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Driving demand for low-carbon commodities: a market-based approach

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The case of green steel and green cement

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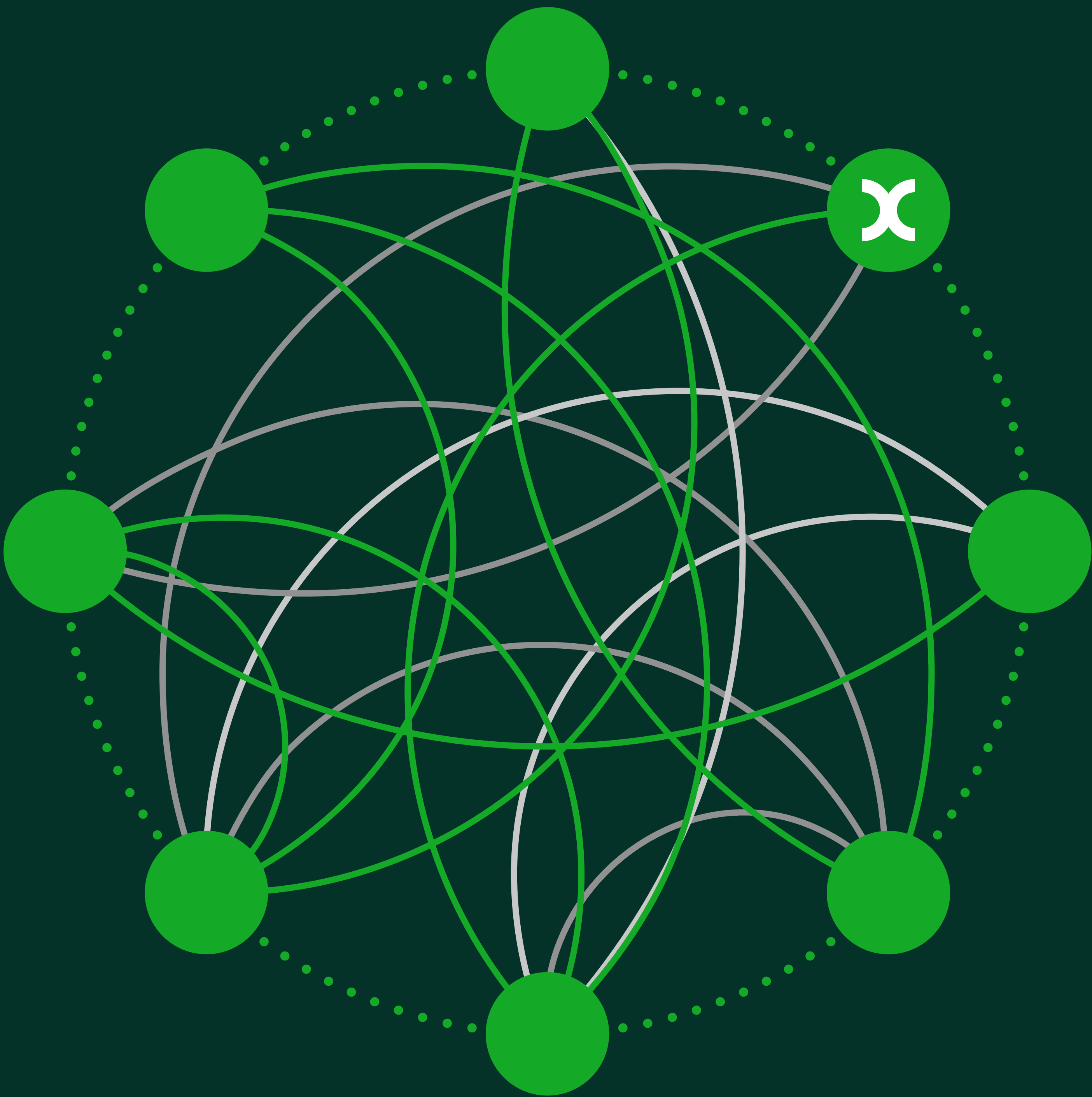

Table of Contents

Figures and Tables

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Summary

This study focuses on how demand for low-carbon steel and cement can be stimulated by highlighting the market features which limit the uptake of low-carbon commodities. Steel and cement are foundational materials underpinning the global economy, serving as essential inputs to construction, infrastructure, transport, and manufacturing. Together, they generate close to USD 3 trillion in annual revenues. However, they also account for an estimated 16% of global CO_2 emissions—making them priority sectors in any credible industrial decarbonisation strategy. Despite the emergence of viable low-carbon technologies, such as hydrogen-based steelmaking and clinker substitution or carbon capture in cement, these alternatives have not yet reached commercial scale. Low-carbon steel accounts for less than 1% of EU production; green cement remains largely at pilot stage.

The limited uptake is not primarily due to technological barriers, but to persistent structural and economic barriers in relation to the functioning of the markets for these commodities. These include unpriced externalities, capital market constraints, fragmented supply chains, and information asymmetries. These features drive a persistent green premium ranging from 35–70% in steel and 50–70% in cement, while also deterring long-term investment. Procurement practices, particularly in public infrastructure, often default to lowest-cost bids and fail to reward low-carbon performance, further inhibiting demand. Current EU policy tools such as the Emissions Trading System (ETS), the Carbon Border Adjustment Mechanism (CBAM), and public funding initiatives provide important foundations, but are not sufficient on their own to close the gap between ambition and market reality.

The report discusses a range of demand-side tools, including green public procurement, product standards, buyer alliances, carbon contracts for difference, and de-risking instruments. It also examines the potential of Environmental Attribute Certificate (EAC) systems to stimulate demand in nascent markets. These models decouple environmental claims from physical delivery, enabling buyers to support low-carbon production even when green materials are not locally available. By issuing tradable certificates tied to verified emissions reductions, EAC approaches create flexibility and lower transaction costs in supply chains where logistical constraints, geographic mismatches, or infrastructure gaps make physical matching difficult. Used effectively, such systems can help aggregate early demand, channel revenue to green producers, and support the commercial

scaling of low-carbon materials. While not a substitute for full traceability, EAC offers a credible interim solution during the early stages of market development.

1 Introduction

Oxera has been commissioned by Amazon to examine the market for low-carbon steel and green cement, with a focus on identifying market features that limit the uptake of low-carbon commodities. These issues are often referred to by economists as 'market failures'.[1] We also assess potential interventions to stimulate demand for low-carbon commodities. The objective is to inform strategies that will enable these markets to scale and contribute meaningfully to climate change mitigation.

Steel and cement[2] are foundational to economic activity and provide essential inputs for infrastructure, construction, transport and manufacturing industries globally.[3] Together, these sectors generate nearly USD 3 trillion in annual revenue worldwide.[4]

In the European Union, the steel industry generated approximately €152 billion in gross value added, and supported over 300,000 direct jobs and 2.6 million indirect jobs as of 2024.[5] In 2021, the EU cement sector contributed €7.6 billion in gross value added, while the related concrete and mortar sectors generated €20.2 billion. The cement sector directly supports the construction industry, which accounted for 14.3 million jobs in the EU in 2022.[6]

At the same time, the cement and steel industries are among the most carbon-intensive and collectively account for approximately 16% of global CO_2 emissions.[7] Cement alone contributes around 8%,[8, 9] emitting approximately 0.6 tonnes of CO_2 per tonne produced[10], while

[1] See Stiglitz et al. (2015), 'Economics of the Public Sector (4th Edition)', Part 2, Section 4.
[2] This report uses 'cement' as the primary term rather than 'concrete' to emphasise the focus on decarbonising the material responsible for the majority of emissions. Cement, the key binding ingredient in concrete, is mixed with water, sand, and aggregates to form the final construction material. Although concrete is the end-use product, it is cement production that generates most of the associated carbon footprint. Cement accounts for approximately 88% of the CO_2 emissions linked to concrete production - see Global Efficiency Intelligence (2023), 'What are Green Cement and Concrete?', December.
[3] IEA (2025), 'Demand and Supply Measures for the Steel and Cement Transition', 19 March, pp. 7-13.
[4] See Expert Market Research (2025), 'Cement Market Size Analysis – Market Share, Forecast Trends and Outlook Report 2025-2034' and IEA (2020), 'Iron and Steel Technology Roadmap: Towards more sustainable steelmaking', p. 16.
[5] EUROFER (2024), 'European Steel in Figures 2024', p. 8.
[6] Cembureau (2024), 'Cembureau Key Facts & Figures', June, p. 2.
[7] Centre on Global Energy Policy (2023), 'Decarbonizing Steel and Cement', 8 August.
[8] This is largely due to the calcination process in kilns where limestone is heated to produce clinker.
[9] World Economic Forum (2024), 'Cement is a big problem for the environment. Here's how to make it more sustainable', 13 September.
[10] S&P Global (2022), 'Decarbonizing cement: How EU cement-makers are reducing emissions while building business resilience', 27 October.

conventional steel contributes another 7–9% of global emissions, primarily from coal-based blast furnaces.[11, 12] Emissions in both sectors are driven by their dependence on fossil fuels and process-related emissions that are difficult to avoid.

The EU has recognised the need to decarbonise these sectors, embedding industrial emissions reduction targets into the European Green Deal[13], the Fit for 55 package[14], and instruments such as the EU Emissions Trading System (ETS)[15] and the Carbon Border Adjustment Mechanism (CBAM)[16]. The extension of ETS2 to buildings and transport from 2027 further integrates carbon pricing into downstream material demand.[17] The industry has also set ambitious climate goals—for example, the EU steel sector aims to cut emissions by 80–95% by 2050 compared to 1990 levels.[18]

More recently, policy ambition at the EU-level was further reinforced through initiatives such as the EU Clean Industrial Deal and the launch of the Industrial Decarbonisation Accelerator.[19] Furthermore, the Antwerp Declaration, backed by major European industrial stakeholders, also calls for a coherent and competitive policy framework to accelerate clean technology investment. These developments form an important backdrop for assessing the evolving role of demand-side policy tools to facilitate the production and use of decarbonised steel and cement.

Technological alternatives capable of important emissions reductions have emerged over the recent years. In steel, hydrogen-based Direct Reduced Iron (DRI) combined with Electric Arc Furnaces (EAF) powered by renewable electricity can reduce emissions by over 90%.[20] In cement, emissions reductions are being achieved through several technologies

[11] SEI (2024), 'A matter of transparency: 2024 insights on the steel industry's evolving commitments to reach net zero by 2050', 30 October.
[12] World Steel Association (2021), 'Climate change and the production of iron and steel', p.3.
[13] See the European Commission 'The European Green Deal' website, available here.
[14] See the European Council explainer on Fit for 55, available here.
[15] See European Commission article on EU ETS, available here.
[16] European Commission (2025), 'Carbon Border Adjustment Mechanism', 28 March.
[17] As part of the 2023 revisions to the EU ETS Directive, a new emissions trading system—ETS2—was established. Rather than being a direct expansion of the existing EU ETS (ETS1), ETS2 will operate as a separate and parallel system, initially covering CO_2 emissions from the combustion of fuels in buildings, road transport, and certain additional sectors not previously covered under ETS1. This separation allows for differentiated design features, such as the timing of implementation (ETS2 is scheduled to start in 2027) and specific price stabilisation mechanisms.
[18] Climate Group & Ramboll (2024), 'The Steel and Concrete Transformation' , September.
[19] See European Commission (2025), 'The Clean Industrial Deal: A joint roadmap for competitiveness and decarbonisation', 26 February and European Parliament (2025), 'Industrial Decarbonisation Accelerator Act', 21 May.
[20] See Shahabuddin et al. (2023), 'Decarbonisation and hydrogen integration of steel industries: Recent developments, challenges and technoeconomic analysis',1 April and ING (2023), 'Hydrogen sparks change for the future of green steel production', 19 July.

clinker[21] substitution[22], alternative binders[23] and carbon capture technologies, such as those deployed at Heidelberg's Brevik plant in Norway.[24]

Recent analysis highlights that clinker remains the most effective abatement point for cement in the near term—especially where R&D or market deployment funding is targeted.[25] However, industry perspectives vary on the long-term role of clinker. To minimise the risk of asset stranding risk and technology lock-in, effective decarbonisation strategies should ideally accommodate multiple decarbonisation pathways, including novel chemistries that reduce or eliminate clinker use altogether.

These solutions are technically proven at pilot or early commercial scale,[26] but have yet to be deployed widely. A number of large corporates buyers—such as Microsoft, Volvo, Skanska, and Shell—have signed early procurement agreements or joined alliances like the First Movers Coalition.[27] In parallel, some governments and cities are beginning to mandate or incentivise the use of low-carbon construction materials through public procurement frameworks and building standards.[28] These early signals are important, but the overall volume remains low. Low-carbon steel production accounts for less than 1% of total EU output, while low-carbon cement has yet to scale beyond pilot projects and niche applications.[29] Limited infrastructure for clean energy inputs (such as green hydrogen)[30] and high capital costs, continue to constrain broader adoption.

[21] Clinker is the primary component of cement, produced by heating limestone and other materials at high temperatures, and is responsible for the majority of CO_2 emissions in cement manufacturing.
[22] Cembureau (2024), 'Clinker substitution in the cement industry', 5 March.
[23] CAP (2024), 'Cement and Concrete Companies Leading the Net-Zero Transition', 11 July.
[24] Clean Air Task Force (2025), 'Recasting the Future: Policy Approaches to Drive Cement Decarbonization', 9 May.
[25] Barbhuiya et al. (2024), 'Decarbonising cement and concrete production: Strategies, challenges and pathways for sustainable development', 1 June.
[26] Eurometal (2025), 'European green steel market remains muted', 8 May.
[27] Clean Air Task Force (2025), 'Recasting the Future: Policy Approaches to Drive Cement Decarbonization', 9 May.
[28] For example, see House of Commons Environmental Audit Committee (2022), 'Building to net zero: costing carbon in construction', 26 May which outlines that building regulation will be tightened to ensure that by 2030 all new buildings operate at net zero carbon for regulated and unregulated energy including embodied carbon.
[29] According to a 2024 report by Fastmarkets, less than 1% of steel produced in Europe currently comes from green production methods, specifically hydrogen-based Direct Reduced Iron (DRI) combined with Electric Arc Furnace (EAF) technology. The vast majority of European steel continues to be produced via conventional blast furnace–basic oxygen furnace (BF–BOF) routes, which are significantly more carbon-intensive. See Fastmarkets (2024), 'Green steel transition in focus: Key takeaways from Eurometal Steel Day in Zurich', 17 May.
[30] SEI (2024), 'A question of demand – hydrogen and renewable electricity for the EU steel and iron transition', 11 November.

Aside from residual technological readiness issues, a key barrier to uptake of decarbonised steel and cement appears to be economic feasibility: investment risks, persistent cost premiums, and insufficient demand signals continue to inhibit large-scale adoption.

The disparity between decarbonisation ambitions and their effective deployment is evident in current production figures. The EU produces over 150 million tonnes of steel annually[31], making it one of the world's largest producers. Yet green steel output remains negligible[32], with early efforts —such as H2 Green Steel's facility in Boden, Sweden— targeting 5 million tonnes by 2030, which represents less than 2% of annual EU production.[33] Similarly, companies such as Heidelberg Materials[34] and Holcim[35] are marketing low-carbon cement, but volumes remain modest and market penetration limited.

In general, 'market failures' include:

- negative externalities, as emissions are not fully priced or reflected in procurement decisions;
- capital market imperfections, with high up-front costs and long investment horizons;
- coordination challenges, between suppliers, producers and users, particularly in fragmented supply chains like cement;
- information asymmetries, due to inconsistent certification and emissions data;
- public good dynamics, observable in the form of missing markets where early adopters bear disproportionate costs while benefits are diffuse and systemic.

These 'market failures' limit the uptake of low-carbon commodities and contribute to a persistent 'green premium': low-carbon steel is estimated to cost 35–70% more than conventional steel,[36] while green cement carries a premium of 50–70%.[37] This price differential hinders the uptake of low-carbon commodities, especially in sectors such as

[31] EUROFER (2023), 'European Steel in Figures 2023'.
[32] Eurometal (2025), 'European green steel market remains muted', 8 May.
[33] Marcegaglia (2021), 'The first real "green" steel plan will set in Sweden: Marcegaglia is among the partners of the initiative', 25 May.
[34] Heidelberg Materials (2024), 'Heidelberg Materials gets off to a solid start in the 2024 financial year', 7 May.
[35] See Holcim ECOPlanet website, available here.
[36] MPP (2022), 'Making net-zero aviation possible', July.
[37] World Economic Forum (2024), 'Net-zero industry tracker: 2024 edition', p. 9.

construction and public infrastructure where purchasing decisions are heavily driven by price.

Policy intervention may therefore be warranted to correct these ‘market failures’ and improve long-term market outcomes. However, the design of such interventions requires careful attention to proportionality, competitive neutrality, and efficiency—including clarity about which part of the value chain is being targeted. Whether subsidies or support schemes are directed at producers, downstream users, or intermediaries can significantly influence market dynamics and determine where value and incentives accrue. Poorly targeted measures risk distorting markets, crowding out innovation, or locking in immature technologies. In contrast, well-calibrated instruments such as green public procurement, carbon contracts for difference, product standards, and Environmental Attribute Certificate (EAC) systems can align incentives, stimulate investment, and support commercial scale-up.[38]

EAC models, for instance, offer an alternative pathway to generate credible demand signals in fragmented markets by decoupling environmental attributes from physical supply—and from the costs associated with transporting and storing physical commodities. This flexibility can be particularly valuable in early-stage markets where low-carbon materials may be produced far from demand centres, and where logistical or contractual barriers limit the ability to match low-carbon supply with specific buyers. As such, EAC models may help accelerate uptake during the initial stages of market formation.[39]

The remainder of this report is structured as follows.

- Section 2 analyses the economics of low-carbon steel and cement, identifies key emission sources along the value chains and examines the market failures—such as externalities, capital constraints, and information gaps—that hinder commercial adoption. It also explores the drivers of the green premium and the investment risks associated with scaling low-carbon production.

[38] Book-and-claim is a particular form of an Environmental Attribute Certificate (EAC) system, where environmental benefits are decoupled from physical product flows and tracked via certificates. Throughout this report, we will predominately use the term Environmental Attribute Certificates – though EAC’s and book-and-claim are interchangeable.
[39] See SBTi (2023), ‘Book-and-claim System for Sustainable Aviation Fuel (SAF)’, November and SBTi (2023), ‘Book and Claim Community Survey Responses’.

- Section 3 evaluates policy tools to stimulate demand, including green public procurement, product standards, buyer alliances, and carbon contracts for difference.
- Section 4 provides a deep dive into the EAC policy tool, assessing its potential to decouple carbon claims from physical supply and accelerate market formation.

2 The Economics of Low Carbon Steel and Green Cement Markets

This section explores why low-carbon technologies for steel and cement, though technically viable, have not achieved commercial scale. It begins by identifying where emissions are concentrated, then examines the structural market failures that distort incentives. Finally, it looks at how these failures lead to persistent cost premiums and limited investment.

2.1 Key Emission Points Along the Conventional and Green Value Chains

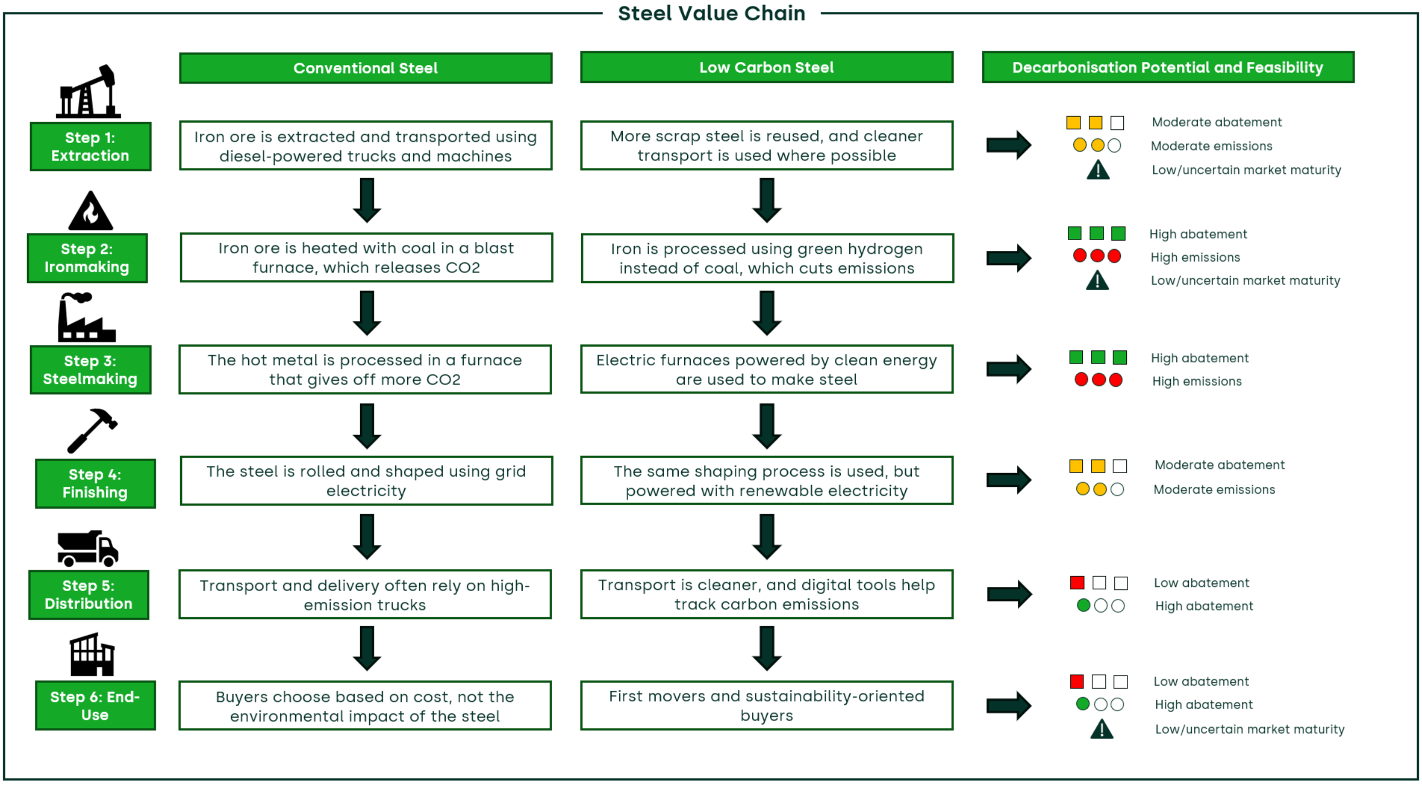
Emissions from steel and cement are concentrated at specific stages of production, which makes both sectors suitable for targeted intervention to reduce emissions.

- In steel, most CO_2 arises from the use of coal in the blast furnace–basic oxygen furnace (BF–BOF) route. This process uses coking coal as both a fuel and chemical reductant, emitting approximately 1.8 to 2.2 tonnes of CO_2 per tonne of steel produced.[40] The BF-BOF route accounts for over 70% of global steel production, and its emissions are largely unavoidable without changes to the process.[41]
- In cement, emissions stem largely from clinker production, where heating limestone releases CO_2 through both fuel combustion and chemical reaction. Clinker production alone accounts for more than 90% of cement's lifecycle emissions, with approximately 50% arising from the calcination reaction, and the remainder from fuel combustion.[42]

Emerging technologies such as hydrogen-based steelmaking, electric arc furnaces, and clinker substitution target these points directly. Figure 2.1 and 2.2 below maps where emissions occur across both conventional and low-carbon value chains to inform the design of effective policy instruments.

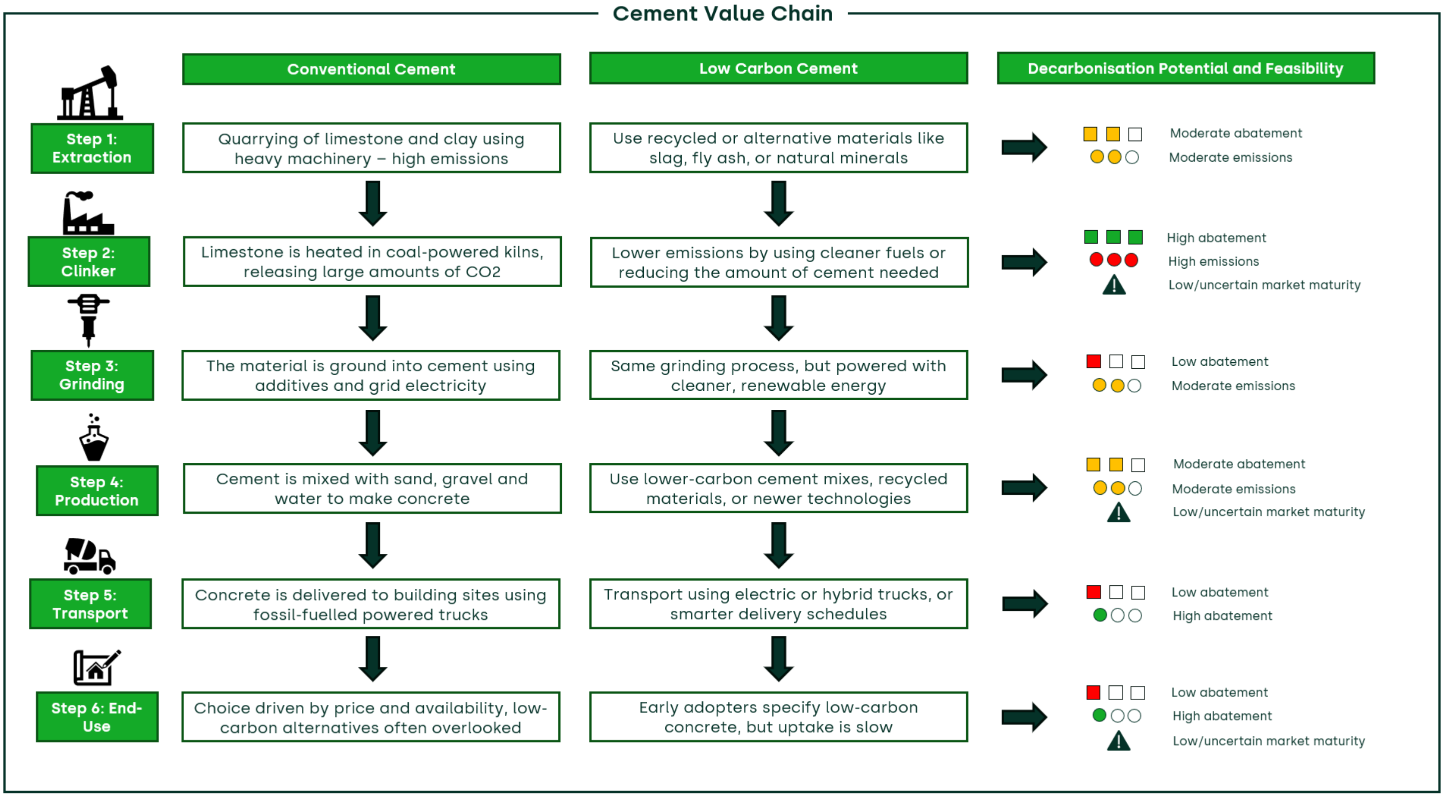
[40] Shahabuddin et al. (2023), 'Decarbonisation and hydrogen integration of steel industries: Recent development, challenges and technoeconomic analysis', 1 April.
[41] Xia et al. (2022), 'The CO_2 reduction potential for the oxygen blast furnace with CO_2 capture and storage under hydrogen-enriched conditions', December.
[42] See World Economic Forum (2024), 'Cement is a big problem for the environment. Here's how to make it more sustainable', 13 September.

Figure 2.1 Conventional and Low Carbon Steel Value Chains and Benefits associated with abatement



Source: Oxera.

Figure 2.2 Conventional and Low Carbon Cement Value Chains and Benefits associated with abatement



Source: Oxera.

2.2 Structural market failures in low-carbon commodities

Despite the existence of lower-emission technologies, low-carbon steel and cement continue to account for only a small share of total production.[43] This limited uptake is not primarily due to technological barriers, but rather a set of persistent and interrelated market failures that dampen demand and stall investment across the value chain. These failures drive a wedge between producers' willingness to supply at a higher cost and buyers' willingness to pay a green premium , making it difficult for low-carbon alternatives to gain market traction.

In principle, market signals—such as price signals—can help align supply and demand to deliver socially desirable outcomes—such as emissions reductions. However, in the case of low-carbon commodities, several challenges arise. These include environmental impacts not fully reflected in market prices (externalities), lack of trusted emissions data

[43] See Fastmarkets (2024), 'Green steel transition in focus: Key takeaways from Eurometal Steel Day in Zurich', 17 May.

(information asymmetries), and fragmented decision-making across supply chains (coordination failures). Together, these issues create a gap between the cost of producing low-carbon materials and what buyers are willing to pay. These failures manifest in several concrete barriers: the absence of carbon pricing that reflects environmental costs, inconsistent standards that undermine buyer confidence, and difficulties coordinating decisions across complex supply networks. Long investment cycles and capital market imperfections make it difficult for producers to justify the upfront costs of transitioning to green capacity, particularly in the absence of clear long-term demand.

While these challenges are common across energy- and emissions-intensive sectors, certain characteristics of steel and cement— such as their commodity-like nature and the importance of public procurement in infrastructure projects—introduce specific barriers. Public buyers often select the lowest-cost bids, which can disadvantage low-carbon options. However, if procurement criteria are updated to include emissions performance or sustainability standards, public sector demand could play a powerful role in scaling greener alternatives.

The remainder of this section outlines five key market failures affecting low-carbon steel and cement, each of which has implications for how policy and market mechanisms are designed to support decarbonisation.

Figure 2.3 Market Failures associated with Low Carbon Steel and Cement Technologies

Market Failures of Low Carbon Technologies

	Negative Externalities	Coordination Failures	Capital Market Imperfections	Missing Markets & Time Inconsistency	Information Asymmetry
Both Steel & Cement	• Emissions externalities not reflected in price of conventional materials. • Embodied emissions not considered in procurement decisions.	• Construction sector is fragmented and requires coordination across many sectors. • Complex procurement chains make it difficult to drive system-wide change.	• Old assets are long-lived making it hard to retrofit without major investment. • Market conditions do not justify large upfront capital expenditure without policy support.	• Producers face significant upfront capital costs. • Cost-sensitive, risk-averse buyers. • Limited public procurement requirements for low-carbon materials.	• Lack of harmonised certification and transparency (which can lead to greenwashing). • Uncertainty around carbon content of materials (weakens demand signals).
Steel only	• Steel is a global commodity which creates highly price-sensitive procurement. • Unless cost parity is achieved, large-volume switching to low-carbon steel is unlikely.	• Steel sector is relatively concentrated, compared to cement and concrete. • Commitment from key firms can drive systemic change faster.	• Low-carbon steel depends heavily on green hydrogen and renewable electricity supply. • Hydrogen availability may bottleneck investment.		
Cement only	• CCS for cement adds significant cost and is not yet commercially deployable at scale. • High cost of alternative chemistries.	• Cement and concrete industries are highly fragmented and localised (many SMEs). • Greater effort needed to coordinate procurement.			• Regulatory approval for novel binders and materials is slow and unclear. • Life-cycle carbon assessments for concrete are often inconsistent.

Source: Oxera.

2.2.1 Negative externalities

A core challenge in the uptake of low-carbon steel and cement is the limited extent to which the price of conventional materials reflect their full emissions impact. In both sectors, the market price of high-carbon products does not yet comprehensively incorporate the broader environmental costs associated with CO_2 emissions.[44] This creates a structural cost gap for low-carbon alternatives, which typically face higher production costs due to more expensive inputs (such as green hydrogen or carbon capture and storage) and the need for new infrastructure.

While mechanisms such as the EU Emissions Trading System (EU ETS) and the CBAM aim to address this gap by placing a value on carbon, current carbon prices may not be sufficient to eliminate the differential between conventional and low-carbon production methods.[45] In the

[44] The Greens/EFA (2021), 'The true cost of the cement, steel and chemical industries', July.
[45] See European Court of Auditors (2020), 'The EU's Emissions Trading System: free allocation of allowances needed better targeting, July and Material Economics (2019), 'Industrial Transformation 2050 which highlights the cost differentials between conventional and low-carbon production methods for steel and cement.

absence of stronger pricing signals or complementary policies, this results in a persistent 'green premium'.

Estimates suggest that low-carbon steel currently cost 35–70% more than conventional steel,[46] while low-carbon cement may carry a 50–70% premium.[47] These cost differentials are driven primarily by input and capital costs—rather than any differences in material quality or performance—and reflect the current stage of market development. With current low volumes, producers cannot spread high fixed costs over large outputs, making unit costs significantly higher than they would be under mature market conditions. As production scales up and supply chains mature, costs are expected to fall.

Procurement practices in downstream sectors can reinforce this price gap. In construction, for example, materials are often selected based on upfront cost, with limited consideration of embodied emissions.[48] Environmental attributes are unlikely to be a determining factor unless mandated through regulation or incentivised by procurement frameworks. Additionally, the commoditised nature of steel markets, where materials are traded on cost and specification alone, limits the ability of producers to differentiate based on carbon performance.[49]

Although regulatory initiatives such as product labelling and embodied carbon reporting are emerging, adoption remains uneven across countries and sectors. Without stronger policy instruments to fully reflect the external cost of emissions—through pricing, standards, or targeted procurement—low-carbon materials are likely to remain at a disadvantage relative to more carbon-intensive alternatives.

2.2.2 Coordination failures

The transition to low-carbon steel and cement is also hindered by coordination challenges across supply chains. These sectors involve multiple actors—producers, contractors, engineers, architects, and end clients—whose incentives are not always aligned.[50] This fragmentation makes it difficult to synchronise investment, innovation, and

[46] MPP (2022), 'Making net-zero aviation possible', July.
[47] World Economic Forum (2024), 'Net-zero industry tracker: 2024 edition', p. 9.
[48] Buildings & Cities (2022), 'Embodied carbon emissions in buildings: explanations, interpretations, recommendation', 21 November.
[49] A key issue is the lack of a universally accepted definition or standard for 'green steel'. S&P Global Commodity Insights (2024), 'Listen: What it means to be green: Steel market lacks consensus on what low-carbon looks like' 9 August highlighted that the absence of a single definition forces market participants to develop their own standards for low-carbon steel, leading to fragmentation and confusion in the market.
[50] Lofgren and Rootzen (2021), 'Brick by brick: Governing industry decarbonization in the face of uncertainty and risk'.

procurement decisions, particularly in construction, where responsibilities are distributed across numerous stakeholders.[51]

In the steel sector, production is relatively more concentrated, which could support coordinated shifts toward green technologies if credible demand signals are present.[52] However, buyers often prioritise cost and delivery timelines over carbon performance, and there are few mechanisms that support long-term, collaborative procurement.[53] As a result, steel producers face uncertainty about the scale and consistency of future demand for green steel, making it harder to justify investment in new capacity.

In the cement sector, coordination issues are compounded by the localised nature of production.[54] Concrete is typically manufactured close to construction sites using regionally sourced materials. This makes it more difficult to implement uniform standards or aggregate demand at scale.[55] Even when lower-carbon alternatives are available, uptake may be limited if local contractors are unfamiliar with them or if regional building codes have not been updated to accommodate new materials.[56]

These coordination issues create a risk of delayed or subscale adoption. In the absence of stronger frameworks to support alignment—such as common procurement standards, pooled demand mechanisms, or clearer regulatory guidance—low-carbon technologies may remain underutilised, even when technically and commercially viable.

Emerging mechanisms that provide greater flexibility in how environmental attributes are transferred—such as EAC—may help address some of the structural barriers to early demand formation. By separating emissions claims from the physical delivery of materials, these approaches can reduce reliance on co-located supply chains, enable broader participation where infrastructure is limited, and offer clearer investment signals during the early stages of market development.

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[51] Department for Business Innovation & Skills (2013), 'Supply Chain Analysis into the Construction Industry', October.
[52] EUROFER (2024), 'European Steel in Figures'.
[53] Energy Transitions Commission (2021), 'Steeling Demand: Mobilising buyers to bring net-zero steel to market before 2030', July.
[54] SkyQuest Technology Consulting (2022), 'Ready-Mix Concrete Market is Capital Intensive but Highly Fragmented', 13 December.
[55] Factset Insight (2024), 'Surveying the cement decarbonization landscape', 17 January.
[56] Clean Air Task Form (2025), 'Recasting the Future: Policy Approaches to Drive Cement Decarbonization', 9 May.

2.2.3 Capital Market imperfections

Investment in low-carbon steel and cement technologies is often constrained by capital market barriers. These include high up-front capital costs, long payback periods, and uncertainty over future returns. The typical asset life in these industries ranges from 20 to 50 years, meaning that decisions made today can lock in emissions trajectories for decades.[57] As a result, firms may delay investment in green technologies unless future policy, demand, and input costs are sufficiently predictable.

Low-carbon steel production, for example, often requires substantial infrastructure changes, such as the installation of hydrogen-based direct reduced iron (DRI) systems and access to clean electricity.[58] Early-stage projects, such as Thyssenkrupp's €3 billion hydrogen-ready plant, face potential risks related to underutilisation, fluctuating energy input prices, and policy volatility.[59] Similarly, in the cement sector, technologies such as carbon capture and novel binders are still maturing, and the associated supply chains—especially for alternative materials—are underdeveloped or lack scale.[60]

Access to finance is further limited by the perceived riskiness of first-of-a-kind projects, particularly where demand is not assured. While some public financing mechanisms and green funds exist, they are not always sufficient to bridge the gap between the capital required and the return profiles expected by private investors.[61] Without additional instruments to de-risk these investments, the pace of decarbonisation may remain slow.

2.2.4 Missing markets and Time inconsistency

Low-carbon steel and cement face structural demand-side constraints due to the absence of well-functioning markets that reward early adoption.[62] In particular, there are few long-term offtake agreements, forward contracts, or procurement mandates that create reliable investment signals.[63] As a result, producers often need to invest in new capacity without clear visibility on future demand. This creates a mismatch between the multi-year timelines needed to scale up

[57] IEA (2020), 'Aligning investment and innovation in heavy industries to accelerate the transition to net-zero emissions', 20 July.
[58] IEA (2023), 'Iron and Steel Technology Roadmap', October.
[59] FCW (2025), 'Thyssenkrupp CEO Warns Green Steel Plant Unviable without Cheap Renewable Hydrogen Supply', 20 March.
[60] GCCA (2023), 'Cement Industry Net Zero Progress Report'.
[61] See ETC (2021), 'Making Mission Possible – Delivering Net-Zero Industry' and OECD (2022), 'Financing Climate Action in Regions and Cities'.
[62] IEA (2022), 'Achieving Net Zero Heavy Industry Sectors in G7', 25 May.
[63] Green Steel World (2025), 'ITA's bold push for decarbonization', 12 March.

production and the shorter-term procurement cycles and material availability needs of buyers.[64]

This time inconsistency presents a further challenge. Buyers—particularly in construction—may express support for decarbonisation in principle but face short-term pressures that prioritise cost or delivery over sustainability.[65] At the same time, public procurement frameworks may lack clear criteria or enforcement mechanisms for low-carbon materials that are needed to shape markets at scale.[66] In the private sector, risk aversion and a preference for established suppliers and products often result in a bias towards incumbent technologies.[67]

These gaps create a form of market incompleteness. Without predictable and scalable demand signals—such as multi-year procurement agreements, robust policy incentives, or recognised certification schemes—investors and producers have limited visibility over future revenues. This weakens the business case for deploying new technologies and slows the development of supporting infrastructure, including logistics, energy inputs, and quality assurance systems.

2.2.5 Information asymmetries

A further barrier to the uptake of low-carbon materials is the lack of consistent, credible, and comparable information about product-level emissions.[68] In both the steel and cement sectors, there is as yet no universally adopted definition of what constitutes a "low-carbon" product.[69] Different certification schemes, emissions accounting methodologies, and product categories can result in confusion among buyers and suppliers alike.

In steel, emissions can vary significantly depending on production methods and electricity inputs, yet buyers may struggle to compare offerings due to limited transparency. In cement, regulatory approval processes for novel binders or new formulations can be slow and

[64] Material Economics (2019), 'Industrial Transformation 2050 – Pathways to Net-Zero Emissions from EU Heavy Industry', April, p. 6.
[65] Clean Air Task Force (2023), 'Building demand for low-carbon materials)', September, p. 6.
[66] Ramboll (2024), 'Green Public Procurement in Construction', November, p. 9.
[67] Research published in the Journal of Risk and Uncertainty discusses the concept of status quo bias, noting that individuals have a strong tendency to remain at the status quo, because the disadvantages of leaving it loom larger than advantage. See Zeckhauser and Samuelson (1988), 'Status quo bias in decision making', March.
[68] OECD (2024), 'Towards more accurate, timely, and granular product-level carbon intensity metrics: challenges and potential solutions', p. 8.
[69] IEA (2024), 'Definitions for near-zero and low-emissions steel and cement, and underlying emissions measurement methodologies', 8 November, p. 6.

inconsistent across jurisdictions, making it difficult for producers to introduce lower-carbon alternatives to market.[70]

This lack of clarity may increase the risk of greenwashing, where environmental claims may be exaggerated or unverifiable. It also undermines the effectiveness of procurement policies and buyer alliances, which depend on accurate emissions data to assess and reward performance.[71] While initiatives such as Environmental Product Declarations (EPDs) and digital product passports can help address these issues by providing third-party verified, product-level emissions information, and enabling traceability across complex supply chains. These instruments offer a basis for more rigorous due diligence and can serve as quality assurance mechanisms for buyers seeking to substantiate green claims. However, adoption remains fragmented and largely voluntary, with limited harmonisation across jurisdictions and sectors. In recognition of this gap, the EU has committed to developing a voluntary label for the carbon intensity of industrial products under the Industrial Decarbonisation Accelerator Act—an initiative aimed at supporting early movers in capturing green premiums.[72]

Improving the quality, comparability, and accessibility of emissions data is increasingly seen as critical to enabling informed decisions across value chains. Standardised data and certification frameworks can support targeted green procurement policies, enable product differentiation, and stimulate demand for verified low-carbon materials.[73] Tools such as EPDs and digital passports—[74] while still fragmented and largely voluntary—offer mechanism for third-party verification and traceability of product-level emissions data, helping buyers substantiate environmental claims and mitigate greenwashing risk.[75]

This push toward greater transparency and traceability is being reinforced by emerging regulatory frameworks. The EU's Corporate

[70] AllianceLCCC (2024), 'Harmonise to decarbonise – A review of European concrete standards', October, p. 2.
[71] Harvard Law School Forum on Corporate Governance (2023), 'Greenwashing: Navigating the Risk', 24 July.
[72] European Commission (2025), 'Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions', 19 March.
[73] Moshood et al. (2024), 'Combating Greenwashing of Construction Products in New Zealand and Australia: A Critical Analysis of Environmental Product Declarations', 6 November.
[74] Initiatives such as supplier disclosure requirements and support for certified low-carbon products highlight the role of standardised tools in building market trust for emerging green commodities. See Oxera (2025), 'The Economic Impacts of Digital Product Passports in the EU', 24 March.
[75] IIMPCOLL (2023), 'Digital Product Passports (DPP): what, why, and how?', 1 December.

Sustainability Due Diligence Directive (CSDDD), for example, will require large companies to conduct due diligence on environmental and human rights risks throughout their supply chains, including emissions and sustainability credentials.[76] By mandating supply chain-level scrutiny, such regulation acts as a catalyst for harmonised emissions data collection and verification systems that could underpin trusted low-carbon procurement markets in the coming years. However, some of these policy measures, like the CSDDD, are either being delayed[77] or changing in scope. As such, flexible market mechanisms such as EACs represent viable short-term solutions can create alternative solutions supporting the production of low-carbon materials when global output levels are low and local availability of low-carbon materials is limited.

2.3 Costs of transitioning towards low-carbon steel and green cement

As outlined in section 2.2 above, producers of low-carbon steel and cement face a challenging investment environment shaped by structural market failures. Even where low-carbon technologies are technically feasible and commercially available at pilot scale, significant economic barriers remain. Chief among these is the so-called "green premium"—the additional cost associated with producing low-carbon materials relative to conventional alternatives.

For low-carbon steel, cost premiums are estimated to range between 35% and 70%, primarily due to the high cost of inputs such as green hydrogen and the capital intensity of alternative production routes like hydrogen-based direct reduced iron (H_2-DRI) combined with electric arc furnaces (EAF).[78] These methods often require new facilities, upgraded power infrastructure, and access to renewable energy at scale. In the case of green cement, estimated premiums are even higher—between 50% and 70%—driven by the cost of carbon capture systems, the use of alternative binders, and uncertainties surrounding regulatory approvals and market acceptance.[79]

Importantly, these premiums reflect early-stage cost structures rather than any fundamental inefficiency in the underlying technologies. As green production scales, the cost differential is expected to narrow due to several reinforcing trends. First, economies of scale and learning-by-

[76] European Union (2024), 'Directive (EU) 2024/1760 of the European Parliament and the Council on corporate sustainability due diligence and amending Directive (EU) 2019/1937 and Regulation (EU) 2023/2859', 13 June.
[77] European Parliament News (2025), 'Sustainability and due diligence: MEPs agree to delay application of new rules', 3 April.
[78] MPP (2022), 'Making net-zero aviation possible', July.
[79] World Economic Forum (2024), 'Net-zero industry tracker: 2024 edition', p. 9.

doing can reduce unit costs over time, particularly as producers accumulate operational experience and optimise plant design. Second, broader supply chain development—such as the expansion of green hydrogen networks, carbon capture logistics, and raw material availability—will likely improve efficiency and lower procurement costs.[80]

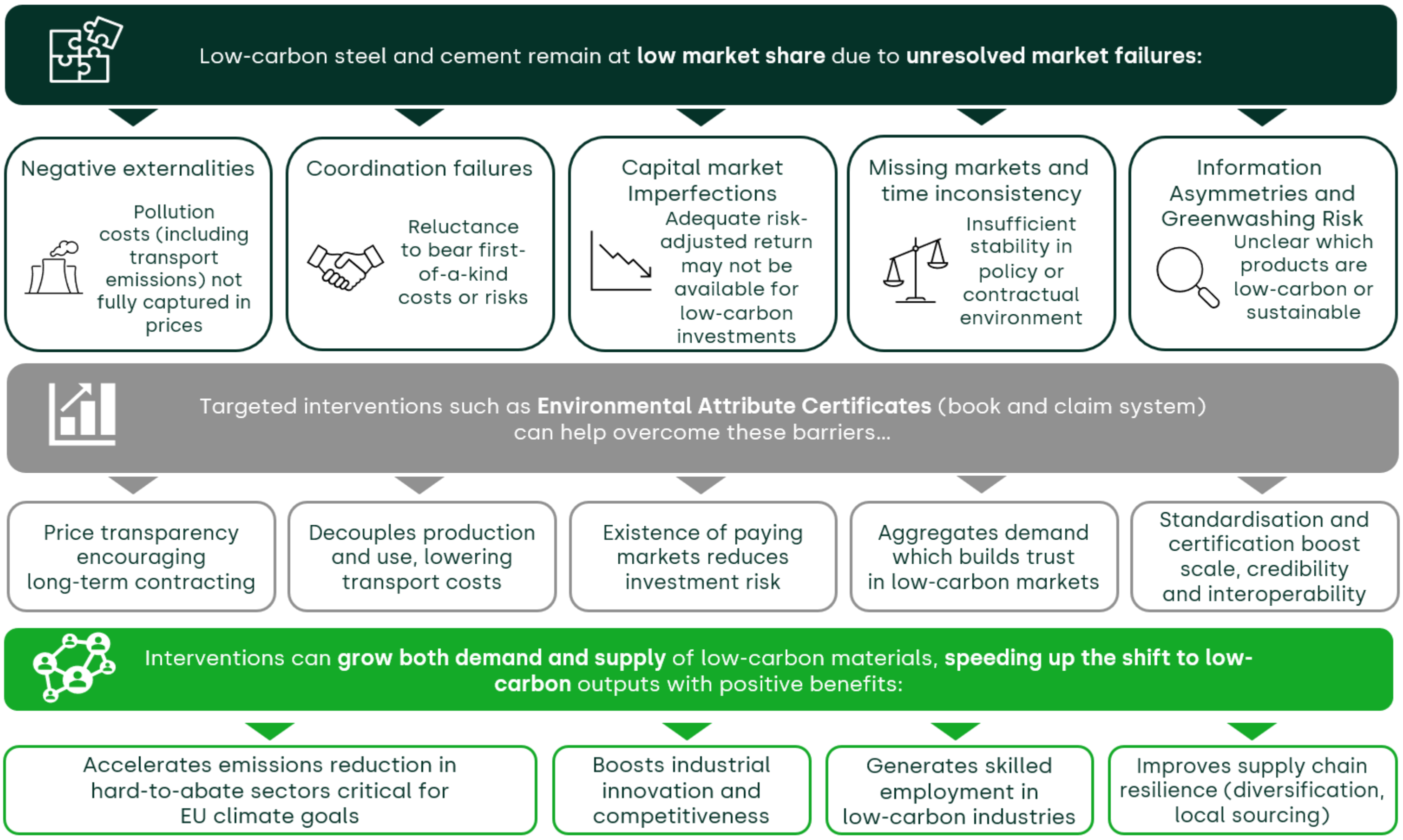
Input costs are also expected to fall. For example, the cost of green hydrogen—a key determinant of green steel economics—is projected to decline significantly as cumulative production increases and electrolyser technologies mature.[81]

In parallel, policy measures such as the EU Emissions Trading System (EU ETS) and the Carbon Border Adjustment Mechanism (CBAM) may improve cost competitiveness by increasing the effective price of carbon-intensive materials.[82] As carbon pricing becomes more stringent, the relative cost of conventional steel and cement is likely to rise, further reducing the green premium.[83] In addition, increasing demand signals from public procurement programmes, private buyer alliances, and forward purchasing agreements could offer producers greater market certainty and unlock new financing pathways.

Nonetheless, the transition will require substantial upfront investment. For instance, H2 Green Steel's flagship plant in Sweden is expected to cost approximately €5 billion to deliver 5 million tonnes of annual capacity—equivalent to around €1 billion per megatonne of output.[84] Similar levels of investment are anticipated across both sectors as producers retrofit or replace existing facilities and develop supporting infrastructure.

[80] See Systemiq (2023), 'The Breakthrough Effect: How to trigger a cascade of tipping points to accelerate the net zero transition', January; and World Economic Forum (2023), 'Winning in Green Markets: Scaling Products for a Net Zero World', January, p. 4.
[81] Zeyen et al. (2023), 'Endogenous learning for green hydrogen in a sector-coupled energy model for Europe', 23 June and Rubin et al. (2007), 'Use of experience curves to estimate the future cost of power plants with CO_2 capture', April.
[82] European Commission (2025), 'Carbon Border Adjustment Mechanism', 28 March.
[83] Reuters (2024), 'New green steel firms could reap rewards as EU carbon tariffs loom', 8 November.
[84] See [84] Reuters (2024), 'Sweden's H2 Green Steel raises $5.2 billion in new funding', 22 January and the following article by Stegra available here.

Figure 2.4 How Targeted Interventions Tackle Market Failures and Unlock the Demand for Low-Carbon Steel and Cement: the Role of EACs



Source: Oxera.

Given these dynamics, early-stage policy support may be needed to bridge the investment gap, reduce first-mover risks, and support the emergence of functioning markets. Mechanisms such as carbon contracts for difference (CCfDs), green public procurement, and demand aggregation platforms can help de-risk investment and facilitate cost convergence over time. Ultimately, a well-designed policy mix that combines supply-side support with strong and predictable demand signals will be essential for scaling up low-carbon production and reducing reliance on conventional materials.

3 Market Tools that Stimulate Demand for Low Carbon Steel and Cement

The transition to low-carbon steel and cement requires not only cleaner production technologies but also a robust demand-side ecosystem that rewards their uptake. A growing number of policy tools—both regulatory and market-based—are being developed to help close this gap. This section provides an overview of key instruments currently in use or in development across the EU. These include regulatory frameworks, public procurement strategies, product standards, financial de-risking mechanisms, and voluntary buyer-led initiatives. Together, these tools can play a pivotal role in aligning procurement choices, investment decisions, and production incentives with broader climate goals. However, gaps remain, particularly with respect to demand aggregation, market sequencing, and the credibility of carbon claims—areas explored in the section below.

3.1 Current EU Policy Landscape and Gaps

The European Union is seeking to implement a diverse set of instruments aimed at incentivising the adoption of low-carbon industrial materials. On the regulatory side, these include standards for material performance, mandatory emissions reporting, and lifecycle carbon accounting frameworks. The Construction Products Regulation (CPR) is currently undergoing reform to better integrate environmental criteria into construction material approvals,[85] and emerging guidance under the Ecodesign for Sustainable Products Regulation (ESPR) is beginning to establish sustainability requirements for industrial goods.[86]

Market-based mechanisms such as the EU Emissions Trading System (EU ETS) and the Carbon Border Adjustment Mechanism (CBAM) aim to internalise the cost of emissions and create level playing fields across domestic and international suppliers.[87] CBAM, in particular, is designed to ensure that imported materials bear equivalent carbon costs, mitigating the risk of carbon leakage and incentivising cleaner production globally. Other instruments under discussion include chain of

[85] URSA (2025), 'CPR and the Future of Construction', 5 April.
[86] European Commission (2025), 'Commission rolls out plan to boost circular and efficient products in the EU', 16 April.
[87] European Commission (2025), 'Carbon Border Adjustment Mechanism', 28 March.

custody models, such as EAC schemes, which could allow for more flexible forms of carbon accounting tied to material procurement.[88]

Financial mechanisms such as the EU Innovation Fund, Horizon Europe, and national-level industrial decarbonisation programmes also provide critical R&D support and early-stage capital for demonstration projects.[89] Contracts for difference, tax incentives, and risk-sharing facilities have begun to target the industrial sector, although coverage remains uneven.[90] Key instruments include the following.

- EU Innovation Fund: one of the world's largest funding programmes for the demonstration of innovative low-carbon technologies, financed by revenues from the EU ETS. It supports projects across energy-intensive industries, renewables, and carbon capture.[91]
- Horizon Europe: the EU's research and innovation framework programme (2021–2027), which allocates significant funding for climate-related R&D, including materials innovation, industrial decarbonisation, and digital tools to improve energy efficiency.[92]
- National industrial decarbonisation programmes: several member states, including Germany, France, and the Netherlands, have launched targeted national funding schemes that support pilot projects and the deployment of breakthrough technologies in heavy industry.[93]
- Carbon Contracts for Difference (CCfDs): a policy instrument that guarantees investors a fixed carbon price over a project's lifetime, bridging the gap between the actual carbon price and

[88] Book-and-claim chain of custodies with tradable certificates already exist in EU legislation, such as Guarantees of Origin (GoO) under the Renewable Energy Directive for biomethane in Germany and Renewable Energy Units (HBE) in the Netherlands. Plans for a central EU registry for pan-EU transfer of bioenergy sustainability certificates (Proof of Sustainability) are already underway. This indicates that such models are already under consideration as part of the EU's wider effort to enhance chain of custody flexibility and traceability. See SBTi (2023), 'Book-and-Claim for Sustainable Aviation Fuel', November.
[89] Horizon Europe is the EU's main funding programme for research and innovation which helps to tackle climate change and helps to achieve the UN's Sustainable Development Goals and boosts the EU's competitiveness and growth. The EU Innovation Fund is one of the world's largest funding programmes for the demonstration of innovative low-carbon technologies and is funded by the EU ETS.
[90] Richsstein and Neuhoff (2022), 'Carbon contracts-for-difference: How to de-risk innovative investments for a low-carbon industry?', 19 August.
[91] See European Commission website on the Innovation fund, available here, for further details.
[92] See European Commission website on Horizon Europe, available here, for further details.
[93] For example, Germany's CCfD pilot will allocate up to €4 billion over 15 years to support low-carbon heavy industry, including steel and cement. See Associated Press (2024), 'Germany launches bidding for carbon contracts to support climate-friendly industrial production', 12 March.

the level needed to make a project viable. These are especially relevant for capital-intensive abatement technologies.[94]

- Tax incentives: Fiscal mechanisms—such as investment tax credits or accelerated depreciation for low-carbon assets—aimed at improving project economics and encouraging earlier adoption of clean technologies.[95]
- Risk-sharing facilities: Instruments such as blended finance schemes or public-private guarantees to lower the cost of capital for early-stage or high-risk decarbonisation investments, helping to crowd in private finance.[96]

Despite the wide range of policy tools available, market demand for low-carbon steel and cement remains limited;[97] high costs are a major barrier to adoption of low-carbon steel[98] and low-emission cement is less than 1% of global supply.[99] Most existing instruments target supply-side decarbonisation or emissions accounting, but relatively few directly incentivise the purchase of low-carbon materials at scale. Procurement standards vary significantly across member states, making it harder to coordinate demand. In addition, it is still difficult to clearly determine the added value—or fair market price—of greener materials, which creates uncertainty for both buyers and sellers.[100] The absence of strong signals from the demand-side is a disincentive, and addressing it will require more targeted interventions that can accelerate market formation.[101]

[94] Climate Strategies (2022). 'Carbon Contracts for Difference (CCfDs) in a European context', June.
[95] IEA (2024), 'Tax credit for investments in green industries – Solar panels', 28 June.
[96] Outlook Planet (2025), 'How Blended Finance Could Bridge the Missing Middle in Climate Finance', 2 June.
[97] See Fastmarkets (2024), 'Green steel transition in focus: Key takeaways from Eurometal Steel Day in Zurich', 17 May and Ramboll (2024), 'The Steel and Concrete Transformation', 1 September.
[98] Ramboll (2024), 'Nearly half of global companies are ready to pay a premium for lower emission steel and concrete', 24 September.
[99] World Economic Forum (2023), 'Net-Zero Industry Tracker 2023', 28 November.
[100] Bellona (2024), 'Green Public Procurement of Cement and Steel in the EU' highlights that the adoption of green public procurement criteria for materials like cement and steel is inconsistent across the EU.
[101] MPP (2021), 'Steeling Demand: Mobilising buyers to bring net-zero steel to market before 2030', July.

EU Clean Industrial Deal

Unveiled in early 2025, the EU Clean Industrial Deal is the European Commission's updated strategy to accelerate industrial decarbonisation while enhancing the EU's global competitiveness in clean technologies. Building on the Green Deal Industrial Plan, the initiative places greater emphasis on implementation, investment readiness, and the resilience of supply chains. The Deal is expected to mobilise over €100 billion to scale clean manufacturing and low-carbon technologies across Europe and is structured around six core pillars:

- A revised state aid framework and a strengthened Innovation Fund, alongside a proposed Industrial Decarbonisation Bank and amendments to InvestEU, with the aim of unlocking up to €150 billion in total investment.
- Targeted funding for industrial research and innovation, including dedicated calls under Horizon Europe.
- Circular economy measures, such as an EU-wide demand aggregation mechanism for critical raw materials, a centralised purchasing platform, and a forthcoming Circular Economy Act targeting 24% circularity by 2030.
- Global engagement through new Clean Trade and Investment Partnerships, simplification of the Carbon Border Adjustment Mechanism (CBAM), and reinforced trade defence tools to support strategic autonomy.
- Workforce development via the creation of a Union of Skills and targeted support through Erasmus+ to address labour shortages in clean tech, digital, and industrial sectors.
- Cross-cutting enablers to improve competitiveness, including regulatory simplification, a deeper single market, and enhanced coordination across EU and national policies.

The Deal complements broader EU initiatives under the European Green Deal, RePowerEU, and the Net-Zero Industry Act, aiming to align decarbonisation with industrial growth.

Source: European Commission (2025), 'Clean Industrial Deal. A plan for EU competitiveness and decarbonisation'

3.2 Demand Aggregation and Buyer Alliances

One approach to stimulating early demand is the use of buyer alliances to aggregate purchasing commitments across public and private sector actors. These alliances operate by coordinating forward commitments, often through volume pledges or procurement guidelines, to create credible demand signals for low-carbon suppliers. Examples include SteelZero and ConcreteZero, which convene large buyers to collectively commit to sourcing 100% net-zero steel or concrete by 2050, with interim milestones along the way.[102, 103] These groups are joined by industry-led initiatives such as ResponsibleSteel and the Centre for Green Market Activation, which provide verification, market engagement, and standard-setting functions.[104]

In recent years, competition authorities in both the UE and UK have signalled support for sustainability-driven cooperation, granting exemptions that enable competitors to collaborate on green initiatives without violating antitrust rules. For instance, in June 2022 the Dutch competition regulator (ACM) issued a no-action letter authorising Shell and TotalEnergies to jointly market up to 20% of the capacity of a North Sea CO_2 trunkline for carbon capture storage—recognising that pooled infrastructure and pricing offered societal benefits that outweighed any competitive concerns.[105]

Similarly, the UK's Competition & Markets Authority (CMA) has adopted an "open door" approach, issuing informal guidance under its Green Agreements Guidance to clarify that sustainability agreements—such as a joint commitment by supermarkets to reduce suppliers' GHG

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[102] See GlobalABC (2022), 'SteelZero', 12 December and Buro Happold (2023), 'ConcreteZero: providing a solid foundation for low carbon construction', 23 January.
[103] Amazon is a named member of the RMI-led Sustainable Steel Buyers Platform (SSBP) which launched with funding and strategic support from RMI, the Climate Group, and the First Movers Coalition. Alongside other members, including Microsoft, Invenergy, Meta, Johnson Controls, Google, Nextracker, Trammell Crow Company, and Dvele, Amazon is working to aggregate demand, support market transformation, and drive investment in green steel production. This collaboration is part of Amazon's broader efforts to decarbonize supply chains and promote sustainability in the steel sector. The work done through SSBP complements Amazon's ongoing efforts to explore innovative solutions like the Book-and-Claim (B&C) mechanism, which can further enable the scaling of low-carbon steel demand by overcoming logistical and market barriers to direct procurement today. The SSBP initiative has committed to procuring near-zero emission steel-scaling to a collective annual target volume of 1 million tonnes by 2028. See RMI website available here.
[104] ResponsibleSteel is a global, not-for-profit organisation created to maximise steel's contribution to a sustainable world – see further detail here. The Center for Green Market Activation (GMA) is a U.S. based, globally-focused nonprofit organization formed for the purpose of promoting the uptake of low-carbon and zero-carbon fuels and materials as a means of combatting climate change – see further detail here.
[105] Covington (2023), 'Building a sustainability strategy – what companies can (not) do from a competition law perspective', 30 January.

emissions—can be acceptable under competition law, provided environmental benefits are demonstrated.[106]

Together, these rulings show regulators are increasingly prepared to permit strategic cooperation—such as co-marketing, joint purchasing, or demand aggregation arrangements—that would traditionally raise competition concerns, where there is a clear climate benefit. This creates a precedent for buyer alliances in green materials markets: for example, coalitions of construction firms or public bodies could collectively commit to pay a premium for low-carbon steel or cement without breaching antitrust restrictions—an important enabler for mechanisms like EAC's or joint offtake agreements.

Alliances, such as the ones mentioned above, serve several functions. First, they provide suppliers with greater visibility into future demand, helping to de-risk early investments.[107] Second, they promote harmonisation across buyers, reducing market fragmentation and enabling standardised approaches to green procurement.[108] Third, they offer a platform for collective learning and knowledge-sharing, which is particularly valuable in nascent markets with evolving technical standards.

By aggregating demand, these initiatives can help bridge the gap between pilot-scale green production and commercial viability. However, their impact is limited by the voluntary nature of commitments, the absence of binding purchasing requirements, and the difficulty of coordinating diverse buyers with different needs, budgets, and levels of climate ambition.

3.3 Product Standards and Embodied Carbon Benchmarks

Product-level standards are central to the creation of functioning low-carbon material markets.[109] In contrast to prescriptive regulations that favour specific technologies, performance-based standards set benchmarks for environmental outcomes—such as embodied carbon per tonne of steel or cement—allowing producers to choose the most effective technological pathway.[110] These benchmarks can be tied to procurement eligibility, labelling schemes, or financial incentives.

[106] IIGCC (2024), 'CMA clarifies stance on climate collaborative sustainability agreements', 25 April.
[107] MPP (2021), 'Steeling Demand: Mobilising buyers to bring net-zero steel to market before 2030', July.
[108] Eurometal (2024), 'SteelZero calls for public sector-led transition, procurement', 19 November.
[109] EPA (2024), 'Implementation Approach for the U.S. EPA Label Program for Low Embodied Carbon Construction Materials', August, p. 1.
[110] Structure (2025), 'Performance-Based Specifications and Embodied Carbon', 31 March.

The reform of the EU's Construction Products Regulation offers an opportunity to integrate such performance-based environmental criteria into core material standards.[111] Lifecycle carbon assessments (LCAs) and environmental product declarations (EPDs) are increasingly used to quantify emissions across production stages. However, uptake is uneven, and methodologies are not yet fully harmonised across member states or sectors.[112]

The introduction of tiered benchmarks, similar to those used in vehicle emissions regulation, could offer a way to incentivise progressive improvement without excluding early movers. Over time, these standards could be ratcheted down to reflect technological progress, thereby creating a long-term trajectory for market transformation.

3.4 Green Public Procurement (GPP)

Public procurement represents a significant source of potential demand for green steel and cement, particularly in sectors such as transport, housing, and infrastructure. The Clean Energy Ministerial's Global Guide for Government Green Procurement provides a blueprint for embedding climate criteria into procurement policies, recommending tools such as shadow carbon pricing, lifecycle carbon thresholds, and minimum environmental performance standards.[113]

At the EU level, public procurement policy is increasingly aligned with green objectives, but implementation varies significantly by country and sector. Some member states have introduced mandatory green criteria for public projects, while others rely on voluntary guidelines. In practice, procurement officers face challenges in applying these criteria due to limited technical capacity, lack of clear data, and concerns over higher costs.[114]

Strengthening the capacity of procurement authorities—through guidance, training, and technical support—will be essential to mainstreaming low-carbon materials in public projects. In addition, coordinating procurement specifications across municipalities and

[111] European Commission (2025), 'New EU rules on the safety and sustainability of construction products mark a new step for the sector's competitiveness', 7 January.
[112] BPIE (2024), 'How to establish Whole Life Carbon benchmarks', September.
[113] Clean Energy Ministerial (2024), 'Green Public Procurement Guide: How to set commitments to buy low and near-zero emission concrete, steel and construction projects in public procurement practices', December
[114] OECD (2024), 'Harnessing Public Procurement for the Green Transition', May.

national bodies could help aggregate demand and provide greater certainty to suppliers.[115]

3.5 Carbon Contracts for Difference (CCfDs) and Investment De-risking

Carbon Contracts for Difference (CCfDs) are designed to bridge the cost gap between conventional and low-carbon production by guaranteeing a fixed carbon price over a defined period.[116] If the prevailing carbon price (e.g. under the EU ETS) falls below this level, the public sector pays the difference to the producer, thus derisking investment in low-carbon technologies. The EU Innovation Fund is currently piloting this approach in the industrial sector.[117]

CCfDs address a core problem in green investment: revenue uncertainty. By stabilising expected returns, they reduce the perceived risk of green capital expenditures and facilitate financing from banks and institutional investors.[118] In effect, they convert uncertain policy environments into more investable propositions.

While promising, CCfDs can be complex to implement and require robust monitoring, clear baselines, and transparent allocation processes. They may also need to be tailored to sector-specific cost structures and emissions profiles.[119]

In parallel, other instruments such as Power Purchase Agreements (PPAs), volume-based offtake agreements, and blended finance facilities can complement the role of CCfDs. PPAs, in particular, are a well-established mechanism in the renewable energy sector and offer important lessons for industrial decarbonisation. A PPA is a long-term contract between a buyer (typically a corporate or utility) and a producer of renewable energy, guaranteeing a fixed price for electricity over a defined period.[120] This structure provides revenue certainty to project developers, enabling them to raise capital at lower cost and de-risk investment in new generation capacity.[121]

[115] Hasanbeigi et al. (2021), 'Fostering industry transition through green public procurement: A "How to" Guide for the cement & steel sectors', June.
[116] CATF (2024), 'Designing Carbon Contracts for Difference', 12 February.
[117] According to the European Commission, in 2023, the Innovation Fund began allocating funds through a fixed-premium pilot auction to support the production of Renewable Fuels of Non-Biological Origin (RFNBO) hydrogen. See the following European Commission website on competitive bidding for further detail – available here.
[118] CATF (2024), 'Designing Carbon Contracts for Difference', 12 February.
[119] ERCST (2022), 'Reflection note on Carbon Contracts for Difference (CCfD)', January.
[120] Eurelectric (2023), 'Explainer: What are Power Purchase Agreements (PPAs)?', 1 September.
[121] Eurelectric (2023), 'Explainer: What are Power Purchase Agreements (PPAs)?', 1 September.

The relevance of PPAs extends beyond electricity. In green steel production, where hydrogen-based direct reduced iron (H_2-DRI) processes require significant volumes of renewable electricity, long-term access to low-cost power is essential. PPAs can serve as a foundational component of low-carbon steel business models by securing input cost stability and aligning energy procurement with emissions reduction objectives. Some early-stage low-carbon steel projects have already signed PPAs to anchor their operations, particularly in jurisdictions with abundant renewable potential.[122]

Adaptations of the PPA model could also be considered for low-carbon cement, particularly in relation to securing renewable heat or power for alternative kiln processes, or in cases where carbon capture and storage (CCS) systems increase electricity consumption.[123] Moreover, the contractual logic of PPAs—anchored in long-term, price-stabilised supply agreements—can be repurposed in commodity markets to underwrite demand for low-carbon materials.[124] For example, large construction buyers or public agencies could enter forward contracts with producers of certified green steel or cement, offering guaranteed pricing and minimum volume commitments.[125]

While not a substitute for public policy tools like CCfDs, PPAs and offtake agreements can be effective in mitigating market and financing risks in the early stages of deployment. Together, these mechanisms contribute to a broader toolkit for accelerating industrial decarbonisation by improving the bankability of green projects and fostering more predictable market conditions. Unlocking supply at pace is critical to meeting the global target of limiting temperature rises to less than 2°C. Market-based mechanisms can play a pivotal role in

[122] H2 Green Steel has entered into a 7-year PPA with Statkraft to supply 2 TWh per year of renewable electricity to its operations in Boden, Sweden. This agreement ensures a long-term supply of green electricity – more detail available here. Similarly, Thyssenkrupp Steel and RWE have signed a 10-year PPA to supply 112 GWh per year of green electricity from RWE's Nordsee Kaskasi offshore wind farm to Thyssenkrupp's direct reduction plant in Duisburg – more detailed available here.

[123] Holcim is actively shifting to renewable energy sources, including on-site installations and off-site PPAs, to power its cement production facilities. See Holcim (2023), 'Shifting to renewable energy', 12 April.

[124] The concept of Forward Commitment Procurement (FCP) exemplifies this approach, where buyers commit to purchasing a product or service that currently does not exist, at a specified future date, provided it meets agreed performance levels and costs. This model helps manage risk in procuring innovative goods and services, thereby stimulating market demand for low-carbon materials. See DEFRA (2007), 'Environmental Markets and Economic Performance: Report', November.

[125] Reuters (2024), 'Policy Watch: COP29 comes up short on spurring reduction in industrial emissions', 10 December.

catalysing this action by creating early demand signals and reducing investment risk.

3.6 Voluntary markets and corporate disclosures

In addition to formal regulation, voluntary market initiatives and corporate disclosure requirements are increasingly influencing procurement decisions. Companies operating under ESG reporting frameworks such as the Corporate Sustainability Reporting Directive (CSRD), the Sustainable Finance Disclosure Regulation (SFDR), and global standards such as ISSB may face pressure to demonstrate emissions reductions not just at the corporate level but across their supply chains.[126] The recently adopted Corporate Sustainability Due Diligence Directive (CSDDD) further reinforces this shift by requiring large companies operating in the EU to identify and address environmental and human rights risks across their value chains, including emissions-related impacts—thereby strengthening the case for transparent procurement and credible climate claims throughout the supply chain.[127]

In this context, the ability to credibly procure and report on low-carbon materials becomes a strategic consideration. Investor coalitions and green bond frameworks are also beginning to favour issuers with clear supply chain decarbonisation strategies, reinforcing the demand signal.[128] While these developments are still evolving, they suggest that voluntary markets—when supported by robust traceability and certification mechanisms—can complement formal policy tools by creating reputational and financial incentives for early adoption.[129]

3.7 Market sequencing and policy tool complementarity

The effectiveness of any individual policy tool depends on its alignment with the maturity of the market it seeks to shape.[130] In nascent markets, where supply chains are still under development and production costs remain high, flexible instruments—such as EAC models or voluntary

[126] The CSRD requires large companies to publish sustainability reports aligned with European Sustainability Reporting Standards (ESRS), providing detailed disclosures on risks, opportunities, and material impacts related to environmental, social, and governance (ESG) issues. See Greenly (2025), 'What is the Corporate Sustainability Reporting Directive (CSRD)?', 11 March.
[127] Ramboll (2024), 'How to reduce supply chain emissions through policy', 4 December.
[128] EIB (2023), 'Global Green Bond Initiative strengthened by a new strategic partnership to foster green capital markets', 6 September.
[129] The Carbon Disclosure Project (CDP) and initiatives like the Science Based Targets initiative (SBTi) are examples of voluntary frameworks that encourage companies to disclose and reduce their environmental impacts, including those across their supply chains.
[130] Allan and Nahm (2024), 'Strategies of Green Industrial Policy: How States Position Firms in Global Supply Chains', 10 May empathises that state-driven tools are most effective when supply chains are not yet established, requiring coordination and planning. Conversely, in mature markets, firm-driven policies can allow industries to scale domestically and internationally.

procurement commitments—may be more appropriate than rigid compliance-based mechanisms, which typically require established supply chain infrastructure, standardised product definitions, and stable market conditions to function effectively. [131]These tools allow for early demand aggregation and enable producers to make investment decisions even in the absence of large-scale physical infrastructure.

As markets mature, more prescriptive or price-based instruments—such as product standards, carbon pricing, and public procurement rules—can play a greater role in ensuring broad uptake and levelling the playing field.[132] Strategic sequencing and layering of these tools is therefore essential. A clear understanding of when and how to deploy different mechanisms can help policymakers balance early support with long-term efficiency, avoiding both under-incentivisation and premature regulatory burdens.

3.8 Remaining gaps in the policy landscape

Despite the availability of a growing number of policy tools, several barriers to widespread uptake of green steel and cement remain. Geographic and logistical mismatches between low-carbon material production and local procurement needs continue to limit accessibility. The administrative burden associated with certification, emissions reporting, and traceability—particularly for smaller firms—deters participation and undermines inclusivity.

In addition, the lack of mechanisms that allow for credible carbon claims in cases where physical delivery is decoupled from commercial transactions limits the development of flexible, scalable markets. Finally, the absence of a harmonised approach across Member States results in policy fragmentation and reduces the effectiveness of demand-side signals. These challenges point to the need for more integrated approaches to market development.

Moreover, physical factors play an important role in determining whether flexible mechanisms like EAC's or more direct, traceable systems are appropriate.[133] First, fungibility matters — if 'grey' and 'green' versions of a commodity are physically interchangeable, the

[131] RMI (2023), 'Clean Energy 101: Book and Claim', 30 May identified how book-and-claim systems can connect buyers and sellers to decarbonise value chains, especially when physical offtake options are impractical.
[132] CO2RE (2023), 'Governing permanence of Carbon Dioxide Removal: a typology of policy measures', November discuss how policy sequencing is a key strategy of climate policymaking and proved to be successful in overcoming political challenges in other areas of decarbonisation strategies.
[133] Dukku et al. (2025), 'Techno-Economic Feasibility Study of Hydrogen Transportation in Greenland Using Pipeline and Maritime Routes', 28 February.

primary barrier is pricing and credible verification. In such cases, instruments like digital product passports or certificates of origin can enable differentiation without requiring new physical infrastructure. This mirrors models used in electricity markets, where Guarantees of Origin allow buyers to claim renewable attributes even when power is delivered through the shared grid.[134] Conversely, in sectors like biofuels—where specificity in blending ratios is essential—physical interchangeability is limited, which constrains the effectiveness of non-physical instruments and requires more integrated tracing mechanisms.[135]

Moreover, logistics and cost considerations affect the choice of procurement strategy. When a low-carbon commodity is expensive or technically complex to transport or store, EAC's may offer an early-stage advantage by removing the need to physically move the cleaner product to every buyer. This is particularly relevant for hydrogen: long-distance transport via pipelines or ships is both logistically challenging and capital intensive, with pipeline retrofits costing up to €0.6–1.2 million per km or €2.2–4.5 million/km for greenfield routes.[136]

Liquid or carrier-based transport options can reduce energy efficiency by up to 40%, further raising costs.[137] Similar transport burdens apply to heavy materials like cement or steel, where weight and volume drive up logistical emissions and costs. In these contexts, EAC's can reduce barriers to early deployment by avoiding the need to reconfigure supply chains and build specialized logistics.

Matching procurement mechanisms to physical constraints is likely to lead to more efficient market design. Where commodities are interchangeable and easier to move, traceability tools may suffice. Where infrastructure hurdles are large, EAC or other certificate-based approaches may serve as viable stopgaps until physical delivery becomes more practical and affordable.

134 3Degrees (2024), 'Guarantees of origin (GOs): What are they and how do they fit into your climate plans?', 31 January.
135 ISCC (2025), 'Guidance for the certification of co-processing' highlights that biofuel use is heavily regulated by specific blend mandates, necessitating accurate tracking and stricter chain-of-custody than flexible certificate systems like book-and-claim. This reflects both the need for precise attribution of carbon benefits and the significant environmental impact associated with physically transporting and blending biofuels.
136 Hydrogen Council (2021), 'Hydrogen Insights: A perspective on hydrogen investment, market development and cost competitiveness', February, p. 21.
137 Hren et al. (2023), 'Hydrogen production, storage and transport for renewable energy and chemical: An environmental footprint assessment', March, p. 9.

4 Deep dive on Environmental Attribute Certificates as a policy tool

This section examines the Environmental Attribute Certificates (EAC) policy, which is an example of a chain of custody (CoC) model. We examine its potential to enable faster and more scalable market formation for green industrial commodities. EAC are already used in other sectors (e.g. Sustainable Aviation Fuel (SAF) and maritime fuels[138]) and offers a flexible mechanism for attributing environmental benefits in complex, distributed supply chains where physical traceability is costly or impractical.

4.1 Chain of Custody Models—conceptual overview

As efforts to decarbonise heavy industry accelerate, there is increasing interest in how the environmental attributes of lower-carbon materials—such as reduced carbon intensity—can be credibly transferred along the value chain. However, fully traceable physical chain-of-custody models can be costly, logistically complex, or even counterproductive from a sustainability perspective, particularly when green production is geographically limited. To address this, different chain-of-custody (CoC) models have emerged, which range from fully traceable systems to more flexible approaches like EAC's. Each offer trade-offs between accuracy, cost, and feasibility. These models link environmental claims to production, distribution, and consumption in different ways that allow buyers to credibly support green production even when the direct transport or availability of certified materials is limited.

The **identity-preserved model** requires that the environmental characteristics of a product are maintained without mixing throughout the entire supply chain. Materials must remain physically separated, with full traceability from origin to end user.[139] This model offers the highest level of assurance and is typically used in tightly controlled supply chains (e.g. high-value specialty materials) but is rarely feasible in large, decentralised industrial markets due to the cost and infrastructure requirements involved.

The **segregation model** permits products with the same sustainability characteristics to be grouped together, provided they are kept separate

[138] Sustainable Aviation Fuel (SAF) is a low-carbon alternative to conventional jet fuel, made from renewable or waste-derived feedstocks.
[139] ISEAL Alliance (2016), 'Chain of custody models and definitions', September.

from conventional equivalents.[140] Although this model allows for some operational flexibility compared to identity preservation, it still relies on dedicated handling and storage systems, which may limit its applicability in commodity markets. Segregation is more commonly applied where facilities can accommodate parallel streams without excessive operational burden.

The **mass balance model** allows for the mixing of certified and non-certified materials in the production process. Certification is based on ensuring that the proportion of sustainable inputs and outputs remains consistent over a given accounting period.[141] This model is widely used in sectors like biofuels and chemicals, where strict physical separation is impractical but where basic traceability is still required. Mass balance can facilitate broader market participation, though it depends heavily on reliable tracking systems and independent audits. It is particularly suited to transitional contexts, where full segregation is not yet viable.

The **EAC model** takes a different approach by fully separating the physical flow of goods from the associated environmental claims.[142] Producers of low-carbon materials are issued certificates for verified volumes of low-carbon output, which can then be sold to buyers independently of the physical product. This allows environmental attributes to be transferred even when the physical product is consumed elsewhere, potentially lowering transaction costs and enabling greater flexibility in supply chains where physical tracing is not viable. EAC systems are already in use in the transport sector (e.g., for SAF) and are being piloted in maritime transport, where complex, global logistics make direct traceability impractical.

These models are not mutually exclusive, and their suitability depends on the specific context. In some markets, multiple CoC models may operate in parallel or evolve over time as supply chains mature, regulatory requirements tighten, or verification systems improve. Selecting the appropriate model often involves balancing assurance, scalability, and operational feasibility particularly in early-stage markets for low-carbon industrial commodities.

[140] ISEAL Alliance (2016), 'Chain of custody models and definitions', September.
[141] ISEAL Alliance (2016), 'Chain of custody models and definitions', September.
[142] ISEAL Alliance (2016), 'Chain of custody models and definitions', September.

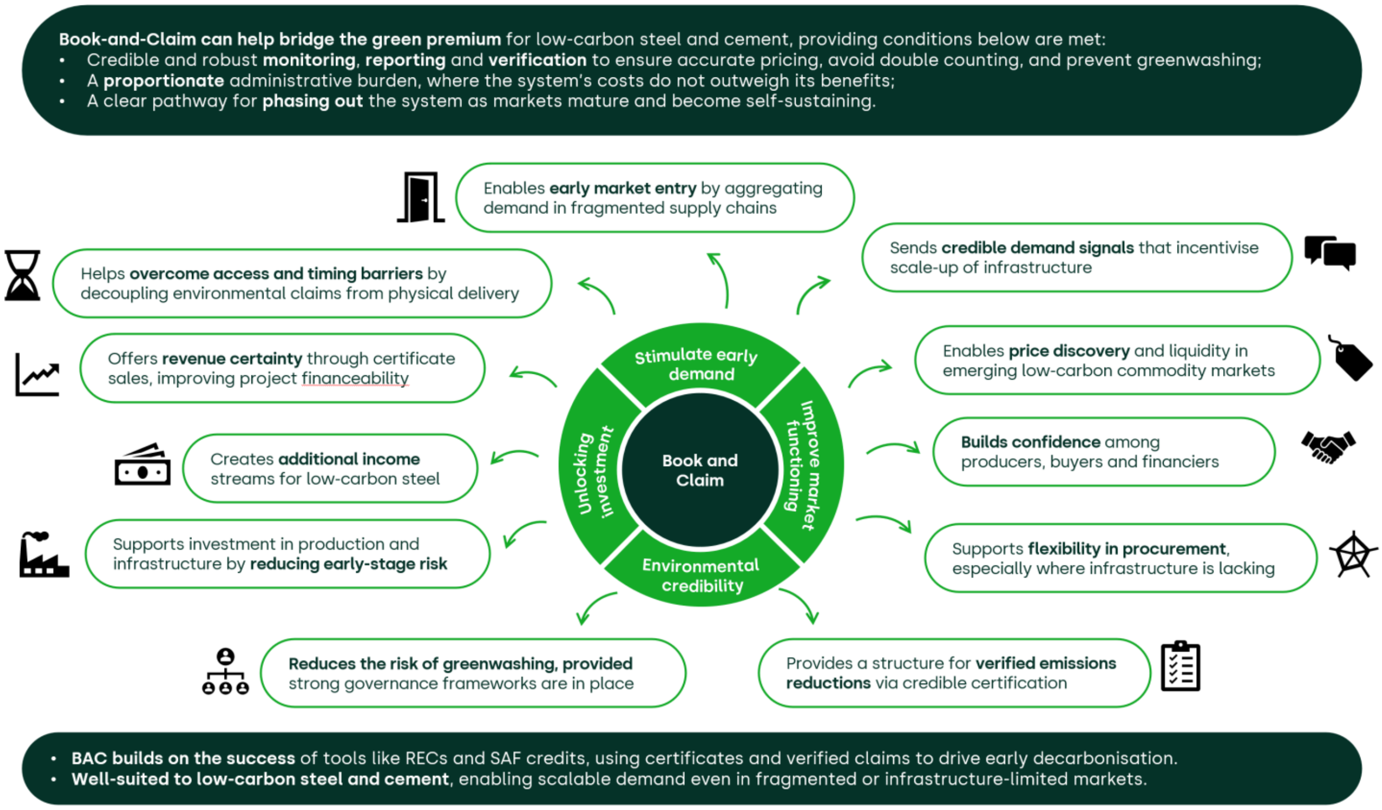
4.2 Definition and key advantages of Environmental Attribute Certificates

As mentioned above, the EAC model is a CoC model that enables the decoupling of environmental attributes form the physical flow of goods. Under this model, producers of verified low-carbon materials are issued certificates that represent a quantified reduction in emissions relative to a conventional baseline.[143] These certificates can then be sold separately from the physical product, allowing buyers to claim the associated environmental benefits without requiring physical possession of the low-carbon material itself.[144]

This approach has become increasingly relevant in markets where the physical distribution of green alternatives is constrained by geography, scale or infrastructure.[145] In the EU context, it complements broader Green Deal objectives by enabling verified low-carbon commodities to be traded and claimed independently of physical delivery. More precisely, it incentivises both demand and supply, accelerates market formation, and supports national decarbonisation targets without being limited by infrastructure gaps or regional availability.

[143] ISEAL Alliance (2016), 'Chain of custody models and definitions', September.
[144] RSB (2025), 'RSB Book & Claim Manual (RSB Chain of Custody Procedure for book and claim)', 24 March.
[145] RSB (2025), 'RSB Book & Claim Manual (RSB Chain of Custody Procedure for book and claim)', 24 March, p. 4.

Figure 4.1 The Role of Environmental Attribute Certificates (EACs) in Scaling Low-Carbon Steel and Cement



Source: Oxera.

EAC's primary advantage lies in its ability to overcome logistical and market barriers that may inhibit the development of green steel and cement supply chains.[146] Both materials are typically produced and consumed in geographically dispersed, highly localised contexts, often without the transport infrastructure or contracting arrangements needed to match low-carbon supply with specific buyers. In such settings, EAC's provide a practical solution. It enables demand aggregation from buyers that may be unable to access physical product due to location, scheduling, or contractual constraints, while still channelling revenue to certified low-carbon producers.[147] As the model scales, it can create a more stable and predictable revenue stream for early movers, encouraging investment in low-carbon production

[146] RMI (2024), 'Structuring Demand for Lower-Carbon Materials: An Initial Assessment of Book and Claim for the Steel and Concrete Sectors'.
[147] Latitude Media (2024), 'Scaling low-carbon products with book and claim systems', December highlight how BAC bridges geographical mismatches—e.g., producers in low-cost regions supplying green inputs, while high-margin purchasers in other regions can support them through attribute purchases without physical receipt of product.

capacity even in the absence of direct offtake agreements. This dynamic can help bring low-carbon materials to markets where infrastructure and demand remain underdeveloped, supporting both supply expansion and broader market access.

Boosting Demand

EAC systems are emerging as powerful tools for catalysing early demand for low-carbon fuels and materials. By decoupling environmental attributes from physical delivery, EAC allows organisations to credibly claim emissions reductions even when direct sourcing isn't feasible—removing a major barrier to demand formation in fragmented or immature markets.

A leading example is the Sustainable Aviation Buyers Alliance (SABA), where 20 major corporations—including airlines and corporate purchasers—committed to certificates covering nearly 50 million gallons of Sustainable Aviation Fuel (SAF). This represented an investment of around $200 million and was expected to avoid about 500,000 tonnes of CO_2e. Multi-year purchases gave producers revenue certainty while enabling buyers to meet decarbonisation goals without direct SAF access. SABA described the initiative as 'essential in driving scale', highlighting BAC's role in creating aggregated, bankable demand.[1] The Zero-Emission Maritime Buyers Alliance (ZEMBA), launched in 2023, aggregates corporate demand for zero-emission shipping and using Sustainable Maritime Fuel certificates (SMFc) to enable carriers to sign contracts with low-carbon bunker fuel suppliers. This collective procurement strategy intends to support new vessel purchases and infrastructure investments—such as refuelling hubs or fuel production sites—that might otherwise lack the commercial certainty to move forward.

In the electricity sector, Europe's Guarantees of Origin (GOs)—a well-established EAC system— have grown rapidly as companies use certificates to meet renewable energy targets. Issuance more than doubled from 370 TWh in 2015 to 747 TWh in 2021, while prices rose from under €1 to nearly €8 per MWh by 2022, reflecting surging demand for credible renewable claims even via shared grids.[3]

EAC is also driving growth in renewable gas. In the EU's biomethane market, GO-based certificates supported a 20% year-on-year production increase, reaching 37 TWh in 2021, as more upgraded biogas entered the grid.[4] In 2023 alone, biomethane certificates helped facilitate an estimated 15 million tonnes of CO_2e in avoided emissions.[5]

These examples show how EAC's enable buyers to send credible demand signals ahead of physical supply or infrastructure readiness—building market confidence, reducing supplier risk, and accelerating the scale-up of low-carbon technologies.

Source:
[1] Amazon is a member of the Concrete and Cement Working Group led by GMA and RMI, which is aimed at addressing the challenges of reducing emissions in the cement and concrete sector, which accounts for approximately 8% of global emissions. This initiative focuses on developing a credible Book-and-Claim (B&C) system for low-carbon cement and concrete with the aim of spurring innovation and facilitating demand aggregation. Alongside other industry leaders, Amazon is working to provide clear demand signals to encourage investment in low-carbon cement production and drive reductions in embodied carbon in the built environment. The working group will lead the design of a standardised system to enable bankable contracts and collective procurement processes similar to those established in other sectors, such as sustainable aviation and steel. See RMI (2024), 'Structuring Demand for Lower-Carbon Materials: An Initial Assessment of Book and Claim for the Steel and Concrete Sectors'.
[2] McKinsey (2024), 'Guarantees of origin: Playing a vital role in decarbonization', 16 January.
[3] McKinsey (2024), 'Guarantees of origin: Playing a vital role in decarbonization', 16 January.
[4] REGATRACE (2022), 'Renewable Gas Trade Centre in Europe', p. 14.
[5] EBA (2024), 'First comprehensive report on the trading of biomethane certificates confirms solid tracking systems are in place and working in EU and USA', 24 October.

This flexibility makes EAC a potentially powerful tool for stimulating early-stage demand in fragmented markets.[148] By allowing buyers to express credible demand signals through the purchase of certificates, EAC helps producers secure revenue streams and investment cases before physical volumes are widely available.[149] In essence, it decouples demand formation from supply build-out, enabling progression on both sides of the market.[150] This can be particularly important in the initial years of market formation, when low-carbon production capacity is nascent, and conventional procurement practices may not yet be adapted to accommodate low-carbon alternatives.

Moreover, EAC's can support liquidity and price discovery in emerging green markets by facilitating a tradable, standardised unit of environmental value.[151] If designed appropriately, certificates can create fungibility across producers and buyers, allowing market participants to transact based on verified emissions reductions rather than physical delivery logistics. This creates the basis for a digital environmental commodity market, where attributes such as low-carbon steel or cement can be priced, benchmarked, and contracted independently from physical constraints.[152]

However, the effectiveness of EAC's depends on strong governance. To function credibly, the system must include robust monitoring, reporting, and verification protocols, clearly defined baselines, and safeguards against double counting.[153] Without these elements, the model risks undermining trust in the market or enabling greenwashing. Nevertheless, where these conditions are met, EAC systems offers a mechanism for accelerating decarbonisation in sectors where physical matching of low-carbon supply and demand is challenging.

[148] A RMI-Mærsk pilot for maritime fuels noted that B&C allows cargo owners to use their purchasing power to advance low-emission ocean transportation solutions in a transparent, credible manner, even when physical delivery was not available. This highlights how B&C can help bridge fragmented demand in early-stage markets. See RMI (2024), 'Maritime Book and Claim System Advances Pilot Study to Support First Movers in Zero-Emissions Shipping', 16 April.
[149] The UC Irvine Clean Energy Institute (2023), 'Environmental Attribute Credits: Analysis of Program Design Features and Impacts', 15 September, p. 5.
[150] Aviation Week (2023), 'Book-And-Claim's Role in Scaling SAF', 15 November.
[151] [151] RMI (2024), 'Structuring Demand for Lower-Carbon Materials: An Initial Assessment of Book and Claim for the Steel and Concrete Sectors', p. 5.
[152] A report by the Clean Energy Institute notes that environmental attribute credits allow producers and consumers to trade on a common platform and that fungible certificate markets minimise the overall cost of physical supply and consumption. See The UC Irvine Clean Energy Institute (2023), 'Environmental Attribute Credits: Analysis of Program Design Features and Impacts', 15 September, p. 9.
[153] The International Tracking Standard Foundation (I-TRACK) outlines that trustworthy attribute systems must have traceable systems designed to avoid double counting, double certificate insurance, and doble attribute claims. See The International Tracking Standard Foundation (2025), 'The International Attribute Tacking Standard', 1 April.

Unlocking Investment and Infrastructure

EAC systems are emerging as powerful tools for unlocking investment in low-carbon production and infrastructure by providing credible, bankable demand signals. By separating environmental attributes from physical delivery, EAC allows buyers to commit to climate-aligned purchasing even when logistical or supply constraints prevent direct sourcing. This flexibility can translate into upfront revenue certainty for producers, enhancing the financeability of capital-intensive projects.

The Zero-Emission Maritime Buyers Alliance (ZEMBA), launched in 2023, is aggregating corporate demand for zero-emission shipping and using EAC credits to provide reliable income for low-carbon bunker fuel suppliers. This collective procurement strategy enables infrastructure investments—such as refuelling hubs or fuel production sites—that might otherwise lack the commercial certainty to move forward.

EAC can also help make low-carbon infrastructure projects more financeable by creating additional and tradable revenue streams. In the EU electricity market, Guarantees of Origin (GOs) now yield meaningful value—at recent prices (~€6/MWh), they can increase a wind farm's internal rate of return by 0.7 percentage points, helping bridge the financing gap as subsidies tighten. Analysts have described GOs as an 'indispensable enabler' for project developers navigating uncertain public support.

In heavy industry, companies like ArcelorMittal are applying similar models. Its XCarb™ certificate programme monetises the CO_2 savings associated with investments in electric arc furnaces, hydrogen-based direct reduced iron (DRI), and carbon capture technologies.[1] The sale of certificates representing 100,000 tonnes of emissions savings in 2021 provided revenue to help justify further decarbonisation projects and signal real customer willingness to pay. These proceeds are being reinvested to fund the company's 2030 CO_2 roadmap and support over €10 billion in low-carbon steelmaking investments.

Together, these cases illustrate how EAC systems can mobilise private capital, reduce investment risk, and enable early deployment of green infrastructure—particularly where physical supply chains remain immature or prohibitively expensive to reconfigure.

Sources:

[1] RMI (2023), 'Clean Energy 101: Book and Claim', 30 May

[2] McKinsey (2024), 'Guarantees of origin: Playing a vital role in decarbonization', 16 January

[3] Gestamp (2021), 'Gestamp signs agreement with ArcelorMittal to use XCarb green steel certificates', 20 October

[4] ArcelorMittal (2022), 'ArcelorMittal roadmap to net zero', October.

4.3 Examples of implementation (steel, concrete, and aviation)

The most appropriate precedent for EAC implementation comes from the aviation sector, where it has been adopted to facilitate market entry for sustainable aviation fuel (SAF). Given the complexity and cost of SAF logistics, especially in jurisdictions lacking dedicated fuelling infrastructure, airlines have relied on EAC systems to make emissions reduction claims even when SAF is consumed elsewhere.

The International Civil Aviation Organization (ICAO) formally recognises BAC under the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA),[154] and the European Commission has allowed similar approaches under the ReFuelEU Aviation Regulation.[155] Airlines such as United and DHL Global (Air Freight provider) have launched pilot programmes using EAC's to bridge the gap between demand for SAF and its physical availability, often through verified registries and certificate retirement systems.[156]

More recently, EAC models are beginning to emerge in industrial materials. In the cement sector, Microsoft has signed a forward agreement with Sublime System to procure environmental certificates representing over 600,000 tonnes of low-carbon cement.[157] Under this model, Microsoft will not take direct delivery of the physical cement but will still be able to claim the associated emissions reductions based on verified output and third-party certification. This structure has allowed Sublime to raise capital and scale up its production capacity while bypassing the physical distribution challenges that would otherwise limit market access. [158]

Green Electricity Certificates

Green electricity certificates are market-based instruments that represent the environmental attributes of renewable power. In Europe, the most common is the Guarantee of Origin (GO), which certifies that one megawatt-hour (MWh) of electricity was generated from renewable sources.

Issued by accredited bodies, GOs can be traded separately from the physical electricity, allowing buyers to claim renewable attributes even when consuming grid power. This flexibility supports renewable energy financing by creating an additional revenue stream for producers.

GOs are widely used in corporate sustainability strategies, electricity markets, and Scope 2 reporting under the Greenhouse Gas Protocol. Their effectiveness, however, depends on strong tracking, verification, and cancellation systems to prevent double counting and ensure credibility.

Source: 3Degrees (2024), 'Guarantees of origin (GOs): What are they and how do they fit into your climate plans?' and AIB article on Renewable Energy Guarantees of Origin, available here.

[154] ICAO (2023), 'SAF accounting and Book & Claim systems', 20 October.
[155] European Commission (2023), 'Regulation (EU) 2023/2405 of the European Parliament and the Council on ensuring a level playing field for sustainable air transport (ReFuelEU Aviation)', 18 October.
[156] DHL (2021), 'DHL Global Forwarding implements 'book & claim' mechanism for Sustainable Aviation Fuel and joins United Airlines' Eco-Skies Alliance program', 27 May.
[157] ESG Today (2025). 'Microsoft Buys over 600,000 Tons of Green Cement to Help Build Sustainable Materials Market', 28 May.
[158] Cement Optimized (2025), 'Microsoft Weighs 600K-Ton Sublime Cement Order', 23 May.

exploring models to monetise the environmental value of their output beyond the local buyer base.[159] The emergence of voluntary buyer alliances and third-party registries suggest that EAC-like structures could be formalised over time, enabling wider market access even before full logistical integration is achieved.[160]

The growing interest in EAC's across these sectors reflects a broader recognition of the challenges involved in physically matching low-carbon supply and demand. In construction and heavy industry, where procurement cycles are complex and materials are sourced locally, EAC's offer a mechanism to connect global climate objectives with the specific characteristics of regional supply chains. By enabling environmental claims to be separated from physical flows, it allows climate-aligned investment and procurement to proceed without waiting for complete logistical maturity.

4.4 Risks and limitations

While the EAC models offers considerable flexibility, it is not without limitations. While its strength lies in decoupling environmental claims from physical transactions, this same characteristic also exposes it to scrutiny and potential risk. Without adequate governance, EAC systems risk enabling double counting, misleading claims, or emissions reductions that are not genuinely additional.[161] Ensuring environmental integrity requires a robust certification framework that clearly defines eligible activities, enforces one-time certificate requirement, and prevents resale or duplication of claims.[162] This, in turn, requires a trustworthy and transparent registry system with third-party oversight.[163]

There is also a broader credibility risk. In some sectors, especially those governed by compliance obligations or formal procurement criteria, the absence of physical traceability may reduce the perceived legitimacy of

[159] See GIZ (2021), 'Potential of Article 6 and other financing instruments to promote Green Hydrogen in the Steel, Cement and Mining Industries', 16 December and BNED (2024), 'Scaling Up Hydrogen: The Case for Low-Carbon Steel', 11 January.
[160] A report by the MIT Roosevelt Project highlights that the Sustainable Steel Buyers Platform (SSBP), launched in 2023, has secured forward-offtake commitments totalling 2 million short tonnes of green steel. It also references similar alliances such as the FirstMoversCoalition and SteelZero. See MIT CEEPR (2024), 'The Roosevelt Project: Iron and Steel Decarbonization by 2050: An Opportunity for Workers and Communities', July.
[161] RSB (2025), 'RSB Book & Claim Manual (RSB Chain of Custody Procedure for book and claim)', 24 March, p. 9.
[162] RSB, and other standards like IRMA, require that registries issue unique retirement statements, limited re-sale, and mandatory public audit trails to ensure one-time transfer and prevent double transactions. See IRMA (2024), 'IRMA Chain of Custody: Claims Procedure and Communications Policy', October and RSB (2025), 'RSB Book & Claim Manual (RSB Chain of Custody Procedure for book and claim)', 24 March.
[163] RSB (2021), 'Book & Claim for SAF – FAQs', 21 November.

environmental claims.[164] To address this, EAC systems need to align with evolving reporting frameworks such as the GHG Protocol, SBTi and emerging standards for carbon accounting in materials supply chains.[165]

A further consideration is the interaction between EAC systems and future policy environments. While currently utilised in voluntary markets, EAC schemes may need to evolve to remain compatible with regulatory approaches such as the ETS, the CBAM, or mandatory green procurement rules. It remains unclear whether EAC's will be accepted as evidence of compliance under these schemes—for example, whether they can count towards meeting carbon requirements under CBAM or be used in public tenders for low-carbon materials. If not, this could limit the relevance of EAC's as formal climate policies expand. As such, there is a need for flexible system design that includes robust verification and transparency, enabling EAC models to adapt and remain credible as part of a changing regulatory landscape.

The long-term credibility and scalability of EAC's will also depend on decisions around system governance. Key questions include who should issue and retire certificates, whether the system should be centralised or decentralised, and whether certificates should be fungible across sectors or specific to individual materials and use cases. If not carefully designed, EAC's could fragment into parallel schemes with inconsistent methodologies and limited interoperability. To avoid this, there is growing interest in internationally harmonised framework and registry platforms that provide common rules and promote liquidity.[166]

Finally, EAC's should not be viewed as a permanent substitute for physical traceability. Rather, it is best seen as a transitional mechanism—appropriate in early-stage markets where supply chains are still emerging, but potentially less suitable as markets mature and direct delivery of low-carbon materials becomes feasible.[167] Policymakers and market designers will need to define clear thresholds or review points at which EAC schemes are reassessed, phased out, or

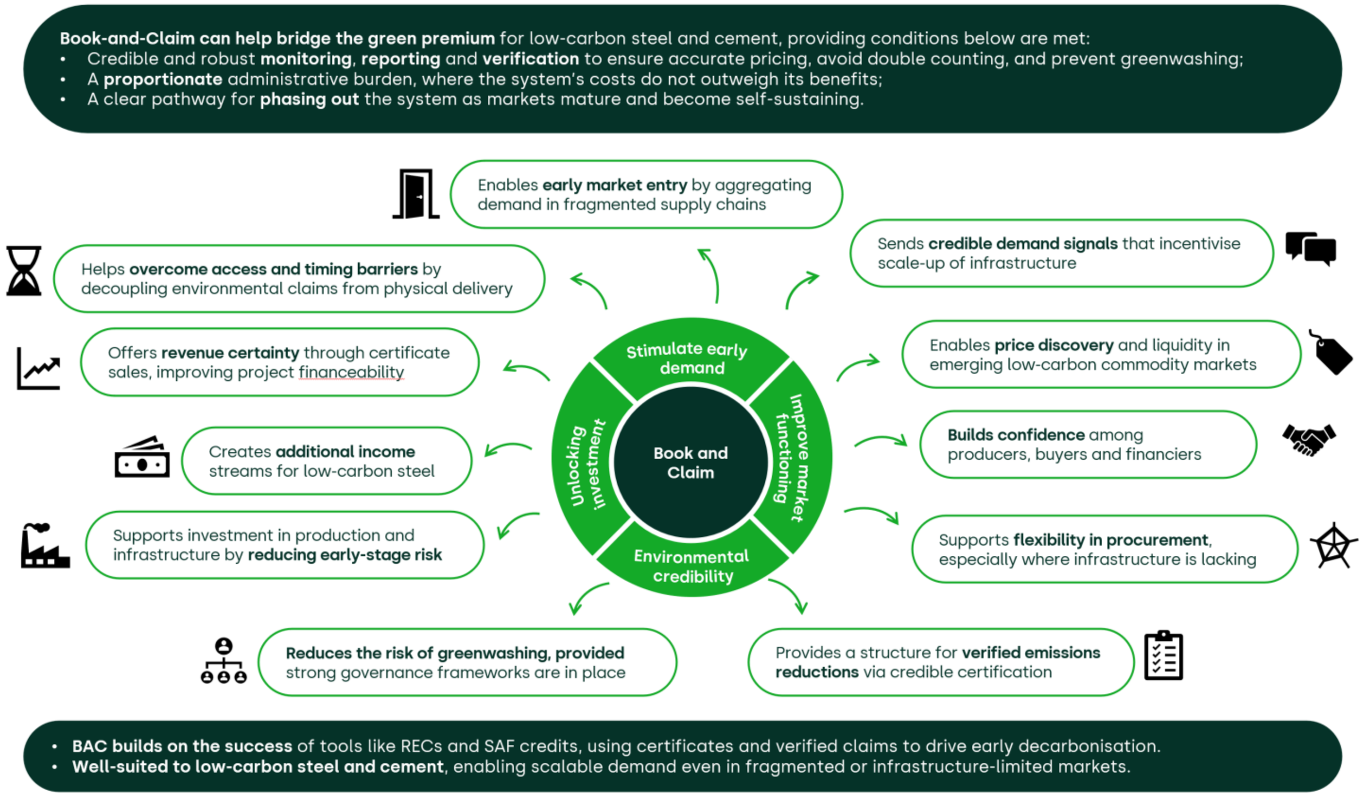
[164] A GHG Protocol survey summary indicated that many respondents opposed certain market-based approaches like BAC due to the absence of physical relationships undermining the integrity of emissions inventories. See GHG Protocol (2024), 'Greenhouse Gas Protocol: Detailed Summary of Survey Responses on Market-based Accounting Approaches Stakeholder Survey', July, pp. 4-24.
[165] Carbon Direct (2025), 'Key updates to HGH Protocol and SBTi: What companies need to know', 5 June.
[166] RSB emphasise that in the absence of definitive market solutions, there is no common standard or data harmonisation. RSB claim its registry promotes harmonisation and interoperability. See RSB (2025), 'RSB Book & Claim Manual (RSB Chain of Custody Procedure for book and claim)', 24 March.
[167] A RMI report states that direct procurement of decarbonised produced is far simpler and preferable, highlighting that B&C is designed to enable investment at scale in early, nascent markets. See RMI (2023), 'Clean Energy 101: Book and Claim', 30 May.

integrated into more conventional procurement and compliance frameworks.

5 Conclusions

Low-carbon steel and cement are essential to Europe's industrial decarbonisation ambitions, yet the markets for these materials remain nascent, fragmented, and constrained by persistent economic and coordination failures. Demand-side policy tools (such as green public procurement, buyer alliances, carbon contracts for difference, and EAC systems) can play a pivotal role in overcoming these barriers and accelerating market formation. In particular, the EAC model offers a practical interim solution in cases where physical supply chains are geographically mismatched, infrastructure is lacking, or market liquidity is low, as shown in Figure 5.1 below.

Figure 5.1 The role of EACs in simulating demand for low-carbon commodities



Source: Oxera.

EAC systems provide a flexible, early-stage solution in fragmented or immature supply chains—such as those for low-carbon steel and cement—where full physical traceability is not yet feasible. By decoupling environmental claims from physical delivery, EAC’s help channel revenue to early movers, aggregate demand across buyers, and enable participation in settings where conventional contracting would be prohibitive. EAC’s offer enduring value in segments where supply chains are distributed, infrastructure remains uneven, or full traceability is cost-prohibitive.

While EAC’s offers flexibility and early momentum, more granular and standardised traceability tools will become increasingly important as green material markets mature.

In this context, digital product passports, with their ability to embed verified emissions and product data, can support the evolution toward more transparent, interoperable, and accountable supply chains. These instruments are not substitutes, but rather serve distinct purposes at different stages of market development: EAC’s to unlock demand and support investment in early phases, and digital product passports to provide robust verification and traceability as scale and complexity grow.

Ultimately, a well-sequenced toolkit—combining flexible, early-stage instruments with robust, data-driven accountability frameworks—will be essential to accelerate the uptake of low-carbon industrial materials and ensure the credibility and efficiency of Europe's decarbonisation strategy.

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