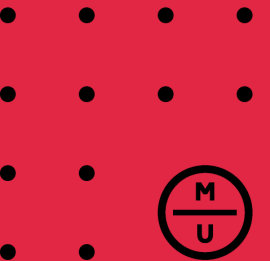




Future resources: the role of minerals in a modern world and the path to a sustainable circular economy

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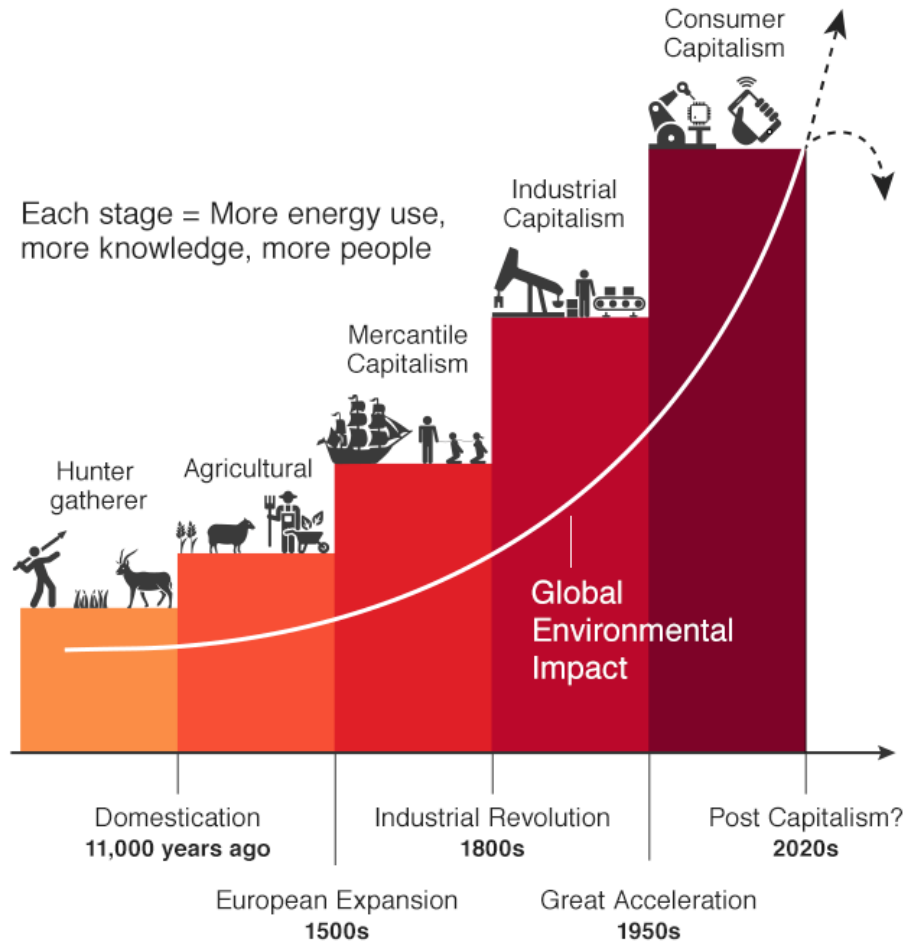
From physical tools to science fiction

- Few professions have been more important to civilisation than metallurgy, and no group of elements have had more impact on humankind's control of their environment than metals.
- The development of technology to produce smelted iron, the main metal of construction, by the application of stored energy in fossil fuels, marked a turning point for human quality of life.
- Unfortunately, the use of science to harvest the earth's gifts was not always done the most wisely and responsibly.
- The industries of the future will have to address this more wisely.



Exploding demand and pollution

Human societies and their increasing environmental impact



- What followed was an exponential growth of industrialisation and the exploitation of a seemingly limitless supply of fossil fuel energy and easily accessible resources to meet human needs.
- Many new metals were discovered in the next 100 years, each with its own unique physicochemical properties and possible uses.
- As a result, within a period of only one century, we have exhausted almost all easily accessible and high-grade ore deposits and contributed to global warming.
- This has prompted significant research efforts to develop better technology, reduce waste disposal, obtain metals from alternative sources, including recycling, and to ensure cleaner living environment.

New energy sources and storage



Hitech devices

Today, supplying enough minerals and metals to meet the world's ever-increasing demand is a global challenge.

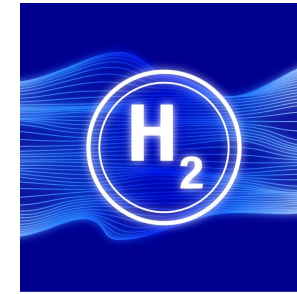
The materials that are used to produce the modern devices are primarily metals.



Clean energy storage

Battery production is rapidly increasing to meet the ability to capture renewable energy.

The rapidly increasing adoption by the market of clean and portable energy storage is fuelling a dramatic increase in the demand for 'energy' metals.

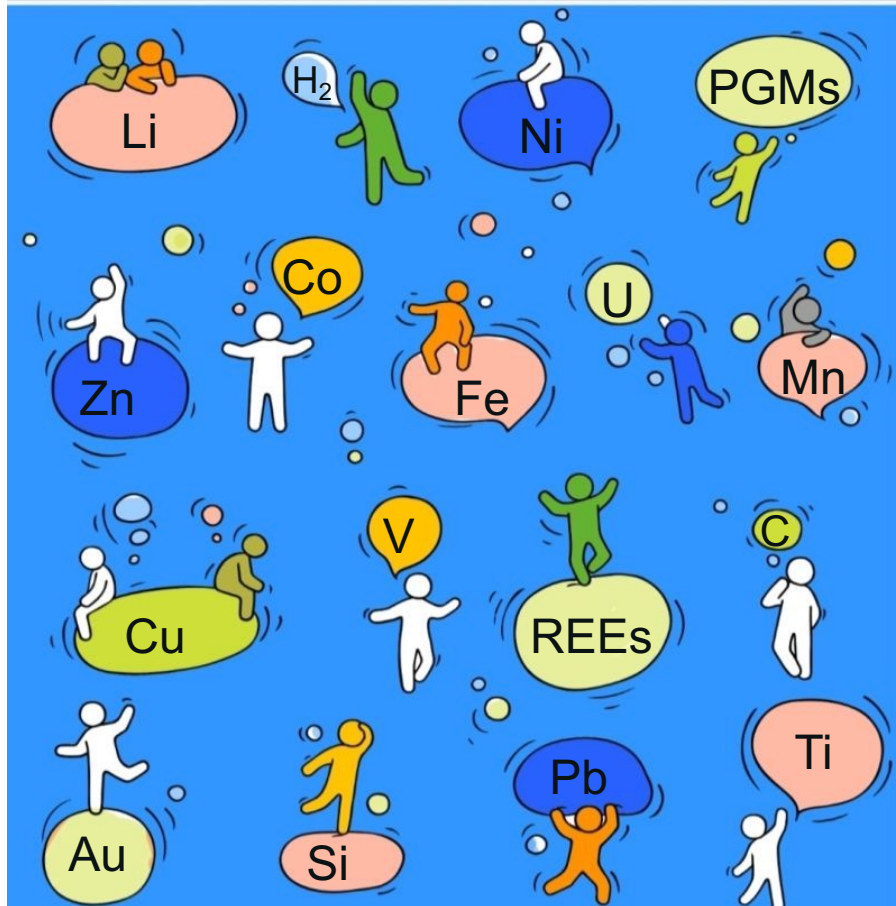


Green steel

Next-generation of clean energy solutions are required in the metal production technology to reduce the reliance on fossil fuels, in order to decarbonize the production and limit global warming.

Hydrogen is an effective solution to eliminate CO₂ emissions but much research is needed to develop the implementation of this technology.

Research & Development at the Centre for Water Energy and Waste



- Metallurgical science and engineering have a large role to play in moving towards the next generation of energy generation and storage.
- The rapidly increasing adoption by society of clean and portable energy storage is fuelling a major increase in the demand for ultrapure metals.
- At the same time, the build-up of waste is increasing the need for production of by-products, reuse of tailings and multicommodity technology.
- Clean energy depends on the ability to produce enough metal for batteries and green hydrogen, but also, on finding solutions to appropriately manage the waste associated with the used devices and increased production.
- **Murdoch has a long and proud track record of partnering with industry and government to help develop solutions to many of those problems and to see that we succeed in this challenge.**

Critical requirements include the mineral resources and innovative technology, but also a skilled workforce

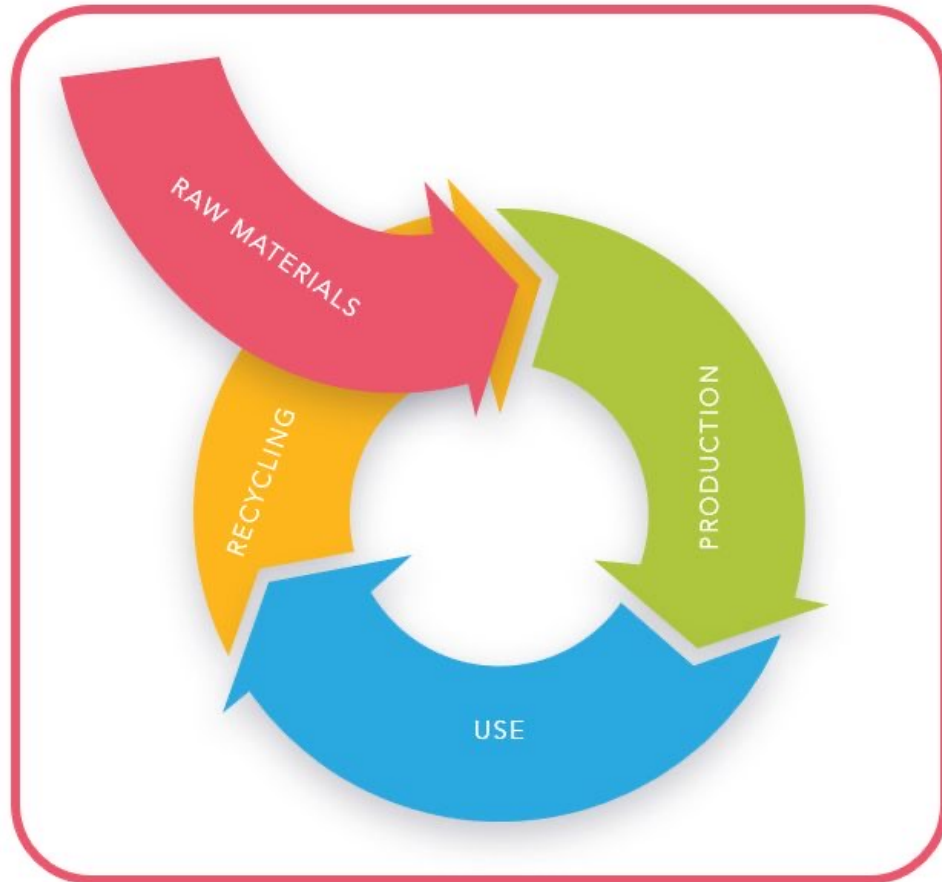
Labor shortages



Critical technical skills

- Minerals processing**
 - Physical processing the feed to produce mineral concentrates
- Pyrometallurgy**
 - Thermal extraction of metals from concentrates to produce bulk metals
- Hydrometallurgy**
 - Aqueous processing of solutions to produce high grade individual metals
- Electrochemistry**
 - Recovery of the metals into precursor chemicals for final products manufacture
- Plant design**
 - Design, construct and operation of new metal production facilities

Recycling, sustainability and the circular economy



- Metals are essentially indestructible and thus infinitely recyclable, which opens the possibility of developing effective technologies to solve both the supply and disposal issues.
- This leads to a circular economy and, with the use of renewable energy, the only true prospect of establishing a sustainable society.
- It is important for industry companies, government and research institutions to collaborate, share ideas and create facilities to help identify opportunities for improvement, develop new process solutions and human resources to implement these changes.
- **Industries of the future that will improve life today without degrading life for future generations. Metals reused indefinitely. A clean, resources-driven revolution.**

Thank you

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