KAREN HANGHØJ, BRITISH GEOLOGICAL SURVEY, BGS

Geoscience and the Energy Transition

GeoWeek: What might net zero look like locally?

British Geological Survey

BRITISH GEOLOGICAL SURVEY

BGS offices and staff across the UK

651 total staff

FUNCTION

447 Science

204 Non-science

BGS offices

BGS observatories and facilities

Staff head count as of January 2021

The national role of BGS

- We provide the national repository of data and knowledge for geoscience in the UK.
- We develop services and provide impartial and independent geoscientific advice to Government, Industry and the public.
- We provide analytical facilities, including observatory networks, in support of earth science research and Government needs.
- We deliver UK leadership and make our skills, expertise and knowledge available globally.
- We undertake research and development in pursuit of these aims.

BGS Vision and Mission, Understanding our Earth

Our vision

Our vision is for a safer, more sustainable and prosperous planet and a future based on sound geoscientific solutions.

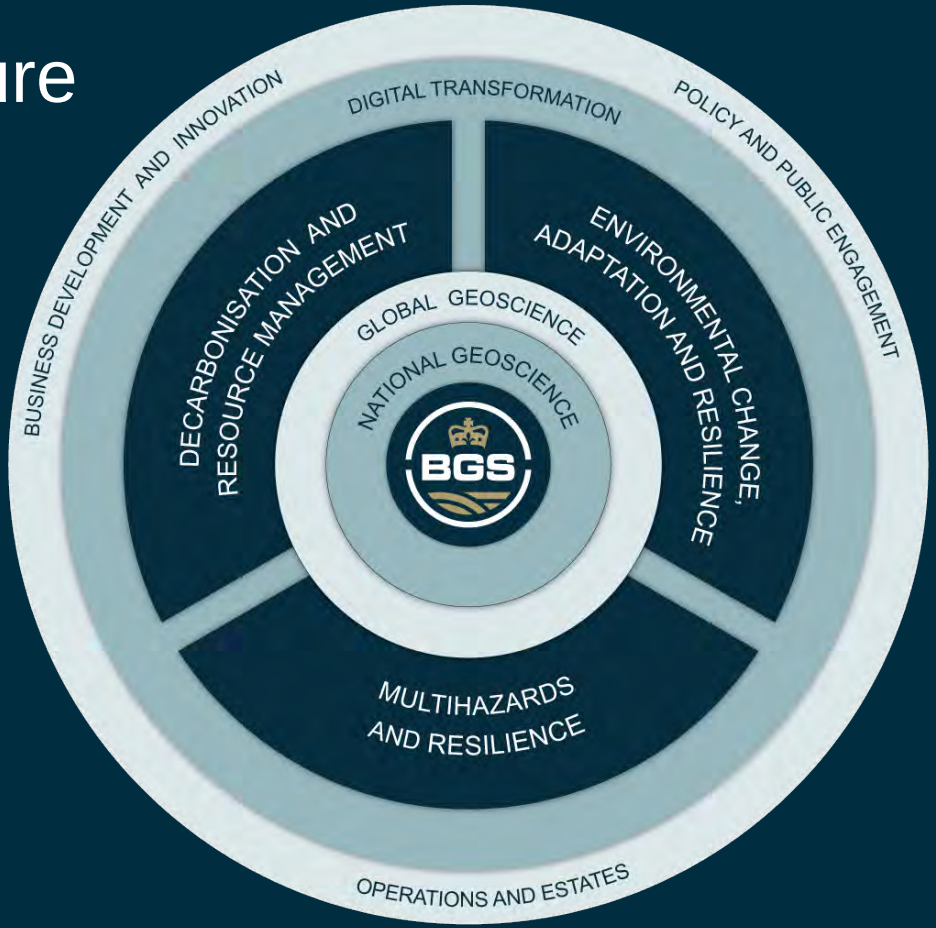
Our mission

Our mission is to provide impartial and independent geoscience advice and data.

We observe, monitor and characterise geological environments, using our proven abilities in earth systems science.

We also build strategic partnerships with academic institutions, governments, industry and the public to develop our work and share our expertise.

BGS Science Structure



SUSTAINABLE DEVELOPMENT GOALS

1 NO POVERTY

2 ZERO HUNGER

3 GOOD HEALTH AND WELL-BEING

4 QUALITY EDUCATION

5 GENDER EQUALITY

6 CLEAN WATER AND SANITATION

7 AFFORDABLE AND CLEAN ENERGY

8 DECENT WORK AND ECONOMIC GROWTH

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

10 REDUCED INEQUALITIES

11 SUSTAINABLE CITIES AND COMMUNITIES

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

13 CLIMATE ACTION

14 LIFE BELOW WATER

15 LIFE ON LAND

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

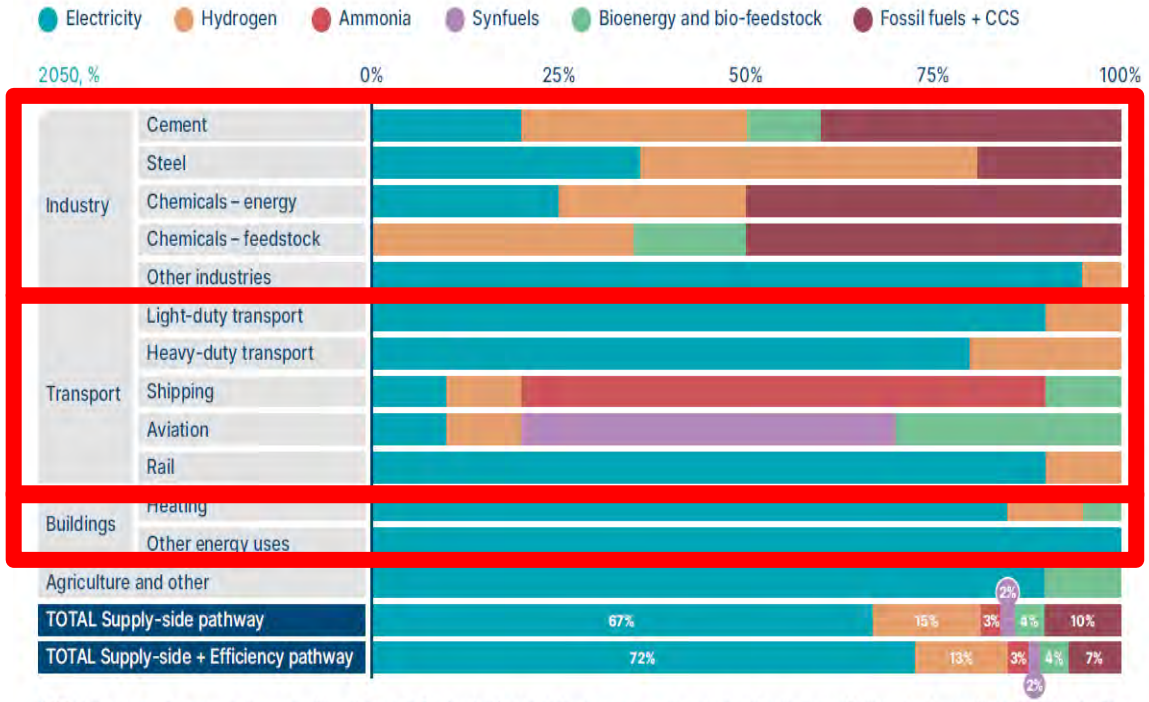
17 PARTNERSHIPS FOR THE GOALS

SUSTAINABLE DEVELOPMENT GOALS

SDG7

- ‘Ensure access to affordable, reliable, sustainable and modern energy’
- aims at improving energy access, increasing renewables in the energy mix, energy efficiency, and integration and international cooperation
- has targets to 2030, and indicators of progress.

The world in 2050?



NOTE: Steel energy mix represents the supply-side pathway only. For chemical feedstock, inputs are not used as energy but in order to provide the molecules required to build the chemicals. In our model, for comparison we express it in EJ equivalent.

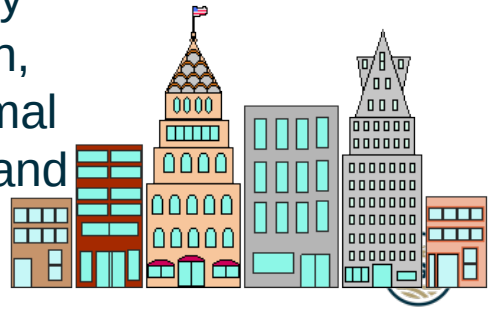
SOURCE: SYSTEMIQ analysis for the Energy Transitions Commission (2020)

https://www.energy-transitions.org/wp-content/uploads/2020/09/Making-Mission-Possible-Full-Report.pdf

Hydrogen, CCS, electricity

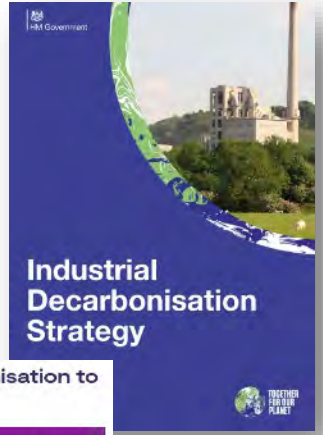
Electricity hydrogen, ammonia, synfuels

Electricity hydrogen, geothermal heating and cooling



What does Government decarbonisation policy look like?

- Prime Minister's ten point plan
- Energy White Paper
- North Sea Transition Deal
- Global Britain in a competitive age
- Industrial Decarbonisation Strategy
- Nine industrial cluster projects



Prime Minister's Ten point plan

HM Government

The Ten Point Plan for a Green Industrial Revolution

Building back better, supporting green jobs, and accelerating our path to net zero

THE PRIME MINISTER'S TEN POINT PLAN

NUCLEAR POWER

Nuclear power provides a reliable source of low-carbon electricity. We are pursuing large-scale nuclear, whilst also looking to the future of nuclear power in the UK through further investment in Small Modular Reactors and Advanced Modular Reactors.

GREEN PUBLIC TRANSPORT, CYCLING AND WALKING

We will accelerate the transition to more active and sustainable transport by investing in rail and bus services, and in measures to help pedestrians and cyclists. We will fund thousands of zero-emission buses and give our towns and cities cycle lanes worthy of Holland.

OFFSHORE WIND

By 2030 we plan to quadruple our offshore wind capacity so as to generate more power than all our homes use today, backing new innovations to make the most of this proven technology and investing to bring new jobs and growth to our ports and coastal regions.

HYDROGEN

Working with industry the UK is aiming for 5GW of low-carbon hydrogen production capacity by 2030. We are also pioneering hydrogen heating trials, starting with a Hydrogen Neighbourhood and scaling up to a potential Hydrogen Town before the end of this decade.

JET ZERO AND GREEN SHIPS

By taking immediate steps to drive the uptake of sustainable aviation fuels, investments in R&D to develop zero-emission aircraft and developing the infrastructure of the future at our airports and seaports, we will make the UK the home of green ships and planes.

GREENER BUILDINGS

Making our buildings more energy efficient and moving away from fossil fuel boilers will help make people's homes warm and comfortable, whilst keeping bills low. We will go with the grain of behaviour, and set a clear path that sees the gradual move away from fossil fuel boilers over the next fifteen years as individuals replace their appliances and are offered a lower carbon, more efficient alternative, supporting 600,000 jobs.

CARBON CAPTURE, USAGE & STORAGE (CCUS)

Our ambition is to capture 10Mt of carbon dioxide a year by 2030 - the equivalent of four million cars' worth of annual emissions. We will invest up to £1 billion to support the establishment of CCUS in four industrial clusters, creating 'SuperPlaces' in areas such as the North East, the Humber, North West, Scotland and Wales. We will bring forward details in 2021 of a new mechanism to bring private sector investment into industrial carbon capture and hydrogen projects via our new business models to support these projects.

PROTECTING OUR NATURAL ENVIRONMENT

We will safeguard our cherished landscapes, restore habitats for wildlife in order to combat biodiversity loss and adapt to climate change, all whilst creating green jobs.

ZERO EMISSION VEHICLES

From 2030 we will end the sale of new petrol and diesel cars and vans, 10 years earlier than planned, and provide a £2.8 billion package of measures to support industry and consumers to make the switch to cleaner vehicles.

GREEN FINANCE AND INNOVATION

We have committed to raising total R&D investment to 2.4 per cent of GDP by 2027 and in July 2020 published the UK Research and Development Roadmap. The next phase of green innovation will help bring down the cost of the net zero transition, nurture the development of better products and new business models, and influence consumer behaviour.

UK CONTEXT

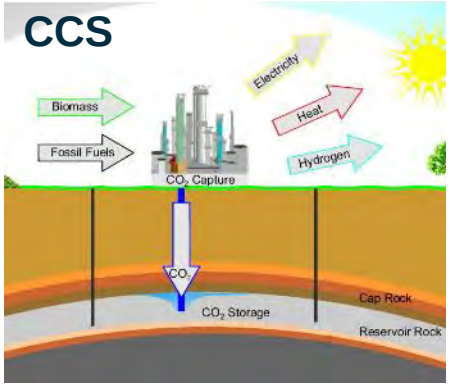
Energy White Paper – Powering our Net Zero Future

	Industry & Power	Buildings	Transport
			
Where the geosciences can contribute?	CCS, hydrogen, energy storage, turbine geotechnical, metals	Geothermal, heat storage and coal mine energy, metals	Metals, critical metals/circular economy
Awareness of geoscience contribution	GOOD	POOR	RISING!

UK CONTEXT

- Cavern storage
- Halite behaviour for Hydrogen storage
- Energy storage in porous media
- Battery metals

- Optimising CO_2 storage
- Storage containment
- UK Storage Pilot
- CO_2 Storage Technology Development



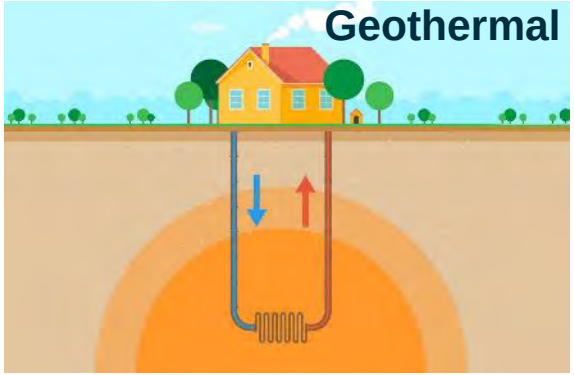
transport

industry & power

buildings

Critical metals

- Geology of platinum group, rare earth metals or silver and cobalt

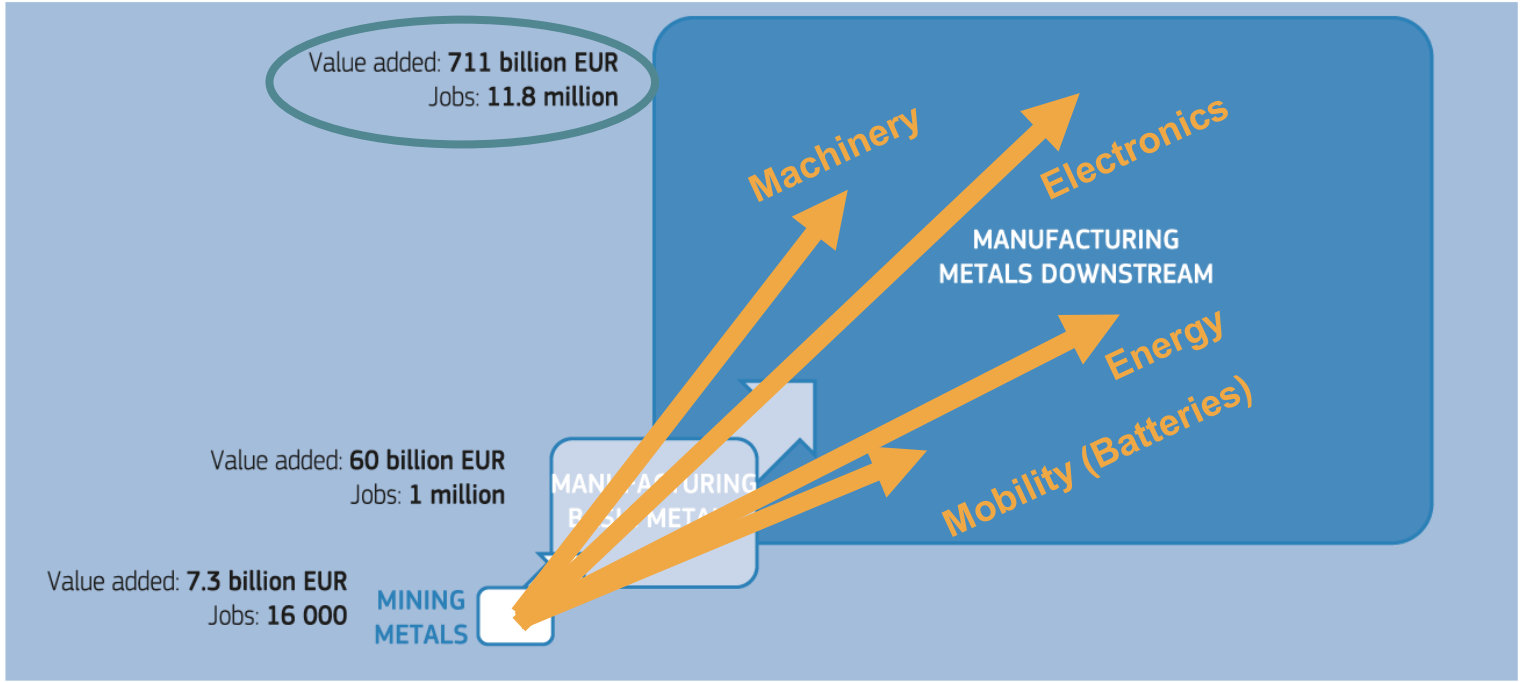


- Geothermal Road Map
- Geothermal potential of local rocks
- Subsurface urban heat resources

After PR Neeb, 2006

Raw materials key enablers Europe

Figure 19: Value added and number of jobs associated with metals (mining, basic manufacture and downstream sectors) in the EU (2012)[82]



Source: JRC

Raw materials key enablers for energy transition

Brown Economy

Green Economy

Fossil Fuels for combustion engines, generators and power stations: oil. gas, coal

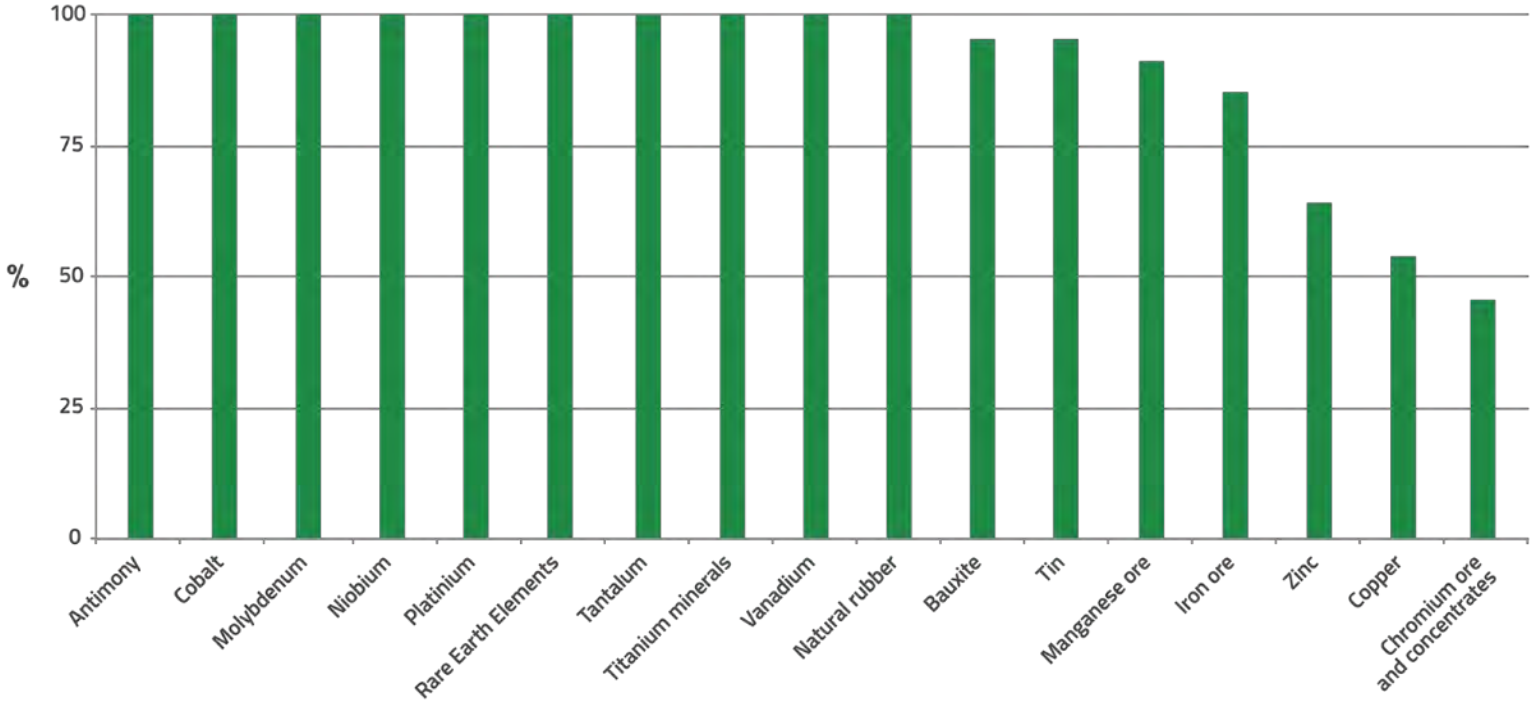
Energy Transition

Functional Materials in e-motors, energy storage, energy conversion containing, for example, Co, Li, Pt, REE, Ge, Ga, Si, V

Fundamental shift in the resource basis of a society

Images: Agarwal et al. 2017 Green Transparency

Import dependence for selected raw materials



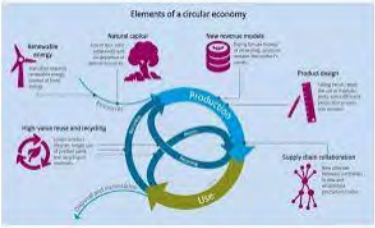
Source: JRC analysis based on data from report of the Ad hoc Working Group on defining critical raw materials, 2010, 'Critical raw materials for the EU'

Closed loops? - Recycling

Profitable shift to Circular Economy ...
iceclog.com

The circular economy concept, explained
innovationnewsnetwork.com

The Circular Economy In Detail
ellenmacarthurfoundation.org



Circular economy: a definition and most ...
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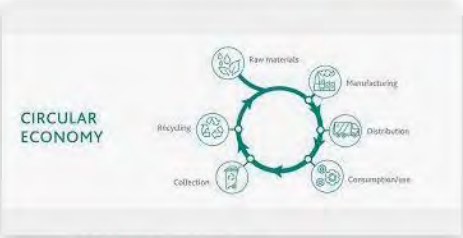
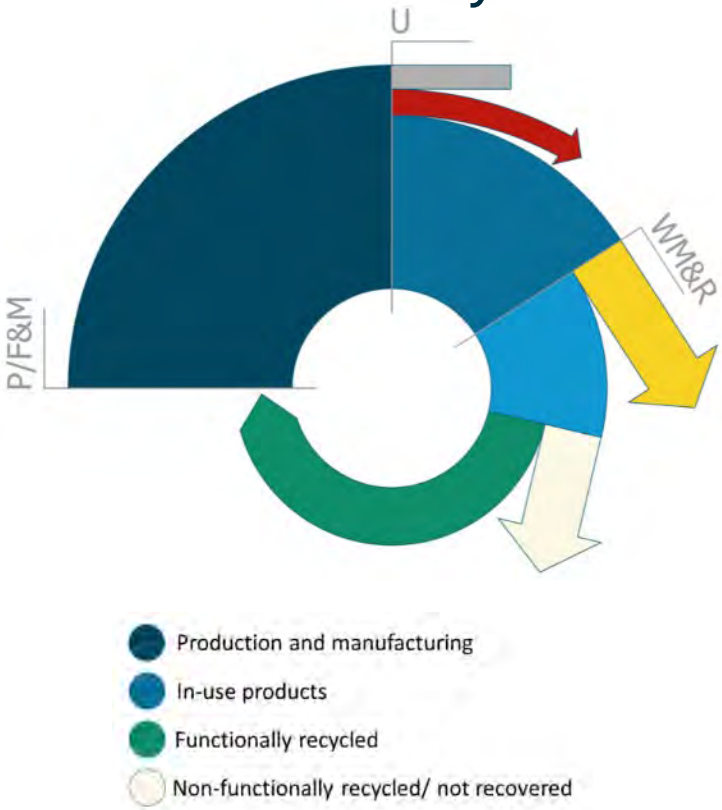


Eastman | Enabling a Circular Economy ...
eastman.com

Research helps Europe advance towards ...
ec.europa.eu

How much can we recycle?



In-use dissipated

- Se, Mn in fertilizers
- Al, Cu, Mg in pyrotechnics

Currently unrecyclable

- REEs in polishing powders
- Al in steelmaking

Potentially recyclable

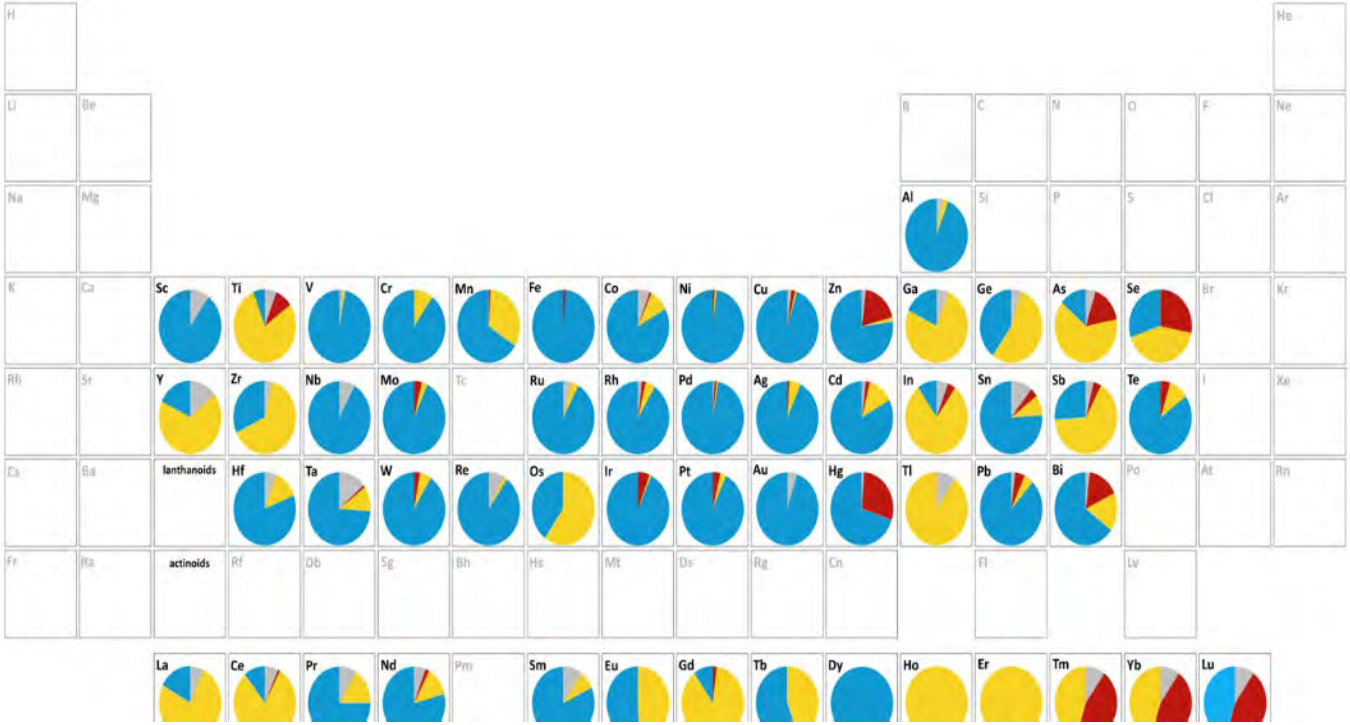
- Alloying elements recoverable/recyclable

Unspecified

- Miscellaneous uses

Source: Graedel Pers. Comm. and Ciacci et al. Environ Sci. Technol. 2015

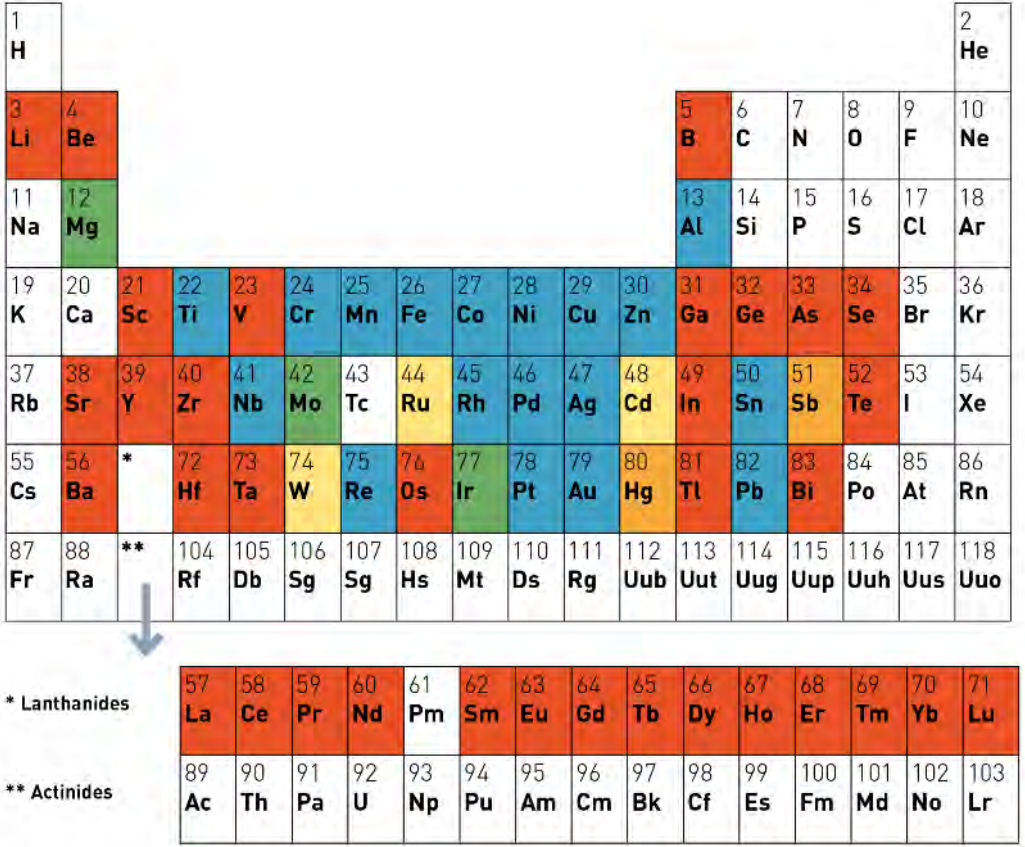
How much can we recycle?

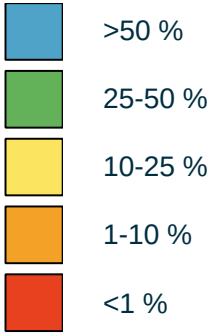


In-use dissipated **Currently unrecyclable** **Potentially recyclable** **Unspecified**

Source: Ciacci, L., B. K. Reck, N. T. Nassar, and T. E. Graedel. 2015. Lost by Design. Environ. Science & Technology 49(16): 9443-9451

How much do we recycle?





Source: UNEP 2011.
Recycling rates of metals

After PR Neeb, 2006


Right

Closed loops? - Demand

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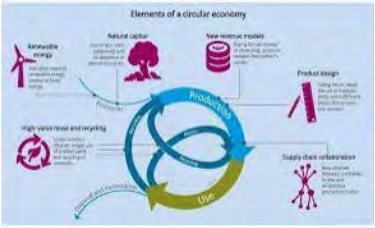

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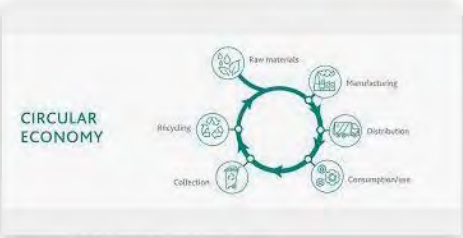

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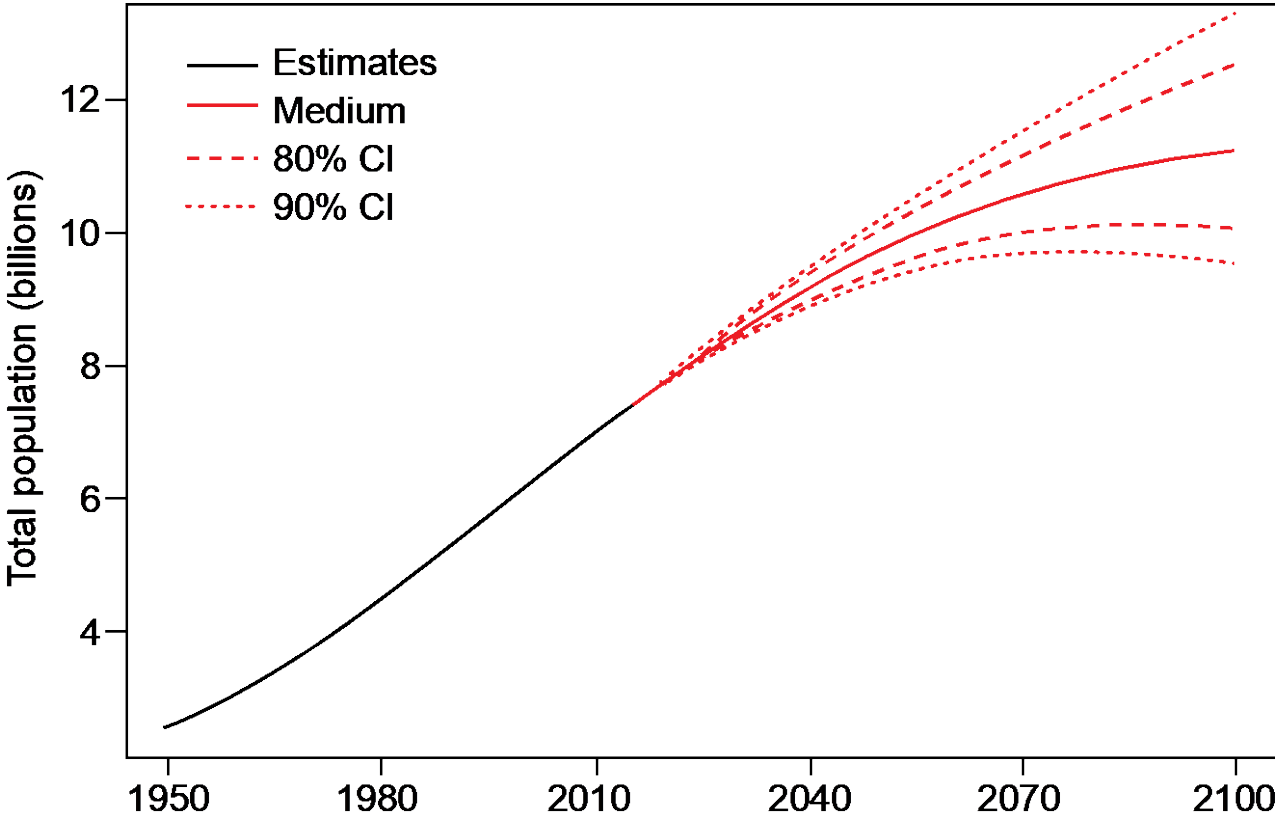
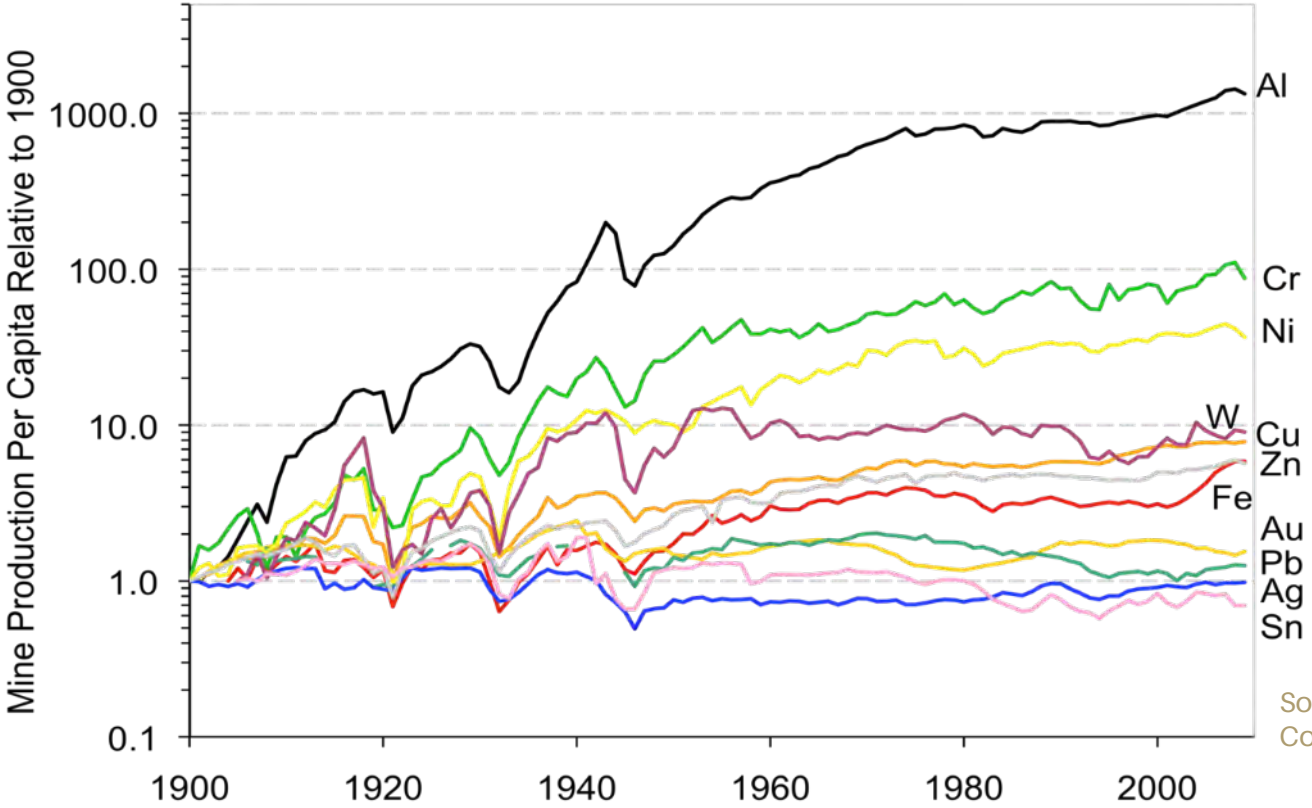
World population



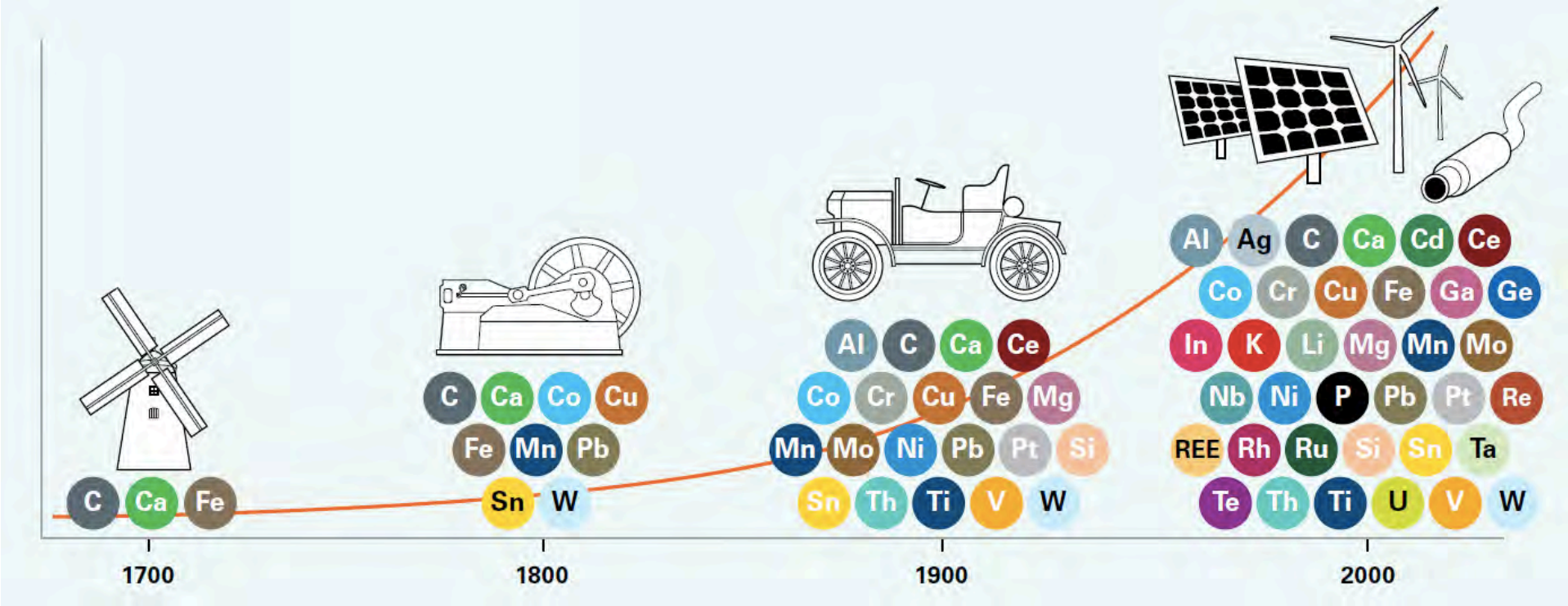
Source: United Nations, Department of Economic and Social Affairs. Population Division (2015). World Population Prospects: The 2015 Revision, New York, United States.

Global per Capita metals use 1900-2008



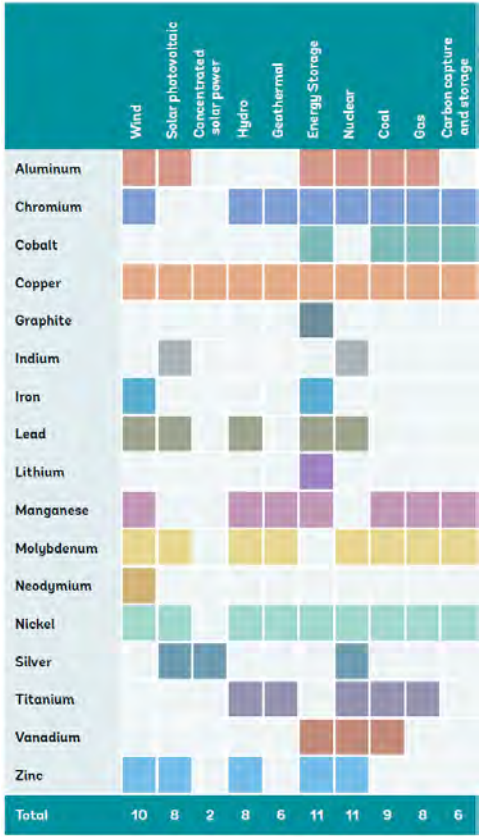
Source: Graedel, Pers. Comm. (2015)

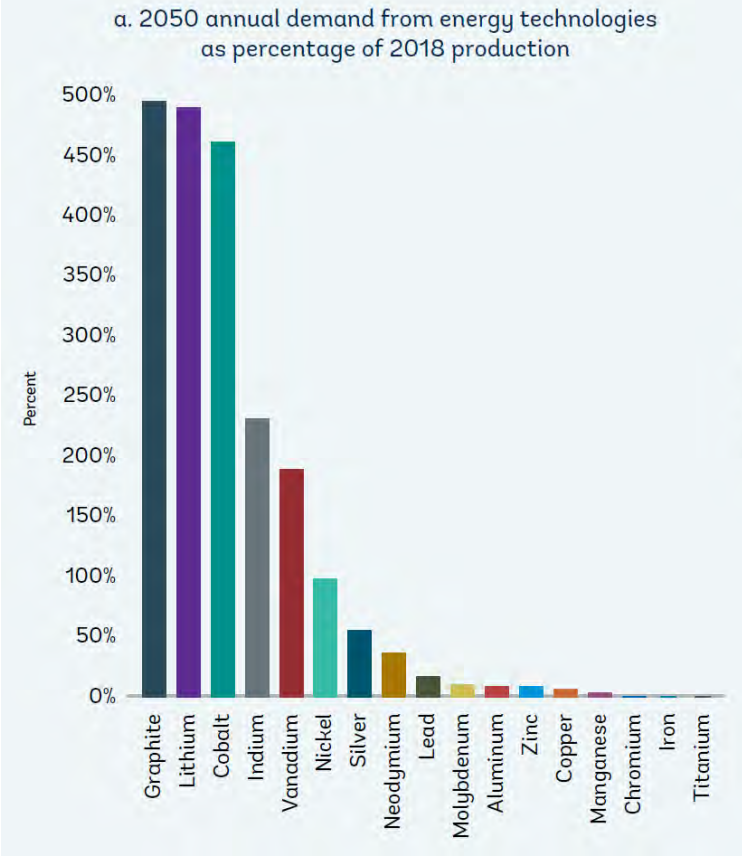
Which mineral raw materials do we use?



Source: Achzet et al (2009)

Metals and minerals in the energy transition

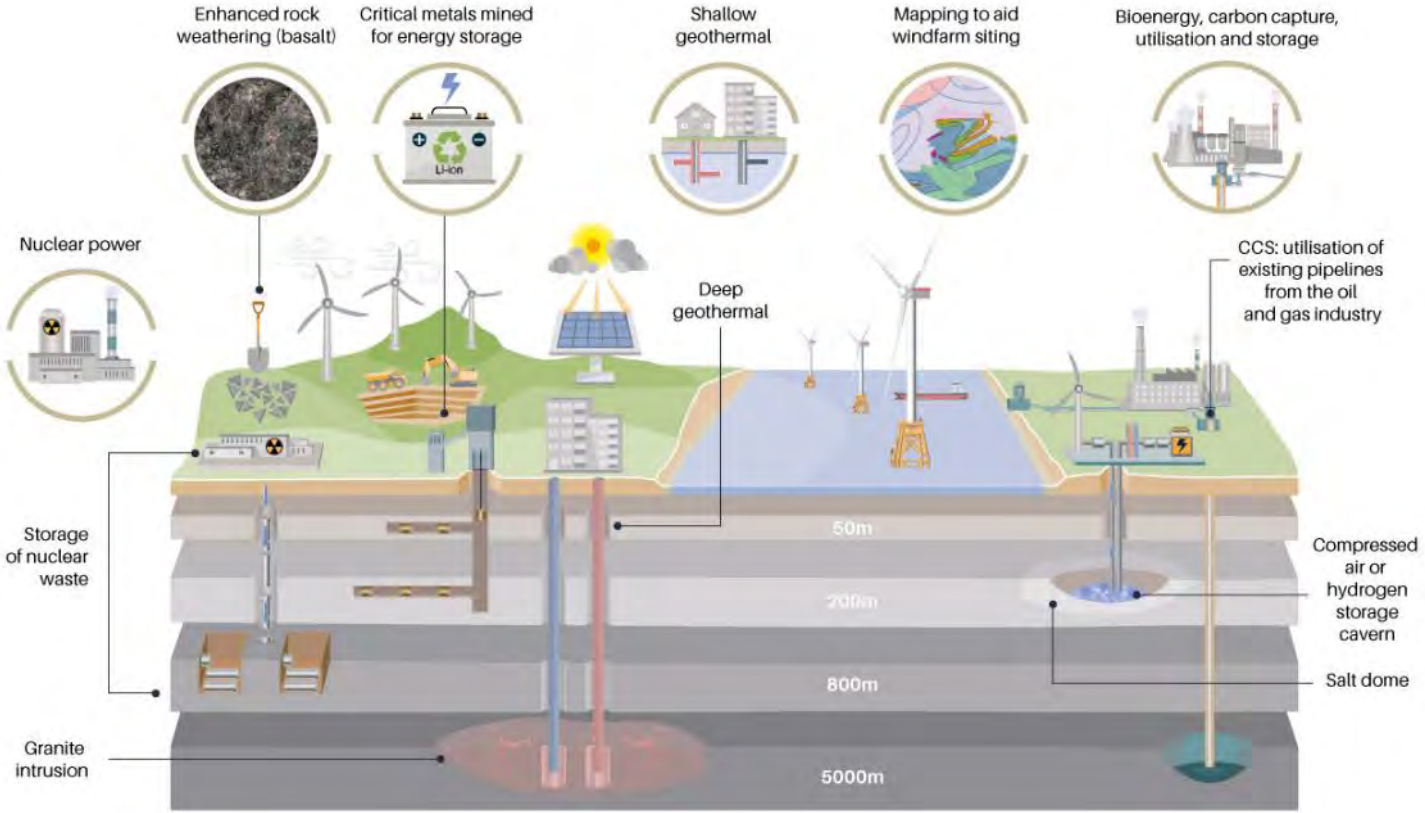




Source: World Bank 2018 Report; Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition

The Metal Value Chain and the circular economy

Geoscience needed to achieve Net Zero



Knowledge, Skills, Attitudes

- **Understand the Trends:** Focus on sustainability, Increased demand for some raw materials, digital transformation, miniaturization, products as a service (PAAS), waste minimization, globalization
- **Understand the Societal Relevance:** Role of green energy and raw materials to the SDGs, sustainability assessment, safety, resource efficiency, social license to operate, material intensity, design for post-use, material flow analysis, industrial symbiosis, business models
- **Understand the Complexity of achieving Net Zero:** Geoscience, engineering, metallurgy, design for circularity, psychology, social sciences, entrepreneurship, international standards, creativity
- **Build strong Awareness and Skills :** Education, strengthen diversity, and inclusion in Geoscience (and everywhere else) and at all levels

Natural Environment Research Council

British Geological Survey