European Commission

Science for Environment Policy

Demand for copper could increase by 213–341% by 2050, and account for up to 2.4% of global energy demand

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Global demand for copper could increase by up to 341% by 2050, and energy use is likely to increase with it — rising to a possible 2.4% of global energy demand in 2050, according to new research. Policy actions to avoid such drastic changes could include improving copper recycling and using renewable technologies.

There are increasing concerns about the future supply of copper. It is used to conduct heat and electricity, as a building material, in metal alloys and a wide range of electrical and electronic equipment. Indeed, copper is one of the most widely used metals, with demand on the rise due to the growing population and economy. Although copper has been used by human societies for at least 10 000 years, over 95% of all copper ever mined has been extracted since 1900[1] and more than half of the copper ever mined and smelted has been extracted in the last quarter century.

Demand for copper is rising faster than it can be recovered from secondary sources (e.g. industrial and consumer waste, such as pipes, brass and old electrical appliances) and, as a result, reliance on primary copper (which must be mined) is increasing. Estimates suggest that copper reserves could be depleted in just 25 to 60 years[1].

Mining is extremely energy intensive and one of the biggest contributors to global CO_2 emissions. Copper in particular is highly energy intensive and, as demand increases, the quality of its ore is expected to decrease; meaning the energy needed to extract copper (and thus CO_2 emissions) will increase further.

To help policymakers to better plan for this future, this study estimated copper demand, supply and its associated energy use up until 2050 (with a 2010 baseline). Estimates were given for four different scenarios for the future, based on the Fourth Global Environmental Outlook (GEO-4) scenarios of the United Nations Environment Programme[2].

The four scenarios are:

- **Market First (MF)**: A market-driven world in which demographic, economic, environmental and technological trends unfold in line with current trends. This is the 'business as usual' scenario.
- **Policy First (PF)**: Strong actions are taken by governments to reach specific social and environmental goals (especially regarding renewable energy).
- **Security First (SF)**: A world of inequality and conflict due to socio-economic and environmental pressures.
- **Equitability First (EF)**: A future of more equitable values and institutions.

Overall, the results suggest that increases in copper demand over the next four decades will be dramatic, with all scenarios requiring substantial increases in copper mining and processing.

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1. http://www.salon.com/2006/03/02/peak_copper/

2. http://www.unep.org/geo/geo4/media/GEO4%20SDM_launch.pdf, scenarios described on page 22. This topic will be the subject of a report on resource policy options to be produced in 2017 by the United Nations Environment Programme's International Resource Panel.

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Total demand for copper in 2050 was estimated to increase by between 213% and 341%, compared with 2010. Demand was highest in the 'EF' scenario, in which achieving global equity requires significant increases in metal production to meet the needs of the world's population. Per capita GDP is the highest in this scenario, which is a good predictor of copper demand. Demand was lowest in the 'SF' scenario, where regional isolation and lack of income growth prevents an increase in metal use. Demand estimates for the 'MF' and 'PF' scenarios were both 275%, as growth in per capita GDP (on a global level) is the same in the two scenarios.

Demand for copper in all scenarios is expected to exceed copper reserves (amounts that are currently economic to mine) and the reserve base (reserves plus the copper in deposits that are not economic to mine) before 2050. Production is expected to exceed current reserves earliest in 'EF' (2036), followed by the 'MF' and 'PF' scenarios (2038) and then the 'SF' scenario (2040).

Estimates of the energy required for copper production (primary and secondary) ranged from 0.83% (SF) to 2.33% (EF) of total global energy required for all societal uses in 2050 — compared to just 0.3% today. Although the highest amount of energy was required by the 'EF' scenario, this does not necessarily mean the highest CO_2 emissions, as this scenario also has the highest share of renewable technologies.

Overall the paper confirms that, as copper is needed to conduct energy, its use will increase with population and economic activity. Copper production will thus represent an increasing and substantial share of global energy demand, creating a feedback loop that could be harmful to the environment.

To mitigate these negative impacts, the researchers recommend that governments encourage mineral research and exploration and provide incentives to increase rates of copper recycling. They also suggest the copper cycle could be made more efficient by reducing losses at all stages, from mining to product manufacture, and recommend reducing the amount of copper used in non-recyclable applications and re-designing existing technologies that include copper. The metal could be partially replaced with graphene, for example, which is also an excellent conductor of electricity. The shift towards renewable forms of energy production will also reduce negative impacts associated with copper production.