intensity is low enough relative to global practice that there is little risk of resource shuffling for aluminium or cement, and probably only short-term risk in the case of steel.

The existing CBAM proposal considers only scope 1 coverage, meaning that for now resource shuffling is not a significant concern. But it is possible that the mandated review (due before the end of the transition period on 31 December 2025) will recommend that the CBAM be expanded to include scope 2 emissions at some point in the future.

All else being equal, eventually expanding the CBAM to cover scope 2 emissions makes environmental sense. Without such coverage, some of the most important incentives for foreign process improvement are missing; as Figure 8 shows, scope 2 is the major element of difference between high and low-carbon production. Scope 2 coverage would also offer the potential for a decarbonized EU materials sector to gain an edge vis-à-vis foreign producers that are slower to adopt low-carbon technologies, including decarbonised power. Finally, many energy-intensive industrial processes will need to gradually become electrified, either directly or indirectly (using hydrogen) using low carbon power to decarbonise. Inclusion of scope 2 emissions would help to ensure that foreign producers did not electrify their energy sources using CO_2-intensive power sources to escape CBAM costs at the EU's border.

However, the EU's electricity market has special characteristics that complicate this basic picture. Consumers pay the marginal cost of electricity generation, meaning the highest-cost producer sets prices. As the ETS allowance prices rise, the highest-cost producers will increasingly be the most GHG-intensive. As such, even consumers of very clean electricity are paying carbon costs associated with high-carbon electricity generation. Depending on how the CBAM calculated scope 2 emissions of imported products, EU producers might pay more in indirect carbon costs than foreign producers would be charged in a CBAM adjustment for their scope 2 emissions.

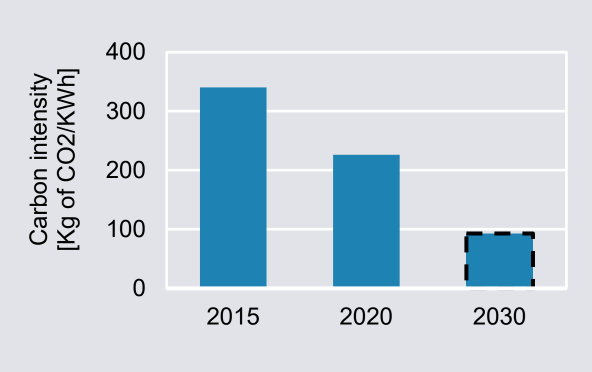
In practice, a level playing field between EU and non-EU aluminium producers might ultimately be resolved if the CBAM design were to include indirect emissions on imported products in a specific way. Notably, if the CBAM required that imported products report the CO_2 intensity of their product as being determined by the marginal power producer in their relevant electricity market. For example, an aluminium importer to the EU for products produced in Canada might need to report the Scope 2 emissions as the average annual CO_2 intensity of the marginal power producer in their national or regional power market (from the previous year). In general, such data could be provided on an annual basis for any given power grid since the network operators would normally have data on the capacity factors of the different plant during the year and could deduce mathematically the share of load hours supplied on an annual basis by each kind of generation. But even where such data might not be available, a very close proxy measurement would be to report the average annual CO_2 intensity of fossil fuel-based generators.

Calculating indirect emissions in this way would largely eliminate resource shuffling as a phenomenon within countries since the CO_2 intensity of any one producer would be calculated based on the whole national or regional grid's marginal CO_2 intensity. Thus, in general, there would be no reduction in CBAM liabilities from switching which producers in a given country (or electricity bidding zone) exported to the EU. Moreover, in the case just described the treatment of exports to the EU would also tackle indirect CO_2 costs in exactly the same way as indirect costs were incurred in the EU's power market. This approach would in effect overcome any economic advantage for producers linked to resource shuffling.

Nevertheless, even if embedded indirect carbon costs were calculated in the manner just described under the CBAM, the concern of EU aluminium producers would still be that domestic indirect costs in the EU may still be higher than foreign indirect costs coming from some very decarbonized power markets in certain cases. This would be true, for example in some islanded hydropower-based markets, such as in parts of Russia, Canada or China. Thus, the concern of EU producers of electro-intensive goods might not be resource shuffling so much as a simple loss of competitiveness due to the fact that EU power markets are not yet as decarbonized and some fraction of their international competitors' power markets.

On the other hand, it is worth noting that the scope 2 "carbon competitiveness" gap highlighted here – between EU producers and relatively lower-carbon foreign producers – will be significantly reduced over time. Figure 9 shows the expected trajectory of GHG-intensity of the EU power sector which, by 2030, will be reduced by more than half of today's intensity, according to European Commission projections. Thus, it might be expected that scope 2 emissions could be included in the CBAM at a later stage, at a point where EU producers would increasingly face CO_2 free marginal generation determining

Figure 9: Average carbon intensity of the EU power sector (recent and forecast data)



Agora Industry based on data from Agora Energiewende and the European Commission's Impact Assessment on the 2030 Climate Target Plan (2020).

power prices. At higher shares of renewable power, the marginal generators would often be CO_2 free for a growing share of annual load hours, even if during certain hours of high demand, gas-based generators might operate.

For these reasons, we would tend to conclude that the inclusion of indirect emissions in the CBAM – while ultimately desirable and arguably feasible – may be a step too far during the initial years of a CBAM. Nevertheless, the EU might wish to use the transitional period until, say, 2030, to collect data on indirect emissions for foreign importers as a means of establishing the reporting and CO_2 accounting basis for their future introduction from 2030 onwards.

Beyond 2030, however, indirect emissions would need to be included in the CBAM's scope. One of the main reasons for this is that electrification of energy inputs into industry – whether directly or indirectly (via hydrogen) is one of the main means of decarbonizing certain CBAM products, such as steel and ammonia. Thus, indirect emissions from these sources would need to be included to avoid the risk of importers to the EU being able to circumvent the CBAM via the use of direct electrification or hydrogen produced using fossil fuel-based power generation.

3.2 Is resource shuffling a problem for non-electro-intensive sectors?

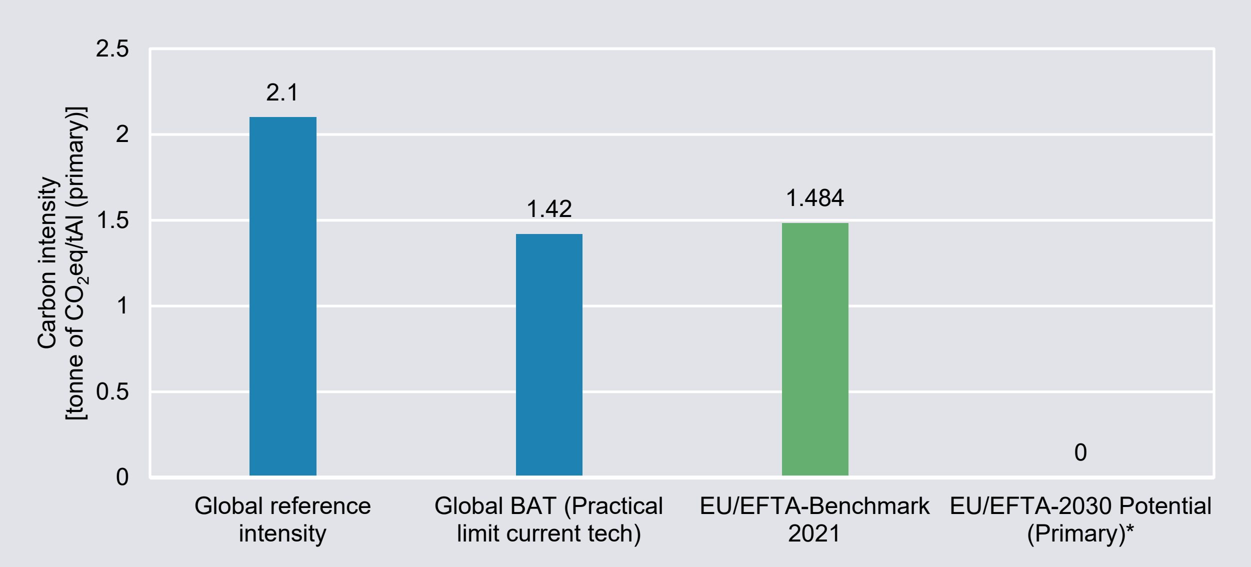
Beyond the possibility of resource shuffling linked to low-carbon power sources available for electro-intensive production, EU policy makers may also wonder whether carbon leakage for EU producers might occur because of resource shuffling in other sectors subject to CBAM.

To analyse this risk, we collected data on average CO_2 performance for the top 10 percent of steel, aluminium and cement producers in the EU. We then attempted to do the same for the best available technologies for these products globally based on an analysis of the existing literature and available databases. Because the CBAM will probably cover only scope 1 emissions, at least initially, our analysis focuses exclusively on these.

As explained above, it can be expected that, under a CBAM regime, and to the extent that the transaction costs of "shuffling" the materials sent to Europe are low for exporters from non-EU countries, some resource shuffling may occur. However, while this behaviour would somewhat lower the CBAM charge paid by importers to the EU, resource shuffling may need not lead to an automatic loss of competitiveness and thus to carbon leakage for EU producers. In fact, this would only be the case if the "shuffled" imported products to the EU had a significantly lower CO_2 intensity – and thus had much lower CO_2 costs – than EU producers of the same products under the EU ETS.

Under a shift to auctioning of allowances and a CBAM, EU producers can take two steps to reduce their emissions. In the short run, EU installations can seek to reduce their emissions by making marginal

Figure 10: Comparison of primary aluminium sector scope 1 emissions CO_2 intensities



Agora Industry based on data from European Commission (2021f), JRC (2017), www.International-Aluminium.org; IEA (2020), Saeversdottir et al (2019); Notes: Concerns Scope 1 emissions only; figures for primary aluminium production. *2030 Potential Reductions depend on commercialisation of inert anode technologies currently under development (cf. discussion of IEA 2020).

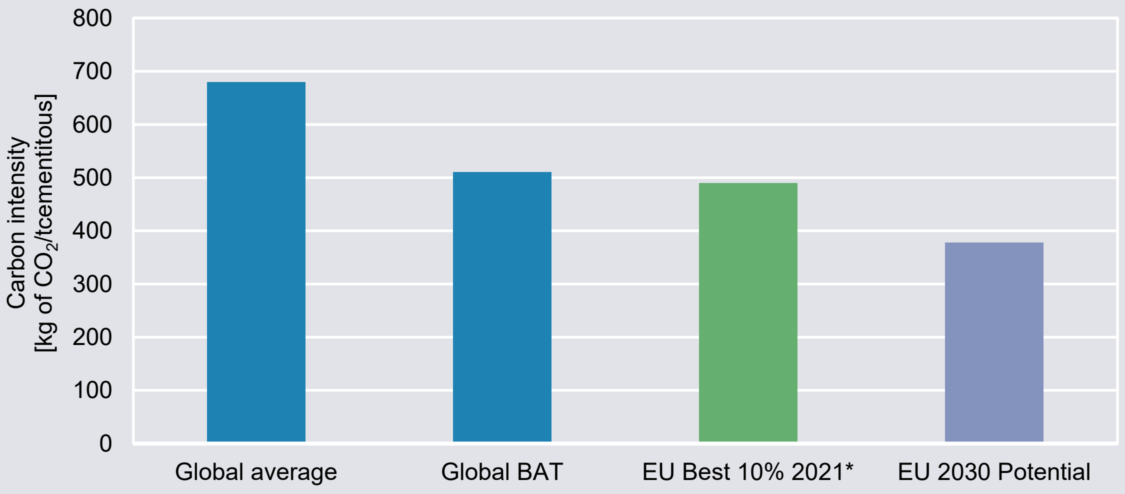
improvements to existing conventional technology – we proxy for this behaviour by assuming that CBAM installations could reduce their emissions to the current level of free allocation by 2026 or thereabouts. In the medium term, i.e. by approximately 2030 or shortly thereafter, EU installations can be expected to begin to transition to relatively mature or emerging technologies that allow for much deeper emissions reductions.

For the scope 1 emissions of the steel, cement and aluminium sectors, we compared –

- the global average CO_2 intensity of the sector
- the best available technology currently in use globally outside of Europe
- the best available technology currently in use inside of Europe
- the CO_2 intensity of the most mature abatement options considered feasible for a significant share of European sites by 2030 (or 2035 where noted).

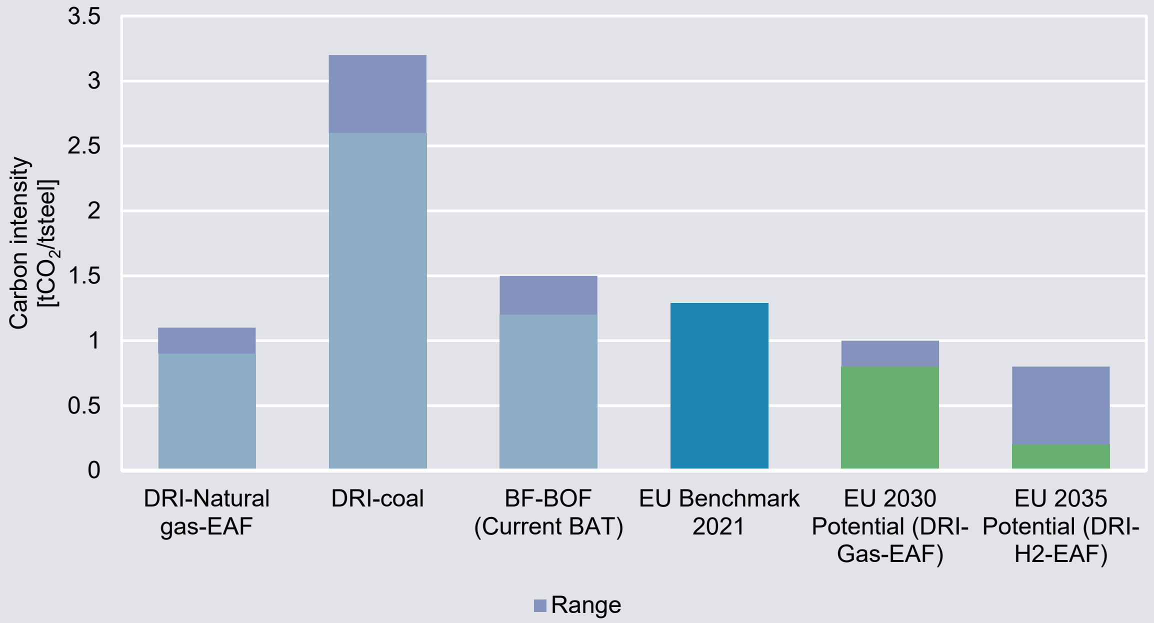
Figure 10 shows this comparison for the primary aluminium sector. The EU primary aluminium sector's best-performing installations have scope 1 (direct) emissions of just 1.484 t CO_2/tAl. This compares favourably to the global reference CO_2 intensity of 2.1 tCO_2/tAl. It is also very close to the best globally available technology of 1.42 t CO_2/tAl. It should be noted moreover that this global BAT is very close to the technical limits and probably already at the practical limits of the current process, which uses prebake, carbon-based anodes (Saeversdottir et al (2019)). Thus, in the short run, even if foreign competitors were to only send their most carbon-efficient aluminium to the EU to lower their CBAM costs, they could not gain a meaningful CO_2 cost advantage compared with EU installations performing at the level of the best available European technology. Moreover, in the medium term, there may be a

Figure 11: Comparison of cement sector CO_2 intensities



Agora Industry evaluation based on data from IEA (2020), JRC (2017), European Commission (2021f), Material Economics (2019), Haselbeigi et al (2016)

Figure 12: Comparison of steel sector CO_2 intensities



Agora Industry based on data from IEA (2020), JRC (2017), European Commission (2021f), Material Economics (2019), Haselbeigi et al (2016) potential for aluminium producers in the EU (or internationally) to outperform the current global BAT by adopting new anode technologies.

Figure 11 provides a similar comparison of cement sector CO_2 performance inside and outside the EU. It shows that the average of the EU's best 10 percent of performers in terms of gross emissions per tonne of cementitious material are, at 490kg CO_2/t, well below the global average of 680kg CO_2/t. Moreover, data from the GCCA's GNR database suggest that the EU's best performers are on average better than the next best producers globally. If most EU producers could approach this level of performance by the time the CBAM were to phase in, EU cement producers would not face a loss of competitiveness from the CBAM even if resource shuffling were to occur. Furthermore, Figure 11b includes our own best estimate of the potential abatement for an average EU cement producer by 2030. In view of the higher ETS prices and a growing set of support policies for industry to reduce emissions, we believe that further improvements are not only possible but also likely.

Figure 12 shows the same type of analysis for the primary steel sector. Here we compare the EU's best performers for hot metal production using current blast furnace technologies (i.e., the most common technology in Europe) to what is considered efficient performance for the three main categories of primary steel production globally today – namely DRI (natural gas), DRI (coal) and blast furnace (coke). Based on a direct CO_2 intensity of 1.29 t CO_2/t hot metal for basic EU steel production, the best 10 percent of EU steel producers are already essentially at the level of what can be considered the best available CO_2 performance for blast furnaces globally. By comparison, even efficient DRI (coal) technologies are roughly two to three times as CO_2-intensive.

On the other hand, current EU best performers using blast furnace (coke) technologies are approximately 30 percent more CO_2 intensive than the globally best available technology: DRI-EAF using natural gas.

This result may give rise to some concern that EU blast furnace technologies, if left in place as the CBAM was phased in, might suffer some CO_2 cost disadvantage if certain regions of the world were to shift to selling DRI (gas)-based steel to Europe. While the share of DRI using natural gas globally represents less than 10 percent of global steel production, there may be some residual risk to EU steel producers here.

However, here it is important to take a dynamic view of EU steel production intensity. As explained in section 1, by 2030, approximately 50-60 percent of EU steel production capacities will require reinvestment and many companies have announced their intension to switch from blast furnace-based manufacturing to DRI via either gas or hydrogen technologies themselves (Cf. Global Steel Tracker Database, n.d.). If this occurs, as is expected, it will reduce EU producers' CO_2 intensity in line with the world's best performers. In fact, to the extent that operations were based on new, efficiently designed installations and configured to minimise CO_2 emissions using hydrogen, it could be expected that at least some share of EU DRI-gas/EAF installations could be best in class globally.

We therefore conclude that, assuming the CBAM only covers scope 1 and not scope 2 emissions, then the risks of resource shuffling leading to carbon leakage from the EU will be very low for these products by 2030. The one possible exception may be some steel production, although here the risks would fade with time. This finding may suggest using a slightly slower phase-down of free allocation to CBAM sectors prior to 2030, until assets have had a reasonable time to transition to low-carbon technologies within the EU. This finding is further reinforced in the following section.

3.3 Ensuring carbon leakage protection for exporters

Another key design question is whether the EU CBAM should only apply to imported products to the EU, or whether it should also offer a carbon price rebate to products exported from the EU. From the perspective of mitigating carbon leakage risks, insofar as exporters lose market share to more CO_2-intensive foreign competitors, then carbon leakage would occur.

In practice, an export rebate for CBAM products might take one of two forms. One option would be to provide an explicit rebate for CO_2 costs at the border. A second, and probably an administratively simpler alternative to a functionally equivalent export rebate might be to simply continue free allocation to EU ETS installations producing CBAM products for an equivalent amount of their exported products each year. In effect, this would continue the current system of free allocation to ETS installations at the full benchmark. To limit the need for tracing exported products, this approach might be further simplified by allocating freely allowances equivalent to the average sector-wide exports from the EU-EFTA region based on a reference year or period. In administrative practice, therefore, some form of functional equivalent to an export rebate might be possible.

However, from a WTO perspective, export rebates have a significant risk of being found in contravention of the rules on prohibited subsidies outlined in the Agreement on Subsidies and Countervailing Measures (ASCM). This interpretation comes from the fact that the ASCM is generally interpreted as only allowing export rebates on indirect taxes on products, such as VAT. It does not allow for rebates for regulations placed on domestic companies (Holzer, 2014). This raises the vexing question of whether the EU ETS carbon price can be considered an indirect tax.

At one level, the legality of the CBAM under WTO law is not a red line barrier to EU action. There have been cases in the past where the EU has decided to act in contravention of WTO rulings.[17] Further, the process that leads to the need for policy change can be long. To cite an extreme example, the US first requested a WTO dispute panel in its complaint against EC subsidies to Airbus in 2005, but it took more than 15 years for a final ruling to be adopted (WTO, 2020). Moreover, for the foreseeable future, the WTO's process for settling disputes is effectively broken. During the Trump Administration, the US began to block the appointment of Appellate Body members, with the result that as of December 2019 the Appellate Body has lacked a quorum.

Some affected countries may not choose such a circuitous and uncertain route of redress, however. Any subsidy can either be taken to the WTO, or addressed in national trade remedy law, the provisions for which are outlined in Part V of the ASCM. National trade law decisions are widely considered to be more likely to determine the presence of subsidies and assess higher damages. In that scenario, the investigating country would assess countervailing duties (CVDs) on the exports they have found to be subsidised, if they can show that such subsidies cause injury to domestic producers. It is doubtful whether free allocation to EU exports would necessarily cause damage to foreign producers in practice. However, it might also be expected that CVDs would come mainly from countries that have strong opposition to the CBAM for other more political or geostrategic reasons. These may include countries with large fossil-fuel reserves (such as Russia, Saudi Arabia, Australia) as well as developing countries that

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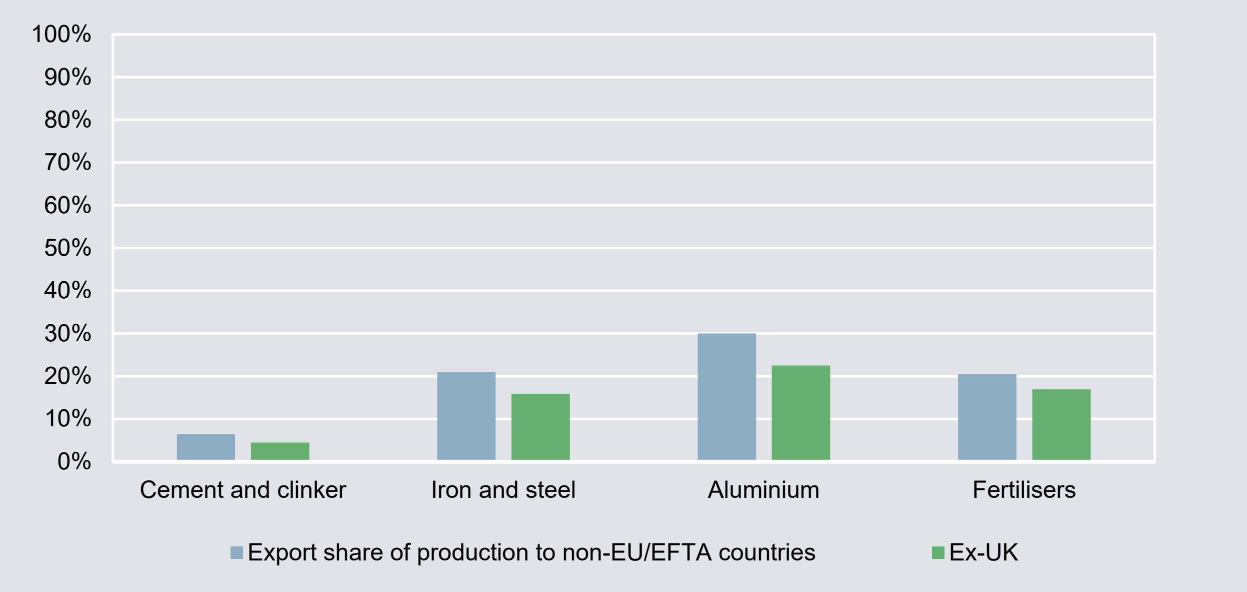
[17] One example is the 1997 "Hormone Beef Ban Dispute" case.

Figure 13: Share of total CBAM products exported from the EU-EFTA region in 2019



Comtrade, Sourrisseau and Sartor (2022)

Table 1: Destination of EU exports of CBAM products to selected countries (share of total EU value exported)

	Brazil	Russian Federation	India	China	USA	South Africa
Iron and steel	1.4%	2.5%	4.1%	6.3%	12.0%	1%
Aluminium	1.3%	2.1%	2.3%	4.5%	15.2%	1%
Cement and clinker	0.8%	0.0%	0.1%	0.1%	17.8%	0%
Fertilisers	9.4%	1.1%	1.0%	6.3%	4.2%	1%

Agora Industry based on data from Comtrade and cited in Sourrisseau and Sartor (2022)

are opposed to CBAM on principle (this would likely include China, Brazil, India).

An important question is thus whether CVDs on CBAM products is a major or a minor concern. In practice, not all countries to which the EU exports would retaliate with CVDs. For certain countries, this might raise the cost of their imports to certain value chains. It would also risk creating further trade frictions with the EU, and some countries have expressed a wish to implement CBAMs or similar anti-carbon leakage measures of their own and may thus be dissuaded from undermining the EU's own efforts. This group includes UK, Japan, Canada, New Zealand and the United States.

Table 1 shows that the share of EU exports for CBAM products to larger developing countries is less than half of all exports. If retaliation in the form of CVDs were limited to this set of countries, then the overall impact of CVDs on the ability of EU exports to find an alternative market internationally might be limited. For instance, if importers representing only 20 percent of 20 percent of EU production were to place CVDs on EU products, the effective share of production in the EU would be 4 percent. On the other hand, the ideal scenario would be to remove virtually all risk of retaliation against the EU, especially in a context of broader opposition to the CBAM, where there might be uncertainty about the scale of the reaction.

In this context of uncertainty – both with regard to legality and the international response to an export rebate – there may be value in the EU adopting a precautionary and measured approach to protecting exports from carbon leakage – at least until more cooperative agreement on its right to protect exporters can be found. Germany has proposed that the issue may be addressed via a cooperative climate club (see Section 1.3).

In this context, a more plausible approach for the EU to the export question might resemble something like the following:

Step 1. (2026–2029): To avoid an attackable export rebate, the EU could continue to protect EU ETS installations (including exporters) via other means.

Three policies might be considered (and possibly combined) here. First, the rate of free allocation phase-down/CBAM phase-in might be slowed to a rate of -6 percent per year until 2030 (but with a faster rate implemented starting from 2030 to achieve a phase-out by 2035). This would reduce the share of carbon costs that EU exporters might need to buy prior to 2030 to a maximum of 24 percent in 2029.

Second, the bought time until 2029 could be used to provide support for decarbonisation in the form of state aid or EU funds to all EU assets under the CBAM sectors, including those with export intensive operations. This would further reduce the exposure of exporters prior to 2030 and thereafter, as it would help to reduce ETS liabilities by decreasing their emissions. Indeed, our analysis suggests that with readily available or emerging technologies, EU exporters in the CBAM sectors could reduce their emissions by between 30 percent and 50 percent by 2030, on average. (For further information on this assumption, see Annex 1.)

To create confidence for exporters and other industrial sectors subject to CBAM, concrete 2030 decarbonisation milestones could be set. These could be based on the sectoral roadmaps required under the EU Climate Law. One option might be to make supporting the achievement of industrial sectoral transition goals part of the mandate of EU ETS Innovation Funds and other industrial decarbonisation funding mechanisms. Such milestones, if backed by robust financing mechanisms, would likely give industry, exporters in particular, greater confidence that support would be available to help them decarbonise during the CBAM phase-in.

Third, to avoid "artificial" reductions due to the implementation of breakthrough technologies with the support of state aid, the benchmark used to calculate the level of free allocation itself might be frozen at its current level (i.e. for 2021–2025). This would provide a high degree of protection to exporters until 2030 without any risk of export-rebates becoming a lightning rod for opposition to CBAM. If needs be, the cross-sectoral correction factor limit might also need to be temporarily raised to 50 percent of ETS allowances in 2030, from the current level of 46 percent, but it should not be raised much higher than this.

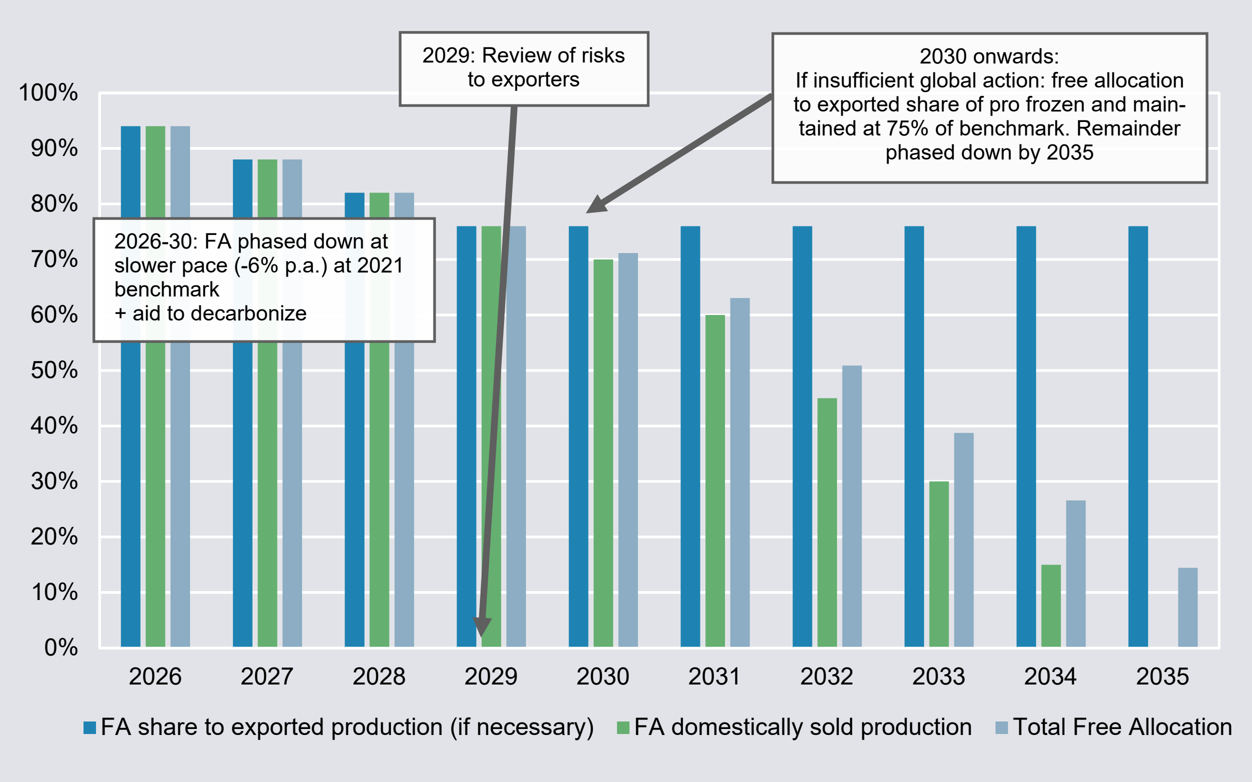
Step 2 (2029): The EU would conduct a review of international efforts to develop equivalent carbon prices or markets for low-carbon CBAM products in relevant global markets.

A review could help to determine whether dedicated protection instruments for exports would be necessary if free allocation was phased down more quickly after 2029. (While such a review clause would create some uncertainty for European industry, it could nevertheless be interpreted as a commitment by policy makers to address their concerns more fully. It should also be noted that the alternative to a CBAM – continuing an unsustainable level of free allocation to all producers until 2030 – would not provide greater certainty.)

Step 3 (2030–onwards): The EU could then decide if the risks to exporters were too large to freeze the phase-down of free allocation to the exported share of production until global action was deemed adequate to phase it down further. Free allocation could then (if necessary) be continued to only the exported share of production, while CBAM would be phased in at the full rate for imports to the EU.

Starting in 2030, the level of free allocation for the exported share of production for the relevant products could be frozen at 76 percent of the full benchmark. After 2030, the free allocation could be phased down at a faster rate on the domestically sold share of production in CBAM sectors. (In the Scenario outlined in Figure 14, we assume a rate of -10 percent from 2030 to 2031 followed by -15 percent per annum until 2035.) Since the exported share of production is a minor share of total production in CBAM sectors, the overall level of free allocation would also decline quickly to a very low level by 2035. Free allowances for exported goods might also be made conditional on a given level of climate action in CBAM sectors globally.

Figure 14: How the export question may be tackled as part of a combination of solutions

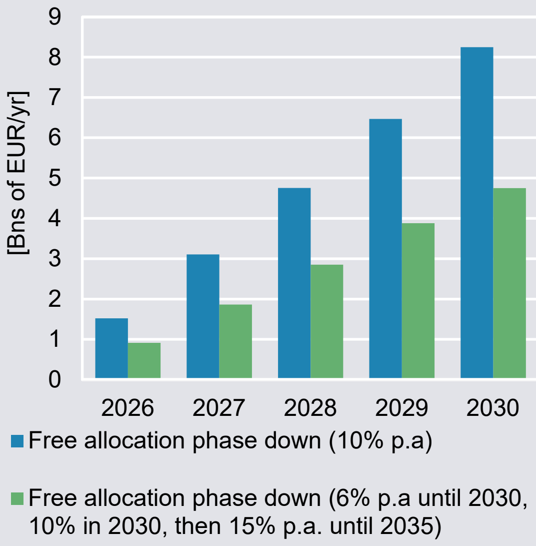


Sourrisseau and Sartor (2022)

The scenario outlined in Figure 14 might have several advantages compared with the current proposal outlined in the Commission's CBAM and ETS proposals. It would allow the CBAM to be phased in from 2026 and tested with a meaningful but modest reduction in free allocation during the initial years of application. It would provide sufficient protection for exported products until at least 2030 due to higher shares of free allocations (and freezing of the free allocation benchmarks) during the first 5 years of operation. It would place the CBAM on a legally stronger footing (regarding export) during the initial period of introduction (i.e., the 2020s) and allow initial opposition to the CBAM to pass. Finally, it would ensure that the measure was gradually legitimised, accepted and perhaps copied in other jurisdictions.

By 2030, once CBAM was established, it might be possible for the EU to implement free allocation as a temporary export protection mechanism for exporters without the threat of significant retaliation. This may be the case if initial opposition to CBAM has been absorbed and the mechanism had nonetheless become established. At the very least, the worst-case scenario in 2030 would likely be no worse than in 2023–2026 – i.e., a small share of EU exports might face some CVDs from some specific countries. If, however, a significant share of major economies was unable to cooperate on decarbonising energy-intensive industrial sectors by 2030, then the EU would arguably face bigger concerns regarding its climate agenda than steel and cement clinker exports.

Figure 15: Potential auction revenues from the sale of allowances to CBAM sectors (2026-2030)



Agora Industry estimates (2021)

The approach outlined in this section seeks to strike a balance between the arguments for a slower phase-in of CBAM/phase-down of free allocation and those for a faster phase-in/phase-down outlined in Section 1. The CBAM would nevertheless begin to be implemented from 2026, and free allocation would begin to phase down. Some funding could be raised from the ETS Innovation Fund to support breakthrough innovations prior to 2030. (See Section 1.)

Figure 15 compares estimates of potential additional revenues raised for the ETS Innovation Fund under two different free allocation phase-down scenarios. The taller bars show the scenario of the Commission's proposal, while the smaller bars show the impact of the proposal outlined in this section by the authors. The result suggests that, even with a slower – i.e., -6 percent per annum – rate of free allocation phase-down prior to 2030, and even when freezing the free allocation to exported shares of production after 2029, the revenues generated for the ETS Innovation Fund could still be very significant. In 2026, 2027, 2028, 2029, and 2030, amounts of 1.05, 2.15, 3.28, 4.47, and 5.47 billion EUR, respectively, would be generated, amounting to a total of approximately 16 billion EUR during the latter half of the decade. If coupled with national funding instruments, this amount would nonetheless significantly contribute to the first wave of low-carbon technologies in CBAM sectors.

3.4 Use of CBAM revenues from obligations fulfilled by importers

One additional important design consideration of the CBAM is the question of the use of direct revenues acquired by the EU from the payment of the CBAM obligations by importers from third countries. Since it is not possible under European budgeting rules to earmark revenues for a given purpose, the CBAM regulation proposal returns revenues to the EU budget but does not define a specific usage (European Commission, 2021).

However, while this may satisfy the legal requirements of the EU's budgeting arrangements, it creates a political problem that the EU needs to solve. Developing countries have objected on principle to the CBAM, arguing that it violates the concept of "common but differentiated responsibilities" (a key principle defended by developing countries under the UN Framework Convention on Climate Change and referenced by the Paris Climate Agreement (UNFCCC, 2015)) (Germanwatch, 2021). Although the legal merits of this argument can be questioned – doesn't CBRD oblige developed countries to show more ambitious climate action? – the political legitimacy of the CBAM is an important factor in international climate negotiations.

Some developing countries have indicated that they may be more willing to accept the EU's CBAM if the revenues from payments on exports to the EU's market were somehow returned to them. (See

Germanwatch, 2021; E3G-Sandbag, 2021). Moreover, communications during COP26 highlighted a growing rift between developing and developed countries because the 100 bn USD/year in climate financing promised by 2020 under the Paris Agreement has not yet been released (LDC-Climate Change, 2021; Power Shift Africa, 2021).

Therefore, there may be a broader political value in returning revenues generated by CBAM to less developed countries in the form of international climate finance and contributing to the 100 billion USD/year promise. Another alternative would see those funds flow not to exporting countries, but to exporting firms, perhaps in the form of subsidies to facilitate the task of collecting and certifying the GHG-intensity data required under the CBAM.

It should also be noted that the revenues directly generated by the CBAM from importer obligations will tend to generate more limited amounts of revenues than from the sale of ETS allowances (European Commission, 2021b). As such, the financial loss to the EU may be manageable. By contrast, the symbolic value of such a gesture may be worth the cost to the EU budget on account of the goodwill obtained in relation to CBAM implementation (reduced trade conflicts) and because it helps to resolve a key sticking point in international climate negotiations.

4 Conclusions

One of the most difficult challenges in reaching a global net-zero future will be the decarbonisation of energy-intensive trade-exposed sectors like steel, aluminium, cement and fertilisers, which account for an outsized share of global emissions. We are starting to see viable technology pathways for low-carbon production in all of these sectors, but even after commercialisation they will require significant investments in new capital goods and infrastructure.

Those innovations and investments will not occur if we cannot ensure that the cost of carbon is felt by the sectors throughout the value chain and passed along to consumers. This is a critical prerequisite to climate ambition; the status quo is not a viable option as we move toward a net-zero future. But achieving it is fundamentally complicated by open trade with countries of uneven levels of ambition.

This report explores one way that ambition might be enabled in the EU: the introduction of a CBAM, accompanied by supporting policies and finance to bring down the costs of decarbonisation and ensure markets for green materials. Though any such regime faces challenges such as preserving export markets, resource shuffling and the phase-out of free allowances, this report finds none to be insurmountable. Moreover, it finds that a properly elaborated CBAM can assist in the EU's process of industrial transformation. A CBAM can provide revenues to support the effort while inducing foreign producers and governments to advance low-carbon pathways.

5 References

ADE and Compass Lexecon (2020): *Combined Retrospective Evaluation and Prospective Impact Assessment Support Study on Emission Trading System (ETS) State Aid Guidelines.* (Final report). European Commission, DG Competition. https://ec.europa.eu/competition/state_aid/what_is_new/2020_ets_revision/consultants_study_ets_guidelines.pdf

Agora Energiewende (2020): *Breakthrough Strategies for Climate Neutral Industry.* (Study). https://www.agora-energiewende.de/en/publications/breakthrough-strategies-for-climate-neutral-industry-in-europe-study/

Agora Energiewende (2020): *Enabling European Industry to Invest into a Climate-NeutralFfuture before 2030.* https://static.agora-energiewende.de/fileadmin/Projekte/2020/2020_10_Clean_Industry_Package/A-EW_201_Enabling-industry-invest-before-2030_WEB.pdf

Agora Energiewende (2020): *A Clean Industry Package for the EU: Making Sure the European Green Deal Kick-Starts the Transition to Climate-Neutral Industry*, Berlin Germany. https://www.agora-energiewende.de/en/publications/a-clean-industry-package-for-the-eu-impulse/

Agora Energiewende (2021): *Global Steel at a Crossroads: Why the Global Steel Sector Needs to invest in Climate-Neutral Technologies in the 2020s.* https://www.agora-energiewende.de/en/publica-tions/global-steel-at-a-crossroads/

Climate Strategies (2021): A Design of the Carbon Border Adjustment Mechanism for an Inclusive Transition to Climate Neutrality Policy Proposal from the Climate Friendly Materials Platform, June 2021 https://climatestrategies.org/wp-content/uploads/2021/06/PolicyProposal_CFMP_June2021.pdf

Cosbey, A. (2021): *Principles and Best Practice in Border Carbon Adjustment: A Modest Proposal.* Trade and Sustainability Review, 1(4), November 2021.

European Commission (2014): *Results of Carbon Leakage Assessments for 2015–19 list* (based on NACE Rev.2) as sent to the Climate Change Committee on 5 May 2014

European Commission (2020): *Impact Assessment accompanying the document "Stepping Up Europe's 2030 Climate Ambition Investing in a Climate-Neutral Future for the Benefit of our People"*

European Commission (2020b): *Communication of the European Commission on Guidelines on Certain State Aid Measures in the Context of the System for Greenhouse Gas Emission Allowance Trading Post 2021*, Brussels, 21.9.2020. https://www.euractiv.com/wp-content/uploads/sites/2/2020/09/ets_guidelines_2021_en.pdf

European Commission (2021a): *Proposal for a Regulation of the European Parliament and of the Council Establishing a Carbon Border Adjustment Mechanism*, European Commission July 2021. https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/delivering-european-green-deal_en#documents

European Commission (2021b): *Impact Assessment Report accompanying the Proposal for a Regulation of the European Parliament and of the Council Establishing a Carbon Border Adjustment Mechanism, European Commission July 2021.*

European Commission (2021c): *Impact Assessment accompanying the EU ETS Directive Revision, European Commission July 2021.*

European Commission (2021d): *Proposal for a Directive Amending Directive (EU) 2018/2001 of the European Parliament and of the Council, Regulation (EU) 2018/1999 of the European Parliament and of the Council and Directive 98/70/EC of the European Parliament and of the Council as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652*

European Commission (2021e): *Proposal for a Directive amending Directive 2003/87/EC establishing a system for greenhouse gas emission allowance trading within the Union, Decision (EU) 2015/1814 concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading scheme and Regulation (EU) 2015/757.* https://ec.europa.eu/info/sites/default/files/revision-eu-ets_with-annex_en_0.pdf

European Commission (2021f): *Commission Implementing Regulation (EU) 2021/447 determining revised benchmark values for free allocation of emission allowances for the period from 2021 to 2025 pursuant to Article 10a(2) of Directive 2003/87/EC of the European Parliament and of the Council.* https://ec.europa.eu/clima/news-your-voice/news/adoption-regulation-determining-benchmark-values-free-allocation-period-2021_en

Eurostat (n.d.) : https://ec.europa.eu/eurostat/data/database

E3G-Sandbag (2021): *A Storm in a Teacup: Impacts and Geopolitical Risks of The European Carbon Border Adjustment Mechanism*, https://www.e3g.org/publications/a-storm-in-a-teacup/

Falkner, R., N. Nasiritousi and G. Reischl (2021): *Climate Clubs: Politically Feasible and Desirable?* Climate Policy DOI: 10.1080/14693062.2021.1967717.

Fleming, S. and C. Giles (2021): *OECD Seeks Global Plan for Carbon Prices to Avoid Trade Wars.* Financial Times. September 13, 2021.

Garicano L. (2020): *Towards a Feasible Carbon Border Adjustment Mechanism: Explanation and Analysis of the European Parliament´s Proposal Paper presenting the European Parliament's Proposal - 2020/2043 (INI): "Towards a WTO-compatible EU carbon border adjustment mechanism".* https://luisgaricano.eu/wp-content/uploads/2021/03/CBAM_WorkingPaper_LuisGaricano-1.pdf

German Finance Ministry (2021): *Key Issues Paper: An International Climate Club.* https://www.bundesfinanzministerium.de/Content/EN/Downloads/key-issues-paper-international-climate-club.pdf?__blob=publicationFile&v=3

GCCA (n.d.): *Getting the Numbers Right Database. GCCA.* https://gccassociation.org/gnr/

Germanwatch (2021): *More Cooperation, Less Confrontation*, Germanwatch, Berlin. https://www.germanwatch.org/sites/default/files/GERMANWATCH_Increasing%20the%20acceptability%20of%20the%20EU%20CBAM_2021-06-17_2.pdf

Gerres et al (2019): *Can Governments Ban Materials with Large Carbon Footprint? Legal and Administrative Assessment of Product Carbon Requirements.* https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3501408

Global Efficiency Intel (n.d.): *Webpage on 19 Emerging Technologies for Energy-efficiency and GHG Emissions Reduction in the Cement and Concrete Industry.* Accessed November 3rd, 2021. https://www.globalefficiencyintel.com/new-blog/2017/technologies-energy-emission-cement-concrete-

Global Steel Tracker database (n.d.): https://www.industrytransition.org/green-steel-tracker/

Hasanbeigi A. M. Arens. J. Carlos. R. Cardenasa. L. Price. R. Triolo (2016): *Comparison of Carbon Dioxide Emissions Intensity of Steel Production in China. Germany, Mexico, and the United States. Resources. Conservation and Recycling.* Volume 113. October 2016. Pages 127-139. https://www.sciencedirect.com/science/article/abs/pii/S0921344916301458

Hernandez, America. (2021): *EU Steelmakers Under Pressure as Global Green Steel Race Accelerates.* Politico, February 2, 2021. https://www.politico.eu/article/eu-steelmakers-under-pressure-global-green-steel-race-accelerates/

Holzer, K. (2014): *Carbon-Related Border Adjustment and WTO Law.* Cheltenham, UK: Edward Elgar.

IEA (2020): *Iron and Steel Technology Roadmap Towards More Sustainable Steelmaking.* Energy Technology Perspectives. IEA/OECD. https://iea.blob.core.windows.net/assets/eb0c8ec1-3665-4959-97d0-187ceca189a8/Iron_and_Steel_Technology_Roadmap.pdf

IEA (2020): *Aluminium – Tracking Report.* IEA. Paris. https://www.iea.org/reports/aluminium-2

International Aluminium (n.d.): www.International-aluminium.org. Statistics Webpage. https://international-aluminium.org/statistics/greenhouse-gas-emissions-intensity-primary-aluminium/

Ismer.R. M. Haussner. K. Neuhoff. W. Acworth (2016): *Inclusion of Consumption into Emissions Trading Systems: Legal Design and Practical Administration.* Discussion Papers 1579. 23 S. https://www.diw.de/de/diw_01.c.534397.de/publikationen/diskussionspapiere/2016_1579/inclusion_of_consumption_into_emissions_trading_systems__legal_design_and_practical_administ ration.html

JRC (2012): *Prospective Scenarios on Energy Efficiency and CO_2 Emissions in the EU Iron & Steel Industry.* JRC. European Commission

JRC (2017): *Best Available Techniques (BAT) Reference Document for the Non-Ferrous Metals Industries.* JRC. European Commission. https://eippcb.jrc.ec.europa.eu/sites/default/files/2020-01/JRC107041_NFM_bref2017.pdf

Korsunskaya, Darya and Alexander Marrow (2021): *Russia Considers Own Carbon Tax as EU Prepares One.* Reuters. September 23, 2021. https://www.nasdaq.com/articles/russia-considering-own-carbon-tax-as-eu-prepares-one-vedomosti-2021-09-23

Material Economics (2018): *The Circular Economy: A Powerful Force for Climate Mitigation.* https://materialeconomics.com/publications/the-circular-economy-a-powerful-force-for-climate-mitigation-1

Nordhaus, W.D. (2015): *Climate Clubs: Overcoming Free-Riding in International Climate Policy.* American Economic Review, 105(4), 1339–1370.

Okonjo-Iweala, N. (2021): *Adopting a Global Carbon Price is Essential.* Financial Times, October 14, 2021

Parry, I., S. Black, and J. Roaf (2021): *Proposal for an International Carbon Price Floor among Large Emitters.* IMF Staff Climate Notes 2021/001.

Power Shift Africa (2021): COP26: *A Five Point Plan for Solidarity Fairness and Prosperity*. https://powershiftafrica.org/wp-content/uploads/2021/07/COP26-A-five-point-plan-for-solidarity-fairness-and-prosperity.pdf

Sartor. O. S. Sourrisseau (2022): *Le mécanisme d'ajustement carbone aux frontières (MACF)*, ADEME Policy paper – Forthcoming, 2022.

Saevarsdottir. G.. H. Kvande (2019): *Aluminum Production in the Times of Climate Change: The Global Challenge to Reduce the Carbon Footprint and Prevent Carbon Leakage*. Journal of the Minerals. Metals & Materials Society 72(1). https://www.researchgate.net/publication/337430874_Aluminum_Production_in_the_Times_of_Climate_Change_The_Global_Challenge_to_Reduce_the_Carbon_Footprint_and_Prevent_Carbon_Leakage

LDC-Climate Change (2021): *Thimphu Call for Ambition and Action*, LDC Ministerial Meeting, 11 Oct 2021. https://www.ldc-climate.org/wp-content/uploads/2021/10/Thimphu-Call-for-Ambition-and-Action.docx.pdf

UNFCCC (2015): *The Paris Agreement*, UNFCCC. https://unfccc.int/files/meetings/paris_nov_2015/application/pdf/paris_agreement_english_.pdf

World Bank (2021): *State and Trends of Carbon Pricing 2021.* https://openknowledge.worldbank.org/handle/10986/35620

WTO (1947): *Agreement on Subsidies and Countervailing Measures (ASCM).* https://www.wto.org/english/docs_e/legal_e/24-scm.pdf

WTO (1994): *General Agreement on Tariffs and Trade (Conclusions of Uruguay Round 1994).* http://ctrc.sice.oas.org/Trade/ur_round/58.ASP

WTO (1998): *United States - Import Prohibition of Certain Shrimp and Shrimp Products.* Appellate Body Report, WT/DS58/AB/R, 12 October 1998.

WTO (2020): *Dispute Settlement Summary: DS316: European Communities and Certain Member States — Measures Affecting Trade in Large Civil Aircraft.* https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds316_e.htm.

6 Annex: Estimated CO_2 reduction potentials by CBAM sector by 2030

Table 2: Estimated CO_2 reduction potentials by CBAM sector by 2030

Sector	EU ETS free allocation benchmark (current best available technologies)[18]	Relevant technologies deployable by 2030[19]	Feasible emissions reduction potentials vs. ETS benchmark by 2030
Fertilisers and ammonia	1.57 tCO_2/t ammonia	Replacement of H_2 inputs in ammonia using renewable or blue[20] H_2 (70–100% of emissions)[21 22]	Up to 50% clean H_2 by 2030 (as required by new revised renewable energy directive), leading to a **35–50% reduction** in total CO_2 emissions
		Electrification of onsite energy use (0–30% of emissions)	A **0–30% reduction**, depending on current energy mix
Aluminium	1.48 tCO_2/t aluminium (process emissions only)	Use of inert anodes with wetted cathodes[23]	**Up to a 100% reduction** in process CO_2 emissions (depends on successful finalisation of ongoing large-scale projects)
		Increased recycling rates[24]	**A 20–30% reduction** of process emissions, depending on shares of virgin vs recycled materials in final product, and the availability of high-quality scrap sorting
Cement and clinker	0.693 tCO_2/t grey cement clinker (Implying approx. 0.485 tCO_2/t Portland cement)[25]	Low-clinker cement and concrete formulations[26]	**A 25–50% reduction** in clinker-related emissions (65–70% of total emissions) per unit of cementitious material and up to an 80% reduction per unit of ready-mix concrete are possible through the use of higher strength concrete formulations, engineered ready-mixed concrete mixtures and clinker substitutes[27] (higher reduction potentials are limited by material availability in some locations)
		Cement recycling and reprocessing routes[28]	**Up to a 50% reduction in process emissions** due to recycling of cement binder (recycling potentials limited by availability of end-of-life concrete, depending on location)
		Carbon curing technologies[29]	**A 30–70% reduction of total cement emissions** (combined process and energy)
		CCS (for a limited subset of sites only by 2030)[30]	**Up to a 50–100% capture of cement process emissions**; possibility for negative emissions biomass used as energy source
		Fuel switching to biomass (and electrification) of kiln and pre-treatment processes	**A 0–35%** reductions in total emissions per unit cement clinker or concrete

Sector	EU ETS free allocation benchmark (current best available technologies)	Relevant technologies deployable by 2030	Feasible emissions reduction potentials vs. ETS benchmark by 2030
Iron and steel	1.662 tCO_2/t of basic steel including upstream steps[31] 1.29 tCO_2/t of hot metal	Direct reduced iron technologies and EAFs using natural gas (or a blend of gas and hydrogen)	**A 30–40% reduction of emissions from hot metal production and up to a 50–60% reduction from an integrated process of coking, sintering and hot metal production** compared with a blast furnace using gas; up to 90% for a share of production using hydrogen and biomethane
		Shifting from blast furnaces to EAFs and the recycling of high-quality steels	**Up to a 90% reduction** of process emissions (limited by the availability of high-quality scrap/need to invest in new capacities)
		Higher levels of steel scrap blending with virgin pig iron, or DRI	**A 10–50% CO_2 savings** per tonne of hot metal, depending on current scrap-use rates, scrap quality

Adaption by Agora Industry from S. Sourrisseau and O. Sartor (2022) and with the support from work by the Ademe in France

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18 These represent the New EU ETS Free Allocation Benchmarks.

19 This list includes technologies that may be deployable only by the sector, depending on site-specific considerations.

20 Air Liquide, Borealis, Esso S.A.F., TotalEnergies and Yara International ASA have signed a Memorandum of Understanding (MoU) to explore the development of a CO2 infrastructure, including capture and storage, to help decarbonise the industrial basin located in the Normandy region, France. The objective is to reduce CO2 emissions by up to 3 million tons per year by 2030 https://www.yara.com/news-and-media/news/archive/2021/air-liquide-borealis-esso-totalenergies-and-yara-collaborate-to-help-decarbonize-the-industrial-basin-of-normandy-in-france/

21 See Material Economics (2019): Industrial Transformation 2050.

22 See https://finance-climact.fr/wp-content/uploads/2021/06/memo-pts-chimie-2021.pdf

23 See https://www.alcoa.com/sustainability/en/elysis

24 See https://www.hydro.com/fr-CA/aluminium/products/aluminium-a-bas-carbone/hydro-circal/

25 This assumes a 70% clinker/cement ratio in Ordinary Portland Cement (ratios as low as 50% are now possible).

26 See https://www.globalcement.com/magazine/articles/1203-towards-net-zero-low-co2-cement-production

27 A range of solutions are available that could achieve different levels of emissions reductions per unit of cement or concrete compared with the current benchmark. For an (incomplete) list, see Global Efficiency Intel (n.d.), Material Economics (2019). Reductions are also possible by optimising cement sub types applied to end products.

28 See, for example, Ottele and Schenk (2020) "The Smartcrusher Quarry" (https://www.slimbreker.nl/downloads/) or the "Celitement" process https://celitement.de/us/

29 For carbon curing, see Solidiatech : https://www.solidiatech.com/solutions.html ; https://www.3blmedia.com/news/solidia-technologies-announces-possibility-turning-concrete-carbon-sink-planet

30 For a real-world example of a project, see https://www.heidelbergcement.com/en/pr-17-06-2020

31 This includes emissions benchmarks for coking, sintered ore production and hot metal production.

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