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Third-party study on impact of CBAM on alumina & scrap markets

April 2025

Alumina refineries would benefit from a CBAM inclusion, while additional costs are likely to be passed on to European smelters

Alumina

Would the European refineries benefit from the inclusion of Alumina under CBAM?

Key conclusions for direct impact on Alumina refineries:

1. If alumina is included in CBAM, the **European marginal price for alumina in the EU + EEA could raise by 12-16% in a 2030 scenario and by up to 24% in a 2034 scenario** under different CBAM/ETS assumptions.* The price increase would be beneficial to EU alumina refineries, by improving their cost competitiveness, relative to imports.
2. The **CBAM application in the aluminium industry raises concerns around downstream demand destruction**, where the **inclusion of alumina in the CBAM scope could significantly raise raw material prices for European primary aluminium smelters and all downstream producers**, thus adding an additional carbon cost to all aluminium products downstream, as alumina would become a precursor.
3. **Alumina should not be included in the CBAM scope until all downstream industries, including final goods, are included** under the CBAM scope and downstream demand impact from CBAM and ETS can be better understood. Furthermore, an export support mechanism would be necessary for alumina refineries to remain competitive on the global market.
4. In the absence of an effectively designed CBAM, the remaining European installations **require a dedicated ETS alumina product benchmark in the short- to medium-term** to mirror the high energy intensity of alumina production and the absence of technologically and economically viable decarbonisation options. The ETS fallback benchmark, which is the relevant benchmark for alumina refineries, covers a broad range of sectors and processes, and thus does not accurately reflect a level of emissions performance that can be achieved by any alumina refinery, resulting in disproportionately high carbon costs for alumina producers.

Note: *Based on specific assumptions regarding CBAM/ETS outlined in this report and no significant changes to production and import volumes into Europe

A suitably designed CBAM will be needed under the overall ETS development to protect the European aluminium industry

Scrap

How should scrap be accounted for under CBAM?

All aluminium metal (sold as unwrought aluminium or included in aluminium semi-finished products) should be accounted for under national default values at the level of primary aluminium to mitigate circumvention risks, ensure fair and simplified CBAM fee calculations, and incentivise global decarbonization efforts.

Key conclusions for Scrap:

1. All metal available in the market was once produced though a primary process, which generated GHG emissions. If these emissions are **not accounted for in the CBAM regulation, European producers who pay a carbon price on their full value chain would be at a significant disadvantage.**
2. The **high complexity in global scrap flows for pre- and post-consumer scrap cannot be effectively managed through current CBAM reporting**. Furthermore, recycled aluminium cannot be physically distinguished from primary aluminium, and it is also not possible to check upon import of a product whether it is made of primary metal, pre-consumer scrap or post-consumer scrap (or a mix of them). Self-declaration of these values would be the sole basis for the calculation of the CBAM fee. This high circumvention risk may result in CBAM failing to meet its objectives of mirroring the ETS system and incentivising decarbonisation in other geographies. **Default values would address these issues, making CBAM reporting more transparent and simplified**.
3. In the current design of the CBAM, where scrap is not assigned any embedded emissions, importers **can use scrap to undercut the European market, leading to carbon leakage.**
4. **The current design of CBAM allows for the reshuffling of resources on a wider scale**, whereby only lower-carbon installations or producers with access to larger scrap volumes would import to Europe, while foreign industries would have no effective incentive to decarbonize.
5. The **abundance of global scrap creates an opportunity for circumvention**. High EU aluminium prices will incentivize foreign producers to exploit scrap content, selling at elevated prices and benefiting from windfall profits.
6. Further, false claims, non-exclusive trade codes, and mixing of different scrap types are **other significant circumvention risks if CBAM does not account for scrap emissions by a default value**.

A suitably designed CBAM will be needed under the overall ETS development to protect the European aluminium industry

Scrap

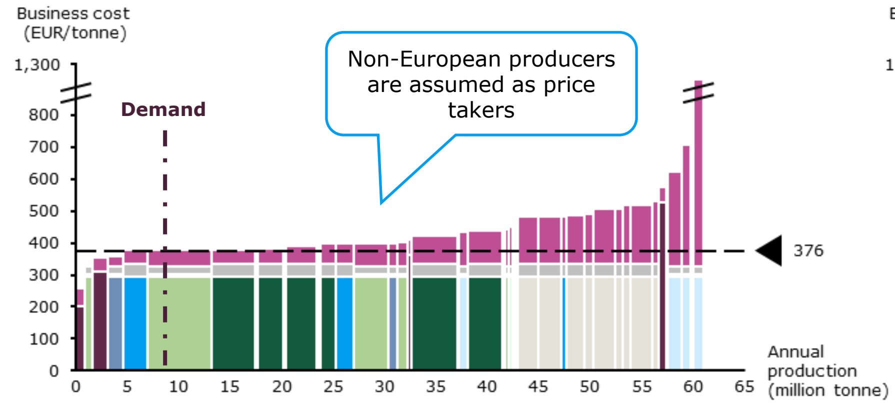
Further relevant findings of the study for the overall aluminium value chain:

1. CBAM will **create a separate higher premium European market for aluminium**. CBAM fees will be directly passed on by importers and will affect downstream industries and consumers negatively, impacting the European economy.
2. In a high premium European market, **pre- and post-consumer scrap prices would rise, regardless of CBAM inclusion**.
3. The aluminium **downstream industry (manufacturing) must be simultaneously included in CBAM**. Otherwise, the European aluminium industry will face significant carbon leakage under the current ETS and CBAM design.
4. **Indirect emissions should not be included in the CBAM design for aluminium** and the product scope should first be expanded. In the meantime, indirect cost compensation remains vital to European smelter businesses, and the impact in terms of raw material costs increases, and the competitiveness of aluminium transformation and recycling companies must first be assessed. The inclusion of indirect emissions can only be considered in the long-term, once European grids have been mostly decarbonised and third-country importers supplying European demand have had reasonable opportunities to switch to low-carbon electricity.
5. The European aluminium industry exports significant volumes. Under increasing ETS and raw material costs, **an export compensation mechanism is needed to remain competitive on the global market** while providing lower-carbon aluminium compared to global competition.
6. Under increasing ETS and raw material costs, a **correctly designed CBAM is required in order to reduce - albeit not fully eliminate - the competitive disadvantage for European producers** resulting from the application of carbon pricing in Europe, but not elsewhere in the world.

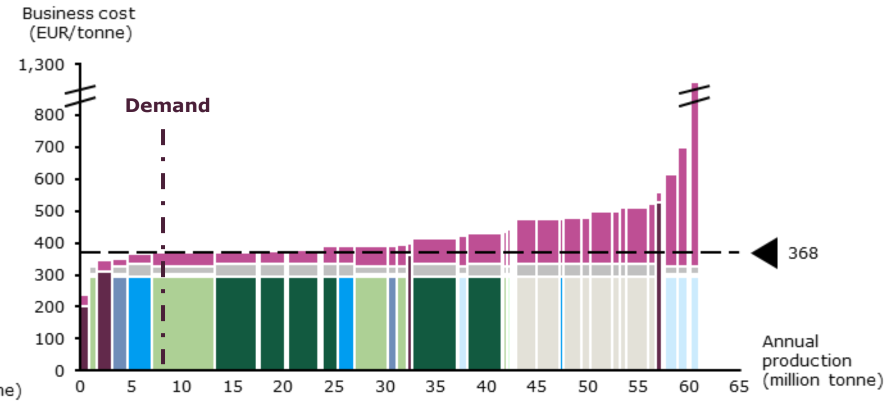
Alumina

European refineries become more competitive under CBAM, but alumina prices faced by smelters increase by up to 52 €/ton

CBAM on direct emissions



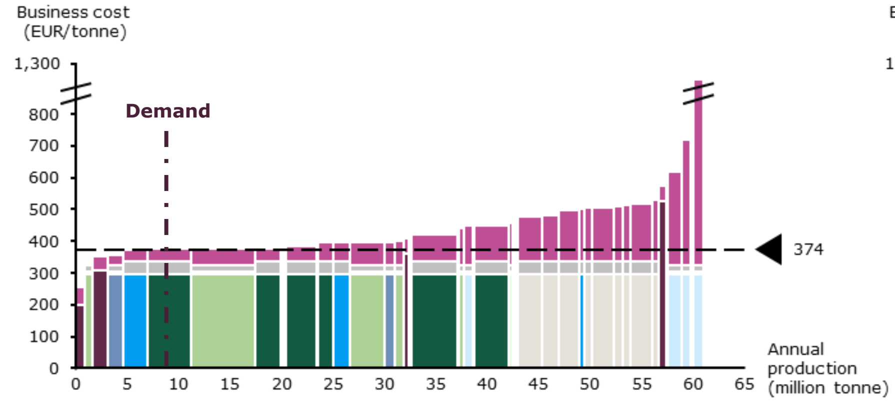
CBAM on direct emissions + separate benchmark



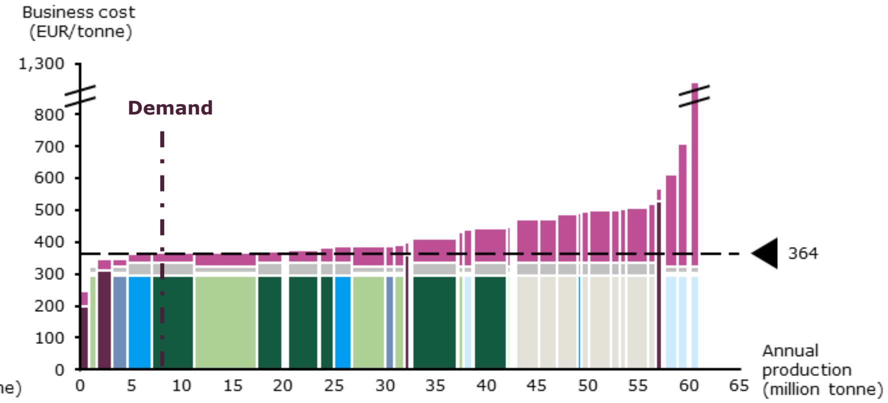
Comments

- European alumina refineries become relatively more competitive, because they move down the cost curve
- The price of alumina faced by aluminium smelters rises, but our analysis of alumina demand indicates that it is fairly price inelastic, so demand is not expected to fall in the short-term
- Survival of alumina refineries thus depends on eventual changes in demand as a result of CBAM on primary aluminium

CBAM on total emissions



CBAM on total emissions + separate benchmark



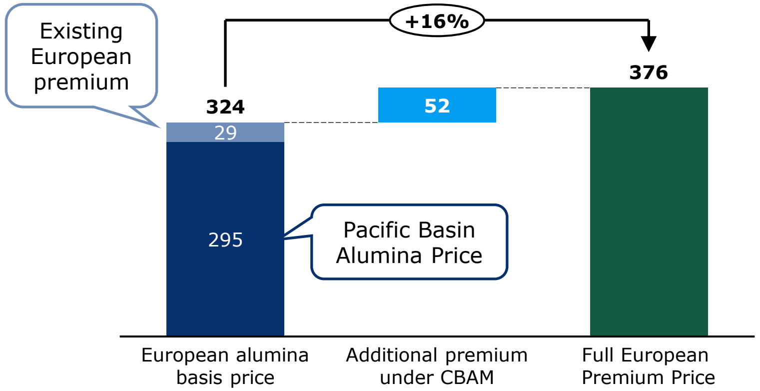
Legend

- Carbon tax
- Freight
- Atlantic differential
- Africa
- Oceania
- South America and Caribbean
- Russia and Central Asia
- European Union
- Middle East
- Non-EU Europe
- North America
- Asia (ex. China)

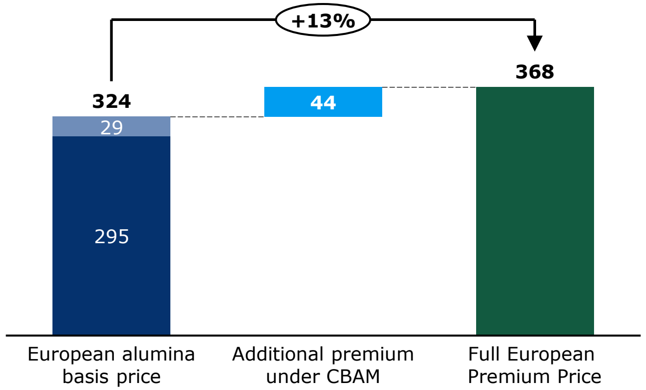
Note: 2030 assumptions for ETS/CBAM phase-in; EUA price at 140 €; assuming no state aid for indirect emission costs for alumina refineries; Chinese refineries are excluded for simplicity, as they do not export alumina to Europe; **Sources:** Ramboll analysis, Ramboll CBAM model, CRU Data;

Inclusion of Alumina under CBAM will create a separate European Market with price premiums of 12-16%

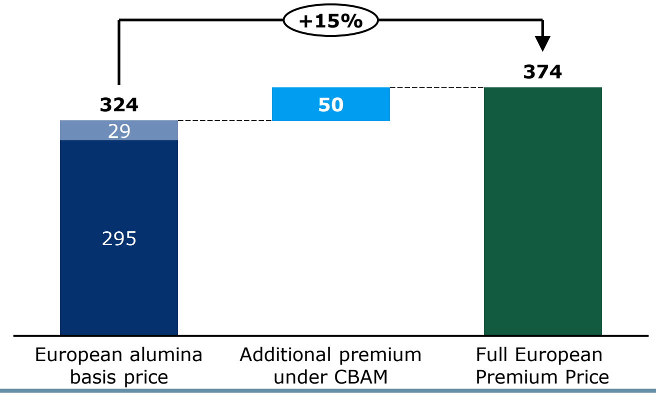
CBAM on direct emissions, price impacts in EUR/tonne



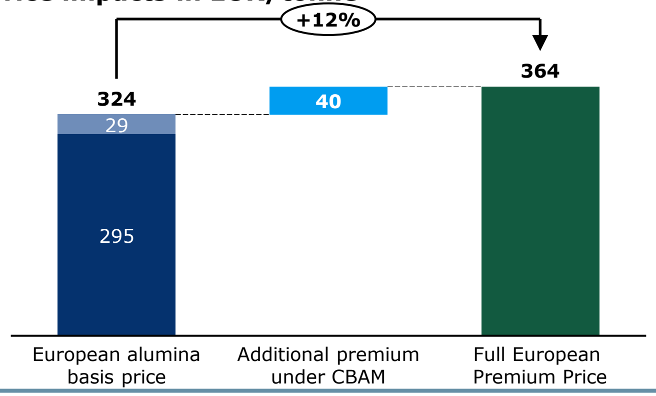
CBAM on direct emissions + separate benchmark, price impacts in EUR/tonne



CBAM on total emissions, price impacts in EUR/tonne



CBAM on total emissions + separate benchmark, price impacts in EUR/tonne



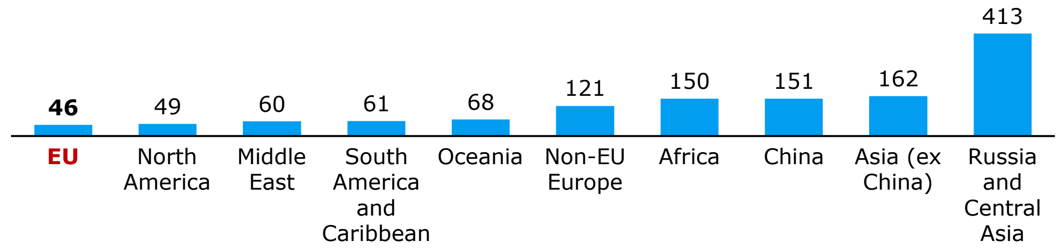
Comments

- Compared to a benchmark scenario using the current ETS costs and alumina prices, the European price of alumina under the four scenarios will rise between 12-16%
- Indirect emissions are not significant for alumina refining and thus have no impact on the resulting carbon costs.
- Based on data from CRU, some alumina refineries do not report indirect emissions of production. Because the benchmark used in the study is based on European refineries, which do have limited indirect emissions, foreign refineries with low total emissions actually face lower carbon costs in the scenarios where indirect emissions are in scope, hence the lower marginal price in these scenarios.

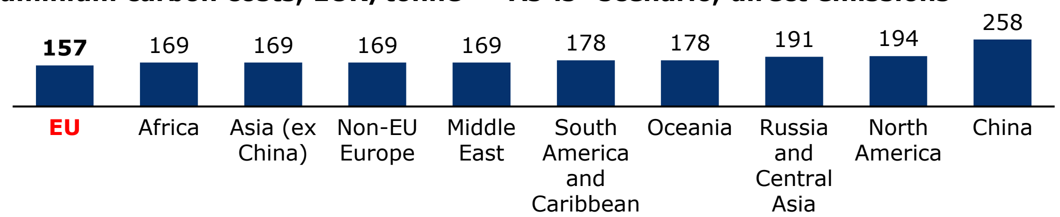
 Note: 2030 assumptions for ETS/CBAM phase-in; EUA price at 140 €; assuming no state aid for indirect emission costs for alumina refineries; **Sources:** Ramboll analysis, Ramboll CBAM model, CRU Data;

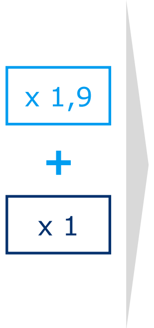
Inclusion of alumina under CBAM increases raw material prices for smelters and the overall carbon price of aluminum further

Alumina carbon costs*, EUR/tonne (at average emissions from refineries in region)

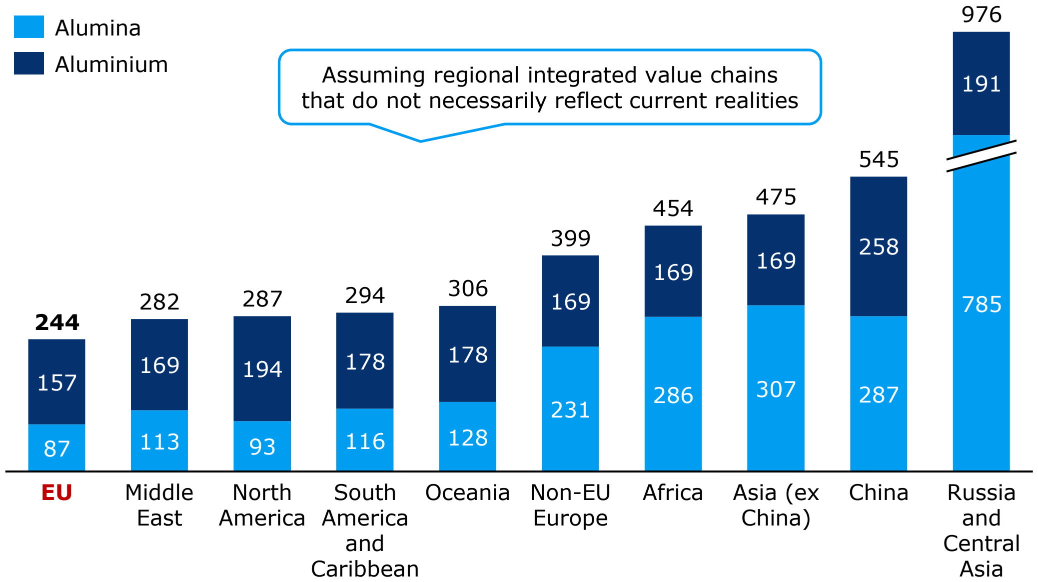


Aluminium carbon costs, EUR/tonne – "As-is" scenario, direct emissions





Primary aluminium carbon costs, EUR/tonne when alumina is a precursor

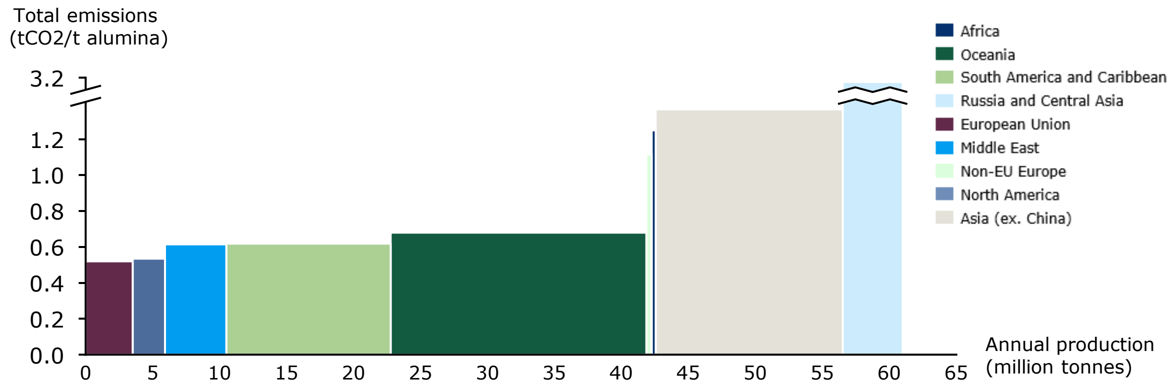


- An above shown integrated European value chain for aluminum has relatively lower carbon emissions, while in practice, value chains are globally integrated.
- EU production of alumina is mainly consumed domestically in EU and EFTA smelters, while there are some exports to Russia. EU and EFTA smelters also import alumina. Domestic production in 2023 was 3.4 million tonnes and total demand was 6.8 million tonnes, meaning domestic production only satisfies half of demand.
- Inclusion of alumina into CBAM raises the raw material price for European smelters. Being precursor to aluminium, the CBAM fee on aluminium imports also increases. This raises concerns about downstream demand destruction, impacts of cost absorption and inability of European producers to export, if there is no export support scheme.

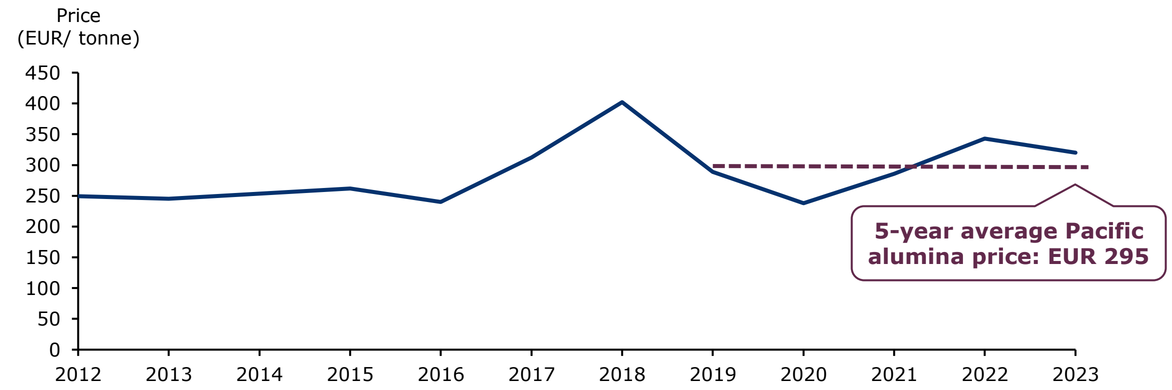
Note: *Assuming CBAM on direct alumina emissions; 2030 assumptions for ETS/CBAM phase-in; EUA price at 140 €; alumina and aluminium are produced in the same region; 1.9 tonnes of alumina used to produce 1 ton of primary alumina; **Sources:** Ramboll analysis, Ramboll CBAM Model, CRU data, JRC report for primary direct emissions

Emissions, demand, prices and costs have been used to determine the price set by the marginal producer or importer

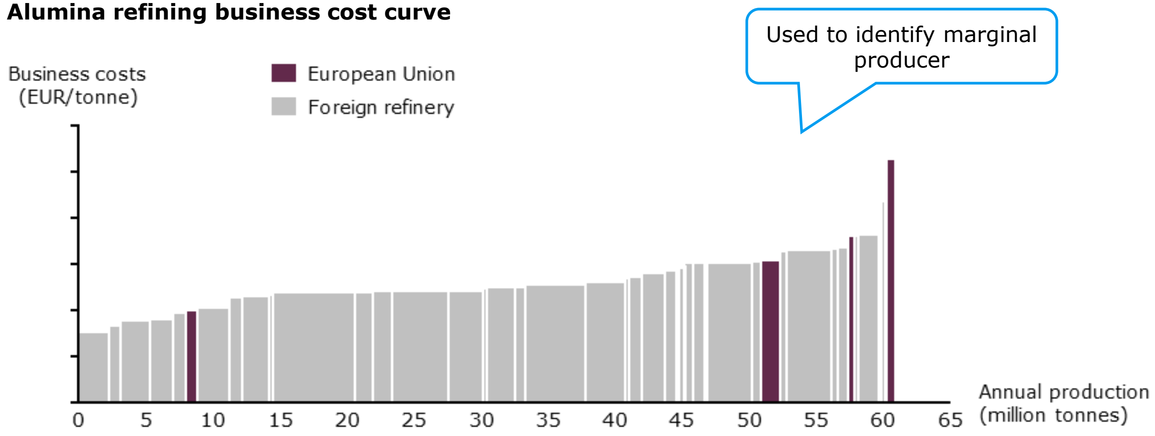
Global direct and indirect emissions from alumina production (aggregated to regions)



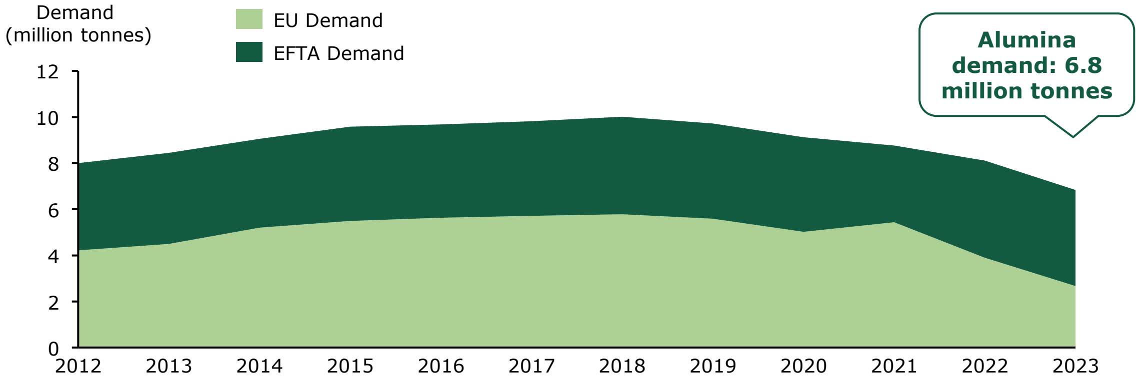
Global annual alumina price



Alumina refining business cost curve



EU + EFTA alumina demand



Note: 2030 assumptions for ETS/CBAM phase-in; EUA price at 140 €, assuming State aid for indirect emission costs for alumina refineries; Chinese refineries are excluded for simplicity, as they do not export alumina to Europe; **Sources:** Ramboll analysis, Ramboll CBAM model, CRU Data

Scrap

CBAM creates a high premium European aluminium market, affecting aluminium scrap regardless of CBAM scope

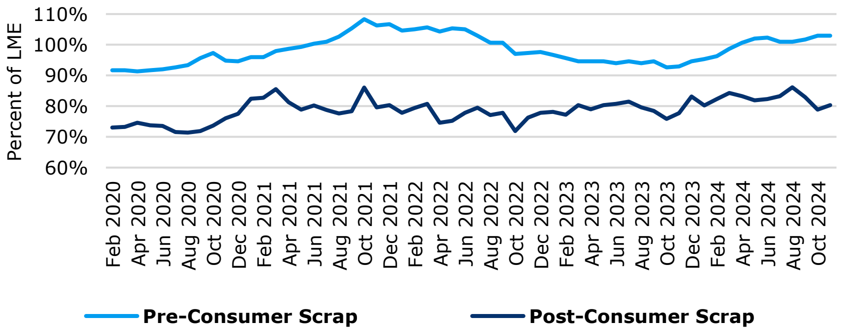
Creation of a separate European Market

- For importers, CBAM acts like a tariff on imports, where they will directly pass the cost on in the value chain.
- Because CBAM mirrors the ETS, which simultaneously also significantly **increases the price for European producers at the same rate**, the price for domestic production will rise at the same rate as the CBAM.* Therefore CBAM is not directly comparable to a simple import tariff.
- As a result, the price level on the European aluminium Market will rise, **creating a separate higher premium inner-European market under CBAM import fees and ETS production costs set by the marginal importer/producer**, adding to the already existing gap of European market premium added to the global LME price.
- Third country importers will sell the products at the marginal European price, and not at their own cost. **CBAM circumvention or reduction will thereby directly improve 3rd country importer margins** and not reduce the price for European off-takers.
- If **downstream manufacturing is not included in CBAM, this will create a significant risk of carbon leakage** for the overall aluminium industry, as foreign producers can avoid this price premium.

Effects on Scrap markets under CBAM

- Scrap is highly correlated to the overall aluminium price. If the European market price for aluminium rises, **scrap prices will increase regardless of assigning embedded emissions to aluminium scrap**.
- Under CBAM, **scrap will become more attractive to reduce overall carbon costs**, especially if scrap is excluded from any CBAM fees.
- As a result, market effects will negatively impact recyclers and remelters **facing higher prices for their raw scrap material inputs**, regardless of scrap in- or exclusion under CBAM.
- Based on current limited imports of scrap**, negative effects for the accounting of scrap are assessed marginally compared to overall outlined circumvention risks.

EU Scrap Prices - As Percentage of LME



European premium aluminium market
(illustrative)

Scrap contents (pre- and post-consumer) should be accounted for under default values in the embedded emissions calculation for imported CBAM goods.

***Sources:** Ramboll Analysis, CRU data; Economic Impact of Section 232 and 301 Tariffs on U.S. Industries; ****Note:** Current trade codes do not mutually exclusively distinguish between pre- and post-consumer scrap, complicating the possible distinction for CBAM imports;

By increasing the scrap content, importers have a possibility to significantly circumvent CBAM fees

For the calculation of the CBAM fee in aluminium products the direct emissions of the 3 main process steps are considered:

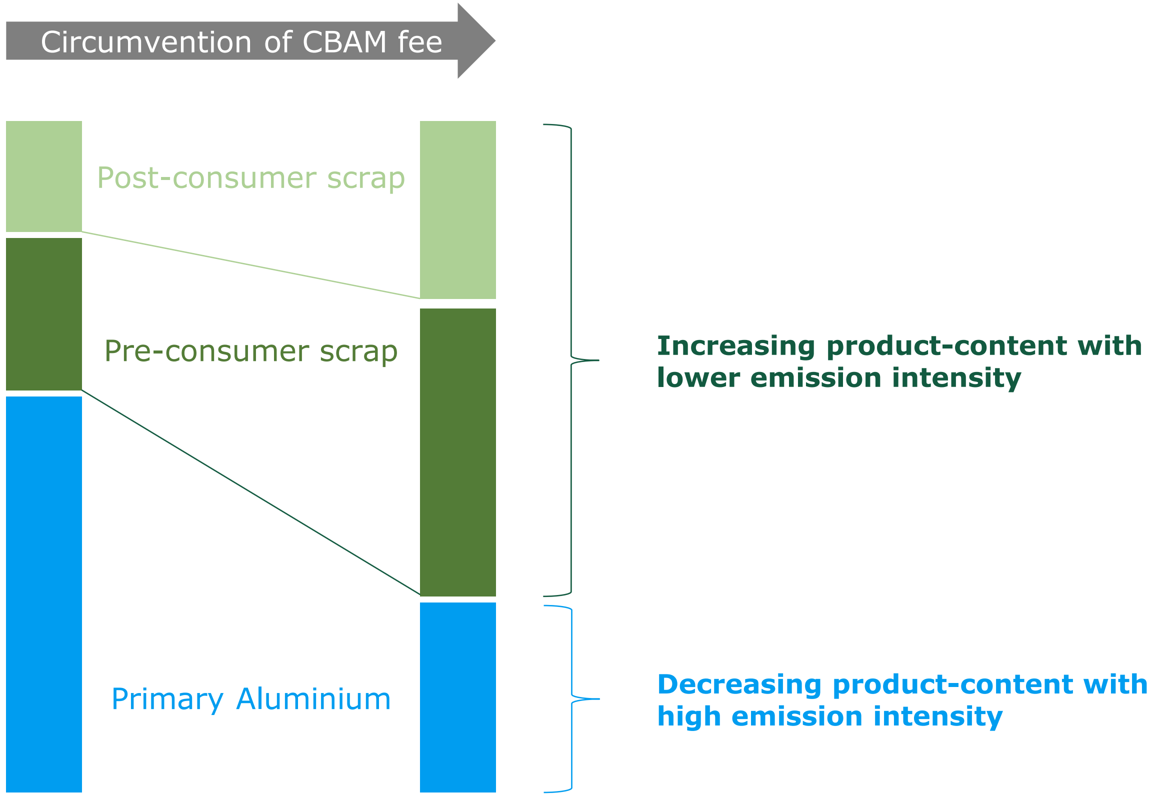
1. **Production (smelting) of primary aluminium**
2. **Recycling (remelting) of aluminium scrap**
3. **Emissions from semi-fabrication** (e.g. extrusion, rolling)

Emissions from primary aluminium smelting are the main driver behind the overall emissions reported in aluminium(-products) and, consequently, the calculated CBAM fee. Under current CBAM regulations, scrap itself has no embedded emissions.

Emissions from remelting and semi-fabrication processes only have a marginal contribution to the overall carbon intensity and the resulting CBAM fee. For instance, in the EU, the smelting process produces emissions that are approximately 7.5 times higher than those from remelting, with a similar distribution pattern observed in other world regions.

Since scrap carries no embedded emissions in the current regulation, increasing its use can substantially reduce potential CBAM fees. This reduction can be achieved by overstating the scrap content in products or by simply redirecting products with higher scrap content to the European market, without incentivizing any substantive decarbonisation efforts in the country of origin.

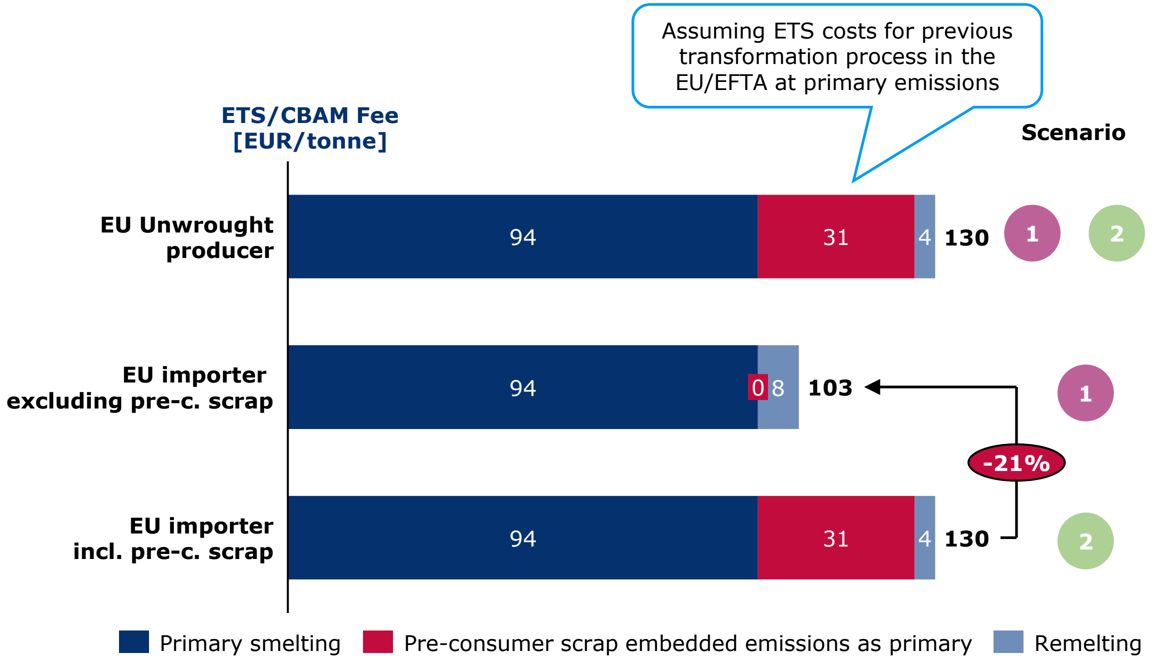
Typical aluminium products are mad out of a mix of primary and recycled (scrap-) aluminium, where the increase of scarp in products contents can be used to circumvent CBAM



 Notes: Based on simplifications made in global Ramboll CBAM model; Circumvention potential and calculation of CBAM fees based on current design of CBAM regulation

Accounting for scrap increases the CBAM fee, while more accurately representing the true carbon costs

Excluding scrap vs. accounting for scrap in CBAM
(Scenario 1 vs. Scenario 2 - 2030)



Assuming an importer exactly equal in emission intensity to the average EU producer

Pre-consumer scrap content	**20%**
Post-consumer scrap content	**20%**

Accounting for scrap under CBAM

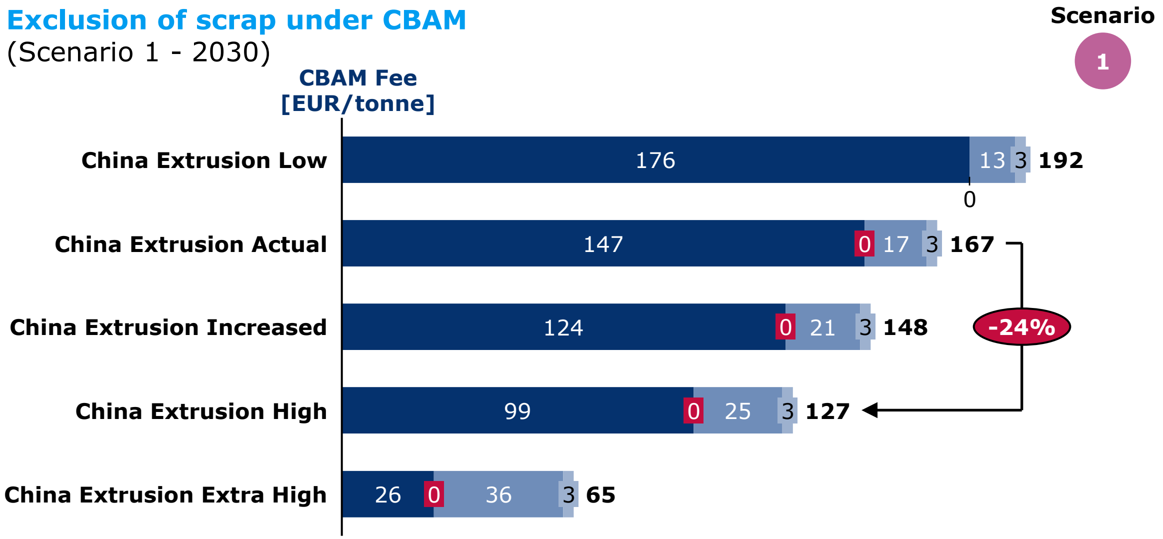
- Assuming **a correct policy design/implementation, European producers have a carbon cost advantage per tonne** due to overall lower emissions in the value chain compared to third country importers.
- From a **cost absorption** perspective, **European producers face a significant disadvantage**, as they **must pay the full EU ETS carbon price on their entire production volume**. In contrast, **foreign producers are only subject to CBAM obligations on imported volumes**, which may be limited based on import choices.
- In the boundaries of ETS and CBAM, a **European producer will always pay ETS for all value chain steps**. European scrap always has some historic smelting and/or remelting carbon cost of primary aluminium embedded. Therefore, to better protect against carbon leakage, pre-consumer scrap, is set at the embedded emission of primary in shown Scenario 2.
- A **non-European producer will not be subject to such costs** based on current CBAM design, neglecting the initial carbon cost caused by the generation of aluminium scarp.
- Therefore, **not accounting for scrap leaves room to circumvent CBAM fees** for 3rd country importers, leading to a **significant competitive advantage for importers**.
- As such the **CBAM should mirror ETS cost** inflicted on European smelters, recyclers and semi-producers and act as a **carbon leakage protection mechanism,** taking into account as well the carbon cost embedded in the price of metal in Europe. The ETS cost as such is not directly linked to sustainability reporting, LCA methods or product carbon footprints, where emissions can be more accurately distributed based on a different boundary setting system.
- **Post-consumer scrap** will require the same or additional mechanisms, or default values to prevent CBAM circumvention.

All aluminium metal (unwrought aluminium or in semi-finished products) should be accounted for under national default values at the level of primary aluminium, to mitigate circumvention risks, ensure fair and simplified CBAM fee calculations, and incentivize global decarbonization efforts.

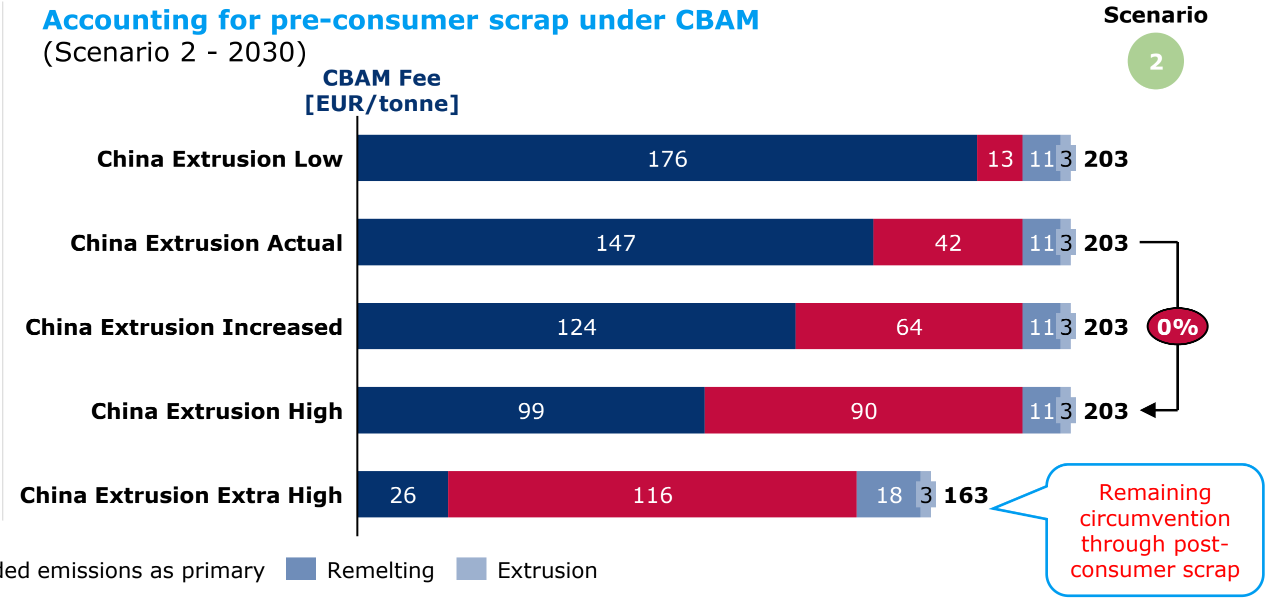
Notes: Assuming no circumvention; **Model settings:** 2030 assumptions for ETS/CBAM phase-in; EUA price at 140 €; considering full product scope in current CBAM policy design and additional extension with pre-consumer scrap accounted as primary in Scenario 2; **Sources: Sources:** Ramboll analysis, Ramboll CBAM Model, CRU data, IAI Aluminium stocks and flows model, JRC report for primary direct emissions

Using or claiming higher scrap contents leads to a significantly reduced CBAM fee under the current CBAM policy design

Exclusion of scrap under CBAM
(Scenario 1 - 2030)



Accounting for pre-consumer scrap under CBAM
(Scenario 2 - 2030)



Primary smelting | Pre-consumer scrap embedded emissions as primary | Remelting | Extrusion

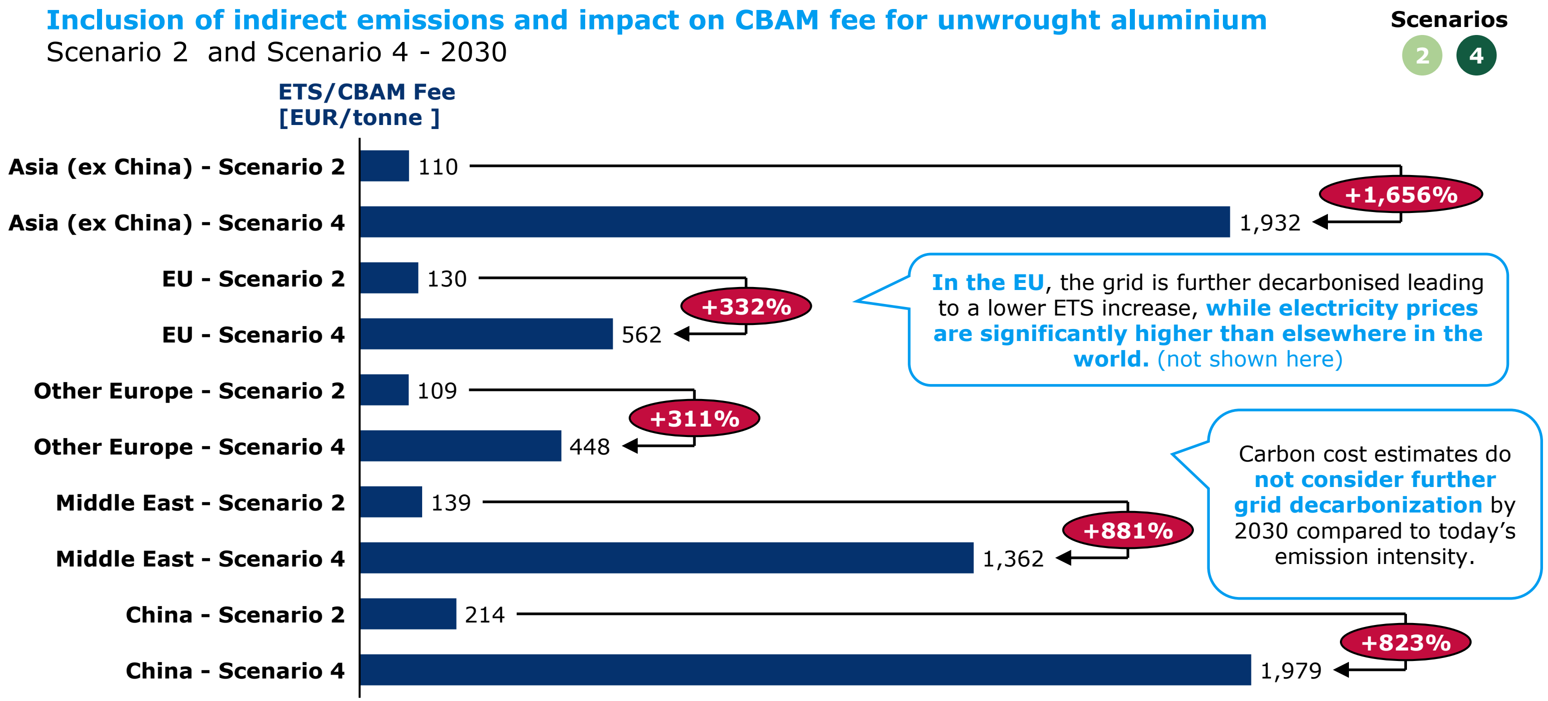
- Changing the percentage of pre-consumer scrap by **resource re-shuffling or by falsely claiming scrap contents significantly lowers the CBAM fee**, reaching up to - 24% in the "High" scrap content case in Scenario 1.
- These potential cost saving will directly improve the margins of 3rd country importers, while simultaneously increasing the attractiveness and demand of scrap by foreign producers importing to Europe.
- In Scenario 2 this is less possible* as pre-consumer scrap is accounted for at the embedded emissions of primary
- Similar circumvention can be achieved through the utilization of post-consumer scrap modelled in the "Extra High" case. Post-consumer scrap has not been assigned embedded emissions in both scenarios.

Case	Pre-consumer scrap content	Post-consumer scrap content (constant)
Low	5%	26.8%
Actual	16.4%	26.8%
Increased	25%	26.8%
High	35%	26.8%
Extra High	45%	45%

Notes: China has been chosen as an example geography, due to high exports, large aluminium industry and high amounts of available scrap volumes, * Assuming no other circumvention methods applied; **Model settings:** 2030 assumptions for ETS/CBAM phase-in; EUA price at 140 €; considering full product scope in current CBAM policy design and additional extension with pre-consumer scrap accounted as primary in Scenario 2; **Sources:** Ramboll analysis, Ramboll CBAM Model, CRU data, IAI Aluminium stocks and flows model, [JRC report for primary direct emissions]

Including indirect emissions prior to global grid decarbonisation would paralyze the European aluminium industry

Inclusion of indirect emissions and impact on CBAM fee for unwrought aluminium
Scenario 2 and Scenario 4 - 2030



Pre-consumer scrap content	**20%**
Post-consumer scrap content	**20%**

Considerations for including indirect emissions under CBAM for aluminium

- Including indirect emission under CBAM would realistically mean the phase-out/ end of remaining indirect cost compensation for European producers. **EU scenarios modelled assume therefor no further indirect cost compensation**.
- Due to the high indirect emission intensity of aluminium **CBAM fees can rise between 311% and 1,656% across scenarios**.
- This would create significantly higher CBAM fees compared to the current inclusion of only direct emissions.
- For example, compared to a global LME prices, **Chinese imports could for example rise by over 80% in total price in 2030**.
- Market impacts would lead to **significant decrease of demand, supply and high substitution** outside of market comparable elasticities.
- The inclusion of indirect emissions is **only feasible once wider sources of low carbon electricity are available** to the aluminium industry, European and Global, as downstream producers cannot absorb price increases at current scales.

Including indirect emissions for aluminium would paralyze the European aluminium industry and all downstream producers, rendering aluminium not commercially available on the European market. Inclusion of indirect emissions can only happen if decarbonised electricity is widely available to the European and global aluminium industry.

Notes: Assuming no circumvention; Actual reported fees reported for indirect emissions under Scenario 4 might differ in real scenarios due to green energy claims (e.g. PPAs) resulting in additional circumvention risk **Model settings:** 2030 assumptions for ETS/CBAM phase-in; EUA price at 140 €; considering full product scope in current CBAM policy design plus extension with pre-consumer scrap accounted as primary, Scenario 4 to include indirect emissions, Indirect emissions modelled based on process electricity demand and regional grid emission factors; **Sources:** Ramboll analysis, Ramboll CBAM Model, CRU data, IAI Aluminium stocks and flows model, JRC report for primary direct emissions

Contacts

Martin Langhorst
Senior Consultant
MNLT@ramboll.com

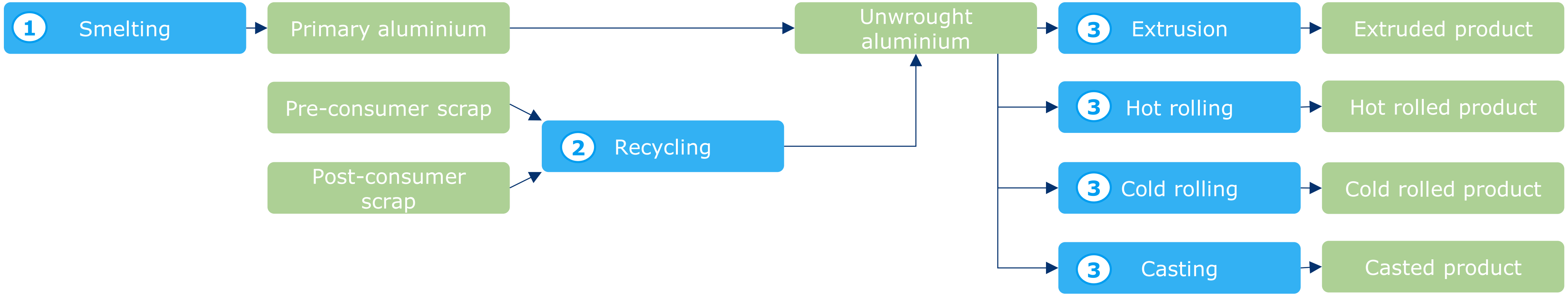
Taila Senanu
Consultant
TAIS@ramboll.com

Niki Bey
Senior Manager
NIKIB@ramboll.com

Appendix A

Scrap scenarios – additional material

To calculate carbon cost, scrap contents across global regions and individual value chain steps are modelled across scenarios



	1 Smelting		2 Remelting		3 Semi-fabrication	
Assumed 2030 benchmark:	**Direct**	**Direct+ Indirect**	**Direct**	**Direct+ Indirect**	**Direct**	**Direct+ Indirect**
	1.449 tCO2/t	4.438 tCO2/t	0.142 tCO2/t	0.163 tCO2/t	0.084 tCO2/t	0.150 tCO2/t

Semi fabrication benchmarks **differ significantly across product types**, based on their energy intensity

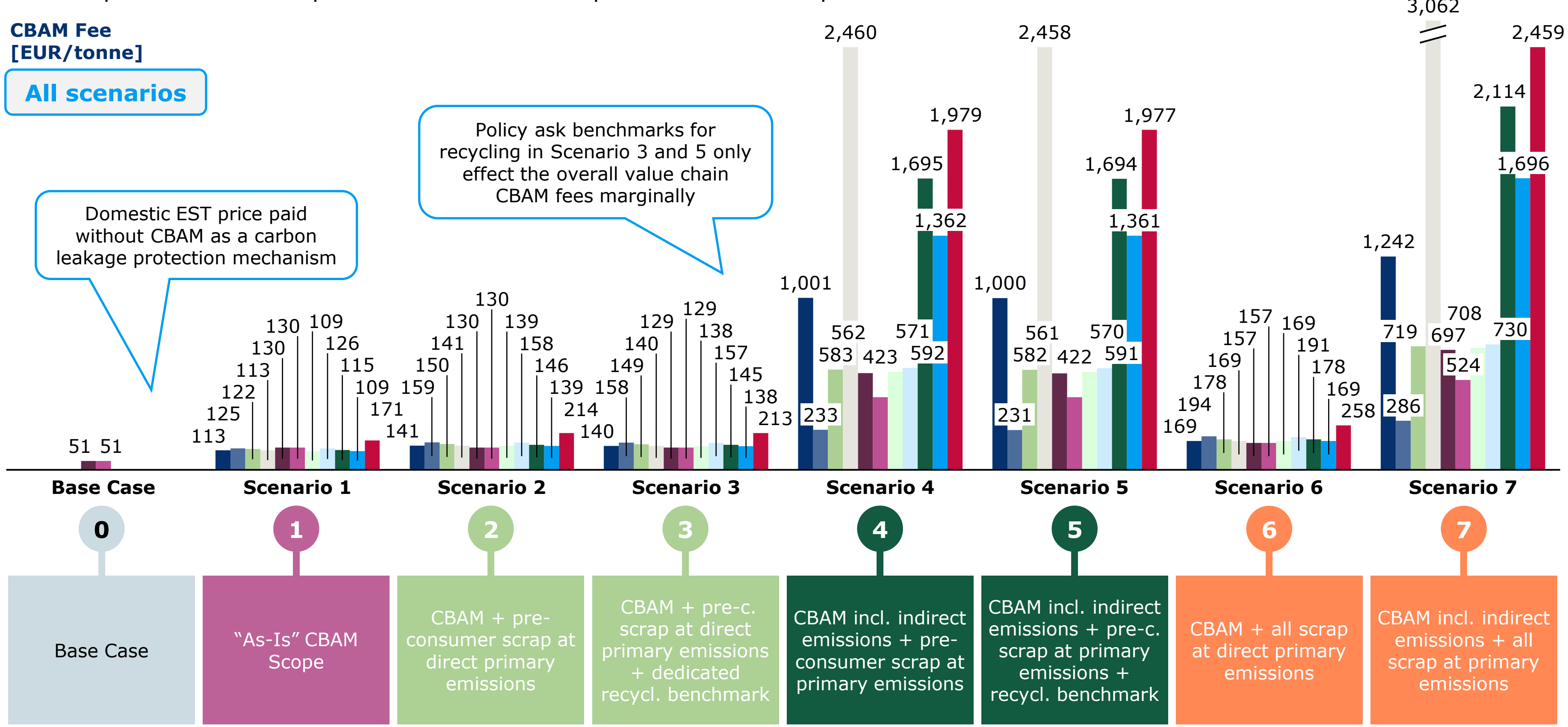
Aluminium scrap scenarios – Assessing CBAM impact on the European aluminium industry

Scenario		CBAM Implementation
0	Base Case	No CBAM
1	"As-Is" CBAM Scope	Current CBAM scope accounts all scarp at zero emissions as a precursor and in product scope.
2	CBAM + scrap at direct primary emissions	Pre-consumer scrap is accounted at the level of primary aluminium in unwrought aluminium or semi-finished products under CBAM (direct emissions).
3	CBAM +scrap at direct primary emissions + dedicated benchmark	Pre-consumer scrap is accounted at the level of primary aluminium in unwrought aluminium or semi-finished products under CBAM (direct emissions). Additionally, a dedicated benchmark for aluminium recycling is applied.
4	CBAM +scrap at indirect emissions +indirect emissions	CBAM also applies to indirect emissions. Pre-consumer scrap is accounted at the level of primary aluminium in unwrought aluminium or semi-finished products under CBAM (direct emissions + indirect emissions).
5	CBAM +scrap at indirect emissions +indirect emissions + dedicated benchmark	CBAM also applies to indirect emissions. Pre-consumer scrap is accounted at the level of primary aluminium in unwrought aluminium or semi-finished products under CBAM (direct emissions + indirect emissions). Additionally, a dedicated benchmark for aluminium recycling is applied.
6	CBAM + all scrap at direct primary emissions	All scrap is accounted at the level of primary aluminium in unwrought aluminium or semi-finished products under CBAM (direct emissions).
7	CBAM incl. indirect emissions + all scrap at primary emissions	CBAM also applies to indirect emissions. All scrap is accounted at the level of primary aluminium in unwrought aluminium or semi-finished products under CBAM (direct emissions + indirect emissions).

Unwrought aluminium carbon cost scenarios across defined scenarios show impacts of accounting for scrap

Unwrought aluminium ETS/CBAM fee [EUR/tonne] for domestic producers and importers under CBAM - 2030

Set scrap content of 20% pre-consumer and 20% post-consumer scrap



Legend:

- Africa
- North America
- South America and Caribbean
- Asia (ex China)
- EU
- EFTA
- Other Europe
- Russia and Central Asia
- Oceania
- Middle East
- China

Comments:

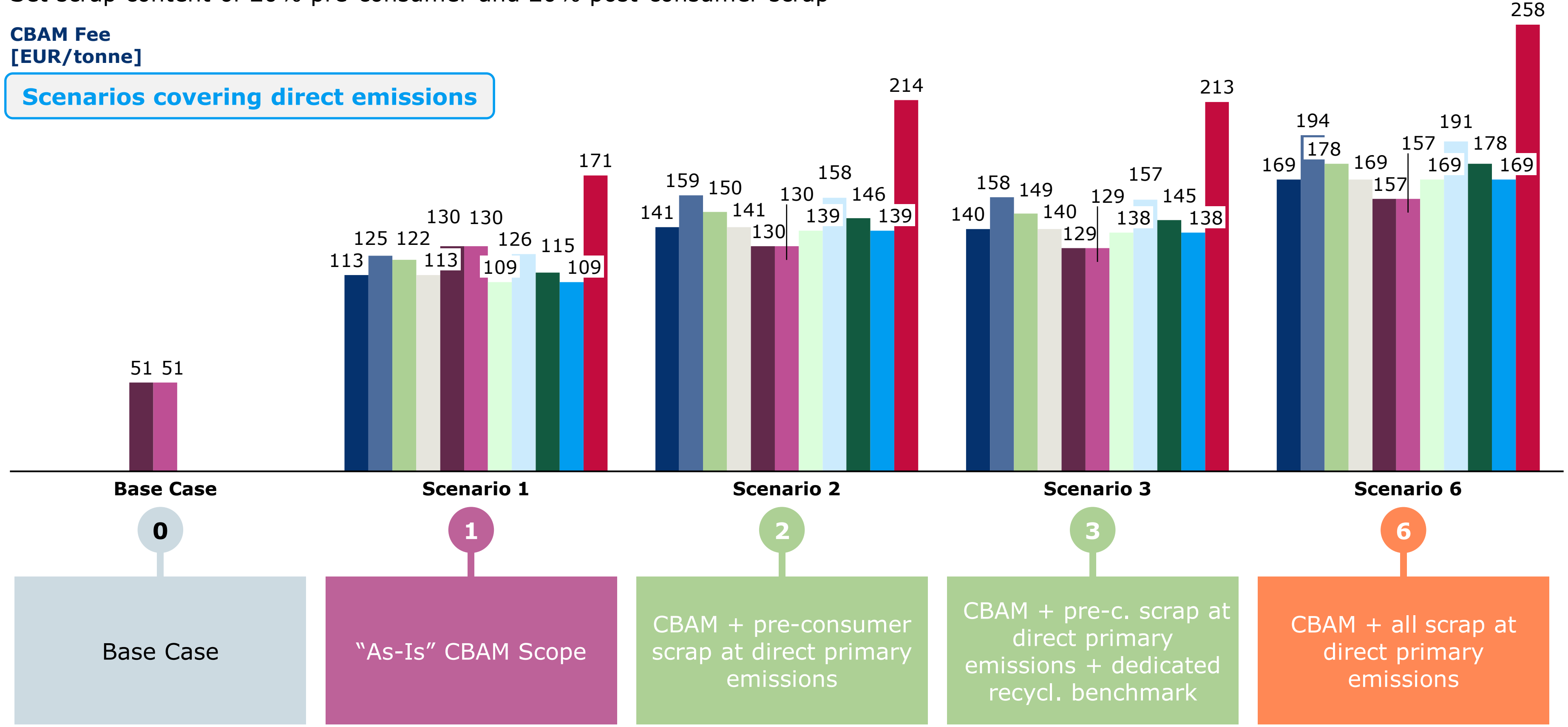
- Full value chain carbon costs from aluminium smelting and remelting
- Cost shown are only carbon cost
- For reference the current LME price tracks at around 2,380 EUR/ton
- All CBAM charges are based on regional averages. For actual ETS and CBAM implementation installation – and product-based emissions will apply

Note: 2030 assumptions for ETS/CBAM phase-in; EUA price at 140 €; no further decarbonisation of current emission levels is assumed ;considering full product scope in current CBAM policy design; The underlying JRC (Joint Research centre) report scenario assigns relatively very high emissions to Chinese producers of primary aluminium, also due to higher PFCs emissions. **Sources:** Ramboll analysis, Ramboll CBAM Model, CRU data, IAI Aluminium stocks and flows model, [JRC report for primary direct emissions]

Unwrought aluminium carbon cost scenarios across defined scenarios show impacts of accounting for scrap

Unwrought aluminium ETS/CBAM fee [EUR/tonne] for domestic producers and importers under CBAM - 2030

Set scrap content of 20% pre-consumer and 20% post-consumer scrap



Comments:

- Full value chain carbon costs from aluminium smelting and remelting
- Cost shown are only carbon cost
- For reference the current LME price tracks at around 2,380 EUR/ton
- All CBAM charges are based on regional averages. For actual ETS and CBAM implementation installation – and product-based emissions will apply

Note: 2030 assumptions for ETS/CBAM phase-in; EUA price at 140 €; no further decarbonisation of current emission levels is assumed; considering full product scope in current CBAM policy design; The underlying JRC (Joint Research centre) report scenario assigns relatively very high emissions to Chinese producers of primary aluminium, also due to higher PFCs emissions. **Sources:** Ramboll analysis, Ramboll CBAM Model, CRU data, IAI Aluminium stocks and flows model, [JRC report for primary direct emissions]

Unwrought aluminium carbon cost scenarios across defined scenarios show impacts of accounting for scrap

Unwrought aluminium ETS/CBAM fee [EUR/tonne] for domestic producers and importers under CBAM - 2030

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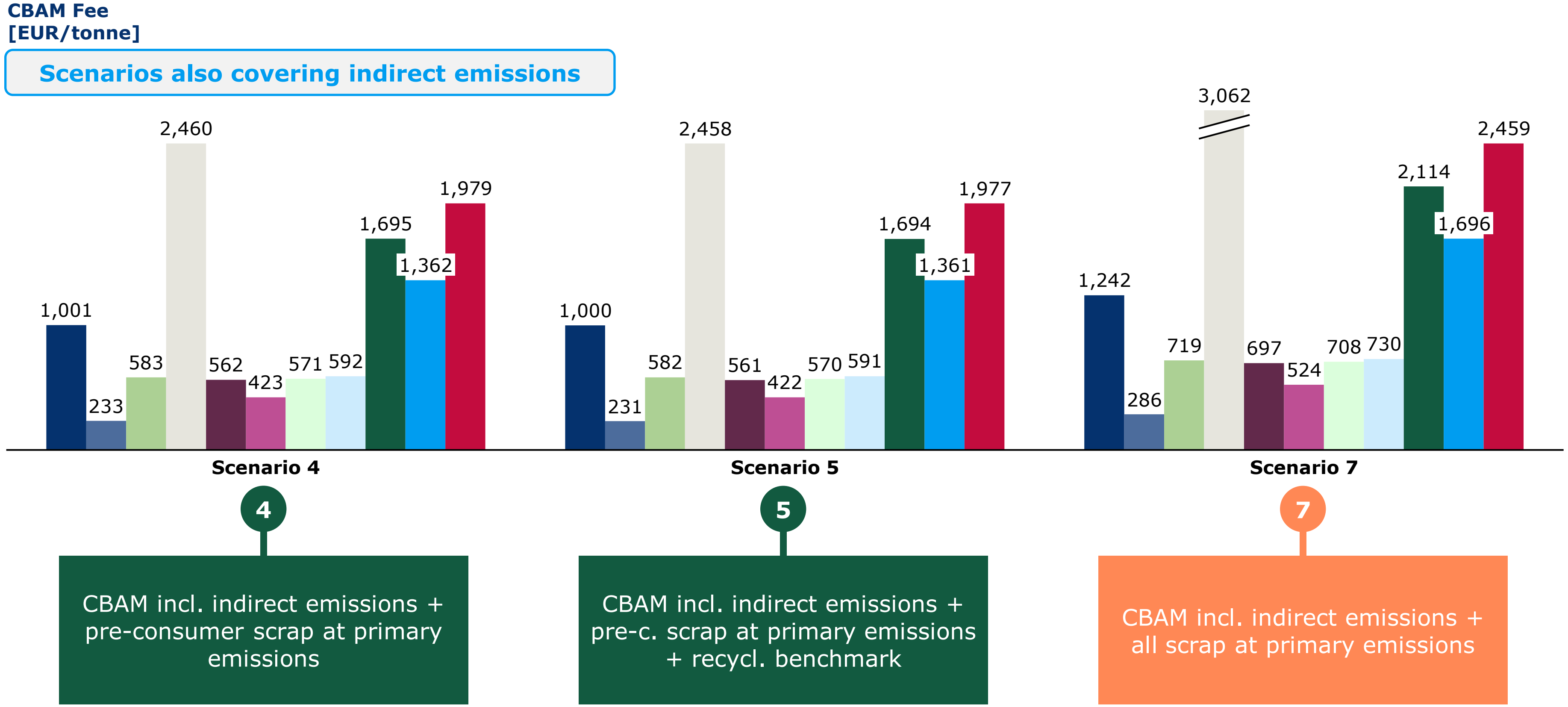


Legend:

- Africa
- North America
- South America and Caribbean
- Asia (ex China)
- EU
- EFTA
- Other Europe
- Russia and Central Asia
- Oceania
- Middle East
- China

Comments:

- Full value chain carbon costs from aluminium smelting and remelting
- Cost shown are only carbon cost
- For reference the current LME price tracks at around 2,380 EUR/ton
- All CBAM charges are based on regional averages. For actual ETS and CBAM implementation installation – and product-based emissions will apply

Note: 2030 assumptions for ETS/CBAM phase-in; EUA price at 140 €; no further decarbonisation of current emission levels is assumed; considering full product scope in current CBAM policy design; The underlying JRC (Joint Research centre) report scenario assigns relatively very high emissions to Chinese producers of primary aluminium, also due to higher PFCs emissions. **Sources:** Ramboll analysis, Ramboll CBAM Model, CRU data, IAI Aluminium stocks and flows model, JRC report for primary direct emissions

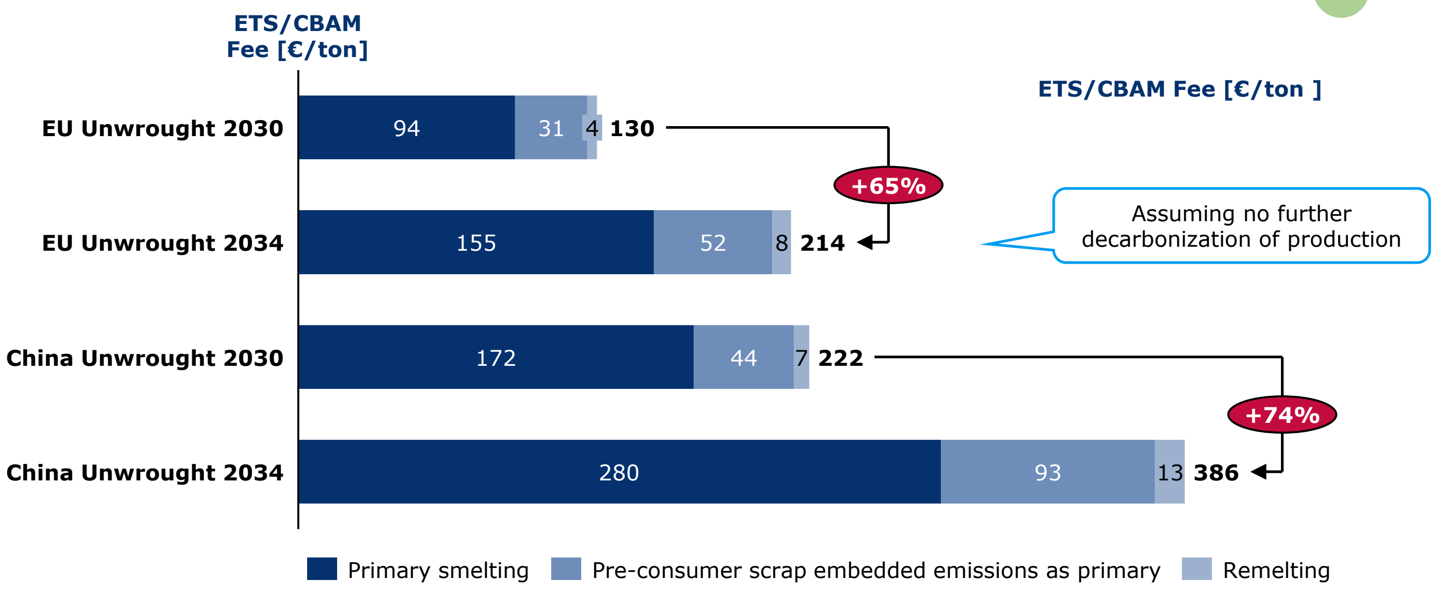
Forecasting CBAM to 2034 creates uncertainty but prices will rise further, due to full CBAM phase-in and a higher EUA price

Further emission growth of fees by 2034

Scenario 2 - 2034

Scenario

2



Pre-consumer scrap content	**20%**
Post-consumer scrap content	**20%**

EUA price 2030: 140 €/ ton CO2e
EUA price 2034: 180 €/ ton CO2e

Further CBAM and ETS increase by 2034

Forecasting **CBAM fees past 2030 is highly speculative** due to uncertain changes to the ETS past 2030 in a ETS Phase 5. This includes:

1. Development of EU Allowances (EUA) price
2. Further reduction trajectories of ETS benchmarks
3. Overall emission cap and industry allocation might be further reduced (currently at 43%)
4. Potential introduction of a CSCF (cross-sectoral correction factor) to benchmarks if industry allocation should exceed available allowances
5. Uncertainty around further application off state aid for indirect emission costs past 2030
6. Potential significant changes to CBAM, including potential extension to downstream sectors, potential export compensation and inclusion of indirect emissions
7. Potential more global carbon taxation schemes

In the modelled CBAM scenarios carbon cost for CBAM and ETS will **rise by an additional 65% in Europe and by 74% for Chinese imports significant accelerating the creation of a decoupled European market with significant higher prices on aluminium**.

Full CBAM implementation by 2034 will further rise CBAM fees by up to 74% compared to a 2030 scenario

 Note: Assuming no circumvention; **Model settings:** All scenarios assuming inclusion of pre-consumer scrap under CBAM, 2030 scenarios assuming EUA price of 140 €/ 2034 scenario assuming EUA price of 180€; **Sources:** Ramboll analysis, Ramboll CBAM Model, CRU data, IAI Aluminium stocks and flows model, JRC report for primary direct emissions

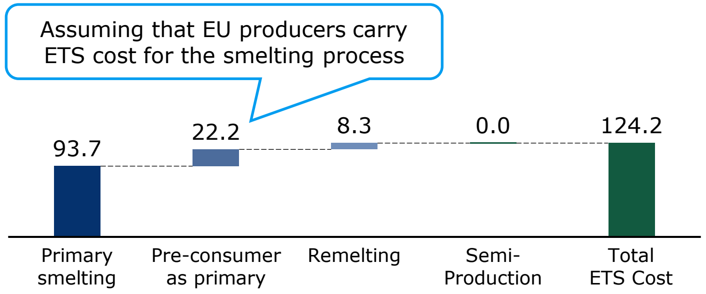
ETS and CBAM fees in a 2030 scenario across selected regions and products based on actual scrap contents in Scenario 1

CBAM charges generated across different steps of the production of unwrought aluminium or cold rolled sheets across major importing regions. Calculations are based on **average actual region-specific scrap contents**. Numbers displayed as per **Scenario 1,** current CBAM design with no emissions assigned to pre-consumer scrap.

1

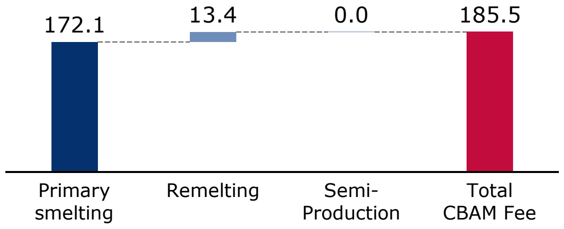
Unwrought aluminium

EU ETS cost [EUR/tonne product]



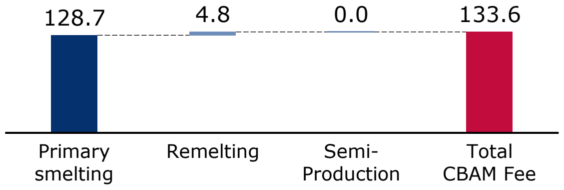
Pre-consumer scrap content	**14%**
Post-consumer scrap content	**26%**

China CBAM fee [EUR/tonne product]



Pre-consumer scrap content	**17%**
Post-consumer scrap content	**16%**

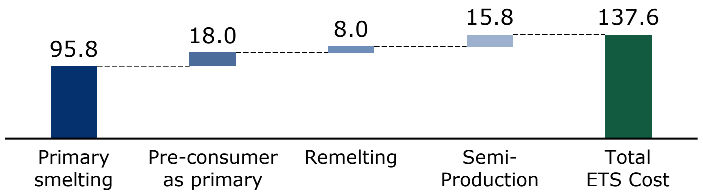
Middle East CBAM fee [EUR/tonne product]



Pre-consumer scrap content	**8%**
Post-consumer scrap content	**16%**

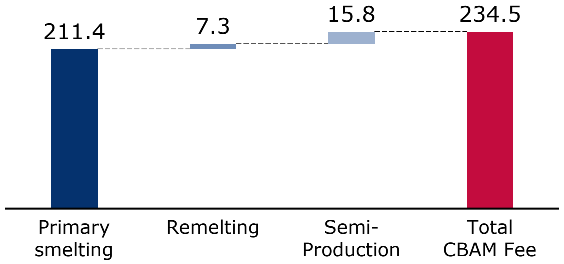
Cold rolled sheets

EU ETS cost [EUR/tonne product]



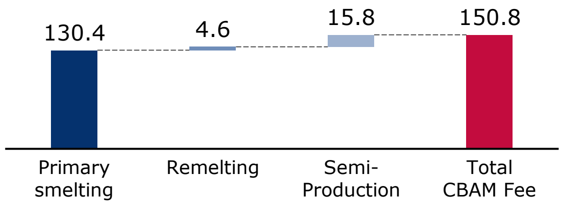
Pre-consumer scrap content	**12%**
Post-consumer scrap content	**28%**

China CBAM fee [EUR/tonne product]



Pre-consumer scrap content	**2%**
Post-consumer scrap content	**16%**

Middle East CBAM fee [EUR/tonne product]



Pre-consumer scrap content	**4%**
Post-consumer scrap content	**19%**

Notes: Assuming no circumvention; **Model settings:** 2030 assumptions for ETS/CBAM phase-in; EUA price at 140 €; considering full product scope in current CBAM policy design
Sources: Ramboll Analysis, Ramboll Aluminium CBAM Model, IAI Model; For cold rolled sheets, the modeling doesn't account for the increased raw material cost due to CBAM impact on the European market premium

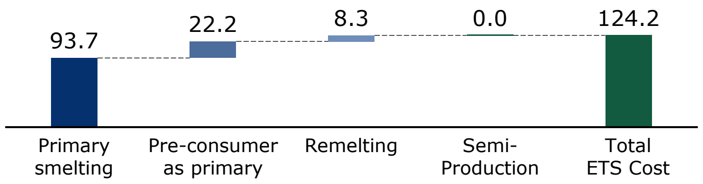
ETS and CBAM fees in a 2030 scenario across selected regions and products based on actual scrap contents in Scenario 2

CBAM charges generated across different steps of the production of unwrought aluminium or cold rolled sheets in across major importing regions. Calculations are based on **average actual region-specific scrap contents**. Numbers displayed as per **Scenario 2**, with emissions assigned to pre-consumer scrap as primary.

2

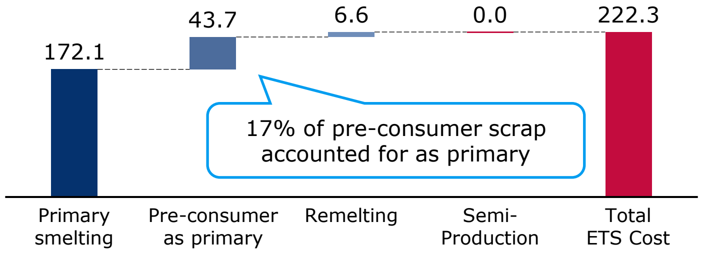
Unwrought aluminium

EU ETS cost [EUR/tonne product]



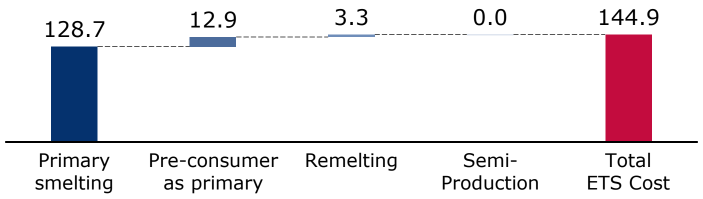
Pre-consumer scrap content	**14%**
Post-consumer scrap content	**26%**

China CBAM fee [EUR/tonne product]



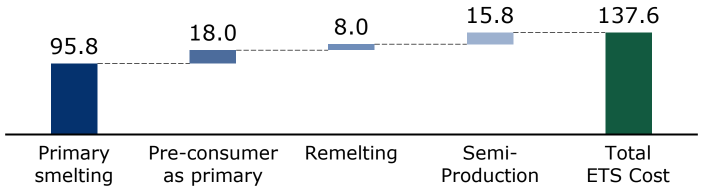
Pre-consumer scrap content	**17%**
Post-consumer scrap content	**16%**

Middle East CBAM fee [EUR/tonne product]

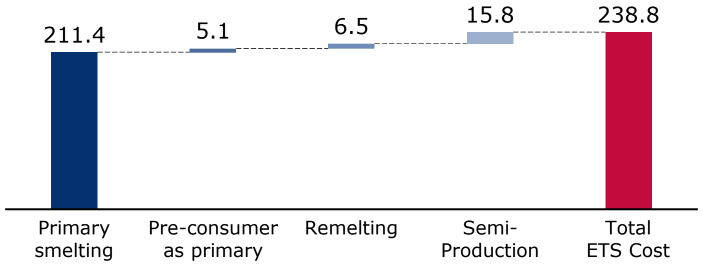


Pre-consumer scrap content	**8%**
Post-consumer scrap content	**16%**

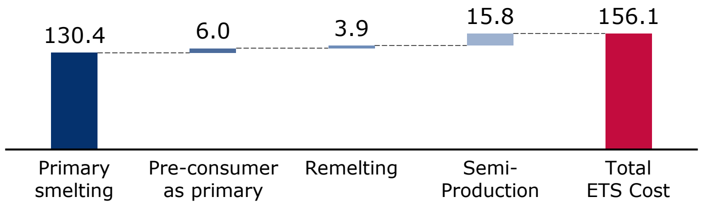
Cold rolled sheets



Pre-consumer scrap content	**11%**
Post-consumer scrap content	**28%**



Pre-consumer scrap content	**2%**
Post-consumer scrap content	**16%**



Pre-consumer scrap content	**4%**
Post-consumer scrap content	**19%**

Notes: Assuming no circumvention; **Model settings:** 2030 assumptions for ETS/CBAM phase-in; EUA price at 140 €; considering full product scope in current CBAM policy design plus extension with pre-consumer scrap accounted as primary; **Sources:** Ramboll Analysis, Ramboll Aluminium CBAM Model, IAI Model

Appendix B

General ETS development

CBAM can only be assessed in conjunction with the ETS, where carbon cost will rise significantly in the medium-term

EU producers – what will drive the future carbon cost of manufacturing

Reduction of allowances

- Lower overall amount of allowances

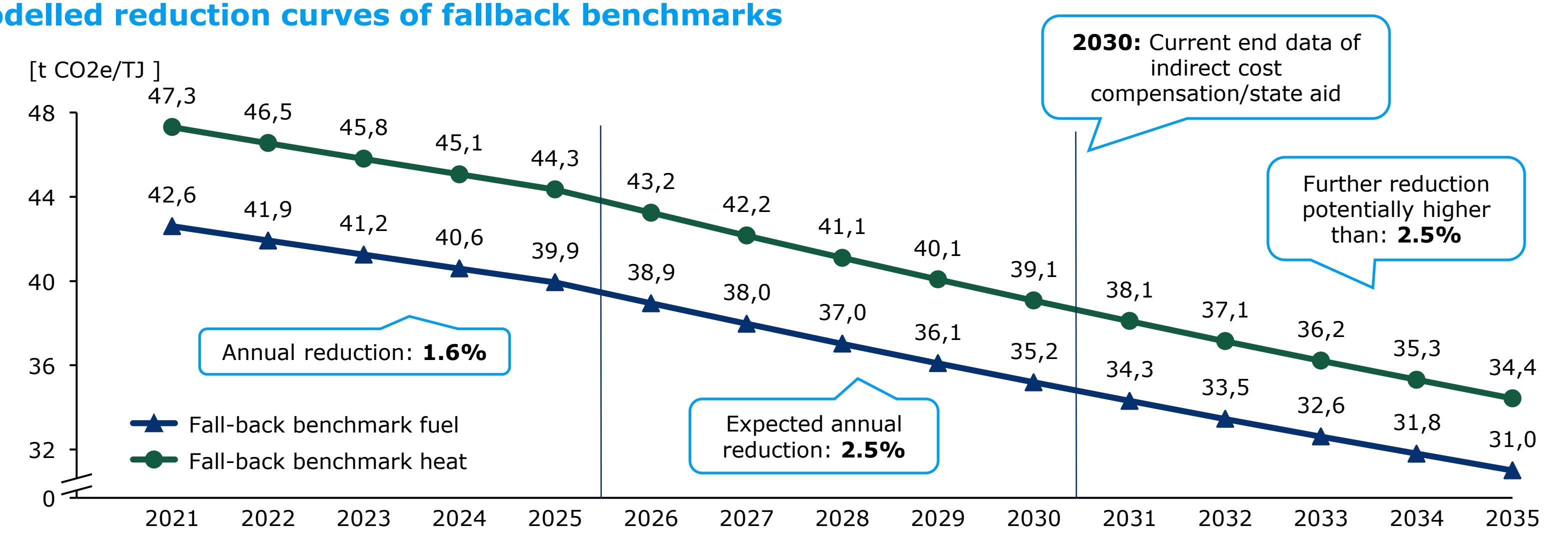
Reduction of free allocation

- Steeper reduction of ETS Benchmarks
- CBAM Factor
- Assigned industry cap (currently at 43%)
- Potential Cross Sectoral Correction Factor (most likely past 2030), applied before the CBAM factor

State-aid for indirect carbon costs

- State-aid for indirect carbon emission costs runs until 2030, after 2030 this is unclear
- State-aid is only granted on a national level
- Program unlikely to be continued if indirect emissions in CBAM are included

Modelled reduction curves of fallback benchmarks



- Heat and fuel benchmarks set baseline of calculation for alumina refining, remelting and semi manufacturing. Aluminium smelting has a dedicated benchmark with a different reduction trajectory.
- Energy intensities and fuel input for respective processes are used in the model to calculate applicable benchmarks, where "derived ETS product benchmarks" are assumed to set the respective not yet published CBAM product benchmarks
- Policy ask benchmarks in this study are also used based on current energy intensities and applying minimal reduction rates (0.2% and 0.3% past 2026)

A European manufacturer will **need to buy more allowances at a higher price**. Across the aluminium industry this will happen at a significantly higher rate than decarbonisation options are commercially available

Appendix C

Definition of alumina scenarios

Alumina scenarios – Assessing CBAM impact on the European aluminium industry

Scenario		CBAM Implementation scenario
0	Base Case	No CBAM
1	"As-Is" CBAM Scope	No CBAM on alumina as a precursor or as a product; Current CBAM scope on primary aluminium and semi-fabricated products
2	Alumina in CBAM	CBAM to directly cover alumina as a precursor and in product scope (direct emissions)
3	Alumina in CBAM + separate benchmark	CBAM to directly cover alumina as a precursor and in product scope (direct emissions) and dedicated benchmark for emissions from alumina refineries.
4	Alumina in CBAM + indirect emissions	CBAM to directly cover alumina as a precursor and in product scope (incl. indirect emissions of alumina refining process)
5	Alumina in CBAM + indirect emissions + separate benchmark	CBAM to directly cover alumina as a precursor and in product scope (incl. indirect emissions of alumina refining process) and dedicated benchmark for emissions from alumina refineries.

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