Challenges for global energy transition:

Based on the major findings from "IEEJ Outlook 2024"

Session 3 Long Term Perspectives

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Scenarios of IEEJ Outlook 2024

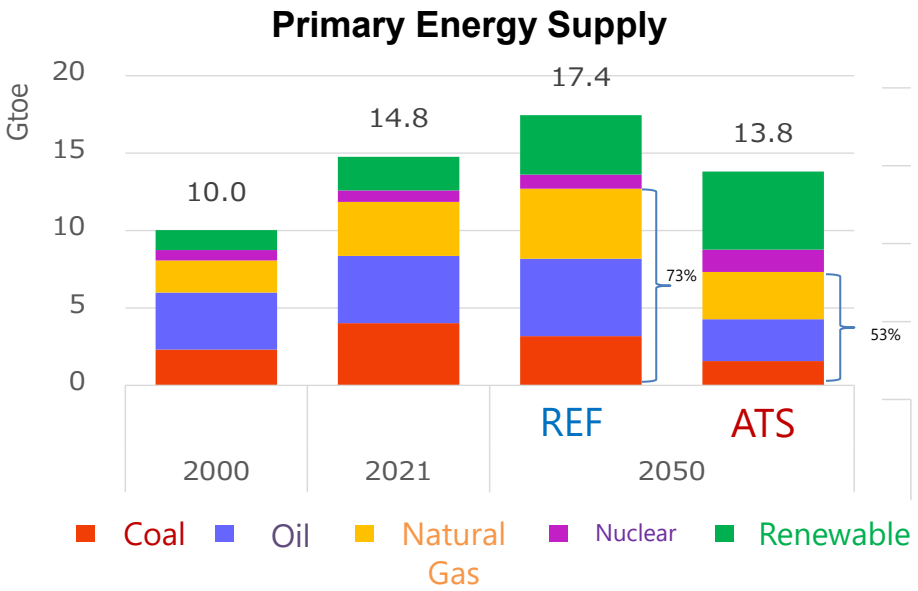
■ Regular scenarios

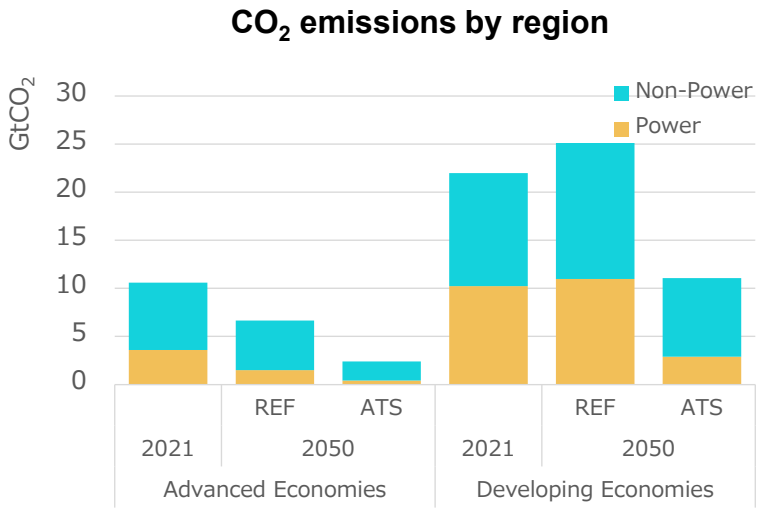
- Reference Scenario (RS): Business-as-usual future
- Advanced Technology Scenario (ATS): Maximum introduction of energy related technologies (Bottom-up approach)

■ Highlights of this year

1. Cost minimum pathway to CN in ASEAN
2. Importance of LNG in energy transition
3. Vehicle electrification and critical minerals
4. Importance of Negative Emission Technologies (NETs)

Energy Supply-Demand and CO2 Emission Outlook





- （**ATS**）Significant energy efficiency improvement and change in energy mix share compared with REF (but fossil fuel account 53% in 2050
- （**ATS**）The emission peaks out before 2030 and decline to 14.7 $GtCO_2$ in 2050 (56% below 2021).

It is still far from carbon neutrality, and decarbonization in the non-power sector and emerging and developing countries are significant challenges.

Source: IEEJ Outlook 2024 (IEEJ, October 2023)

Cost minimum pathway for ASEAN Carbon neutrality

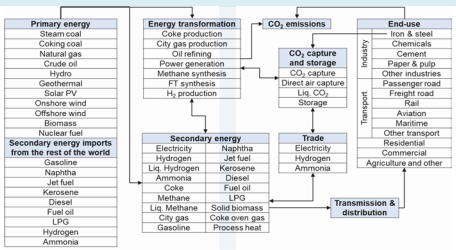
- **Optimal Case** is the energy mix that can meet the net-zero target of each ASEAN country at the lowest cost while meeting the demand of ERIA/IEEJ.
- Under the same demand growth, three cases are simulated; **RE40**: lower penetration of renewable energy, **RE80**: higher penetration of renewable energy, and **gas-cap**: gas supply constraint.

Case Assumptions

Cases	Renewable share in power	Primary supply of gas	CN Year
Optimal	**No limitation** (60% as a result)	No limitation	2050/2060
Gas-Cap	No limitation	**Same as 2019**	
RE40	**40%**	No limitation	
RE80	**80%**	No limitation	

IEEJ-NE Model
(Bottom-up Optimization model)

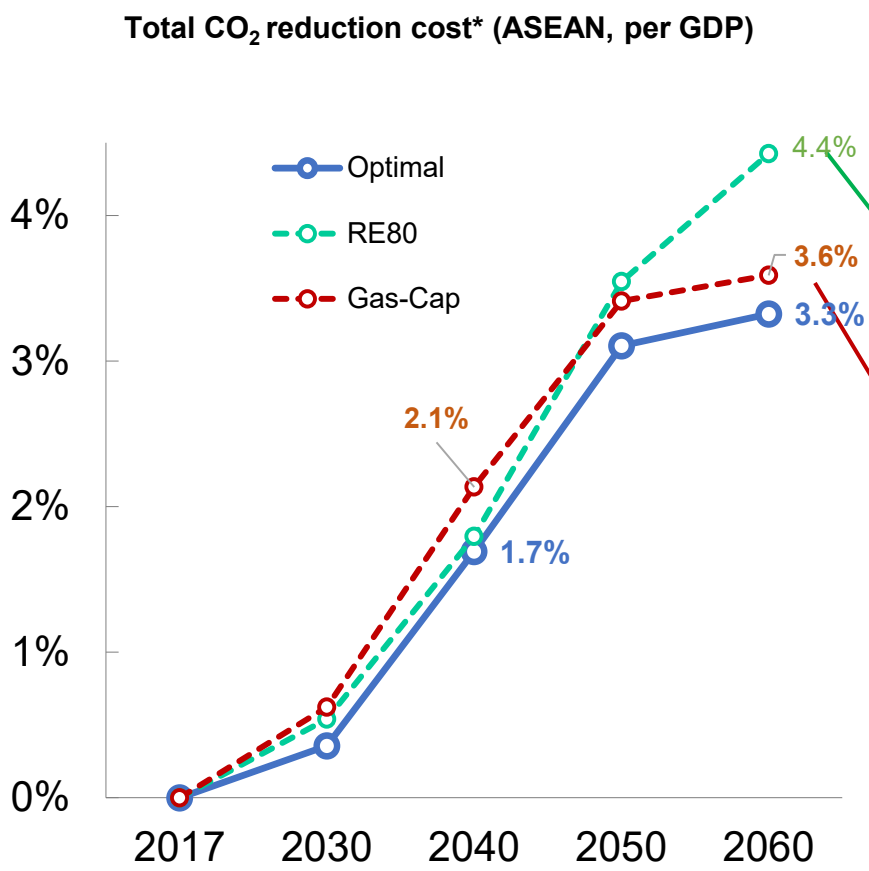
Input:
- CO_2 Reduction Target - Energy Demands
- Tech. Information (Cost, Efficiency, etc.)



Output :
Cost-minimum energy mix which achieve the CO2 reduction target

Source: IEEJ Outlook 2024 (IEEJ, October 2023)

Difference in Cost for CN transition in ASEAN



- The total CO2 reduction (abatement) cost to achieve 2060 net zero is US$570 billion/year, equivalent to 3.3% of GDP, in the **optimal case**.
- If the optimal energy mix is not realized, the abatement cost rises further;
  - **RE80** : Cost in 2060 rises to 4.4% of the GDP. The increase in 2050-2060 is especially significant.
  - **Gas-Cap** : The costs during the 2030-2040 are particularly large.

In other words, the expansion of natural gas supply during the transition period will contribute significantly to cost reductions.

＊ The cost difference between the total cost of energy supply (capital, fuel, O&M, etc.) , compared to the baseline case without emission reductions. The future GDP is estimated from “Energy Outlook and Energy Saving Potential in East Asia 2020”(ERIA, 2021). 2017 Constant USD.

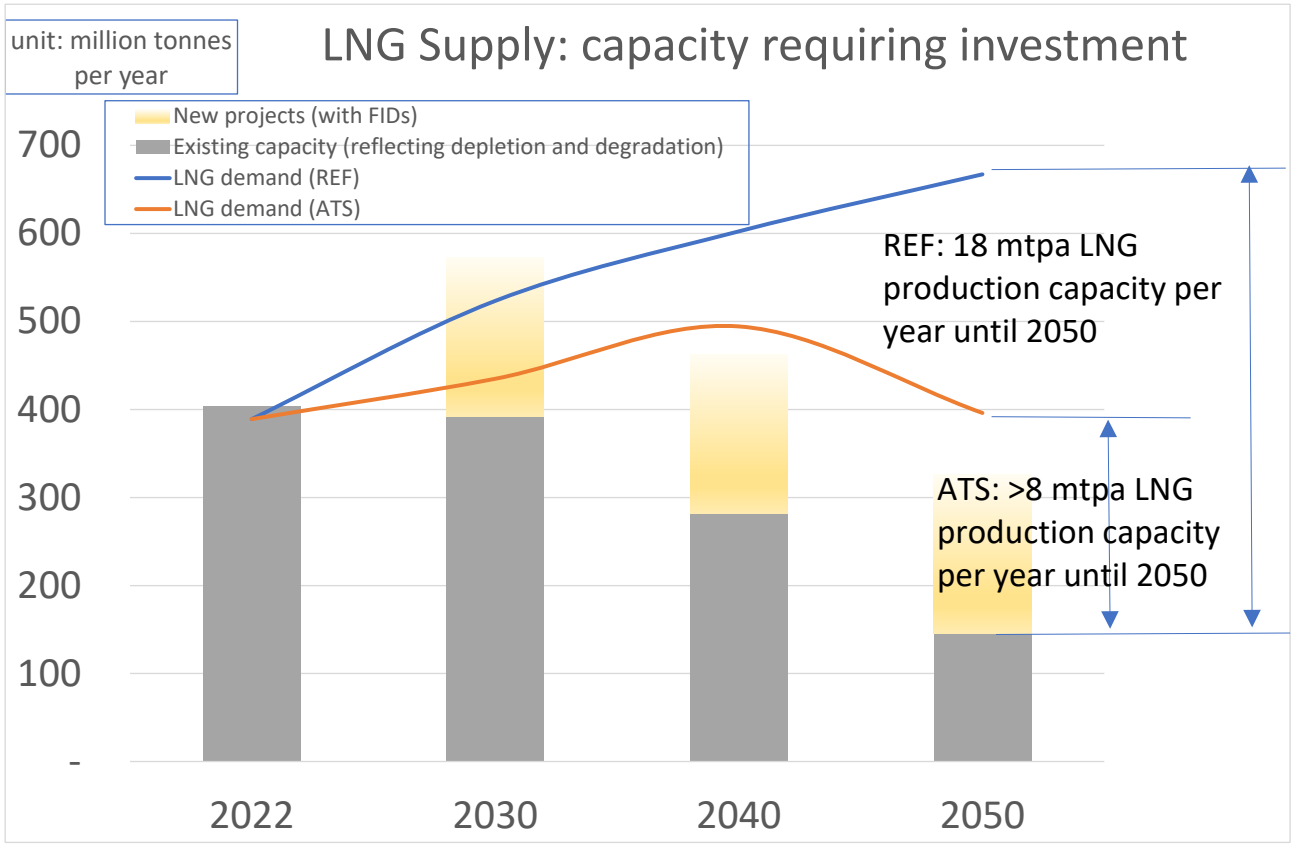
Source: IEEJ Outlook 2024 (IEEJ, October 2023)

Long-term LNG Investment needed

- Investment is needed in 8 - 18 mtpa LNG production capacity per year until 2050
- Required additional capacity investment means the gap between projected LNG demand and decreasing existing production capacity, to be filled by the followings:

1. Greenfield project investment
2. Alternative new field development (backfill) investment
   (the yellow stack indicates already sanctioned projects)
3. Investment in existing fields to offset production decline
4. Rejuvenation of existing liquefaction facilities

✓ *Those projects already greenlighted (included in the yellow stacks) may entails uncertainty with possible delays and failures to materialise

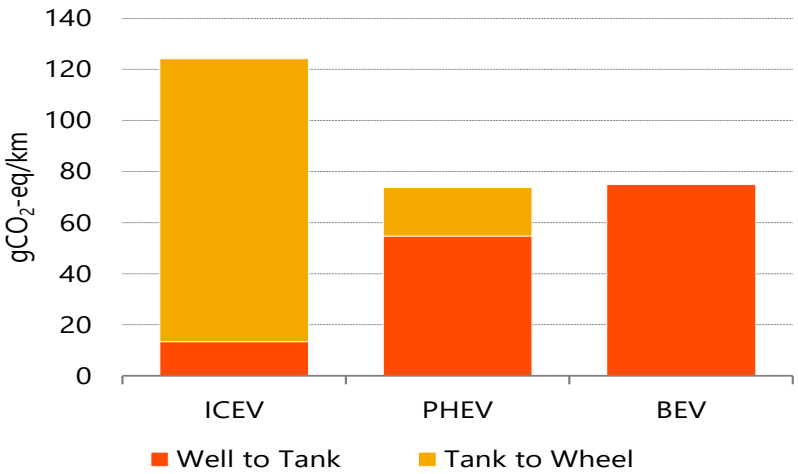


Source: IEEJ Outlook 2024 (IEEJ, October 2023)

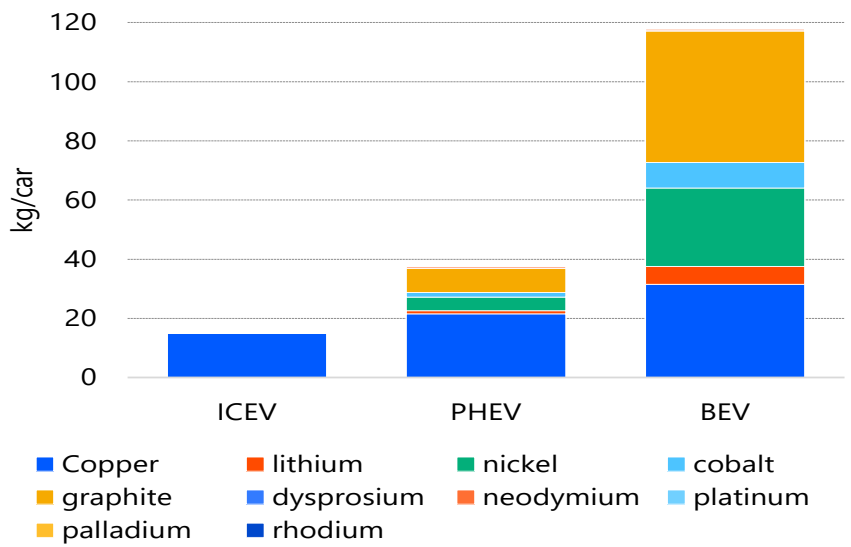
Vehicle electrification: GHG and Critical minerals

- EVs accounted for 14% of global vehicle sales in 2022, up from 9% in 2021 and less than 5% in 2020
- Well-to-Wheel, GHG emissions are lower for EVs than for ICEVs. As the average power generation mix (coal is included) becomes more decarbonized, emissions from EVs become even smaller.
- However, EVs are equipped with a high-capacity batteries that require more critical minerals, such as nickel and graphite, as raw materials. BEVs require about three times more critical minerals than PHEVs.

GHG emissions per kilometer (WtW basis)



Critical minerals required



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