Life cycle assessment of metals: A scientific synthesis

Philip Nuss, Matthew J. Eckelman

dx.doi.org/10.1371/journal.pone.0101298

“Metals are ubiquitous in today's society; there are few materials or products where metals are absent or have not played a role in their production. A sustainable metals management system has to consider many aspects of a metals life cycle and include the environmental, social, and economic spheres of sustainability. This work showed that for the majority of elements in their metallic form, the cradle-to-gate environmental burdens are largely a result of the purification and refining stages. Cumulative energy use, global warming potential, human health implications and ecosystem damage are estimated by metal life cycle stage (i.e., mining, purification, and refining) were analysed and showed that precious metals including platinum group elements (Ru, Rh, Pd, Os, Ir, Pt) and Au, display the highest environmental burdens on a per kilogram comparison, while many of the major industrial metals (e.g., Fe, Mn, Ti) are found at the lower end of the environmental impacts scale.
Another important factor to consider is end-of-life recycling, however rates for only eighteen metals (out of a total of sixty) are above 50%. These include silver, aluminum, gold, chromium, copper, iron, manganese, niobium, nickel, lead, palladium, platinum, rhenium, rhodium, tin, titanium, and zinc. For many of the specialty metals, such as scandium and yttrium, as well as the rare earth elements, end-of-life recycling rates were found to be less than 1%.[1]”

1. Graedel TE, Allwood J, Birat J-P, Buchert M, Hagelüken C, et al.. (2011) What Do We Know About Metal Recycling Rates? *J. Ind. Ecol,* 15: : 355–366. doi/10.1111/j.1530-9290.2011.00342

~~~~~~

Criticality of metals and metalloids

T. E. Graedel, E. M. Harpera, N. T. Nassara, Philip Nussa, and Barbara K. Recka

10.1073/pnas.1500415112

Criticality of 62 metals and metalloids in a 3D “criticality space” consisting of supply risk, environmental implications, and vulnerability to supply
~~~~~~

restriction was determined. Contributing factors that lead to extreme values include high geopolitical concentration of primary production, lack of available suitable substitutes, and political instability. The results show that there are limitations for many metals important in emerging electronics.

`~~~~

US Environmental Protection Agency - Understanding Global Warming Potential

www.epa.gov/ghgemissions/understanding-global-warming-potentials