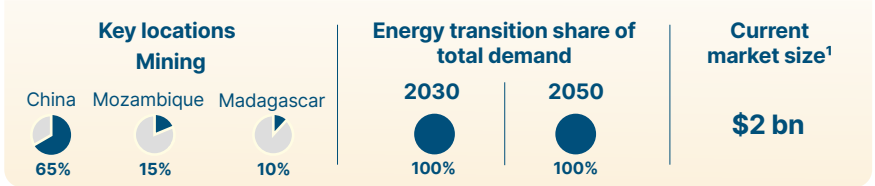


Graphite

for the energy transition



Outlook to 2030 and key challenges

Demand

- Graphite is the dominant material used for **battery anodes**, where demand is expected to grow very strongly in coming decades.
- Potential to **substitute some graphite with silicon** (silicon doping), or to shift entirely to lithium metal anodes.

Supply

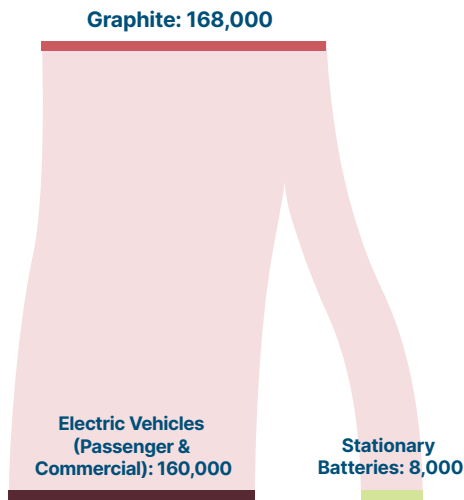
- Two supply routes: mining of **natural graphite**, or production of **synthetic graphite** from petroleum or coal tar coke.
- Natural graphite tends to be cheaper but lower-quality; significant number of new natural graphite mining projects in pipeline across East Africa, USA, and Canada.

Key challenges

- High life-cycle emissions** associated with production of synthetic graphite.
- Could see growing demand competition from use of graphite electrodes in electric arc furnaces – a key technology for decarbonising steel production.

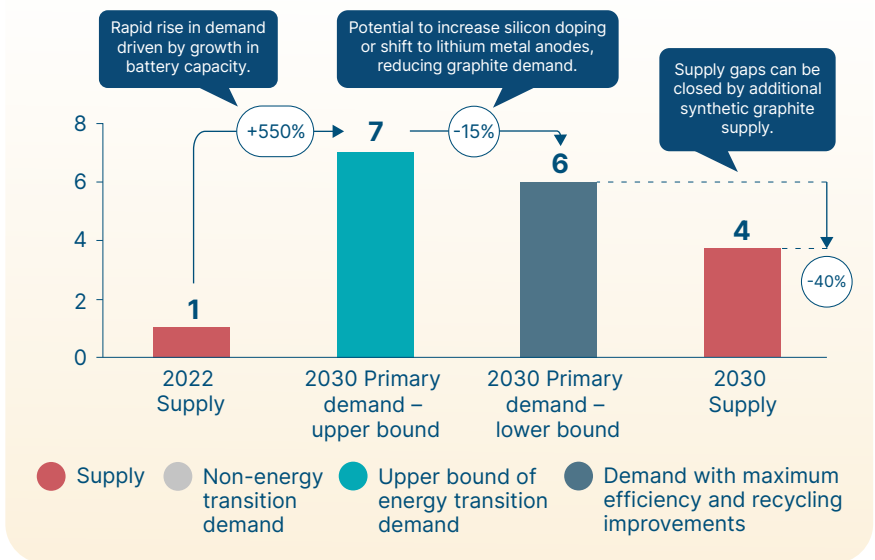
Cumulative demand 2022–50 from clean energy technologies

Thousand metric tonnes



Demand and primary supply in 2030

Million metric tonnes

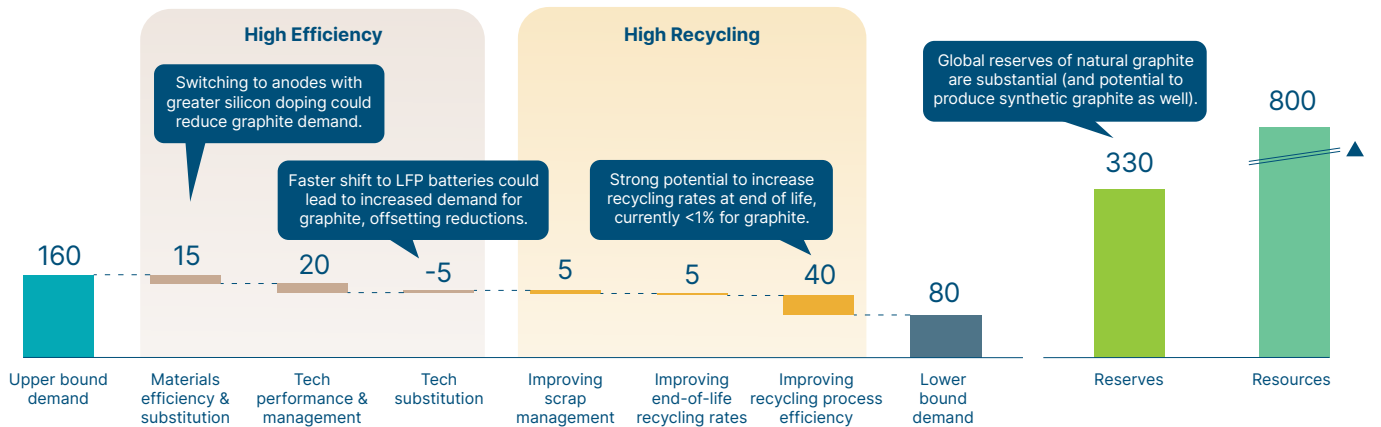


Silicon doping can reduce demand over short term, strong potential for recycling over long term

Cumulative primary demand 2022–50, reductions due to efficiency and recycling levers, and resources and reserves

Million metric tonnes

Potential for substitution **H** | Potential for recycling to meet supply **H** >70% of clean energy demand could be met by recycling by 2050



SOURCES: Systemiq analysis for the ETC; IEA (2021), *The Role of Critical Minerals in Clean Energy Transitions*; BNEF (2022), *2H Battery metals outlook*; IEA (2023), *Energy Technology Perspectives*; BNEF (2021), *Global graphite outlook*.

NOTE: The upper bound demand is the ETC's Baseline Decarbonisation scenario, which assumes an aggressive deployment of clean energy technologies for global decarbonisation by mid-century, but materials intensity and recycling trends follow recent patterns. The lower bound demand is the ETC's Maximum Efficiency and Recycling scenario, which assumes accelerated progress in material and technology efficiency, and recycling clean energy technologies, thereby reducing requirements for the primary supply (i.e. mined supply) of materials. ¹Calculated assuming average 2022 price of around \$2,000 per tonne of graphite (across flake and spherical graphite). L=Low, M= Medium, H = High.