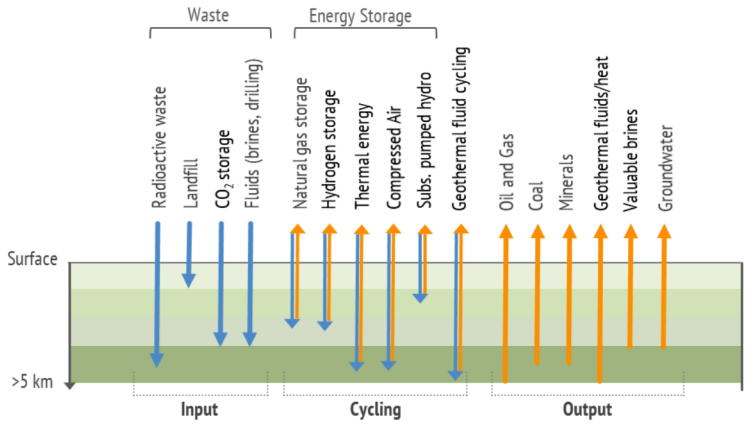
The Geological Society

Meeting the Paris Agreement: the critical role of Earth science



Delivery of the Paris Agreement requires coherent and strategic management of the subsurface to deliver decarbonisation targets and to prevent conflicting use of the space.

Geological technologies, skills and knowledge are essential to the characterisation and stewardship of the subsurface resources needed to meet the Nationally Determined Contributions (NDCs).

Image left: The multiple - and sometimes conflicting - uses of geological basins for decarbonisation. Adapted from Cook (2017) by G Johnson.

Energy

Greenhouse gas removal (GGR)

Greenhouse gases will need to be removed at >5 Gt/yr by 2050, equal roughly to emissions from the current oil industry (IPCC). Meeting this removal target will require a 100-fold increase in carbon capture and storage (CCS), in addition to exploring nature-based solutions. Carbon capture and storage is a proven technology. At present, there are 51 large-scale CCS facilities worldwide.

Energy storage

The subsurface storage of energy will be increasingly important in managing intermittency gaps in some sources of renewable energy, such as wind and solar. It will also address the security of long-term supply i.e. replacing gas storage or international imports.

This will require a careful assessment of subsurface conditions and storage availability for pumped storage hydropower, thermal, compressed air or hydrogen storage.

Hydrogen

Hydrogen emits no CO_2 when burned as fuel. It can be combusted to provide heat or used in fuel cells to generate electricity. Hydrogen can also be used to store excess energy generated by renewable sources at multiple time scales and then stored in the subsurface in caverns until demand requires. It can also be used as a replacement fuel for heavy goods vehicles and shipping.

However, most hydrogen is currently produced by reforming methane, which generates CO_2. The development of a hydrogen economy will need to be supported by the expansion of CCS, ideally in integrated operations until hydrogen can be produced entirely using renewable energy (via hydrolysis).

Geothermal

Geothermal energy can be used to generate electricity if temperatures are high enough or to heat homes or commercial buildings at lower temperatures with heat pumps. Geothermal heating systems can also be used to cool buildings, providing a low-carbon solution to the growing global demand for air conditioning.

Geothermal energy offers a low-carbon solution to the complex heating and cooling needs faced by many nations, but requires financial risk-sharing from governments and infrastructural support in order to maximise this resource.

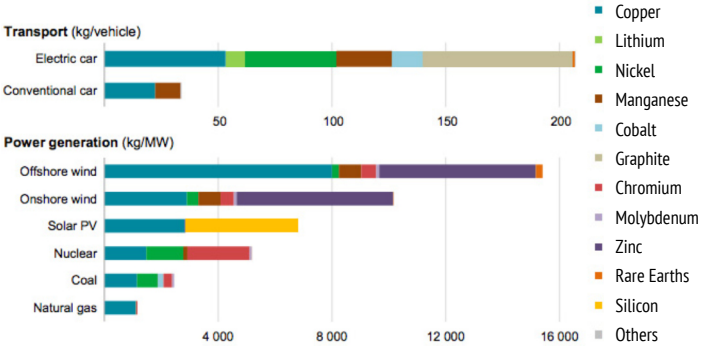
Renewable energy

The energy industry's demand for minerals will increase 6-fold by 2040 and cannot be met through recycling and reuse alone.

Supplying the mined minerals needed to support the expansion of renewable energy technologies proposed in the NDCs requires a secure, sustainable and just supply chain.

Nuclear

Nuclear power is a low-carbon energy source, and may be a useful contribution to NDCs, especially considering the lifetime of a standard nuclear power plant (~80 years). Any expansion of nuclear power capabilities will require subsurface planning to ensure sustainable mining of uranium, site stability and the safe, long-term disposal of radioactive waste.



Minerals used in selected clean energy technologies and fossil fuel technologies. Source: IEA / Carbon Brief.

UN CLIMATE CHANGE CONFERENCE UK 2021
IN PARTNERSHIP WITH ITALY

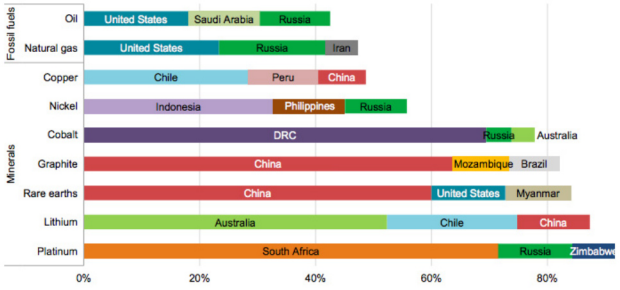
The Geological Society

Meeting the Paris Agreement: the critical role of Earth science

Transport

Electric vehicles (eVs) require 6 times the amount of minerals and materials than that of a regular petrol car. Mineral supplies for eVs must increase 30-fold to meet targets aligned with the Paris Agreement; this target cannot be met solely through reuse and recycling.

Mineral resources are not distributed equally across nation states and this must be taken into consideration when considering equitable access to resources and developing sustainable and just supply chains. Careful management of the subsurface is required to ensure we can meet mineral needs as well as the needs of a growing population.



Share of top three producing countries in total production for selected minerals and fossil fuels, 2019. Source: IEA / Carbon Brief.

Cities, Regions and the Built Environment

Urbanisation

An increasing urban population will require holistic subsurface and resource planning to ensure that city development is sustainable and low carbon.

Without careful planning, the development of subsurface infrastructure such as public transport, road tunnels, and utilities could prevent the development of low-carbon energies such as district heating and cooling.

Emissions from construction activities such as concrete production and steel-making will need to be managed through CCS or other carbon-removal technologies (e.g. low carbon concrete, wood in building).

Built environment

The need for building materials such as sand and gravel will increase as cities and populations grow. Irresponsible extraction of these materials can damage ecosystems and water supplies. Geologists are required to identify supplies of these materials and support responsible, sustainable extraction with minimal impact to the environment.

Changes in precipitation location and amount will increase the occurrence of ground subsidence and sinkholes in many regions. Sustained subsurface monitoring and analysis is key to managing associated risks.

Adaptation, Loss and Damage

Understanding hazards

The geological record provides access to very long-term data on the impacts of environmental change, mass extinctions and major shifts in Earth processes. It provides a perspective on managing changing and interacting hazards, including sea level rise, flooding, drought, and land stability.

Surface, subsurface and satellite monitoring by geologists provides real-time assessment of hazards, to inform rapid response and mitigation. Geologists are working to understand multiple hazards and their interrelationships, and thus reduce the risk posed by complex and cascading hazards.

Nature

Freshwater

Groundwater accounts for >96% of all available freshwater on planet earth. With climate change causing surface water availability to fluctuate dramatically (drought and flood increase) groundwater is increasingly being relied upon for many uses. In addition to potable water demands (50% of all drinking water = groundwater) and agriculture, a number of industries require freshwater resources for essential processes.

Landfill, and other waste stored in the subsurface, must be effectively monitored and managed to ensure contamination of freshwater supplies is minimised.

It is vital to map existing subsurface and surface water resources, manage their use and any contamination and determine their recharge rates to ensure sustainable water supplies.

Environment

The increased demand for mineral resources will create increased volumes of mine waste. This must be appropriately treated to ensure that there is no contamination to surface and subsurface water resources.

Soil protection and management can prevent the release of stored carbon and encourage the uptake and retention of carbon in the form of organic carbon.

The underlying geology of biomes is a key driver of ecology, and must be considered in biodiversity management and planned rewilding.

About the Geological Society

As the national forum for the debate and development of cutting edge Earth science, the Geological Society has a special responsibility to communicate this science and its importance to society, the Government, the media, other scientific communities and the general public.

We are working with the geoscience community, as well as decision makers and stakeholders outside the geosciences to understand and raise awareness of the various ways that geoscience will underpin the global decarbonisation goals.

For more information visit **www.geolsoc.org.uk/COP26**