# Turning Buyer Demand into Lower-Emissions Copper Production

An initial assessment of book-and-claim for the copper sector

Report / September 2026

# Authors and Acknowledgments


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Wenjuan Liu, Hao Wu, Sravan Chalasani, Hylla Barbosa, Tim Bush, Meitheng Chow, Richard Charlesworth, Grace Lee, Ben Ellis, TJ Conway, Nemi Vora, Bogachan Gungor, and Benjamin Rizzo, *Turning Buyer Demand into Lower-Emissions Copper Production*, RMI, 2026, **https://rmi.org/resources/turning-buyer-demand-into-lower-emissions-copper-production-an-initial-assessment-of-book-and-claim-for-the-copper-sector**.




## Acknowledgment


We would like to thank the industry organizations that generously shared their perspectives and expertise through our consultation process, helping inform the development of this pilot and report. We are especially grateful to Skarn Associates Limited for their data, collaboration, and continued engagement throughout the project.

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## About RMI

Rocky Mountain Institute (RMI) is an independent, nonpartisan nonprofit founded in 1982 that transforms global energy systems through market-driven solutions to secure a prosperous, resilient, clean energy future for all. In collaboration with businesses, policymakers, funders, communities, and other partners, RMI drives investment to scale clean energy solutions, reduce energy waste, and boost access to affordable clean energy in ways that enhance security, strengthen the economy, and improve people's livelihoods. RMI is active in over 50 countries.

# Executive Summary

## The opportunity explored: whether a book-and-claim (B&C) mechanism could create a credible demand signal that reaches the mine

Copper enables electrification, digital infrastructure, and the energy transition. However, the greenhouse gas (GHG) emissions associated with copper at different stages across the supply chain are difficult for end-users to influence: copper is mined, blended, and traded through many tiers before it reaches a cable, busbar, printed circuit board, or battery cell. Manufacturers of those products have very limited opportunity to source lower-carbon copper components, and a premium paid downstream is often diluted before reaching the upstream producer.

This is increasingly becoming a strategic procurement challenge. The International Energy Agency expects copper demand from low-carbon energy applications (like solar and wind generation, associated electrical transmission and distribution infrastructure, and electric vehicles) to grow substantially, while the International Copper Association projects total copper demand doubling by 2050: from roughly 25 million tons in 2020 to about 50 million tons by 2050.[1] This increasing need for copper comes at the same time that copper mines face declining ore grades and are focused on reducing their own GHG emissions.[2]

## How a Book & Claim mechanism could help close this gap

Buyers motivated to reduce the embodied GHG emissions of copper in their supply chain do have some ability to influence where larger, simpler copper components get sourced from. However, it becomes far more difficult as copper is dispersed across smaller, more complex components and multiple supplier tiers. Under a B&C mechanism, a verified producer would "book" the GHG emissions–related environmental attributes (EACs) of eligible lower-emissions copper. A buyer would purchase and retire ("claim") those attributes against eligible copper in its own inventory. A B&C system registry prevents duplicate issuance and use of the attributes — while physical copper, with those environmental attributes removed, continues through its normal channels.

## The pilot transaction and what it demonstrates

Copper is produced through two major routes globally: a pyrometallurgical route, in which copper ore is processed into concentrate for subsequent smelting and refining — and a solvent extraction and electrowinning (SX-EW) route, in which copper is extracted from ore and directly recovered as refined cathode at the mine site. The bilateral B&C pilot transaction described in this report involved verified GHG emissions–related attributes associated with copper concentrate and SX-EW route copper cathode produced by Escondida, a BHP-operated mining operation in Chile,[i] and Amazon Web Services as the EAC buyer.

The pilot provided an opportunity to explore the potential value and certain aspects of using B&C to connect downstream demand with lower-emissions copper production. It tested how core rules — including eligibility, issuance, transfer, retirement, claims, and reporting — can be applied to the exchange of EACs

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i Minera Escondida Limitada is owned by its joint venture participants.

between a seller and a buyer. The pilot transaction provides a practical starting point to consider how an industry-wide system could operate, while highlighting the need for further industry testing to assess broader applicability, potential for scale-up, and governance requirements.

## What remains to be built and a call to action

The pilot does not establish a final industry-wide system or demonstrate scalability, sustained buyer demand, willingness to pay, or the level of investment that an industry-wide system could ultimately mobilize. Further work is also needed to support aligning with relevant accounting, reporting, assurance, and claims expectations. This pilot is not intended to establish the B&C mechanism as the only or necessarily preferred approach, and participants remain responsible for ensuring that B&C claims comply with applicable laws and regulations. Further industry collaboration among copper producers, downstream buyers, standards bodies, industry associations, and other stakeholders is needed to align approaches to upstream value chain emissions measurement and allocation; refine eligibility thresholds and emissions baselining methods; clarify claiming practices; ensure that EACs support meaningful interventions; and establish enduring registry, assurance, certification, and governance arrangements.

RMI invites industry leaders across the copper value chain to help shape and scale a credible B&C system through targeted pilots, market infrastructure, and coordinated action. To explore collaboration opportunities, please contact Wenjuan Liu at **wliu@rmi.org** and Hylla Barbosa at **hbarbosa@rmi.org**.

# Purpose of This Report

This report shares the outcomes and observations from a limited bilateral pilot exploring the application of a book-and-claim mechanism to copper. It is intended to stimulate industry discussion, highlight key design considerations, and identify areas requiring further collaboration and testing. The report does not propose or endorse a final market framework or industry standard; rather, it serves as a discussion document to support the ongoing consideration and testing of potential approaches for connecting buyer demand with lower greenhouse gas emissions (GHG) copper production. The design choices and observations described in this paper are specific to the pilot and should not be understood as representing a position or commitment of any participant regarding future transactions, investments, accounting approaches, or market frameworks.

## An important notice

This report is provided for informational and discussion purposes only. It reflects the outcomes of a limited pilot and does not establish, endorse, or approve a final B&C framework, market standard, methodology, or claims protocol for copper or environmental attribute certificates. Nothing in this report creates any contractual commitment, representation, warranty, or obligation for any participant, nor should it be interpreted as a commitment to enter into future transactions, make investments, adopt any system, or support any standard.

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Any statements regarding lower-emissions copper, environmental attributes, GHG emissions accounting, additionality, emissions reductions, or EAC-related claims are subject to applicable laws, reporting standards, assurance requirements, registry rules, and approved claims guidance. No representation or warranty is made that any methodology, certificate, accounting treatment, or claim described in this report will be accepted by regulators, auditors, standard setters, customers, or other third parties.

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# Copper Production and Decarbonization Opportunities

*BHP photo*

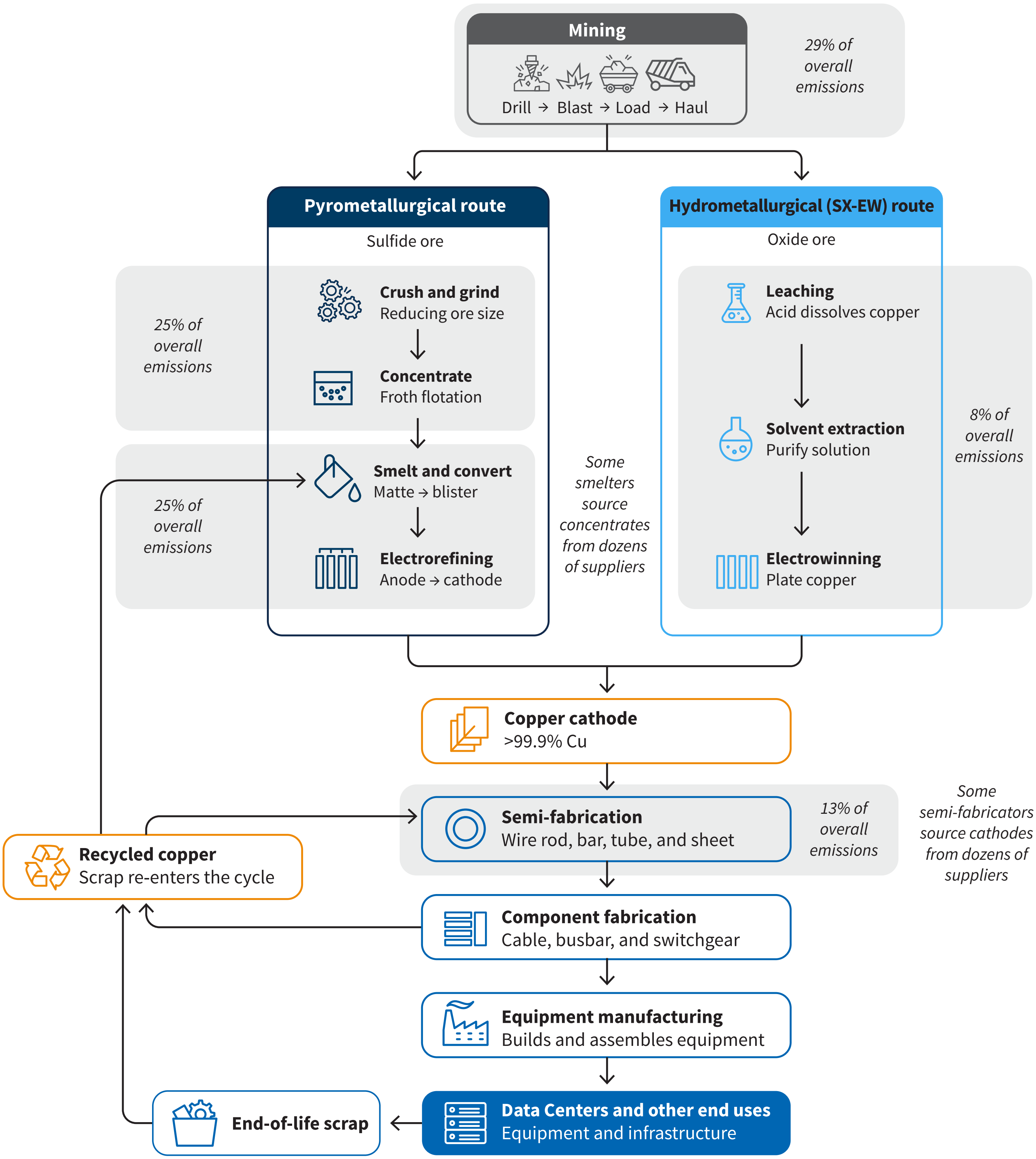
## The long and complex supply chain

Copper is embedded in nearly every part of modern life—from the electricity that powers homes and data centers to the vehicles, electronics, and infrastructure people rely on every day. Its supply chain, however, is global, complex, and largely invisible to end users.

Approximately 70% of the world's copper is produced from mined ore through one of two routes, largely determined by ore type (see Exhibit 1). The pyrometallurgical route, used mainly for sulfide ores, crushes and concentrates ore into a product containing approximately 20%–30% copper, which is then smelted and refined — often off-site — into cathode of more than 99.9% purity. The hydrometallurgical route — more commonly known as the SX-EW route — is typically used for oxide ores and certain lower-grade sulfide ores, dissolves copper through leaching, purifies it through solvent extraction ('SX'), and produces cathode through electrowinning ('EW'). Both routes yield electrical-grade cathode suitable for downstream fabrication, but they involve different processes, intermediate products, and greenhouse gas (GHG) emissions profiles.

Moreover, a single mining complex may process both sulfide and oxide ores through parallel facilities supported by shared mining infrastructure. The oxide ore is processed on-site to produce cathodes through the SX-EW route, while sulfide ore is typically concentrated and shipped to an external smelter and refinery. However, SX-EW production is geographically constrained because suitable oxide ore resources are unevenly distributed and represent a smaller share of global copper resources than sulfide ores. As a result, the SX-EW route is responsible for only 16% of the global total cathode production, with the remainder coming from the pyrometallurgical route.[3]

## Exhibit 1 Simplified copper production routes and the downstream journey




Note: Graphic is illustrative only; individual operations and GHG emissions intensities may vary. Percentages indicated are the approximate proportion of overall copper sector emissions.

RMI Graphic. Source: Emissions data from International Copper Association *Pathway to Net Zero 2023* report

## Copper emissions in a nutshell

The GHG emissions profile of copper production varies substantially depending on a list of factors including production route, location, ore grade, energy source, coproducts and by-products, technology configuration, embodied emissions of input materials and chemicals, proportion of recycled content, and accounting methodology.

In the pyrometallurgical route, mining and concentration are significant emissions sources because of the low head grade (e.g., 0.5%–1.5% copper), meaning a large volume of rock must be extracted (using explosives with embodied emissions), hauled, crushed, and finely ground for each ton of contained copper produced. Comminution (crushing and grinding) is particularly electricity-intensive, and mobile mining equipment (including different classes of haul trucks, excavators, loaders, and drilling equipment) remains dependent on diesel at many operations. Smelting adds emissions from the use of fossil fuels (to generate high-temperature heat) and carbon-based reductants (used to remove oxygen), and the embodied emissions from lime (used as flux). Electricity usage for electrolytic refining also contributes to emissions.

The SX-EW route is more electricity- and reagent-intensive: electrowinning requires substantially more electricity than the pyrometallurgical route's electrorefining process, while sulfuric acid production can add upstream emissions. With low-carbon electricity, this route can achieve comparatively lower emissions and offer a direct decarbonization pathway, but it is not inherently low carbon — performance also depends on acid sourcing and ore grade. Its potential is further constrained by the availability of technically and economically leachable ores.

Recycled copper used across smelting, anode casting, and the melting and casting stages of semi-fabrication can materially reduce sectoral emissions. However, even under a high-scrap-supply scenario with maximized end-of-life collection and recovery, recycled copper is expected to meet only 46% of final copper demand by 2050, leaving substantial demand dependent on primary ore-based production.[4] Regional constraints on scrap availability further reinforce the need to decarbonize primary copper production.

Mine-site activities, including mining, concentration, and SX-EW route cathode production, contribute to more than 60% of the overall mine-to-semi-fabrication copper sector emissions, making it a priority for copper sector decarbonization.[5]

Across both the SX-EW and pyrometallurgical routes, the major shared decarbonization priorities are the sourcing of electricity, and the minimization of fossil fuels in haul truck movement and loading. Their relative significance will depend on the emissions profile, operating context, and available technologies of each operation. The International Finance Corporation's net-zero roadmap suggested that decarbonizing electricity used at the mine site could reduce the mine-to-cathode emissions intensity by approximately 41% in the near-term, while longer-term goals like zero-emissions haulage (such as by battery-electric haul trucks) could contribute to a 17% reduction, and an additional 15% reduction could come from renewable electricity procurement at the smelter and refinery.[6,ii]

**ii** Industry-level estimates cited are illustrative and should not be interpreted as estimates of the reduction potential, pathway, or commitments of Minera Escondida or any other individual operation.

Further measures — including zero-carbon explosives, reagents, and fuels; electrified or renewable process heat; energy efficiency; improved comminution and ore sorting; optimized material movement; and lower-emissions concentrate transport — would be needed to address the remaining emissions. **As renewable electricity is becoming more widely adopted, the marginal decarbonization challenge is shifting toward mine electrification, diesel displacement, and other interventions that depend on technologies reaching commercial maturity — then becoming economically viable and being widely adopted, supported by substantial capital investment and complex changes to operating practices.**

*BHP photo*

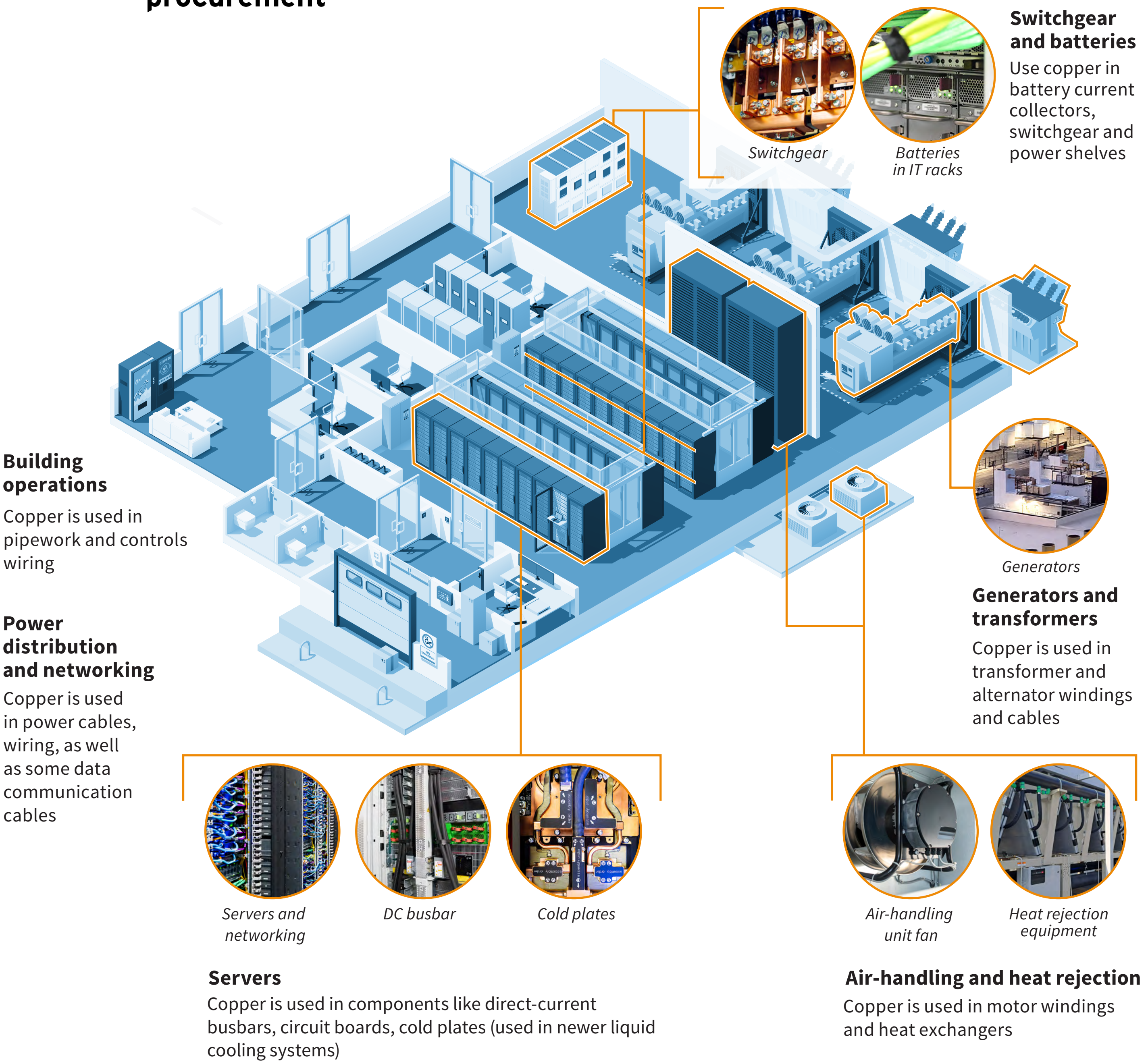
# Why Book-and-Claim Is Being Explored for Copper

Copper is essential to the electrical, digital, and thermal systems that support modern society. Its high electrical and thermal conductivity and durability make it irreplaceable in traditional end-use categories such as power generation and transmission, electric appliances, machinery, construction, and cooling systems as well as in traditional modes of transportation. Over the past decade, copper demand from the energy transition (such as solar and wind generation, associated transmission and distribution infrastructure, and electric vehicles) has increased. Significant growth in data center capacity has also contributed to an increase in copper demand.

For data centers, copper is used in a variety of applications, including electrical cables, utility connections, transformers, switchgear, uninterruptible power supplies, generators, busbar, busways, grounding conductors, printed circuit boards, cold plates, cooling coils, piping, pumps, and fans (see Exhibit 2). The data center developer, however, does not purchase copper cathodes directly, but procures finished products that contain copper from different original equipment manufacturers (OEMs), contractors, and specialist suppliers. Those suppliers purchase copper in different forms — including cathode, wire rod, strip, tube, foil, and fabricated components — from their own upstream suppliers. Copper demand is therefore distributed across many different equipment categories, bills of materials, supplier tiers, geographies, technical specifications, and procurement cycles. Between 2025 and 2040, copper demand from artificial intelligence and data centers is expected to increase from 1.1 to 2.5 million tons of copper per year.[7]

*AWS photo*

## Exhibit 2 Copper's dispersed use in data centers complicates low-carbon procurement




### Four reasons why a large physical low-carbon copper purchase is difficult

1. Copper is purchased inside finished equipment — not as cathode.
2. Equipment comes from multiple suppliers and procurement contracts.
3. Copper is blended and transformed across several upstream tiers.
4. The aggregate copper volume may be significant, but the end buyer rarely controls one consolidated physical purchase.

RMI Graphic. Source: RMI analysis informed by Amazon Web Services insights on data centers

Solar, wind, and EV supply chains face a similar distributed copper demand challenge. In solar projects, copper is used in panels, inverters, transformers, and electric cables; in wind projects, across turbines, transformers, switchgear, and grid connection cables; and in EVs, in internal wiring, electric motors, capacitors, and other battery pack components. These copper-containing products are typically procured through multiple tiers of equipment suppliers and contractors, leaving project developers and OEMs several steps removed from copper cathode production. At the same time, copper demand for the energy transition (including for solar and wind generation, transmission and distribution infrastructure, and EVs) is expected to keep rising from 8.6 million tonnes per year in 2025 to 15.6 million tons by 2040.[8]

In these examples, **the accumulative copper use across many individual products can be significant, but it does not translate into a handful of large copper purchases over which the end-user has direct control or sufficient influence to affect decisions.** Tracing every bit of copper across a long list of copper-containing products to specific mines is impractical — and requiring every supplier of the end-user to source copper from a small number of mines or smelters would present significant barriers with respect to factors like regional supply arrangements, pricing competition, and delivery schedules. Mass balancing across individual smelters, semi-fabricators, and manufacturers can help preserve a closer link between environmental attributes and physical material — but will still prove cumbersome when it comes to the long tail of smaller, more complex copper-containing components. It also imposes significant administrative and assurance burdens across multiple supply-chain tiers — and defined geographic and production system boundaries can prevent the connection of downstream demand with low-emissions copper production elsewhere.

Copper's deep supply chain can also dilute any sustainability premium that might exist as it passes through traders, fabricators, manufacturers, and other intermediaries. Copper with sufficiently low emissions intensity to meet buyers' expectations may be unavailable through already established supply chains, in the required geography, or within procurement-cycle time frames. As a result, relying only on physical procurement can limit the scale and speed at which demand can support upstream investment in decarbonization.

In this context it's apparent that the market would benefit from a new mechanism that aggregates buyers' fragmented demand and directs a clearer financial signal toward verified emissions reductions by producers. Book-and-claim (B&C) is one potential approach to addressing this gap, separating the environmental attribute from the physical copper and enabling buyers to support verified decarbonization without having to change existing supply chains (see Exhibit 3). Revenue from a separately contracted environmental attribute could provide an additional revenue signal to a producer and may contribute to the business case for certain decarbonization activities, depending on the scale, terms, and circumstances of the transaction.

## Exhibit 3 Limitations of physical procurement and exploration of a complementary approach

| Barrier | Consequence | The role of B&C |
|---|---|---|
| **Tiered and opaque chains** | End-users cannot reliably specify a mine or preserve attributes through blending. | A direct, traceable link between demand and verified production. |
| **Misplaced price signal** | A downstream sustainability premium can be diluted across intermediaries. | Contractable environmental attribute certificates (EACs) create a revenue stream for the lower-emissions copper producer. |
| **Scarce, uneven supply** | Production with emissions low enough to meet the buyer's expectations may not be available in their geography or product channel. | Product and geographic flexibility, while matching the buyer's copper inventory. |

RMI Graphic. Source: RMI analysis

*AWS photo*

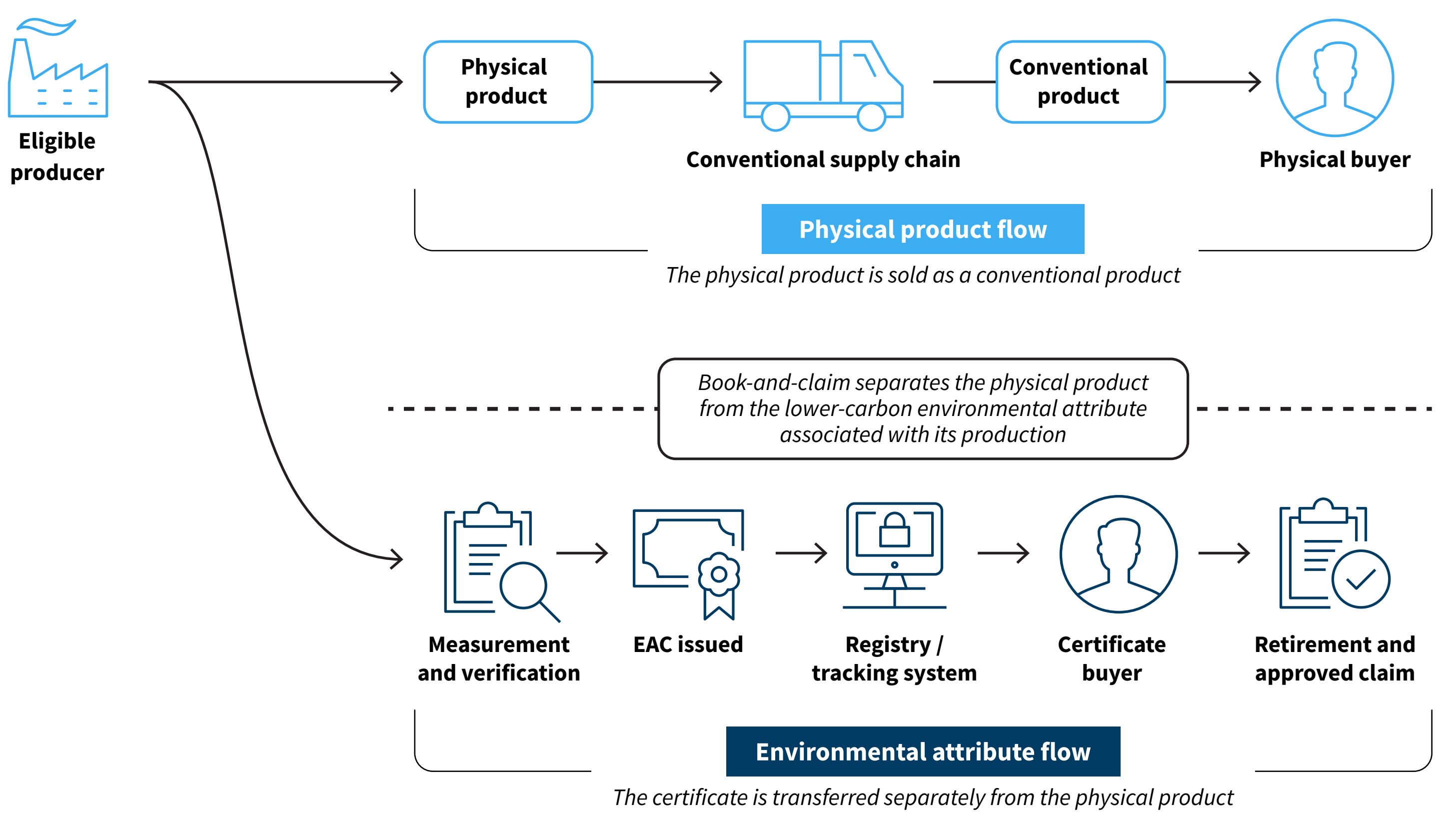
"AWS is exploring a range of approaches to support copper sector decarbonization. Data centers — and the computer hardware inside them — use a significant amount of copper overall, but it's spread across many different components, suppliers, and procurement channels. At the end of 2025 we updated our global design standards to require < 3.0 $tCO_2e/t$ copper busbar in switchgear and power distribution cabinets. But those are larger, simpler copper components. Where book-and-claim has real potential is as a complementary mechanism to reduce the embodied carbon of copper in smaller, more complex data center components."

*— Tim Bush, Principal Sustainability Engineer, Amazon Web Services*

# B&C in Plain Language

B&C is a market mechanism that separates the physical product from the lower-GHG-emissions environmental attribute associated with its production (see Exhibit 4). This approach enables buyers to support lower-emissions production even when physical traceability is difficult or supply chains are highly fragmented, and may provide a basis for certain market-based supply-chain emissions claims, subject to applicable accounting standards, reporting frameworks, assurance requirements, and claims guidance. Similar mechanisms are already used for renewable electricity (albeit with transparency/additionality questions to learn from) and are being explored for sustainable aviation fuel and marine fuels, while comparable approaches are also being considered for hard-to-abate materials including steel, cement/concrete, and chemicals.[9] In parallel, organizations such as the GHG Protocol, the Science Based Targets initiative (SBTi), and the International Organization for Standardization (ISO) are clarifying the use of EACs in corporate reporting, helping define quality criteria, reporting expectations, and safeguards that support the development of high-integrity B&C systems.[10] Although these rules are still evolving, this pilot is designed to reflect current good practice and is intended to align with these evolving requirements.

## Exhibit 4 How B&C works in both physical and virtual supply chains




RMI Graphic. Source: RMI analysis

Although the underlying concept is straightforward, designing a credible B&C system requires careful decisions and consistency with respect to how certificates are generated, managed, and used. The system must clearly define what environmental attribute is being certified, how emissions are measured and independently verified, and which production is eligible to generate certificates. It must also establish an emissions baseline and consider how to create appropriate incentives that ensure certificates represent meaningful emissions outcomes from decarbonization efforts. Finally, robust transaction rules are needed to govern certificate issuance, transfer, retirement, registry tracking, and the prevention of double counting, alongside clear guidance on the environmental claims buyers can make after certificate retirement.

*AWS photo*

# Proof of Concept: Application to Copper

In a copper B&C system, a mine or smelter producing lower-emissions copper products could separate the verified emissions attributes associated with a portion of its production. These attributes could then be issued as EACs (see Exhibit 5) and sold directly to virtual customers that face practical physical sourcing barriers, without disrupting physical supply chains.

## Exhibit 5 **Example copper EAC record in a B&C registry**

*Illustrative data, not actual results*

Cu **COPPER**
EAC REGISTRY

Record ID
**CU-CONC-IBC-2024-000184**

Export date
**2026-11-30**

### Registry Retirement Statement

This statement confirms permanent retirement of a sustainable copper environmental attribute certificate

| UNITS COUNT | INTENSITY DIFFERENTIAL | UNIT TYPE | STATUS |
|---|---|---|---|
| **1,000** | **2.222** | **CU-CONC-EAC** | **RETIRED** |
| *t contained Cu* | *$tCO_2e$/t* | *Dataset Site* | *Final* |

| BENEFICIARY, HOLDINGS & DATES | |
|---|---|
| End user beneficiary | **XYZ Global Industries Ltd.** |
| Account held with | **Supplier account - Buyer account** |
| Issuing registry account | **XYZ Registry operator** |
| Production vintage | **FY2025** |
| Issuance / retirement | **2026-09-15 / 2026-11-30** |
| Buyer claim year | **2025** |
| Production to claim window | **Within 36 months** |

| EMISSIONS PERFORMANCE & METHOD | |
|---|---|
| Actual verified intensity | **2.222 $tCO_2e$/t contained Cu** |
| Eligibility threshold | **3.333 $tCO_2e$/t contained Cu** |
| EAC baseline | **5.555 $tCO_2e$/t contained Cu** |
| Reduction versus baseline | **60.0% \| 3.333 $tCO_2e$/t** |
| Product boundary | **Mining through concentrator** |
| Functional unit | **1 t copper contained in concentrate** |
| Method / calculation | **Illustrative Method v1.0 \| life cycle GHG** |

| PRODUCTION & INTERVENTION | |
|---|---|
| Producer / facility | **AB Mining Co. / Example Copper Operation** |
| Country / product | **Country X / copper concentrate** |
| Production scale | **Surface / open-pit** |
| Equipment context (scale) | **Large-scale concentrator** |
| Intervention type | **Renewable electricity / efficiency upgrade** |
| Assurance reference | **AS-2024-118** |

Note: This exhibit illustrates the types of information a registry could record but does not depict any actual transaction term. All emissions values are illustrative and do not represent finalized baselines, thresholds, or site-level performance in the pilot.

RMI Graphic. Source: RMI analysis

To explore how a potential B&C system in the copper sector could work in practice, Amazon Web Services (AWS) and Minera Escondida Limitada (operated by BHP) entered into a bilateral agreement to undertake a pilot transaction involving lower-emissions copper EACs. This pilot used certain tentative design choices (see Exhibit 6) specific to its context and timing to explore selected aspects of a possible B&C system that might work at scale. It was intended to identify practical implementation considerations and areas that may require further industry collaboration. With Minera Escondida Limitada as the copper producer and AWS as the EAC buyer, RMI's role was both as the system facilitator responsible for developing and testing the proposed design choices and as the registry tracking the transaction process. Skarn Associates Limited contributed independent copper industry and emissions data to support the assessment of industry-wide emissions performance.

The Escondida mine, a BHP-operated copper operation in Chile and the world's largest copper mine, was selected as the operating context for the pilot because it produces both copper concentrate and SX-EW route copper cathode.[11] This allowed the pilot to explore proposed EAC design choices for two copper products within a single operating context. Escondida is one of the major electricity consumers in the region, and its electricity demand is currently covered by renewable power purchase agreements (PPAs). Certain information relating to the Escondida mine's production processes, electricity supply, and emissions profile was used solely for the limited purposes of the pilot and should not be interpreted as establishing future performance, production, emissions, or decarbonization commitments.

The Escondida operation, located in Chile's Atacama Desert approximately 160 km southeast of Antofagasta, comprises the main Escondida pit and the adjacent Norte pit and is supported by a resource base of approximately 26 billion tonnes. *BHP photo*

> **“The pilot provides valuable insight into how a book-and-claim mechanism could operate alongside existing copper markets. It helps identify the accounting, assurance, claims, and governance questions that would need further consideration before any broader application. By enabling downstream buyers to support verified lower greenhouse gas emissions production, the approach has the potential to create demand signals and support decarbonisation across the copper value chain.”**
>
> *— Ben Ellis, Vice President of Marketing Sustainability, BHP*

## Exhibit 6 **Key B&C design choices for this pilot**

| Design area | Working pilot choice | Why it was selected |
|---|---|---|
| **Functional unit:** Defines the specific product from which an EAC is generated | • For concentrate EACs: tons of copper contained in concentrate. | • Normalizes variations in copper content of concentrate (20%–30%) across production periods. Feasible for EAC buyers to match against their inventories, unlike alternatives such as copper equivalent.<br>• Reflects GHG emissions performance of concentrate production and recognizes emissions improvements at the mining and concentration stages. |
| | • For cathode EACs: tons of copper cathode. | • Represents the final refined copper product traded and consumed across downstream value chains, aligning with buyers’ procurement and functional unit commonly used in life-cycle assessments (LCAs).<br>• Recognizes GHG emissions improvements across all primary copper production routes. |
| **Emissions measurement:** Defines the accounting basis | • Cradle-to-gate emissions.<br>• Mass allocation for coproducts and by-products from mining and concentration stage. | • Aligns with the International Copper Association’s (ICA) *Carbon Footprint of Copper Production: Best Practice Guidance for Greenhouse Gas Measurements*. |
| **Eligibility threshold**: Sets the maximum emissions intensity for EAC issuance | • Concentrate: 1.20 tons of $CO_2$e/ton of copper contained plus Escondida-specific upstream Scope 3 emissions.*<br>• Cathode: 2.47 tons of $CO_2$e/ton of cathode plus Escondida-specific upstream Scope 3 emissions.* | • Represents lowest-emissions quartile of global concentrate and cathode production based on 2024 Skarn Associates data, balancing accessibility with meaningful differentiation; see Exhibit 7 for illustration. |
| **Reference emissions intensity:** Averaged across all producers in the market | • Concentrate: 2.86 tons of $CO_2$e/ton of copper contained plus Escondida-specific upstream Scope 3 emissions.*<br>• Cathode: 3.20 tons of $CO_2$e/ton of cathode plus Escondida-specific upstream Scope 3 emissions.* | • The reference intensities for concentrates and cathodes were calculated based on Skarn Associates’ 2024 global average production emissions for both products because both are globally traded commodities. Mines where copper is not the primary product or where economic and mass-based allocation results differ by more than 50% were excluded from the calculation for a better representation.<br>• A single reference intensity and threshold were calculated across SX-EW- and pyrometallurgical-produced cathodes, reflecting product fungibility. |

| Design area | Working pilot choice | Why it was selected |
|---|---|---|
| **Transaction:** Defines how EACs are issued, transferred, tracked, and retired | • EACs are issued only after eligible production has been completed, shipped, measured through asset-specific LCA, independently verified, and reviewed against pilot rules.<br>• AWS purchases and retires the EACs. Pilot transaction is recorded in a private registry that RMI administers for AWS and BHP, with the record transferred to a public registry if available in future.<br>• Physical customers are notified that the attributes have been separated and must adopt the reference intensity GHG emissions factor. | • Creates a traceable record from verified production through retirement and prevents double issuance, sale, use, and claiming while leaving existing physical supply chains unchanged. |
| **Claims and inventory accounting:** Defines how the buyer may report the retired EACs† | • Inventory accounting — substitution with adjustments: AWS reports the difference between the EAC reference intensity and verified emissions intensity under contractual/market-based accounting consistent with the AIM standard††, disclosed separately from its physical inventory. EAC use is capped at the volume of copper that can be identified and quantified in AWS's inventory.<br>• EAC retirement only enables Scope 3 corporate GHG inventory claims and does not substitute the production's actual emissions intensity into a physical product LCA. | • Aligns with emerging reporting frameworks like the AIM standard.†† A large proportion of buyer inventories likely rely on third-party Scope 3 datasets such as those provided by GaBi and Ecoinvent. These are not directly equivalent to the cathode and concentrate embodied carbon values that miners report — for methodological reasons, but also because there are intermediate steps such as semi-fabrication included in GaBi and Ecoinvent values.<br>• The pilot approach maintains separation between physical and market-based accounting and prevents buyers from claiming more low-emissions copper than they can substantiate in their inventory. |

## Key Learning

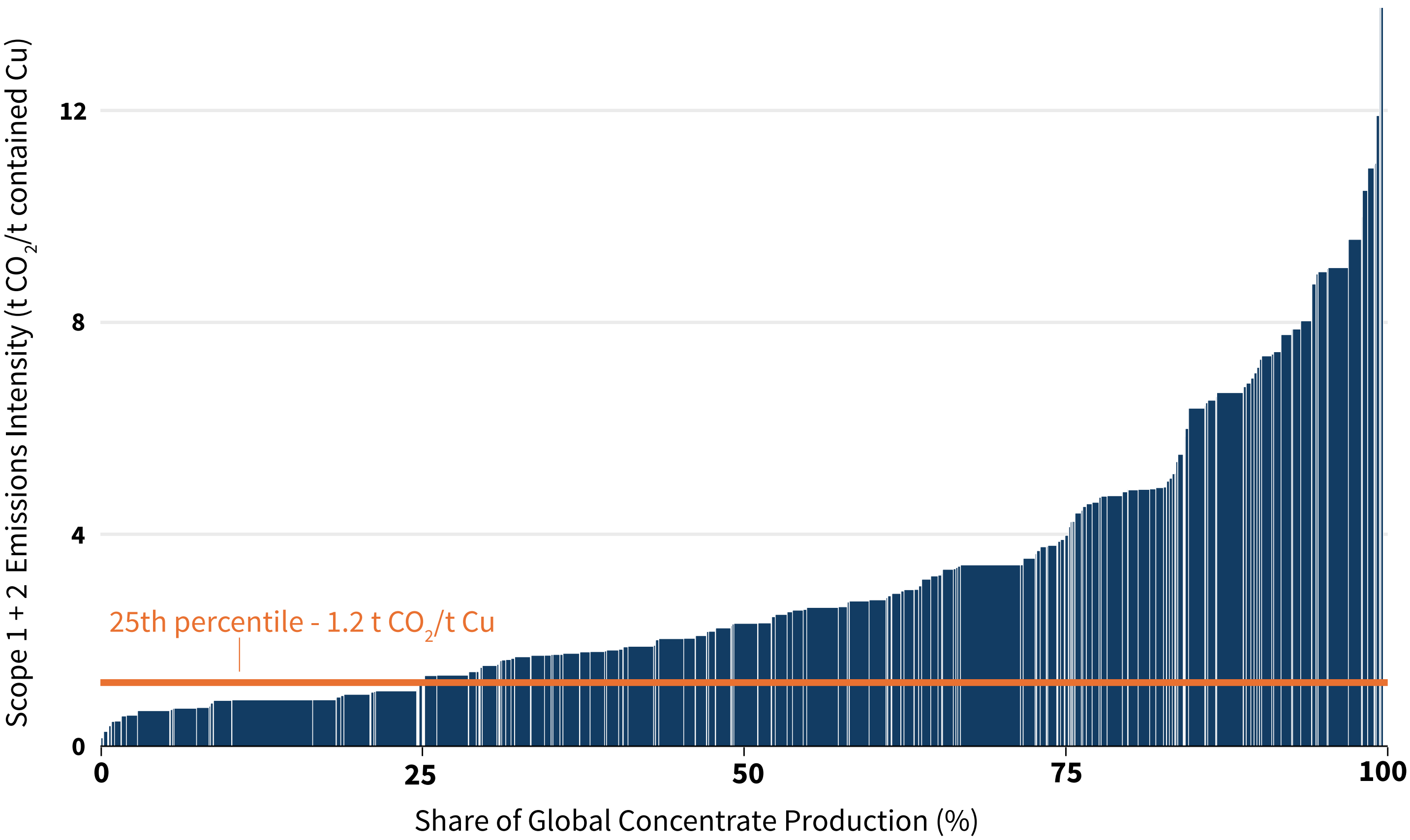
* Threshold and reference emissions intensity values were calculated using asset-level Scope 1 and 2 emissions data for the year 2024 from Skarn Associates Limited (as of July 15, 2026) and site-specific upstream Scope 3 emissions from Escondida's concentrate and cathode LCAs. These components were combined to derive cradle-to-gate emissions. This approach was used because upstream Scope 3 estimates varied substantially across Skarn Associates data, BHP's LCA, and other public sources. Before adding Escondida-specific upstream Scope 3 emissions, system boundaries were reviewed for consistency with the Skarn Associates Scope 1 and 2 dataset. In particular, the Skarn Associates data was checked to confirm that upstream emissions from electricity supply and the production of diesel, explosives, reagents, and sulfuric acid were not already included, thereby avoiding double counting.

Note: †EAC buyers are responsible for confirming that the reporting and claiming are compliant with applicable laws and regulations.

††The AIM standard here refers to the *AIM Platform Standard and Guidance* (**https://aimplatform.org/wp-content/uploads/2026/04/AIM-Platform_Standard-and-Guidance_V1.0.pdf**).

RMI Graphic. Source: RMI analysis and agreed by pilot partners

## Exhibit 7 **Copper concentrate B&C threshold and industry profile**




Note: Data represents independent third-party industry analysis and is provided for contextual purposes only.

RMI Graphic. Source: Skarn Associates Limited (data as of July 15, 2026)

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> **"Credible market mechanisms depend on clear accounting rules, strong safeguards, and practical implementation. This pilot shows how book and claim can connect downstream demand with verified lower-emissions copper production, while identifying the technical alignment, governance, and market collaboration still needed to scale."**
>
> *— TJ Conway, Principal, RMI*

# What Remains To Be Built

To better understand what would be involved in scaling a copper B&C system to the industry as a whole, RMI consulted industry stakeholders to identify key technical priorities that will require further testing and industry collaboration. RMI engaged 16 stakeholders across producers, buyers, industry associations, standards organizations, and data providers.[iii] Stakeholders broadly supported further exploration of B&C but identified different conditions needed to achieve scale. Buyers sought B&C functional units and claims that align with procurement and reporting, alongside confidence that EACs support meaningful interventions. Producers emphasized comparable accounting across diverse assets and production routes, practical implementation, and recognition of the investment required to maintain and expand lower-emissions production. Industry associations, standards organizations, and data provider stakeholders highlighted compatibility with existing standards, industry-wide impact, double-counting safeguards, and credible long-term governance. These considerations shape the priorities below.

## GHG emissions measurement

**Scope 3 alignment:** A scalable system requires consistent cradle-to-gate emissions measurement. For the pilot transaction we found that upstream Scope 3 estimates varied significantly across asset-specific LCA data, Skarn Associates data, and ICA averages. AWS, BHP and RMI concluded that there is currently too much uncertainty on data quality, boundaries, and methodological consistency for Scope 3 emissions. As an interim solution, the upstream Scope 3 emissions component of the Escondida mine concentrate and cathode LCA was added to the Scope 1 and 2 threshold and reference emissions intensity values calculated from Skarn Associates data.

For long-term system design, industry bodies, LCA practitioners, and data providers should work toward a common product category rule or equivalent methodological framework for copper to standardize accounting boundaries, allocation methods, and emissions factors for key inputs such as diesel, explosives, and sulfuric acid.

**Allocation:** The pilot used mass allocation for concentrate-related GHG emissions, consistent with ICA guidance. Beyond the concentration stage, ICA recommends different allocation methods depending on the coproducts generated. Escondida's SX-EW production does not have co-products (and therefore does not require allocation for SX-EW production–related GHG emissions), but design of an industry-wide B&C system will need broader stakeholder inputs regarding how different allocation approaches should be accommodated, or whether there should be consistent accounting and allocation rules for multimetal production across mining, smelting, and refining.

## Eligibility threshold

The pilot used the lowest-emissions quartile of global concentrate and cathode production, without differentiating between pyrometallurgical and SX-EW cathode, to balance participation with meaningful differentiation of emissions performance. Although this approach could broaden participation, it may not provide enough differentiation to incentivize deep decarbonization. Industry-wide B&C system design

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iii "Buyers" include hyperscalers, automakers, copper semi-fabricators, and energy companies.

should explore alternative approaches and test diverse production routes (e.g., pyrometallurgical-based cathode). For instance, thresholds could be informed by industry net-zero-aligned trajectories, a tiered system that rewards continuous improvement, or potentially route-specific thresholds. These approaches would require broader, methodologically consistent asset-level data across the copper industry to develop representative and comparable benchmarks.

Eligibility should also consider responsible-production credentials, drawing on frameworks such as the Copper Mark, the Organisation for Economic Co-operation and Development Due Diligence Guidance for Responsible Supply Chains of Minerals, and the International Labour Organization Just Transition Guidelines as part of qualifying criteria.[12] Such frameworks could help address labor standards, human rights due diligence, community engagement and benefit sharing, and other environmental and social safeguards alongside GHG performance.

## Emissions baseline

The pilot used global average emissions intensity to reflect internationally traded copper markets, as well as data availability. Long-term system design needs to consider whether regional or production-route-specific baselines, potentially including separate values for pyrometallurgical and SX-EW cathodes, would better represent displaced production while maintaining market comparability.

An industry-wide B&C system would also need to consider how to address other production configurations such as integrated mine-to-cathode pyrometallurgical operations, stand-alone smelters and refineries sourcing from multiple concentrate mines, and dedicated recycled copper production facilities. Beyond previously discussed considerations — such as thresholds and baselines for pyrometallurgical cathodes and emissions allocation across smelting and refining — these configurations raise additional questions about upstream emissions data uncertainty for stand-alone smelters sourcing concentrate from multiple mines, route-specific benchmarks, thresholds that account for recycled content, and consistent definitions of recycled material.

## EAC transactions and claims

A scalable copper B&C system will require robust registry infrastructure and clear rules governing certificate issuance, transfer, retirement, and co-claiming across the value chain. It will also require transparent claims guidance that defines how EACs can be used and communicated, ensuring market integrity while preventing double counting, overclaiming, and greenwashing (including compliance with various national laws). EAC transfer and co-claiming were not relevant to this bilateral pilot because EACs moved directly to one buyer for retirement. In a broader system, transfer could enable certificates to move through the market, while co-claiming could allow downstream participants at different value-chain layers to share costs and claim defined portions of the emissions benefit. Detailed rules would be needed when co-claiming and transfer occur to prevent multiple companies at the same value-chain layer from claiming the same benefit. Because their inventories represent separate product volumes, doing so would count the same benefit more than once.

# The Path Forward: Activating the Market for Lower-Emissions Copper

A copper B&C system should do more than differentiate current production — it should strengthen the business case for investments in renewable and low-carbon electricity, mine electrification, diesel displacement (such as battery-electric and trolley-assisted haulage), and other decarbonization technologies. These measures require substantial up-front capital and long investment horizons. Achieving net zero Scope 1 and 2 emissions in the copper mining industry will require significant investment between 2030 and 2050, in addition to the capital needed to expand supply to meet growing demand.[13] ICA's 2023 cost estimates exclude maintenance, supporting infrastructure, and some emerging technologies such as battery-electric fleets and green hydrogen reductants — but they highlight that the biggest investments should be directed at decarbonized electricity (73%).

Long-term decarbonization options, including increased **electrification of the mine haulage fleet,** will **require** substantial **investment in charging infrastructure,** power management systems, and **operational redesign**, even as battery-electric haulage technology reaches commercial maturity for safe, reliable, and productive deployment at scale for copper producers. Stronger buyer commitments and confidence that markets will reward the efforts to secure **verified low-emissions production** can strengthen the business case for these long-lived investments.


*BHP photo*

Interest in lower-emissions copper from downstream buyers is beginning to emerge, reflecting growing focus on Scope 3 emissions and supply-chain decarbonization. However, demand remains fragmented, willingness to pay is uncertain, and physical sourcing is constrained by complex supply chains and limited traceability. B&C can aggregate this demand and provide a mechanism through which environmental attributes may be recognized and valued by the market. EAC revenues alone may not be sufficient to wholly finance major projects, but depending on their scale and terms, could help recover incremental costs, demonstrate demand, and reduce investment uncertainty. A broader B&C system should consider to what extent (and how) it can establish transparent governance over how EAC revenues are allocated and used to support decarbonization at mines.

Moving from pilot to practice requires coordinated progress in three areas. First, market participation should expand to additional producers, buyers, and value-chain stakeholders through an industry working group and further pilots across regions, sites, and production routes. This would test buyer demand, willingness to pay, and whether EAC revenue can influence investment. Existing initiatives, such as the Copper Mark's Responsible Metals Value Chain Platform, offer opportunities to build on established networks and avoid duplicating efforts.[14] Second, a robust B&C framework should establish consistent approaches to product carbon accounting, eligibility, verification, and certification, aligned with existing standards and initiatives. Existing efforts, like the London Metal Exchange's proposed definitions of sustainable copper (embodied emissions of ≤ 4 tons of $CO_2$/ton of copper for cathode) provide a useful foundation.[15] But more dialogue among the different copper sector stakeholders is necessary to establish a robust copper B&C framework. Finally, effective governance and infrastructure are needed, including registry rules and systems, clear institutional responsibilities, double-counting safeguards, credible claims guidance, and transparent procedures for updating rules and resolving disputes.

## Join the next phase

Developing a credible B&C system for copper will require sustained collaboration across the value chain. RMI welcomes copper producers, downstream buyers, standards bodies, industry associations, civil society organizations, and other stakeholders to help shape the next phase through an industry working group, additional pilot transactions, and continued technical and market input. These efforts can refine the proposed approach into a practical mechanism that complements existing decarbonization pathways and strengthens incentives for investment in lower-emissions copper production. To explore collaboration opportunities, please contact Wenjuan Liu at **wliu@rmi.org** and Hylla Barbosa at **hbarbosa@rmi.org**.

# Glossary

**Book-and-Claim (B&C)** — A market mechanism that separates a physical product from the verified environmental attribute associated with its production, allowing buyers to support lower GHG emissions production without physically sourcing the same material.

**Book-and-Claim (B&C) system** — This term is used to describe the infrastructure required to create and transact environmental attribute certificates. This includes things like a detailed book-and-claim standard along with a registry that records EAC-related information as per the standard.

**Copper Cathode** — High-purity refined copper, typically more than 99.99% copper, produced through pyrometallurgical or hydrometallurgical (SX-EW) processing and suitable for downstream fabrication.

**Copper Concentrate** — An intermediate copper product produced by crushing, grinding, and concentrating ore, typically containing approximately 20%–30% copper.

**Cradle-to-Gate** — A GHG emissions accounting boundary covering production from extraction through the point at which the copper product leaves the production facility, before downstream processing and use.

**Emissions Intensity** — The GHG emissions associated with producing a defined quantity of copper, expressed in this paper as tons of $CO_2$ equivalent per ton of copper.

**Environmental Attribute Certificate (EAC)** — A certificate representing a verified GHG emissions–related environmental attribute associated with eligible copper production that can be issued, transferred, and retired separately from the physical copper.

**GHG** — Greenhouse gases.

**Hydrometallurgical Route** — A copper production route that uses leaching, solvent extraction, and electrowinning to produce copper cathode, primarily from oxide and certain secondary sulfide ores.

**Life-Cycle Assessment (LCA)** — A methodology for quantifying environmental impacts, including GHG emissions, across defined stages of a product's life cycle. For the pilot discussed in this paper, the LCA only considered GHG emissions.

**Lower-Emissions (or Lower-GHG-Emissions) Copper** — For the purpose of this paper, this refers to copper produced with a greenhouse gas emissions intensity below the eligibility threshold (see Exhibit 6, Page 19) defined under the book-and-claim framework.

**Mass Allocation** — An approach for allocating GHG emissions among coproducts or by-products based on their mass.

**Pyrometallurgical Route** — A copper production route primarily used for sulfide ores that involve concentration, smelting, and refining to produce copper cathode.

**Registry** — A system that records the issuance, transfer, and retirement of EACs and is intended to help mitigate the risk of duplicate issuance, use, or claims.

**Semi-fabrication —** Production of semifinished copper products like copper wire, rod, tube, sheet, plate, strip, castings, powder or other shapes.

**Solvent Extraction-Electrowinning (SX-EW)** — A copper production route that uses leaching, solvent extraction, and electrowinning to produce copper cathode, primarily from oxide and certain secondary sulfide ores.

# Endnotes


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