Rare earths: hidden leverage beneath the surface

November 2025

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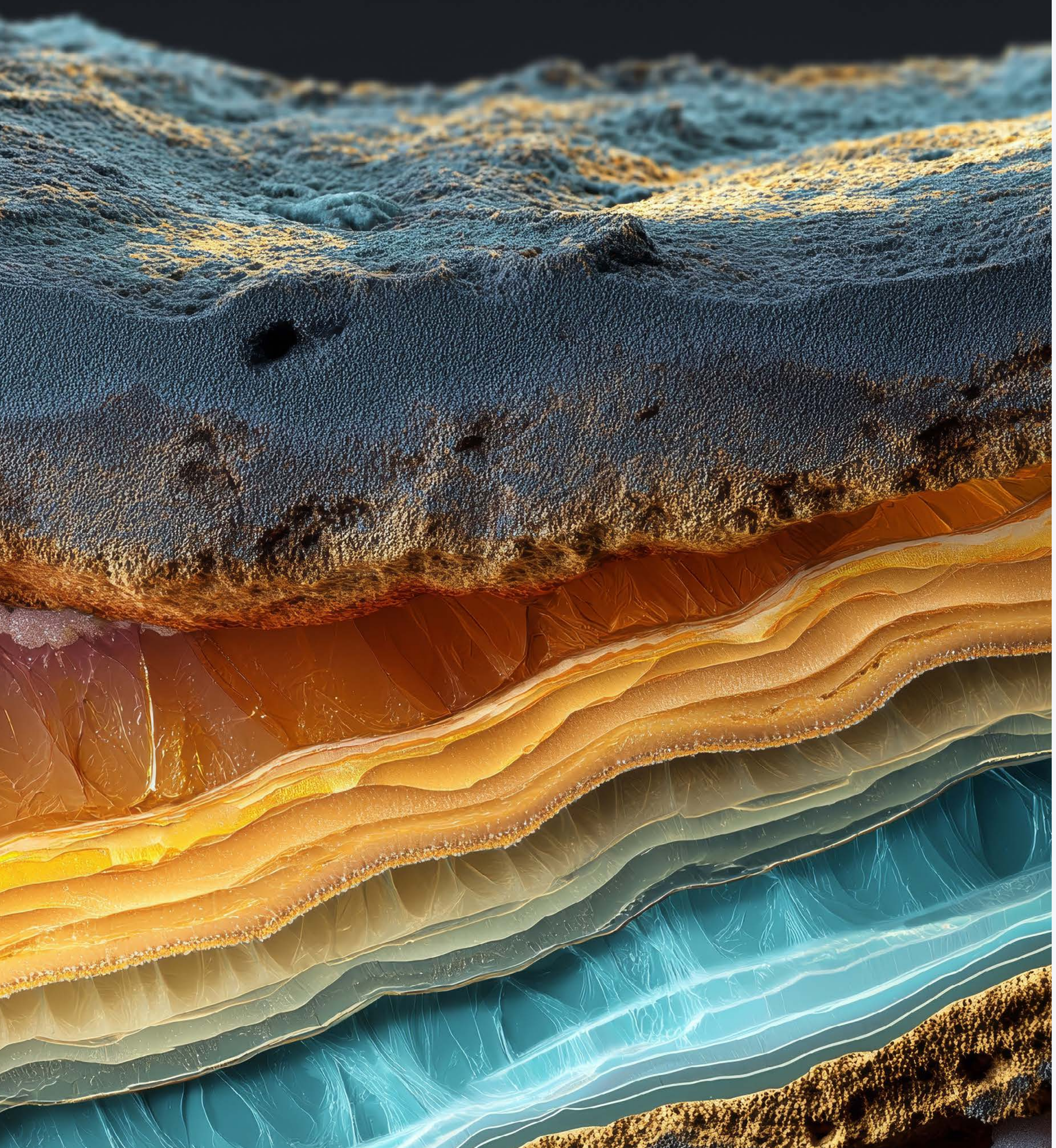
Introduction

The global push toward green energy technologies, advanced electronics and defense applications has dramatically increased demand for rare earth elements (REEs), which are among the most critical materials on the planet, deeply embedded in the technologies which underpin modern life. Global use for REE magnets could growth at 9% per annum over the next 10 years.[1]

The world has long relied for its REEs on China, but its export restriction policy has raised concerns about the future of supply chains.



01

Seventeen elements represent the group of rare earth elements suitable for a wide variety of applications

REEs are 17 chemically similar metals (atomic numbers 21, 39 and 57-71)[2] valued for their exceptional magnetic, optical and electrical properties, as well as high thermal stability.

Their typical classification is as light or heavy rare earths, depending on atomic weight – each deposit usually dominated by one group.

REEs are indispensable to modern technology, powering everything from smartphones and medical imaging to radar, satellites and night vision systems. They also drive green innovation, forming the backbone of electric vehicles and renewable energy systems that help reduce carbon emissions (see Figs. 1 and 2).

However, geologically speaking, most REEs are not as rare in the Earth's crust as their name suggests. For instance, cerium is the most abundant REE and is more common in the crust than copper[3] or lead (see Fig. 3).[4]

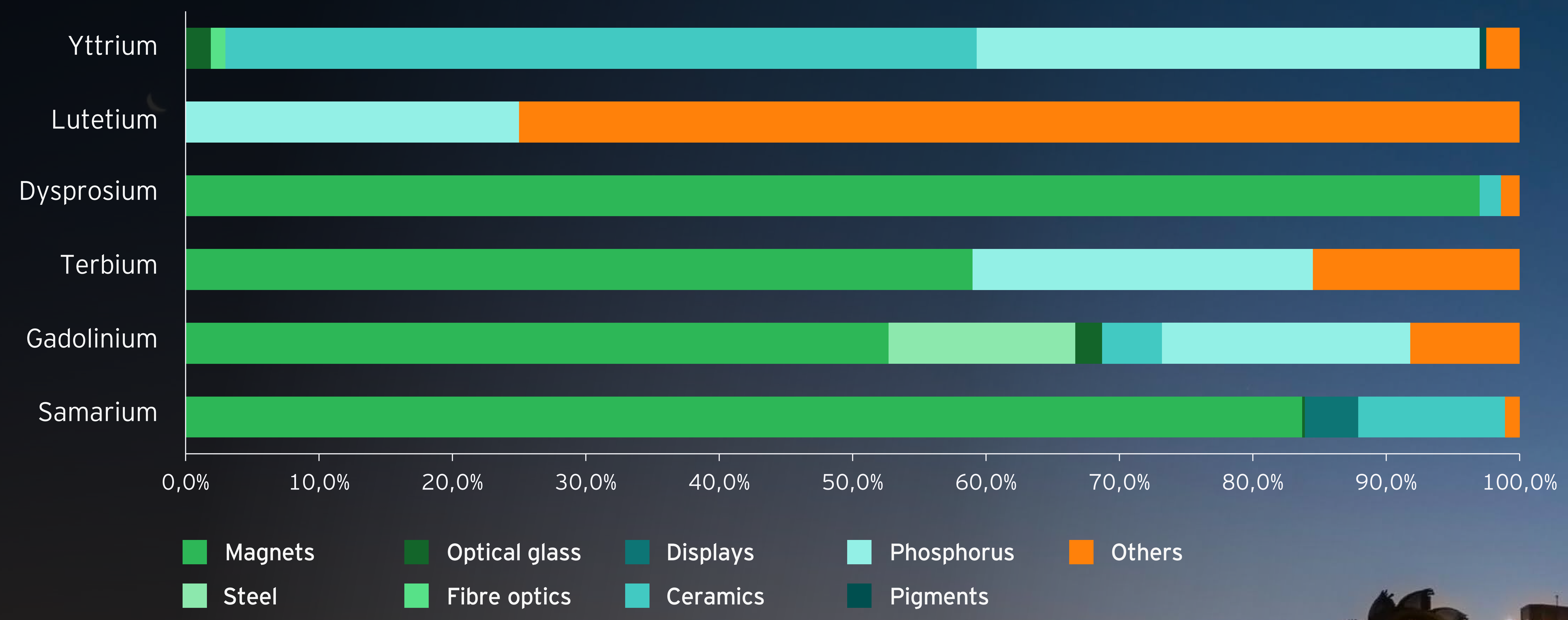
All the REEs, except promethium, are more abundant on average in the Earth's crust than silver, gold, or platinum.

Figure 1.
Overview of REEs

Rare earth element	Atomic number of the periodic table	Crustal abundance (ppm by mass)[5]	Key characteristics	Key applications
Rare earth-like				
Scandium (Sc)	21	22	High strength-to-weight, corrosion resistance, weldability, thermal efficiency	Ceramics, fuel cells, metallurgy
Yttrium (Y)	39	33	Thermal stability, luminescence, catalytic activity, corrosion resistance	Catalysts, ceramics, lasers, metallurgy, phosphors
Light REE				
Lanthanum (La)	57	39	Large ionic radius, catalytic, redox properties	Batteries, catalysts, ceramics, glass, metallurgy
Cerium (Ce)	58	66.5	Redox capability, UV absorption	Catalytic converters, ceramics, glass, metallurgy, polishing compounds
Praseodymium (Pr)	59	9.2	Magnetic and optical properties	Aerospace alloys, batteries, ceramics, colorants, permanent magnets
Neodymium (Nd)	60	41.5	Strong magnetic properties	Catalysts, lasers, permanent magnets
Promethium (Pm)	61	Extremely low	Radioactive, very rare	Scientific research, nuclear technologies
Samarium (Sm)	62	7.1	Magnetic and neutron absorption	Cancer treatments, nuclear, permanent magnets
Europium (Eu)	63	2.0	Luminescence	Nuclear control rods and phosphors
Gadolinium (Gd)	64	6.2	Magnetic and neutron absorption	Medical imaging, metallurgy, permanent magnets
Heavy REE				
Terbium (Tb)	65	1.2	Luminescence and magnetism	Fiber optics, lasers, permanent magnets, solid state devices
Dysprosium (Dy)	66	5.2	Magnetic coercivity, heat resistance	Data storage devices, lasers, permanent magnets
Holmium (Ho)	67	1.3	High magnetic moment, neutron absorber	Lasers, nuclear control rods, permanent magnets
Erbium (Er)	68	3.5	Optical amplification	Fiber optics, glass colorant, lasers, optical amplifiers
Thulium (Tm)	69	0.52	High energy density	Lasers and metallurgy
Ytterbium (Yb)	70	3.2	Optical and chemical properties	Catalysts, lasers, metallurgy, scintillators
Lutetium (Lu)	71	0.8	High density, catalytic properties	Cancer therapies, electronics, medical imaging

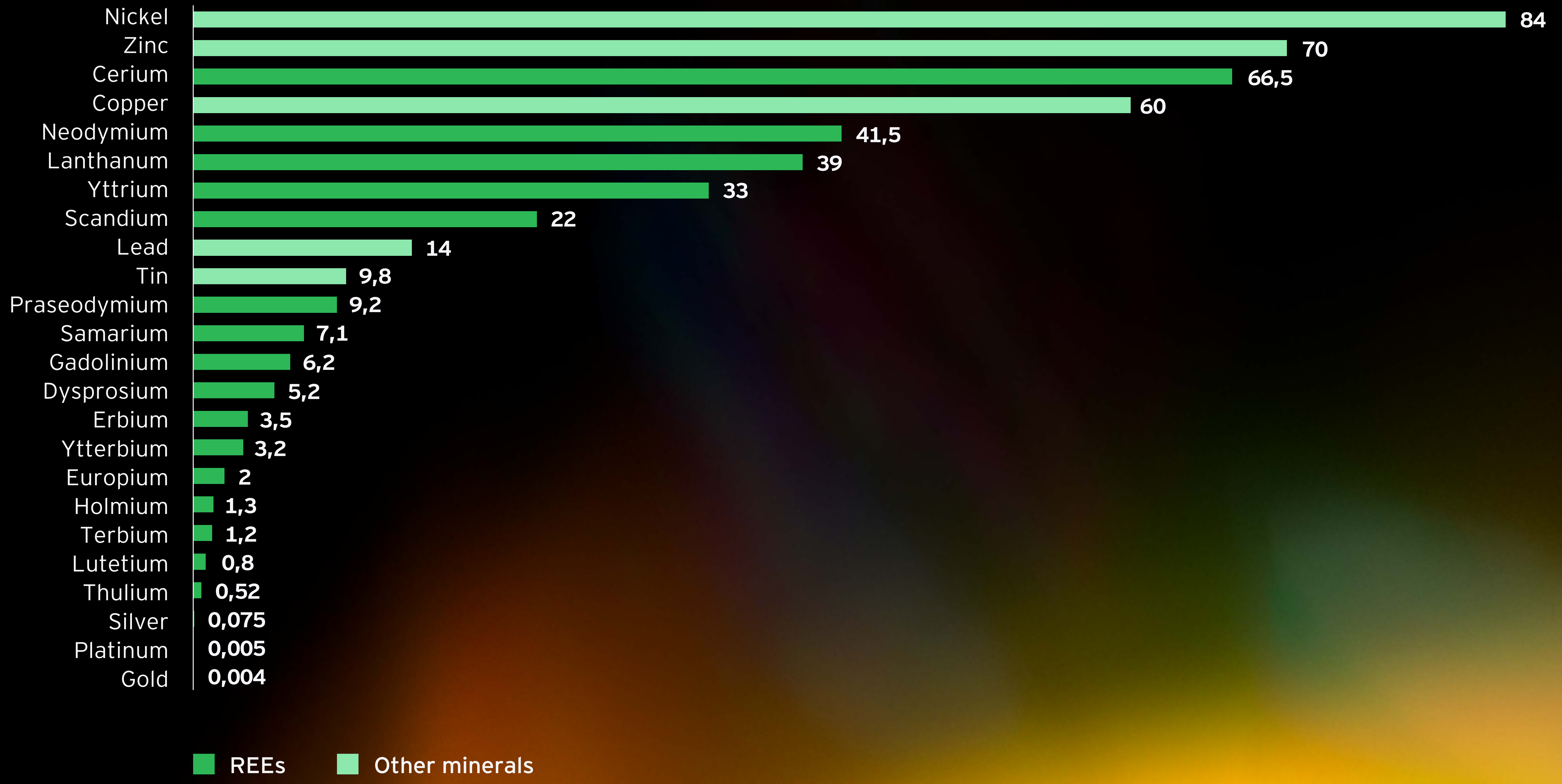
Note: Scandium and yttrium are "rare earth-like" because they fall outside the lanthanide series but share chemical properties. Some sources treat gadolinium as the start of the Heavy REEs group as it sits at a transitional point in the lanthanide series. Crustal abundance assessment was in 2014.
Source: EY Regional Center's analysis of US Geological Survey (USGS) data and open sources.

Figure 2.
Primary application areas of selected REEs across key sectors



Source: International Energy Agency (October 2025).

Figure 3.
Average crustal abundance of selected metals/elements, ppm



Source: The Global Rare Earth Industry Association, USGS.

The challenge lies not in their geological scarcity, but in the fact that REEs typically do not occur in concentrated, mineable deposits – their chemically similar nature causes them to disperse widely, making extraction technically and economically difficult. As a result, producing REEs at scale can require significant water and energy use, with potential environmental risks such as chemical runoff and the release of naturally occurring radioactive elements like uranium and thorium, which often co-exist with rare earth minerals.

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390,000

tonnes in 2024

According to the US Geological Survey (USGS), worldwide REE mine output has tripled since 2017 and reached 390,000 tonnes in 2024, up 3.7% y-o-y (see Fig. 4).[7] These volumes do not include rare earth-like elements such as yttrium and scandium.

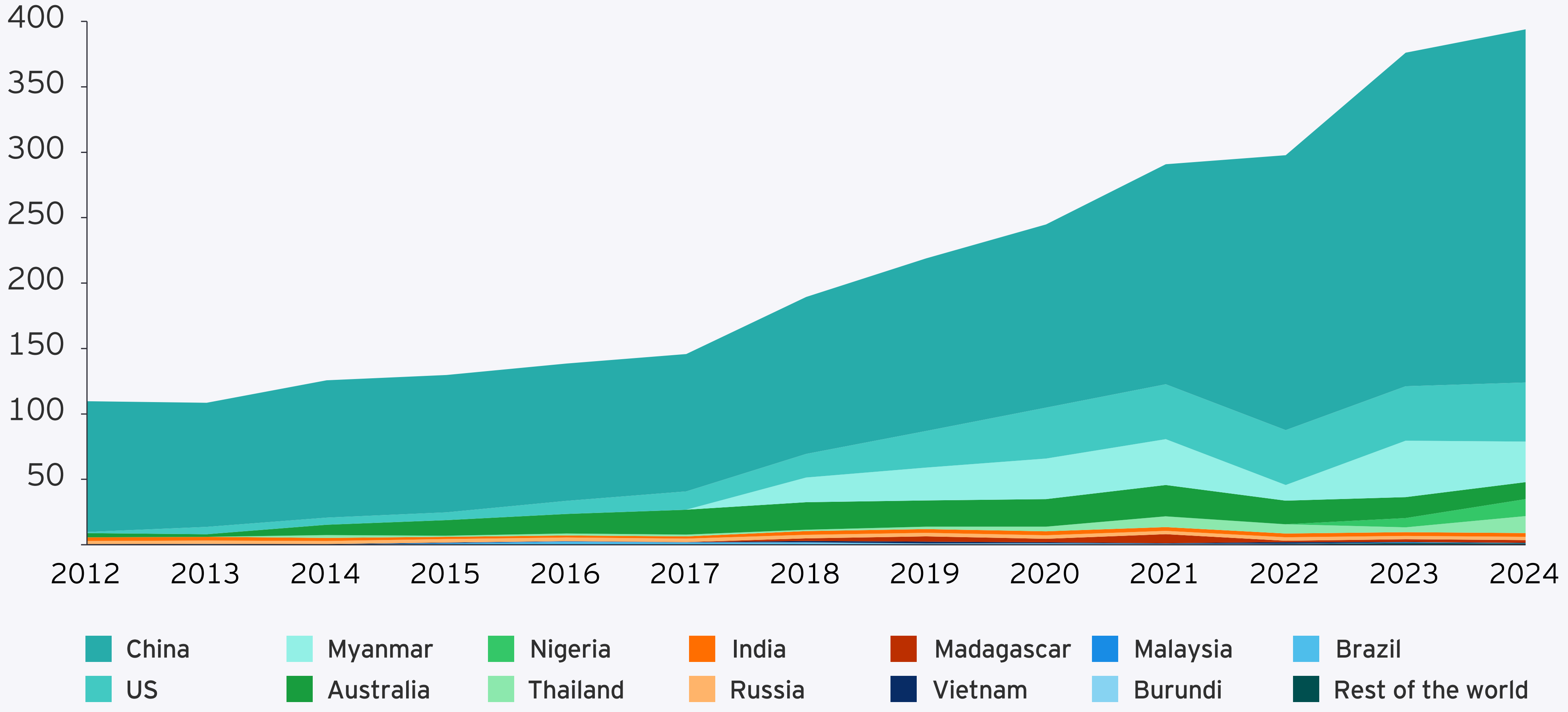
World mine production of yttrium oxide equivalent contained in REE mineral concentrates was estimated to be between 15,000 and 20,000 tonnes, most of which took place in China and Myanmar.

02

China dominates through the overall supply chain in the REE market

Figure 4.

Global REE mine production (excl. scandium and yttrium), thousand tonnes



Source: USGS.

The USGS does not provide scandium mine production as it is produced exclusively as a byproduct during processing of various ores or recovered from previously processed tailings or residues (for instance, as byproduct material of iron ore, rare earths, titanium and zirconium in China, of uranium in Kazakhstan and Ukraine, and of nickel in the Philippines).[6]

The supply of REEs is among the least geographically diversified among all critical minerals.

Throughout the 1960s and 1980s, the US was the world's top REE producer, but fell away as China began to scale up its efforts and increased annual REE production by an average of 40% per annum between 1978 and 1995. Beginning in the 1990s, companies owned by the Chinese government sought to buy controlling shares in rare earth companies located in other countries.[8] Low-cost operations enabled the Asian nation to flood the market with cheap rare earths and establish a near-monopoly over the global supply chain.

As of 2024, China is responsible for around 70% of the REE volumes extracted from mines globally or 270,000 tonnes, compared with the second-largest producer, the US with its 45,000 tonnes.[9]

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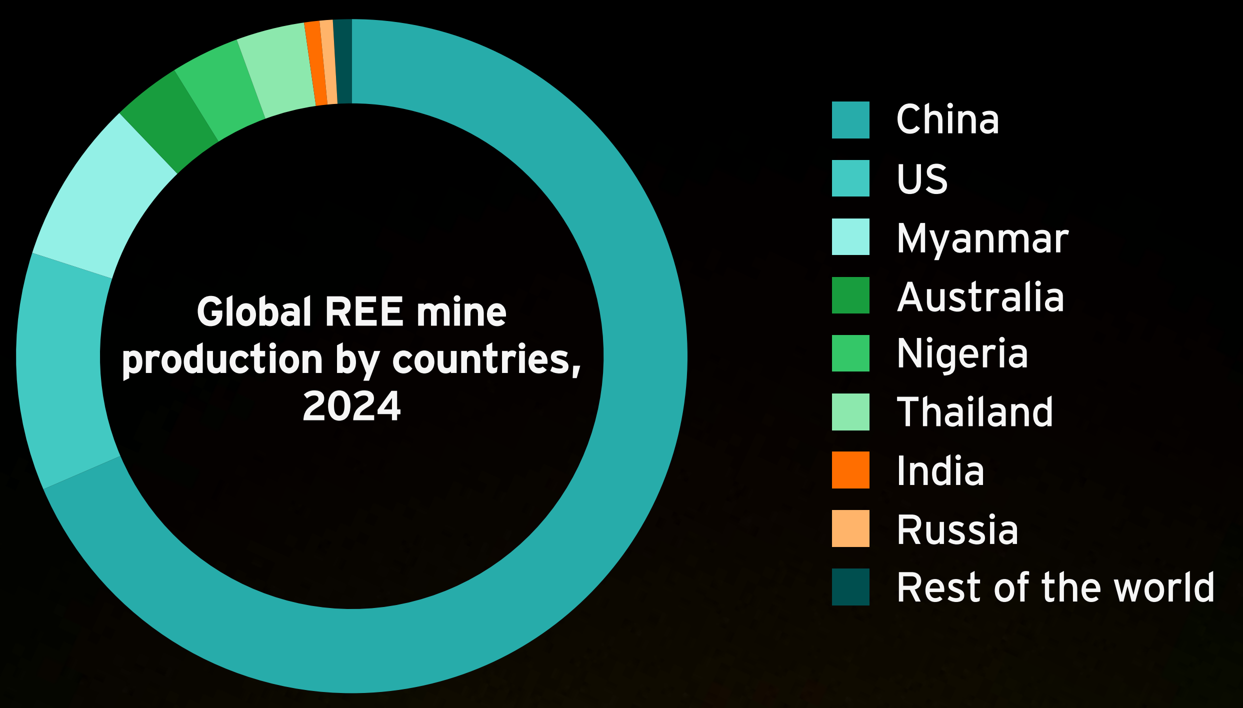
Figure 5.
Global REE mine production by country, 2024

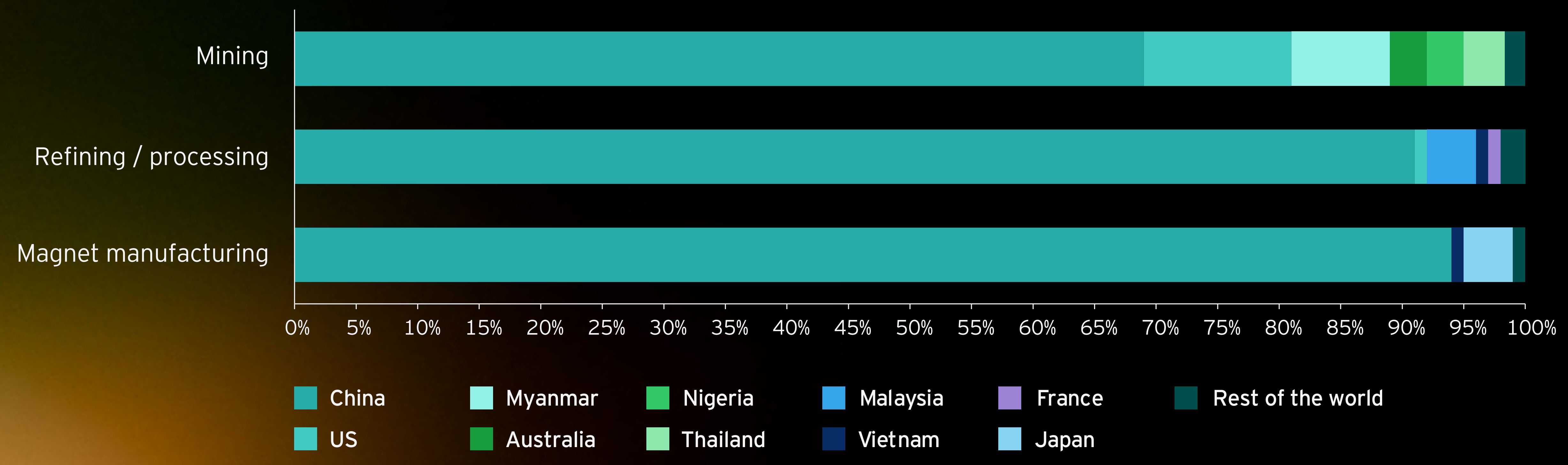


Source: USGS 2025.

As seen in Fig. 6, China's dominance is even greater in the separation and refining stages (above 90% of global production).

Moreover, China has significantly strengthened its position in the manufacturing of rare earth-containing permanent magnets (REPM) – magnets that retain their magnetic properties indefinitely without the need for external power.

Figure 6.
Global REE mine production by country, 2024



Note: Mining structure includes total rare earth oxides mined, including nonmagnetic elements.
Sources: USGS 2025, International Energy Agency (October 2025).

Today, China accounts for 94% of the production of sintered permanent magnets commonly used in cars, wind turbines, industrial motors, data centers and defense systems (up from 50% two decades ago).[10, 11]

However, such high market concentration leaves global supply chains in strategic sectors – such as energy, automotive, defense and artificial intelligence (AI) data centers – vulnerable to disruption.

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Figure 7.
Key milestones of China's minerals export control regime

2020

Enactment of Export Control Law establishing legal groundwork for export regulation.[12]

2023

August
Export controls on gallium and germanium.[13]

December
Export controls on certain graphite products.[14]

December
Export ban on REE magnet manufacturing technology.[15]

2024

September
Export controls on antimony products.[16]

December
Tightening export controls on gallium and germanium (as well as antimony and graphite), explicitly prohibiting shipments of both metals to the US.[17]

Updated framework for exports of dual-use products.

2025

February
Expanded controls on critical minerals including tungsten, tellurium, bismuth, indium and molybdenum.[18, 19]

April
Export controls of seven REEs and related items – samarium, gadolinium, terbium, dysprosium, lutetium, scandium, yttrium.[20, 21]

November
Extension REE export controls with extra five REEs – holmium, erbium, thulium, europium, ytterbium – and related technologies. Initially announced in October planned effective November 2025, implementation was paused for one year.[22]

Ongoing 2025-2026

Enforcement of controls on suspended five REEs, including extraterritorial provisions, requiring export licenses for products manufactured abroad that contain more than 0.1% Chinese-origin REEs or related technologies.[23]

Potential extensions of the list of REEs under export controls.

Source: EY Regional Energy Center's analysis.

03

The world's second-largest economy has tightened REE export controls

China has shifted its view of REEs from simple economic commodities to strategic national assets with both economic and geopolitical importance. This shift is evident in the comprehensive legal and regulatory framework developed between 2020 and 2025 (see Fig. 7).

China has progressively introduced specific export restrictions and targeted controls on selected minerals. In 2025, restrictions rolled out on certain critical minerals, echoed in the rare earths.

In April 2025, China imposed export controls on seven key REEs (samarium, gadolinium, terbium, dysprosium, lutetium, scandium and yttrium), requiring companies to secure special licenses for exporting certain raw materials, alloys, oxides and permanent magnets.[24,25]

China dominates global refined output of these REEs, with shares ranging from 85% for scandium and 95% for yttrium to between 97% and 98% for samarium, gadolinium, terbium, dysprosium and lutetium.[26]

In October 2025, China announced export controls on five additional REEs – holmium, erbium, thulium, europium and ytterbium – with the measures originally set to take effect in November 2025. Following a high-level trade agreement, these controls are planned to be suspended for one year, delaying implementation.[27, 28] China has indicated that the suspension also extends to the EU.[29, 30]

The paused measures also include other curbs unveiled earlier in October – tightened restrictions on the export of Chinese production technology and introduced unprecedented extraterritorial controls over foreign products containing even trace amounts (≥0.1%) of Chinese raw materials or those manufactured with Chinese equipment.[31]

China seeks to align its export controls with global frameworks, prioritizing national security by preventing dual-use technology transfers, keeping value-added processing domestic, and reinforcing its leverage in global trade and tech competition.

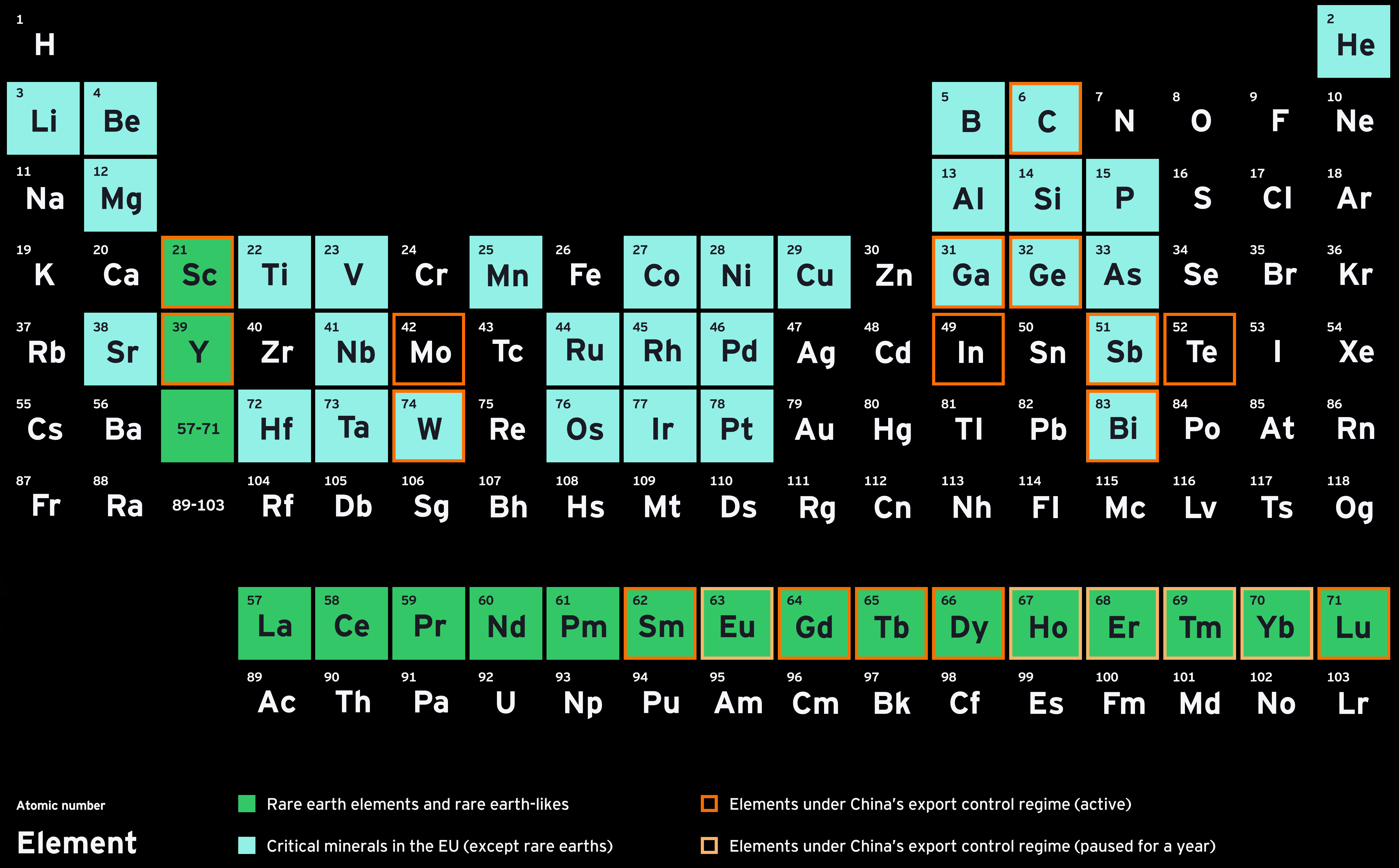
If no extra REEs are added to the list, by late 2026, export licenses could be required for 12 out of the 17 total REEs – significantly extending China's regulatory grip from current seven REE products. This expansion would complement restrictions on other minerals also designated as critical by the EU (see Fig. 8).[32]

The latest suspensions may give importers some breathing room but won't alter the bigger picture, nor stop countries from diversifying their REE supply chains.

This broad and evolving framework significantly impacts global supply chains, especially critical sectors relying on Chinese rare earths, including energy, automotive, defense, semiconductors, aerospace, industrial motors and AI data centers. While civilian applications like renewable energy typically face fewer restrictions, military and semiconductor or AI uses are under stricter scrutiny.

Figure 8.

Critical materials, including REEs, included in China's export controls list



Note: Graphite is composed of carbon; therefore, element 6C is highlighted as an EU critical mineral. Ruthenium, rhodium, palladium, osmium, iridium and platinum – collectively known as the platinum-group metals (PGMs) – are classified as precious metals and are included in the EU list of critical raw materials.**Sources:** USGS 2025, International Energy Agency (October 2025).
Source: EY Regional Energy Center's analysis.

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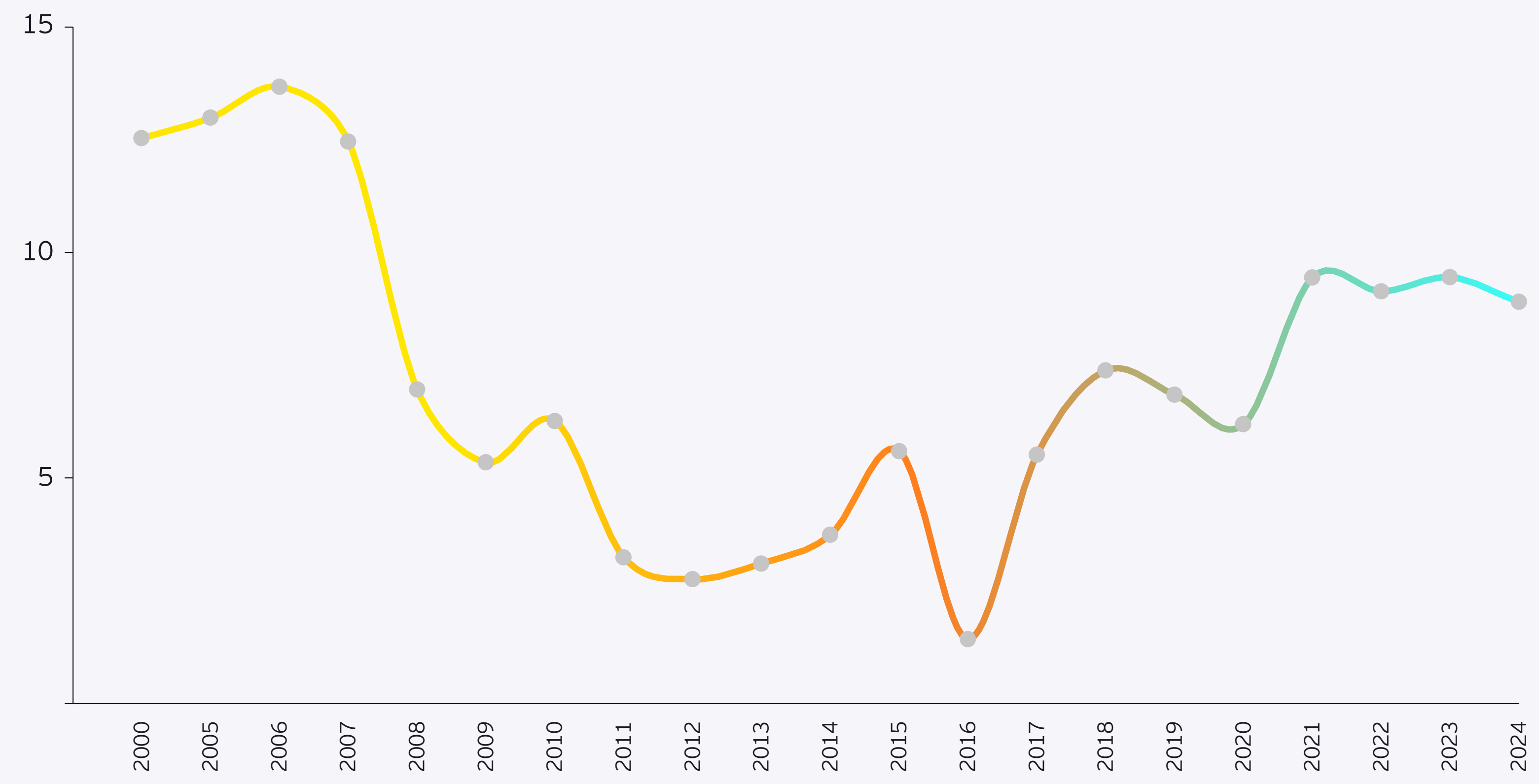
04

Europe remains one of the key destinations for China's exports of raw REEs and permanent magnets

In 2024, China exported approximately 8,900 tonnes of raw REEs, including scandium and yttrium, reflecting a 6% decline from the previous year (see Fig. 9).

Figure 9.
China REE (including scandium and yttrium) exports, thousand tonnes



Source: World Bank – World Integrated Trade Solution

2008 drop:

- Strict export quotas,
- Closure of illegal/inefficient mines,
- Rising domestic demand and value-added output

2008-2016

- Industry consolidation,
- Strict quotas,
- Environmental policies,
- Domestic use prioritization.

Post-2016

- Slightly eased export quotas,
- Higher efficiency,
- Rising global demand,
- Ongoing domestic priority,
- Environmental constraints.

The European continent accounted for 20% of these exports, an increase from 16% in 2023. The primary European importers of China's raw REEs were the Netherlands, Italy and Spain (see Fig. 10).[33]

The export of value-added REEs from China is even more significant.

China's exports of rare earth compounds (oxides, fluorides, chlorides, carbonates, etc.) rose 9% y-o-y, reaching approximately 46,500 tonnes in 2024, with 17% of this volume delivered to the EU.[34]

In the same year, China supplied over 58,000 tonnes of rare earth permanent magnets (REPM) to international customers, marking a 10% increase compared with the previous year.[35,36] This amount represents 24% of the country's total output in 2024.[37]

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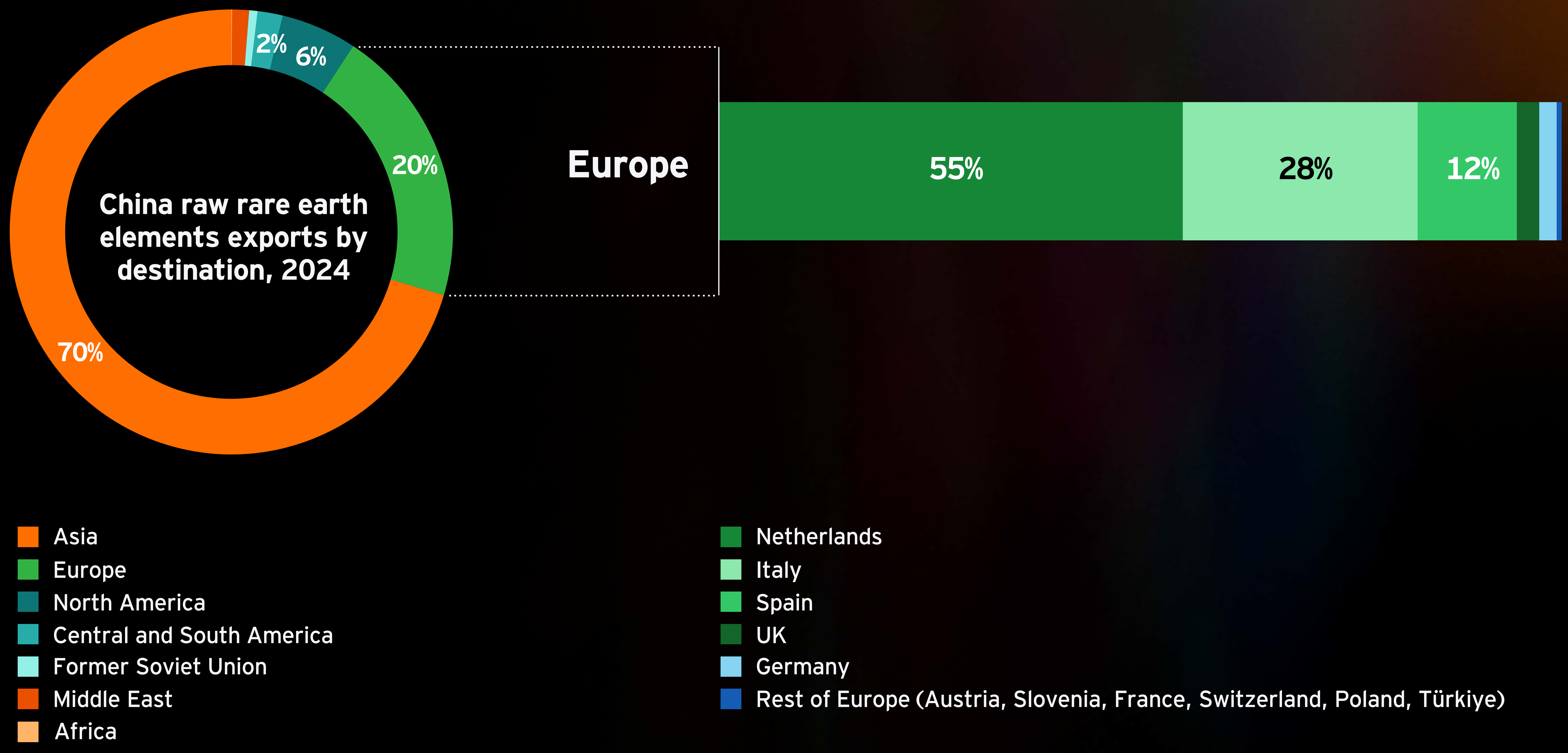
Figure 10.
China raw rare earth metals, scandium and yttrium exports by destination, 2024

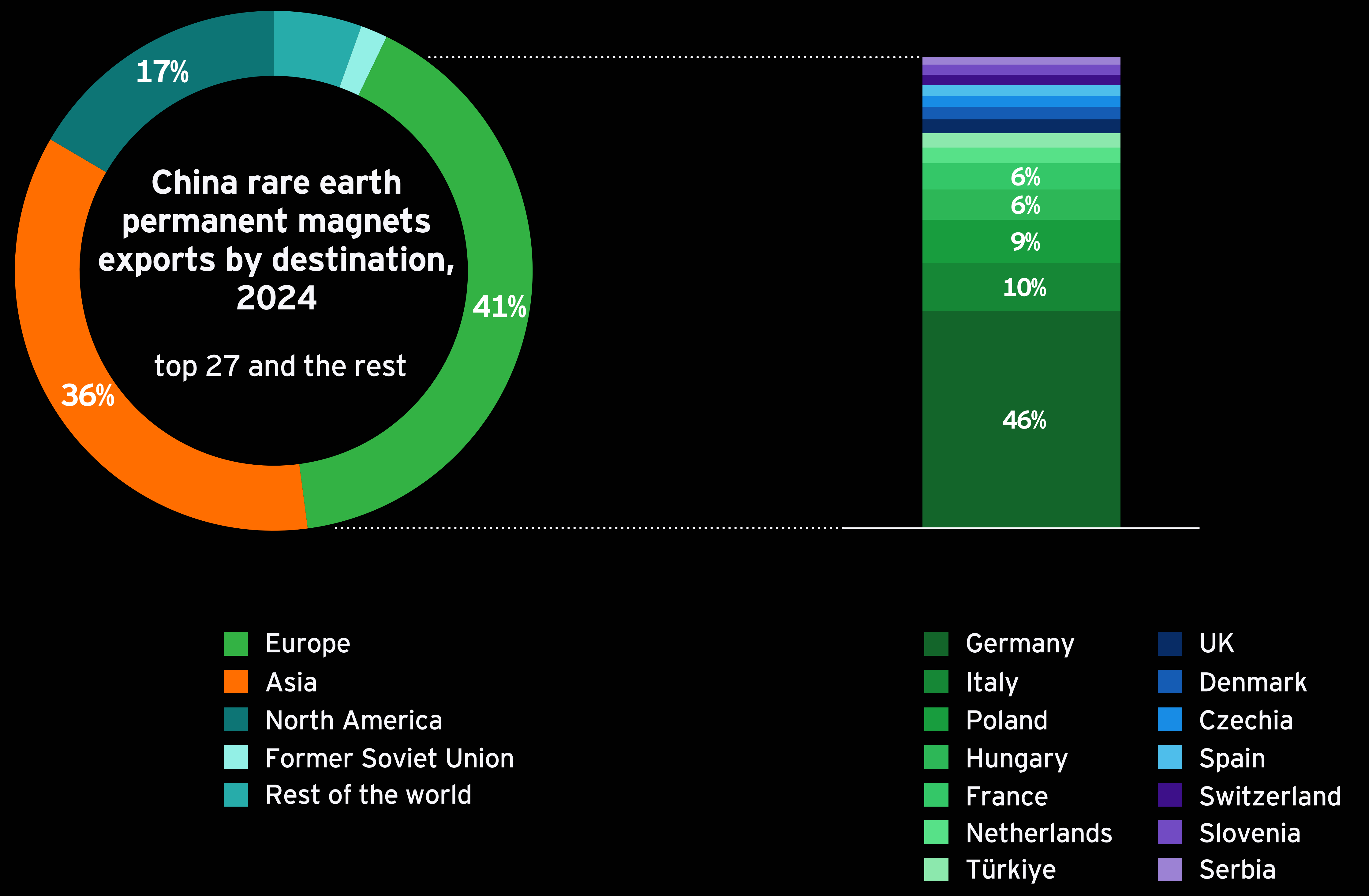


Note: 1) HS 280530, 2) Europe includes the EU and non-EU countries.
Source: World Bank – World Integrated Trade Solution.

The top 27 destinations accounted for 95% of China's REPM exports, totaling 55,000 tonnes, with over 40% directed to Europe (see Fig. 11).[38]

Germany was the largest consumer of China's REPMs in Europe, receiving nearly 11,000 tonnes in 2024. The countries in the Europe Central region – Poland, Hungary, Türkiye, Denmark, Czechia, Slovenia and Serbia – also imported China's rare earth magnets.

Figure 11.
China rare earth permanent magnet exports by destination, 2024



Note: The data includes REPMs and items prepared for production into permanent magnets after magnetization.
Source: China Customs.

However, following China's tightening of REE export controls this year, REPM exports experienced a downturn, decreasing by 7.5% year-on-year to 39,817 tonnes in the first three quarters of 2025.[39]

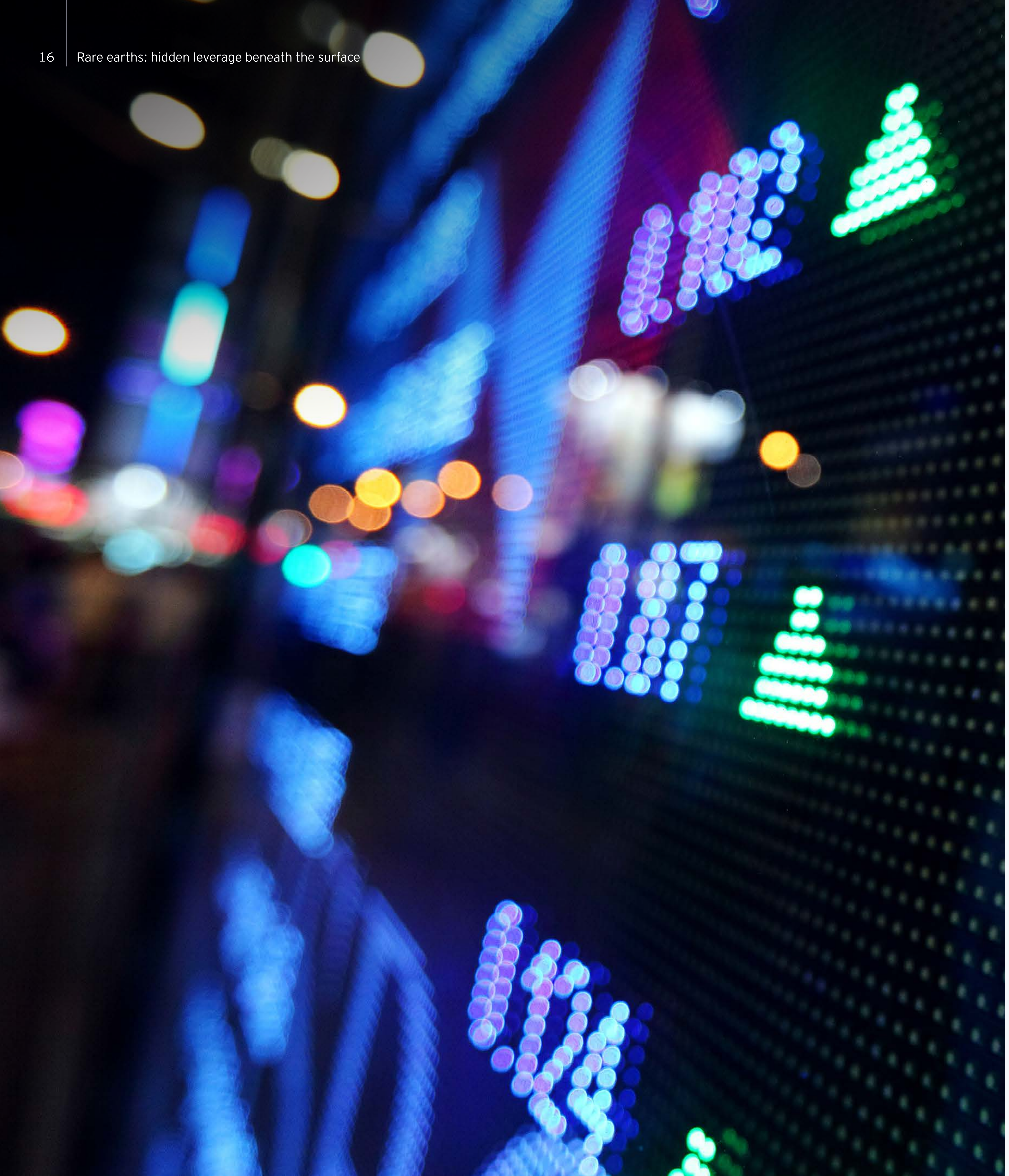
Licensing delays are already hindering European companies' access to essential materials, leading to production halts. A September survey conducted by the European Chamber of Commerce in China revealed approval of only 13% of 141 export applications, which was anticipated to result in 46 production shutdowns that month, with an additional 10 expected by December.[40]

According to the EU's Chamber of Commerce in China, shortages caused seven production stoppages at companies in the bloc in August, and more are expected.[41]

Germany was the largest consumer of China's REPMs in Europe, receiving nearly **11,000** tonnes in 2024

Disruptions in China's supply – such as extended delays or rejections in licensing – directly affect European importers, jeopardizing their revenues, competitiveness and employment, and resulting in slower growth and heightened vulnerability to supply shocks.

Furthermore, China will require consumers to submit detailed sensitive information for export approval, including product images showing mineral placement, manufacturing diagrams and customer details.



05

Rare earth stocks rally as supply security concerns fuel the market

Rare earth stocks have rallied sharply amid renewed concerns over supply security and escalating policy frictions. The rare earth market reacted strongly to these developments, triggering a rapid appreciation in REE equities.

The cumulative market capitalization of a representative group of five REE producers – comprising two Chinese, two Australian and one US company – increased by 175% between 1 January and 31 October 2025.

This growth far outpaced that of Big Oil, the combined capitalization of which rose by 10%, and Big Tech, which gained 19% over the same period (see Fig. 12).

The cumulative market capitalization of a representative group of five REE producers increased by

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Figure 12.

Comparative dynamics of cumulative market capitalization for top five companies in each industry: REE vs. Big Oil vs. Big Tech

Source: EY Regional Energy Center's analysis of S&P Capital IQ data.

A similar surge cycle occurred in 2021, when the cumulative market capitalization of REE stocks climbed by 150% over the year. The post-COVID-19 industrial rebound, soaring demand for electric vehicles and green technologies, government initiatives to secure critical mineral supplies, and broad investor enthusiasm for strategic commodities fueled that rally. However, the cycle reversed thereafter, with cumulative valuations declining by 43% in 2022, 22% in 2023, and a further 7% in 2024.

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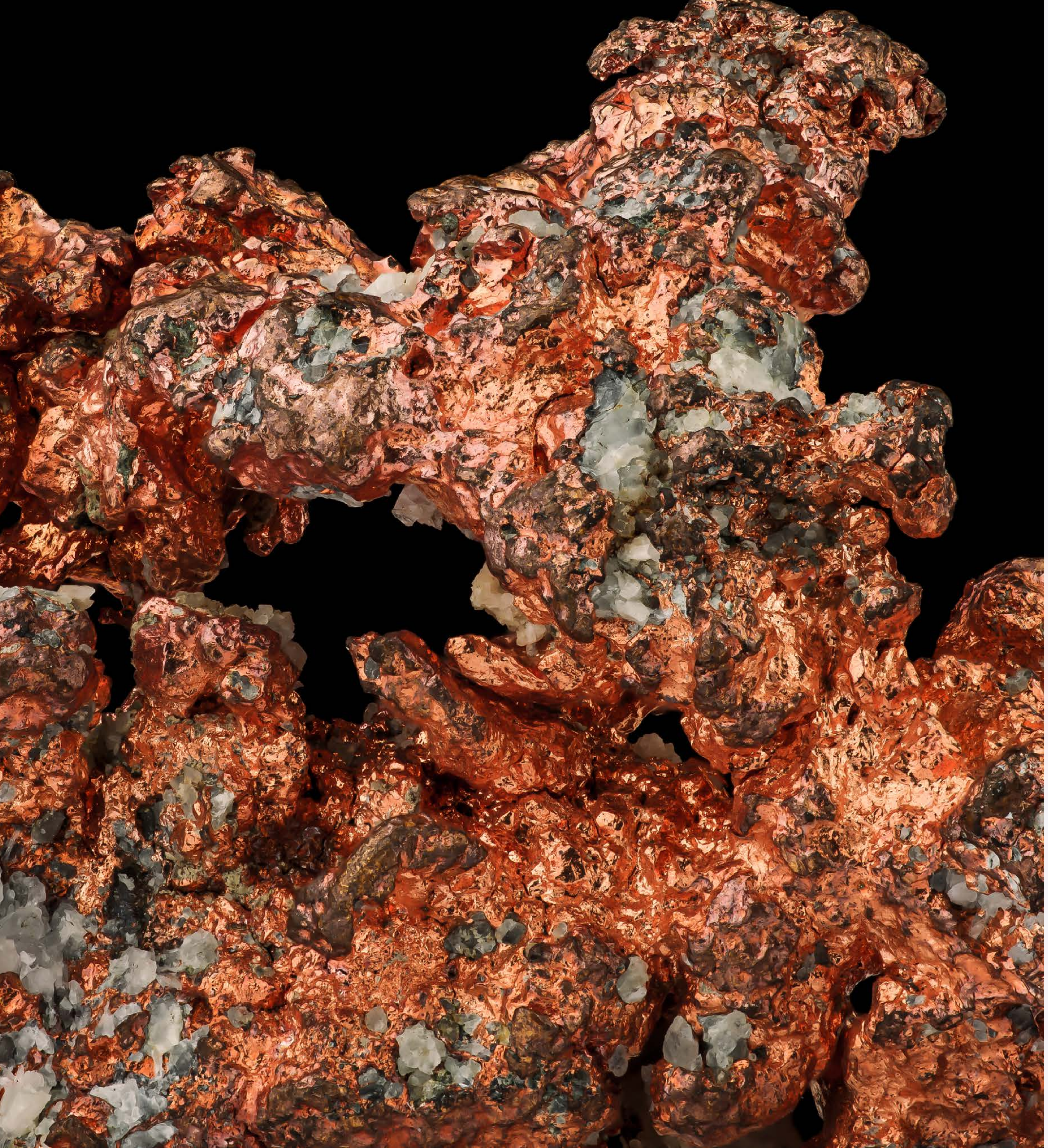

Although China holds almost half of global REE reserves, numerous projects are underway worldwide

While the enforcement of emerging export control regimes remains uncertain amid shifting geopolitics, recent developments underscore the imperative of supply chain diversification to strengthen long-term resilience.

China controls almost 50% of worldwide REE reserves (see Fig. 13). Combined reserves in Brazil, India and Australia account for 37%, and remain one-quarter lower than China's.

China controls almost

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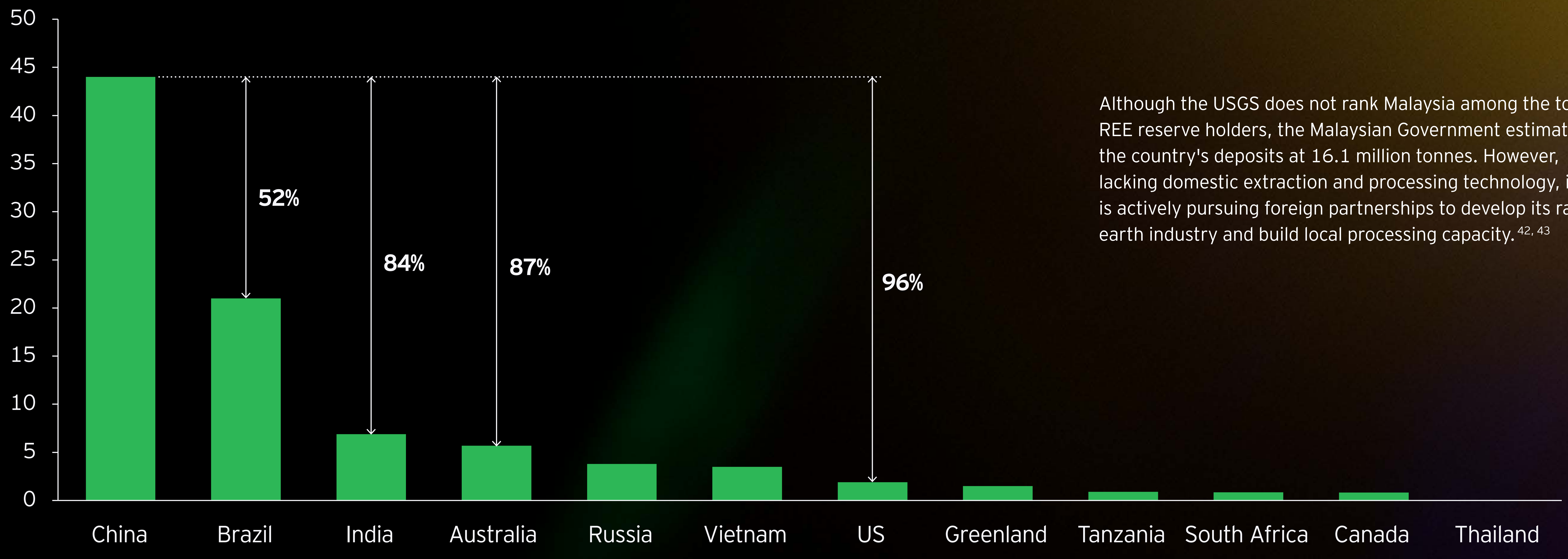
Figure 13.
Reserves of rare earth elements worldwide, million tonnes



Note: Scandium and yttrium reserves not included.
Source: USGS 2025.

Although the USGS does not rank Malaysia among the top REE reserve holders, the Malaysian Government estimates the country's deposits at 16.1 million tonnes. However, lacking domestic extraction and processing technology, it is actively pursuing foreign partnerships to develop its rare earth industry and build local processing capacity.[42, 43]

Beyond the nine rare earth mine projects in the US, 132 projects are underway globally (including early-stage projects without a defined resource estimate), notably in Africa, Australia, Brazil, Canada and India.

Around

140

REE mine projects are underway globally

(including early-stage projects).

Reserves

The Europe Central region* could become central to Europe's strategy for securing and diversifying REE supplies

There are also promising alternatives for primary REE supply to the European continent in the Europe Central region, including Central Asia.

Note: EY's Europe Central region includes 33 countries across several sub-regions. These include Denmark, Finland, Norway and Sweden in the Nordics; Poland, Estonia, Latvia, Lithuania and Ukraine in the North; Croatia, Czechia, Hungary, Serbia, Montenegro, Bosnia and Herzegovina, Slovakia and Slovenia in the Central; Albania, Bulgaria, Cyprus, Greece, Malta, North Macedonia, Romania and Moldova in the South; Türkiye; Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan in the Caucasus and Central Asia.

Sweden

In Sweden, deposits such as Norra Kärr[44], Per Geijer and Olserum[45,46] have drawn EU-level attention. The Per Geijer deposit near Kiruna, estimated to contain around 2.2 million tonnes of in-situ REE oxides, is one of Europe's largest and has been designated a strategic project under the EU Critical Raw Materials Act.[47, 48] If brought into production, Sweden could eventually meet up to 18 % of Europe's REE demand.[49]

Norway

In Norway, preliminary assessments at the Fen Carbonatite Complex suggest nine million tonnes of REE oxides, potentially covering one-third of Europe's expected demand by 2050.[50, 51, 52]

Finland

Finland is emerging with its Sokli project, where preliminary drilling has found high concentration of REEs such as neodymium and praseodymium.[53] This deposit has the potential to provide around 10% of Europe's annual demand for REEs used in permanent magnets.[54, 55]

Ukraine

Ukraine shows promise for heavy rare earths like dysprosium, though resource estimates remain based on Soviet-era data and require modern verification and substantial investment.[56, 57]

Other countries in the Europe Central region – **Romania**, **Greece**, **Slovakia**, **Serbia**, **Türkiye** and others – add to the broader regional potential.

Central Asia

In Central Asia, **Kazakhstan** hosts over 120 known deposits of critical and rare earth metals, around 40 of which have been explored.[58] A recently identified deposit in the country's central region may contain 20 million tonnes of potential REE resources, including about 1 million tonnes of cerium, lanthanum, neodymium and yttrium.[59] In collaboration with the US, Kazakhstan is to explore another of the country's northern locations with estimated REE reserves of 349,000 tonnes, which include neodymium, dysprosium and terbium.[60] Rare-earth mining is also a priority for **Uzbekistan** due to its substantial reserves, and like its northern neighbor, the country has already established strategic partnerships with Western nations.[61]

However, access to raw REE deposits alone does not eliminate dependence on China since most countries outside China remain constrained by limited refining and separation capacity. These processes are technically demanding and often associated with radioactive byproducts such as uranium and thorium, requiring specialized infrastructure.

Currently, Europe hosts only two operational REE processing facilities – the **Silmet plant in Estonia**[62] and the **La Rochelle facility in France** (the only plant outside of China that can process **all 17 different REEs**)[63, 64] – with new projects planned in **Luleå (Sweden)**[65] and **Puławy (Poland)**[66] in the **Europe Central** region.

Past crises, such as China's 2010 export embargo against Japan, generated considerable global interest but did not significantly challenge Beijing's dominance. Developing a new mine or a refinery could take between eight and ten years and five years, respectively.[67]

The development of recycling infrastructure and urban-mine recovery systems could partially offset the need for primary REE extraction. The **European Critical Raw Materials Act**, effective from 2024, targets 25% recycling of strategic raw materials (including REEs) by 2030 to strengthen supply chain resilience.[68, 69]

The Europe Central region, including Central Asia, could provide important support, but building end-to-end REE supply chains remains complex and capital intensive. This will require coordinated policy, strategic partnerships, and technological innovation to reduce reliance on China.

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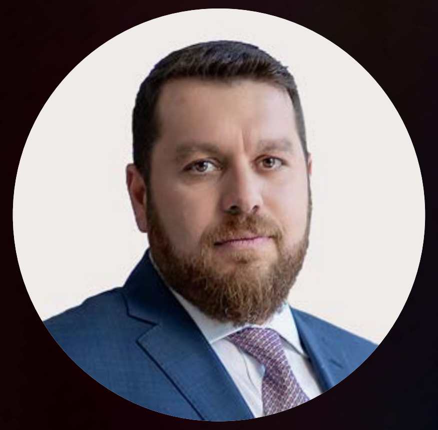

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