

New Dynamic Copper Stock-and-Flow Models Chart Rapid Growth of China's Copper Use

The International Copper Association (ICA) today announced new research from the Fraunhofer Institute for Systems and Innovation Research ISI that models the global flow of copper through time with unprecedented detail and accuracy. The model tracks copper tonnage with respect to global mining, international trade, end-uses and recycling.

The research cites that China is the largest user of copper worldwide and its rate of use has increased rapidly. According to the data, China had over 80 million tonnes of copper stocks in-use during 2015. By comparison, the study shows copper stocks in-use for 1990 accounted for less than 10 million tonnes.

'Dynamic modeling tracks copper through time and is based on the best available data, both public and proprietary. It quantifies recycling and pinpoints areas of improvement,' says Colin Bennett, Market Analysis and Outreach, ICA. 'The study also provides extensive coverage of copper in end use products, which extends knowledge of copper flows worldwide.'

Life Cycle from Primary Production to Semis, End-Use Products and Scrap

The study examines the life cycle of copper in unprecedented detail, from copper primary production, through the production of semi-finished goods, to the fabrication of end-use products. At the end of the life cycle of end-use products, the copper becomes part of the 'urban mine,' and it is either recycled, or becomes waste if it ends its life as landfill or is lost within other cycles, such as steel or aluminum. This detailed accounting of copper flows at each stage of the life cycle is what makes this model especially valuable.

Advantages of Dynamic Modeling

'The big question has always been: how much copper could have been recycled but wasn't? There was no good way to answer this without a dynamic stock-and-flow model as the required data had not been collected,' explains Dr. Luis Tercero Espinoza, who led the research team at Fraunhofer ISI and supervises the institute's research topic [Materials and Raw Materials](#). 'Until recently, there were many one-year snapshots of the copper cycle worldwide and in some regions. We now have the full picture.'

The dynamic model that provides this picture starts in 1910 and tracks copper in all applications through to today. 'Only with such a long modelling timeline can we track copper in long-lived applications such as buildings and infrastructure,' says Marcel Soulier, who is finishing doctoral work at Fraunhofer ISI on the subject.

The Global Supply of Copper

According to the study, approximately 440 million tonnes (Mt) of copper were in use (in buildings, machinery, computers, etc.) worldwide in 2015. Well over 26 Mt went into service that year, while approximately 12 Mt of copper contained in discarded products became available for recycling. Collection and recycling of discarded products together with recycling of manufacturing scrap yielded well over 8 Mt of recycled copper. 'Copper recycling alone cannot satisfy demand for copper—there is simply not enough material to recycle,' says Dr. Tercero Espinoza. 'Still, the contribution of recycling to



global supply can be raised through improved collection and investment in the development and use of better separation technologies for discarded products.'

Basis of Research

The study is based on earlier research at the Fraunhofer Institute for Systems and Innovation Research ISI in Karlsruhe, Germany. It updates data reported in an academic paper titled 'Dynamic Analysis of Global Copper Flows. Global Stocks, Postconsumer Material Flows, Recycling Indicators, and Uncertainty Evaluation.'

[Reference: Glöser, Soulier, and Tercero Espinoza, *Environ. Sci. Technol.*, 2013, 47 (12), pp. 6564–6572.] Additional results are available for trade flows [Tercero Espinoza & Soulier, *Miner. Econ.*, 2016, 29(2-3), 47-56] and for European copper stocks and flows [Soulier, Glöser-Chahoud, Goldmann, and Tercero Espinoza, *Resourc. Conserv. Recycl.*, 2018, 129, 143-152].

For more information, visit the Trends and Innovations section of copperalliance.org, or contact ICA.

About the International Copper Association (ICA)

ICA brings together the global copper industry to develop and defend markets for copper and to make a positive contribution to society's sustainable development goals. Headquartered in New York, ICA has offices in four primary regions: Asia, Europe and Africa, Latin America and North America. Copper Alliance® programs and initiatives are executed in nearly 60 countries through its regional offices. For additional information please visit copperalliance.org.

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