

Optimization for energy transition:

Material sustainability/security and cost minimization

Session 2:

CCUS Synergies in hydrogen and materials transitions

De-risking Large Scale CCUS Investment

2nd IEF High Level Roundtables on Carbon Management Technologies

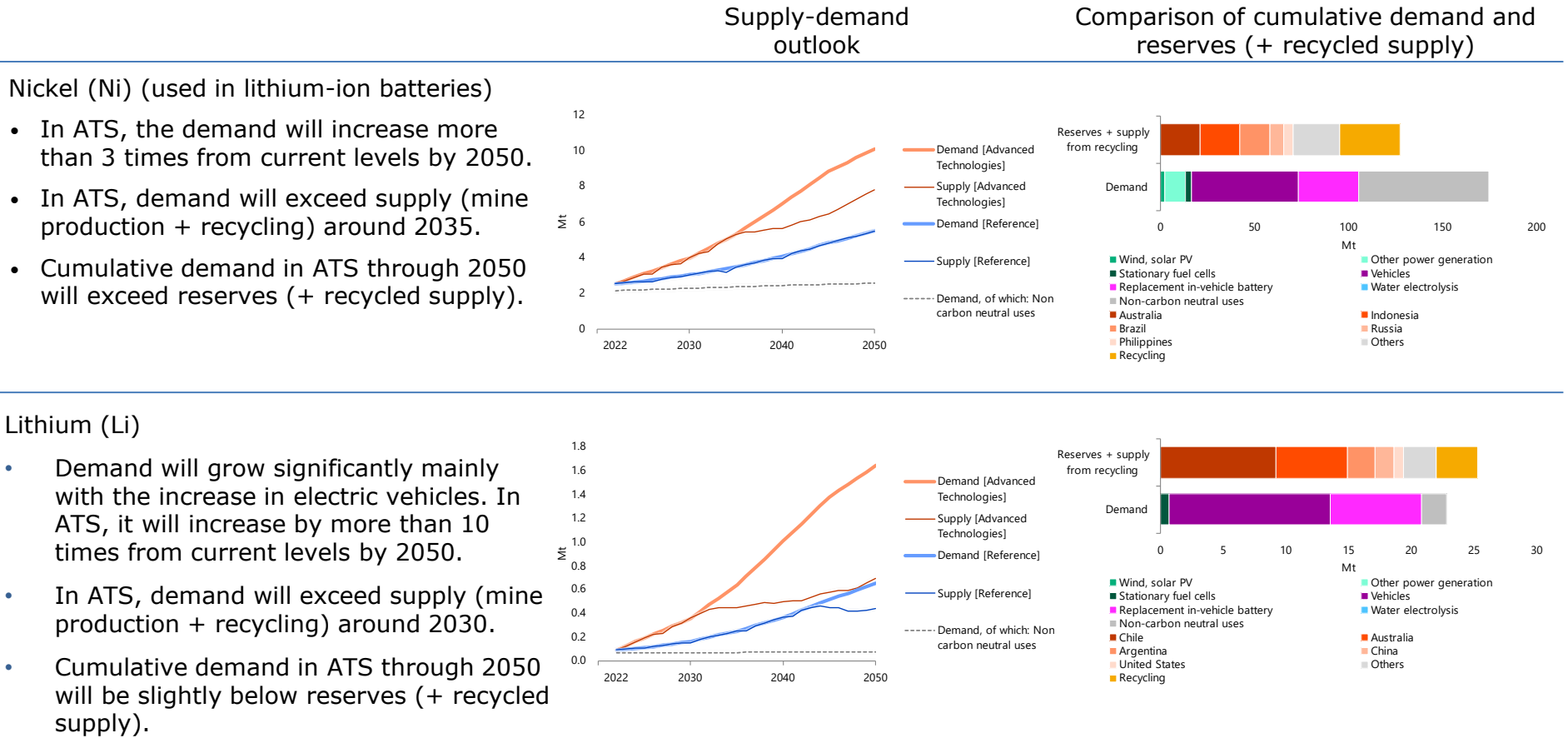
In collaboration with Clean Energy Ministerial and
King Abdullah Petroleum Studies and Research Center

February 16th, 2023

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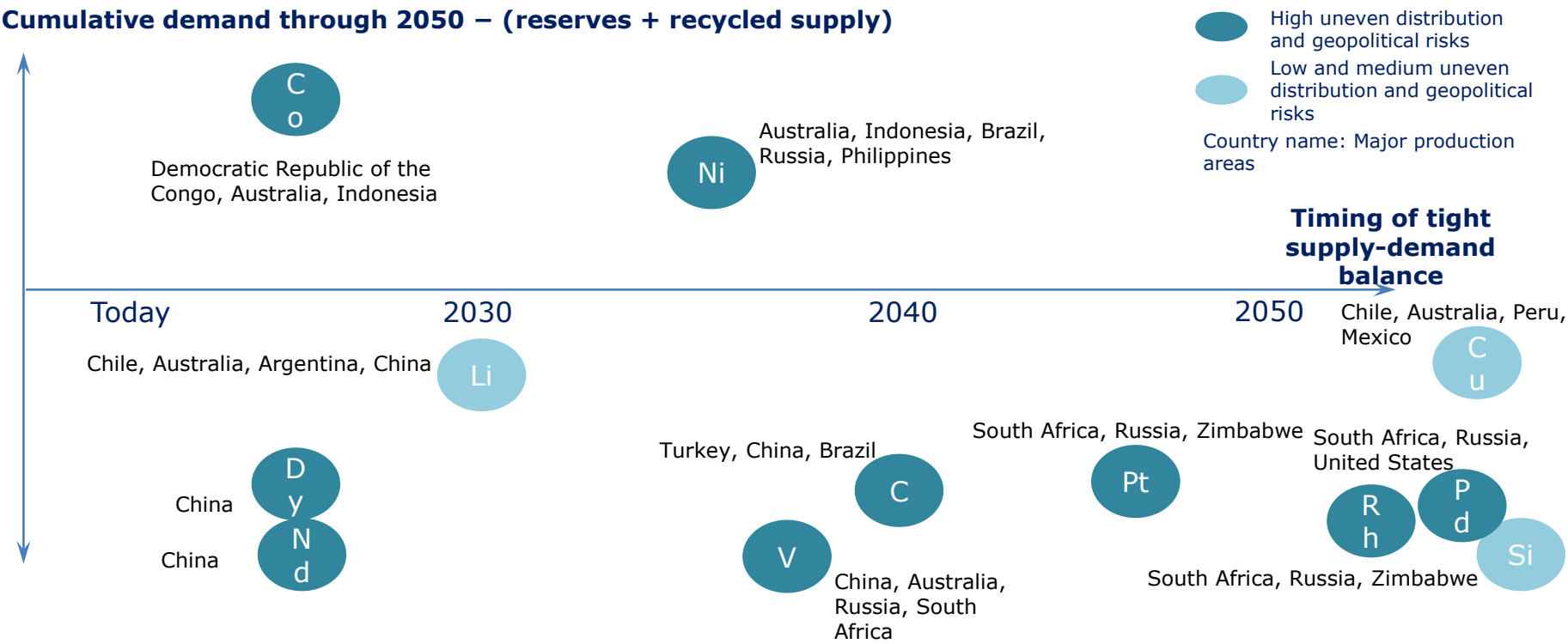
Supply-Demand Analysis: example of Nickel and Lithium



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**

Cumulative demand through 2050 – (reserves + recycled supply)

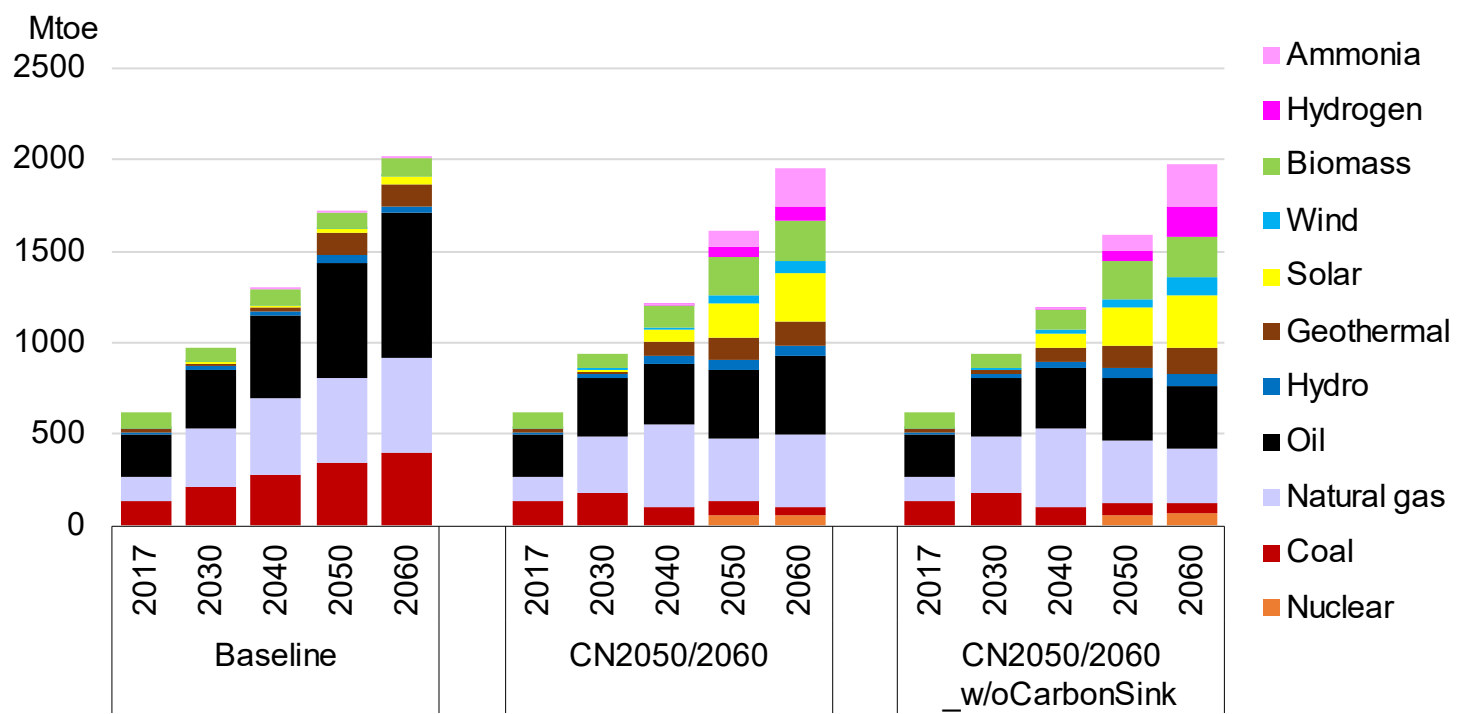


Note: Cu (copper), Li (lithium), Si (silicon), Ni (nickel), Co (cobalt), C (graphite), Pt (platinum), Pd (palladium), Rh (rhodium), Nd (neodymium), Dy (dysprosium) and V (vanadium)

ASEAN Primary energy supply outlook

- A wide range of technologies, including renewables, nuclear, CCS and import of hydrogen and ammonia, are necessary for deep decarbonization.
- Zero emission energies together contribute to 56% of primary energy in 2060 in the CN2050/2060, and 65% in the CN2050/2060_w/oCarbonSink.

Primary energy supply in ASEAN



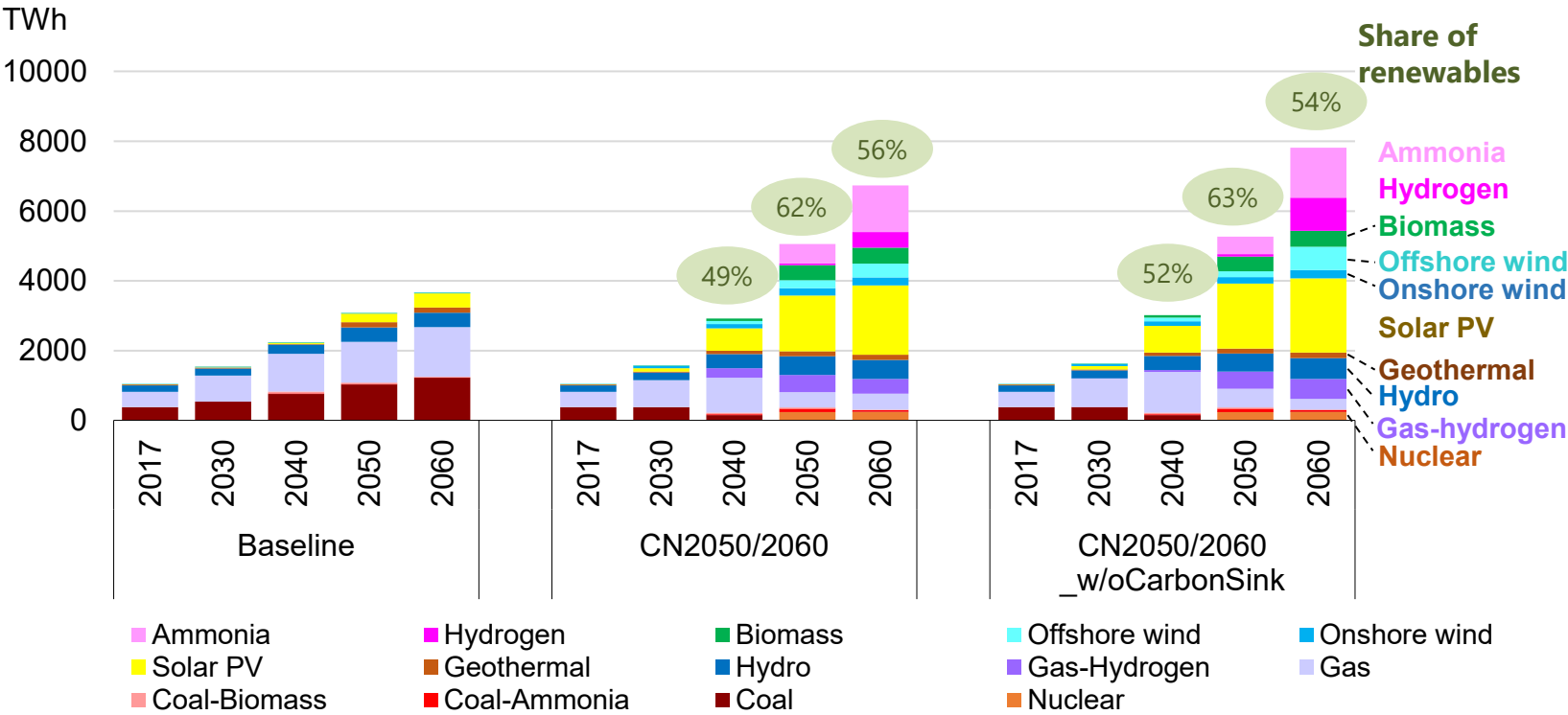
Fossil fuels include non-energy use. CO₂ from fossil fuel combustion in 2060 in CN2050/2060 is offset by NETs and natural carbon sink.

NETs = Negative Emissions Technologies

ASEAN Power generation outlook

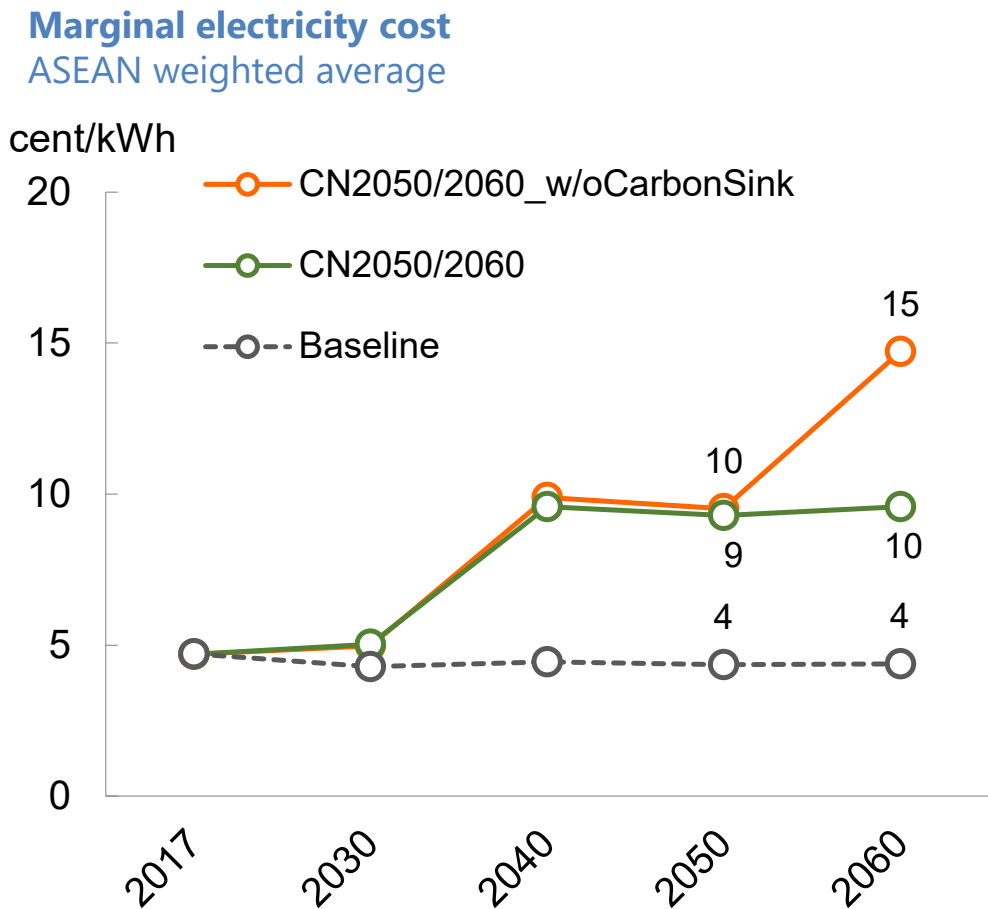
- Renewables become the main power source in the *CN* cases.
- Hydrogen and ammonia, including co-firing, are also projected to be a part of the power generation mix for net zero emissions by 2060.

Power generation in ASEAN



ASEAN Marginal electricity cost

- Marginal electricity cost would rise to 2 folds by 2060 in the *CN2050/2060*.

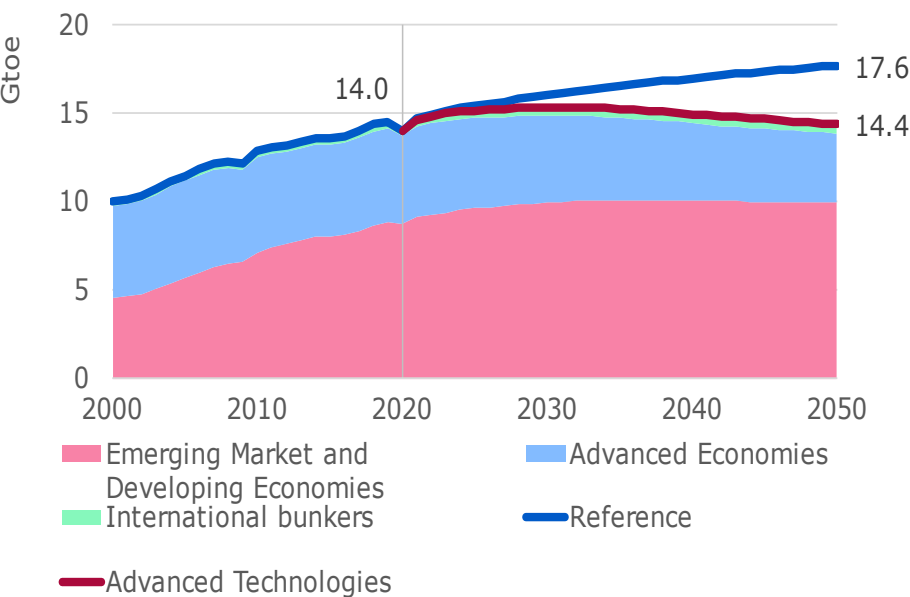


Source: Prepared by IEEJ based on “Decarbonization of ASEAN Energy Systems: Optimum technology selection model analysis up to 2060” (ERIA, July 2022)

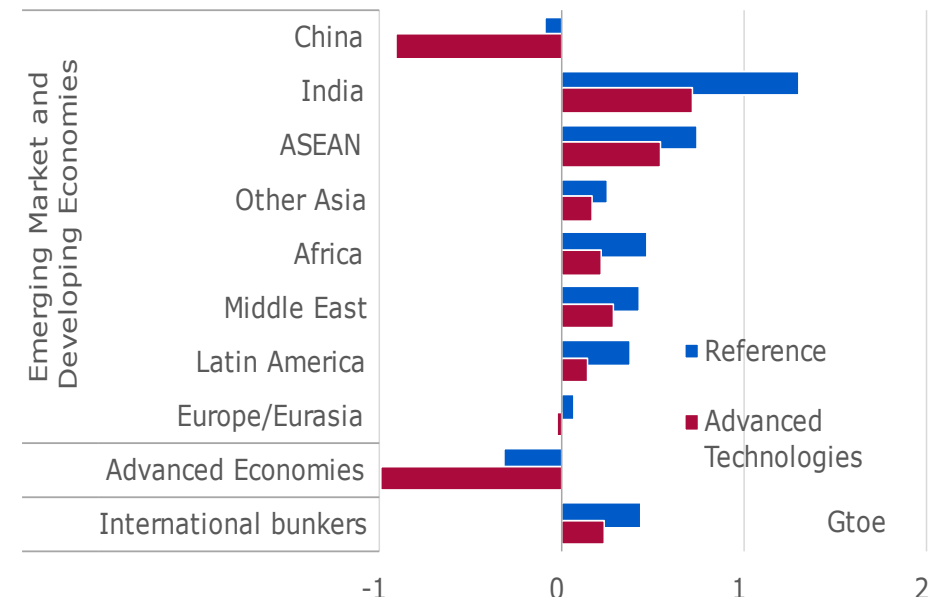
APPENDIX

Energy demand growth led by India & ASEAN

Primary energy demand outlook



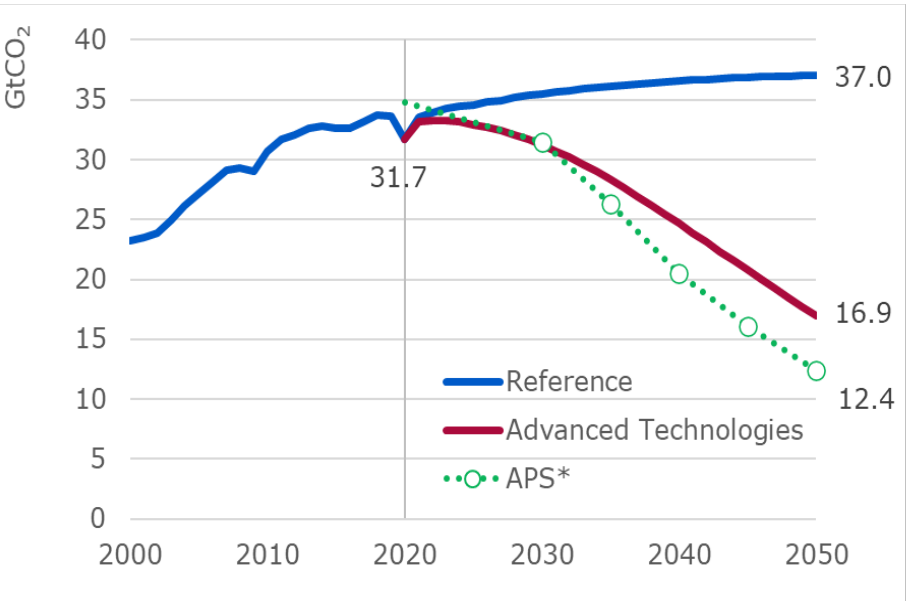
Changes in primary energy demand (2020-2050)



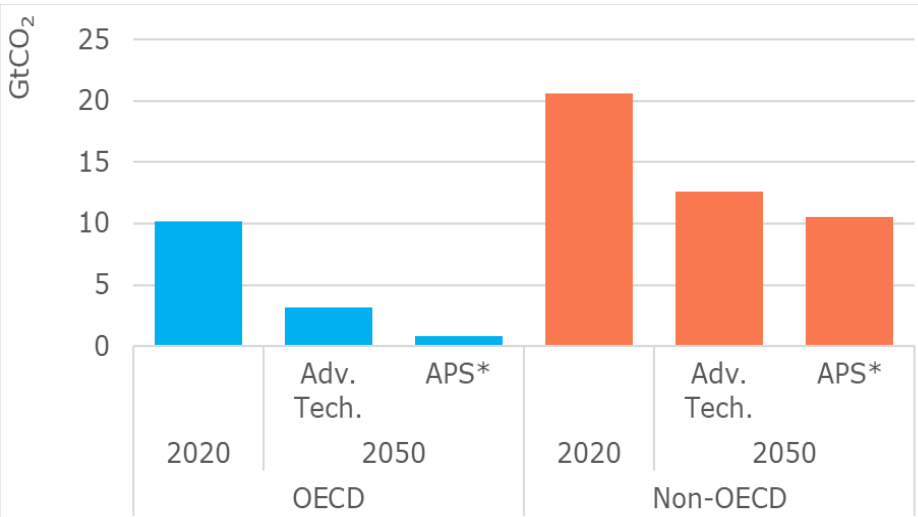
- **(RS) Primary energy demand will continue to grow, increasing 1.3-fold in 2050.**
- **(ATS) After peaking in the early 2030s, it will gradually decrease. Emerging Market and Developing Economies remain largely unchanged after the 2030s.**
- **In both scenarios, demand growth is centred on India and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

CO₂ emission outlook

Energy-related CO₂ emissions outlook



CO₂ emissions outlook by region



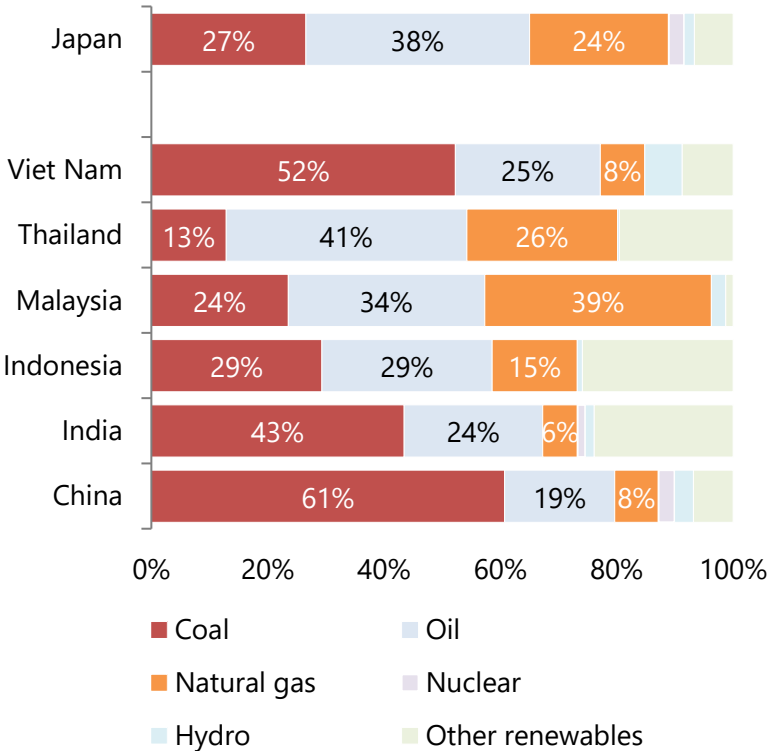
- **Energy-related CO₂ emissions under RS continue to increase. On the other hand, under ATS, it will peak in the first half of the 2020s and decrease to 17 GtCO₂ by 2050. It would be a path slightly above the APS*, which incorporates countries' carbon neutral declarations.**
- **In both ATS and IEA/APS*, 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).

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”