IEEJ Outlook 2024

－How can various pathways toward energy transition be achieved?－

Topic:

ASEAN ‘s Pathways towards Energy Transition

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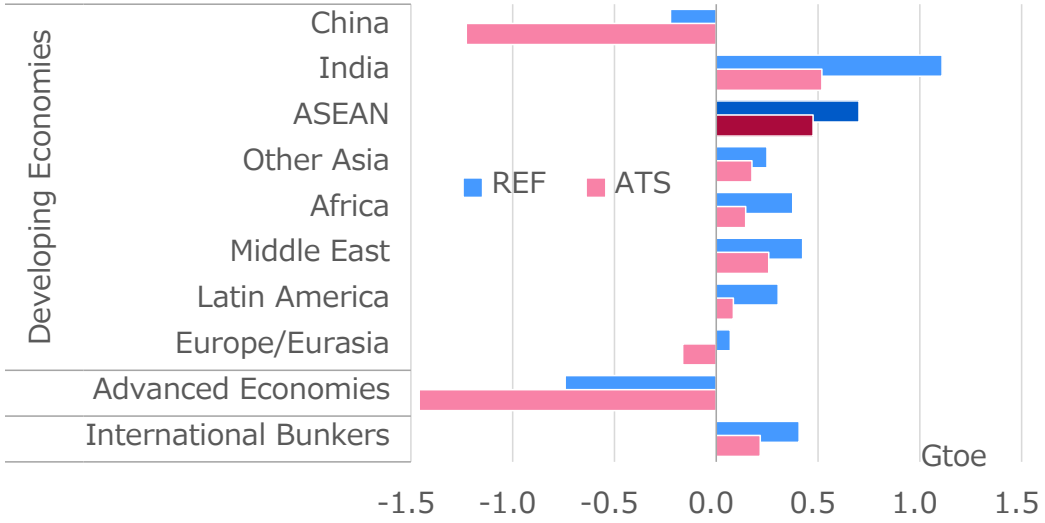
- Part 1 (Main Scenarios)
  - Global Energy Supply and Demand Outlook to 2050
- **Part 2 (Topics)**
  - **➢ ASEAN ‘s Pathways towards Energy Transition**
  - The Important Role of LNG and Natural Gas
  - Negative Emissions
- Box Analysis from the Report
  - Electrification of Automobiles and Synthetic Fuels

Part 2: ASEAN's Pathways towards Energy Transition
Demand growth in ASEAN is significant; net zero is a significant challenge.

Change in Primary Energy (2021-2050)

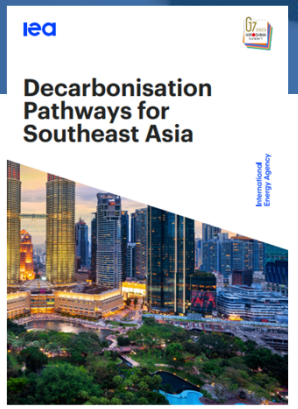


Pledges of ASEAN Countries

	Most recent developments
Brunei	N.A.
Cambodia	CN by 2050 (L/T Strategy, Dec. 2021)
Indonesia	NZ by 2060 or sooner (L/T Strategy, July 2021)
Lao PDR	NZ by 2050 (Climate Ambition Alliance)
Malaysia	CN by 2050 (PM expressed in Sept. 2021)
Myanmar	NZ by 2050 (Climate Ambition Alliance,)
Philippines	N.A.
Singapore	NZ by 2050 (updated L/T Strategy, Nov. 2022)
Thailand	CN by 2050 & NZ by 2065 (PM expressed at COP26)
Vietnam	CN by 2050 (PM expressed at COP26)

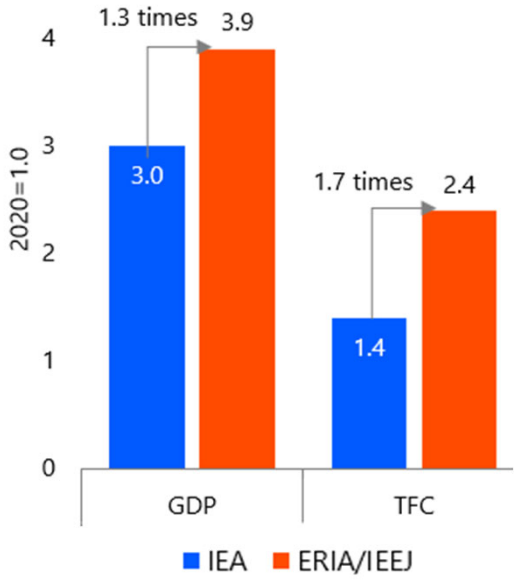
- As ASEAN continues to achieve significant economic growth, the region will be the center of energy demand growth in the world.
- Since COP26, eight countries have announced carbon-neutral targets by 2050 or 2060.
- Reducing CO2 emissions while expanding energy supply is a significant challenge.

Part 2: ASEAN
IEA G7 Report: comparison of IEA and ERIA/IEEJ pathways



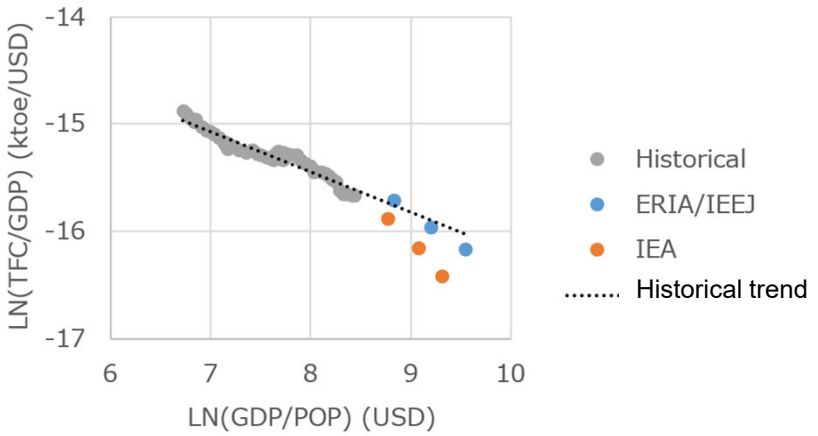
- Future energy demand significantly differs, depending on assumptions of economic growth and energy efficiency improvement.

Growth of ASEAN's GDP and TFC toward 2050



Source: produced from IEA, Decarbonization Pathways for Southeast Asia(2023)

ASEAN's Energy Efficiency Improvement (past five decades and future)



Source: produced from IEA, Decarbonization Pathways for Southeast Asia(2023) and IEA, World Energy Balances

Part 2: ASEAN
IEA G7 Report: comparison of IEA and ERIA/IEEJ pathways

- The optimal energy mix in the future will change depending on the scale of demand.

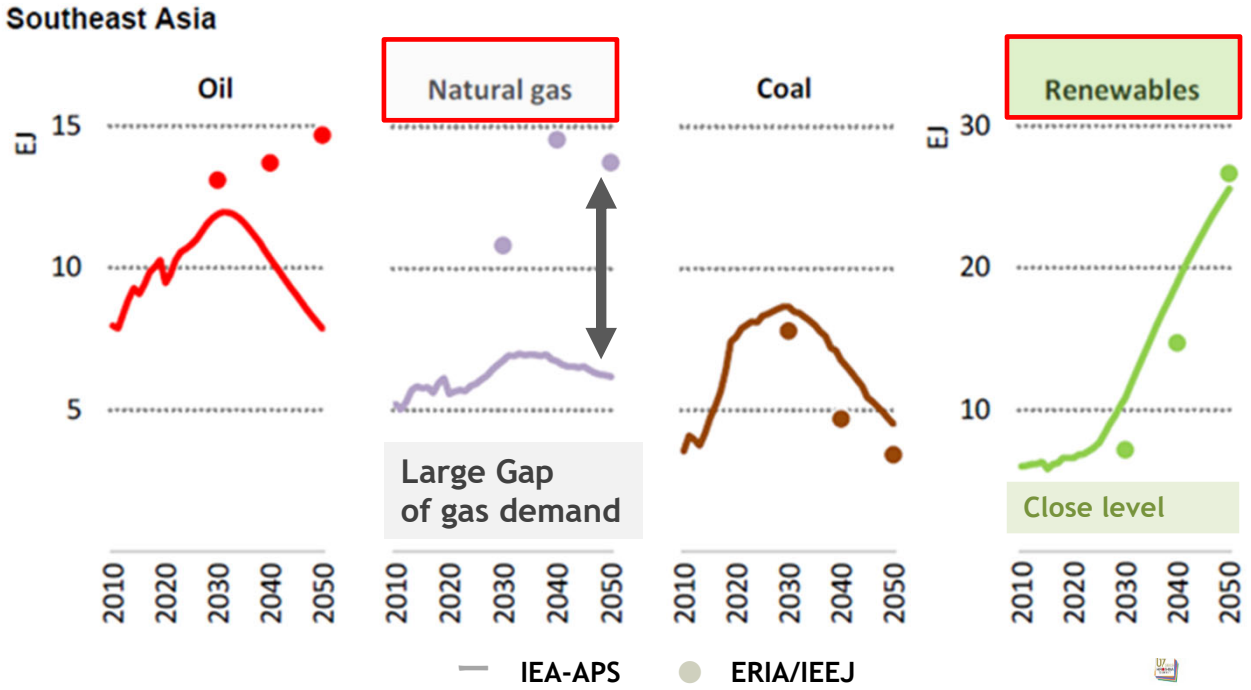
IEA

- The low demand level enables renewable energy and electrification while reducing the supply of natural gas.
- Renewable energy accounts for about 80% of the total power generation in 2050.

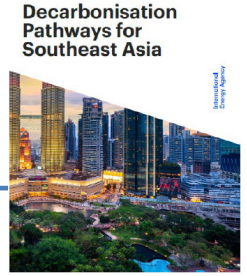
ERIA/IEEJ

- To meet the high demand level, not only renewable energy in the same amount as the IEA;
  (1) fossil fuels expansion (especially natural gas)
  (2) decarbonization by hydrogen and CCS, CO2 removal by DACCS and BECCS are required.
- The renewable energy share is about 60%.

ASEAN Primary Energy Demand (IEA, ERIA/IEEJ comparison)



source：IEA, Decarbonization Pathways for Southeast Asia,(2023)



Part 2: ASEAN
Analysis Framework：Cost-optimal energy mix

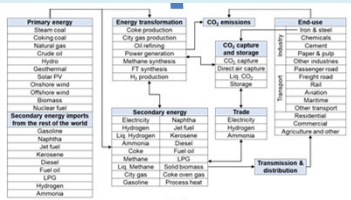
- **Optimal Case** is the energy mix that can meet the net-zero target of each ASEAN country at the lowest cost while meeting the demand of ERIA/IEEJ.
- Under the same demand growth, three cases are simulated; **RE40**: lower penetration of renewable energy, **RE80**: higher penetration of renewable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

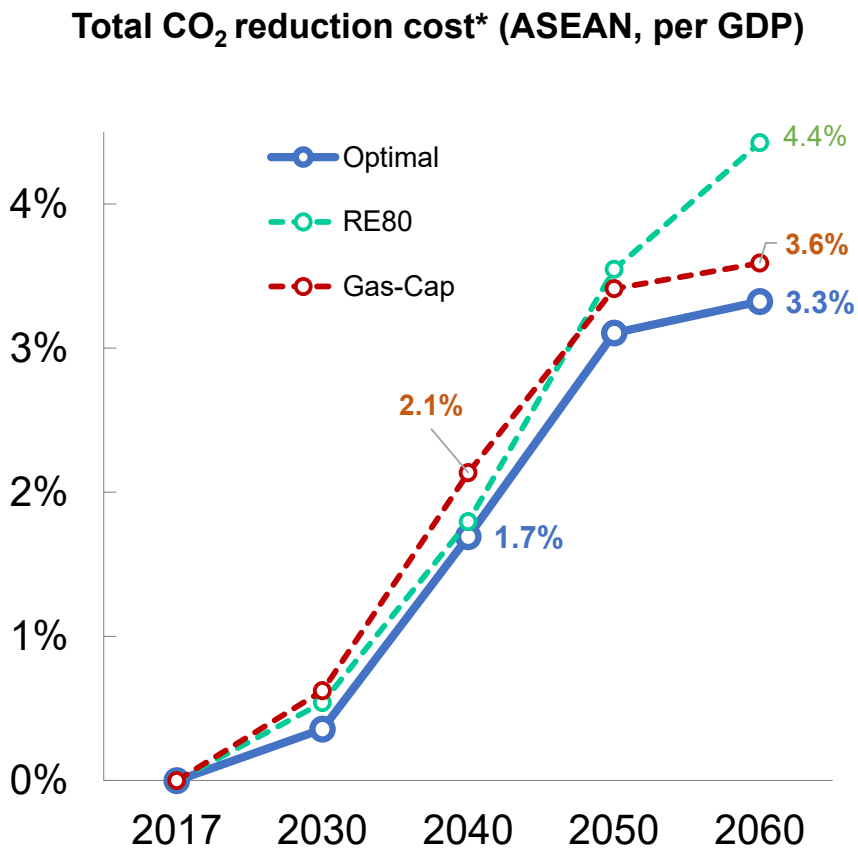
IEEJ-NE Model
(Bottom-up Optimization model)

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



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

Part 2: ASEAN　RE80 increases costs in the long term, while Gas-Cap increases costs in the mid-term.

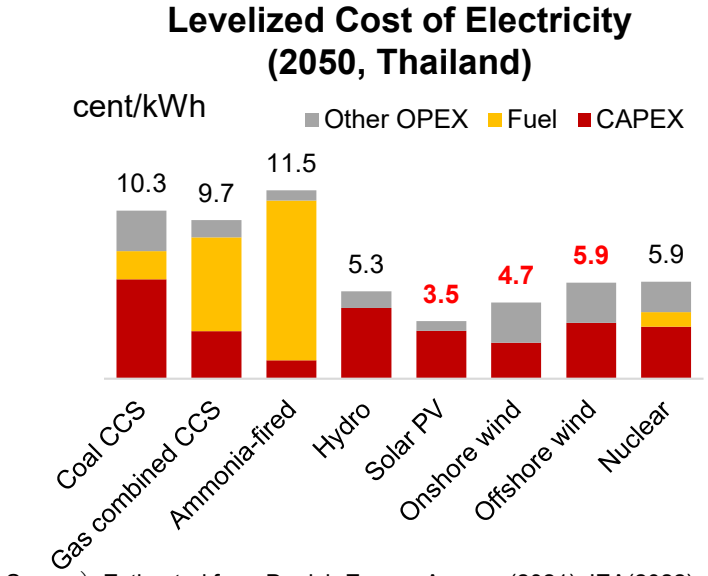


- The total CO2 reduction (abatement) cost to achieve 2060 net zero is US$570 billion/year, equivalent to 3.3% of GDP, in the **optimal case**.
- If the optimal energy mix is not realized, the abatement cost rises further;
  - **RE80** : Cost in 2060 rises to 4.4% of the GDP. The increase in 2050-2060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

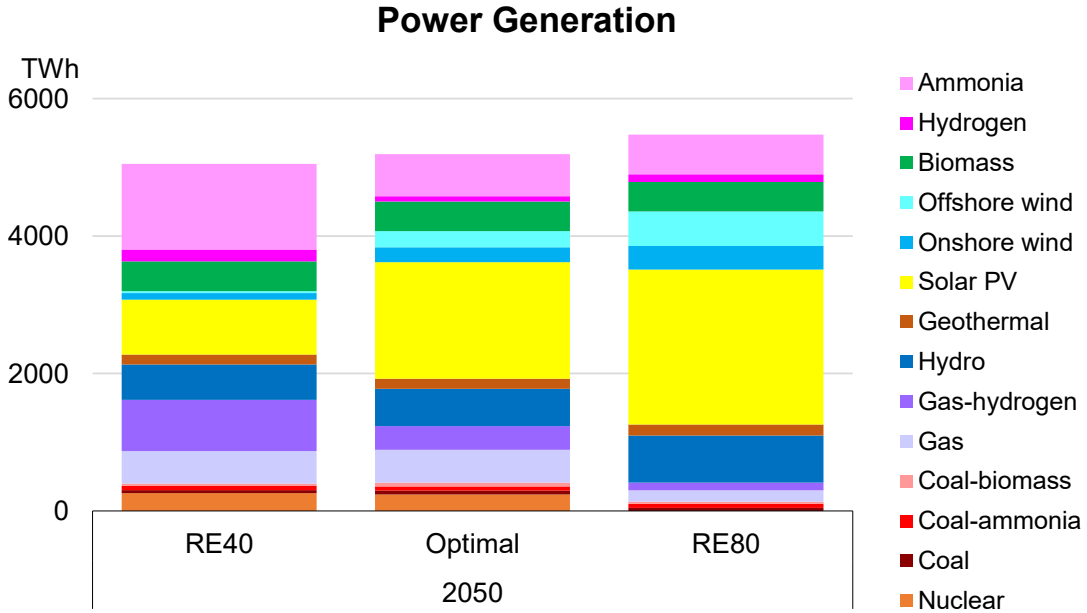
＊ The cost difference between the total cost of energy supply (capital, fuel, O&M, etc.) , compared to the baseline case without emission reductions. The future GDP is estimated from “Energy Outlook and Energy Saving Potential in East Asia 2020”(ERIA, 2021). 2017 Constant USD.

Part 2: ASEAN　Although LCOE of renewable will decrease over time, massive penetration requires additional cost



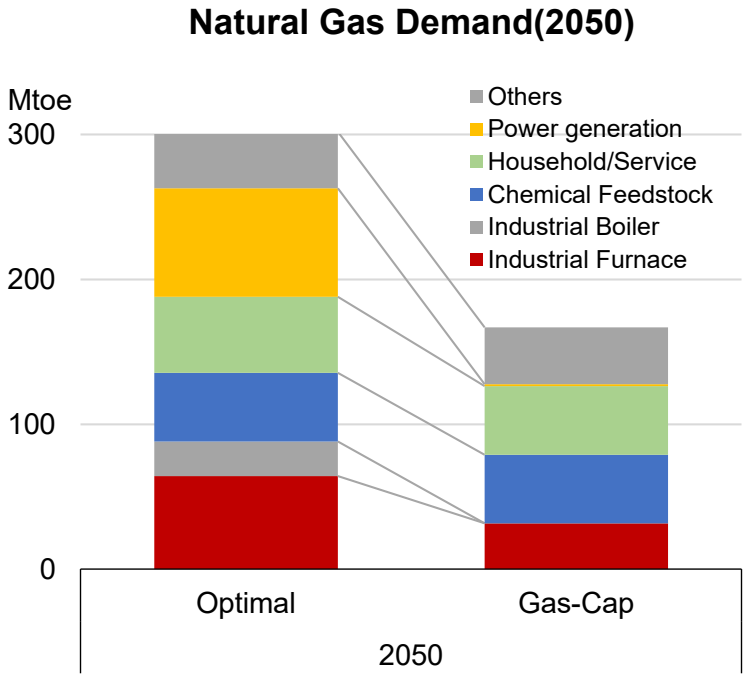
Source）Estimated from Danish Energy Agency (2021), IEA(2022)

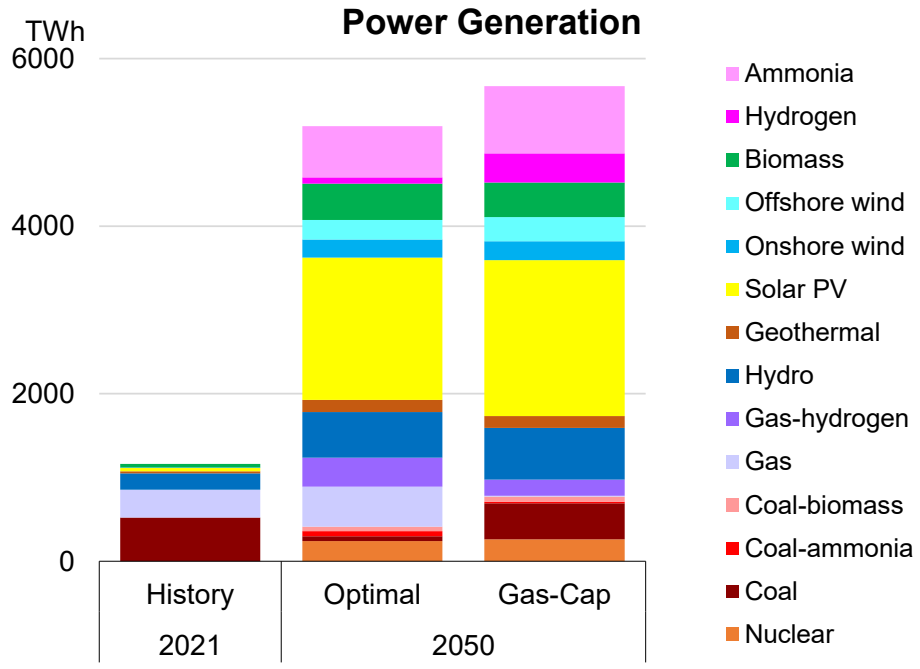
*Costs inside power generation facilities alone; which does not include integration costs.



- The generation cost of renewable energy itself (LCOE) is expected to be relatively low among zero-emission power in 2050. Therefore, if the installation is low, the average power generation cost would increase.[RE40]
- On the other hand, if variable renewable energy (solar and wind) is increased to the level of [RE80], it will be necessary to introduce them to areas with worse weather conditions, and integration costs for dealing with output fluctuations (batteries, etc.) will increase, leading to higher overall system costs.

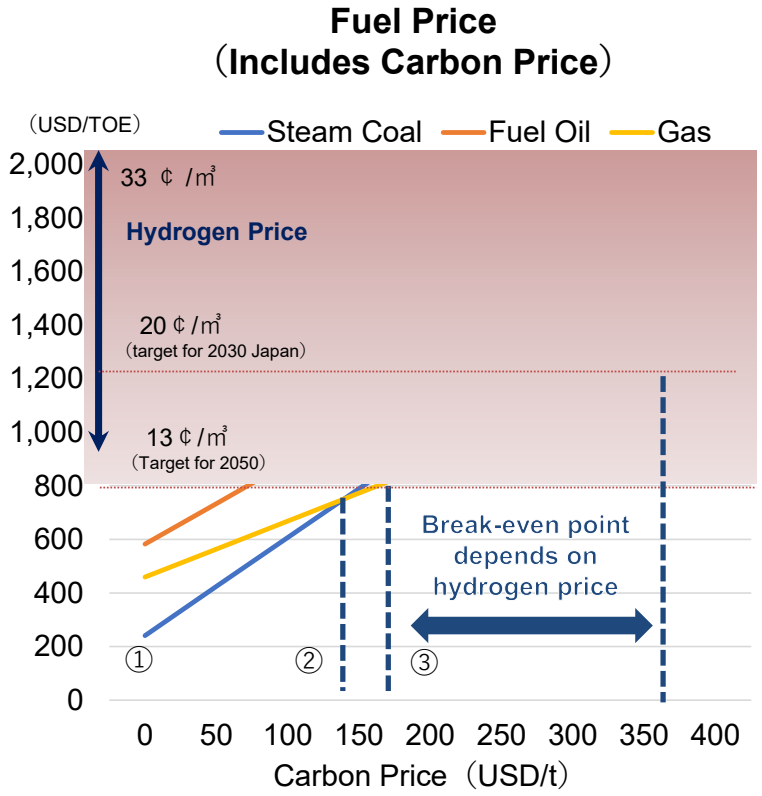
Part 2: ASEAN Gas plays an important role in heat demand and power generation, during the transition period





- In the **optimal case**, natural gas is primarily a fuel for industrial furnaces, which are difficult to electrify. In the **gas-cap** case, the shortage must be offset by oil and coal, which have higher emission factors.
- In the optimal case, gas-fired power generation is introduced to balance supply and demand.

Part 2: ASEAN
On the way to net-zero, gas is competitive among fossil fuels



Source) Advanced Technologies Scenario, 2050

- In demand sectors where electrification is difficult, fossil fuel use is expected to continue until a low-cost hydrogen supply is realized.
- The cost advantages among fuels will change as follows.

  (1) **Coal has the smallest price** per calorific value of fuel alone.

  (2) As ASEAN moves toward net zero, some external cost is expected to be attached to CO_2 emissions.

  If the carbon price increases to around $150/t, **gas would be affordable**.

  (3) If the carbon price increases significantly and the hydrogen price is reduced to about 13 cents/m3, the **H_2 price may fall below the gas price**.

Gas could become competitive where the carbon price falls between (2) and (3).

* The MAC (marginal abatement cost*) calculated from this analysis is around 200$/t-$CO_2$ in 2040 and 370$/t in 2050, a level at which gas use has some advantage.

Part 2: ASEAN's Pathways towards Energy Transition
Conclusion

- For ASEAN, with its remarkable economic development, **cost efficiency of energy transition is essential** to achieve both economic growth and CN.

- Depending on future assumptions for growth and energy efficiency improvements, there will be significant differences in the outlook of future energy demand. It is not sufficient to simply focus on the share of renewable energy, as the **optimal energy mix will vary depending on the total amount of demand**.

- **The cost of renewable energy is expected to be low** among zero-emission power sources, making it a promising power source. However, it should be noted that suitable sites are limited, and the **integration cost may increase when variable renewable covers a large part** of the electricity supply.

- **Gas will mainly play a role in reducing industrial emissions** (especially hard-to-abate sectors) and **in dispatchable power generation**. It can be an important energy source for emission reductions, especially during the transition toward zero emissions.

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