Development of Substituting Import Fuels & New Manufacturing Industry by Coal Green Utilization

DME Supply as LPG・Diesel fuels Substituting & Blue Hydrogen Supply for Future Hydrogen Society

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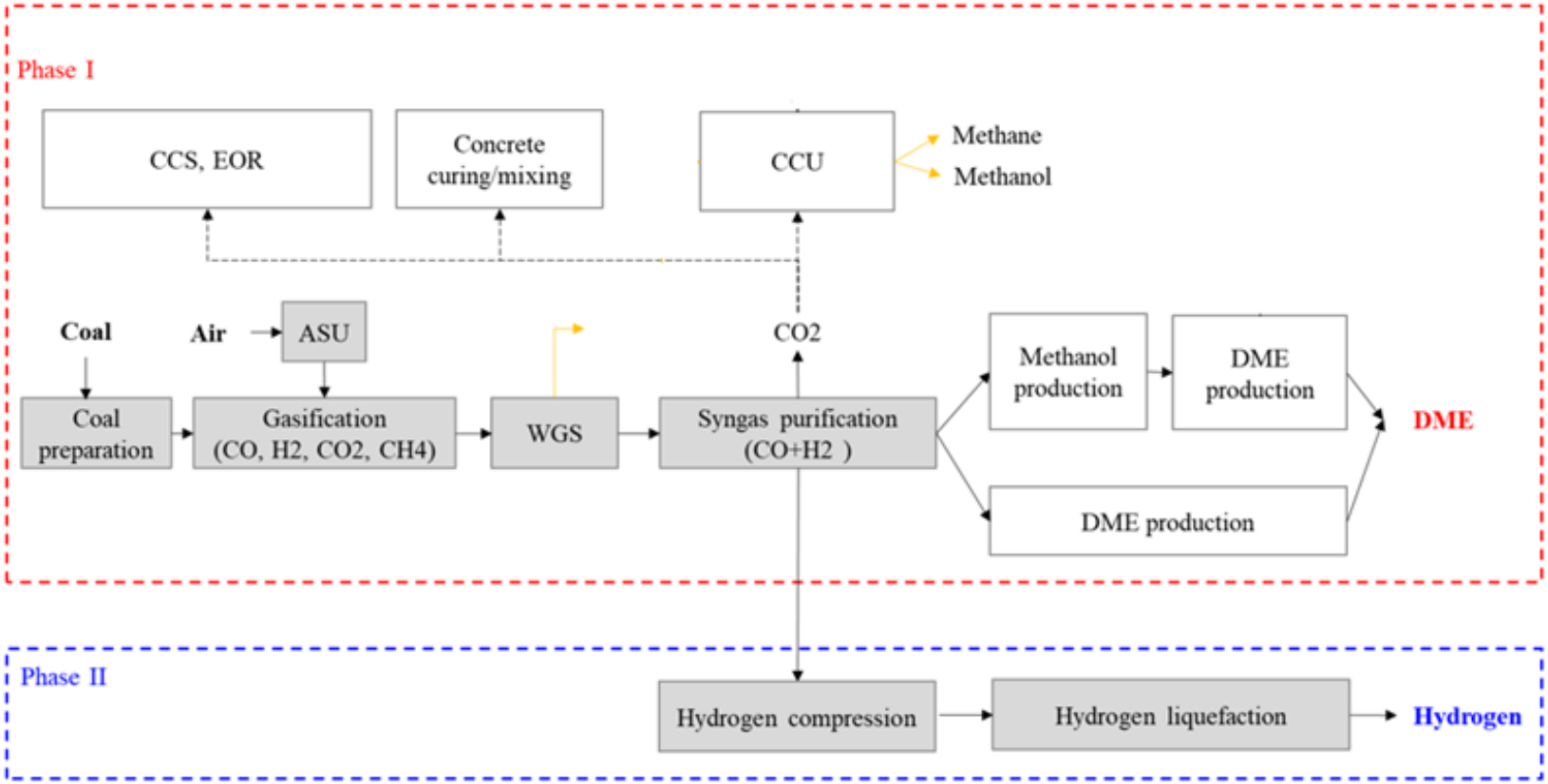
1. Objective of the Study

Mongolia is a coal-rich country, however the global demand for coal is predicted to decrease in the future due to growing environmental awareness. Under such circumstances, Mongolia is considering effective utilization of its coal, and has decided to conduct a preliminary study by the working group to be formed between Mongolian and Japan on the possibility of hydrogen production from coal considering that the demand for hydrogen is expected to increase globally in the near future.

In addition, It will take more time to establish the global hydrogen commercial market and so for the purpose to substitute the imported LPG and Diesel fuels, DME production by coal gasification with CCS is considered as the first phase. After familiarization of this DME plant operation, hydrogen will be produced as a targeted end-product to the global hydrogen market by adding hydrogen compression and liquefaction units.

2. Study Concept

Updated Project Concept for Pre-Feasibility Study



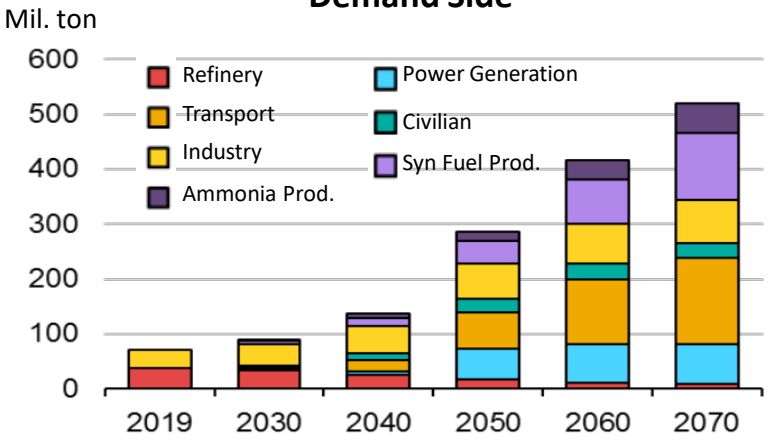
Phase I : Until a stable hydrogen market is established.

Phase II : Hydrogen as an end-product in addition to equipment installed in Phase I

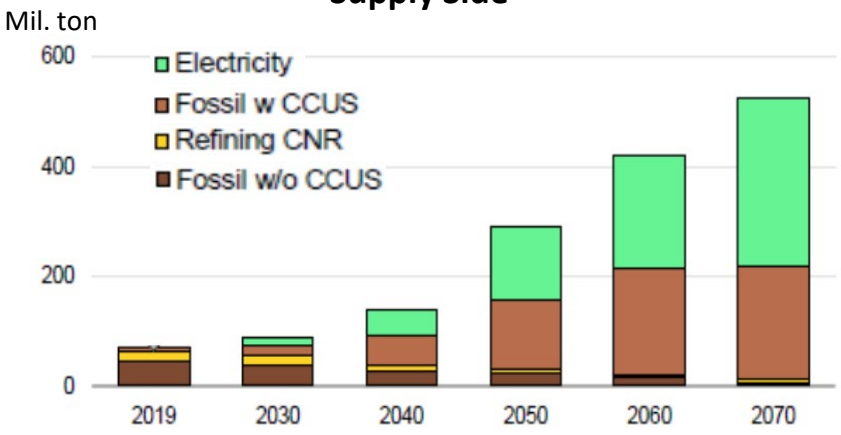
Reference: Future Demand and Supply of Hydrogen

Global Hydrogen Supply and Demand Forecast

Demand Side



Supply Side



CNR: hydrogen as by-product from catalytic naphtha reforming in refinery

Under the Paris Agreement scenario (SDS scenario), the IEA estimates that carbon neutrality should be achieved by 2070. Global hydrogen demand at that time is expected to be about 520 million tons.

Source: IEA, Energy Technologies Perspectives 2020

According to the IEA's SDS scenario, hydrogen from renewable energy sources is expected to account for about 60% and hydrogen from fossil fuels for 40% in 2070, and the total capacity of water electrolyzers in 2070 is expected to be 3300 GW.

For the time being, grey hydrogen and other products that do not implement CCUS are expected to account for a large proportion of supply.

Reference: Carbon dioxide Capture and Storage (CCS)

1 Capture

CO_2 capture separates CO_2 from gas before it is emitted using a chemical solvent. The captured CO_2 is separated from the solvent and compressed into a liquid form for transport.

2 Transport

CO_2 is generally pumped through a pipeline, taking the CO_2 from the industrial site where it has been produced to its storage site, which may be onshore or offshore.

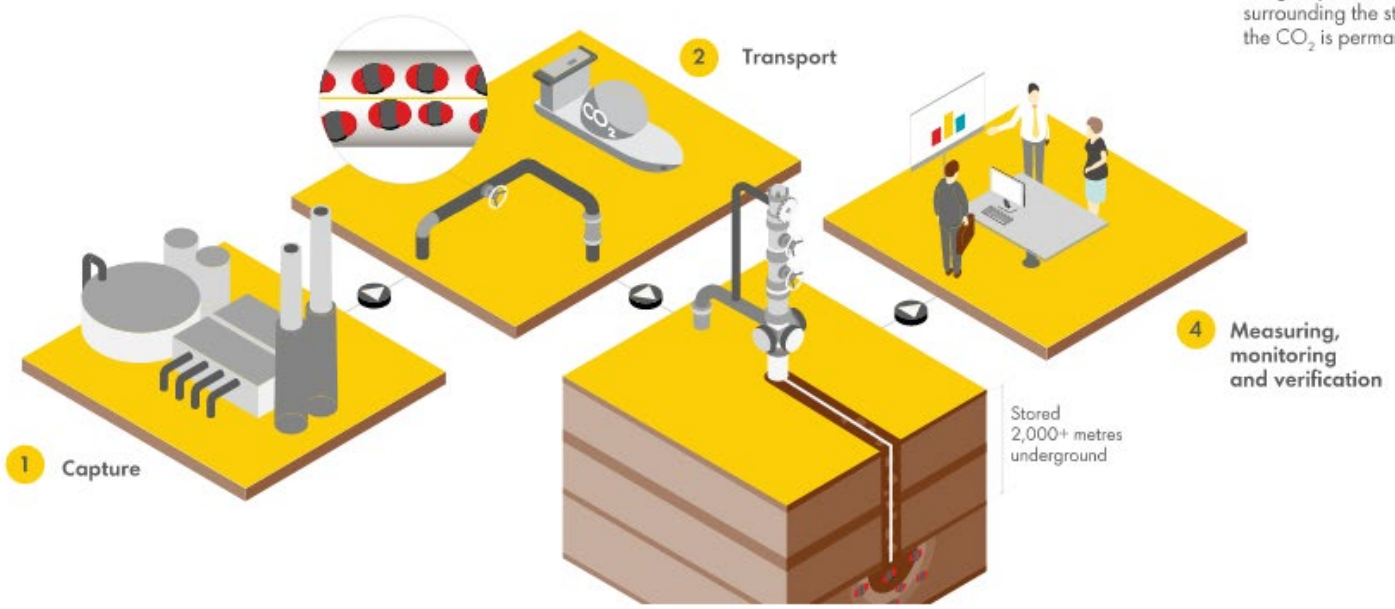
3 Storage

CO_2 is injected deep underground into the microscopic spaces in porous rocks. A layer of impermeable rock, called a cap rock, lies directly above the porous rocks ensuring that the CO_2 remains there permanently.

4 Measuring, monitoring and verification

Monitoring of storage sites takes place within the storage reservoir, as well as at the injection well, where sensors can detect small changes in pressure or CO_2 levels.

In addition, a number of monitoring technologies can be incorporated within the geosphere, biosphere and atmosphere surrounding the storage site to make sure the CO_2 is permanently stored.



Source: https://www.shell.com/energy-and-innovation/carbon-capture-and-storage.html#projects=true&iframe=L3dlYmFwcHMvQ0NTX0dsb2JlLw

3. Mongolian economic challenging points

3.1 Economy dependent on the mining industry and Necessity of New Industry Creation

(1) Currently high dependency on coal export to China, but the demand will decrease in future by global environmental awareness.

(2) Chemicals production from coal was planned in the past, but it is not realized because of the following reasons:

- Volatility of the product price
- Inferior competitiveness to existing product prices
- Recent global low carbon tendency

(3) The country is landlocked with no ports, that makes it difficult to ensure the competitiveness of its export industry due to transportation costs.

3. Mongolian economic challenging points

3.2 Dependent on energy impot from neighboring countries

(1) Almost all fuels are dependent on import from neighboring countries, except electricity by coal power plants.

(2) Electric power also dependent on import from neighboring countries.

(3) Large amount of currency are consumed for these fuel and energy import.

(4) Clean fuel exchange is the most important subject to reduce environmental load.

3.1 Economy dependent on the mining industry and Necessity of New Industry Creation

Blue hydrogen production by coal gasification is one of the options to realize the future hydrogen society.

- Conventional chemicals production by using coal is not accepted by global international society due to the recent global low carbon tendency. Even through chemicals are produced from coal, these coal origin chemicals are recognized as less product value from recent worldwide decarbonization policy and not suitable for new manufacturing industry.

- On the other hand, blue hydrogen production by recovering CO2 and storage as CCS is promoted by Japanese government, such as hydrogen supply chain project from brown coal in Australia. So, if hydrogen production from Mongolian coal has a competitiveness in comparison with the hydrogen project in Australia, this hydrogen would be feasible for exporting industry from Mongolia.

3.1 Economy dependent on the mining industry and Necessity of New Industry Creation

Competitiveness against Preceding Project in Australia??

Hypothesis :

For the preceding project in Australia

- Large brown coal gasification plant
- Large liquified hydrogen ship tanker

For the project in Mongolia

- Difficulty of a large scale hydrogen transportation because of inland transportation by train to the seaport through neighboring countries

＝＞ A big disadvantage for the transportation cost to Japan.

3.1 Economy dependent on the mining industry and Necessity of New Industry Creation

After arrival in Japan

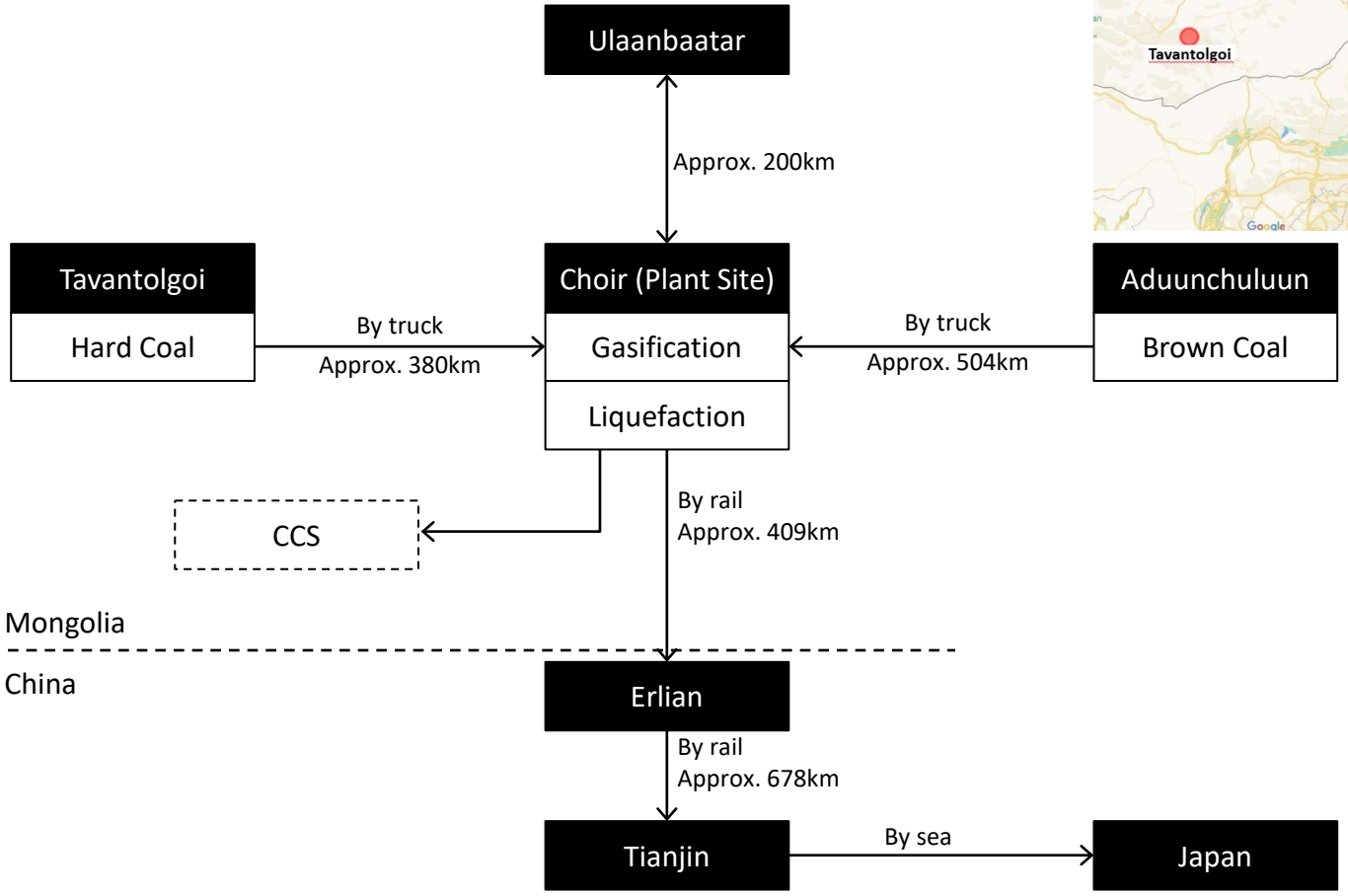
For the preceding project in Australia
Needs to store in receiving storage terminal and transship to the domestic containers for distribution to users
→Certain amount of the additional cost is required.

For the project in Mongolia
Dedicated containers are utilized from Mongolian to Japan.
Transship in Japan is not necessary.

＝＞ Some cost reduction effect can be expected in Japanese domestic transportation handling cost.

3.1 Economy dependent on the mining industry and Necessity of New Industry Creation

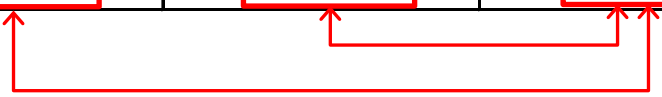
Preliminary study
Feedstock and Product Flow Scheme



3.1 Economy dependent on the mining industry and Necessity of New Industry Creation

Comparison with Preceding Project

	Tavantolgoi Hard Coal (Option A)	Aduunchuluun Brown Coal (Option C)	Preceding Project
Feedstock Coal (t/d)	1,200	1,200	7,800
LH2 Production (1,000t/y)	52.1	34.1	225.5
Transportation Method	Train + Ship		Pipeline + Ship
Transportation Distance (km)	4,400		9,000
CAPEX Index	1,700	1,200	5,700
LH2 Production Cost (&/kg LH2)	4.09	4.29	2.51



As a result of comparing the Project and the preceding project in terms of production cost (CIF Japan), this Project is inferior to the preceding project as shown in the table above.

However, the current hydrogen price is about 15$/kg, and there are many uncertainties as to whether the 2.51$/kg (2030 level) envisioned by the preceding project can be achieved, so it cannot be simply asserted that this Project is inferior in terms of production cost.

3.1 Economy dependent on the mining industry and Necessity of New Industry Creation

As a result of CIF Japan cost for hydrogen, we find a big cost difference between Australia case and Mongolia case.

Further study items:

- Cost reduction for Japanese domestic transportation
- Cost reduction for Mongolian domestic transportation
- Governmental supports such as subsidy, etc. for the project

3.2 Dependent on energy impot from neighboring countries

Mongolia has rich mineral products for export but dependent on import energy. Reduction of energy import, fuel self-sufficiency, import fuel substitution & clean fuel exchange

＝＞ Import value (1,000 US$) for fuel (Source: Mongolia National statistics office)

	2019	2020	2021	2022
Petrol	327,367.8	244,704.1	391,100.67	561,457.02
Diesel	669,381.8	432,420.6	590,100.75	959,719.59
Jet Fuel	33,344.5	12,040	17,240.87	70,835.52
Energy	144,445.9	141,667.5	160,208	182,279

DME fuel produced by coal gasification can be substituted for LPG and Diesel fuels.

It will take some more time to establish the hydrogen market and the materialization of commercial transactions, so we will study the production of DME as first phase of coal gasification.

3.2 Dependent on energy impot from neighboring countries

In next step, the project evaluation will be conducted from both aspects of economical effect and environmental contribution, which means;

- Evaluating the economical effect for import fuel substitution with DME.
- DME as Environmental clean fuel exchanged with coal will leads low carbon society.