International Copper Association
Copper Alliance

COPPER– THE PATHWAY TO NET ZERO

Regional Focus: Latin America

Power of Zero

April 2023

Contents

EXECUTIVE SUMMARY

Copper is essential for a vast array of decarbonizing technologies. When taken together, these technologies have the potential to account for the abatement of approximately two thirds of global greenhouse gas emissions by 2050. The production of copper accounts for around 0.2 percent of worldwide greenhouse gas emissions (97 Mt in 2018, of which 35.2 Mt were generated in Latin America). The copper industry is actively working to reduce these emissions.

The members of the International Copper Association (ICA), the leading advocate for the copper industry worldwide, have committed to a goal of reaching net zero Scope 1 and 2 greenhouse gas emissions by 2050 and to actively engage with their value chain partners to bring Scope 3 emissions as close as possible to net zero by 2050. ICA members active in Latin America fully subscribe to this commitment. Furthermore, ICA members have set intermediate decarbonization ambitions at global level for the years 2030 and 2040, for Scope 1, 2 and 3 emissions, which are outlined in *Copper—The Pathway to Net Zero*. This collective engagement is the result of an in-depth, robust analysis performed by ICA and its members, based on a comprehensive set of facts and sound hypotheses.

The members of the International Copper Association (ICA), have committed to a goal of reaching net zero Scope 1 and 2 greenhouse gas emissions by 2050, and to actively engage with their value chain partners to bring Scope 3 emissions as close as possible to net zero by 2050.

This document provides a regional focus on Latin America. Based on the analysis carried out for *Copper—The Pathway to Net Zero*, it outlines the current GHG emissions of Latin American copper production and sets out the intermediate decarbonization ambitions of ICA members in Latin America for the years 2030 and 2040. It also provides an estimate of the investments needed to reach net zero GHG emissions for Scope 1 and 2 by 2050.

This decarbonization pathway must be accomplished in the context of a significant increase in expected copper demand—a global increase of 100 percent over the period from 2020 to 2050—driven by critical decarbonization technologies such as wind turbines, photovoltaic panels, heat pumps, electric vehicles and energy efficient equipment.

This *Regional Focus: Latin America* demonstrates the commitment of ICA members in Latin America to act on climate change. Copper producers in Latin America have already taken action to reduce their carbon footprint. In the coming 27 years, decarbonized electricity, alternative fuels, equipment electrification and energy efficiency have been identified as the key levers for reducing Scope 1 and 2 GHG emissions. ICA members commit to deploying these and additional decarbonizing measures in a responsible and sustainable manner, noting the increasing acceptance of The Copper Mark®, the world's leading third-party assurance framework for copper production.

ICA members are working on a mechanism to ensure transparent and regular reporting of their progress in decarbonizing copper production, through a coherent and aligned methodology for measuring carbon footprint. In addition, *Copper—The Pathway to Net Zero* and the *Regional Focus: Latin America* will be regularly updated to integrate changes in technology and external variables, e.g. decarbonization of the power grid.

Success in decarbonization depends not only on the efforts of copper producers and the value chain but also on the fulfilment of critical enabling conditions:

1. Decarbonized electricity needs to be available in sufficient quantities and at competitive prices.

2. A stable and fit-for-purpose regulatory framework that provides legal clarity and predictability need to be in place, to incentivize investments into strategic raw material value chains that are essential for achieving the Latin American governments' objective to reach carbon neutrality by 2050.

3. Decarbonization technologies such as battery electric mining vehicles and green hydrogen need to be available at scale and at affordable prices.

4. Public and private financing must be available to support innovation and the deployment of decarbonization technologies.

5. Collection rates of copper-containing products at their end of life must be improved to increase the contribution of recycling to decarbonization.

6. Access to skilled workforce has to be secured to address both the production growth and decarbonization challenges.

The International Copper Association, together with its members looks forward to actively engaging with suppliers, customers, communities and policymakers in Latin America in order to achieve the decarbonization of copper production by 2050.

INTRODUCTION

Copper is a strategic raw material for the clean energy transition. Given its widespread use in decarbonization technologies, global copper demand is expected to double in the run up to 2050. It is therefore important to ensure the availability of low-carbon, sustainable copper to meet this need.

This report (further *"Regional Focus: Latin America"*) complements *Copper—The Pathway to Net Zero*, the roadmap for decarbonizing global copper production developed by the International Copper Association (ICA) and its members. The *Regional Focus: Latin America* outlines ICA members' commitment to decarbonizing the production of copper in Latin America and presents strategies for bringing the carbon footprint of copper mining, smelting, refining and recycling in this region as close as possible to net zero by 2050. It is not intended to prescribe how to decarbonize specific copper production sites, as each asset will have its own, unique conditions that influence its alternatives to reduce greenhouse gas emissions. Rather, it analyses available decarbonization options to propose a general trajectory toward net zero emissions for the copper production industry in Latin America.

The *Regional Focus: Latin America* concludes that by 2050 it should be possible to bring the Scope 1 and 2 GHG emissions from copper production in the region to net zero and to significantly abate Scope 3 GHG emissions, provided that certain enabling conditions are fulfilled, for instance securing access to a sufficient amount of fossil-free, competitively priced electricity or establishing a stable and fit-for-purpose regulatory framework that incentivizes investments.

The methodology behind *Regional Focus: Latin America*

ICA and its members developed "*Copper—The Pathway to Net Zero*" through a pragmatic analytical approach that leverages the know-how of copper producing companies and the public data sets of industry experts like MineSpans. ICA members in Latin America represent the majority of copper production in the region and, together with ICA members active in other parts of the world, are uniquely positioned to collect and analyse data related to carbon emissions.

Developing a roadmap for the copper industry to reduce carbon emissions over the next 30 years poses a critical challenge. It requires rigorous data collection, in-depth analysis and modelling to chart potential pathways for a clean energy transition across the sector. Any forecast of the industry's capacity to reduce carbon emissions—and strategies for achieving targets—must address issues related to production, changes in technology and global trends.

ICA first assessed the current greenhouse gas (GHG) emissions of the copper industry with the support of environmental sustainability consultancy Quantis. Analysts collected emissions data from ICA members for each major step of the production process using 2018 as the baseline, as the COVID pandemic and lockdowns that followed likely skewed the figures from the subsequent years. They incorporated data on local electricity grid emission factors published by the International Energy Agency (IEA) and the model of global copper stocks and flows built by the Fraunhofer Institute to assess the 2018 carbon footprint of the copper industry. They also gathered data on Scope 3 GHG emissions from purchased goods and services, fuel- and energy related activities, transport upstream and downstream in the value chain, operational waste and end-of-life treatment of sold products, six categories that represent the bulk of Scope 3 emissions for copper producers.

The 2018 carbon footprint assessment serves as a starting point for the body of work in this report. It was characterized into an emissions profile for 14 types of production processes, which include various stages and technologies ("archetypes"—see Annex 1 of *Copper—The Pathway to Net Zero*) and cover copper mining, refining, smelting and copper recycling. The production stage "mining" for example, includes open pit mining, underground mining with room and pillar technology, underground mining with block caving and underground mining with long hole stoping.

Options were assessed to reduce GHG emissions from copper production within four abatement categories: decarbonized electricity, alternative fuels, equipment electrification and energy efficiency gains. No offsets were considered in this assessment.

The analysis considered emission abatement options for each archetype, their potential to lower emissions and their total cost of ownership (TCO) to establish the Unconstrained Marginal Abatement Cost Curve (MACC). Drawing on the Unconstrained MACC, a Constrained MACC was constructed for Latin America that considered the emission intensity of the electricity grid, the availability and long term TCO of each abatement option. This analysis established a pathway to reduce Scope 1 and 2 GHG emissions for each archetype in Latin America by identifying:

- The most effective emission abatement options
- The recommended timeline and sequences for implementing these options, with two intermediate milestones for 2030 and 2040 and a third target by 2050
- The financial investment required to reach these ambitions

The analysis estimated Scope 1 and 2 GHG emissions abatement potential through a bottom-up analysis drawing on information about copper production assets, reported mine development projects and country-by-country forecasts on the evolution of grid emission factors. By contrast, it provided a top-down analysis of Scope 3 GHG emissions that identified emission abatement options for each of the Scope 3 categories examined.

This detailed analysis served as the basis for the decarbonization pathway for the copper industry in Latin America. However, when it comes to the GHG emissions-reduction trajectories of individual ICA members, it is expected that these will vary because of the significant differences that exist e.g. in the projected decarbonization of the electricity grids in different countries. The trajectory set out in this document is therefore indicative for the industry as a whole, while individual members remain responsible for setting their own intermediate GHG emissions reduction targets toward net zero.

SECTION 1 – THE COPPER INDUSTRY IN LATIN AMERICA

COPPER IS A CRUCIAL RAW MATERIAL FOR THE ENERGY TRANSITION

Copper's superior electrical conductivity makes it an essential material for the transition to a clean energy system. The transition relies to a large extent on renewable power generation (e.g. wind, solar photovoltaic) and the electrification of energy end use (e.g. heat pumps, electric vehicles), all of which use substantial amounts of copper (see Annex 2 of *Copper—The Pathway to Net Zero*). Copper also enables a more energy efficient electricity system, triggering carbon emission savings at a negative cost in the short term and reducing the need for renewable energy generation capacity in the longer term. For a more comprehensive overview of why society needs copper and where it is used, see The World Copper Factbook 2021[1].

Copper's superior electrical conductivity makes it an essential material for the clean energy transition.

BUILDINGS & INDUSTRY
- Electrical Installations
- Appliances
- Solar Heating
- Air Conditioning
- Heating
- Water & Gas
- Motors

ELECTRICITY SYSTEM
- Renewable Generation
- Transmission & Distribution System
- Submarine & Underground Cable
- Grid Storage

TRANSPORT
- Railways (Catenary)
- Automotive Harness
- Automotive Batteries
- Electric Car Motors

MISCELLANEOUS
- Telecommunications
- Electronic Appliances
- Farming & Agriculture
- Aquaculture
- Marine Applications
- Architecture
- Interior Design

Figure 1 — Overview of Copper Uses

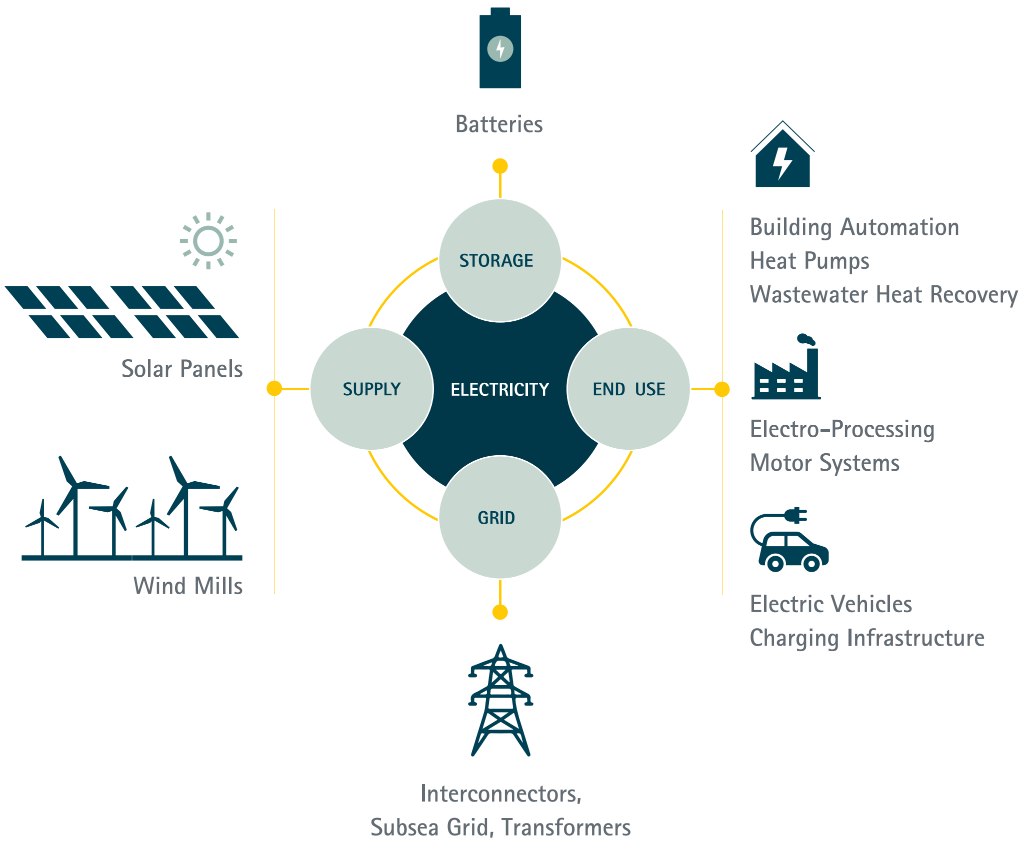


Figure 2 — Copper in the Energy Transition

COPPER DEMAND AND USAGE ACROSS REGIONS

Growth in copper demand differs greatly across regions. For the past 25 years, growth can be mainly observed in the Asian market, where demand has expanded eight-fold over the past four decades, largely driven by industrial expansion in China (source: ICSG World Copper Factbook). Although copper usage in Latin America has increased in real terms, , its share in global copper use has remained stable between 1960 and 2020 (see Figure 3).

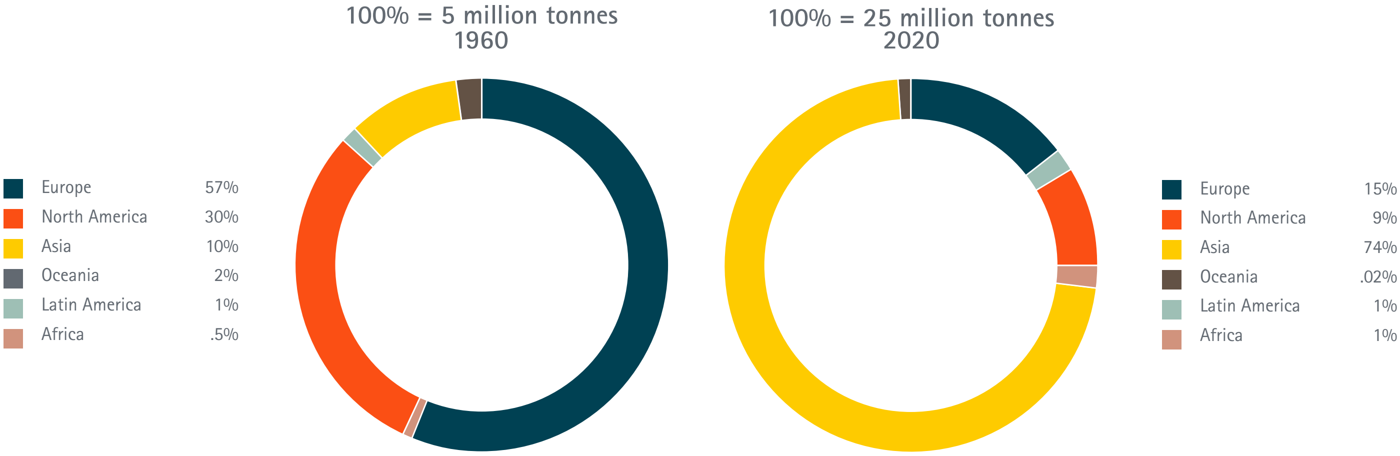


Figure 3 — Refined Copper Usage by Region, 1960 versus 2020 (Source: ICSG)

The annual global refined copper demand is expected to double by 2050 compared to 2020.

As a result of the energy transition, population growth and economic development, the annual global refined copper demand is expected to double by 2050 compared to 2020 (see Figure 4). If measures are taken to restrict global temperature rise to 1.5°C, demand for refined copper by 2050 could even increase to 57 million tonnes.

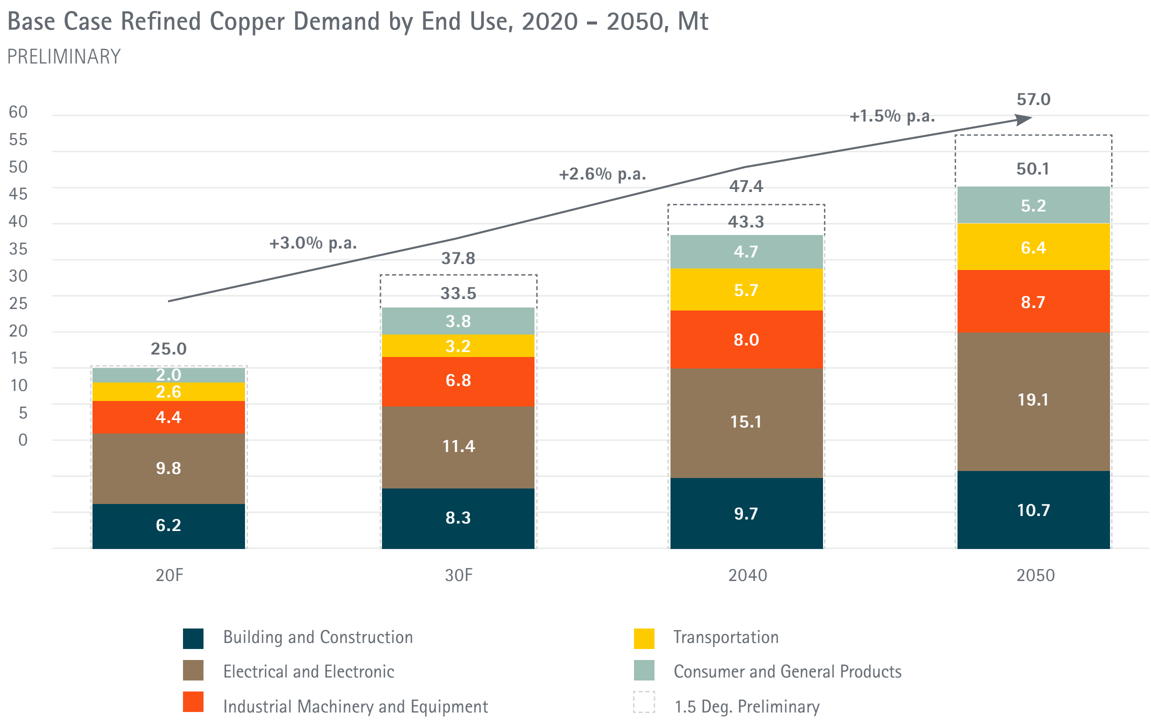


Figure 4 – The Expected Rise in Annual Global Refined Copper Demand between 2020 and 2050 (Source: MineSpans Copper Demand Model Q3 2021)

COPPER PRODUCTION IN LATIN AMERICA

Latin America plays a key role in the supply of copper to the global economy. Indeed, close to half of the worldwide volume of copper ores is mined in Chile, Peru, Brazil, Panama and Mexico. Copper is thus a major contributor to the Latin American economy and the copper industry employs approximately 260,000 people on the continent. Many more individuals are employed indirectly.

Mining

Smelting and refining

Figure 5 – Copper Mining, Smelting and Refining Production in Latin America (Source: ICSG)

LEGEND:

Mining site Smelting/refining site

Mining and Smelting/Refining site (hydro – or pyrometallurgy)

Figure 6 – ICA Members' Copper Mining, Smelting, Refining and Recycling Sites in Latin America (Source: ICSG, ICA)

THE PRODUCTION PROCESS

Production from primary sources starts with the extraction of copper-bearing ores from open-pit or underground mines. The ores typically contain between 0.25 and 1 percent of pure copper, which are then enriched into copper concentrates with a content of pure copper above 25 percent. Subsequently, two different production routes exist (pyrometallurgical and hydrometallurgical), depending on the characteristics of the raw material—sulfide or oxide ores.

Production from secondary sources is fed by copper scrap that originates either from semi-finished or finished products manufacturing waste ("new scrap"), or from copper-containing products reaching the end of their life ("old scrap"). After initial treatment, which usually includes sorting and shredding, the copper scrap enters the pyrometallurgical production process at different stages.

The three production routes to refined copper are shown in Figure 7 and more details on copper production processes can be found in Annex 3 of *Copper—The Pathway to Net Zero.*

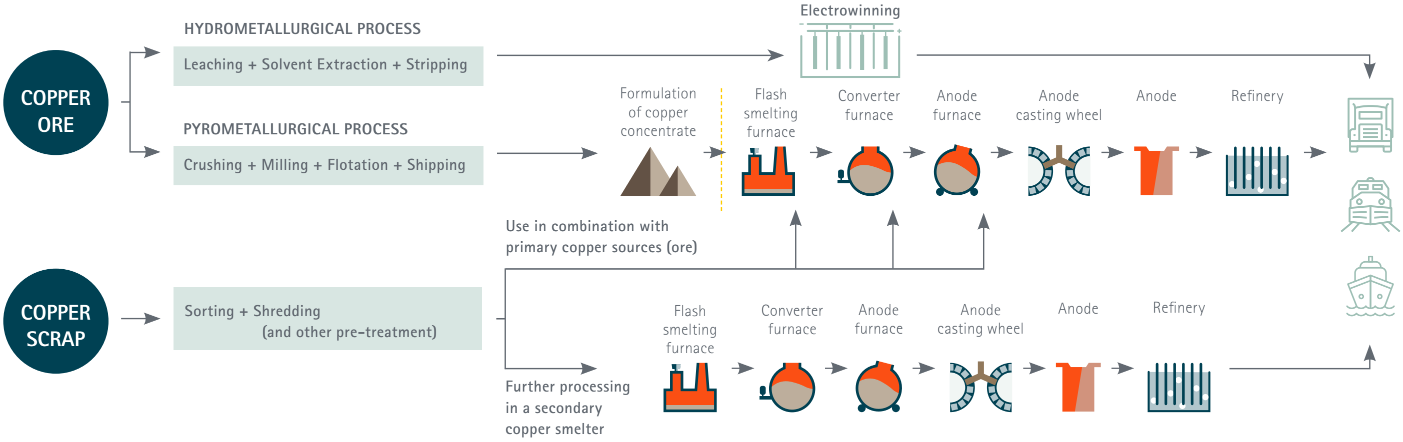
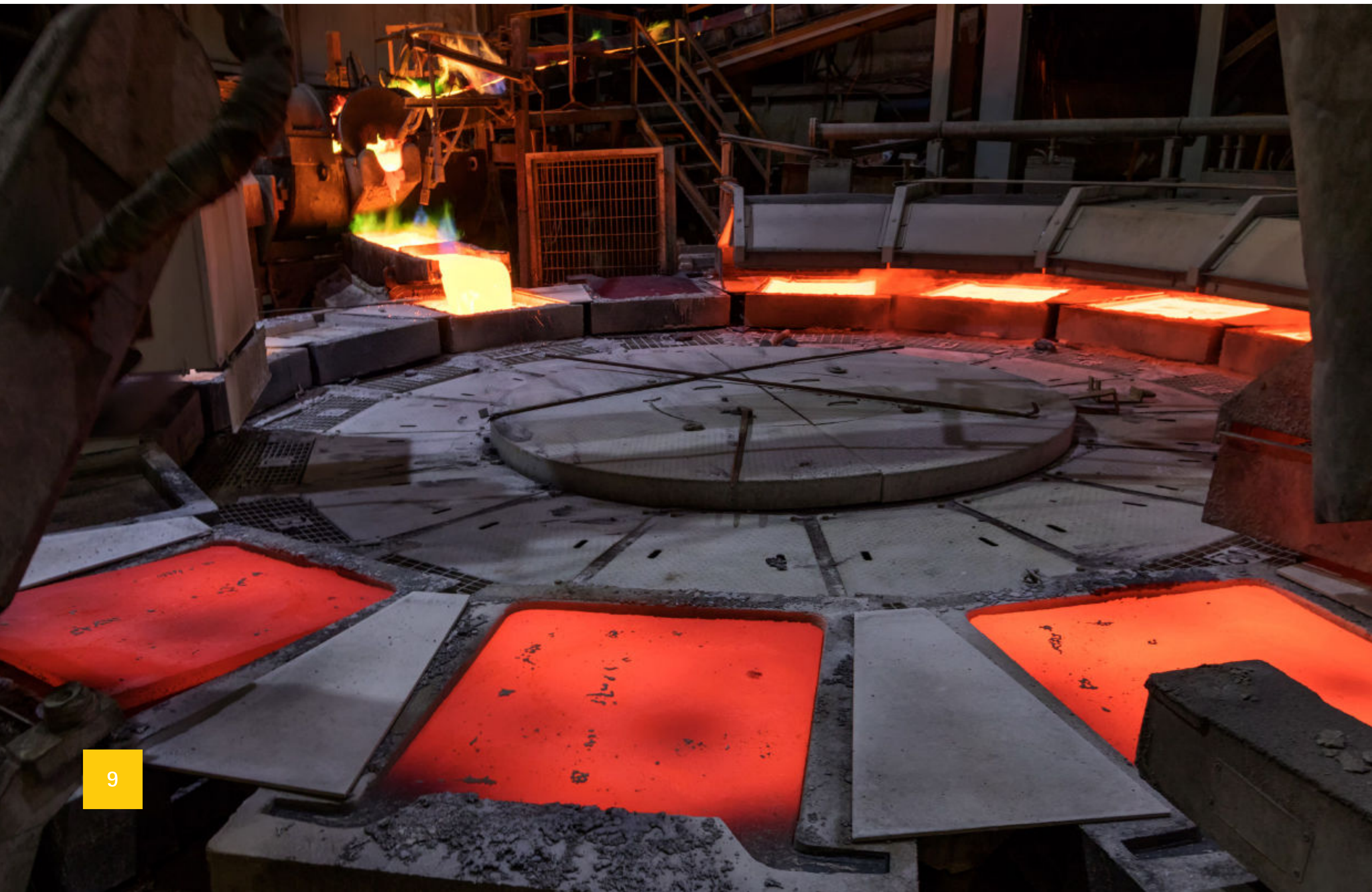


Figure 7 — The Three Production Processes of Refined Copper



CONTRIBUTION TO RESOURCE EFFICIENCY AND TO THE DECARBONIZATION OF OTHER SECTORS

It is worth underlying that copper contributes to resource efficiency as an important 'carrier metal': its production enables the extraction of a range of important metallic by-products that are critical for society —including gold, silver, cobalt, molybdenum, platinum group metals, tin, nickel, lead, selenium, and tellurium.

Copper production also generates more complex by-products, such as sulfuric acid and secondary mineral aggregates (iron silicate) and enables the recovery of excess heat from production processes for use as steam or hot water in the generation of electricity or in district heating. Heat for district heating reduces carbon emissions from conventional sources such as natural gas and hence helps the decarbonization of other sectors. Iron silicate is an industrially produced mineral that can substitute virgin natural resources in a large variety of applications such as cement, concrete and road construction. It can help contribute to the decarbonization of these sectors, while also contributing to saving natural resources and reducing other environmental emissions, together with energy and land use.

COPPER RECYCLING

Copper is a highly recyclable material that can be recycled infinitely without loss of properties. 19 percent of copper demand in Latin America can be fulfilled through the recycling of post-consumer copper scrap from end-of-life products (Fraunhofer Copper stocks and flows, 2019)[2].

Another 22 percent of copper demand can be fulfilled through the recycling of fabrication or "pre-consumer" scrap. This is illustrated in Figure 8. Adding up both numbers shows a total *recycling input rate* of 41 percent. Important to note here is the challenge to increase the end-of-life recycling input rate.

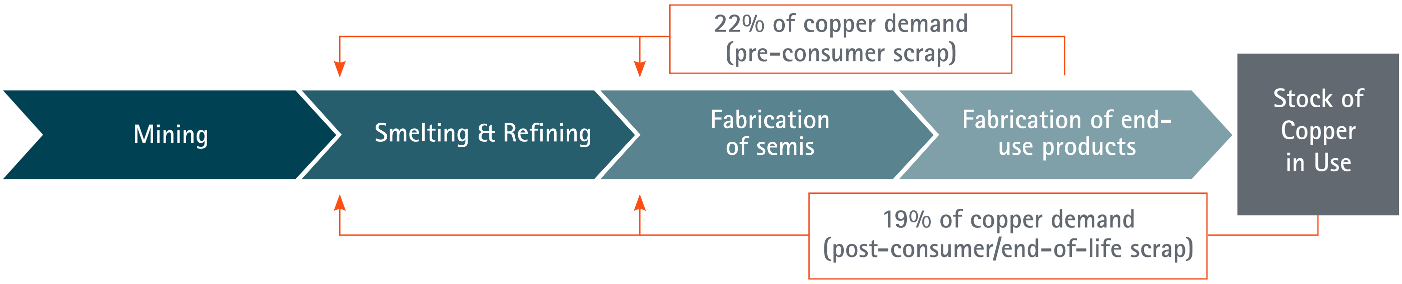


Figure 8 – Industry Flow of Copper in Latin America

Although the end-of-life recycling rate needs to grow to meet increasing demand and conserve existing resources, recycled copper alone will not meet growing demand. The first re-use of extracted copper can be decades later—a long average lifetime is beneficial for reducing the environmental impact of production but has a negative effect on copper availability from secondary sources. The World Bank Group calculated that even a 100 percent end-of-life recycling rate would only reduce the demand for copper from primary sources by 26 percent by 2050 [3]. Moreover, no process is 100 percent efficient, and losses in collection, separation and re-processing of copper scrap will always exist. For this reason, copper produced from mineral ores will still be required, along with recycled copper scrap, to fulfil the growing needs. For more information about the estimated evolution of the global end-of-life recycling input rate, see Annex 5 of *Copper—The Pathway to Net Zero.*

SECTION 2 – DECARBONIZING COPPER PRODUCTION IN LATIN AMERICA

GHG EMISSIONS OF LATIN AMERICA COPPER PRODUCTION TODAY

In 2018, copper production in Latin America emitted an estimated 35.2 million tons of CO_2e. 49 percent of these 35.2 million tons of GHG emitted were Scope 2 emissions, indirect emissions associated with the purchase of electricity, steam, heat and cooling. A significant portion – 31 percent – were Scope 3 emissions[1], all other indirect emissions outside of Scope 2, from sources not owned or controlled by the company. Scope 1 emissions—direct emissions from owned or controlled sources—represented 20 percent of GHG emissions by the industry.

Latin America Scope 1, 2 and 3 copper CO_2e emissions, 2018
Million tonnes

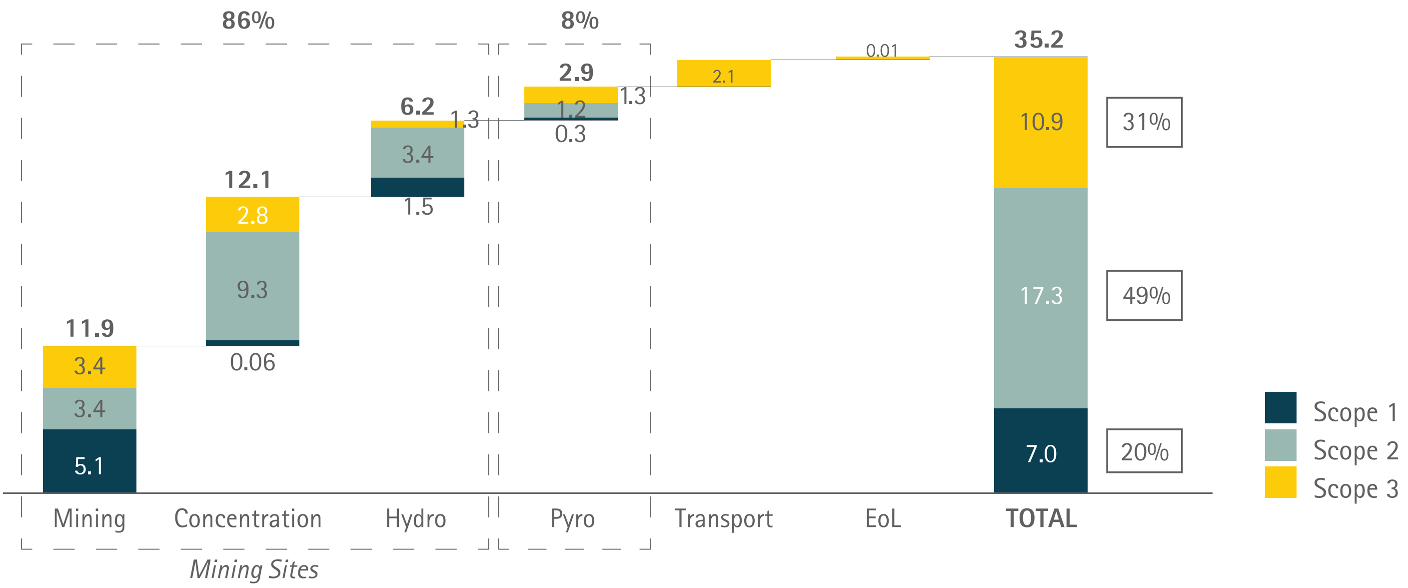


Figure 9 — Scope 1, Scope 2 and Scope 3 CO_2e Emissions of Latin American Copper Production in 2018 (Source: Quantis, ICA Analysis)

Of these 35.2 million tons of GHG emissions, 86 percent were generated by mining sites, 8 percent by the smelting and refining stages of production (pyrometallurgy) and the remaining 6 percent occurred in upstream and downstream transport and in the end-of-life treatment of sold products.

The high share of mining sites (86 percent) in the generation of GHG emissions is linked to the fact that Latin America is the main source for copper ores worldwide. Most of these ores are concentrated on site after extraction and then exported to smelters and refiners across the globe. Smelting and refining activities in Latin America handle much lower volumes due to the limited demand for refined copper on the continent.

Exported volumes of refined copper, mostly produced through the hydrometallurgical route (see Figure 7 in Section 2), are also lower than exported quantities of concentrates. A comprehensive overview of these flows is shown in Figure 10 below and also in the Annex 4 of Copper—The Pathway to Net Zero.

1. This analysis considers Scope 3 emissions from data on six categories material to copper production: purchased goods and services, fuel- and energy-related activities, upstream transport, downstream transport, waste generated in operations and end-of-life treatment of sold products. It excludes an analysis of "use of sold products" due to a current lack of reliable data.

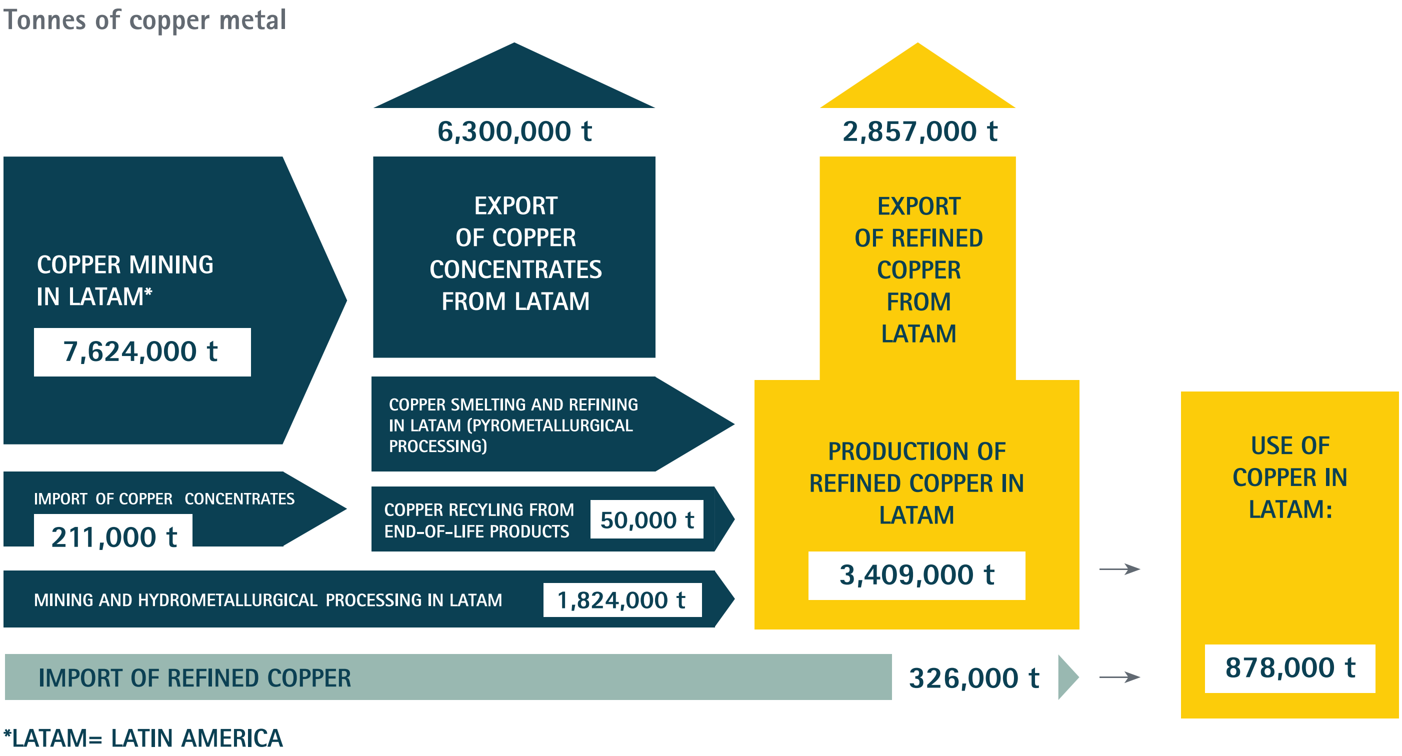


Figure 10 — Copper Flows in Latin America in 2018 (Source: Frauenhofer Institute, ICSG, ICA Analysis)

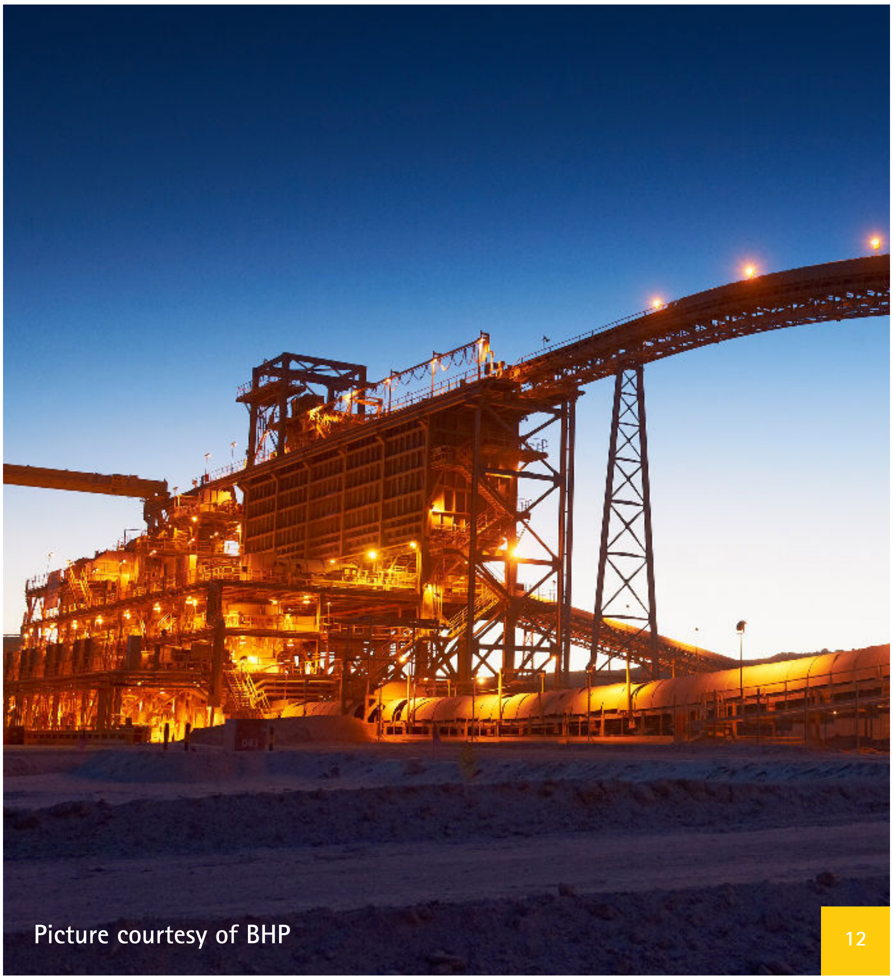
Scopes 1, 2 and 3 have been defined at the *Latin American copper production* level, meaning the range of processes from mining, smelting, refining to recycling. Since some copper producers focus on mining and the production of concentrates—and others on smelting and refining—the classification by these companies of their GHG emissions as Scopes 1, 2 and 3 will differ from the definition used here.

BASELINE FOR COMPUTING THE ABATEMENT POTENTIAL

The production of copper concentrates and refined copper in Latin America is expected to keep growing between 2018 and 2050, because of the forecasted doubling of the global copper demand. Over this period, two major factors will affect the CO_2e intensity of copper production:

1) the decline of the mill-head grade of copper ore will continue to drive up emissions (for further explanation of the evolution of the mill-head grade of copper ore, refer to Section 2 of *Copper—The Pathway to Net Zero*)

2) the shift towards fossil-free energy will lower the CO_2e intensity of the electricity consumed by copper producers. The carbon intensity of electricity grids around the world is expected to decrease from between 200 and 600 kg CO_2e/MWh today to less than 100 kg CO_2e/MWh by 2050.



Picture courtesy of BHP

Scope 1, 2 and 3 emissions, 2018-50 - No-action scenario

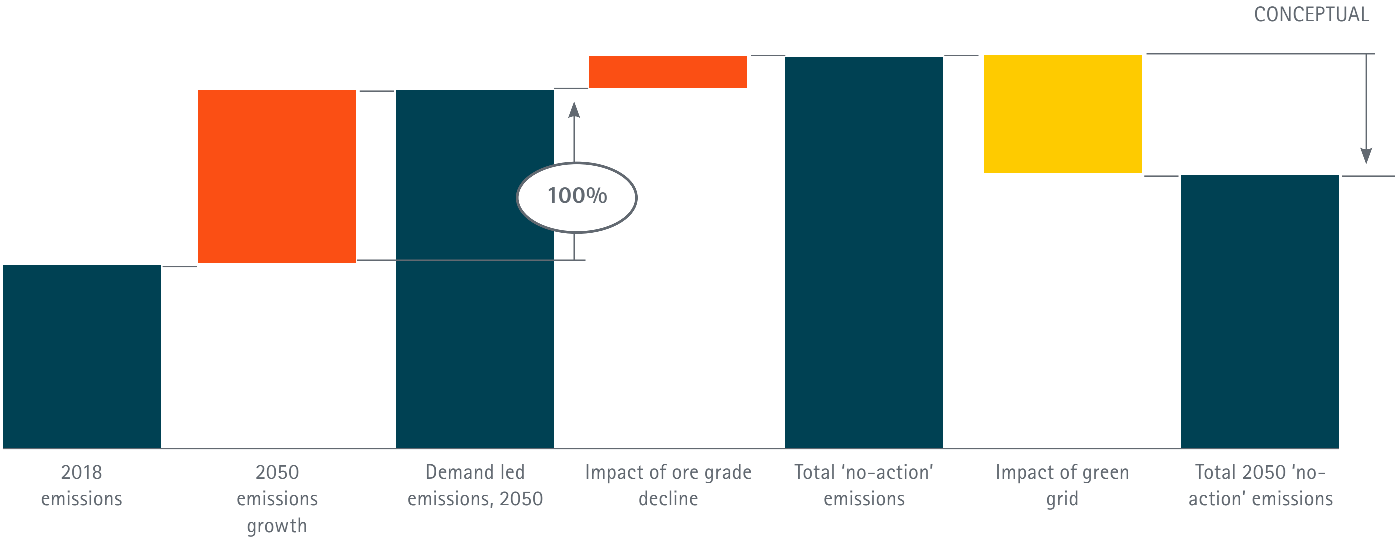


Figure 11 — Modeling Emissions: 2018-2050

The estimated baseline for Latin American copper production in a no-action scenario (no decarbonization initiatives taken by copper producers) is shown in Figure 12 below. GHG emissions of Scope 1 & 2 are expected to reduce till 2040, following the fast decarbonization of the power grids (especially in Chile and Brazil), bringing down Scope 2 emissions. From 2040, as copper production keeps increasing, the sum of Scope 1 and 2 emissions is expected to grow again. Scope 3 emissions, much less dependent on the carbon footprint of the power grid, are expected to increase across the whole 2020-2050 period, driven by production growth.

GHG Emissions - Baseline
Million tonnes CO_2e

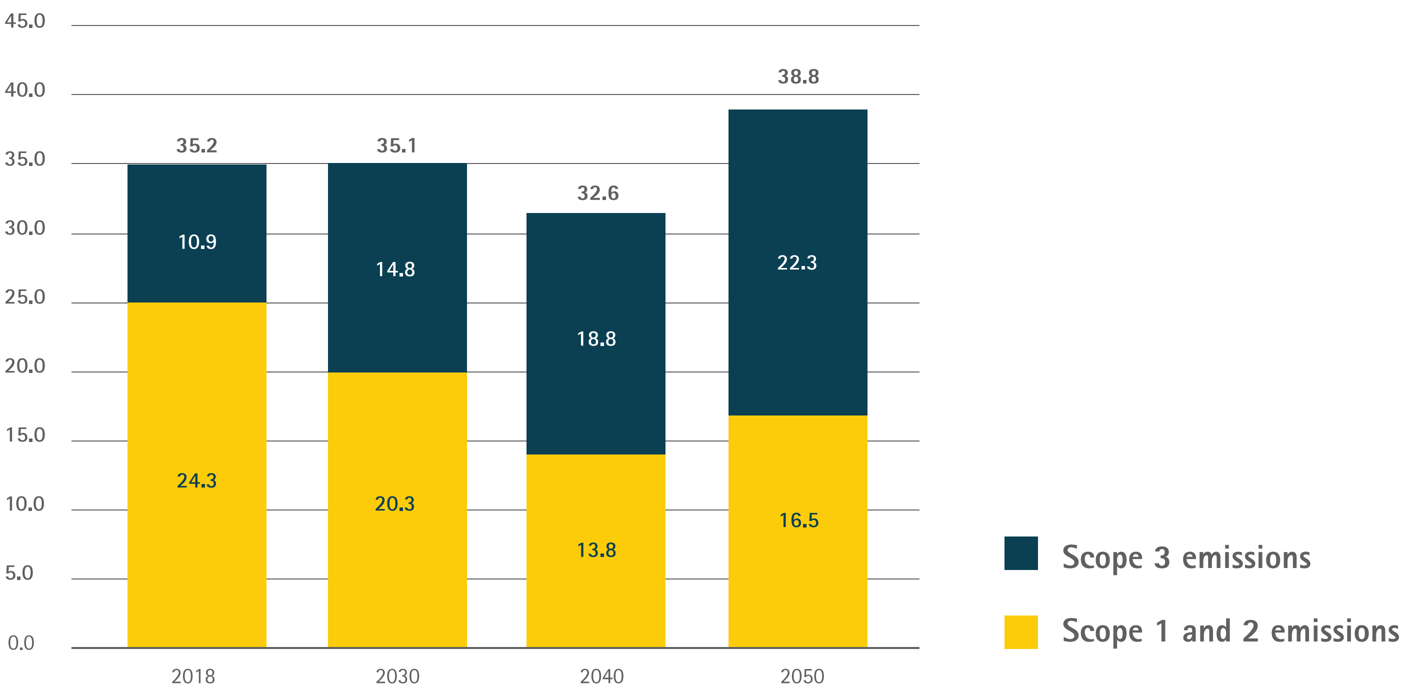


Figure 12 — Baseline: GHG Emissions from Latin American Copper Production in a No-Action Scenario

ABATING SCOPE 1 AND 2 EMISSIONS

A significant percentage of Scope 1 and 2 emissions from Latin American copper production can be reduced by using four types of market-ready and developing technologies:

1. Decarbonized electricity.
This includes the switch from standard to carbon-free purchased electricity through Power Purchase Agreements (PPAs) as well as the installation of wind and solar energy farms at copper production sites. Such measures would allow copper producers to reduce the CO_2e intensity of used electricity faster than if they purchased it from the grid without a specific purchase agreement.

*As an example, **Codelco** signed an agreement with Engie Energia Chile in 2021 to supply 80 percent of the electricity needs of the Chuquicamata mine with decarbonized power. **Antofagasta**'s Zaldivar mine was the first copper mine in Chile to operate, from July 2020, with 100 percent renewable energy, saving around 360,000 tonnes of CO_2 until December 2022. Since 2021, **BHP** has been supplying its Escondida and Spence mines in Chile with 100 percent renewable energy, saving 3 million tonnes of CO_2 annually.*

Picture courtesy of Codelco

2. Alternative fuels.
This includes the transition from diesel to biofuel for trucks, excavators and drills as well as the shift to green hydrogen for haulage trucks. In smelting furnaces, green hydrogen could replace natural gas; other natural gas systems could switch to biogas, ammonia or other alternative fuels; biochar could replace coke.

***Codelco, Antofagasta, Sumitomo, Freeport-McMoRan** and **AngloAmerican** participate in H_2-Chile, a public-private partnership that promotes the use of green hydrogen in mining.*

Picture courtesy of Vale

3. Equipment electrification.
Examples include the introduction of battery or pantograph electric trucks to replace diesel trucks for haulage at mine sites and electric furnaces to replace natural gas furnaces at smelters. Such equipment should of course be supplied by decarbonised electricity.

***Vale's** Green Energy Vehicle Program operates approximately 50 Green Energy Vehicles (GEVs) in underground mines, over 40 of which are Battery-Electric Vehicles (BEVs). **Vale** has been employing electromobility at their mine sites since the 1990s.*

4. Energy efficiency.
Examples include the improvement of milling efficiency using high-chromium grinding media and the installation of in-pit crushing and conveying systems to reduce truck haulage volumes, when applicable.

Picture courtesy of BHP

The relative importance of these four abatement levers over time is illustrated in Figure 13.

In the run up to 2030, decarbonized electricity holds the lion share of the abatement potential, through either Power Purchase Agreements (PPAs) with utilities or installation of own solar farms at or close to production sites. Most potential will occur in ore crushing and milling but also in smelting and refining operations, although at a lower scale. This potential is closely linked to the fast decarbonization of the power grid. Alternative fuels come as a distant second lever to abate GHG emissions, mainly for mining trucks but with limited availability of low-price non-fossil fuels. Equipment electrification is limited to mostly fixed-cable powering of excavators or underground mining equipment, as availability of battery-electric mining trucks is low in the run up to 2030.

From 2030 to 2040, alternative fuels become the leading abatement lever since availability of green hydrogen improves, allowing the switch to fuel-cell mining trucks. Battery-swap mining vehicles also become available at scale, next to pantograph hauling and fixed-cable excavation equipment. More abatement can also be achieved with energy efficiency solutions like in-pit crushing and conveying, where applicable.

From 2040 to 2050, the contribution of alternative fuels to abate Scope 1 & 2 GHG emissions keeps increasing, with still improved availability of hydrogen for mining trucks and for smelting furnaces. With a decarbonized power grid, electrification of equipment (trucks, excavators, underground hauliers) also takes momentum, followed closely by energy efficiency measures that include shifting to in-pit crushing and conveying systems.

The combination of these abatement levers enables a substantial reduction of the Scope 1 & 2 GHG emissions of copper production in Latin America, as shown in Figure 13 below.

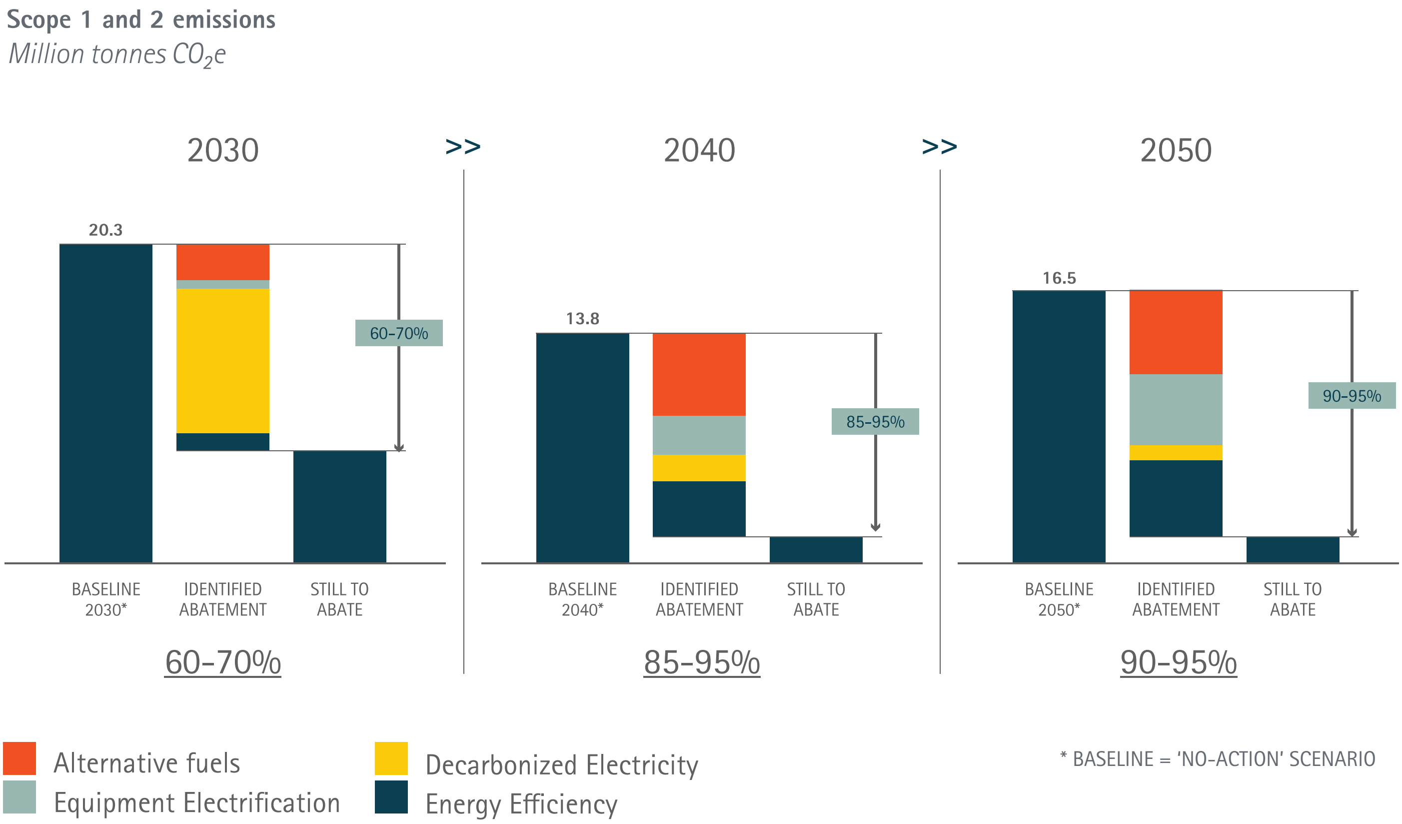


Figure 13 — Potential for Scope 1 and 2 Emission Abatement by 2030, 2040 and 2050 in Latin America (Source: MineLens Asset Decarbonization Tool; Team Analysis)

Based on this analysis, **the members of ICA in Latin America commit to a goal of bringing their copper production to net zero Scope 1 and 2 greenhouse gas (GHG) emissions by 2050**. Research and development efforts will be prioritised to unlock additional decarbonization technologies that should allow reaching a full reduction of Scope 1 and 2 emissions.

This goal should be understood as incorporating the following considerations:

1/ This 2050 target is a collective goal reflecting the decarbonization measures that ICA member companies are pursuing in Latin America. Scope of activities, operating conditions and the speed of decarbonization of the available power grids vary both among copper producers and across countries. These factors will impact the intermediate emission reduction that each member company can achieve by 2030 and 2040. Hence the emission abatement trajectory in Figure 13 should not be used as a benchmark to assess the interim performance of individual companies toward the 2050 net zero goal.

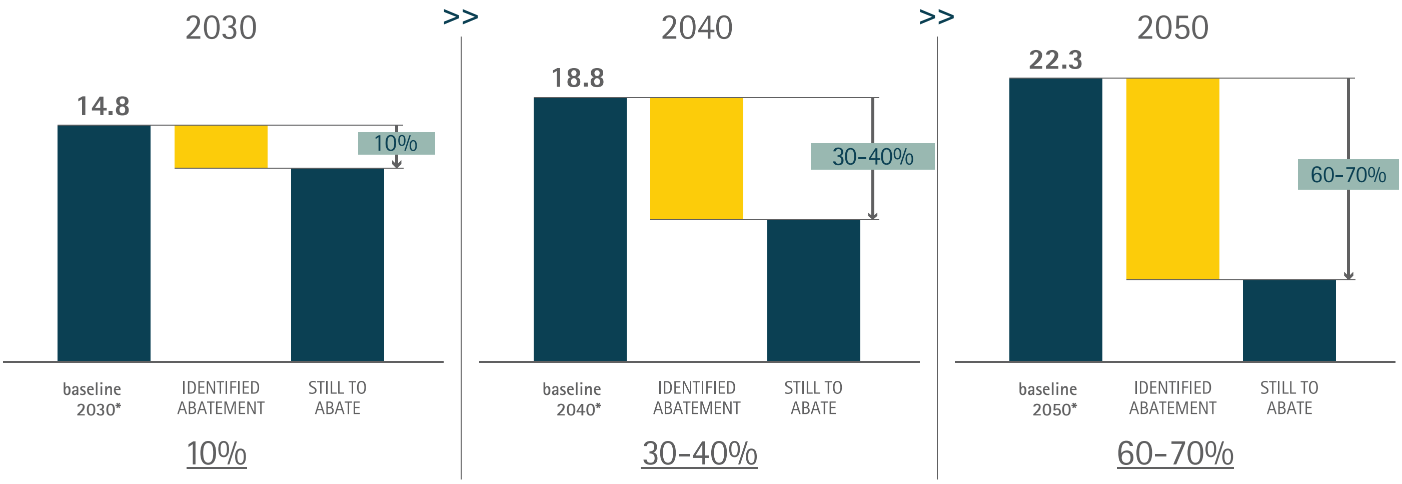
2/ This target is based on current decarbonization technologies and analysis of their cost, availability at scale, and abatement potential. This model of trajectory toward net zero emissions is thus indicative and subject to change as these variables may fluctuate over time.

ABATING SCOPE 3 EMISSIONS

Addressing the reduction of Scope 3 emissions presents additional challenges when compared to Scopes 1 and 2. First, interdependence between actors in the value chain requires a partnership approach to maximize potential abatements, which are not under the sole control of copper producers. The scope of these partnerships can be extensive if tier-2 and tier-3 suppliers collaborate to reduce emissions. Second, the availability of up-to-date, quality data on emissions factors from various suppliers, service providers or customers is still limited. This constraint makes the measurement of Scope 3 emissions and the identification of abatement solutions even more challenging.

An initial assessment of the abatement potential for Scope 3 emissions from global copper production was performed for *Copper—The Pathway to Net Zero*. Currently, it has not been possible to conduct a detailed regional analysis looking at the abatement of Scope 3 emissions from copper production in Latin America, although initiatives are already ongoing, like Huella Chile. *The analysis in this section therefore relies on the global abatement potential identified for Scope 3 and should be considered as a preliminary assessment, subject to refinements based on further future investigation.*

Scope 3 emissions
Million tonnes CO_2e



*BASELINE = 'DO NOTHING' SCENARIO

Figure 14 — Scope 3 Emissions Abatement Potential by 2030, 2040 and 2050 in Latin America – 1st Estimate Based on Global Analysis (Source: MineLens Asset Decarbonization Tool; Team Analysis)

The analysis of Scope 3 emissions considered purchased goods and services, fuel- and energy related activities, transport upstream and downstream in the value chain, operational waste and end-of-life treatment of sold products, the categories that produce the bulk of Scope 3 emissions within the copper sector.

The analysis identified potential decarbonization levers related to decarbonized electrification, near shoring, alternative production technologies or fuels, and efficiency gains. In addition, increased circularity can reduce emissions in the treatment of end-of-life products or in waste generated in operations. Combining these levers may allow the Latin American copper producers to envision reducing Scope 3 emissions by around 10 percent by 2030, 30 to 40 percent by 2040 and 60 to 70 percent by 2050 *together with their value chain partners.*

Active partnerships across the copper value chain will improve the capacity of the industry to reduce Scope 3 emissions. Establishing and managing such collaborations, however, will require substantial resources as well as agreements to ensure goals are reached. Contractual relationships with suppliers and customers should address problems related to compliance.

A positive perspective in this context is the commitment by all ICA members, at global level, to a goal of reaching net zero Scope 1 and 2 emissions by 2050 (see Section 2 of *Copper—The Pathway to Net Zero*). This commitment will significantly contribute to the reduction of the Scope 3 emissions of copper producers in other regions, which are buying Latin American copper concentrates.

ICA members in Latin America will actively engage with the copper industry value chain with the ambition of reducing Scope 3 emissions toward net zero by 2050.

This ambition should be understood as incorporating the following considerations:

1/ As for Scopes 1 and 2, this is a collective ambition that should not be interpreted as a benchmark to assess the performance of individual members companies of ICA in reducing their Scope 3 emissions.

2/ This ambition has been defined to the best of our current knowledge, which is constrained by the challenges in addressing Scope 3 emissions noted above. As ICA members develop better techniques for measuring emissions and partnerships to abate them, they will review and likely revise this ambition. Industry goals thus may shift over time and will depend on the establishment of partnerships to build capacity. ICA members will work with their partners to identify further decarbonization solutions to close the gap to net zero by 2050.

ICA members in Latin America recognise that further measures will be required to bring copper production to net zero by 2050. They commit to pursuing research and development to further reduce Scope 1 and 2 emissions – like for example the emissions associated with carbonates used for leaching in the hydrometallurgical processing- and establishing extensive partnerships with relevant stakeholders to lower Scope 3 emissions. This to bring the decarbonization efforts of the ICA members in full alignment with the Paris Agreement.

This target to decarbonize production hinges on a set of key enabling conditions, including, for example, availability of decarbonized electricity at competitive prices, access to abatement technologies at scale, and a regulatory framework that incentivizes investments. These enabling conditions are addressed in detail in the next section.

ICA members in Latin America will work toward this target through a comprehensive commitment to sustainability. In pursuing decarbonization solutions, they undertake not only to mitigate negative impacts on other environmental categories—such as water, land or air—and local communities but also to maximize the positive impacts of such emissions' reductions by improving, for example, air quality and access to energy infrastructure. ICA members support The Copper Mark®, a voluntary assurance framework set up to promote the responsible production of copper and transparent reporting, which significantly contributes to sustainability. ICA members also recognize and adhere to core principles related to the transition to climate neutrality for all stakeholders.

REQUIRED MEANS FOR REACHING THE DECARBONIZATION TARGETS

Decreasing Scope 1 and 2 emissions for Latin American copper production to net zero by 2050 will require substantial financial resources. ICA members in Latin America estimate an aggregate investment by copper producers of at least 42.1 billion USD at constant currency cost will be necessary to reach this target over the period from 2023 to 2050.

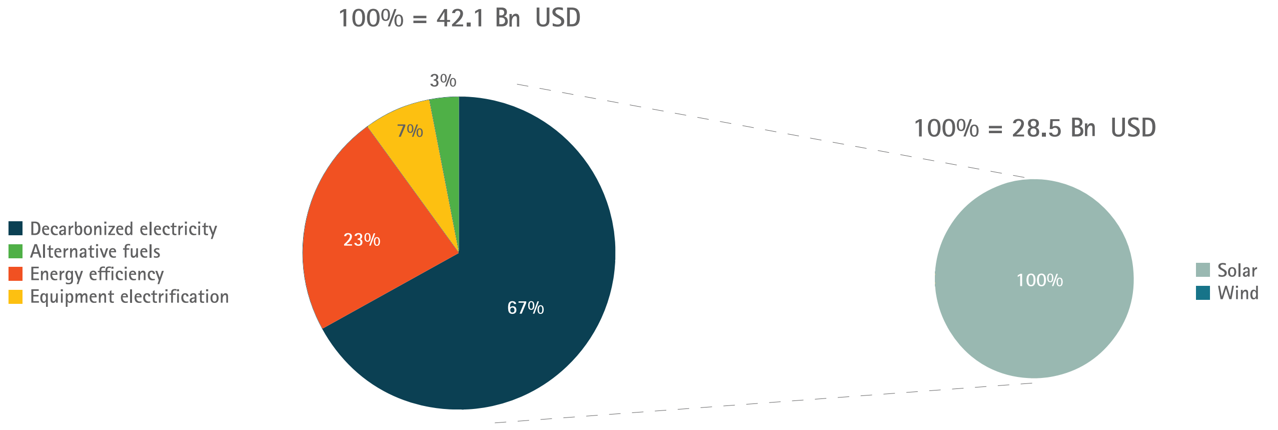
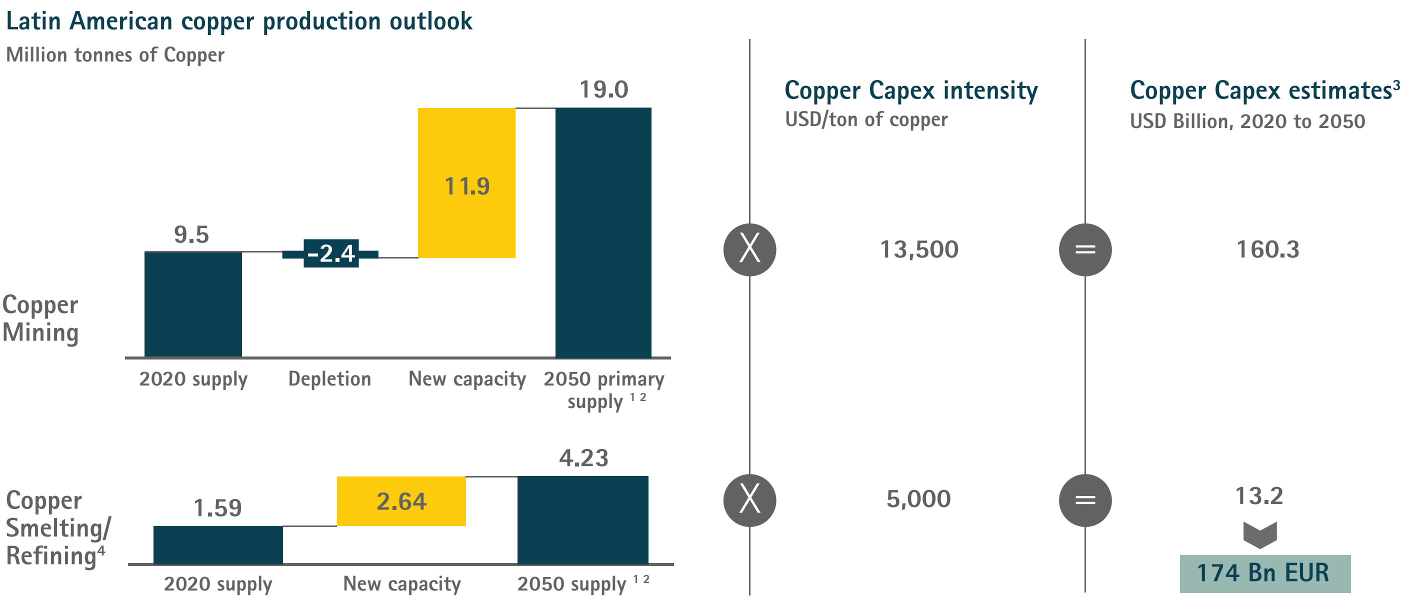


Figure 15 — Estimated Capital Expenditures to Reduce Scope 1 and 2 Emissions to Net Zero by 2050 (Source: MineSpans; MineLens; Team Analysis)

The minimum investment of 42.1 billion USD is in addition to covering recurring capital expenditures to maintain operations ("maintenance Capex"). This estimate also excludes capital costs required to develop at scale the technologies that will enable copper producers to decarbonize (e.g. green hydrogen, battery-electric trucks) or to install the supporting infrastructure to deploy these technologies (e.g. distribution of decarbonized electricity). Several factors may cause this estimate to increase:

- Further research and development, at global and regional level, will be critical to bringing the emission reduction potential closer to 100 percent.
- New decarbonization solutions may be identified and implemented.
- Abatement of Scope 3 emissions could trigger some joint investments with suppliers or customers.
- Base materials costs could keep rising above the industrial price index.

This shows that decarbonization will require significant investments beyond the capital expenditure needed to expand production capacity to meet growing copper demand, estimated at 174 billion USD between 2020 to 2050 (see Figure 16). However, ICA members in Latin America believe these capital expenditures for decarbonization, which amount to around 24 percent of the estimated growth investments, can be managed with an acceptable rate of return provided enabling conditions are met.



1. Based on the Base case for Refined copper demand by use end, 2020-2050, Mt; 2. Assume supply equals demand, includes ~ 0.1Mt of supply estimated to come from scrap in 2050; 3. Does not include specific Capex for secondary scrap facilities, nor Sustaining Capex; 4. Smelting & refining capacity to process concentrate and scrap volumes

Figure 16 — Estimated Capital Expenditure Required to Expand Latin American Copper Production to Meet the Growing Demand (Source: MineSpans; Team Analysis)

SECTION 3 - ENABLING CONDITIONS FOR REACHING THE DECARBONIZATION GOALS OF ICA MEMBERS IN LATIN AMERICA

Six key enabling conditions must be met for ICA members in Latin America to be able to achieve their decarbonization targets:

1) access to a sufficient amount of decarbonized, competitively priced electricity;
2) a stable and fit-for-purpose regulatory framework that incentivises investments;
3) availability of decarbonization technologies from manufacturers at sufficient scale;
4) access to financing;
5) increased end-of-life collection rates of copper-containing products to allow increased recycling;
6) access to skilled workforce.

These are explained in more detail below.

1. Access to a sufficient amount of decarbonized, competitively priced electricity
As copper is an electricity-intensive process, its production requires access to decarbonized electricity that is cost effective, available at scale and supplied through adequate infrastructure. This challenge will only increase into the future, as production volumes are growing and equipment electrification plays a role in decarbonizing copper mining and smelting operations. The speed at which electricity grids expand their capacity, develop their infrastructure and decarbonize their output is therefore critical for the reduction of copper GHG emissions and should be accelerated whenever possible.

2. A stable and fit-for-purpose regulatory framework that incentivizes investments
The copper sector requires a regulatory framework that facilitates and sustains decarbonization while ensuring the industry can invest to meet the growing demand for copper.

a. A faster permitting process for new mining assets and expansions is critical to enable the copper industry to meet growing demand. A sound balance must be reached between consultation of local communities and implementation constraints of industrial projects, to avoid long delays -often triggered by complex regulatory or legal procedures- in developing additional copper production capacities.
b. Installation of on-site electricity generation capacities should be facilitated and accelerated, as it is a key emission abatement lever.
c. Transparent carbon pricing should become common practice, to encourage investment that supports decarbonization and to create a global level-playing field when externalities like climate mitigation are integrated into product costing.
d. A stable regulatory environment that ensures long-term mining licenses with fair and predictable royalty schemes is necessary, given the substantial upcoming capital expenditures by copper producers for process decarbonization and for capacity expansions.
e. Regulations should incentivize the shift to fossil-free land and sea transport.
f. Coherence should be ensured across regulations, standards and policies applicable to the copper sector, with the aim to foster the implementation of decarbonization technologies. This should include the facilitation of testing such technologies before their full-scale application.

3. Availability of decarbonization technologies from manufacturers at sufficient scale
Although most of the decarbonization technologies like battery-electric trucks, on-site storage systems for fossil-free energy or solar farms already exist, these technologies must be available at scale and at affordable prices from their manufacturers in due time. Here again, the increase of copper production compounds the importance of this availability: for example, copper producers will need twice the amount of mining trucks by 2050 compared to today, and all these trucks will need to be zero-

emission by then. Collaborative R&D projects, also through public-private partnerships, should facilitate this availability of decarbonization technologies and their adaptation to the specificities of the copper industry, by enabling their faster testing, validation and integration into the production processes.

4. Access to financing

Flexible investment funds should be available to copper producers in Latin America. Between 2020 and 2050, the copper industry will need to invest around $175 billion to meet increasing demand and an additional $ 42 billion -at least- to reach decarbonization targets, an average of $7+ billion per year. Given the critical contribution of copper to the energy transition and the ambitious plans of ICA members to decarbonize production, copper producers should be granted access to investment funds integrating environmental, social and governance (ESG) criteria to support innovative research and development and these substantial capital expenditures.

5. Increased end-of-life collection rates of copper-containing products to allow increased recycling

Refined copper production from secondary sources does not require the mining and concentration of copper ore, processes that account for about 60 percent of the total GHG emissions of refined copper production. Also, production from high grade scrap—rather than copper ore—reduces 70 to 85 percent of the emissions from smelting and refining. This ratio is lower (10 to 50 percent) when low grade scrap is used.

Consequently, increasing the input rate of recycled scrap in the production process lowers its carbon emission intensity while meeting the growing demand for copper. To achieve this, product designs that facilitate recycling and incentives for end-of-life collection are needed, together with improved separation techniques for the treatment of multi-metal scrap streams.

Here again, it is important to stress that recycled copper alone will not meet growing demand – more mining is and will be required to enable the decarbonization of many sectors of the economy.

6. Access to skilled workforce

Copper production sites need highly skilled staff. Addressing the decarbonization challenge requires skills, such as data mining, carbon footprint measurement and monitoring, energy storage, electrification infrastructure, that are new to the sector. Training and education programs can build the capacity of staff. Copper producers will need to hire new employees with new skill sets, and support from local educational institutions will be indispensable.

SECTION 4 – THE WAY FORWARD

Copper—The Pathway to Net Zero and this *Regional Focus: Latin America* bring additional foresight on a challenging but critical journey toward carbon neutrality on which copper producers have already embarked, be it in Latin America or in other parts of the world.

Copper producers in Latin America are committed to implementing the following next steps to advance the decarbonization of copper production:

• **Measuring progress** through a robust, aligned methodology for calculating the carbon footprint of copper production and a regular, transparent monitoring mechanism (to be established by end of 2024) that provides verifiable reports on progress at industry level;

• **Advancing decarbonisation in a responsible way**, supporting and enhancing communities and the environment around copper assets in Latin America, for example through commitment to The Copper Mark®, an independent third-party assurance framework designed to provide all stakeholders with the confidence that certified copper production sites operate according to internationally accepted, responsible industrial practices;

• **Regularly updating *Copper—The Pathway to Net Zero* and the *Regional Focus: Latin America*** – at least every 5 years- to incorporate technological developments in decarbonisation and increased availability and quality of emissions data across the whole value chain;

• **Engaging in partnerships** to address the challenge of decarbonisation. Partnerships should not be limited to business stakeholders, since policymakers, civil society and academia also have a significant role to play to ensure we transition to a net zero economy by 2050. Broad and deep pilot projects to test decarbonization technologies with the involvement of manufacturers, communities and local authorities will be promoted. Focus will also be on finding mutual benefits for copper producers and their suppliers to reduce the emissions of goods and services purchased, since addressing this category of Scope 3 emissions is of paramount importance for copper producers.

In Latin America, copper producers, together with the International Copper Association, will continue to engage in a constructive dialogue with policymakers, businesses and representatives of civil society to maximize the contribution of copper and the copper industry to achieving the Paris Agreement, in a responsible and sustainable way.

Picture courtesy of Antofagasta

Glossary

Abbreviations

CAPEX: capital expenditures

CO_2e: carbon dioxide equivalent

GHG: greenhouse gases

ICA: International Copper Association

ICSG: International Copper Study Group

IEA: International Energy Agency

MACC: Marginal Abatement Cost Curve

PPA: Power Purchase Agreement

PV: photovoltaic

Terminology

Alternative fuels: e-fuels, biogas, biomethane, hydrogen and ammonia produced with non-fossil energy, hydrotreated vegetable oil (HVO), biochar

Archetypes: short for "archetypical production processes," combinations of major production stages and technologies of copper production

Copper industry: includes copper mines, smelters, refiners, recycling facilities and fabricators of semi-finished products from copper and copper alloys

Copper producers: includes copper mines, smelters, refiners and recycling facilities

Copper production: the production of refined copper from copper ore extracted from mines or copper scrap generated through recycling

Electricity mix: the mix of energy sources used to produce electricity in a particular country or region

End-of-life recycling rate: the share of copper-containing products reaching the end of their life cycle that is collected, separated and processed into copper scrap

End-of-life recycling input rate: the share of refined copper production originating from old scrap

Energy or clean energy transition: the transition from an economy based on fossil fuels to a climate neutral one

Decarbonized electricity: electricity generated from fossil-free energy sources

Mill-head grade: the metal content of mined copper ore going into a mill for processing

New scrap: scrap originating from waste in the fabrication of semi-finished and end-use products

Old scrap: scrap originating from the recycling of copper-containing products reaching end of life

Primary copper sources: copper ore from mining operations

Recycling input rate: the share of refined copper production originating from recycled material, both old and new scrap

Refined copper: copper with at least 99.99 percent purity, which results from a smelting and refining process

Scope 1 emissions: direct GHG emissions from owned or controlled sources

Scope 2 emissions: indirect GHG emissions associated with the purchase of electricity, steam, heat or cooling

Scope 3 emissions: all indirect GHG emissions not included in Scope 2 that occur in the value chain of a company, both upstream and downstream

Secondary copper sources: copper scrap from recycling

Semi-finished products: products fabricated from refined copper, sometimes alloyed with other metals, in the form of wire, rod, tube, sheet, plate, strip, castings, powder or other shapes. They are further transformed by downstream industries to produce copper-containing end-use products.

Picture courtesy of Grupo Mexico

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April 2023, Rev. 0

International Copper Association
Copper Alliance

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