



# Fourth East Asia Energy Forum 'A Low-Carbon Energy Transition in the ASEAN Region'

## Panel Session 2 : Hydrogen, Ammonia and CCUS as Supreme Energy

September 13, 2021

**Chiyoda Corporation**



# I. Hydrogen Production

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# 1. H2 PRODUCTION METHOD : H2 Source & production technology

- Hydrogen can be produced from any kinds of primary energy, from fossil fuel to renewable energy, and major hydrogen sources are as follows :

## HYDROGEN from Fossil Fuel

- **By-product hydrogen** (CCR, ethylene, methanol, chlor-alkali)
- **Reformed hydrogen** (flare gas, reinjection gas, mid-small gas field)
- **Gasified hydrogen** (VR/ pitch / coke, coal / lignite)
- +
- **CCUS** (CO2-EOR, CCS, CO2 feedstock)

## HYDROGEN from Renewable Energy

- **Water electrolysis hydrogen** (solar, wind, hydro, geothermal)
- **Biomass hydrogen** (waste, unutilized, resource crop)

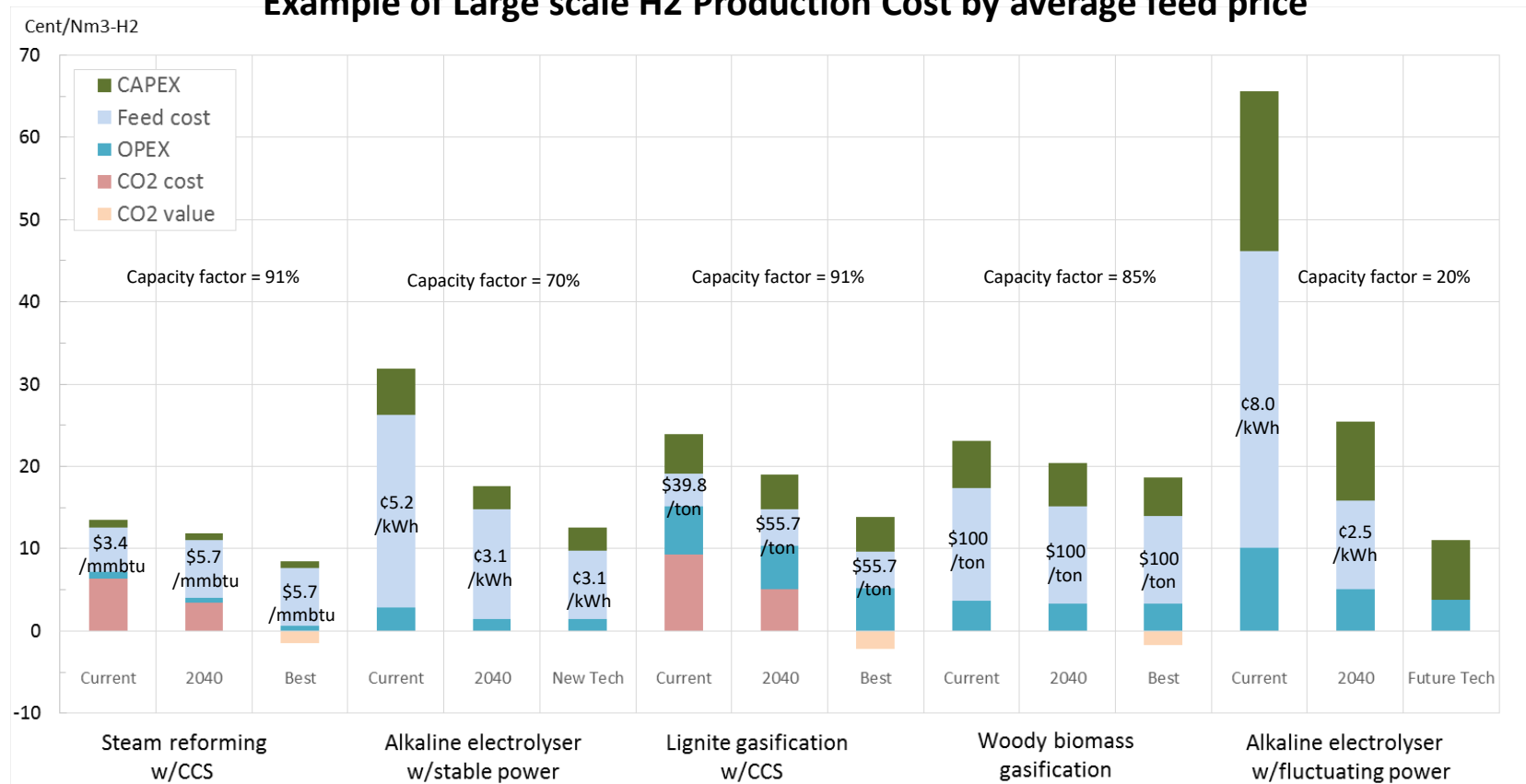
### < Technology Development >

- **Biotech hydrogen** (microalgae, bacterium, etc.)
- **Photo-catalyst hydrogen** (Solar)

## 2. H2 PRODUCTION COST : Example Cost for larger scale (Exporting)

- H2 production cost in 2040 will be in the order of ‘Gas reforming’, ‘Water electrolysis (stable power)’, ‘Biomass gasification’, ‘Lignite gasification’, ‘Water electrolysis (fluctuating power)’.
- It is also important to assess the feasibility of CCS/CCU, including social license, R&D progress.

Example of Large scale H2 Production Cost by average feed price



\*1 : Feed Cost of Lignite gasification is based on FOB price in Exporting Group Countries.

\*2 : CCS cost is based on \$70/t-CO2 for current and \$48/t-CO2 for 2040 (CCS/Utilization Singapore Perspectives).

(Source) ERIA Report “Demand and Supply Potential of Hydrogen Energy in East Asia (2018)”

## II. Hydrogen Transportation

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# 1. TRANSPORTATION METHOD & PORTFOLIO : Method

- Hydrogen logistics will consist of following typical transportation modes and hydrogen carriers.

## < Transportation mode >

- Ship transportation**

Liquid H2 tanker, Chemical tanker, Container vessel, Barge, etc.



- Railway transportation**

Freight train, Container train, etc.



- Truck transportation**

Liquid H2 truck, Chemical / Gasoline tank lorry, Tube trailer for compressed gas, etc.



- Pipeline transportation**

Hydrogen gas pipeline, Natural gas pipeline, etc.



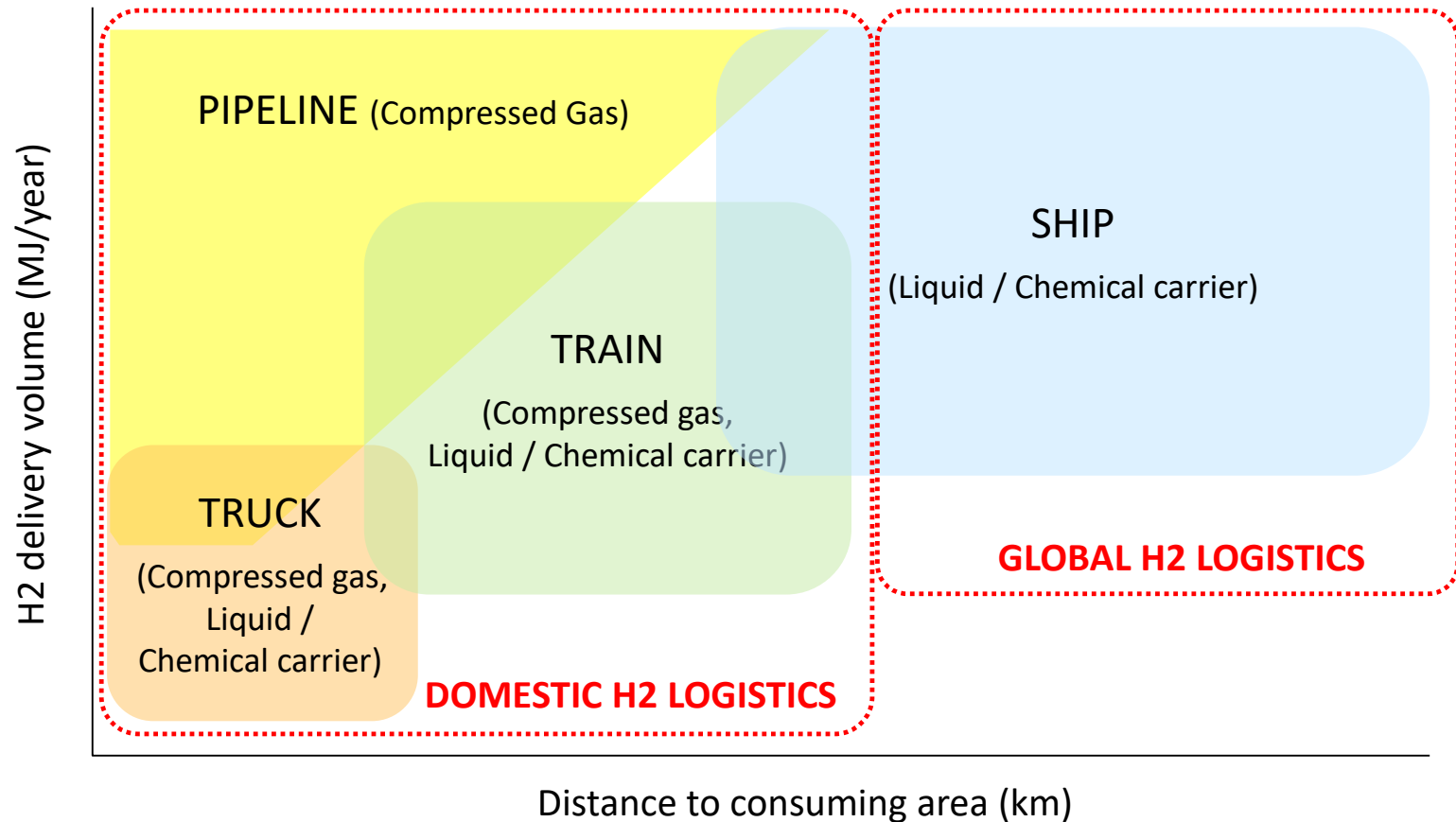
## < Hydrogen Carrier >

	Liquid Hydrogen (LH2)	Ammonia (NH3)	Chemical Hydride (MCH)	Compressed Hydrogen (CH2-700MPa)
Molecular Weight	2.0	17.0	98.2	2.0
H2 Content (wt%)	100	17.8	6.2	100
Volumetric H2 Density (kg-H2/m3)	70.8	121.0	47.4	39.6
Boiling Point (deg-C)	-253	-33.4	101	-
H2 Release Enthalpy Change (kJ/mol-H2)	0.9	30.6	67.5	-
Others	- High purity - Low energy to pressurize	- High H2 density - Direct combustion	- Liquid at ambient - Utilize existing oil infrastructure	- Widely used in existing market

# 1. TRANSPORTATION METHOD & PORTFOLIO : Portfolio

- Transportation modes and hydrogen carriers will be selected and combined based on the delivery volume, distance and characteristic of each transportation modes / carriers.

< Image of H2 Logistics portfolio >

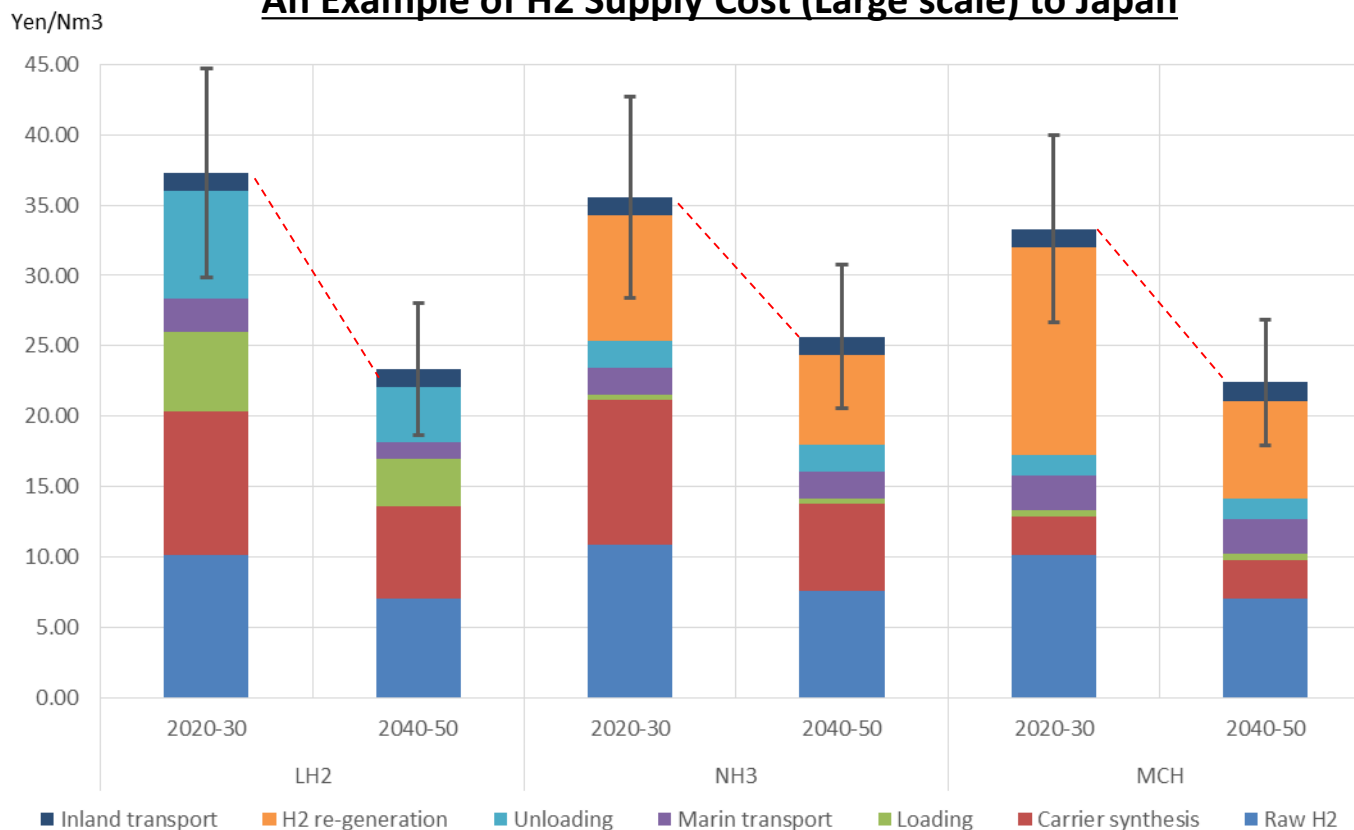


(Source) ERIA Report "Demand and Supply Potential of Hydrogen Energy in East Asia (2018)"

### 3. GLOBAL H2 SUPPLY CHAIN : H2 Supply Chain Cost

- Each hydrogen carriers has each merits and technical challenges, and require continuous technology development to achieve drastic cost down.
- It is also require to consider the balance between the ultimate technological goal in future and uncertainties of technological achievement in longer terms.

**An Example of H2 Supply Cost (Large scale) to Japan**



(Source) ERIA Report "Demand and Supply Potential of Hydrogen Energy in East Asia (2018)"



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