

Growing Potential of Fuel Ammonia

Fourth East Asia Energy Forum

‘A Low-Carbon Energy Transition in the ASEAN Region’

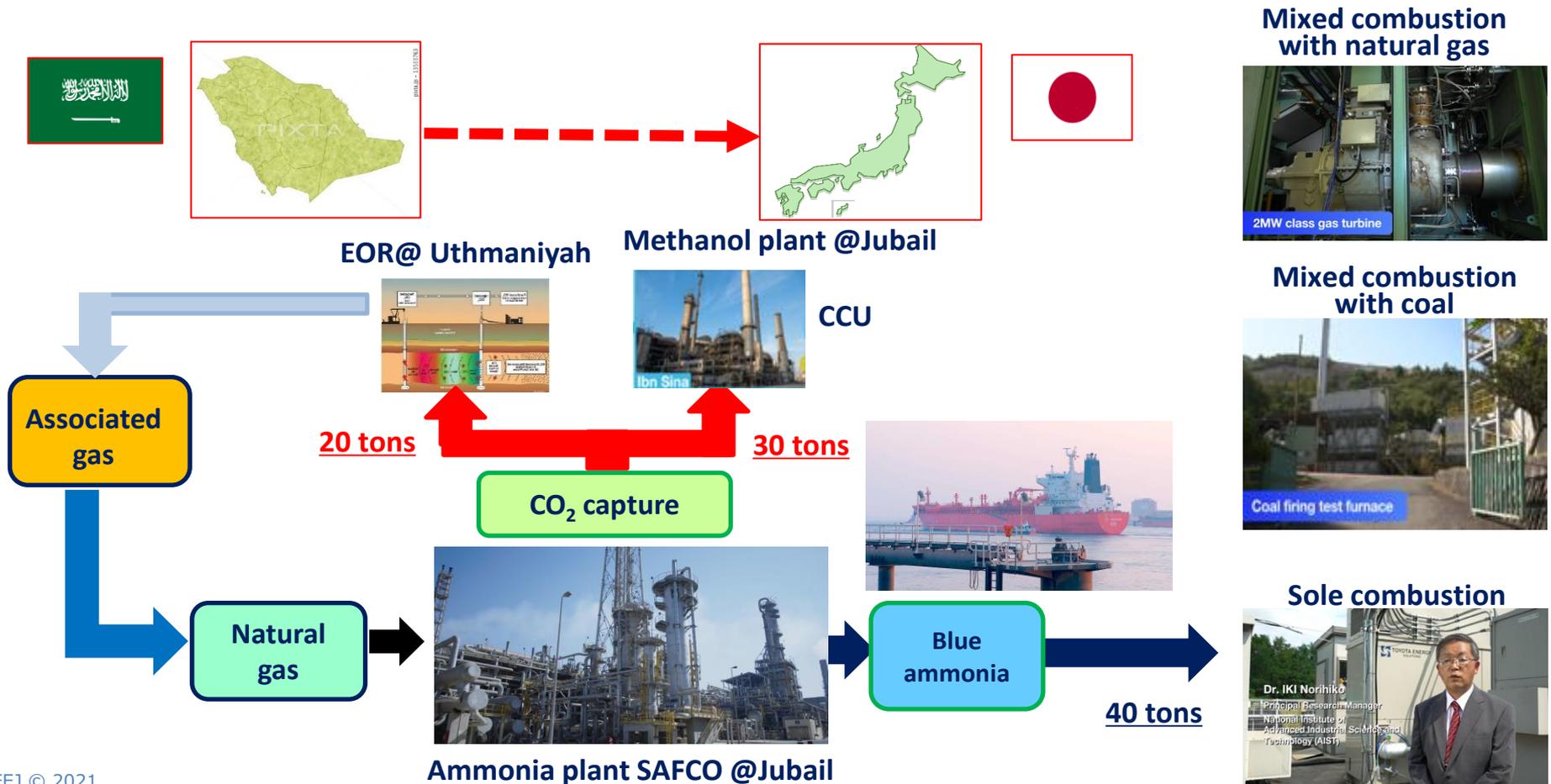
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Demonstration of Blue Ammonia Supply Chain

- Saudi Aramco and IEEJ with Japanese firms jointly conducted production, shipment, and utilization of blue ammonia in 2020.
 - CO₂ emitted from NH₃ production is captured and utilized for EOR and methanol production in Saudi Arabia. Imported ammonia was used as fuel.

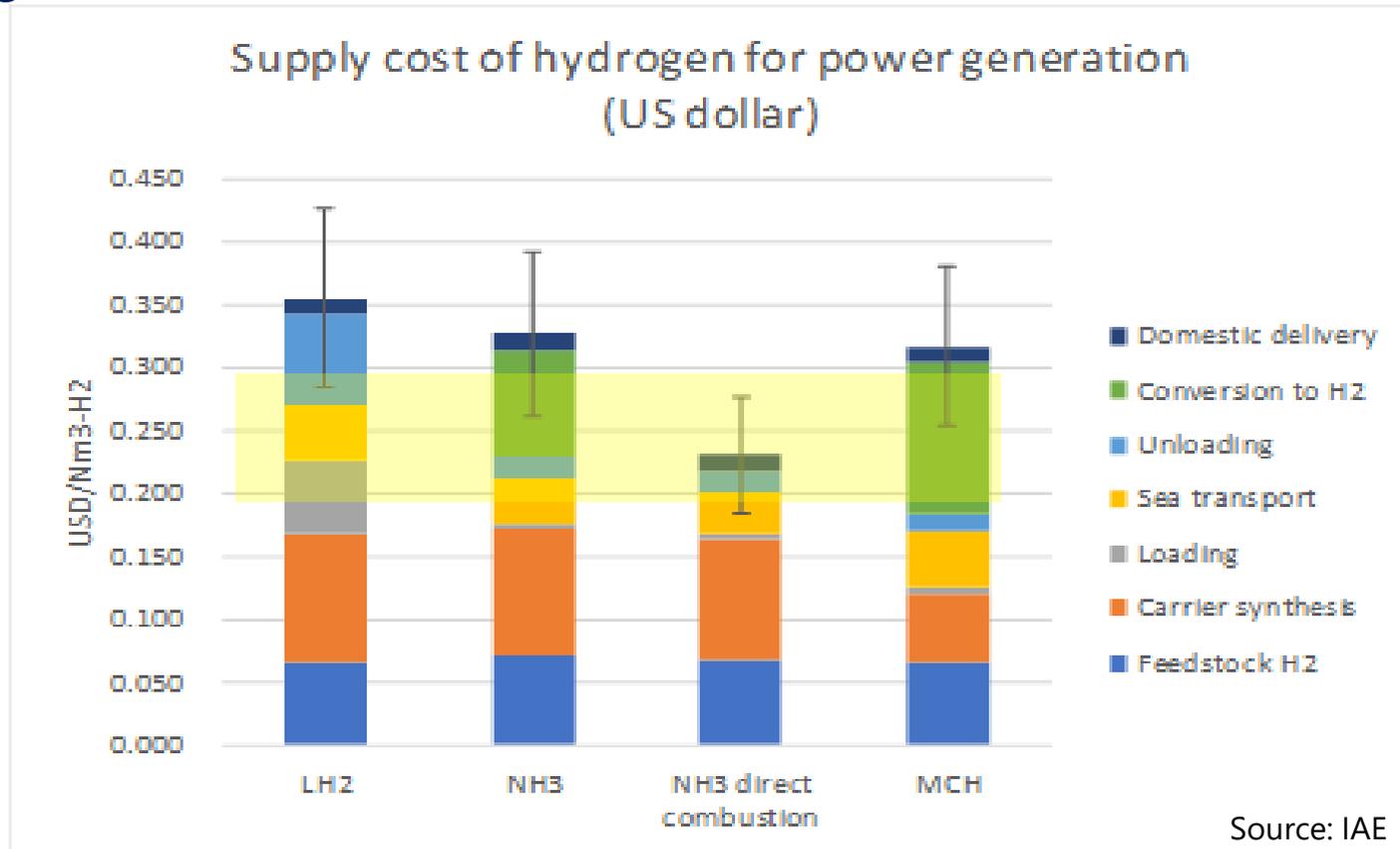


Characteristics of ammonia as fuel

- No CO₂ emissions at combustion
- Established international market
 - Currently used as a feedstock of fertilizer and chemical products
 - Infrastructure (production plants, storage, loading facility, tankers etc.) exists.
 - Pricing mechanism / cost structure are well known.
- Various patterns of utilization
 - Utilized as a carrier of hydrogen
 - Technological development enabled direct use by mixed combustion.
 - In addition to mixed combustion with coal, utilization at gas turbine, industrial boiler, vessel engines is possible.
- Various production sources
 - Clean ammonia is produced from “blue” and “green” hydrogen
 - Competitive hydrogen supply is important.

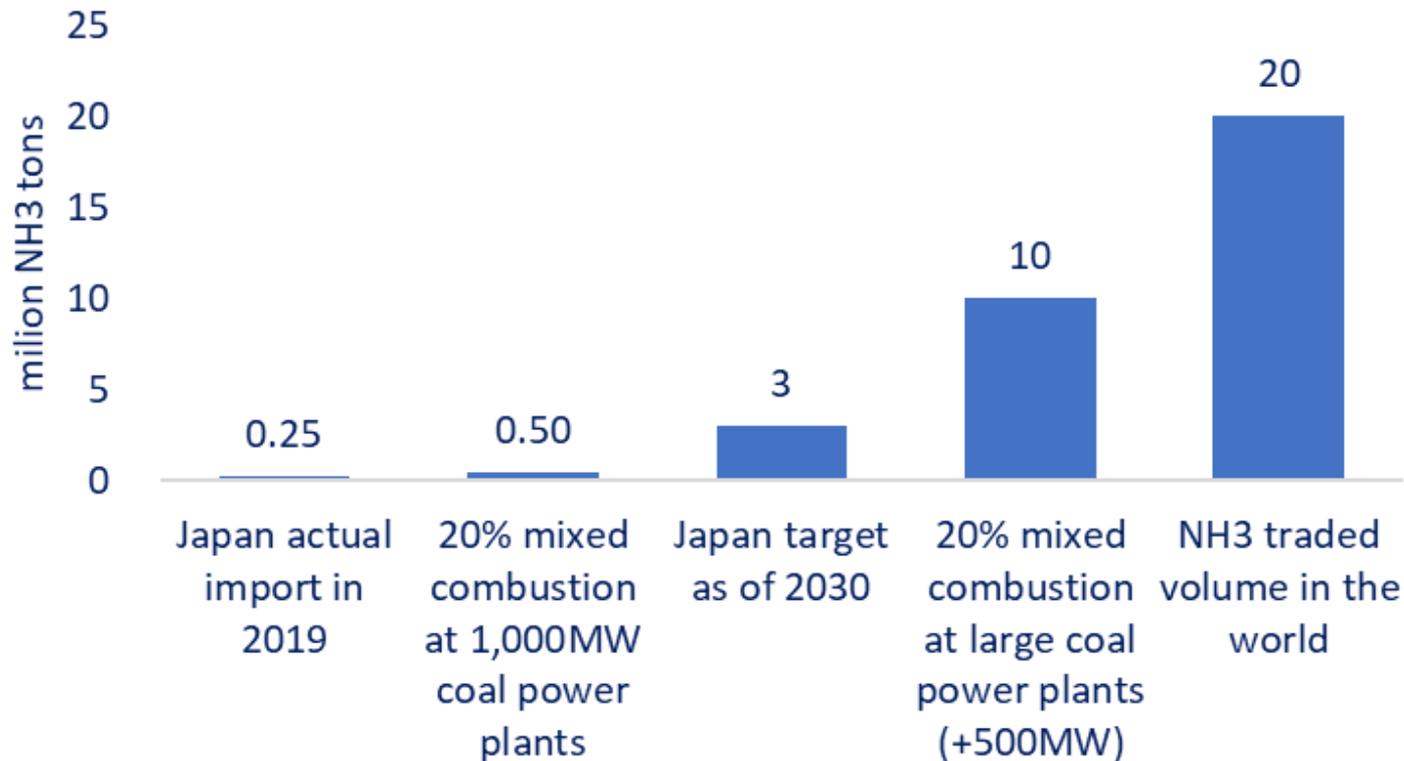
Cost of supply

- At this stage, ammonia is regarded as the most cost competitive mean of hydrogen supply.
- Current supply cost target is \$350/MT.
 - \$0.09/kWh if used by 20% mixed combustion with coal at power generation.



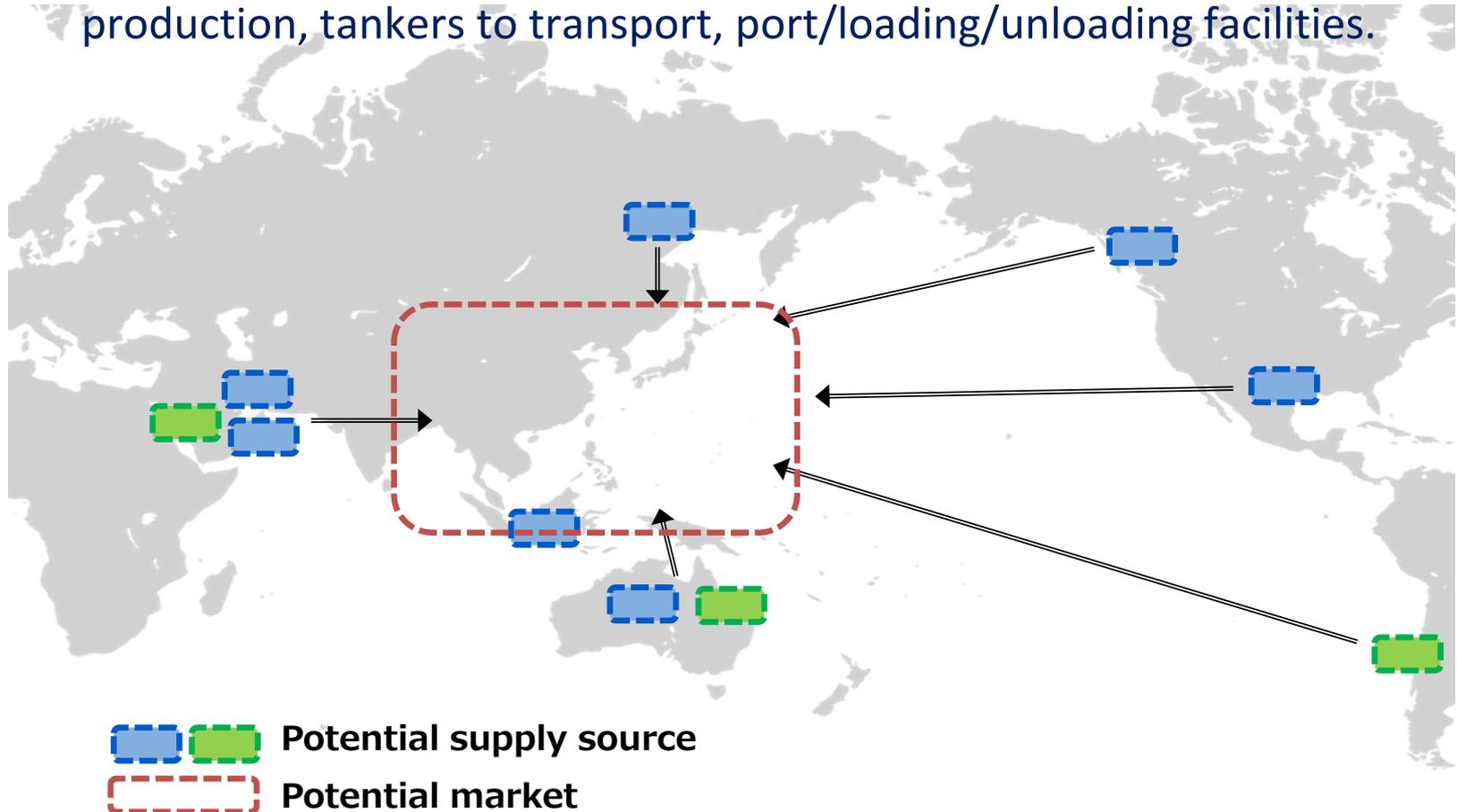
Relative size of the markets

- Market for fuel ammonia will be large compared to the current international ammonia market
 - If ammonia is used as mixed combustion at 20% in all large coal power plants in Japan, the demand will be a half of the world's ammonia trade.
 - The total demand of ammonia in the world (~200 million tons) is far larger than the traded volume.



Expanding supply chain capacities

- Supply chains need to be built up.
 - Typical size of large-sized ammonia plant is one million ton per year.
 - If the market takes off and the demand grows in Asia, significant expansion of production capacities is required in addition to hydrogen production, tankers to transport, port/loading/unloading facilities.



Issues

■ Cost

- Still not comparable to conventional thermal power generation
- Ammonia production is relatively matured technology.

■ Logistics

- Necessity to expand capacity of all value chains from production, shipping, receiving capacity, and consumption

■ Market effects

- Potential impacts on the existing ammonia market
- If blue hydrogen is extensively used as a feed stock, it may also affect the world natural gas market.

■ Safety issue

- Manageable by specialized operators without problem
- Prioritized use power generation and industrial fuel