

From copper scrap to transformer windings: the journey of recycled copper





1. Taking a closer look at the copper value chain

To support our customers achieve their ambitious supply chain emission reduction targets, it is our responsibility at **Siemens Energy** to provide them greener grid products. The grid is expected to double in size by 2040, requiring hundreds of thousands of transformers for the transmission. The urgency becomes even more evident when considering the substantial environmental impact of raw material use.

Four months ago, we partnered with **TenneT** for a **climate-neutral supply chain**. Our goal is to reduce the shared supply chain emissions by 30 % until 2030, utilizing more sustainable materials and decarbonizing our factory network. This includes adopting innovative technologies and assessing the potential for circularity models in grid technologies. As part of this partnership, the first pilot project for transformers manufactured with 100 % recycled copper has already been completed.

1.1 Uncovering the reality of zero- or low-carbon copper products

The concept of zero-carbon copper is currently debatable, as the production process involves substantial energy consumption and emissions at multiple stages. As outlined in a previous article on advancing copper decarbonization and the role of recycling, achieving zero GHG emissions would require further technological advancements, in renewable energy use as well as potentially carbon dioxide removal or carbon offsetting, which are challenging to implement fully.

Approximately 70 % of copper emissions result from mining. Copper mines are actively pursuing various decarbonization strategies, such as

transitioning heavy mining equipment away from fossil fuels. However, this process is both time-consuming and costly. Nonetheless, industry leaders have started implementing these decarbonization strategies and offering green(er), lower-emission products.

Lower-emission or transitional products are essential because they serve as a bridge towards fully sustainable manufacturing, acknowledging that pure green production lines have not yet been achieved due to current technological limitations and economic constraints. At the same time, these products help to develop consumer awareness and market demand, driving further innovation and investment in green technologies.

1.2 Tracking recycled copper across its supply chain

To ensure accuracy of product claim for recycled copper, we at **Siemens Energy Grid Technologies** business are collaborating across the copper supply chain. We are engaging in our suppliers' challenges and opportunities, decarbonization strategies and efforts, effective sourcing strategies, as well as product footprint assessments to not only understand but also confirm sustainability claims.

For example, the supply chain for the recycled copper windings for transformers, as shown in the above figure: **ASTA** is our tier 1 supplier. The 100 % recycled cathodes are sourced from our tier 3 supplier **Montanwerke Brixlegg AG (MWB)**, supplying to **Elcowire Group (Elcowire)** to process the cathodes into rods. The rods are then sent to **ASTA** and processed into conductors for the transformer winding.

Step 1: Manufacturing of recycled cathodes. For almost 50 years, all of Montanwerke Brixlegg AG's copper has come from secondary materials like recycled copper. This is why our Austrian tier 3 supplier is known as a pure secondary copper smelter.

Copper scrap is processed in three stages based on its copper content. Low-grade scrap is refined in a shaft furnace to produce black copper with 75% copper. In the second stage, a converter furnace removes more impurities to produce blister copper with 96% copper. In the final stage, high-grade scrap is added in an anode furnace, refining the copper to 99% purity, which is then cast into anodes. In the tank house, anodes dissolve in sulfuric acid, and electric current causes copper ions to move to stainless steel cathodes, forming pure copper sheets called cathodes with over 99.99% purity.

MWB provides two certificates along with the purchased cathode quantities to customers: one for 100% recycled content of the purchased cathode quantity and another for a low carbon footprint.

Step 2: Processing a recycled rod. MWB then supplies the recycled cathodes to Elcowire Group, our tier 2 supplier. They're one of the largest manufacturers of copper wire rods in Europe, with production plants in Sweden and Germany.

Elcowire produces copper wire rod from recycled copper based on grade A copper cathodes in the production plant for copper rod in Helsingborg, Sweden. The copper rod is produced by first melting the copper cathodes in a furnace and then casting the molten copper into rod, which are subsequently rolled, cooled, and coiled. Recycled and standard copper cathodes are mixed because segregating the production is economically unviable, requiring duplication of the production line and consuming more resources and energy.

A mass balance approach is used to track and allocate recycled copper and its emissions from start to the finished copper rod, ensuring accurate bookkeeping. The allocated carbon footprint is documented on the delivery note to the customer, and Elcowire passes on MWB's certificate for 100% recycled content along with the wire rod to ASTA.

Step 3: Getting recycled conductors. As a last step, the rods are delivered to our tier 1 supplier ASTA, where they are processed into conductors for the transformer windings. The initial step involves transforming the delivered material into a round wire, which is subsequently rolled into a flat wire. This flat, bare wire is then insulated with enamel and processed into a Continuously Transposed Conductor (CTC). The finished CTC is then transported to the respective transformer factory, accompanied by the original certificate from MWB, verifying 100% recycled content, along with a product carbon footprint certificate for the CTC provided by ASTA.

1.3 Collaboration is key: decarbonizing the copper industry

While some readers might question whether the described supply chain is truly green, it is important to note that increasing demand for greener copper is essential for manufacturers to transition towards more sustainable production. At **Siemens Energy Grid Technologies**, we are committed to driving this change within the energy industry.

To effectively decarbonize the copper industry, it is crucial to understand the entire supply chain and identify the key levers for decarbonization. By supporting suppliers and the broader copper industry in their transition efforts, we can ensure a more sustainable future while maintaining the vital role that copper plays in the energy transition.

This article was written with the support and review of ASTA, Elcowire Group, and Montanwerke Brixlegg AG.

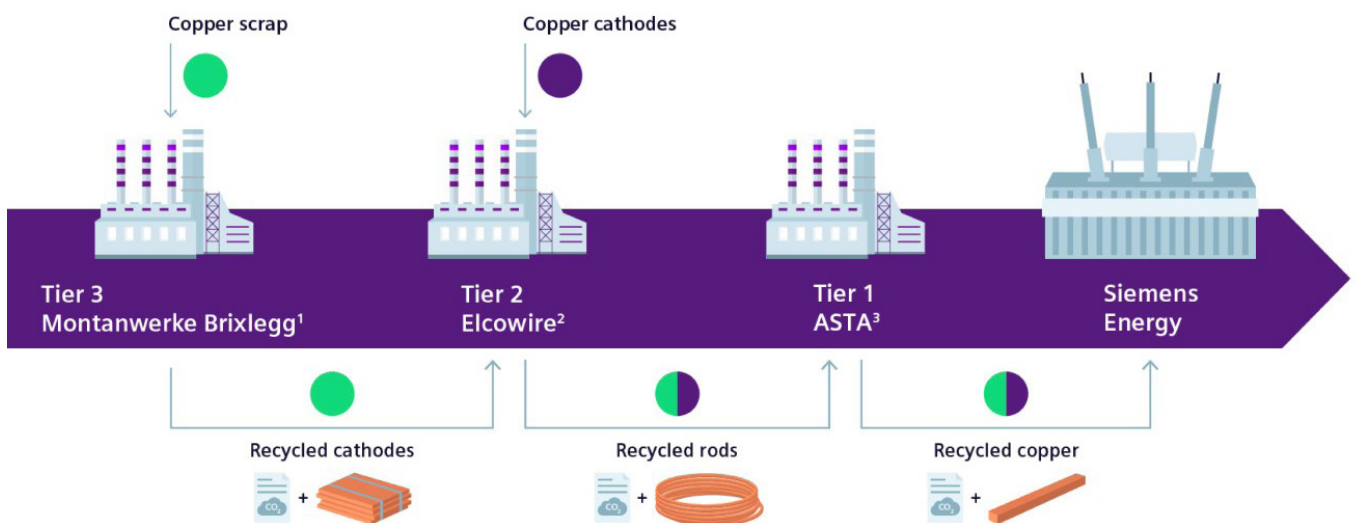


Figure 1 Recycled copper value chain

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