Copper Helps Reduce Carbon Emissions in Buildings

Comparative LCA of water installation tube systems based on copper, PEX-Al and PEX

Annually, the building and construction sector accounts globally for approximately 35 percent of final energy use and 40 percent of global energy and carbon dioxide (CO_2) emissions. Manufacturing building materials and construction are responsible for an additional 11 percent. Selecting greener materials for buildings and construction, such as copper, helps reduce CO_2 emissions and alleviate climate change.

A Life Cycle Assessment (LCA) focused on CO_2 emissions and primary energy reduction

Research conducted by the International Copper Association in collaboration with Sphera and led by Dr. Constantin Herrmann examined the environmental and emissions impacts of three water installation tube systems—copper, plastic multilayer pipes (PEX-Al) and plastic cross-linked polyethylene (PEX). Sphera performed a Life Cycle Assessment (LCA) study to determine how the materials' production, lifetime use and end-life stages compared across the three systems. The LCA researchers investigated the comparative water use for a 100m² (~1076ft²) apartment, analyzing the covered tubes and additional system components, such as fittings and connectors, that connect and fix the tubes. Researchers compared the materials' composition, properties, manufacturing processes and respective recycling potential.

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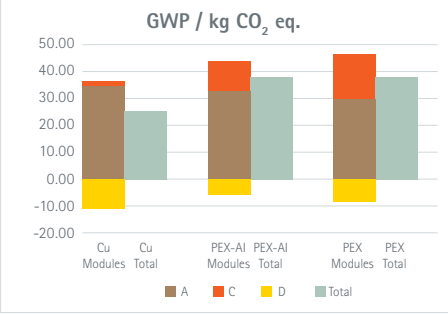
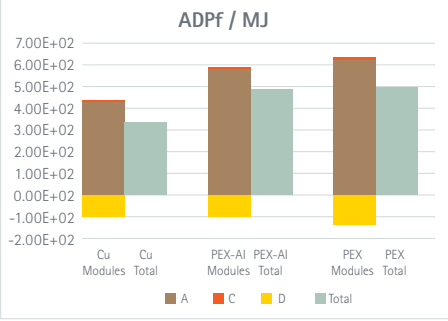
The comparative LCA study was conducted in accordance with ISO14040/44, the overarching international standard for LCA, and the tube systems followed the guidelines of the Environmental Product Declaration (EPD). The analyses of the three systems were structured into modules: A (A1-A5), which covered the product stage and construction process; C (C1-C4), which examined the materials' end-of-life; and D, which reviewed the "benefits beyond the system's boundary" (e.g., potential recycling impact).[1]

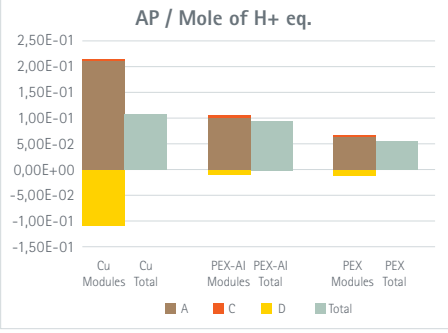
The life cycle impact assessment (LCIA) study results are derived from data addressing 10 impact categories, as required in standard EN 15804+A2 (the European Standard for the generation of EPD for construction products). Global Warming Potential (GWP), one of the impact categories, compiles data regarding the biogenic, fossil fuel and land-use related to GWP. For the GWP category assessment, the baseline calculation used to compare the systems refers to data collected under modules A (product stage and construction process) and C (end-of-life). The LCA provides an additional scenario for comparison that includes net credit for recycling potential (based on the data from module D: benefits beyond the system boundary). In doing so, the LCA follows an "avoided-burden" approach by applying potential credits from recycling for future product life cycles.

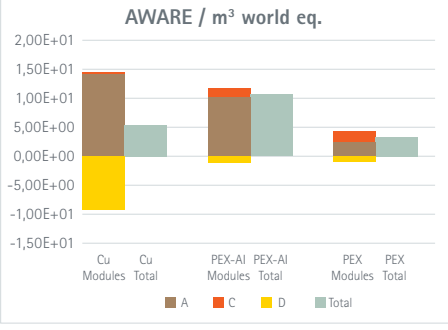
Cu International Copper Association
Copper Alliance

1 *Module B was not included because the findings were the same for all the three materials and is neutral (or does not influence) the study. Its relative impact is minor and not likely to influence the global results.*









Key findings

The **Global Warming Potential (GWP)** indicator showed that the plastic PEX-Al and PEX systems had 18 percent more of an impact on global warming than the copper pipe system. Copper's material circularity lowers its CO_2 footprint by more than 30 percent compared to PEX-Al and PEX because of the benefit from recycling in module D.

Copper's **Abiotic Depletion Potential fossil (ADPf)**, formerly called primary energy demand, is lower in modules A and C, making the copper system a less energy-intensive choice compared to the plastic systems. Copper also has a lower net total ADPf when material circularity is considered.

The copper system had a higher **Acidification Potential (AP)** than the plastic systems for modules A and C. However, copper's AP can drop below the plastic systems in its total net value when benefits from module D (i.e., recycling potential) are considered.

For **water consumption (AWARE)**, the copper pipe system had higher levels in modules A and C than the PEX plastic systems. However, copper's recycling potential (module D) can greatly reduce this estimated impact so that the net total value is lower than the PEX-Al system and is similar to the PEX system.

Compared to systems made from plastic (PEX-Al and PEX), the LCA findings indicate that **copper tube systems used to transport fluids in buildings are better for decarbonization.**

Conclusion: Copper cuts operational and embodied CO_2 emissions

Compared to systems made from plastic (PEX-Al and PEX), the LCA findings indicate that copper tube systems used to transport fluids in buildings (e.g., drinking water, heating, air conditioning, gases) are better for decarbonization. Copper tubes are the greener choice for cutting greenhouse gas (GHG) emissions and mitigating climate change (GWP and ADPf). The data indicated higher acidification potential and water consumption impacts for copper systems in the life cycle stages A1 (raw material) - A3 (product fabrication) compared to the plastic systems. Therefore, improvements need to be made in these areas for copper systems, although the comparative impact is offset when recyclability is considered.

Compared to the plastic systems, only the copper system has guaranteed material circularity. Copper's circularity greatly reduces the environmental impact of buildings, particularly if the future product life cycles consider the use of recycled copper. Both plastic PEX-based systems only demonstrate a reduction in environmental impact in the electricity generation and thermal energy categories, which is a result of the plastic systems' incineration at their end-of-life. Therefore, recovering copper at the system's end-of-life is essential to maximizing copper's potential as a green material of choice for the building and construction sector.

More information on the LCA can be found on ICA's website:
Copper Helps Reduce Carbon Emissions in Buildings
(copperalliance.org/resource/copper-helps-reduce-carbon-emissions-in-buildings)

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