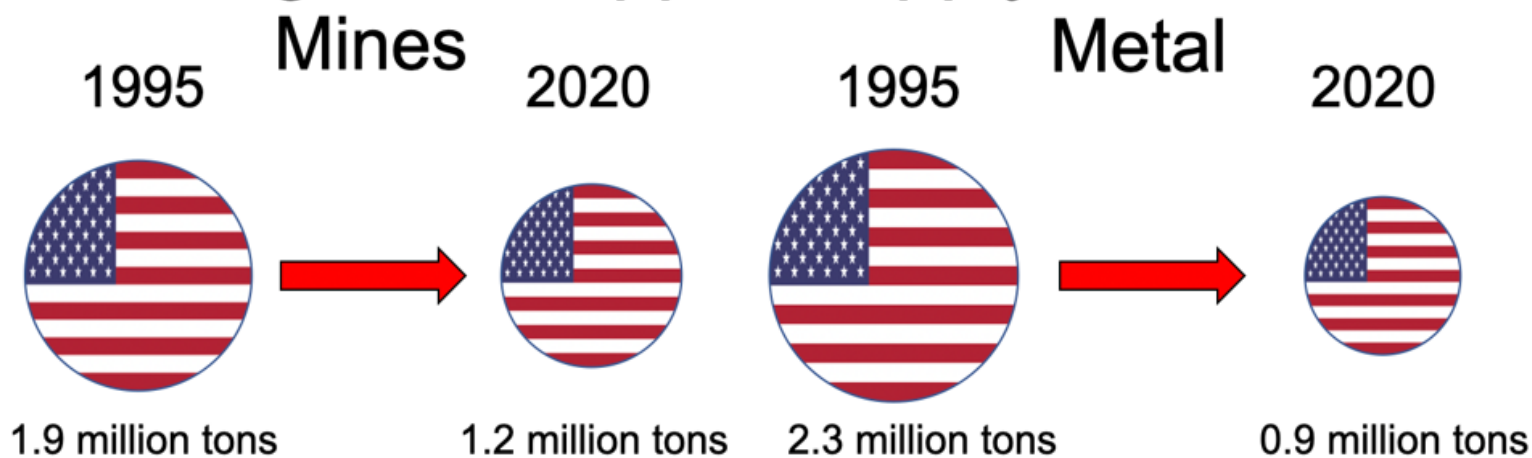
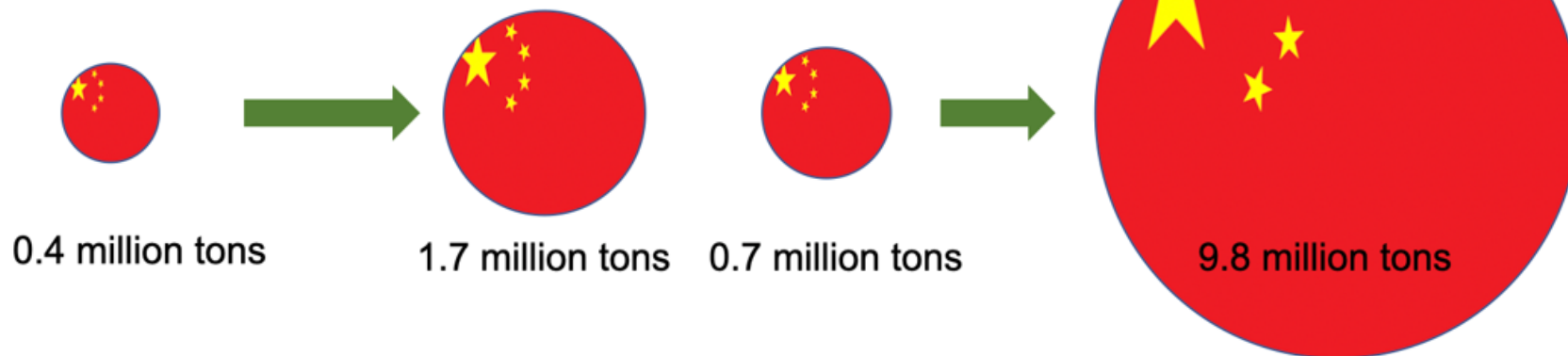


## Changes in Copper Supply Chain



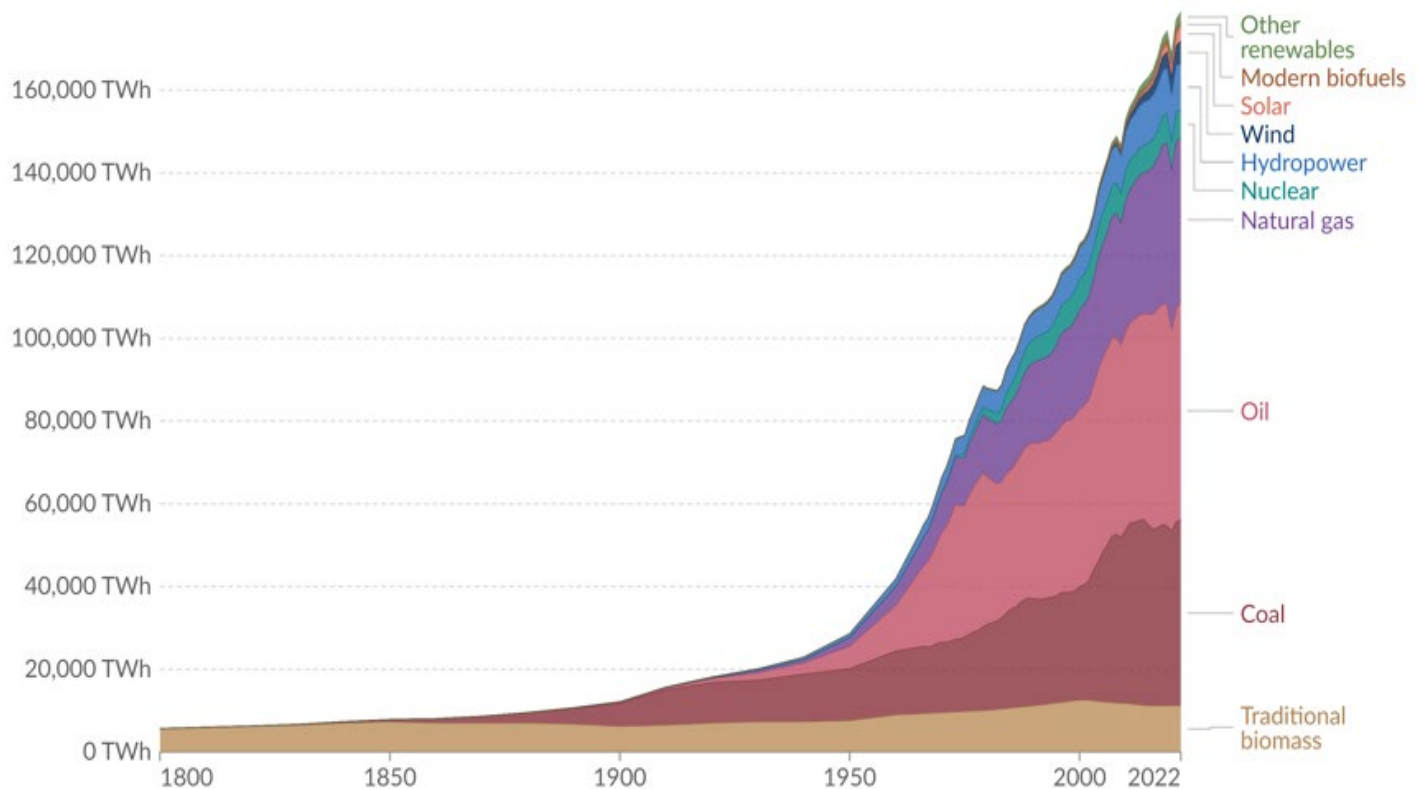
**Critical Minerals  
By-Products  
from Metal  
Production**

**Te, PGMs**



# Global primary energy consumption by source

Primary energy<sup>1</sup> is based on the substitution method<sup>2</sup> and measured in terawatt-hours<sup>3</sup>.



Data source: Energy Institute - Statistical Review of World Energy (2023); Smil (2017)

Note: In the absence of more recent data, traditional biomass is assumed constant since 2015.

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**1. Primary energy:** Primary energy is the energy available as resources – such as the fuels burnt in power plants – before it has been transformed. This relates to the coal before it has been burned, the uranium, or the barrels of oil. Primary energy includes energy that the end user needs, in the form of electricity, transport and heating, plus inefficiencies and energy that is lost when raw resources are transformed into a usable form. You can read more on the different ways of measuring energy in our article.

**2. Substitution method:** The 'substitution method' is used by researchers to correct primary energy consumption for efficiency losses experienced by fossil fuels. It tries to adjust non-fossil energy sources to the inputs that would be needed if it was generated from fossil fuels. It assumes that wind and solar electricity is as inefficient as coal or gas. To do this, energy generation from non-fossil sources are divided by a standard 'thermal efficiency factor' – typically around 0.4 Nuclear power is also adjusted despite it also experiencing thermal losses in a power plant. Since it's reported in terms of electricity output, we need to do this adjustment to calculate its equivalent input value. You can read more about this adjustment in our article.

**3. Watt-hour:** A watt-hour is the energy delivered by one watt of power for one hour. Since one watt is equivalent to one Joule per second, a watt-hour is equivalent to 3600 Joules of energy. Metric prefixes are used for multiples of the unit, usually: - kilowatt-hours (kWh), or a thousand watt-hours. - Megawatt-hours (MWh), or a million watt-hours. - Gigawatt-hours (GWh), or a billion watt-hours. - Terawatt-hours (TWh), or a trillion watt-hours.

# Trends in Aggregate Emissions, Demographics, and Economics: 1980-2022

