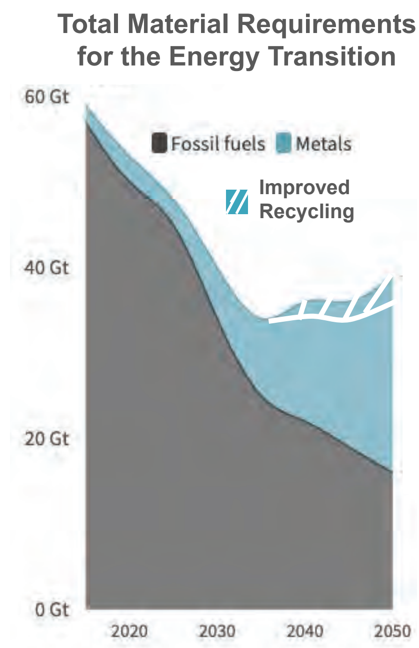
#5: BATTERIES & CRITICAL MINERAL SUPPLY CHAINS

Technology trends and opportunities for reform

GROWING SUPPLY AS OPPORTUNITY FOR IMPROVEMENT

Demand for batteries and critical minerals is surging. The International Energy Agency (IEA) estimates that if all announced and anticipated supplies of critical minerals come online as scheduled, sufficient supply should exist to meet increased demand through 2025. This dynamic will likely hold true through 2030, but with a relatively thin margin that will require significant effort to expand supply and reduce the growth rate of demand through improved efficiency. The next few years present a unique window to ensure supply chain growth is sustainable, just, and low-carbon.



Source: Nijnens et al. (2023)

CLEAN ENERGY REQUIRES LESS MINING

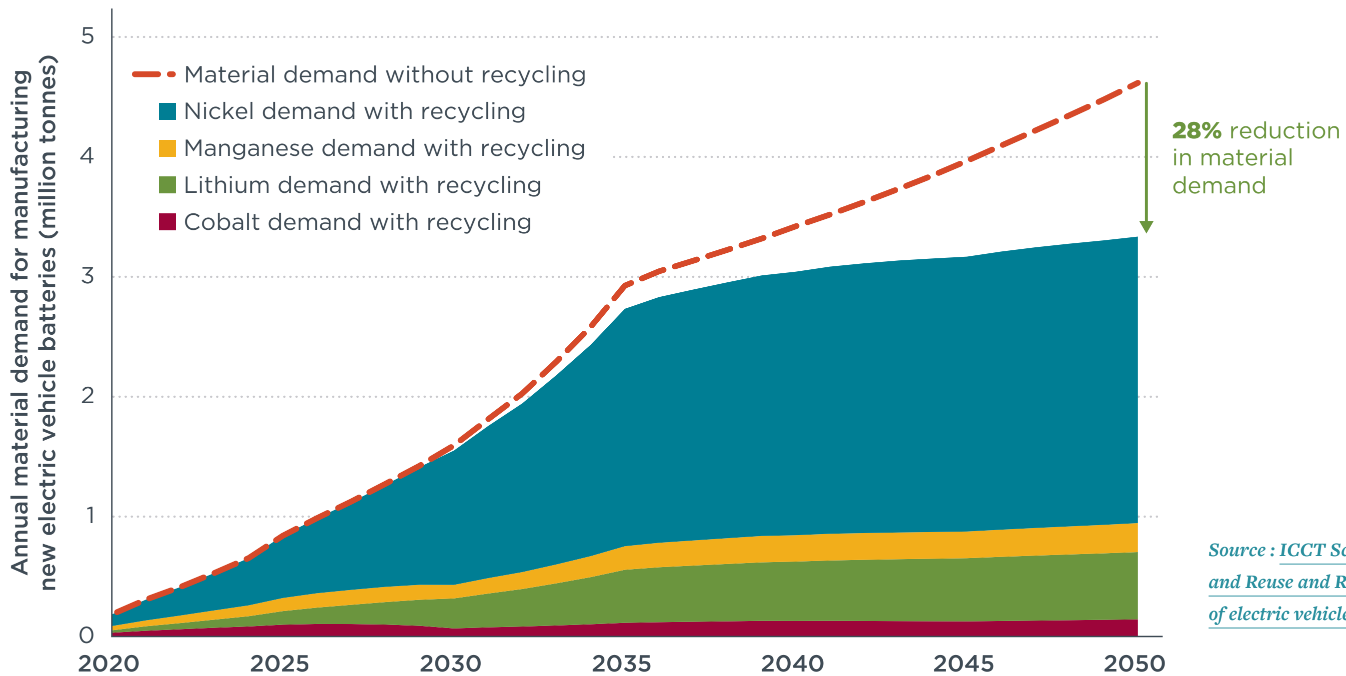
The IEA estimates that annual demand for critical minerals (for all technologies) could reach 43 million tons by 2040 in the most ambitious and mineral-intensive Net-Zero Scenario. This is a fraction of current annual global extraction and mining of 15 billion tons of fossil fuels. However, some minerals exist in very low concentrations within rocks. Several recent analyses account for this by looking at what this means for total "material moved" — not just the ore used, but the amount of earth disrupted to extract the resource. Even accounting for low and potentially declining ore concentrations, a clean energy economy will significantly reduce overall extraction compared to a fossil fuel economy. Expected improvements in technology, recycling, and policy will further enhance this benefit.

ZERO EMISSION TRUCKS LOWER EMISSIONS COMPARED TO DIESEL

The carbon intensity of mineral extraction and battery manufacturing means that ZET production is higher-emission than diesel truck production. However, truck manufacturer Scania found that BETs make up for these production emissions in just the first 68,000 kilometers (42,250 miles) of zero emission driving. ICCT analysis found that 2021 BETs produce at least 63% lower lifetime emissions compared to diesel when using the EU's average electricity grid mix (with a 92% emission reduction projected when 100% renewable electricity is used). These findings hold true for light-duty vehicles as well, all around the world, even when charged from more carbon-intensive electricity grids.

IMPROVING RECYCLING AND LIFE EXTENSION

Markets for battery recycling and life extension (such as refurbishing for continued vehicle use or reuse for grid storage) are still in the beginning stages, with significant opportunities for innovation and technological advancement. These markets will grow as more EVs reach end of life, with a predicted 1.2 million batteries available 2030 rising to 50 million in 2050. There is also significant opportunity for supportive policy and industry coordination to drive innovation and help overcome technological and logistical barriers. China and the European Union have leading policy frameworks to ensure end-of-life batteries are handled responsibly, including: extended producer responsibilities making manufacturers responsible for end-of-life batteries, battery tracing platforms or passports, and targets for improving mineral recycling recovery rates. Implementation of EU Battery Regulation recycling rates would result in an estimated 28% reduction in material demand. Notably, there are a range of estimates for how much recycling and life extension can reduce demand across different minerals. For example, estimates for 2040 demand reductions for nickel range from 12% to up to 35%. While it is technologically possible to recover multiple critical minerals at rates above 90%, current recovery is limited by the lack of strong economic or policy drivers.



Source : ICCT Scaling up and Reuse and Recycling of electric vehicle batteries

BATTERY IMPROVEMENT TRENDS

Advancements in battery chemistry have enabled increased battery density while reducing battery weight. With various battery chemistries available, including lithium-ion and solid-state, the industry has driven significant improvements in battery energy storage capabilities. Moreover, the emergence of recycling and repurposing technologies for batteries signifies a sustainable approach, decreasing the demand for new batteries and contributing to sustainable mining practice efforts.

REDUCING DEMAND THROUGH EFFICIENCY

Reducing demand for critical minerals through improved efficiency will require concerted policy effort and industry coordination but could significantly cut the need for new mining. There are several opportunities for reducing overall battery demand, including: modal shift for freight, such as moving goods by rail or smaller vehicles for last-mile delivery; modal shift for people, such as encouraging public transit and e-bicycles; right-sizing batteries; and technology improvements for reducing the mineral intensity of batteries. One study estimates that reducing car dependence and limiting the size of EV batteries in the US could reduce lithium demand by 18-66%. Investing in innovative technology can reduce mineral demand not only in battery design and chemistry, but also through methods such as “clean-sheet” designs and light-weighting. These take advantage of new materials and zero-emission-specific vehicle architectures that can reduce the weight and cost of vehicles while improving their overall efficiency.

IMPROVING MINING & SUPPLY CHAINS

Below are two key best practice frameworks for improving human rights and the local environmental impact in mining and supply chains. See also the leading policy frameworks in China and the European Union.

- **Standards**: Initiative for Responsible Mining Assurance (IRMA) is an independent third-party standard-setting organization for responsible international mining practices. IRMA stands out by including human rights and environmental issues, setting standards through multi-stakeholder engagement, and offering fully transparent auditing. IRMA is in the process of developing additional standards for minerals processing and refining.

- **Battery Passport**: The Global Battery Alliance (GBA) describes a battery passport as establishing a digital twin of a physical battery with information about all lifecycle elements based on a comprehensive definition of a sustainable battery. It aims to bring new levels of transparency to the global battery value chain by reporting trusted data among all lifecycle stakeholders on the material sources, the battery’s chemical make-up and manufacturing history, and its sustainability performance. This technology could allow better decision-making along the various steps of battery supply chains, including post-vehicle life and recycling, helping to improve human and environmental outcomes.