



# The Role of Critical Minerals in Clean Energy Transitions

Hungarian Battery Day

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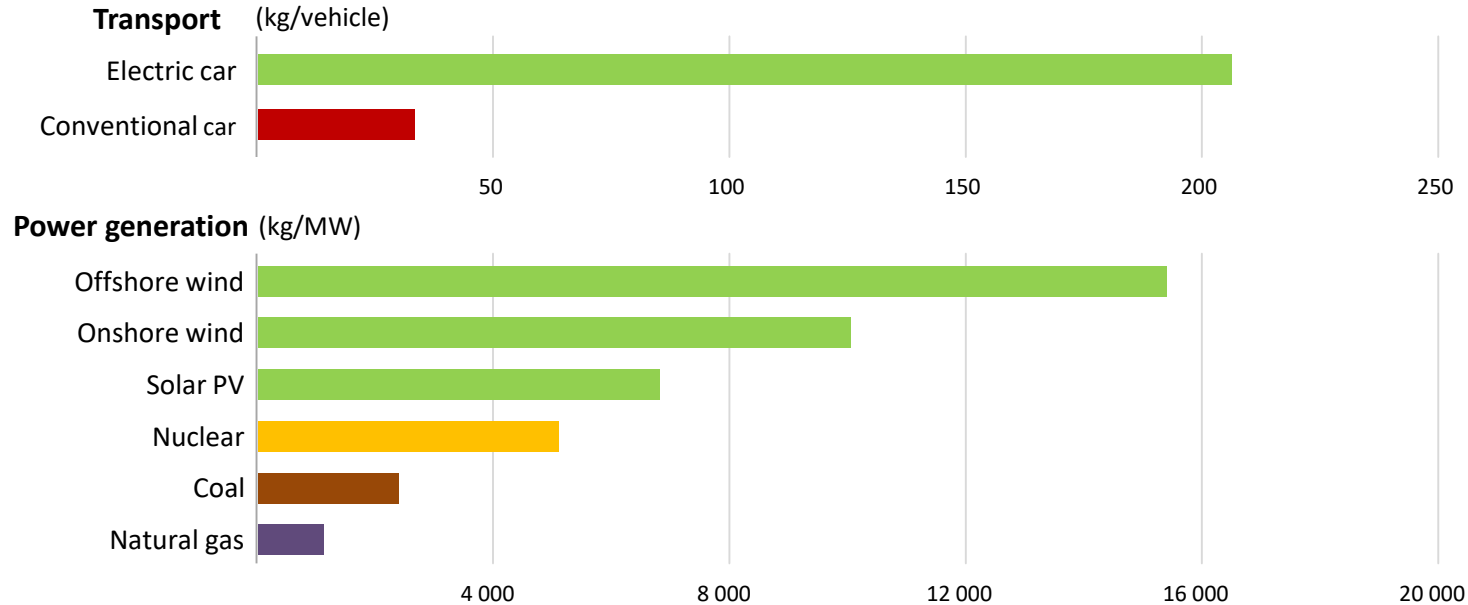
# Context

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- Countries accounting for more than 70% of today's global GDP and emissions have committed to net-zero emissions, implying a massive acceleration in clean energy deployment
- An energy system powered by clean energy technologies needs significantly more minerals, notably:
  - Lithium, nickel, cobalt, manganese and graphite for batteries
  - Rare earth elements for wind turbines and electric vehicles motors
  - Copper, silicon and silver for solar PV
  - Copper and aluminium for electricity networks
- There is no shortage of mineral resources, but recent price rises for cobalt, copper, lithium and nickel highlight how supply could struggle to keep pace with the world's climate ambitions
- An evolving energy system calls for an evolving approach to energy security; policy makers must expand their horizons and act to reduce the risks of price volatility and supply disruptions

# The shift to a more mineral-intensive energy system

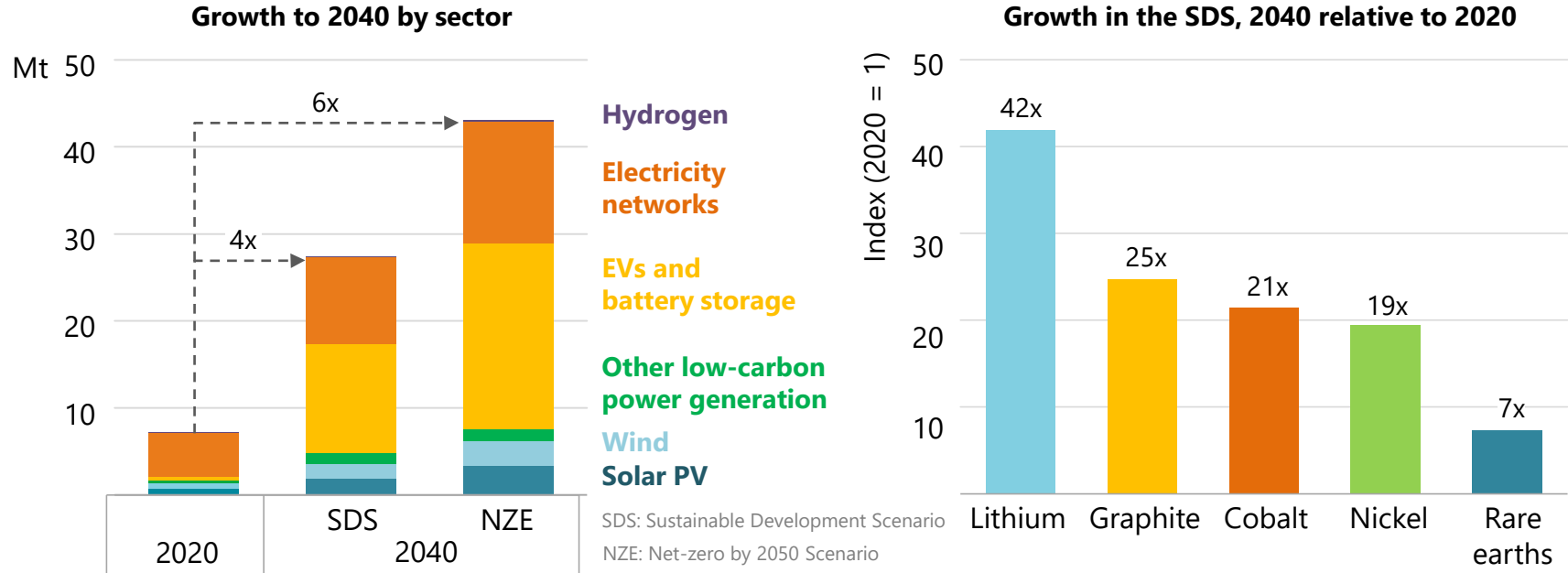
Minerals used in selected energy technologies



A typical electric car requires six times the mineral inputs of a conventional car, and an offshore wind plant requires thirteen times more mineral resources than a similarly sized gas-fired power plant

# Meeting climate goals will turbo-charge demand for minerals

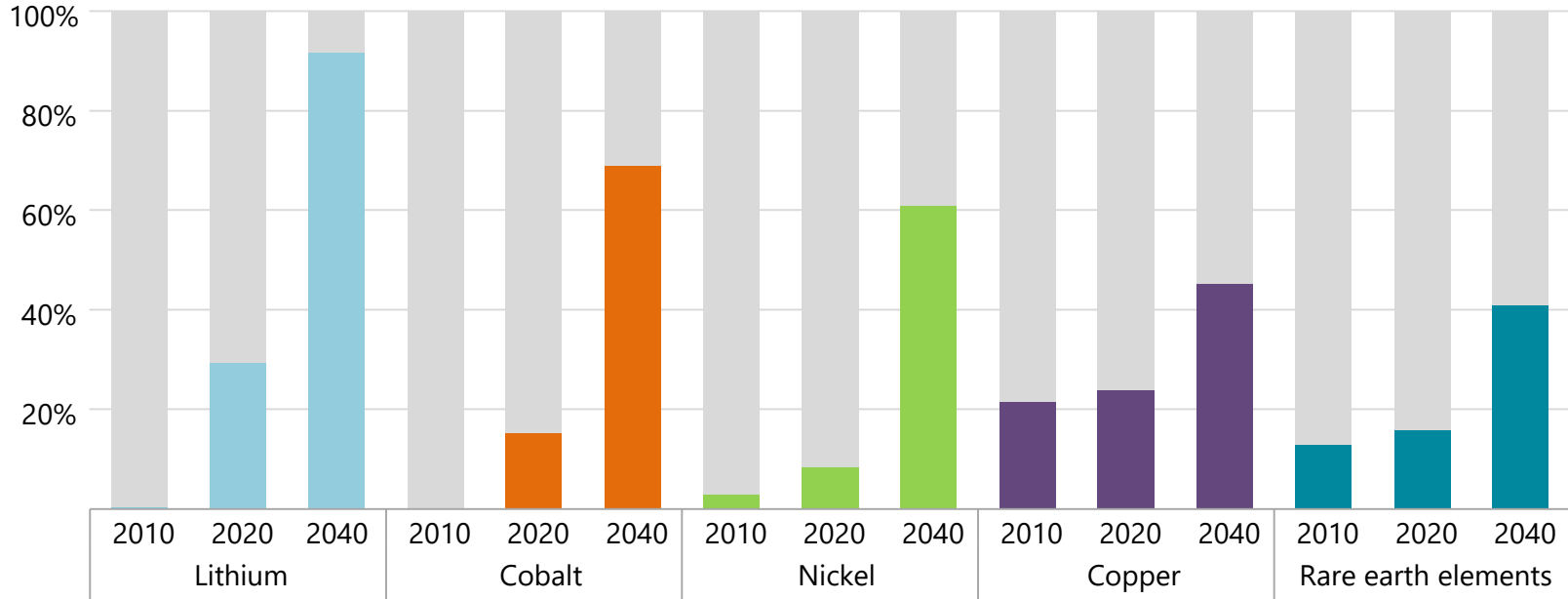
Mineral demand for clean energy technologies by scenario



Demand for critical minerals is set to soar over the next two decades as the world pursues net zero goals; overall requirements rise by as much as 6 times, but individual minerals, led by lithium, rise even faster

# Clean energy in the driving seat for mineral demand growth

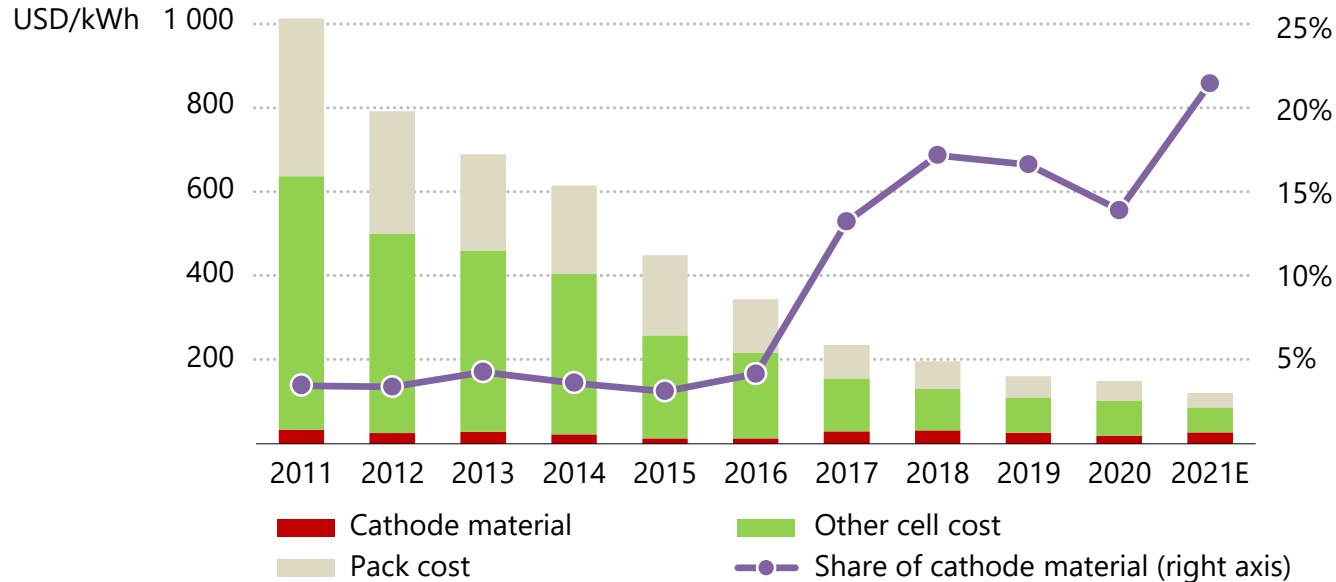
Share of clean energy technologies in total demand for selected minerals in the SDS



Clean energy technologies emerge as the fastest growing segment of demand for most minerals, evolving from a niche consumer to a leading source of demand

# Mineral prices loom large in total cost of clean energy

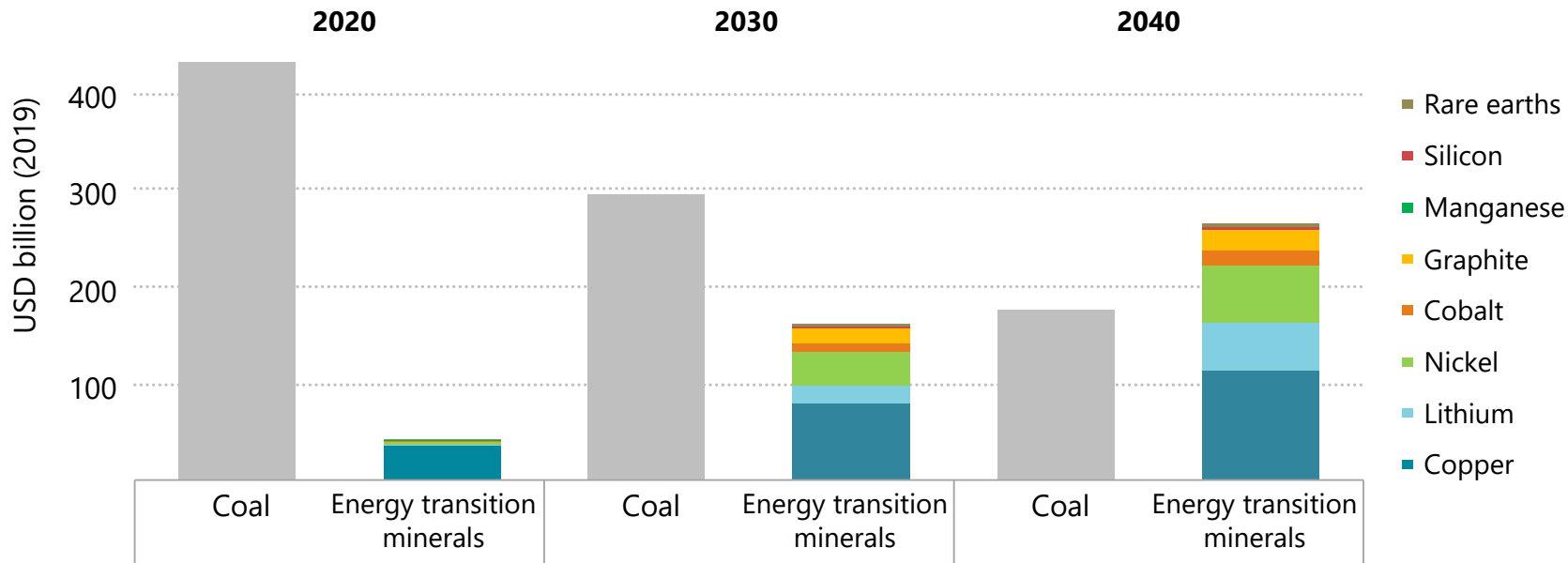
Average pack price of lithium-ion batteries and share of cathode material cost



As learning and economies of scale bring down other cost components, mineral inputs also account for an increasingly large share of the total cost of batteries and other key clean energy technologies

# New reasons to go underground

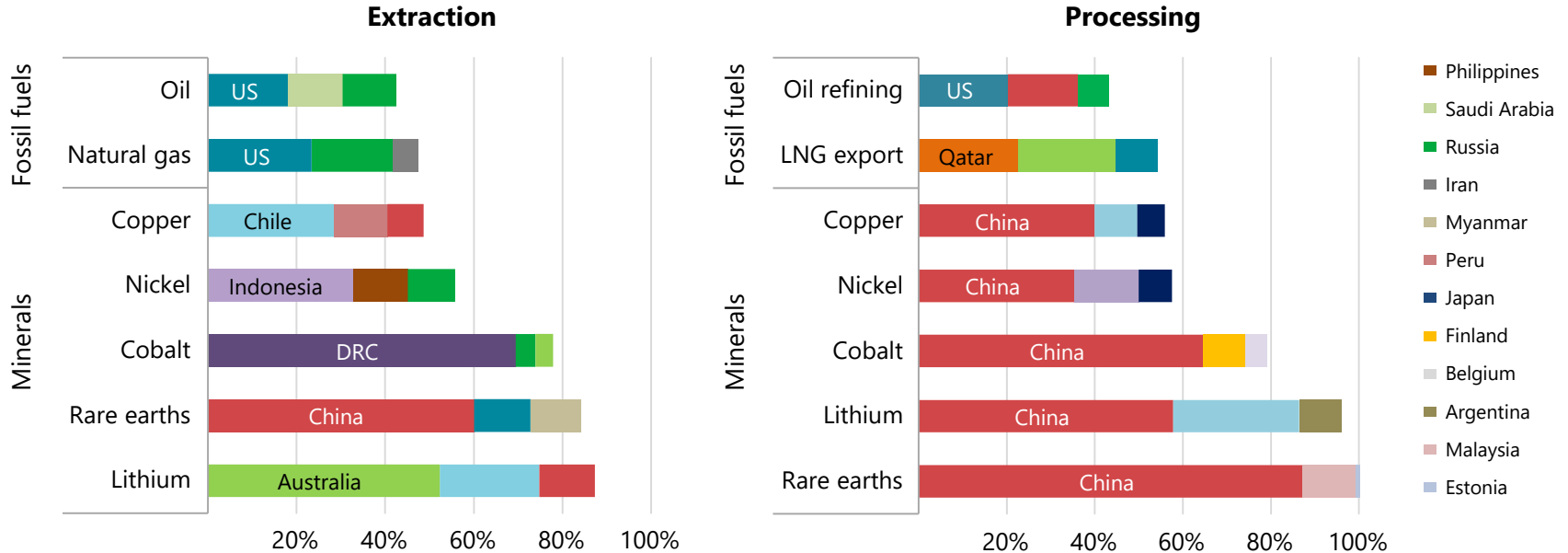
Revenue from production of coal and selected energy transition minerals in the SDS



Today's revenue from coal production is ten times larger than from energy transition minerals. However, in climate-driven scenarios, these positions are reversed well before 2040

# Many mineral supply chains lack diversity

Share of top three producing countries in production of selected minerals and fossil fuels, 2019

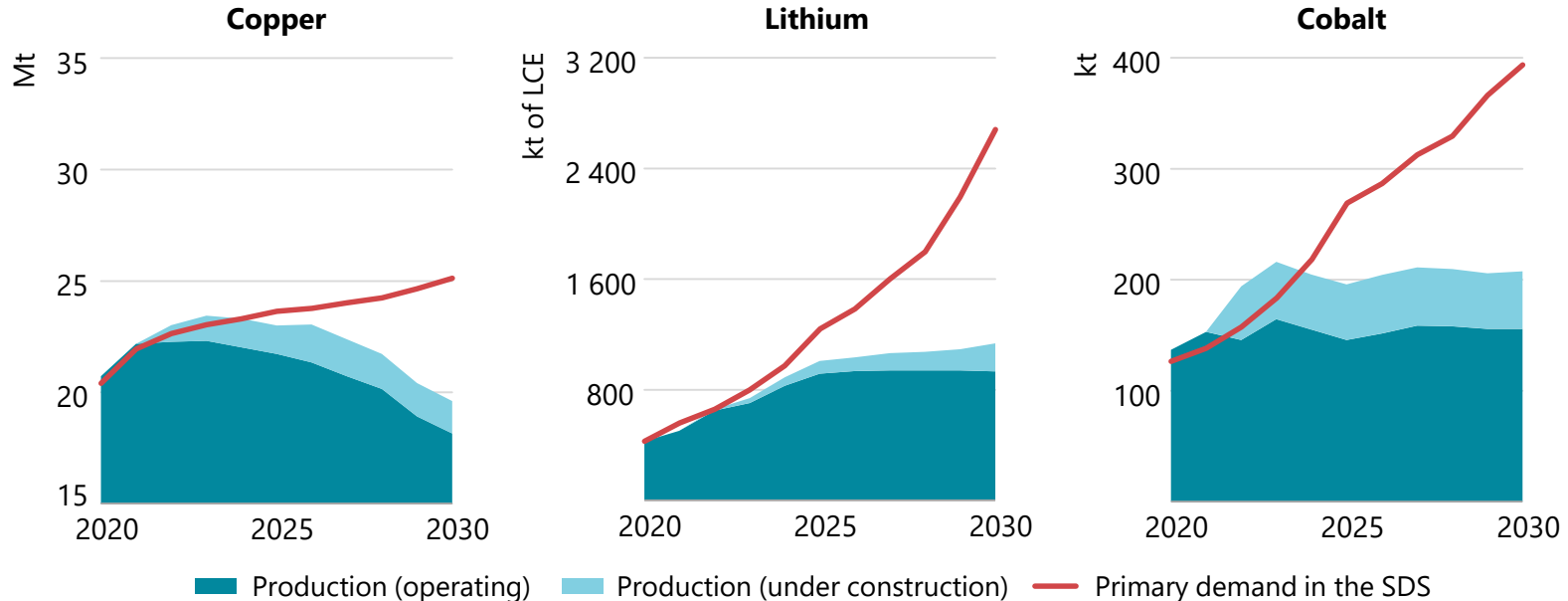


Production and processing of many minerals such as lithium, cobalt and some rare earth elements are geographically concentrated, with the top three producers accounting for more than 75% of supplies



# A looming mismatch between mineral supply and climate ambition

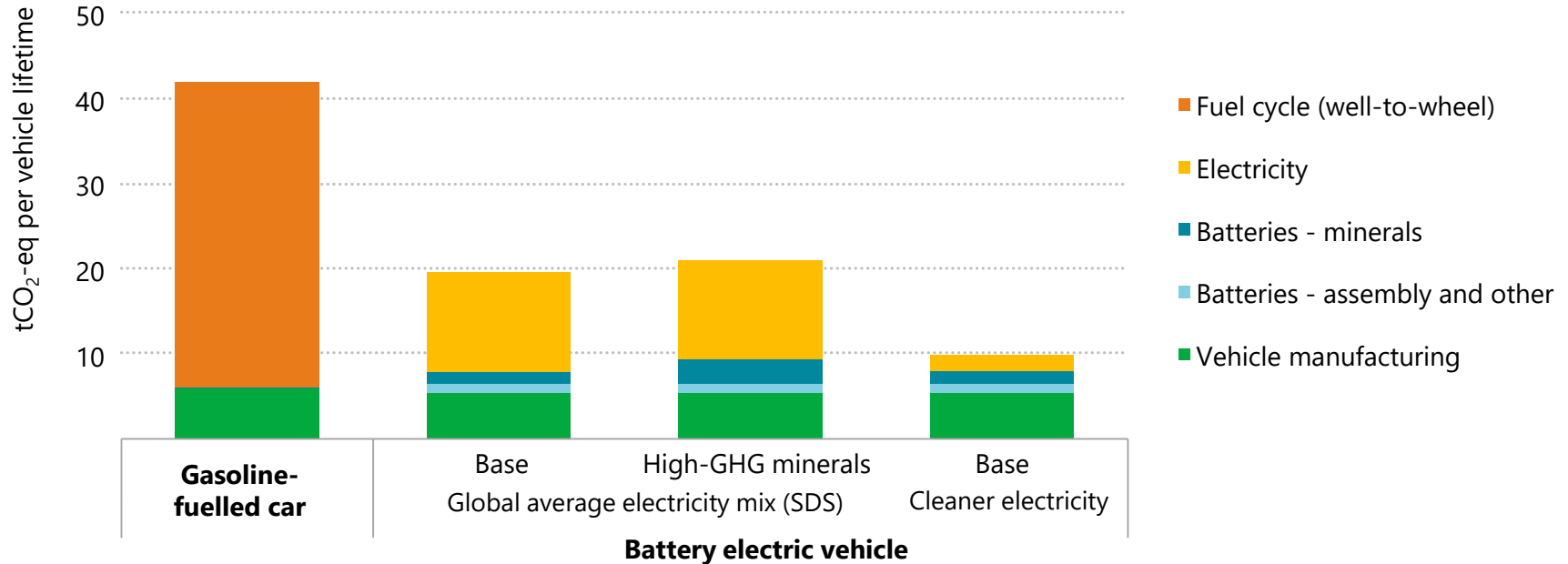
Committed mine production and primary demand (SDS) for selected minerals



Today's investment plans are geared to a world of gradual change; given long leads times for new projects, an accelerated energy transition could quickly see demand running ahead of supply

# Critical minerals do not undermine the case for clean energy

Comparative life-cycle GHG emissions of a mid-size battery electric versus a conventional car



Even though mineral extraction is relatively emissions-intensive, on average the full lifecycle emissions of an EV bought today are around half those of a conventional car

# IEA plan of action: a comprehensive approach to mineral security

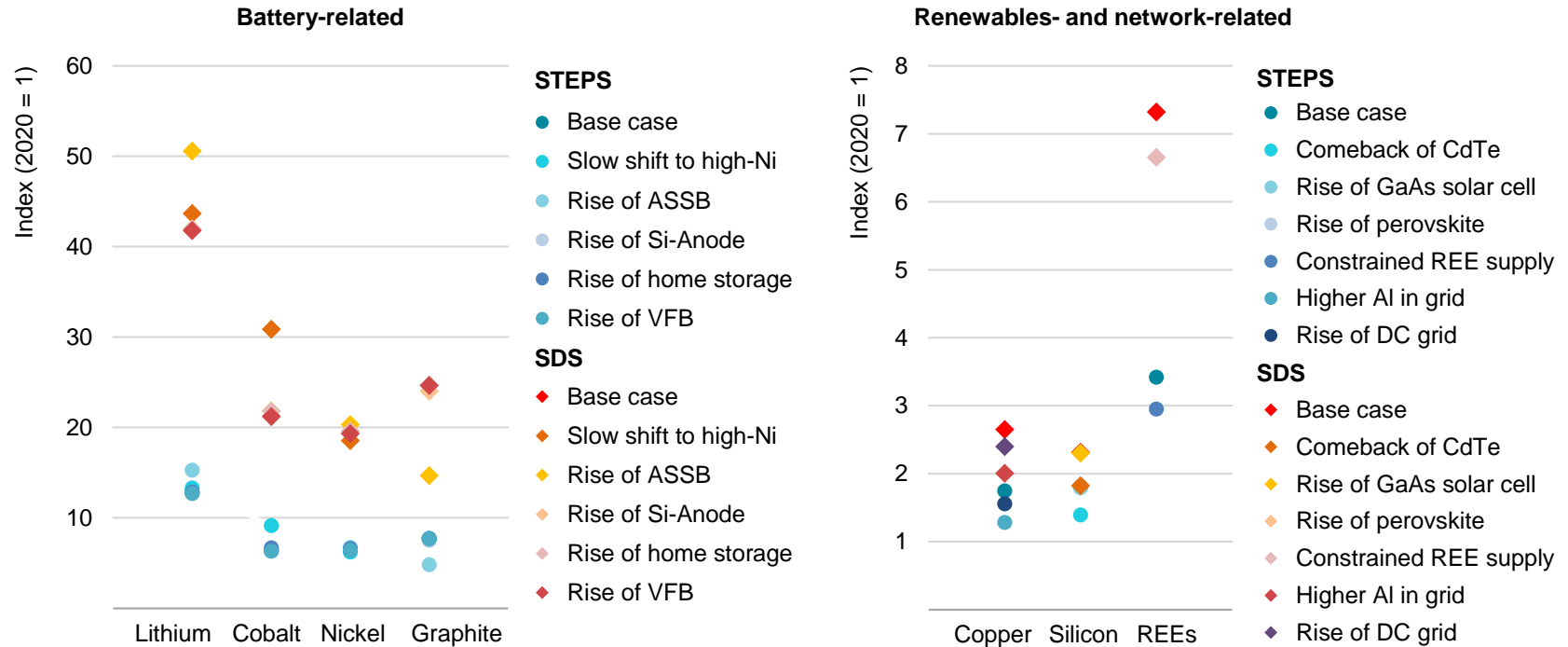
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Building on the IEA's leadership role in energy security, these six key areas of action can ensure that critical minerals enable an accelerated transition to clean energy

- 1. Ensure adequate investment in diversified sources of supply**
- 2. Promote technology innovation at all points along the value chain**
- 3. Scale up recycling**
- 4. Enhance supply chain resilience and market transparency**
- 5. Mainstream higher environmental, social and governance standards**
- 6. Strengthen international collaboration between producers and consumers**

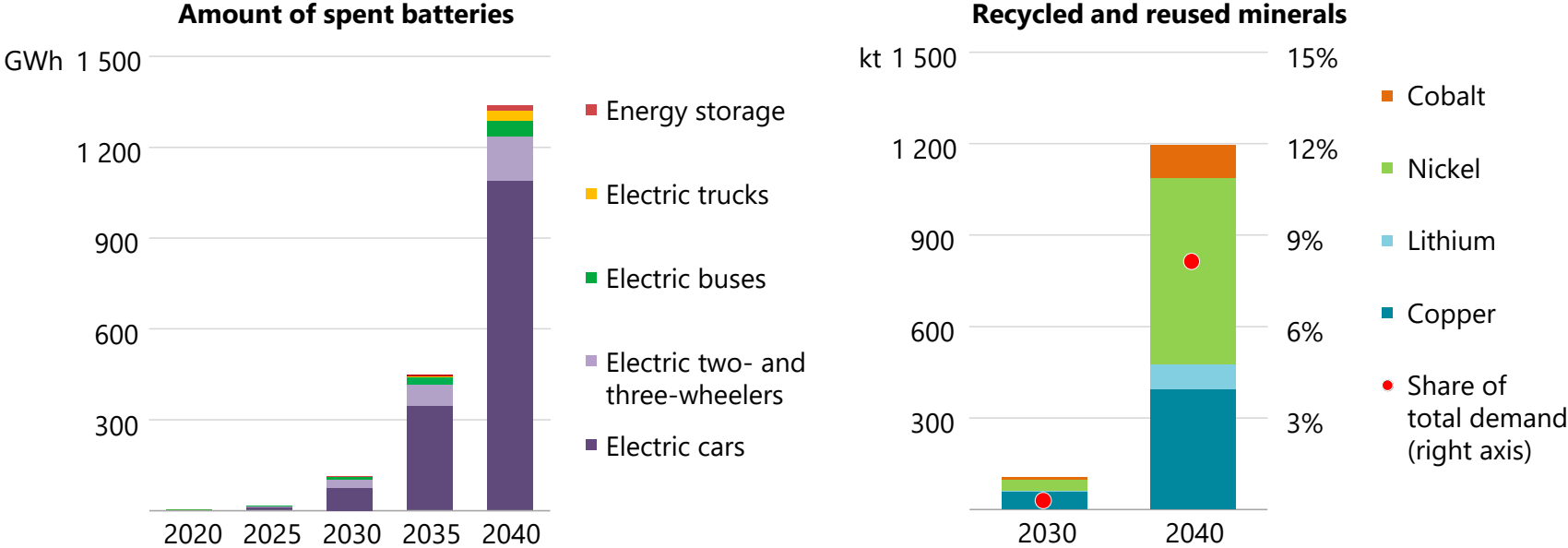
# A major source of demand uncertainty: strength of climate policies

Range of projected demand under different scenarios and varying technology evolution trends, 2040 relative to 2020



# Recycling becomes a significant source of supply

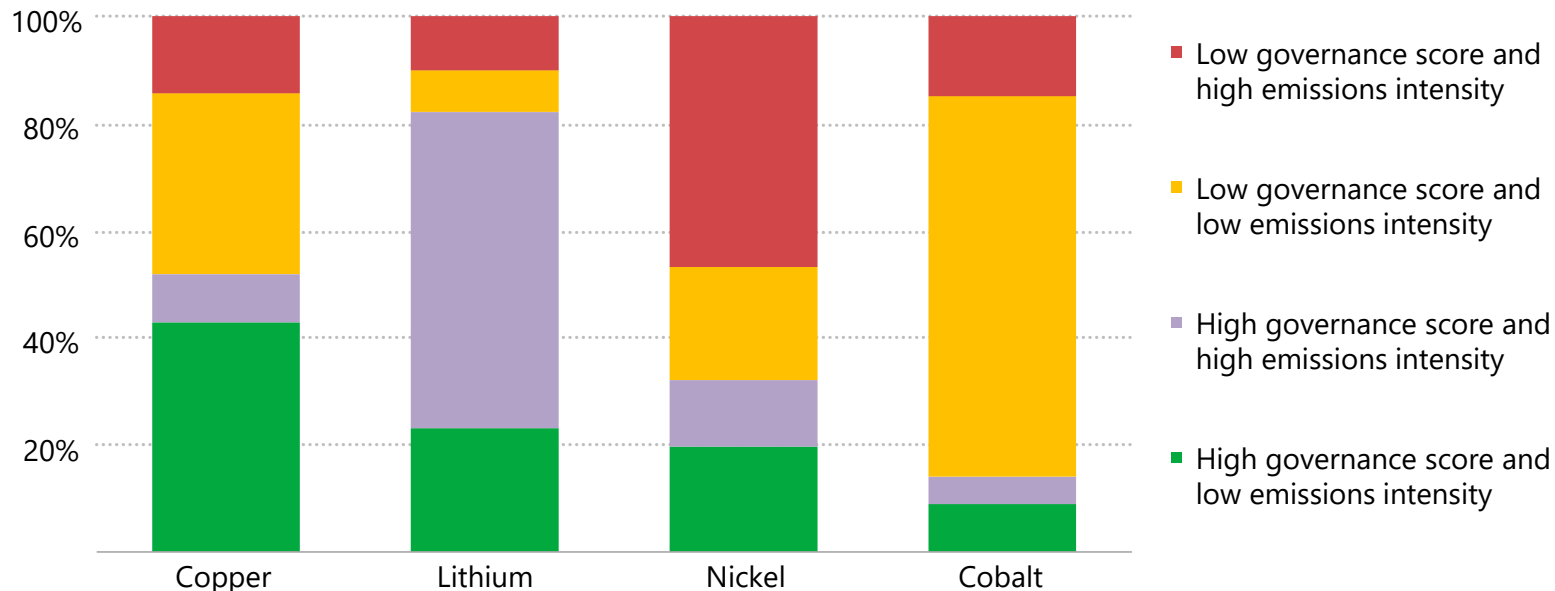
Contributions from spent lithium-ion batteries from EVs and storage to reducing primary demand in the SDS



By 2040, recycled quantities of copper, lithium, nickel and cobalt from spent batteries could reduce combined primary supply requirements for these minerals by around 10%

# Strong linkage between ESG and supply security

Distribution of production of selected minerals by governance and emissions performance, 2019



The majority of current production volumes come from regions with low governance scores or high emissions intensity

**iea**