Coalition On Materials Emissions Transparency

GHG Accounting for Low-emissions Branded Steel and Aluminum Products

Coalition for Materials Emissions and Transparency
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OCTOBER 2023

Columbia Center on Sustainable Investment
A JOINT CENTER OF COLUMBIA LAW SCHOOL AND COLUMBIA CLIMATE SCHOOL

Acknowledgements

The authors would like to thank RMI and Lachlan Wright for their research support and feedback throughout the drafting of this support. We also wish to thank Alison Conroy, Valeria Superti, Hanne Fedje, Hugo Campos, Veronica Martinez, and Tom Gloria for contributing the in-depth industry knowledge that made this report possible. Finally, we would like to thank Sophie Cavalcanti and Samia El-Erian for providing additional research towards this paper.

About

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The Columbia Center on Sustainable Investment (CCSI), a joint center of Columbia Law School and Columbia Climate School at Columbia University, is a leading applied research center and forum dedicated to the study, practice, and discussion of sustainable international investment. Our mission is to develop and disseminate practical approaches and solutions, as well as to analyze topical policy-oriented issues, in order to maximize the impact of international investment for sustainable development. The Center undertakes its mission through interdisciplinary research, advisory projects, multistakeholder dialogue, educational programs, and the development of resources and tools.

COMET Coalition On Materials Emissions Transparency

The Coalition on Materials Emissions Transparency (COMET) accelerates supply chain decarbonization by enabling producers, consumer-facing companies, investors, and policymakers to better account for greenhouse gas (GHG) emissions throughout materials supply chains, in harmony with existing GHG accounting and disclosure methods and platforms.

Suggested Citation

John Biberman, Perrine Toledano, and Chloe Zhou, ***GHG Accounting for Low-emissions Branded Steel and Aluminum Products*** (New York: Columbia Center on Sustainable Investment (CCSI), October 2023).

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Acronyms

BF Blast Furnace

BOF Basic Oxygen Furnace

EAC Energy Attribute Certificate

EAF Electric Arc Furnace

EPD Environmental Product Declaration

EU European Union

GHG Greenhouse Gas

IAI International Aluminium Association

IEA International Energy Agency

ISO International Organization for Standardization

LCA Life Cycle Analysis

LCI Life Cycle Inventory

PPA Power Purchase Agreement

REC Renewable Energy Certificate

VPPA Virtual Power Purchase Agreement

Executive Summary

In recent years, demand for low-emissions products has grown as customers, manufacturers, and governments have become increasingly concerned about sustainability and climate change.[1] In response, companies in the materials sector such as iron, steel, and aluminum producers have made an expanding array of green-branded products available to customers. This green-branding signals to buyers that a product carries a lower reported emissions footprint than available alternatives. However, these emissions reductions are not necessarily as significant as implied. While low-emissions branding should provide consumers with information that allows them to support decarbonization through their purchasing decisions, the current structure of the green products market does not permit this. Over-reliance on green-branded products in their current state will threaten the viability of both public and private decarbonization goals for the following reasons:

- There is no consistent definition of a "green" brand, and emissions claims of competing "green" brands are not comparable;
- Product Category Rules (PCRs), which codify how to run life cycle analysis required by the Environmental Product Declarations (EPDs), do not provide enough detail or transparency to ensure public confidence in the comparability of branded claims;
- The use of certificate-based approaches is widespread and involves many risks for accountability that are poorly codified by current accounting frameworks;
- Certain green products apply specific accounting practices or target specific markets which make additionality less likely.

Drawing from an original analysis of over a dozen steel and aluminum low-carbon brands, this paper argues that while green-branded products can play a role in incentivizing and supporting the expansion of green procurement, they exist in a market that lacks the transparent, harmonized system for emissions accounting necessary to drive broad-based emissions reductions in the materials sector. The opaque and disorganized nature of green-branding strategies in their current state threatens to facilitate greenwashing and hollow out market support for the green premiums which will play a crucial role in financing the decarbonization of these industries. Policymakers should step in and develop strong GHG accounting standards for the materials sector (and beyond). In the absence of regulations imposing strong product accounting standards, iron, steel, and aluminum producers should advocate and work towards harmonized and transparent accounting of GHG footprints for all their products so that green premiums for these products can be determined independently and efficiently by the market. Further, green labels should be issued within an existing and internationally recognized framework for low-emissions product certifications in order to facilitate the development of a truly green global market. Finally, business models should evolve with producers creating opportunities for long-term offtake for specific emissions reducing technology investments and buyers adopting procurement frameworks which take responsibility for identifying and pursuing opportunities to support real sectoral decarbonization.

1 Marcelo Azevedo, Anna Moore, Caroline Van den Heuvel, and Michel Van Hoey, "Capturing the Green-Premium Value from Sustainable Materials," *McKinsey & Company*, October 28, 2022, https://www.mckinsey.com/industries/metals-and-mining/our-insights/capturing-the-green-premium-value-from-sustainable-materials.

1. Introduction

Iron, steel, and aluminum products are major sources of GHG emissions, and these emissions have traditionally been difficult to abate. As of 2020, the iron and steel and the aluminum industries accounted for 7% and 3% of global GHG emissions respectively.[2] The importance of these products in global manufacturing, greater public pressure to reduce supply chain emissions, and the outsized contribution of these products to global emissions have all driven demand for "green" iron, steel, and aluminum products which can allow purchasing companies to reduce their reported upstream scope 3 GHG emissions. For instance, McKinsey forecasts that demand for low-emissions flat steel products will exceed supply by 14 million tons in 2030 within the European market alone.[3] The resulting expected high premiums for low-emissions products have given rise to a range of green-branded iron, steel, and aluminum products which claim to help purchasing companies fulfill their climate goals.

Ideally, these products should facilitate a symbiosis between entities engaging in green procurement and producers seeking to decarbonize. Companies purchasing these products should be able to do so with the assurance that they not only carry a lower carbon footprint than alternative products with similar use cases, but that they also contribute to the overall decarbonization of the production system. Likewise, producers should be able to rely on revenues from green products to continue investing in decarbonization technologies. In this virtuous cycle, green-branding can and should serve as a key signal of information, which guarantees additionality on the side of both supply and demand.

However, this does not characterize the current green products market for iron, steel, and aluminum. No standardized definition for green or low-emissions products is in place, allowing producers to call products "green" while leaving the details in the fine print. Even products following environmental reporting protocols under frameworks intended to yield standardization and comparability, such as the GHG Protocol and ISO standards, have not yet achieved this in practice.[4] Meanwhile, as our analysis below demonstrates, ambiguities and disputes within accounting frameworks create loopholes that allow companies to follow reporting methods which provide distinct advantages to their own products. Furthermore, companies lack a framework to demonstrate that green premiums help yield additionality by supporting the higher production costs of green products. Green-branding can still serve as the informational shortcut which enables sector-wide decarbonization, but only if accounting frameworks and reporting standards are revised in order to make these products truly standardized and comparable

1.1 Defining Green and Low-emissions Brands.

Many products define themselves as green, and most of these do claim some level of emissions reduction compared to conventional products. However, there is no standardized terminology or definition in place to clarify what a "green" product is or to distinguish between different types of "green" products. For steel, the International Energy Agency (IEA) has introduced definitions for *near-zero* emissions materials which are compliant with an emissions trajectory targeting net-zero emissions by 2050. This stands in contrast with *low-emissions* materials, which the IEA would define separately in order to recognize achievements in reducing emissions compared to conventional production while emphasizing that these products are not yet aligned with a net-zero-compliant emissions scenario.[5] However, the products examined do not follow the IEA definitions. Many products examined also do not distinguish between the concepts of "green" and "low-emissions," which enables some companies to make "green" claims on the basis of factors other than their emissions footprint. For instance, Greenable, produced by the South Korean company POSCO, is marketed as a green steel product based not on its low GHG emissions, but rather on its suitability for use in wind and solar infrastructure.[6] The lack of standardized definitions and terminology in the green products space is likely to mislead buyers, hamper green procurement, and slow the ultimate decarbonization of both sectors.

One major factor contributing to this confusing lack of standardization is the proliferation of different types of environmental labels and claims. The International

2 "Iron and Steel Technology Roadmap," International Energy Agency, October 2020, https://www.iea.org/reports/iron-and-steel-technology-roadmap; "Aluminium," International Energy Agency, https://www.iea.org/fuels-and-technologies/aluminium.

3 Azevedo, Moore, Van den Heuvel, and Van Hoey, "Capturing the Green-Premium Value from Sustainable Materials."

4 John Biberman, Gyunbae Joe, and Perrine Toledano, *Harmonizing Product-Level GHG Accounting for Steel and Aluminum* (New York: Columbia Center on Sustainable Investment, June 2023), https://ccsi.columbia.edu/sites/default/files/content/docs/ccsi-steel-aluminum-harmonization.pdf.

5 IEA, *Achieving Net Zero Heavy Industry Sectors in G7 Members* (May 2022), 11, https://www.iea.org/reports/achieving-net-zero-heavy-industry-sectors-in-g7-members.

6 "Greenable, Renewable Energy Enabler," Posco Products, http://product.posco.com/homepage/product/eng/jsp/eco/s91w6000310n.jsp.

Organization for Standardization (ISO) 14020 series defines three different categories of environmental labels, as described below:

- Type I environmental labels: Governed by ISO 14024, type I refers to environmental labeling programs, or "ecolabels." Products which meet the minimum criteria set by a third-party labeler are awarded an ecolabel which can be used in marketing.
- Type II environmental labels: Type II refers to self-declared environmental claims, or claims which are not backed up by outside certifications such as an ecolabel. ISO 14021 lays down a series of practices by which producers making their own environmental claims are expected to adhere to in order to encourage a minimum level of rigor and transparency.
- Type III environmental labels: The most rigorous classification, type III labels and declarations follow ISO 14025 to draw upon life cycle inventories to provide evidence for the environmental impacts of products. The Environmental Product Declaration (EPD) is one of the most common and comprehensive forms of type III declarations.

Ecolabels have likely come under the most recent and intense scrutiny of the three types of environmental labels. Ecolabels have three major drawbacks. First, they aggregate any and all types of environmental, social, and governance (ESG) data deemed relevant by the label creator under a single, binary indicator which communicates only whether those minimum criteria have been met. For example, the steel certification organization ResponsibleSteel's standard currently includes some 13 separate principles covering areas such as corporate leadership, responsible materials sourcing, occupational health and safety, human rights, and biodiversity in addition to climate change. While the requirements of an ecolabeling scheme may be laudable, aggregating multiple different indicators together in this way provides little opportunity for transparency on how a product performs on any individual axis, such as climate. On a related note, ecolabels provide little incentive for ambition beyond meeting the minimum requirements of the ecolabel. Finally, ecolabeling has facilitated the proliferation of countless new certifications and labels, leading to criticism that ecolabels ultimately make it more difficult for consumers to understand the environmental impacts of their product choices. European Union (EU) regulators recently issued a proposal for a directive on green claims identifying the spread of these opaque claims as a problem to be addressed at the EU level.[7] The proposal is now followed by an agreement at the EU level for a ban on climate neutral claims by 2026 unless the company can prove this is accurate; in any event the claim shouldn't include offsets and should be externally certified.[8]

Self-declared environmental claims create many of the same challenges as ecolabels because producers are free to frame these claims in virtually any way they desire. Type II environmental claims are subject only to a few broad requirements: for instance, companies may not make broad claims that their products are "sustainable" or achieve "sustainability."[9] Claims relating to greenhouse gas emissions are required only to follow ISO 14067 requirements laying down general rules for calculating product carbon footprints, which do not provide the level of detail that would enable comparability.[10] While specific claims are required either to be substantiated by non-confidential data or verified by a third, independent party,[11] this verification standard does not shape how claims are framed in a way which allows consumers to make an easy comparison between them. Furthermore, while auditing and third-party verification provide affirmation that emissions data was not falsified, they provide no guarantees with respect to consistency or comparability with similar products. Therefore, emissions reporting under a type II environmental claim has no assurance of consistency or comparability with other brands on the market.

EPDs are generally considered the gold standard of environmental declarations, since they apply a life cycle analysis approach which compiles a product's environmental impact throughout the supply chain. However, EPDs are not without issues. EPDs are issued according to Product Category Rules (PCRs), which are the category-specific rules intended to ensure comparable Life Cycle Assessments (LCAs).[12] PCRs are intended to ensure standardized reporting units and accounting approaches for specific types of products in order to achieve comparability between EPDs, and are generally produced by sponsored groups of stakeholders within the

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7 Directorate-General for Environment, *Proposal for a Directive on Green Claims* (Brussels: European Commission, March 2023), https://environment.ec.europa.eu/publications/proposal-directive-green-claims_en.

8 Alice Hancock, "EU to ban 'climate neutral' claims by 2026," *The Financial Times*, September 20, 2023, https://www.ft.com/content/53f84f03-1f1c-4240-977f-9de0e4893377.

9 ISO 14021:2016, 5.

10 Ibid, 21.

11 Ibid, 8.

12 "Product Category Rules," EPD International, https://www.environdec.com/product-category-rules-pcr/the-pcr.

industry itself.[13] Yet PCRs suffer from poor design, lack of harmonization, and poor comparability, even for products in the same categories and following the same PCRs.[14] According to sustainability management expert Tom Gloria, "the current system we have to create PCRs is one that's unsustainable financially, and there is underfunding and under-participation at the root of what creates these rules." Gloria argues that since those who draft PCRs maintain no authorship rights to them, PCRs must either be developed at a loss or with funding from industry groups. Critics note that existing standards and guides provide insufficient guidance for the development of PCRs, which leads to incomparable claims, lack of transparency, a burdensome environmental claim process, and poor resulting credibility of environmental claims. For instance, the Environmental Protection Agency (EPA) notes that poor cooperation in the development of PCRs "not only results in inefficiencies in the creation of PCRs, but also leaves the environmental claims incomparable and reduces the overall credibility of the LCA-based product claims for decision making."[15]

In addition, ISO 14025 carries no strict requirements that EPDs apply the most precise source of data possible, stressing "coverage, precision, completeness, representativeness, consistency, [and] reproducibility" without imposing hard mandates on any of these.[16] This means that EPD publishers are likely to use the most easily available data, which may be averaged across a company, a region, or an entire industry, to prepare their emissions reporting. This not only limits transparency, but it also creates adverse incentives in which companies can use data to obscure emissions from particularly emissions-intensive processes while using the EPD process to claim high levels of transparency.[17] Moreover, developing EPDs is time- and resource-intensive, making many new EPDs outdated by the time they are published. Additionally, the long validity period of EPDs, typically 3-5 years,[18] disincentivizes continuous emissions reduction action.

Yet despite their shortcomings, EPDs are currently the most comprehensive reporting framework in use for communicating environmental impact, and reforms in some jurisdictions such as the Federal Buy Clean Initiative in the US holds promise for a material improvement of the system.[19] Table 1, below, indicates which of the green-branded iron, steel, and aluminum products examined have made EPDs available through the EPD libraries and publicly-available resources examined, although several manufacturers interviewed are in the process of developing EPDs for their green-branded products which have not yet been made available to the public.

13 "Product Category Rules (PCR) for Environmental Product Declarations," SCS Global Services, https://www.scsglobalservices.com/services/product-category-rules-pcr.

14 M.D.C. Gelowitz and J.J. McArthur, "Comparison of Type III Environmental Product Declarations for Construction Products: Material Sourcing and Harmonization Evaluation," *ScienceDirect* 157, no. 0959-6526 (2017): 125-133, https://www.sciencedirect.com/science/article/abs/pii/S0959652617308624; Nikolay Minkov, Laura Schneider, Annekatrin Lehmann, and Matthias Finkbeiner, "Type III Environmental Declaration Programmes and Harmonization of Product Category Rules: Status Quo and Practical Challenges," *ScienceDirect* 94, no. 0959-6526 (2015): 235-246, https://www.sciencedirect.com/science/article/abs/pii/S095965261500116X.

15 Ingwersen, W., V. Subramanian, C. Scarinci, A. Mlsna, C. Koffler, G. Assefa Wondimagegnehu, H. Imbeault-tetreault, L. Mahalle, M. Sertich, M. Costello, P. Firth, S. Fallaha, and T. Owen, *Guidance for Product Category Rule Development Version 1.0* (Cincinnati: EPA Product Category Rule Guidance Development Initiative, 2013), https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=259406&Lab=NRMRL.

16 ISO 14025:2006, 9.

17 For more on how data quality requirements shape incentives within emissions reporting, see John Biberman, Perrine Toledano, Baihui Lei, Max Lulavy, and Rohini Ram Mohan, *Conflicts Between GHG Accounting Methodologies in the Steel Industry* (New York: Columbia Center on Sustainable Investment, December 2022), https://ccsi.columbia.edu/sites/default/files/content/docs/publications/ccsi-comet-conflicts-ghg-accounting-steel-industry.pdf; John Biberman, Perrine Toledano, and Rohini Ram Mohan, *GHG Accounting Methods in the Aluminum Industry* (New York: Columbia Center on Sustainable Investment, February 2023), https://ccsi.columbia.edu/sites/default/files/content/docs/publications/ccsi-ghg-accounting-methods-aluminum.pdf.

18 "How to Get an EPD," Building Transparency, https://www.buildingtransparency.org/resources/how-get-epd/.

19 "The [US] administration will expand the reliability, transparency and verification of environmental product declarations (EPDs) including GHG emissions reporting for actual supply chain production of these materials. This will be supported by $100 million for program costs and $250 million for grants and technical assistance by the Environmental Protection Agency (EPA)." Source: The White House, "Fact Sheet: Biden-Harris Administration Announces New Buy Clean Actions to Ensure American Manufacturing Leads in the 21st Century," press release, September 15, 2022, https://www.whitehouse.gov/briefing-room/statements-releases/2022/09/15/fact-sheet-biden-harris-administration-announces-new-buy-clean-actions-to-ensure-american-manufacturing-leads-in-the-21st-century/. In particular, the EPA will aim at establishing direct, near-term EPD assistance in priority sectors, receiving stakeholder feedback on shaping EPD assistance and carbon labeling program, ensuring the development & harmonization & typology of PCR and the conformity assessment of PCRs and EPDs, and developing tools to generate product-specific, digital EPDs. Source: EPA Office of Chemical Safety, *Getting to Substantially Lower Embodied Greenhouse Gas Emission Construction Materials* (Washington, D.C. : Environmental Protection Agency, March 2023), https://www.epa.gov/system/files/documents/2023-04/March%2022%20-%20OCSPP%20IRA%20Programs%20-%20EPD%20Assistance%20-%20final_ec.pdf.

Table 1: EPDs Identified for Green-Branded Products

	Company	Product	EPD Identified from Public Library
Al	Alcoa and Rio Tinto	ELYSIS™[20]	EPD not identified
Al	Alcoa	EcoDura™	EPD not identified
Al	Alcoa	EcoLum™	EPD identified
Al	Century Aluminum	Natur-Al™	EPD not identified
Al	Century Aluminum	Natur-Al™ ZERO	EPD not identified
Al	EGA	CelestiAL	EPD not identified
Al	Hydro	CIRCAL	EPD identified
Al	Hydro	REDUXA	EPD identified
Al	Hydro	RESTORE	EPD identified
Al	Marubeni	Neutr-Al	EPD not identified
Al	Novelis	AL:sust™	EPD not identified
Al	Rio Tinto	RenewAl™	EPD not identified
Al	RUSAL	ALLOW	EPD identified
Steel	ArcelorMittal	XCarb® green steel certificates	EPD not directly applicable
Steel	ArcelorMittal	XCarb® recycled and renewably produced	EPD identified
Steel	Nippon Steel	NSCarbolex™ Neutral	EPD not directly applicable
Steel	Nucor	Econiq™	EPD not identified
Steel	Salzgitter	SALCOS® *	EPD not identified
Steel	SSAB	Fossil-free™ *	EPD identified
Steel	SSAB	Zero™ *	EPD identified
Steel	Swiss Steel Group	Green Steel	EPD not identified
Steel	Swiss Steel Group	Green Steel Climate+	EPD not identified
Steel	Tata Steel	Zeremis® Carbon Lite	EPD not directly applicable
Steel	Thyssenkrupp	bluemint® pure	EPD not directly applicable
Steel	Thyssenkrupp	bluemint® recycled	EPD not identified
Steel	Voestalpine	greentec steel	EPD not directly applicable

EPD identified

EPD not identified

EPD not directly applicable
(certificate or internal company certification)

** Not yet commercially available.*

Source: Prepared by the authors according to public information about the products examined.

20 This brand name refers to both the novel technology for aluminum production (which involves "replacing the carbon anodes used in traditional aluminum smelting with inert, proprietary materials" such that oxygen is the main byproduct) and the product produced with that technology. "The World's First Carbon-free Smelting Technology," Alcoa Corporation, https://www.alcoa.com/products/elysis.

1.2 Emissions Reduction Strategies

Beyond the differences between the emissions and other environmental claims made by green and low-emissions products, products also differ in the strategies and approaches they apply to attain these claims. For instance, a number of producers have invested in capital to reduce direct emissions from production. Sometimes these reductions are directly associated with the product line where reductions take place, while other times they are packaged and redistributed across a company's products regardless of which ones are using this improved technology. These reductions can even be packaged for sale as a type of offset under the form of a certificate, as discussed in sections 2.1 and 2.2. Beyond direct emissions, producers can also reduce their reported energy emissions either by sourcing energy directly from low-emissions sources or from applying a series of market mechanisms which allow them to purchase the environmental attributes of low-emissions energy production without consuming the physical energy produced (see section 2.4). Furthermore, producers can source recycled material to reduce their upstream carbon footprint (see section 2.3). Finally, they can simply purchase external offsets to claim that their product supports emissions reduction efforts (see section 2.4). These emissions reduction strategies are tabulated in Table 2 to illustrate the different approaches applied by the products examined.

Table 2: The Green Products Landscape in Iron, Steel, and Aluminum

		Emissions Reduction Strategy					
	Product Name	**Recycling**	**Renewable Energy**	**Bioenergy**	**Alternative Production Technologies**	**Other Process Improvements**	**Offsets**[21]
Al	Alcoa and Rio Tinto ELYSIS™				[blue]		
Al	Alcoa EcoDura™	[blue]					
Al	Alcoa EcoLum™		[blue]				
Al	Century Aluminum Natur-Al™		[blue]				
Al	Century Aluminum Natur-Al™ ZERO		[blue]				[blue]
Al	EGA CelestiAL		[blue]				
Al	Hydro CIRCAL	[blue]					
Al	Hydro REDUXA		[blue]				
Al	Hydro RESTORE	[blue]					
Al	Marubeni Neutr-Al						[blue]
Al	Novelis AL:sust™	[blue]					
Al	Rio Tinto RenewAl™		[blue]				
Al	RUSAL ALLOW		[blue]				
Steel	ArcelorMittal XCarb® green steel certificates[22]					[green]	
Steel	ArcelorMittal XCarb® recycled and renewably produced	[blue]	[blue]				
Steel	Nippon Steel NSCarbolex™ Neutral					[green]	
Steel	Nucor Econiq™						[blue]
Steel	Salzgitter SALCOS® *				[blue]		
Steel	SSAB Fossil-free™ *				[blue]		
Steel	SSAB Zero™ *	[blue]		[blue]			
Steel	Swiss Steel Group Green Steel	[blue]					
Steel	Swiss Steel Group Green Steel Climate+	[blue]	[blue]				
Steel	Tata Steel Zeremis® Carbon Lite					[green]	
Steel	Thyssenkrupp bluemint® pure					[green]	
Steel	Thyssenkrupp bluemint® recycled	[blue]					
Steel	Voestalpine greentec steel		[green]			[green]	

** Not yet commercially available.*

Certificate/Internal Carbon Bank
Emissions reductions from projects are collected and reallocated to products. Reductions may be sourced from outside a product's manufacturing chain.

Product
Embodied emissions are directly measured and traceable to the product and its manufacture.

Source: Prepared by the authors according to public information about the products examined.

21 As opposed to the other emissions reduction strategy, offsets are by definition not attached to the product and coming from outside the supply chain.
22 Future plans for bioenergy route where bio-coal replaces coal in the blast furnace. "Torero: Replacing Coal with Sustainable, Circular Carbon in our Steelmaking Processes," ArcelorMittal, https://corporate.arcelormittal.com/climate-action/decarbonisation-technologies/torero-replacing-coal-with-sustainable-circular-carbon-in-our-steelmaking-processes.

2. Key Issues

2.1 Certificates/Internal Carbon Bank

Some companies use an internal "carbon bank" approach to claim reduced product emissions. Under this approach, emissions reductions from improvements in the manufacturing process are first counted and collected, forming the carbon bank. Reductions from the bank are then either allocated directly to certain products to create "virtually decarbonized" product lines (e.g., thyssenkrupp's bluemint® pure) or sold as credits or certificates that customers can buy along with conventional products to offset their Scope 3 emissions (e.g., ArcelorMittal's XCarb® green steel certificates).[23] Generally, emissions reductions can be allocated to or sold with a product even if the reductions are sourced from outside of the product's manufacturing line, as long as the total reductions generated and reductions allocated are the same (see Figure 1). For that reason, some companies call this approach "mass balancing," referring to the balance of emissions reductions in and emissions reductions out. It is important to note that mass balancing can also refer to a technique for tracking a product's recycled content, which is related, but distinct in concept (see Appendix I).

23 Companies can sell certificates either as tons of carbon (i.e., one certificate equals one ton of CO2) or tons of product (one certificate equals one ton of product). The latter approach requires the producer to convert emissions reductions in tons of CO2 to tons of product. ArcelorMittal, for example, currently converts emissions reductions to tons of "green" steel by dividing the total emissions reductions by the average Scope 1, 2, and 3 CO2 intensity of blast furnace-based steelmaking in the EU according to the most recent EUROFER dataset, measured in 2016-17. Note that this means that the number of certificates generated is highly dependent on the assumed carbon intensity of the product. ArcelorMittal anticipates refining their method by linking this conversion factor to the cradle-to-gate LCA footprint of the products that certificates are packaged with in the future.

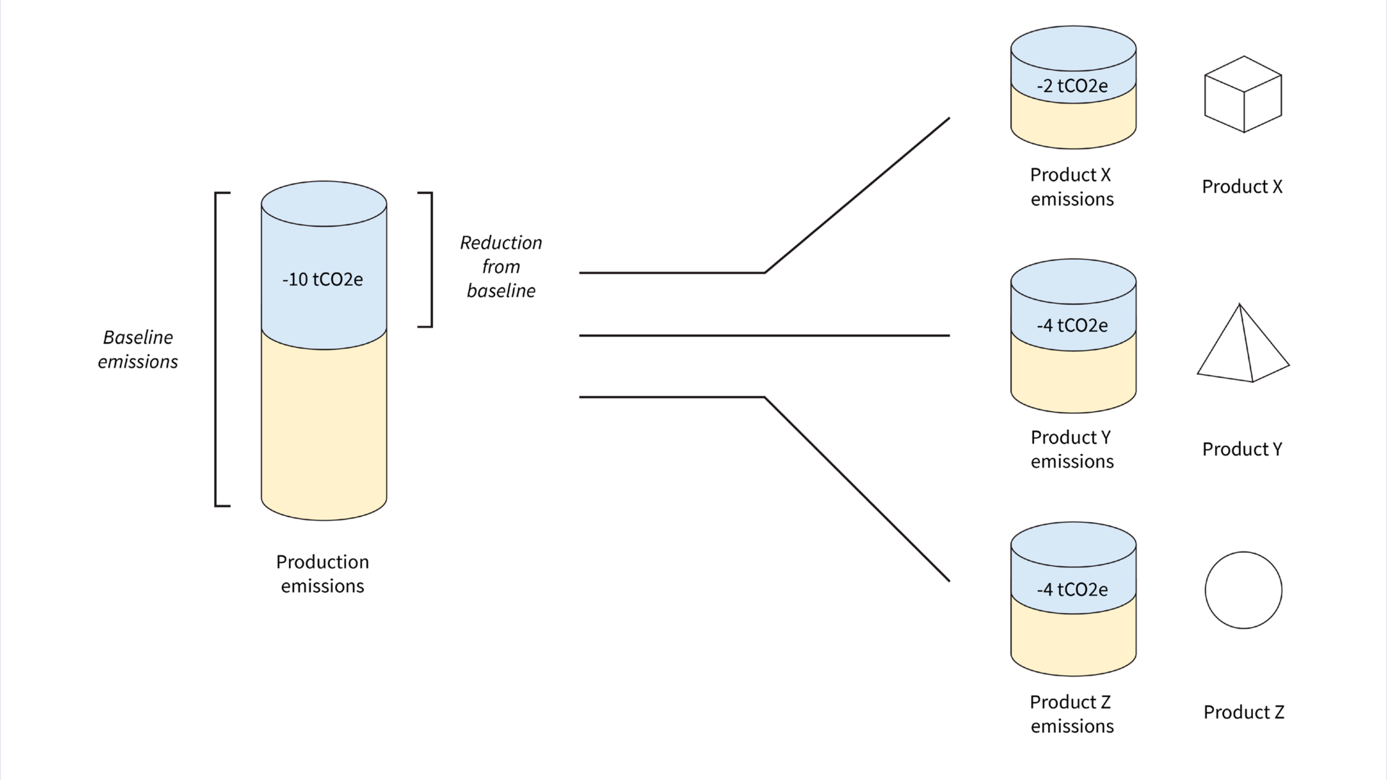

Figure 1. Internal Carbon Bank Approach.
With the internal carbon bank approach, emissions reductions from the production process are allocated to eligible products. Eligible products are not necessarily outputs of the production process from which reductions are sourced (i.e., they may be outputs of different processes).

Source: Prepared by the authors.

Based on our research, the certificate/internal carbon bank approach has generally been pursued by steel companies operating blast furnace facilities and seeking strategies to market incremental process improvements when switching to a different, less GHG-intensive production pathway is not yet feasible. The quantities of emissions reductions sold as certificates generally pale next to the overall volume of these companies' production. For example, the emissions reductions for Tata Steel Nederland's Zeremis Carbon Lite certificates are sourced from three efficiency projects at its Ijmuiden blast furnace plant. The total annualized volume of emissions reductions attributable to these projects over a time period of a year can be estimated as 17,299 tCO2e.[24] For comparison, Tata Steel Nederland's Scope 1 GHG emissions in 2021-2022 was 11.55 million tons, and the Ijmuiden plant alone is capable of producing 7,500,000 tonnes of hot/cold rolled coil per year.[25] Emissions reductions for another mass balance product, thyssenkrupp's bluemint® pure steel, are reported as an annualized 60,000 tCO2e and are allocated to around 40,000 tonnes of reduced carbon steel.[26] For comparison, thyssenkrupp's total Scope 1 and 2 emissions was nearly 22 million tons in 2021-2022 for an annual production of 11 million tonnes of crude steel.[27]

By purchasing emissions reductions as certificates alongside a steel product, it is technically possible for a customer to buy "carbon neutral" steel. However, the emissions reductions associated with certificates/internal carbon bank products in the steel industry are generally sourced from the blast furnace-basic oxygen furnace (BF-BOF) route, which, far from carbon neutral, is more emissions-intensive than alternative production pathways. Although the facilities involved have indeed reduced their emissions, the real GHG intensity of the steel produced through the BF-BOF route remains well above the intensity benchmarks defined by the IEA as compliant with sector decarbonization goals. Therefore, these certificates are at best a short-term solution for decarbonizing the sector, allowing a small number of environmentally-conscious customers to buy steel that is ostensibly low-emissions while most customers continue to buy conventional products.

Even as a short-term solution, certificate/internal carbon bank products face a few fundamental problems. One such problem is the selection of a baseline. Since certificate/internal carbon bank products rely on the allocation of emissions reductions rather than direct measurement of emissions, it is necessary to choose a baseline for carbon emissions in order to determine the amount of emissions reductions that can be attributed to a specific project. Likewise, it is important to regularly update this baseline to ensure that claimed reductions continue to be relevant to recent process improvements (see Box 1 on how ArcelorMittal manages this issue). However, choosing and maintaining a reasonable baseline is extremely difficult to do. While the GHG Protocol for Project Accounting[28] provides some guidance for selecting baseline scenarios, including recommendations for determining the temporal and regional scope of the baseline, how often it should be updated, and whether standard or project-specific data should be used, this guidance is mostly qualitative. Rather than setting strict conditions for when baselines should be updated, for example, it recommends for the valid time length of a baseline to be determined using the principles of conservativeness and justifiability.[29] In practice, a lack of specific requirements means that producers will take the path of least resistance, which could mean adopting different baselines, updating baselines infrequently, and defaulting to generic data when specific data is difficult to acquire.

24 The three projects are: 1) "Installation of a new Coke Oven Gas (COG) holder," 2) "Replacement of the motor gear sets in the cold mill," and 3) "Improved gas recovery from the Basic Oxygen Steel (BOS) plant." Annual rates are extrapolated from the DNV assurance statements, which report 5262 tCO2e in reductions from January 1, 2021 to December 31, 2021 from the COG holder project, 369 tCO2e from April 2022 to June 2022 from the motor gear project, and 10,561 tCO2e from January 1, 2021 to December 31, 2021 from the gas recovery project. DNV Business Assurance Services Netherlands, *Independent Assurance Statement* (Ijmuiden: Tata Steel Europe, July 2022), https://www.tatasteeleurope.com/sites/default/files/dnv-assurance-statement-tsn-22001.pdf; DNV Business Assurance Services Netherlands, *Independent Assurance Statement* (Ijmuiden: Tata Steel Europe, September 2022), https://www.tatasteeleurope.com/sites/default/files/dnv-assurance-statement-tsn-22002.pdf.

25 Tata Steel Nederland, *Sustainability Report 2021/2022* (Ijmuiden: Tata Steel Europe, 2022), https://www.tatasteeleurope.com/sites/default/files/tata-steel-nederland-sustainability-report-2021-2022-en.pdf; "Construction Sustainability Performance at Our Sites," Tata Steel Europe, https://www.tatasteeleurope.com/construction/sustainability/performance-at-our-sites/ijmuiden.

26 Annual rates are extrapolated from the DNV assurance statement, which reports 1447.49 tonnes CO2 reductions, or 965 tonnes of bluemint® pure steel produced over a period of 9 days from July 21, 2021 to July 30, 2021. DNV Business Assurance Services Netherlands, *Independent Limited Assurance Report* (Essen: thyssenkrupp Steel Europe AG, September 2021), https://www.thyssenkrupp-steel.com/media/content_1/produkte/klimastahl/dnv_assurance_statement.pdf.

27 *2021|2022 Annual Report* (Essen: thyssenkrupp Steel Europe AG, November 2022), https://d2zo35mdb530wx.cloudfront.net/_binary/UCPthyssenkruppAG/42a2c9fb-fd14-43b0-9edb-9a038e8db2c0/Annual-report-2021_2022-thyssenkrupp-AG.pdf#page=92; "Our Company – an Overview," thyssenkrupp Steel Europe AG, https://www.thyssenkrupp-steel.com/en/company/.

28 Suzie Greenhalgh, Derik Broekhoff, Florence Daviet, Janet Ranganathan, Mahua Acharya, Laurent Corbier, Kjell Oren,and Heidi Sundin, *The GHG Protocol for Project Accounting* (Washington, D.C. and Geneva: World Resources Institute and World Business Council for Sustainable Development, November 2005), https://ghgprotocol.org/sites/default/files/standards/ghg_project_accounting.pdf.

29 Ibid.

Box 1: ArcelorMittal's XCarb® Green Steel Certificates

While imposing a limit on the time period over which emissions reductions can be offered as certificates is necessary to ensure the relevance of claimed emissions reductions, companies may struggle to do so due to a lack of precise standards and guidance in this area. ArcelorMittal, the world's second-largest steel producer, offers several green steel products under its XCarb® "reduced, low and zero-carbon" brand, including its XCarb® green steel certificates.[30] Each certificate represents specific emissions savings from improvements in ArcelorMittal's blast furnace process, and customers can purchase these certificates to offset the upstream emissions from their purchased steel. Several production facilities participate in the program and contribute to the pool of available certificates by undertaking emissions reduction projects. To calculate emissions reduced, the company uses a project-based accounting approach that compares a baseline emissions scenario with its project activity emissions. Although it intends to do so, ArcelorMittal has not yet specified a fixed time period defining how long it will count emission reductions from its project activities. This is a challenge that the company will face in the coming months and years.

A second problem is that the certificate/internal carbon bank approach creates a particularly high risk of double-counting. For example, there could be a case where emissions reductions are sold as certificates (counted once) and then recorded as part of a product's reported carbon footprint later on (counted twice). This risk is exacerbated by the fact that standards around measuring a product's carbon footprint (e.g., standards for conducting life cycle analysis for reporting in an EPD) do not have provisions for how to handle emissions reductions that have already been sold or accounted for as certificates. Because ISO does not provide settled rules for reporting emissions reductions via certificates, this risk is currently being managed through the auditing and verification process. Auditors will struggle to manage this accurately given the challenges of determining what proportion of continuous improvements from a portfolio of interventions has taken place before or after an emissions footprint measured at one specific point in time. For now, the small share of certificates sold compared to the overall production of these companies means that this likely double-counting would have a relatively minor impact on the resulting CO_2 footprints. However, if mass-balance certificates become more popular and more are sold, the consequences of this double-counting will grow more serious.

In general, guidance around calculating and accounting for emissions reductions in the context of certificate/internal carbon bank products is lacking. While standards like GHG Product Life Cycle Accounting and Reporting Standard address the issue of allocating emissions between products and coproducts, no standards address the allocation of emissions reductions from a baseline between product lines. The drafters of the GHG Protocol recognize the challenges companies face in defining and reporting avoided emissions and recently released additional guidance on calculating avoided emissions.[31] However, companies interviewed such as ArcelorMittal stated that an ISO-certified framework for calculating emissions reductions in the context of the certificate/internal carbon bank approach would improve transparency, rigor, and ease of reporting for this increasingly common practice within the steel industry. Standards-setters must therefore be proactive about drafting and promulgating a common framework for these programs, while being mindful that they do not constitute a long-term solution for sector decarbonization.

2.2 Scrap Accounting

Recycling material that does not meet quality standards or has reached the end of its useful life has the potential

30 "XCarb®: Towards Carbon Neutral Steel," ArcelorMittal, https://corporate.arcelormittal.com/climate-action/xcarb.

31 Cecilia Valeri, Diane Buzea, César Dugast, and Antoine Crépel, *Guidance on Avoided Emissions: Helping Business Drive Innovations and Scale Solutions Toward Net Zero* (Geneva: World Business Council for Sustainable Development and Net Zero Initiative, 2022), https://www.wbcsd.org/contentwbc/download/15909/229494/1.

to substantially reduce system-wide GHG emissions because metals recycling is almost always less GHG-intensive than primary production. Incorporating scrap metal as an input to production has therefore been used as a significant strategy in both the iron and steel and the aluminum industries for reducing the reported GHG intensity of production and marketing these products as green alternatives to competitors on the market.

However, not all scrap is created equal. Metal scrap can be divided into pre-consumer and post-consumer scrap. Pre-consumer scrap is typically produced from the waste trimmings from earlier industrial processes, such as the remaining scrap from aluminum sheets after circles and rectangles have been punched out for can manufacturing. Post-consumer scrap, on the other hand, is produced from products which have reached the end of their useful life. Incorporating each type of scrap within a low-emissions branded product presents unique challenges for demonstrating the additionality of emissions reductions, which buyers genuinely interested in reducing their climate impact expect when they purchase these brands. Moreover, failure to separate pre-consumer and post-consumer scrap, both at a technical level and within the emissions accounting process, prevents the low-emissions products market from achieving the level of transparency which will reassure customers in the long term that these products merit the green premiums they command.

In both the steel and the aluminum industries, post-consumer scrap requires significant processing to achieve a level of purity, precise composition, and quality comparable with primary metals production. The nature of post-consumer recycling systems, in which metal from recycled components is unlikely to be sold back to product systems similar to the initial product, serves as a barrier to obtaining post-consumer scrap inputs whose specifications align with what a precision manufacturer would require. Removing the resulting impurities and adjusting the alloy composition to match the requirements for the new product is difficult to do completely and incurs significant costs. This increases the likelihood that the resulting materials will be downcycled compared to their initial use. Additionally, while aluminum scrap can be melted directly within the casthouse and blended with the primary metal production stream, and scrap iron and steel can be charged directly into the EAF, the BOF can only be charged with a maximum of around 25% solid iron or steel scrap content before it cools too much to operate effectively.[32] The result is that post-consumer recycled material is only likely to reach its full potential for additionality when it is capable of substituting for primary metals production in high-grade steel and aluminum markets. In this use case, a low-emissions brand can support the financing for the heavy investment in technology and capital necessary to make this possible.

In most cases, however, post-consumer recycled material is most likely to be used in low-grade materials where the tolerance for impurities is much higher. For instance, recycled steel products tend to be marketed as long products, typically destined for structural and construction applications, rather than flat products, destined for a much more widespread range of uses including precision applications. In fact, a full 93% of steel used in construction projects in the United States today is recycled.[33] In addition, post-consumer scrap obtained from a recycler is likely to be less expensive than primary metal production, given the presence of impurities.[34] This means that low-emissions branded recycled products are susceptible to carrying a significantly lower emissions footprint than competing products on the market, although those competing products may not carry the same environmental labels. In addition, scrap usage may just be motivated by cost, whereas low-emissions brands should be targeted towards financing processes that would otherwise not be cost-effective. Ultimately, the difficulty of analyzing the intersection between product quality and additionality underlines the need for a more harmonized and transparent framework to communicate product categories and emissions benchmarks.

Pre-consumer scrap is unlikely to present the same specification and purity concerns as post-consumer scrap, since product lines of origin are more readily identifiable and the material itself will not have accumulated impurities from use. Secondary producers might therefore prefer pre-consumer scrap where it is available at a similar cost to post-consumer scrap. However, consensus has not been reached in either industry regarding how the emissions footprint of pre-consumer scrap should be measured.

32 Chuan Wang, Mats Brämming, and Mikael Larsson, "Numerical Model of Scrap Blending in BOF with Simultaneous Consideration of Steel Quality, Production Cost, and Energy Use," *Steel Research International* 84.4, (2012), https://doi.org/10.1002/srin.201200185.

33 "Why Steel Recycling," American Institute of Steel Construction, https://www.aisc.org/why-steel/sustainability/recycling/.

34 Eric Lawson, "Which is Better, Extracting Metal or Recycling Scrap Metal?" *Environmental Protection Online*, May 31, 2017, https://eponline.com/articles/2017/05/31/recycling-extracting.aspx; Terry Norgate, *Metal Recycling: The Need for a Life Cycle Approach* (Canberra: Commonwealth Scientific and Industrial Research Organisation, May 2013), https://publications.csiro.au/rpr/download?pid=csiro:EP135565&dsid=DS2.

According to one secondary producer interviewed, the pre-consumer scrap remaining after a process such as aluminum can manufacturing cannot be reused without undergoing significant processing. This viewpoint, which considers pre-consumer scrap a waste product, supports a "cut-off approach" which assigns an emissions footprint of zero to pre-consumer scrap, identical to how the emissions footprint of post-consumer scrap is ordinarily treated. Since recyclers often indiscriminately mix pre-consumer and post-consumer material, applying this approach allows producers to avoid the technical challenge of attempting to distinguish between the two.

However, others contend that pre-consumer scrap must be treated differently from post-consumer scrap because it is not materially different from the primary metal it is often produced from, and because reprocessing is minimally resource-intensive compared to the cost of producing replacement material. This viewpoint considers pre-consumer scrap a useful coproduct of the original production process and requires an emissions burden to be assigned to that scrap either by allocating a share of the emissions from the original process or by determining the emissions intensity of the metals production that this scrap substitutes for when reused. Supporters of this viewpoint argue that the cut-off approach obscures fundamental differences between pre-consumer and post-consumer scrap, providing no incentive to separate them and discouraging circular reuse of end-of-life material. They further argue that post-consumer scrap has a greater consequential emissions reduction impact than pre-consumer scrap which should be reflected in emissions reporting, since post-consumer scrap not only does not rely on waste in the production process, but also is recycled from products which cannot be used any longer. Some producers, such as Hydro, have begun developing processes to track and distinguish between pre-consumer and post-consumer scrap inputs in their products to enable this separate accounting treatment (see Box 2).

Box 2: Hydro's Reporting System

For some companies selling low-emissions branded products, such as the Norwegian aluminum producer Hydro, these lagging global accounting standards are an opportunity to differentiate their product. In an environment where scrap dealers generally purchase pre-consumer and post-consumer material in bulk without a system in place for differentiating them, Hydro has invested in a process to separate and distinctly report the two. According to a Hydro representative, failure to distinguish between different forms of scrap ultimately incentivizes inefficiency in the manufacturing process, especially as most pre-consumer scrap is simpler to reprocess and reuse than post-consumer scrap. In contrast with EPDs produced by other companies, Hydro's system allows it to report the types of scrap for its products. This provides a greater assurance to consumers that emissions reductions from scrap usage are real and not just an artifact of accounting.

Regardless of what form of scrap is used, use of scrap in one product is likely to reduce the scrap available for use in other products, which further challenges the case that brands marketing their use of scrap are contributing additional emissions reductions. Neither steel nor aluminum scrap are available in sufficient supply to meet existing demand, with recycled steel inputs projected to meet at most 70% of estimated demand by 2050[35] and aluminum scrap estimated to meet only 50% of total demand.[36] This scrap supply constraint creates a zero-sum environment for producers seeking to reduce their reported emissions by using recycled materials. While the GHG footprint of an individual product may be reduced, system-wide emissions may not decrease as a result since less scrap would be available for other producers to use.

35 Rob Campbell-Davis, Alasdair Graham, Maaike Witteveen, Chathu Gamage, and Laura Hutchinson, *Net-Zero Steel Sector Transition Strategy* (Mission Possible Partnership, October 2021), 15, https://missionpossiblepartnership.org/wp-content/uploads/2021/10/MPP-Steel-Transition-Strategy-2021.pdf.

36 *IAI Material Flow Model* – 2021 Update (London: International Aluminium Institute, 2021), https://international-aluminium.org/wp-content/uploads/2021/05/IAI-Material-Flow-Model-2021-Update.pdf.

For the certifying body ResponsibleSteel, the challenge of creating emissions performance benchmarks given insufficient scrap supply is so salient that the organization elects to scale its performance benchmarks according to the percentage share of scrap inputs as illustrated in Figure 2 below in an effort to prevent companies from simply increasing their scrap usage to meet designated emissions intensity thresholds for crude steel production.

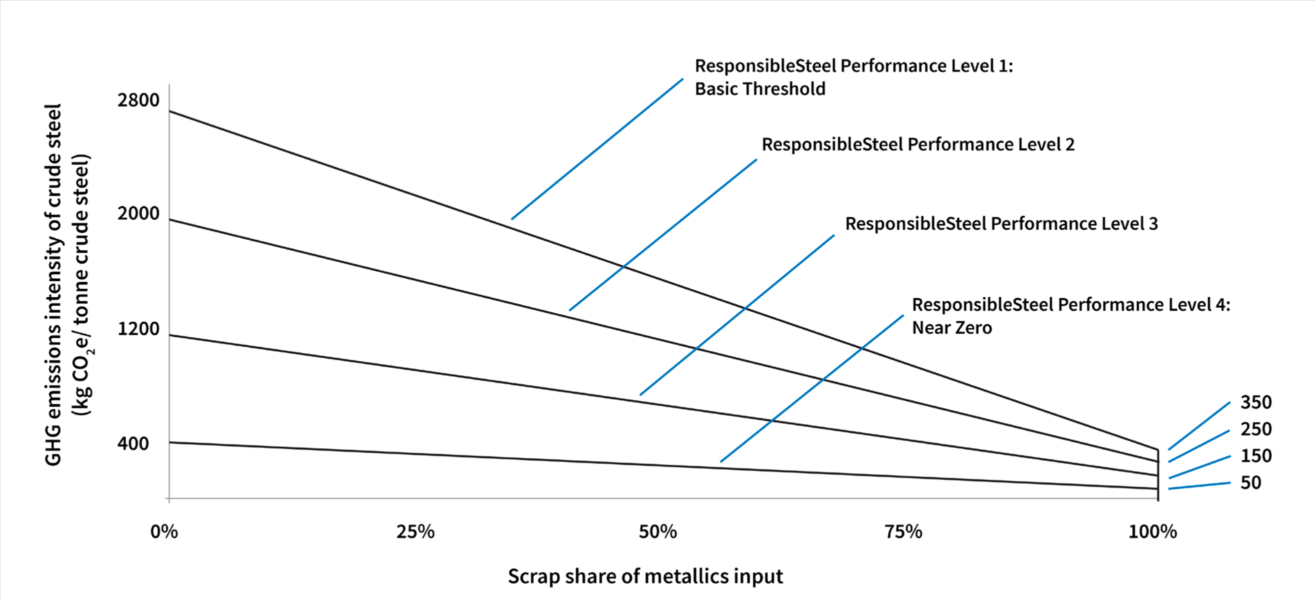

Figure 2. ResponsibleSteel Relationship Between Emissions Benchmarks and Scrap Content.

Source: Adapted from ResponsibleSteel International Standard Version 2.0, 177.

2.3 Carbon Offsets and EACs

Certain green-branded products, such as Marubeni's Neutr-Al aluminum product and Nucor's Econiq™ steel certification, use voluntary carbon offsets to reduce their emissions footprint.[37] Rather than cutting emissions in their own manufacturing processes and supply chains, companies that offer these products purchase third-party carbon offsets and "pass on" the emissions benefit of those offsets by bundling and selling them with the products. This allows Nucor, for instance, to market Econiq™ as "the world's first net-zero carbon steel at scale,"[38] even though elimination of Econiq™'s direct emissions is accomplished entirely via purchasing carbon offsets. This practice happens despite the GHG Product Life Cycle Accounting and Reporting Standard stipulating that "purchased offsets and avoided emissions shall not be deducted from the product's total inventory results, but may be reported separately."[39] As mentioned previously, the EU is now set to ban the use of offsets in environmental claims altogether from 2026 onwards.

37 From Marubeni's press release: "'Neutr-Al' is an aluminium ingot which makes neutralizes its GHG emissions from bauxite mining, alumina production, aluminium smelting, and its transportation to Japan carbon by carbon credits, which are created by GHG reduction and/or absorption activities in Japan and abroad" Marubeni Corporation, "Commencing Sales of Carbon Neutral Aluminium Ingot, "Neutr-Al," press release, August 20, 2021, https://www.marubeni.com/en/news/2021/release/00075.html; From Nucor's webpage for Econiq: "The Econiq certification can be applied to any steel product within the Nucor family. It signifies that the steel is produced with 100% renewable energy to offset Scope 2 emissions and that Scope 1 emissions are countered through the purchase of carbon offsets" "Econiq™: The World's First Net-Zero Steel," Nucor, https://nucor.com/econiq.

38 "Econiq™: The World's First Net-Zero Steel."

39 Pankaj Bhatia, Cynthia Cummis, Andrea Brown, Laura Draucker, David Rich, and Holly Land, *Product Life Cycle Accounting and Reporting Standard* (Washington, D.C.: World Resources Institute and World Business Council for Sustainable Development, September 2011), https://ghgprotocol.org/sites/default/files/standards/Product-Life-Cycle-Accounting-Reporting-Standard_041613.pdf.

Carbon offsets have faced substantial controversy over whether the emissions reductions and/or avoidance they represent are real and additional. In 2023, an investigation by the Guardian revealed that of 94.9 million offsets from rainforest protection projects approved by Verra, a leading carbon offset standard, only 5.5 million represented genuine emissions reductions.[40] A separate investigation by Bloomberg Green looked at 190 million tons of carbon offsets and found that 40% were derived from renewable energy projects that likely would have happened without the existence of offsets.[41] Green-branded products that simply repackage carbon offsets inherit these problems. Even worse, they add a layer of opacity – if a producer fails to disclose the projects that source the offsets attached to its green product offering, it makes it even more difficult for the customer to evaluate the legitimacy of the claimed emissions reductions.

Some producers also claim to reduce or eliminate the Scope 2 emissions of their products by purchasing Energy Attribute Certificates (EACs). EACs allow power consumers to purchase the rights to claim that they are consuming renewable energy, rights which are sold by renewable energy producers according to their energy production. Like offsets, EACs have been the subject of research questioning the validity and additionality of the emissions reductions they allow companies to claim. The low price of EACs combined with a short-term commitment means that purchasing an EAC does not necessarily displace electricity produced from burning fossil fuels.[42] Further, there is little evidence that the sale of EACs has led to the development of new renewable generation capacity.[43] This has led some to argue that EACs constitute nothing more than a "shifting around of existing renewable electrons"[44] with no ultimate impact on global GHG emissions. Therefore, any low-emissions brand which cites EACs as a source of lower emissions relative to its competitors must face a higher burden of proof that this claim reflects real emissions reductions, rather than a simple accounting sleight of hand. As detailed in Box 3, some companies have started steering away from the use of EACs in their low-emissions branded products, even as they continue the controversial use of offsets for direct emissions.

Box 3: Nucor and Scope 2 Emissions

While Nucor's use of voluntary offsets to counter the Scope 1 emissions of its Econiq™ product should be scrutinized, its method for countering Scope 2 emissions is more robust. Rather than purchasing EACs, Nucor participates in Virtual Power Purchase Agreements (VPPAs) with wind and solar developers.[45] VPPAs are long-term contracts with developers to purchase power from specific renewable energy projects, which in theory encourages additional renewable development because "the long-term power price derisks new projects and allows access to project finance."[46]

40 Patrick Greenfield, "Revealed: More Than 90% of Rainforest Carbon Offsets by Biggest Certifier are Worthless, Analysis Shows," *The Guardian*, January 18, 2023, https://www.theguardian.com/environment/2023/jan/18/revealed-forest-carbon-offsets-biggest-provider-worthless-verra-aoe.

41 Akshat Rathi, Natasha White, and Demetrios Pogkas, "Junk Carbon Offsets Are What Make These Big Companies 'Carbon Neutral,'" *Bloomberg*, November 21, 2022, https://www.bloomberg.com/graphics/2022-carbon-offsets-renewable-energy/#xj4y7vzkg.

42 Gautam Naik, "Problematic Corporate Purchases of Clean Energy Credits Threaten Net Zero Goals," *S&P Global*, May 5, 2021, https://www.spglobal.com/esg/insights/problematic-corporate-purchases-of-clean-energy-credits-threaten-net-zero-goals.

43 Anders Bjørn, Shannon M. Lloyd, Matthew Brander, and H. Damon Matthews, "Renewable Energy Certificates Threaten the Integrity of Corporate Science-Based Targets," *Nature Climate Change* 12, (2022): 539-546, https://www.nature.com/articles/s41558-022-01379-5.

44 Ben Elgin and Sinduha Rangarajan, "What Really Happens When Emissions Vanish," *Bloomberg Green*,October 31, 2022, https://www.bloomberg.com/news/features/2022-11-01/intel-p-g-cisco-among-major-companies-exaggerating-climate-progress.

45 "Learn More About Nucor's Virtual Power Purchase Agreements," Nucor, https://nucor.com/vppa.

46 Bjørn, Lloyd, Brander, and Matthews, "Renewable Energy Certificates Threaten the Integrity of Corporate Science-Based Targets."

2.4 Financing the Green Transition

For buyers motivated to use their purchasing decisions to make a concrete impact on addressing climate change, rather than simply projecting an image of sustainability, buying a green product is not enough. The product itself must provide evidence that its purchase will lead to new decarbonization outcomes that would not have otherwise taken place. Furthermore, these outcomes must have a defined role within the long-term decarbonization trajectory of the sector to ensure that green product purchases continue to help keep the industry on track to achieve its climate goals.

The first element of this challenge involves transparency around what green product purchases finance. Under traditional financial accounting practices, this can be challenging. As one ArcelorMittal representative puts it, "companies do not have a 'green' profit and loss account and a 'non-green' profit and loss account." Yet this transparency is important for gaining the confidence of these motivated customers, especially if the revenue stream from the product is decoupled from a production site which needs this finance to support future emissions reductions. Some companies have worked to draw this link more explicitly. For instance, ArcelorMittal has implemented a system whereby revenues are now reallocated to the specific blast furnace facilities that generated the emissions reductions for its XCarb® certificates,[47] although it remains that the certificates are not transparently associated with the revenues they support.

Motivated customers are mindful not only of whether green products finance emissions reduction projects, but also what kinds of emissions reduction projects are financed. For instance, if revenues from certificates are returned solely to the BF-BOF facilities that generated them, then path dependency on the BF-BOF route will increase and these facilities will be incentivized to oppose any updates to baselines which would force them to consider shifting their production route. At the same time, providing finance for facilities expected to continue operating far into the future to make what incremental improvements they can plays an important role in the short-term reductions that also play a role in decarbonization planning. Customers should have the autonomy to determine which aspect of the sector's decarbonization their purchases go to support. Furthermore, "green" commodity producers could borrow from the PPA (direct) and VPPA (indirect) approach used in renewable energy projects to allow customers to support long-term offtake agreements of specific projects. The green premium would then be linked to what its revenue was financing ahead of the project, enabling capital to flow transparently to its target projects.

For companies, this means detailing how revenues are distributed and with what purpose, whether for short-term improvements, scaling new technologies to commercial viability, or long-term research and development.

47 Interview with ArcelorMittal, May 2023.

Towards a Transparent and Cohesive Green Market

Low-emissions branded steel and aluminum products hold great potential to contribute to the decarbonization of the manufacturing sector by serving as critical communications shorthand for the information businesses need in order to engage in more effective green procurement. Green products that succeed in the market can develop into potent sources of funding for producers to continue decarbonizing in order to make their products even more competitive. However, shortcomings in the green products market are preventing this virtuous circle from developing. Fortunately, these challenges and the pathways to resolving them are clear.

First, frameworks must be implemented to communicate exactly what terminology "green" and "low-emissions" products are permitted to use. The lack of definition around these terms facilitates greenwashing, intentional and unintentional, by allowing companies to use them regardless of whether or not their product's emissions intensity is in line with Paris-aligned emissions scenarios, or even whether or not their emissions are substantially lower than those of comparable products. The IEA has developed a framework which does support both comparability and achievement of broader climate goals by tying its proposed emissions benchmarks to the Paris Agreement. Attempts by labeling organizations such as ResponsibleSteel to build their own tiered emissions benchmarks referencing this IEA effort are laudable, but lack the coordination with crucial institutions such as governments that would ultimately allow for comparability across the sector. Close coordination between the IEA or similar organizations, industry stakeholder groups from both the producer and buyer sides, and governments will need to take place in order to arrive at a universal and regulated set of definitions for green products, low-emissions products, and net-zero products that accurately and succinctly relays the characteristics of specific brands to potential consumers.

Second, the standards underlying environmental reporting for steel and aluminum products have not kept up with complex and rapidly changing industries. PCRs, which are intended to divide products on the market into easily comparable buckets using standardized accounting practices, are failing both at ensuring like is compared with like and at providing clear enough accounting guidance to eliminate the ambiguities and loopholes that harm comparability. For steel and aluminum products, accounting for emissions from scrap is the clearest demonstration of the shortcomings of existing PCRs. Likewise, standards-setting committees have not yet published adequate guidance on issuing certificates in a comparable and sound manner. The best way to draft better PCRs is to revamp the PCR drafting process so that rules are developed not on an ad-hoc, sponsored basis, but with the continuous and ongoing involvement of professionals experienced in rulemaking and design. Government involvement has taken place in the US for instance with the Product Category Rule Guidance Development Initiative under the guidance of the EPA, and is paramount to ensure robust, unbiased and harmonized standards.[48] Meanwhile, if companies are unsatisfied with the level of guidance available through existing environmental labeling frameworks, they can participate in their development through platforms such as ISO working groups. Gloria likens this to voting, noting that decisions for standards impacting entire industries are often made by smaller groups, and that "the ISO standards are far from perfect, but have highest value when there is broad participation by a diversity of stakeholders."[49]

Finally, existing environmental labeling standards do little to address the additionality which low-emissions products need to guarantee in order to gain the confidence of consumers that their purchases are supporting global decarbonization. Recycled products, for instance, often compete in market segments where they have little chance of displacing the primary metals production which is the greatest driver of emissions. The lack of additionality from the unregulated use of carbon offsets and RECs has been clearly documented. Businesses also lack credible guidance to communicate how revenues from green product sales are used, a problem when the implicit bargain between good-faith buyers and sellers in this market depends on businesses continuing to invest in decarbonization. In the absence of specific rules to create transparency, steel and aluminum producers will fall back on confidentiality concerns to keep their use of revenues from low-emissions products opaque as a matter of default business practice. However, these aspects of accountability and additionality can all be supported by ensuring businesses are continuously incentivized to invest in decarbonization. It means:

48 Ingwersen, W., V. Subramanian, C. Scarinci, A. Mlsna, C. Koffler, G. Assefa Wondimagegnehu, H. Imbeault-tetreault, L. Mahalle, M. Sertich, M. Costello, P. Firth, S. Fallaha, and T. Owen, *Guidance for Product Category Rule Development Version 1.0*. https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=NRMRL&dirEntryId=259406

49 Interview with Tom Gloria, July 2023.

- Clear accounting principles and stringent product definitions are regulated;
- Producers create opportunities for long-term offsets of specific emissions-reducing technology investments;
- Buyers adopt procurement frameworks which take responsibility for identifying and pursuing opportunities to support real sectoral decarbonization.

Appendix I – Mass Balance Techniques

Broadly speaking, "mass balance" refers to a concept whereby inputs to a system are counted and allocated to outputs, even if it is not possible to physically track the inputs through the system. Figure 3 below shows two typical examples of mass balancing. In the left diagram, input materials A and B are injected into a facility where they are mixed. Materials A and B are allocated to the output products such that both products are 50% A and 50% B. In the right diagram, A and B are injected into the same facility, but they are allocated to the output products such that one product is 100% material A and the other is 100% material B. Importantly, in both systems, it is not important where the physical molecules of A and B end up, just that the inputs and outputs remain in balance.

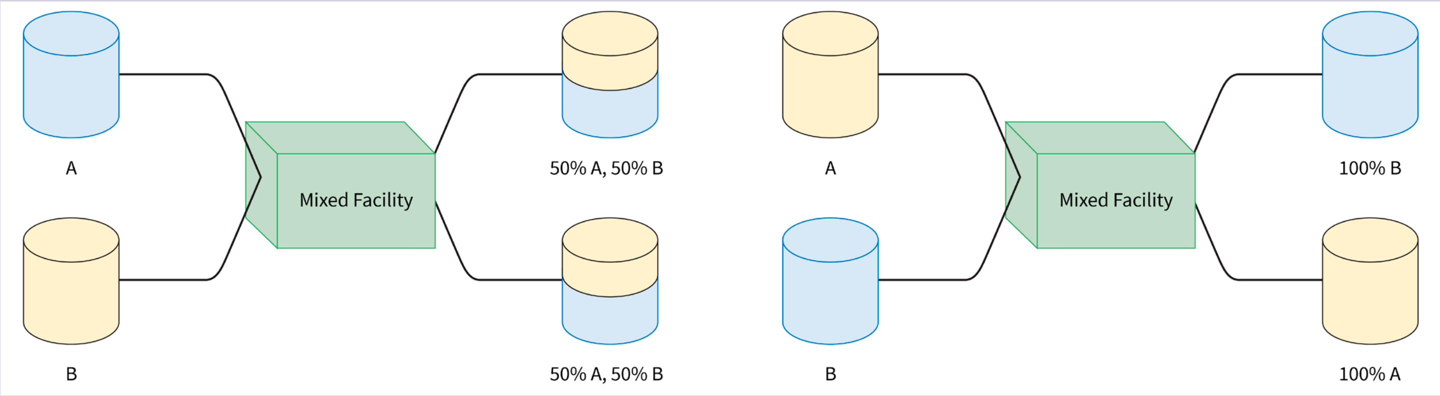

Figure 3. Two Examples of Mass Balancing.

Source: Prepared by the authors.

Mass balance is commonly used in the chemicals sector, where it is used to allocate recycled or renewable material. In this form of mass balancing, the amount of recycled/renewable material used as input must be equal to the amount of recycled/renewable material claimed in the output products. This form of mass balancing is also used in the metals industry – Aluminum Stewardship Initiative (ASI) uses it to track ASI "Chain of Custody," or certified material, as described in the ASI Chain of Custody Standard.[50] ISO is in the process of developing a global standard for mass balance in recycling.

In this paper, we refer to emissions mass balancing, whereby emissions reductions from a baseline are allocated to products according to companies' own mass balancing rules. This is similar to, but distinct from the mass balancing of recycled or renewable material described above. While the ISO is developing guidance for the mass balancing of recycled/renewable material, ISO guidance for emissions mass balancing is notably absent.

50 "ASI Chain of Custody Standard," Aluminium Stewardship Initiative, https://aluminium-stewardship.org/asi-standards/chain-of-custody-standard

COMET Coalition On Materials Emissions Transparency

COMET accelerates supply chain decarbonization by enabling producers, consumer-facing companies, investors, and policy makers to better account for greenhouse gas (GHG) emissions throughout materials supply chains, in harmony with existing GHG accounting and disclosure methods and platforms.

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