Challenges for global energy transition:

Based on the major findings from "IEEJ Outlook 2023"

Session 3 Long Term Perspectives

13th IEA-IEF-OPEC Symposium on Energy Outlooks

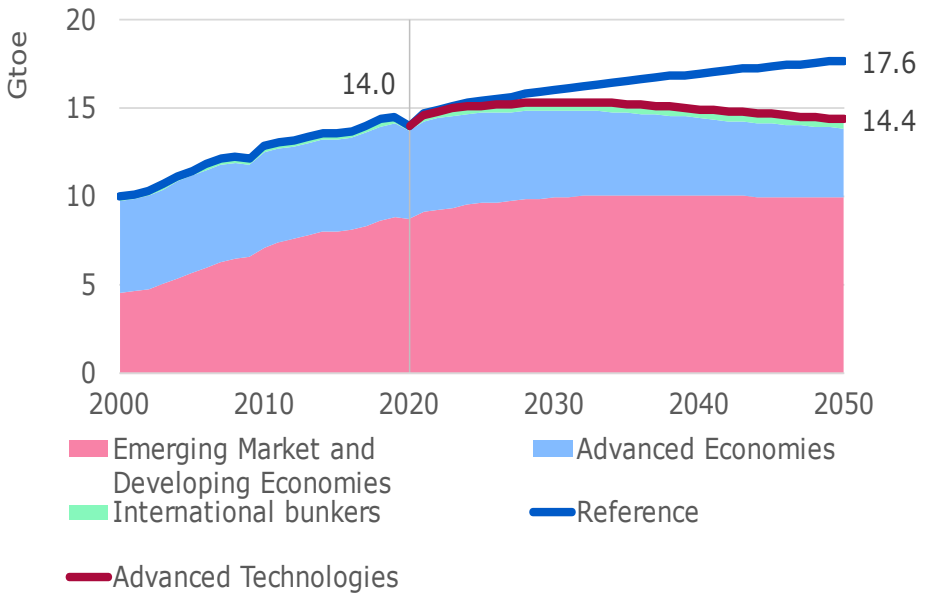
February 15th, 2023

Dr. Ken Koyama

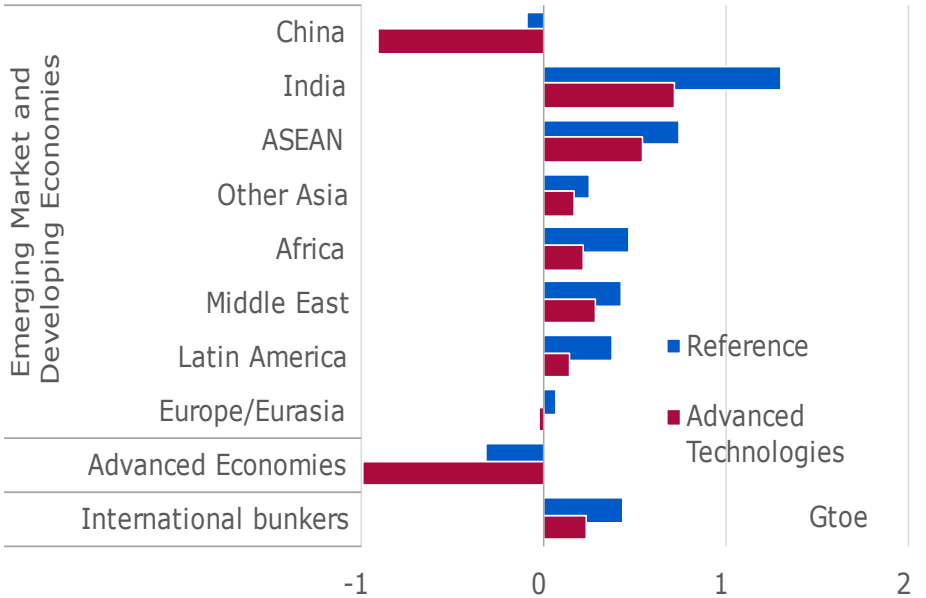
Chief Economist & Senior Managing Director
Institute of Energy Economics, Japan

Energy demand growth led by India & ASEAN

Primary energy demand outlook



Changes in primary energy demand (2020-2050)

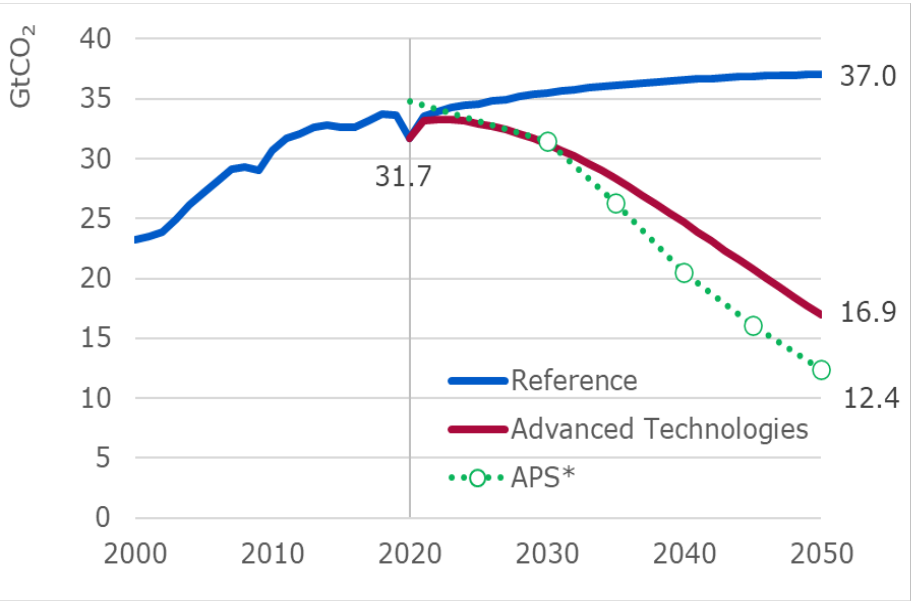


- **(RS) Primary energy demand will continue to grow, increasing 1.3-fold in 2050.**
- **(ATS) After peaking in the early 2030s, it will gradually decrease. Emerging Market and Developing Economies remain largely unchanged after the 2030s.**
- **In both scenarios, demand growth is centred on India and ASEAN. China, which has been driving demand growth, will ~~also~~ peak by 2030 in RS.**

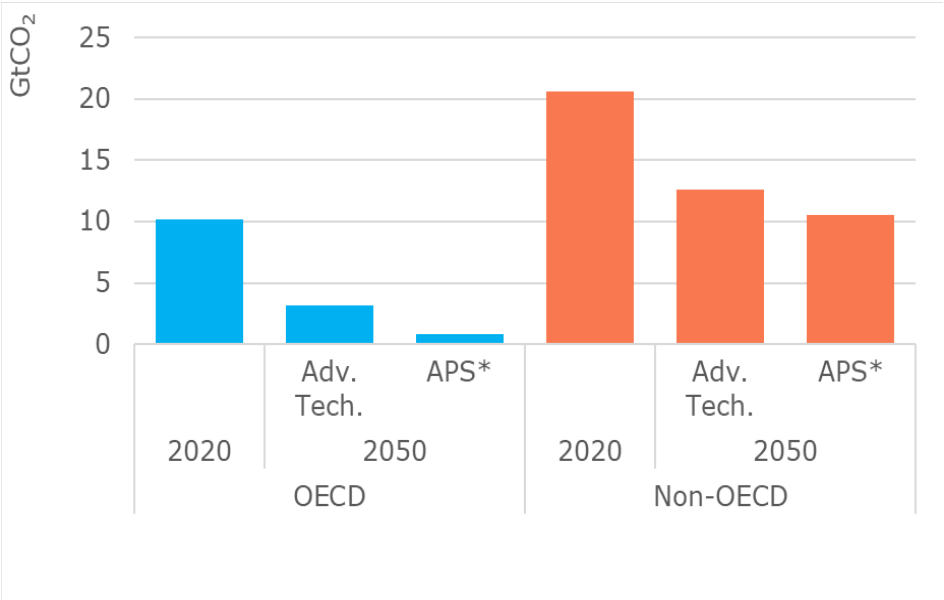
Source: IEEJ Outlook 2023 (IEEJ, October 2022)

CO2 emission outlook

Energy-related CO_2 emissions outlook



CO_2 emissions outlook by region



- **Energy-related CO_2 emissions under RS continue to increase. On the other hand, under ATS, it will peak in the first half of the 2020s and decrease to 17 $GtCO_2$ by 2050. It would be a path slightly above the APS*, which incorporates countries' carbon neutral declarations.**
- **In both ATS and IEA/APS*, overall non-OECD emissions are only about 40-50% lower. Reducing emissions in developing countries is key to achieving global carbon neutrality.**

*APS: Announced Pledges Scenario, estimates when countries' stated policy goals are realised. Includes industrial processes. IEA "World Energy Outlook 2022" (October 2022).

Source: IEEJ Outlook 2023 (IEEJ, October 2022)

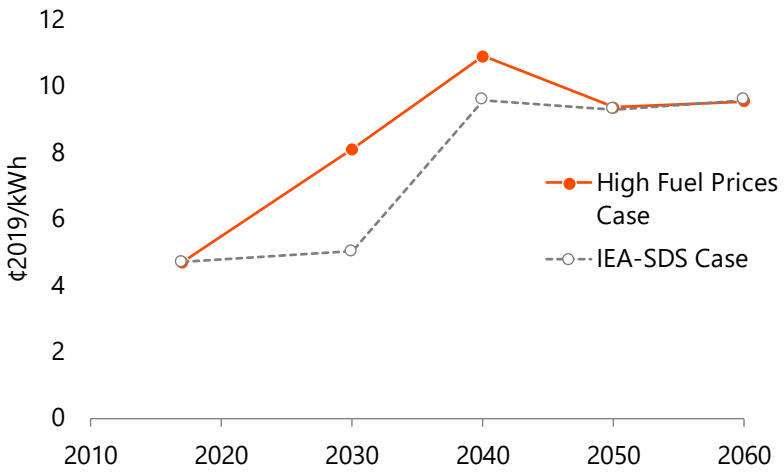
Role of gas/LNG in Asia's energy transition

• A two-stage decarbonisation approach, a realistic solution for Asia

Asian decarbonisation taking advantage of natural gas	Challenges of natural gas
Stage 1: Satisfy energy needs and achieve low carbonisation by switching from coal to natural gas Stage 2: Decarbonisation by commercialising various technologies under development (hydrogen, CCUS) as well as avoiding making natural gas asset stranded.	• The economics of natural gas has declined due to soaring prices. • There is concern that the role of natural gas will diminish as investments in other decarbonised energy increase if the price remains extremely high for an extended period of time.

- **Asia's energy transition/security will be more costly (right figure) and could weaken Asia's relative economic power against other region if constraints on natural gas investment trigger its high price.**
- **The promotion of natural gas and LNG investment will not only help to stabilise the markets, but will also contribute to curbing the cost of energy transition/security in Asia and averting negative impacts on the regional economy.**
- **Therefore, it is necessary to develop an environment for appropriate use of natural gas.**
  - Clarify its role as a transition energy
  - Promotion of natural gas-related investment
  - Supporting technology to decarbonise natural gas (CCS, CCUS, hydrogen)

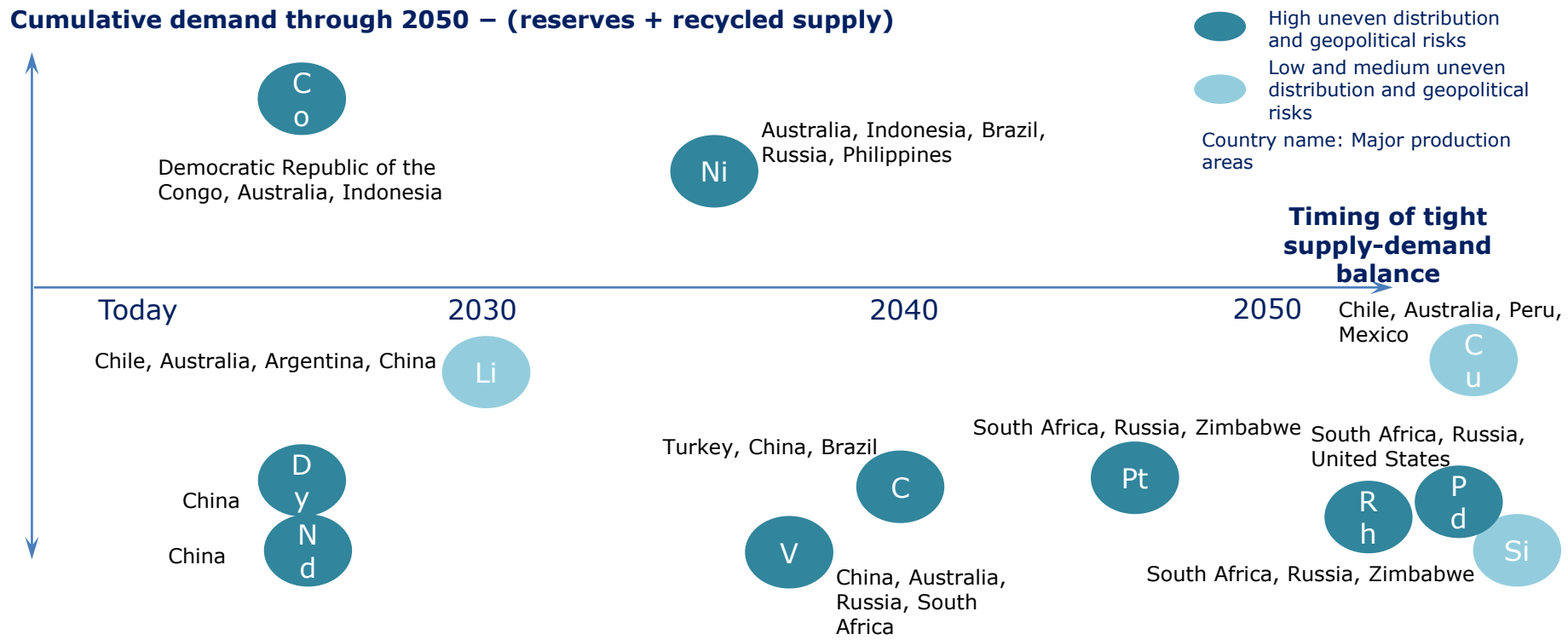
The impact of fossil fuel prices on the marginal cost of electricity in ASEAN



Source: IEEJ Outlook 2023 (IEEJ, October 2022)

Critical minerals' supply-demand balance in ATS

- **Reserves + recycling < Cumulative demand (until 2050): Nickel and cobalt**
- **Early supply shortage concerns: lithium, cobalt, neodymium and dysprosium**
- **Uneven distribution and geopolitical risks: nickel, cobalt, graphite, platinum-group metals, neodymium, dysprosium and vanadium**

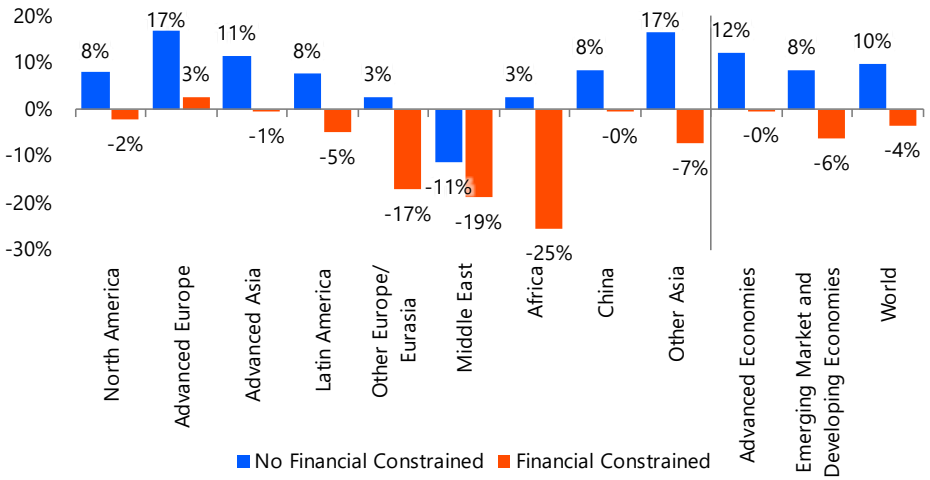


Note: Cu (copper), Li (lithium), Si (silicon), Ni (nickel), Co (cobalt), C (graphite), Pt (platinum), Pd (palladium), Rh (rhodium), Nd (neodymium), Dy (dysprosium) and V (vanadium)

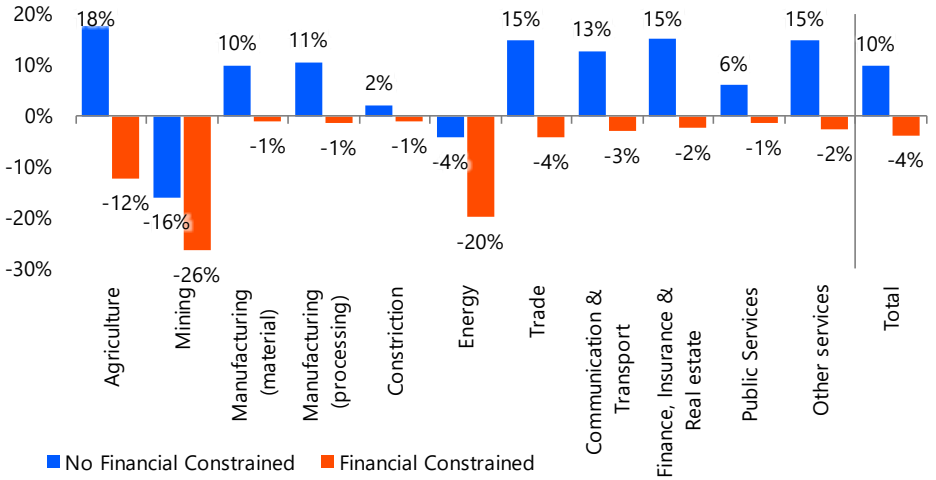
Source: IEEJ Outlook 2023 (IEEJ, October 2022)

Crowding-out may make green growth difficult

Changes in production in 2050 (By region. vs RS)



Changes in production in 2050 (By industry. vs RS)



- Without financial constraints, global production would increase by 9.8%, while with constraints it would decrease by 3.7%.
- Regardless of financial constraints, the production value will decline in economies such as the Middle East, which is highly dependent on mining (fossil fuels).
- Advanced economies are more likely to enjoy green growth, while developing countries are not.

- Regardless of financial constraints, the production value of mining and energy supply related to fossil fuel will decrease.
- GDP accelerates by an average of 0.4% a year without financial constraints and decelerates by 0.1% with constraints (IEA analysed acceleration of 0.4% in the 2020s in their Net Zero Emissions by 2050 Scenario *).

* IEA (2021), Net Zero by 2050 - A Roadmap for the Global Energy Sector

Source: IEEJ Outlook 2023 (IEEJ, October 2022)

APPENDIX

Challenges in Asia's energy transition

- **A growing number of Asian countries have declared carbon neutral (CN) goal, but the roadmap to CN is unclear.**
- **Asian countries, highly carbon intensive, need to re-structure energy system in the next three or four decades.**
- **Developing countries have unique challenges.**

✓ **Energy demand will continue increasing, necessitating a stable supply of large amounts of energy.**

✓ **Affordable energy supplies are essential in light of protecting low-income people.**

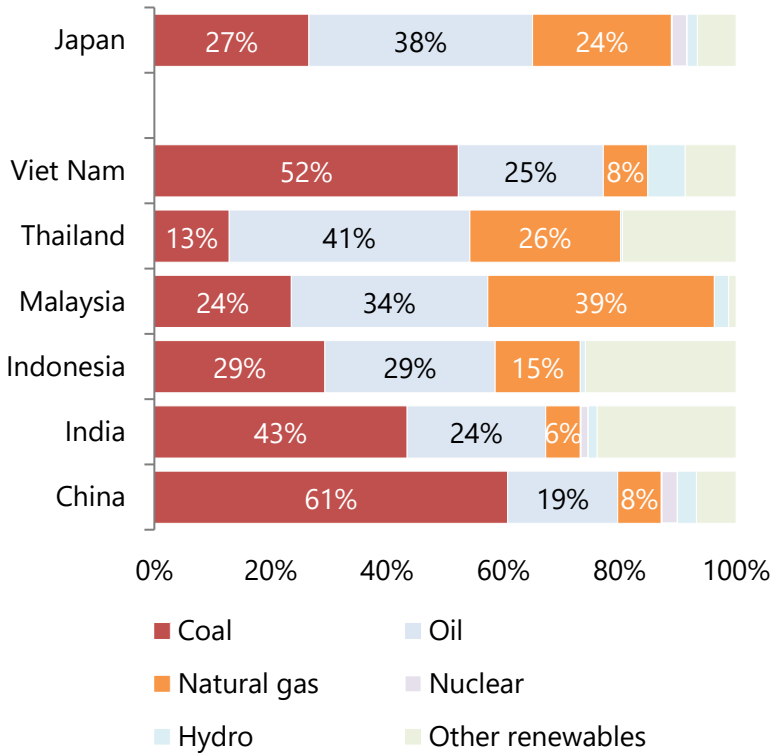
- **Challenges exist in Asia's energy transition.**

✓ **Constraints in RE to supply the fast growing energy demand.**

✓ **Some countries have limited renewable energy availability.**

✓ **There is a strong demand for energy affordability, and the cost of integrating variable renewable energy will become an issue.**

Energy mix of major Asian countries



Source: Compiled from IEA "World Energy Balance 2022"

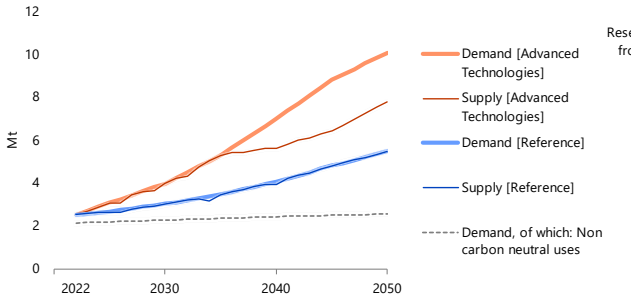
Source: IEEJ Outlook 2023 (IEEJ, October 2022)

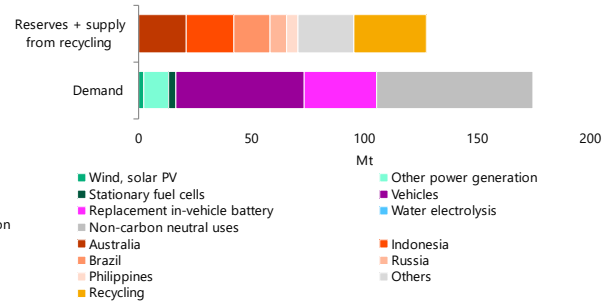
Supply-Demand Analysis: example of Nickel and Lithium

	Supply-demand outlook	Comparison of cumulative demand and reserves (+ recycled supply)

Nickel (Ni) (used in lithium-ion batteries)

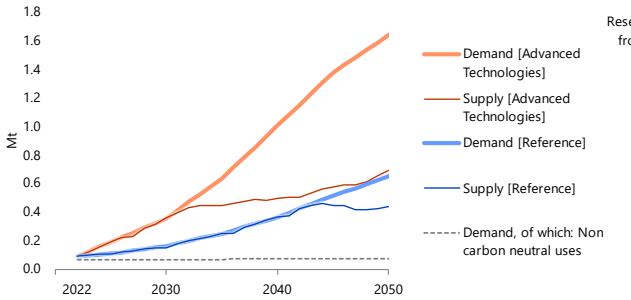
- In ATS, the demand will increase more than 3 times from current levels by 2050.
- In ATS, demand will exceed supply (mine production + recycling) around 2035.
- Cumulative demand in ATS through 2050 will exceed reserves (+ recycled supply).

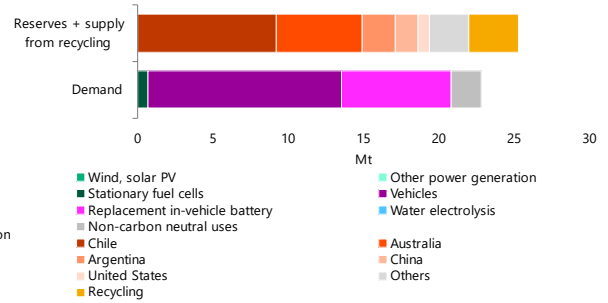




Lithium (Li)

- Demand will grow significantly mainly with the increase in electric vehicles. In ATS, it will increase by more than 10 times from current levels by 2050.
- In ATS, demand will exceed supply (mine production + recycling) around 2030.
- Cumulative demand in ATS through 2050 will be slightly below reserves (+ recycled supply).





Source: IEEJ Outlook 2023 (IEEJ, October 2022)

Major uses of critical minerals

Ore	Major uses
Cu (copper)	Wind power generation, solar photovoltaics power generation, electric vehicles, batteries. However, it is often used outside of CN technology.
Li (lithium)	Lithium-ion battery
Si (silicon)	Solar PV. However, it is often used outside of CN technology.
Ni (nickel)	Lithium-ion batteries. However, stainless steel and heat-resistant steel are the main applications.
Co (cobalt)	Lithium-ion batteries, special steel
C (graphite)	Lithium-ion batteries, metal crucibles, molds, electric furnace electrodes, etc.
Pt (platinum)	Exhaust gas catalysts for automobiles, electrocatalysts for fuel cells and water electrolysers
Pd (palladium)	Exhaust gas catalysts for automobiles, electrocatalysts for fuel cells and water electrolysers
Rh (rhodium)	Exhaust gas catalysts for automobiles
Nd (neodymium)	Electric vehicle motors, magnets in wind power generators
Dy (dysprosium)	Electric vehicle motors, magnets in wind power generators
V (vanadium)	Electrolyte for redox flow batteries. Other than CN technology, additives to steel are main.