How to manage the risk of critical minerals supply?

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Where do risks come from?

1. Geographical concentration of resources
2. Geographical concentration of midstream processes
3. An immature global market
4. Potential for disruptive technological developments

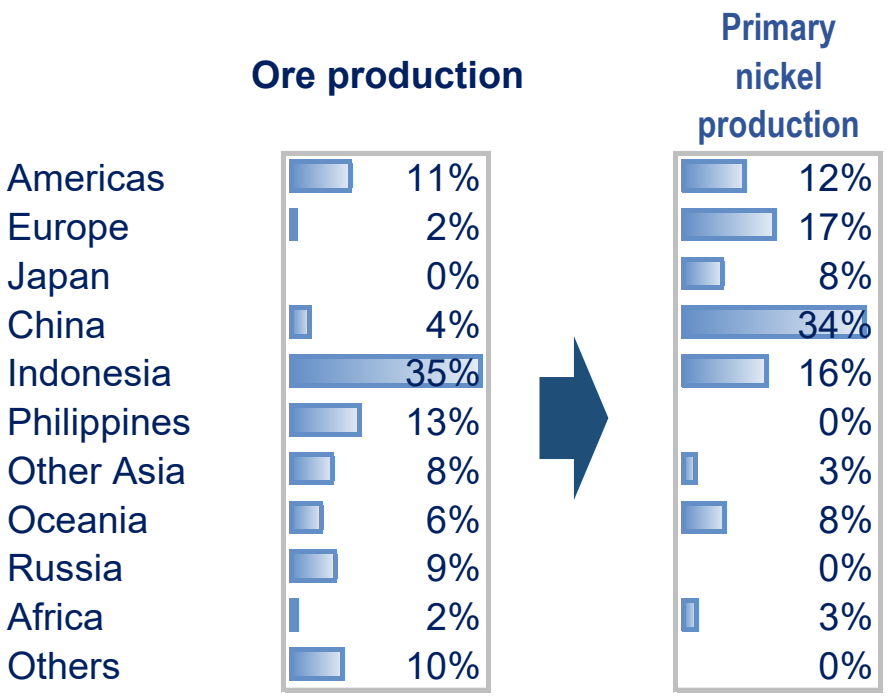
Geographical concentration

- Reserves, production, and refining of many critical minerals are unevenly distributed to specific countries.

Country-wise share of reserves in selected minerals

	Cu (copper)	Co (cobalt)	Ni (nickel)	Li (lithium)	V (vanadium)	PGM (platinum group)	REO (rare earth)
United States	5%	1%	0%	3%	0%	1%	2%
Canada	1%	3%	2%	0%	0%	0%	1%
Mexico	6%	0%	0%	0%	0%	0%	0%
Brazil	0%	0%	17%	0%	1%	0%	18%
Peru	9%	0%	0%	0%	0%	0%	0%
Chile	23%	0%	0%	42%	0%	0%	0%
Argentina	0%	0%	0%	10%	0%	0%	0%
Cuba	0%	7%	0%	0%	0%	0%	0%
Australia	11%	18%	22%	26%	25%	0%	3%
Indonesia	3%	8%	22%	0%	0%	0%	0%
Philippines	0%	3%	5%	0%	0%	0%	0%
Viet Nam	0%	0%	0%	0%	0%	0%	18%
China	3%	1%	3%	7%	40%	0%	37%
Kazakhstan	2%	0%	0%	0%	0%	0%	0%
Russia	1%	3%	8%	0%	21%	6%	18%
Zimbabwe	0%	0%	0%	1%	0%	2%	0%
DR Congo	4%	46%	0%	0%	0%	0%	0%
South Africa	0%	0%	0%	0%	15%	90%	1%
Others	33%	9%	21%	11%	0%	0%	4%

Share of nickel ore and primary nickel production by country (2019)

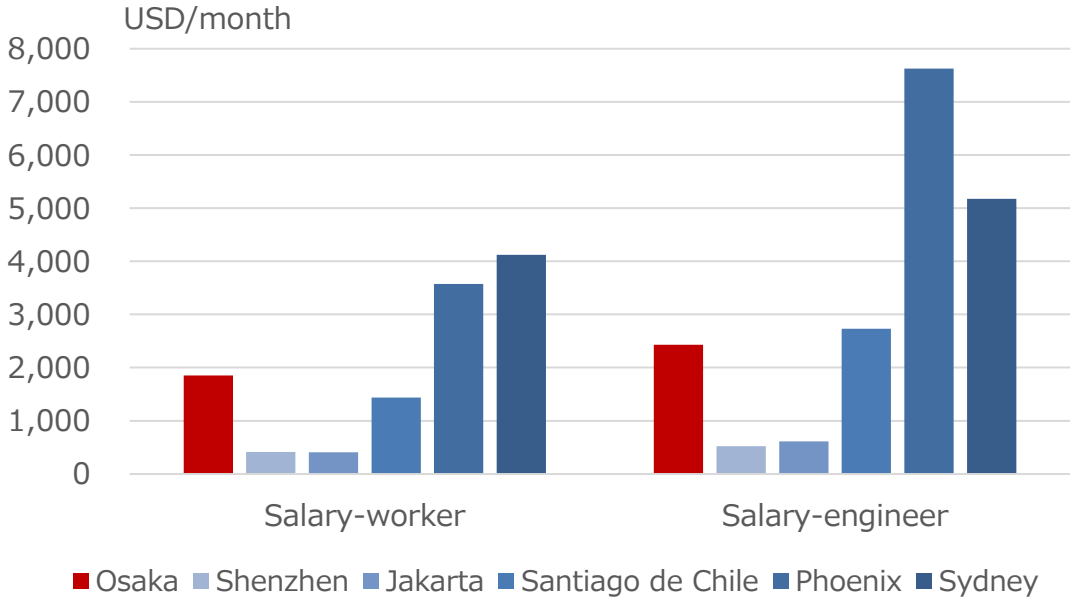


Source: IEEJ (2023), Outlook 2023

Cost of minerals production

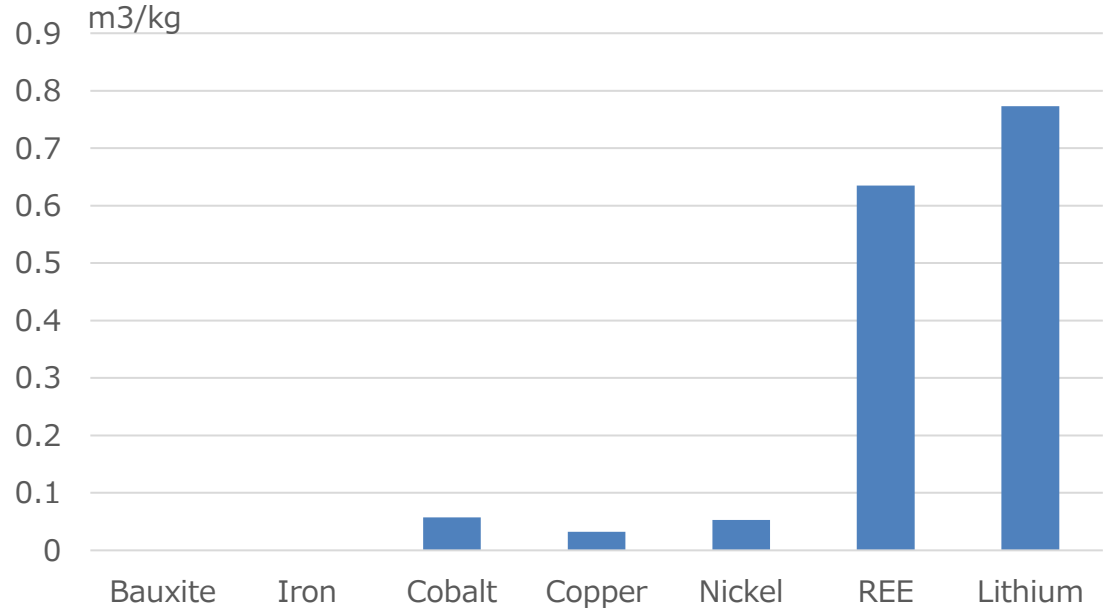
- As mineral extraction and smelting are energy-intensive and environmentally damaging processes, it is not easy to find competitive new sources of supply.
  - Labor and land cost.
  - Costs of electricity and water.
  - Costs of environmental measures.

Labor cost in selected cities



Source: JETRO, Survey of investment costs in selected cities in 2022 or 2023

Water use for selected minerals

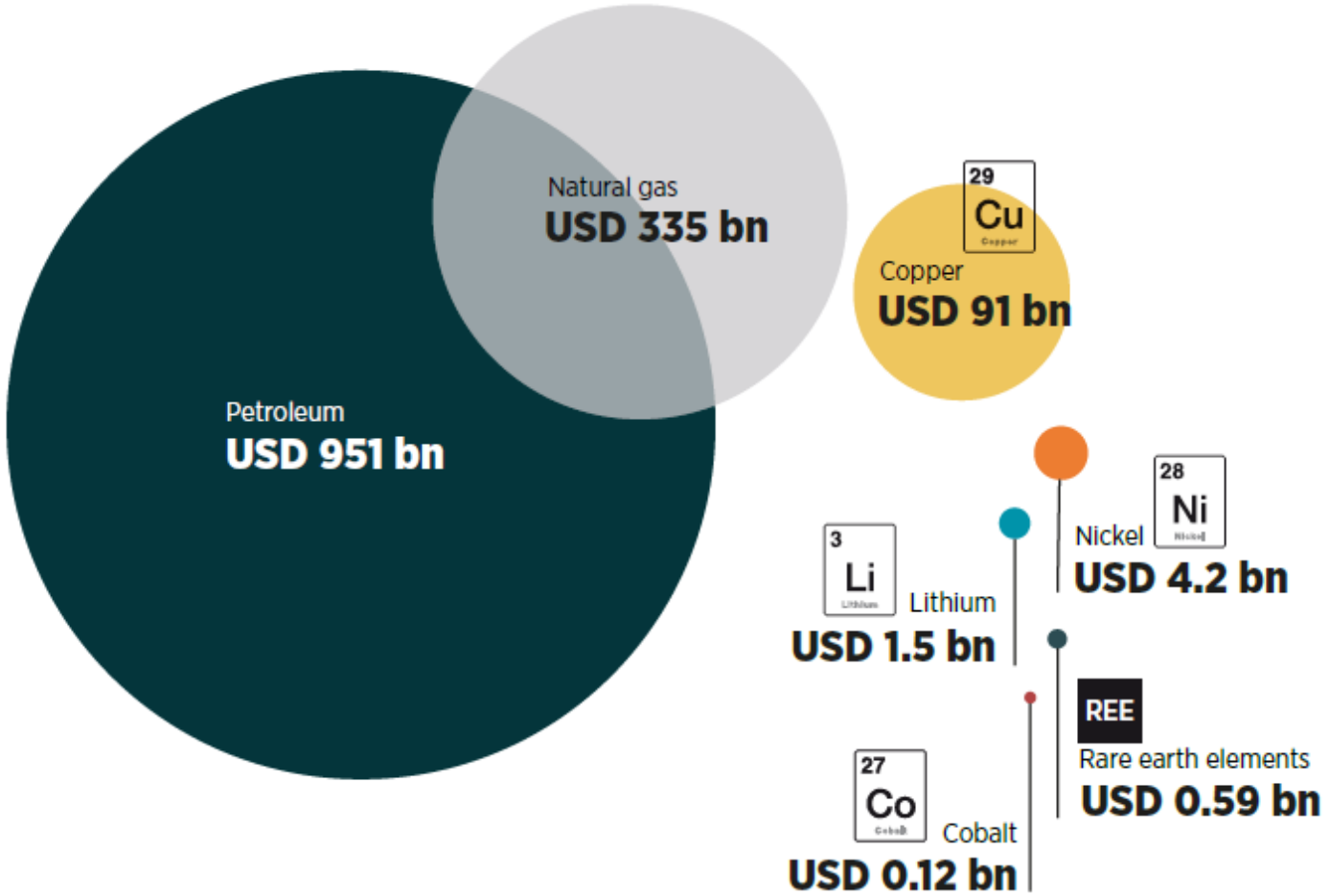


Source: IEA, Sustainable and responsible development of minerals

An immature market

- The market size of minerals is small compared to that of energy.
  - Smaller number of market participants.
  - Smaller transaction amount.
- As a result, market liquidity is not large enough to provide a security of supply/demand function.

Export value of selected commodities (2021)



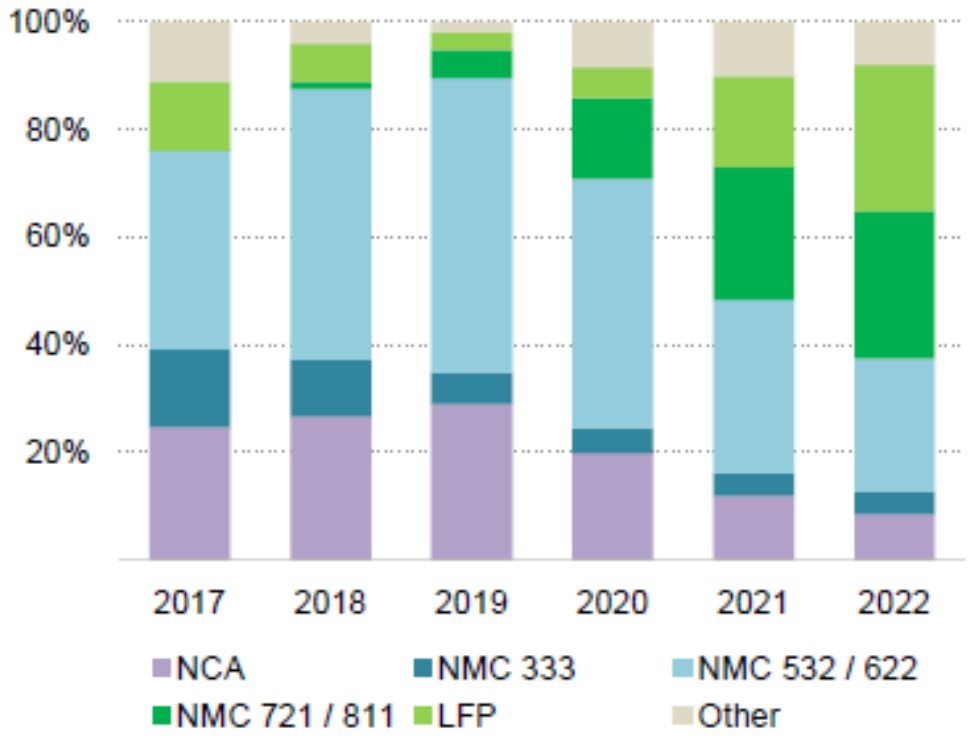
Source: (UN COMTRADE database).
Note: Numbers represent trade in raw, unprocessed fuels and ores only.

Source: IRENA (2023)

Potential for disruptive technological developments

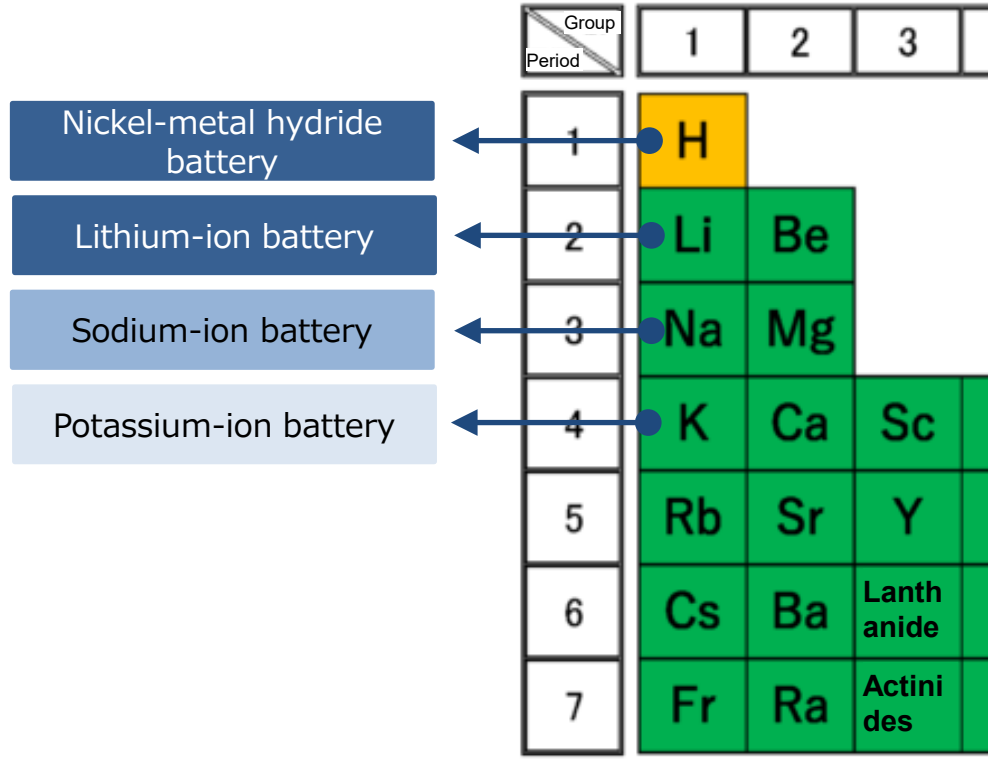
- The development of decarbonization technologies is ongoing.
- Therefore, the demand for, as well as the definition of, critical minerals could change in the future.
- This makes investment difficult.

Evolution of sales share of EV batteries by cathode chemistry



NCA = Nickel-Cobalt- Aluminum, NMC = Nickel-Manganese-Cobalt
LFP = lithium ion phosphate
Source: IEA (2023), Critical minerals market review 2023

Periodic table and battery potential



Source: Create from the periodic table from Science Stock and other sources.

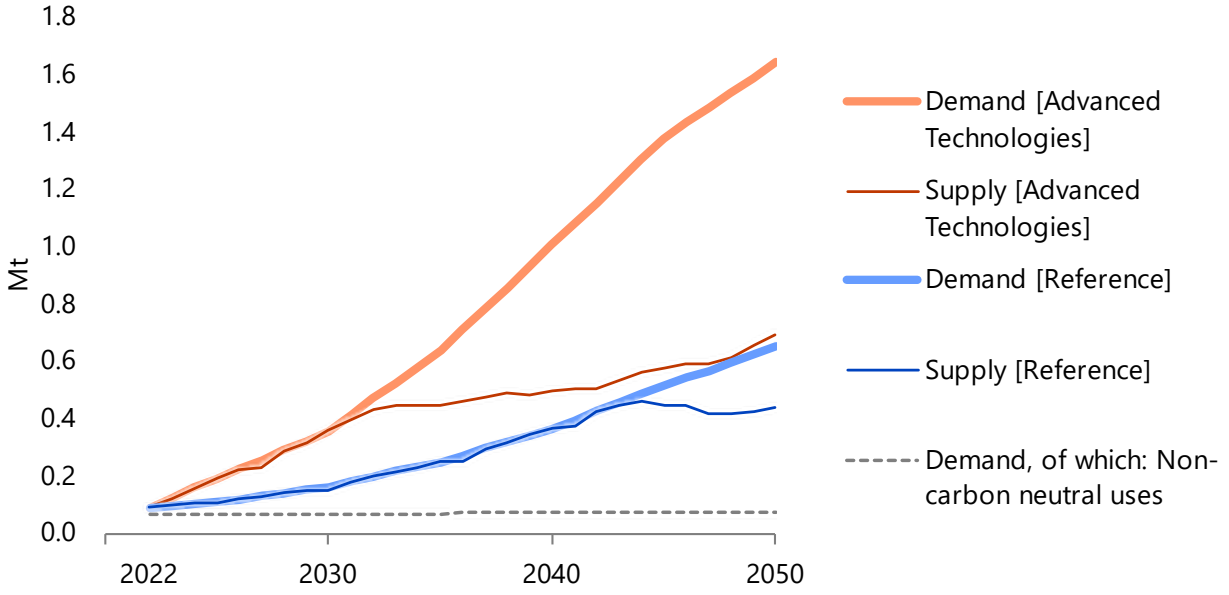
Future can change significantly

- In its 2022 analysis, the IEEJ highlighted the possibility of future lithium supply shortages.
- However, this situation could change significantly with future technological developments.

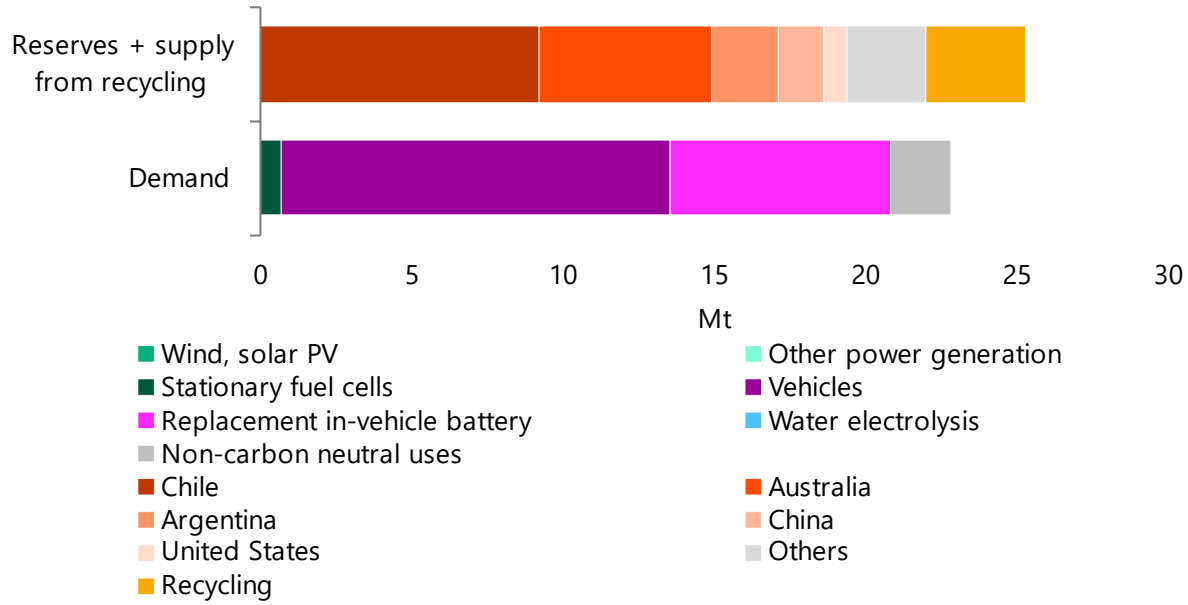
What happens if;

- New production sites come on stream?
- Recycling technology is commercialized in scale?
- Lithium-ion batteries are no longer mainstream?

Supply-demand outlook of Lithium



Comparison of cumulative demand and reserves (+ recycled supply)



Source: IEEJ (2022), Outlook 2023

The experience of Japan in 2010

- Japan has taken measures to reduce the risk of critical mineral supplies.

Comprehensive Rare Earth Measures (October 2010)

Development of technologies to **reduce/alternate materials** (12B Yen)	・Accelerated development of tech. to use alternative materials (6 ores) ・Progress in joint international research (International clean energy technology cooperation)
Strengthen **recycling** of rare earth (3B Yen)	・Development of recycling technology ・Promote capital investment
Enhance **resilience** of industries against rare earth supply shock (39B Yen)	Support for investment needed to improve resilience to rare earth supply risks. ・Introduction of equipment to reduce consumption. ・Introduction of new processes that do not use rare earths. ・Increase concentration of domestic industries with high-level rare earth use.
Secure **mining concessions**, development, and supply (46B Yen)	Secure concessions and develop sources other than China ・JOGMEC investment, risk money supply ・Stronger relations with supplier states

Source: Ministry of Economy, Trade and Industry

How to manage the risks?

Short to mid-term

- **Inventories** help to mitigate shocks.
- Ensure **free trade** of minerals.
- Improve **market transparency**.
  - Supply, demand, inventory, price data
  - Share the market prospects.

Long-term

- Support the development of **new capacity** of mineral supply.
- Support the development of **recycling** technologies and its business models.
  - Need careful assessment of their energy/GHG efficiency and economic viability.
- Support the development of technologies to **conserve and alternate** the minerals.

Thank you !

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