IEA Critical Minerals Data Explorer

Methodological notes

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The IEA has integrated critical minerals into its long-term energy modelling framework. Along with the Critical Minerals Market Review 2023, we are launching the IEA Critical Minerals Data Explorer, an interactive online tool that allows users to easily access the IEA's projection data.

In its first release, the tool provides users with access to the IEA's demand projection results under various energy scenarios and technology evolution trends (through more than ten alternative technology cases). Users can look up total demand for key minerals (copper, lithium, nickel, cobalt and neodymium) and projected mineral demand in the clean energy sector by technology and commodity under different scenarios and technology cases.

Clean energy technologies and other uses

Clean energy technologies - The critical minerals model, added as a permanent module in the Global Energy and Climate (GEC) Model during the 2022 modelling cycle, assesses the mineral requirements for the following clean energy technologies:

- Solar PV (utility-scale and distributed);
- Wind (onshore and offshore);
- Other low emissions power generation technologies (concentrating solar power - parabolic troughs and central tower, hydropower, geothermal, bioenergy for power and nuclear power);
- Electricity networks (transmission, distribution, and transformers);
- Electric vehicles (battery electric and plug-in hybrid electric vehicles, electric vehicle motors);
- Battery storage (utility-scale and residential);
- Hydrogen (electrolysers and fuel cells).

Other uses - For the five focus minerals (cobalt, copper, lithium, nickel and rare earth elements [REEs]), total demand have been assessed. Consumption outside the clean energy sector has been estimated using historical consumption by end-use applications, relevant activity drivers from IEA Global Energy and Climate Model (e.g. GDP, industry value added, steel production, etc.) and material intensities.

Scope of materials

All of these energy technologies require metals and alloys, which are produced by processing mineral-containing ores. Ores – the raw, economically viable rocks that are mined – are beneficiated to liberate and concentrate the minerals of interest. Those minerals are further processed to extract the metals or alloys of interest. Processed metals and alloys are then used in end-use applications. While this analysis covers the entire mineral and metal value chain from mining to processing operations, we use “minerals” as a representative term for the sake of simplicity.

We focus specifically on the use of minerals in clean energy technologies, given that they generally require considerably more minerals than their fossil fuel counterparts. Our model also focuses on the requirements for building a plant (or making equipment) and not on operational requirements (e.g. uranium consumption in nuclear plants).

Our model considers a wide range of minerals used in clean energy technologies. The data explorer provides access to demand projections relevant to arsenic, boron, cadmium, chromium, cobalt, copper, dysprosium, gallium, germanium, graphite, hafnium, indium, iridium, lead, lithium, magnesium, manganese, molybdenum, neodymium, nickel, niobium, platinum-group metals, praseodymium, selenium, silicon, silver, tantalum, tellurium, terbium, tin, titanium, tungsten, vanadium, yttrium, zinc and zirconium.

Other base metals. - Steel and aluminium are widely used across many clean energy technologies, but we have excluded it from the scope of this analysis. Aluminium demand is assessed for electricity networks only as the outlook for copper is inherently linked with aluminium use in grid lines, but is not included in the aggregate demand projections.

Demand projections

For each of the clean energy technologies, we estimate overall mineral demand using four main variables:

- clean energy deployment trends under different scenarios;
- sub-technology shares within each technology area;
- mineral intensity of each sub-technology; and
- mineral intensity improvements

Clean energy deployment trends under the Stated Policies Scenario (STEPS), Announced Pledges Scenario (APS) and Net Zero Emissions by 2050 Scenario (NZE) taken from the projections in the World Energy Outlook 2022, complemented by the results in the Energy Technology Perspectives 2023.

Sub-technology shares within each technology area (e.g. solar PV module types; EV battery chemistries) are also taken from the World Energy Outlook, complemented by the Energy Technology Perspectives, Global EV Outlook and other sources.

Mineral intensity assumptions were developed through extensive literature review (see Table) and expert and industry consultations, including with IEA Technology Collaboration Programmes.

The pace of mineral intensity improvements varies by scenario, with the STEPS generally seeing minimal improvement over time as compared to modest improvement (around 10% in the longer term) assumed in the APS. In areas that may particularly benefit from economies of scale or technology improvement (e.g. silicon and silver use in solar PV, platinum loading in fuel cells, REE use in wind turbines), we applied specific improvement rates based on the review of underlying drivers.

Clean energy deployment trends under the Stated Policies Scenario (STEPS), Announced Pledges Scenario (APS) and Net Zero Emissions by 2050 Scenario (NZE) are taken from the projections from the 2022 GEC Modelling cycle.

Future updates

The numbers will be regularly updated to align with the latest energy projections, when the World Energy Outlook 2023 is released. Long-term supply projection data will also be added to the data explorer at a later stage.