Implementation Plan of C-free Ammonia Value Chain

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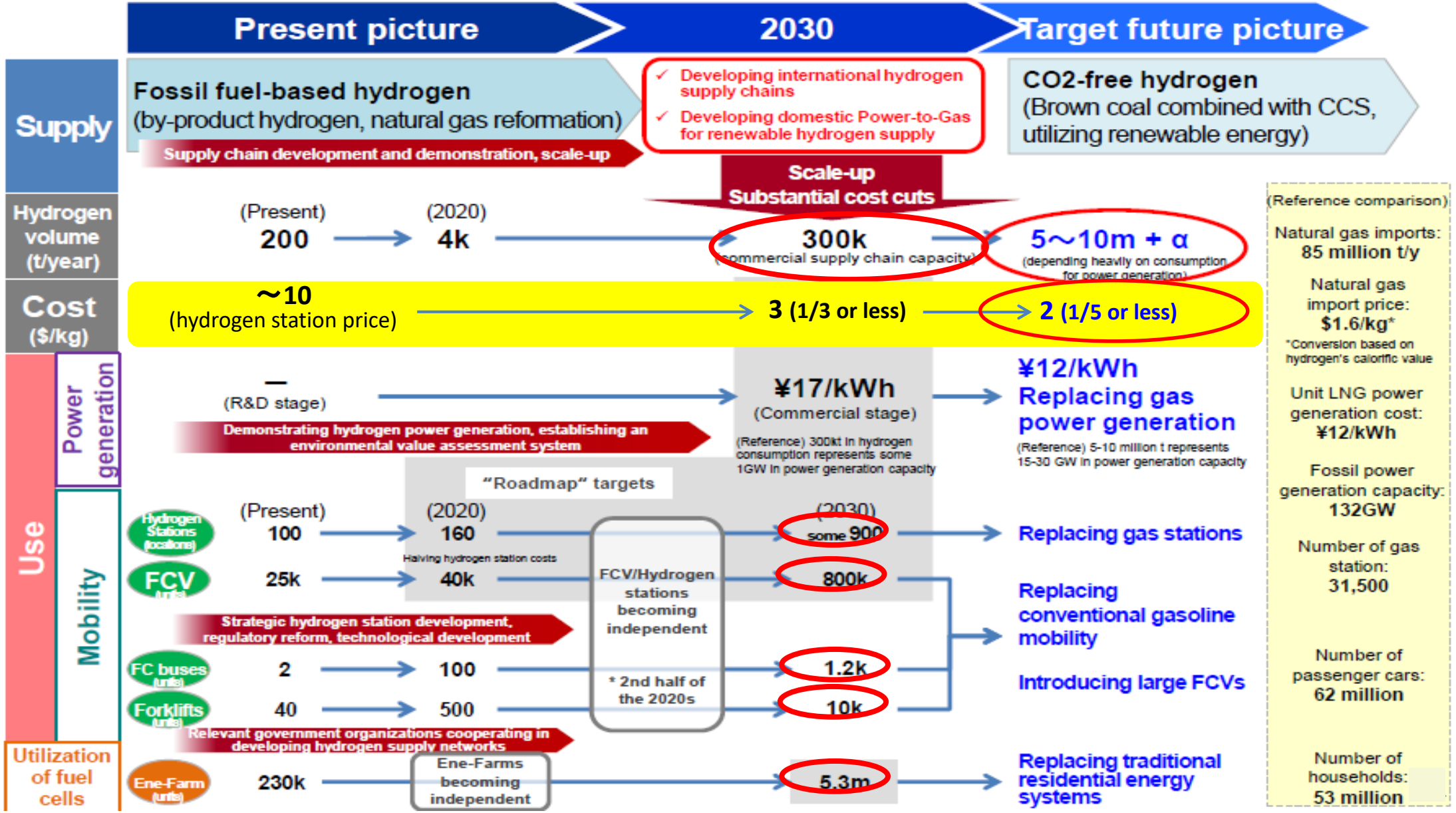
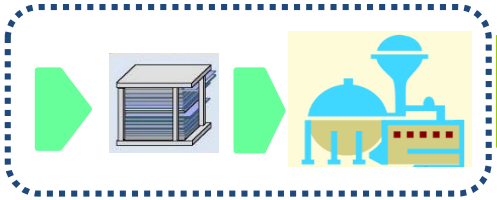
Scenario for Basic Hydrogen Strategy



Strategy for Ammonia Fuel

Renewable energy

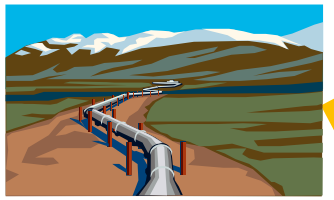


Ammonia production from Renewable energy

Ammonia Fuel

Feasibility study of
C-free Ammonia Supply Chain

Fossil fuel



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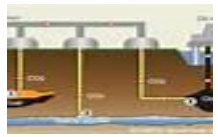
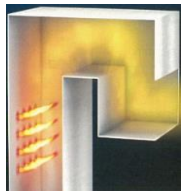


Ammonia Fuel

Estimated Price
$340/ton ($2/kg-H2)



Mix combustion in coal fired boiler

Power generation sector

Gas turbine

Fuel cell

Industrial sector

Industrial furnace

Transportation sector

Maritime

Heavy-duty vehicle

Hydrogen supply system for Transportation sector

Taking into account all cost components, transmission and distribution of hydrogen as ammonia is likely the cheapest mechanism for imports to Japan from Australia
(IEA Hydrogen Report for G20 in 2019)

Why Ammonia

- Directly combusted without CO_2 emissions.
- Largest H_2 content among 3 carriers and most efficient in marine transportation.
  （NH_3 121kg-H_2/m^3 liquid , LH_2 71kg-H_2/m^3 , MCH 47kg-H_2/m^3）
- Large commercial supply chain is established, and cost structure is clear.
  〔Estimated Cost of Blue Ammonia at Japan ; $330～340/ton（$2/kg H_2）〕
- NOx emissions can be controlled by technologies.
  （Air-fuel ratio , Two staged combustion etc.）
- Technologies are becoming ready for commercial use.
- Safety standards are practically used in chemical and power industries.
- Primary markets are controlled facilities with trained operators such as power plant, industrial factories and data centers.

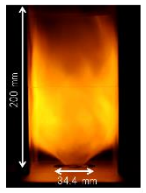
Key Technologies of Ammonia Utilization in the Energy Market

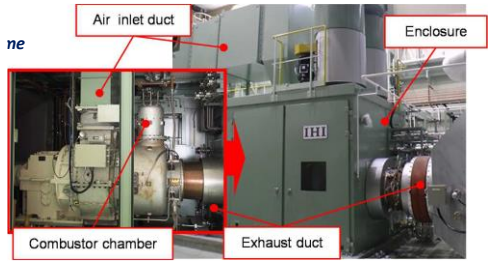
Gas turbines

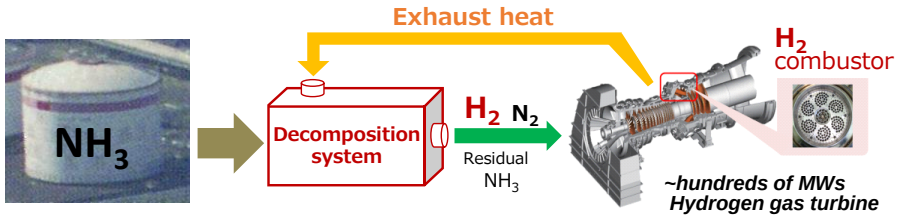
50 kW, 300 KW：NH_3 Single Fuel

2MW：20%～100% NH_3 in Natural Gas

ACCGT：Decomposition of NH_3 using part of exhaust heat and H_2 is supplied to turbine.
Efficiency is equivalent of CH_4.







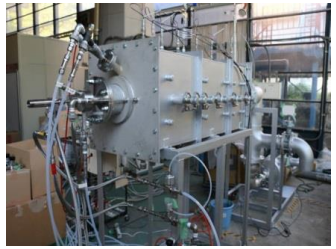
Mix combustion in coal fired boilers

20%～50% NH_3 in Coal

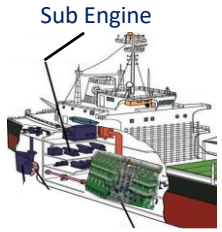
SOFC

10kW～200kW

Industrial Furnaces



Marine Diesel Engine



Roadmap of Ammonia Supply Chain