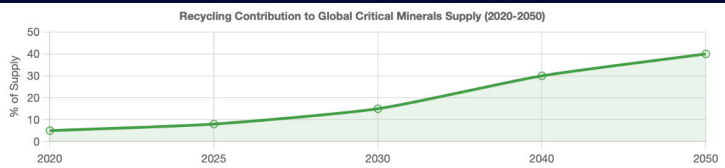
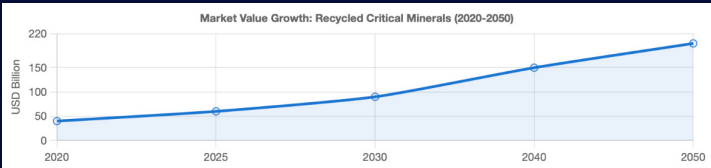
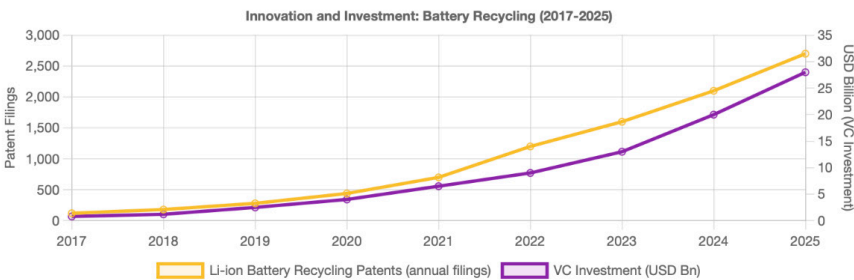


Critical minerals recycling is emerging as an essential pillar for future clean energy supply chains. Recent data and international analysis highlight several important trends and benchmarks for the industry as of 2025.

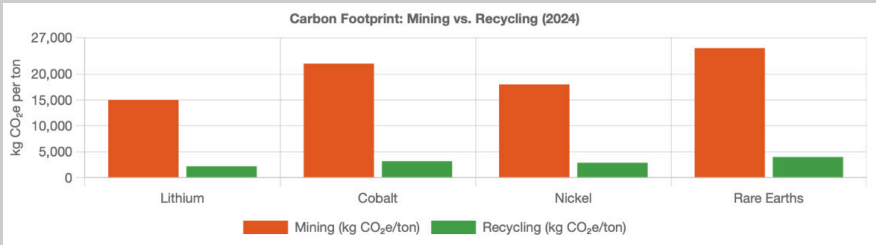


- Recycled materials currently represent a small share of global supply for lithium, nickel, cobalt, and rare earth elements (typically in the range of 1) 10% depending on the mineral.
- Projections by major agencies and market forecasters expect the recycled share of critical minerals to increase significantly, though upper-bound estimates for 2050 (such as 40%) should be viewed as optimistic. The International Energy Agency sees battery recycling meeting 20-30% of projected 2050 lithium, nickel, and cobalt demand, contingent on technological and policy advances.
- Recycling critical minerals reduces the carbon footprint of supply by approximately 70-85% compared to primary mining, largely due to much lower energy requirements and the avoidance of mining-related emissions.
- The recycled critical minerals market is expected to see robust expansion. Global market value forecasts suggest growth from about \$40 billion today toward or above \$100 billion by 2045, with electrification driving demand for battery-related metals in particular.
- Patent activity and R&D investments in battery and critical mineral recycling have increased rapidly over the past five years, reflecting both rising demand and the technical challenges of extracting key materials from complex end-of-life products.

Most rare earths and several key battery minerals remain difficult and costly to recycle at scale due to technical barriers, feedstock limitations, and infrastructure gaps.



Recycling lithium, cobalt, nickel, and rare earth elements can cut life-cycle carbon emissions by up to 80-85% compared to conventional mining. This substantial reduction stems from the avoidance of highly energy- and resource-intensive extraction and processing stages associated with primary production. Incorporating recycled materials is essential for minimizing the environmental impact of future clean energy and manufacturing supply chains.



Advances in battery recycling are accelerating, as evidenced by an exponential increase in both patent filings and venture capital investment over recent years. This simultaneous growth in technological innovation and commercial funding highlights the global prioritization of closed-loop resource systems for critical minerals. The synergistic momentum between research breakthroughs and market engagement is rapidly transforming battery recycling from an emerging concept into a scalable industrial solution.