Copper’s contribution to the energy transition

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Where does copper come from?

Chile accounted for almost one-third of world copper mine production in 2016 with mine output of 5.55 million tonnes copper.
What are major end uses of copper?

**FIGURE 3: Copper in use (ICA/IWCC, 2017)**

- Power Generation, Distribution & Transmission - 45%
- Appliances & Electronics - 12.5%
- Transport - 12.5%
- Construction - 20%
- Other - 10%
Energy transition vocabulary is copper rich


25 Mt Cu would be needed, in EU by 2050, to build a new, 100% renewable electricity system

Lithium batteries:
+0.6 kg Cu/KWh

Smart buildings:
+10% Cu
Smart homes:
+43% Cu
Electric vehicles:
+28 kg Cu
Heat pumps:
+8 kg Cu

Wind and Solar: up to 12 times more Cu intensive

Efficient grids, interconnectors, subsea grids…
(400 kt Cu over next decade)

Source: ECI 2018
Copper use is accelerating in the air-conditioning and refrigeration market

Source: MetalsPlus 2017
Solar and wind power will account for 0.35 Mt of annual copper demand in 2035.

Forecast global copper demand from installed solar power

Forecast global copper demand from installed wind power

Gradual slowing of installed capacity and copper demand due to maturing renewables growth in our Base Case scenario.

Source: WoodMcKenzie 2017

Copper demand in energy efficiency sectors almost doubles from 4.7 Mt in 2017 to reach 9.7 Mt by 2035.

Source: WoodMckenzie 2017

Distribution Transformers
Electric motors
Air Conditioners
The energy efficiency sector will contribute most to copper demand but electromobility grows faster.
Where is the copper in an electric vehicle?

Harness: 30 kg
Others: 5 kg

Source: IDTechEx 2017
Cu content by type of vehicle (kg per vehicle)

<table>
<thead>
<tr>
<th>Type of Vehicle</th>
<th>Cu Content (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel based (ICE)</td>
<td>23</td>
</tr>
<tr>
<td>Hybrid EV (HEV)</td>
<td>39</td>
</tr>
<tr>
<td>Plug-in hybrid EV (PHEV)</td>
<td>60</td>
</tr>
<tr>
<td>Battery EV (BEV)</td>
<td>83</td>
</tr>
</tbody>
</table>

Source: IDTechEx 2017
Copper demand: 1.9 million tonnes by 2035

By 2029, BEV/PHEV copper demand becomes larger than HEV demand and by 2033, EVs in total will consume more copper than ICE vehicles.

Source: WoodMcKenzie 2017

But how sustainable is copper?
How is copper produced?

Source: ICA 2018
The copper life cycle is circular

THE LIFE OF COPPER IS INFINITE

Mining

Smelting and Refining

Semi-Fabrication

Product Manufacture

Use Phase

Recycling
Understanding & reducing upstream impacts


Acidification: -7%
Eutrophication: -5%
Climate Change: -7%
Smog: -7%
Ozone Depletion: -20%
Energy: -14%

Credits: 6%
Other: 4%
Concentration Reagents: 5%
Sulfuric acid: 9%
Explosives: 5%
Transport: 25%
Fuels + Direct Emissions: 51%
Electricity: 31%

-20% to 100% chart showing the percentage contributions to various impacts.
Investment in sustainable operations*

* = (Capital + R&D + Environmental protection + Occupational health and safety) expenditures

- Sum of Environmental protection expenditure ($US)
- Sum of R&D expenditure ($US)
- Sum of Occupational health and safety expenditure ($US)
Reducing carbon emissions

Antofagasta announces **first mine to use 100 percent renewable energy** through agreement with a Chilean electric power utility company.

Zaldivar copper mine in Chile (image courtesy of Antofagasta PLC)
Replacing fossil fuels

Codelco installed a 43,920 m$^2$ solar plant to replace petroleum use at the Gabriela Mistral mine. The solar plant produces 80% of the energy required for the electrowinning process, avoiding 13,600 tonnes of CO$_2$ emitted to the environment each year.
Freeport McMoRan’s Cerro Verde concentrator expansion was completed in 2016. This included a High Pressure Grinding Roll circuit that is approximately 40 percent more energy efficient than a traditional Semi-Autogenous Grinding mill circuit.

(© Cerro Verde/Lance Lundstrom)
Using industrial heat to warm cities

Industrial heat from Aurubis’s Hamburg Copper Smelter will provide heat to the district of Hafencity East.

This is the first time that an entire district will be almost completely supplied with industrial heat from industry and is estimated to save 140,000 tonnes of CO₂ each year.
BHP’s $3.4 billion desalination plant

Largest desalination plant in Latin America

Two 42-inch pipelines transport water from the sea to 3,200 m above sea level

Four high-pressure pumping stations

45 million person-hours of work

“In Chile, we aspire to cease using fresh water altogether from 2030.”

- Daniel Malchuk, President of BHP Minerals Americas
Anglo American uses tech to reduce water use

Anglo developed “Pervasive Sensing” technology with partner Silix

Fiber-optic circuit measures mine water flows in real time and maximizes conservation at multiple points

Ability to monitor a region equal in size to Lower Manhattan, NY

Cost efficient and environmentally sound

Supports better process control, water conservation and, ultimately, improved metal recovery
Mapping copper stocks & flows

Keeping it in the loop

COPPER, THE RECYCLING CHAMPION

On average, 25 million tonnes of copper were used globally (2006 - 2015); 35 percent of this was sourced through recycling.

Source: ICA/Fraunhofer ISI (2017)

Copper recycling includes material collected from end-of-life products such as cables and wires, electric hardware, as well as the remelting of factory waste.

MINING
16.5 million tonnes

PRODUCTION & RECYCLING
5 million tonnes

CONSUMER SCRAP

SEMIFABRICATED PRODUCTS:
pipes, sections, sheets, wires

Some semi-fabricated copper products are manufactured entirely from recycling.

FACTORY SCRAP

3.5 million tonnes

SCRAP DEALERS

Take-back schemes, and collection

COPPER IS 100% RECYCLABLE: unlike most other materials, it can be perpetually recycled without loss of performance or qualities. Recycled copper is identical to mined copper.
Copper abounds…

**FIGURE 1: World copper reserves and resources in million tonnes (USGS, Kesler)**

- **Resource Base:** 300,000 (Kesler, 2008)
- **Reserves:** 790 (USGS, 2018)
- **Resources:** 5,000 (USGS, 2014)
The Long-Term Availability of Copper

**RESERVES IN CONTEXT TO INDUSTRY**

Since 1960, 278 billion metric tons of copper have been mined. Between now and 2050, the copper industry can expect to get another 138 billion metric tons of copper from reserves. In 2020, the United States Geological Survey (USGS) estimated World copper reserves were 766 million metric tons. Current rate of production is 3.5 million metric tons per year. Copper is a finite resource, and it is essential to ensure that we use it responsibly and efficiently.

**Environmental Profile**

Copper Recycling

**THE IMPORTANCE OF RECYCLING**

Copper recycling is crucial for sustainability. Copper is non-degradable and can be recycled indefinitely. Recycling copper reduces the demand for primary copper production, conserving natural resources and reducing greenhouse gas emissions. Copper can be recycled and reused in various applications, including electrical, automotive, and construction industries.

**COPPER IN USE**

Copper has a wide range of applications, including electrical wiring, plumbing, and construction. It is known for its durability, thermal and electrical conductivity, and resistance to corrosion. Copper is also used in aerospace, automotive, and electronic industries.

**Copper. Makes the World Work Better.**

Available at copperalliance.org

Payne Institute, Nov 7 2018
Thank you

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