International Conference on

Carbon Recycling 2022

Introduction to Chiyoda's Carbon Recycling Activities

Chiyoda Corporation

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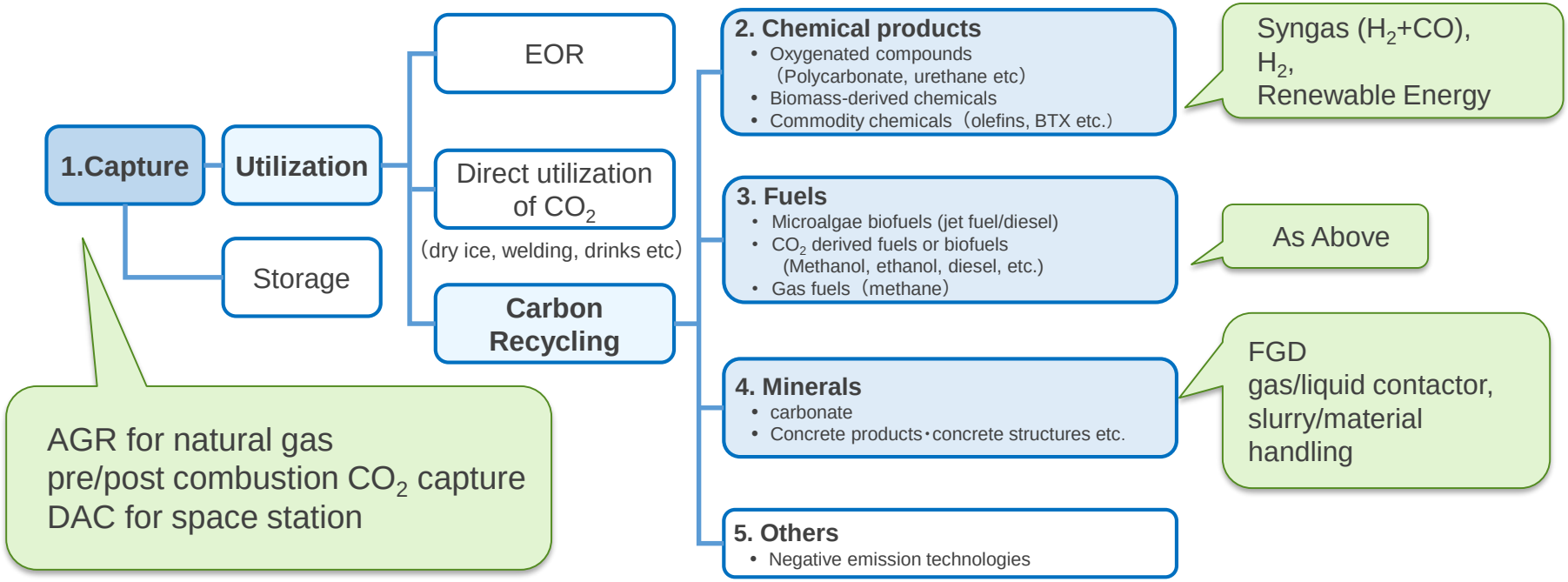
CHIYODA CORPORATION

1. Classification of Carbon Recycling Technologies



【Records & Base Technology】
- CO_2 Capture
- Syngas, Hydrogen
- Renewable Energy
- FGD (Chiyoda Technology)

【Synergy with Carbon Recycling】
- Chemical products & fuels have synergy with syngas, H2 and renewable energy
- Minerals has synergy with FGD

Made by Chiyoda based on “Roadmap for Carbon Recycling Technology” by Ministry of Economy, Trade and Industry
AGR：Acid Gas Removal, DAC：Direct Air Capture,
FGD : Flue Gas Desulphurization, EOR : Enhanced Oil Recovery

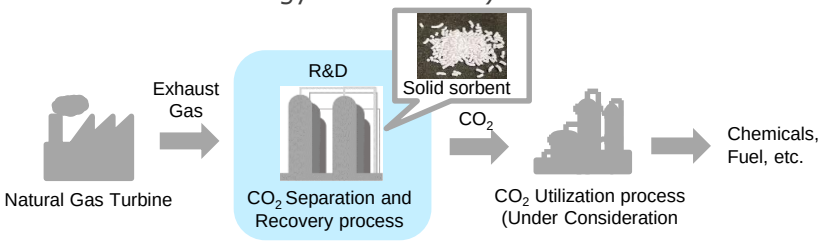
2. Chiyoda's Carbon Recycling Activities

- Chiyoda's Carbon Capture and Utilization (CCU) business from CO_2 capture to utilization.
- Chiyoda is aiming to establish a Carbon Recycle Supply Chain in the near future.

CO2 Capture

◆ Large-scale CO_2 separation and recovery from gas-fired power generation exhaust gas

- R&D stage in NEDO's Green Innovation Fund project (FY2022−2030)
- Partnership with JERA Co. Inc., RITE (The Research Institute of Innovative Technology for the Earth)

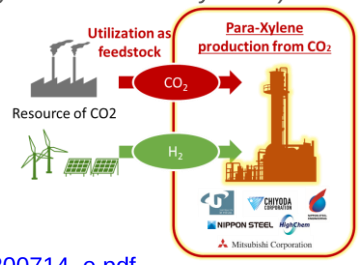


https://www.chiyodacorp.com/media/220513_e.pdf

Para-xylene（Polyester clothes/plastic bottles）

◆ Para-xylene production from CO_2 and H_2

- Para-xylene is essential to manufacture polyester clothes and drink bottles
- R&D stage in NEDO project (July 2020 – February 2024)
- Partnership with University of Toyama, Nippon Steel Engineering Co., Ltd., Nippon Steel Corporation, HighChem Company Ltd. and Mitsubishi Corporation



NEDO project scope

https://www.chiyodacorp.com/media/200714_e.pdf

Carbonate（Concrete）

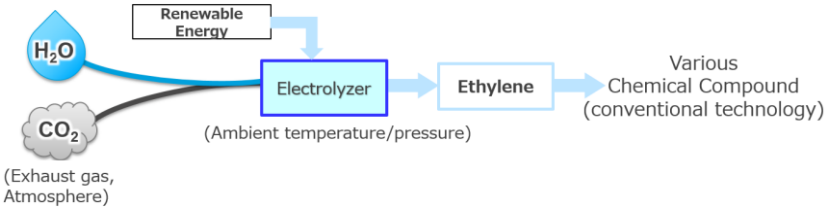
◆ Technology by Blue Planet (a start-up company in the USA).
◆ Chiyoda has entered into an MOU with Blue Planet and Mitsubishi Corporation.
◆ Chiyoda participates in a demonstration project in the USA, providing technical support and accelerating commercialization.

https://www.chiyodacorp.com/media/210205_e.pdf

Ethylene

◆ Ethylene production from CO_2 + H_2O by Integrated Electrochemical Systems.

- Reaction under ambient pressure/temperature
- Ethylene can be made into chemical products such as e-fuel.
- R&D stage in NEDO Moonshot Research & Development Program (July 2020 – March 2030)



https://www.chiyodacorp.com/media/200909_e.pdf

NEDO: the New Energy and Industrial Technology Development Organization
Blue Planet: Blue Planet Systems Corporation
MOU: Memorandum Of Understanding

3. Post Combustion CO_2 Capture for Gas Turbine (R&D)

- Solid sorbent material for low cost CO2 separation and recovery from gas turbines.
- Bench tests and demonstrations to establish low cost processes and lead to early social implementation.
- Funded by NEDO.

Organization

Chiyoda Corporation, JERA Co. Inc.,
The Research Institute of Innovative Technology for the Earth (RITE)

Project Period

Fiscal year 2022～2031 (Nine years)

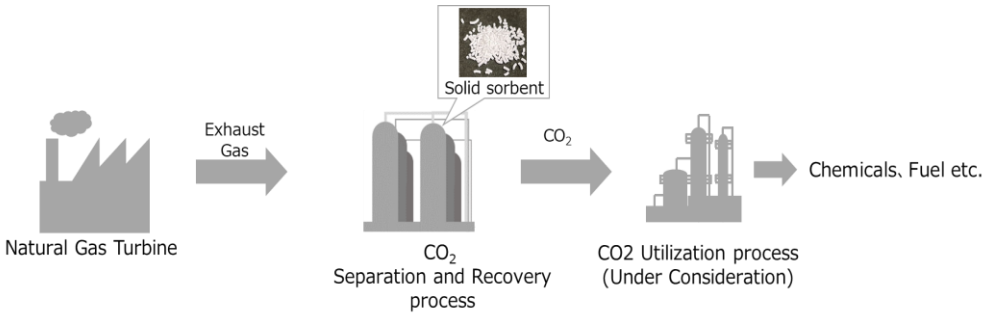
Project Scale

☐ Project scale ：Approximately 10.1 billion yen
☐ Support scale* ：Approximately 8.7 billion yen
* Including incentives. This is subject to change depending on the project progress.
☐ Subsidy rate ：Consignment → 2／3 grant (Incentive 10%)

Scope

Solid sorbent RITE Research Institute of Innovative Technology for the Earth
Process CHIYODA CORPORATION
Pilot test jera

2022	2024	2026	2030
	▼Stage gate 1 ▼Stage gate 2		
Solid Sorbent Development			
- Solid sorbent development - Laboratory test	Bench Test - Performance confirmation - Engineering data acquisition		
		Demonstration	
			Overall system study and long term operation demonstration

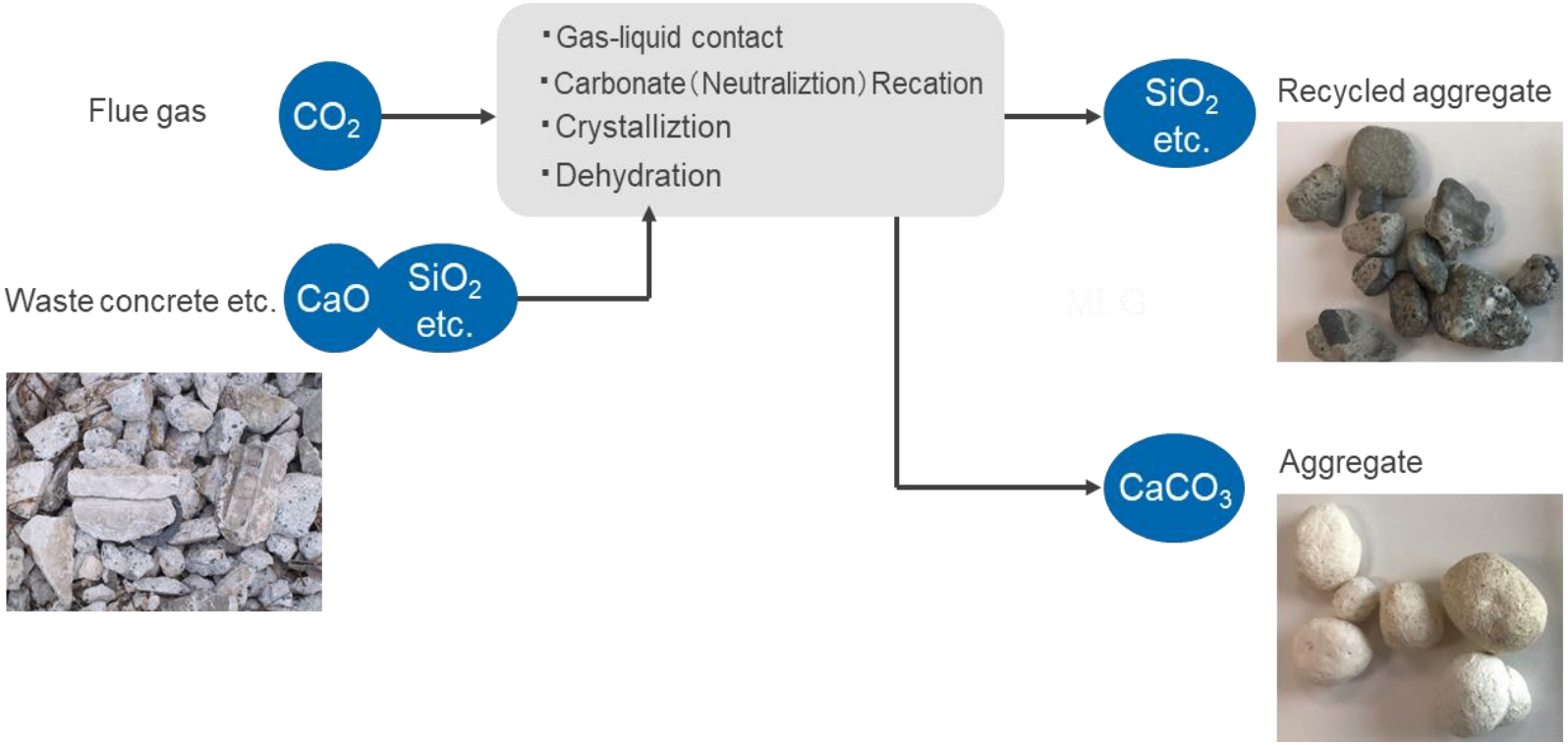


Conceptual image of CO_2 separation and recovery process from natural gas combustion exhaust gas

Press Release: https://www.chiyodacorp.com/media/220513_e.pdf

4. Mineralization (R&D)

- CO_2 is sequestrated as the mineral, $CaCO_3$.
- MOU signed with Blue Planet Systems Corporation (a start up company that owns technology in the USA) and Mitsubishi Corporation
- Joint demonstration is ongoing in the USA

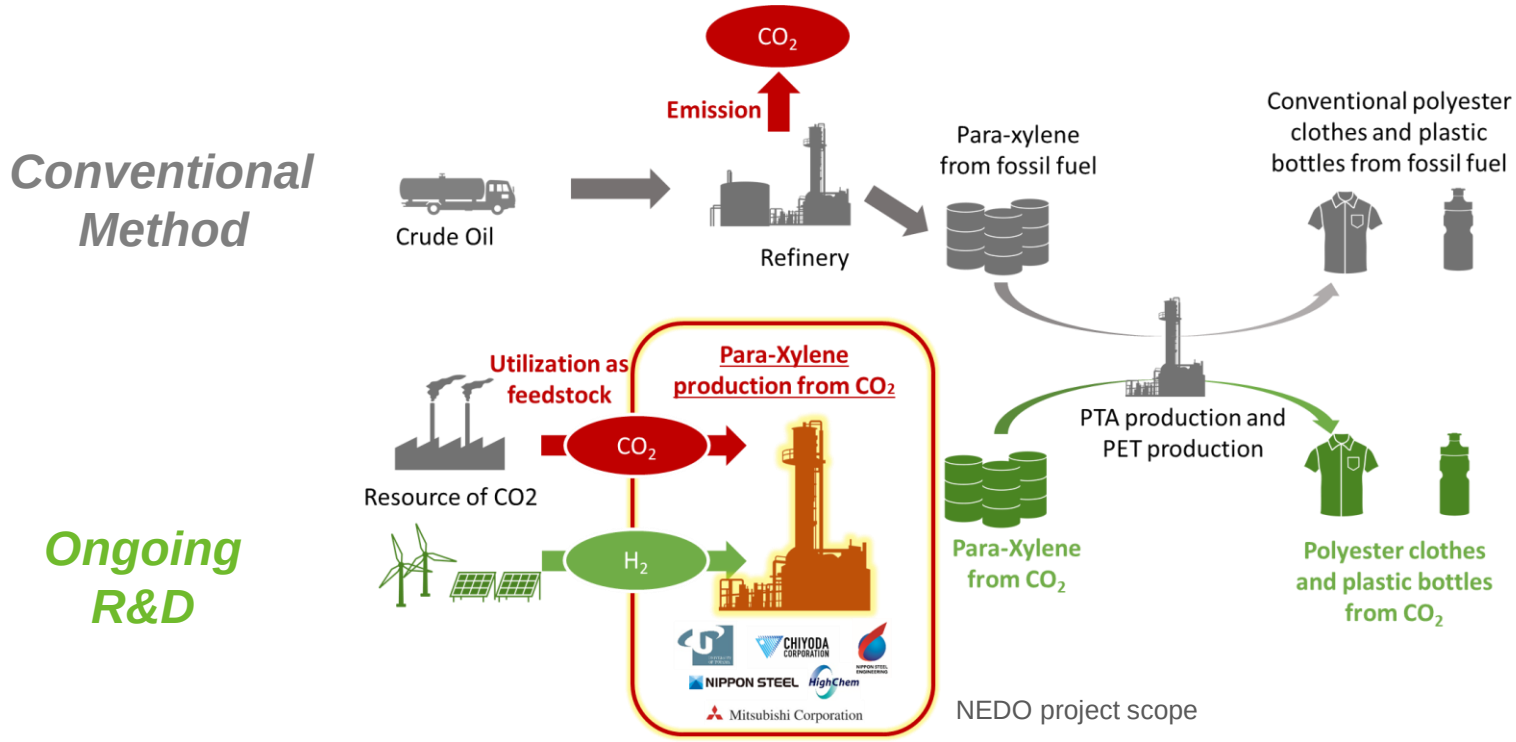


Press Release: https://www.chiyodacorp.com/media/210205_e.pdf

SiO_2: Silicon Dioxide, $CaCO_3$: Calcium Carbonate, CaO: Calcium Oxide

5. Para-xylene Synthesis (R&D)

- Para-xylene synthesis from CO_2 and H_2 (e-PX) to substitute existing fossil fuel-derived chemicals.
- This R&D project is fully funded by NEDO. (Duration: July 2020 to February 2024). Partnership with University of Toyama, Nippon Steel Engineering Co., Ltd., Nippon Steel Corporation, HighChem Company Ltd. and Mitsubishi Corporation
- Started pilot plant operation from March 2022.



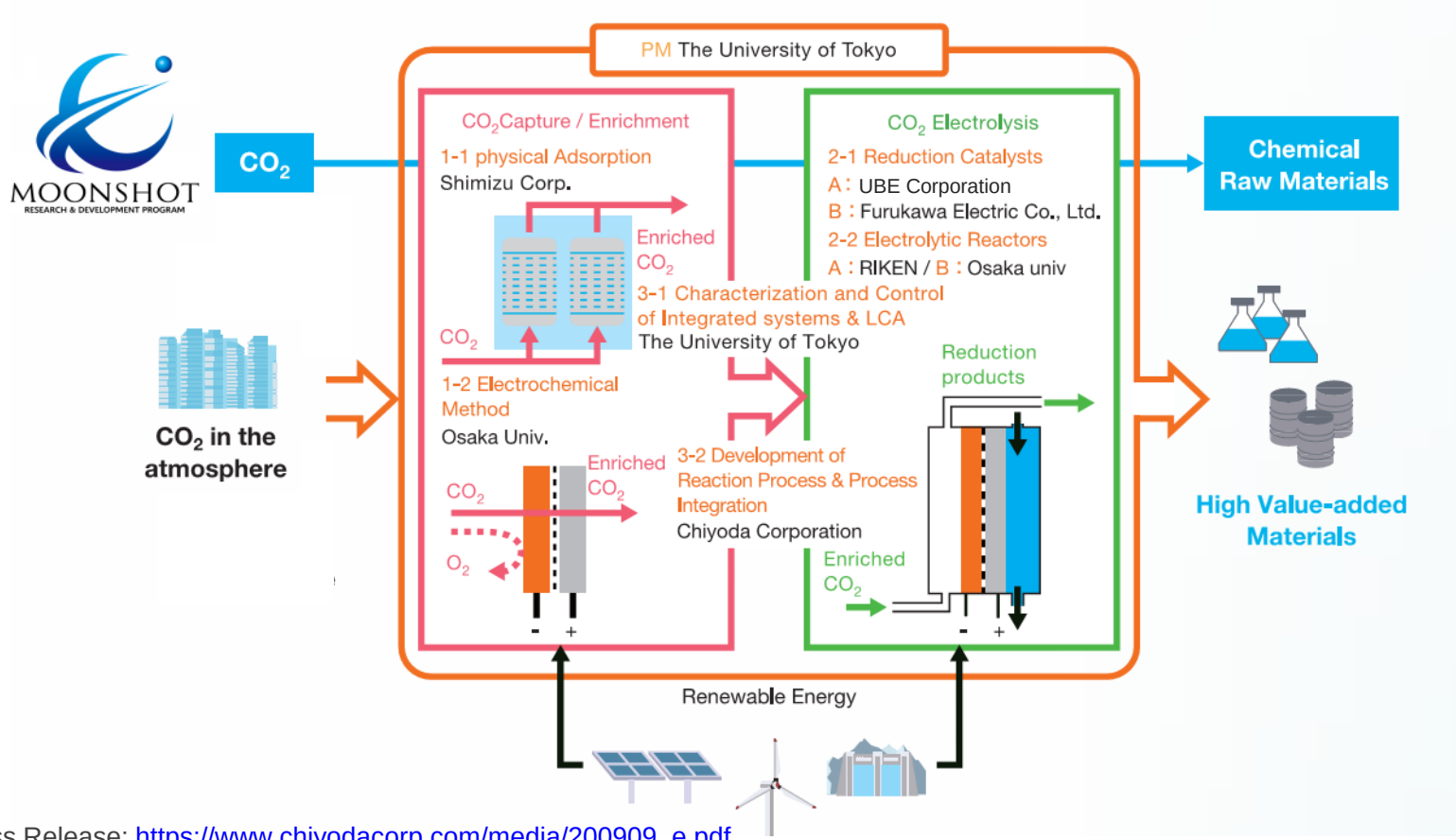
Press Release: https://www.chiyodacorp.com/media/200714_e.pdf

e-PX: Para-Xylene from CO_2 and H_2

PTA: Pure Terephthalic Acid
PET: Poly Ethylene Terephthalate

6. Ethylene Electrochemistry Synthesis (R&D)

- Ethylene production from CO_2 + H_2O by Integrated Electrochemical Systems.
- Funded by NEDO Moonshot Research & Development Program
- Duration: Maximum 10 years from August 2020

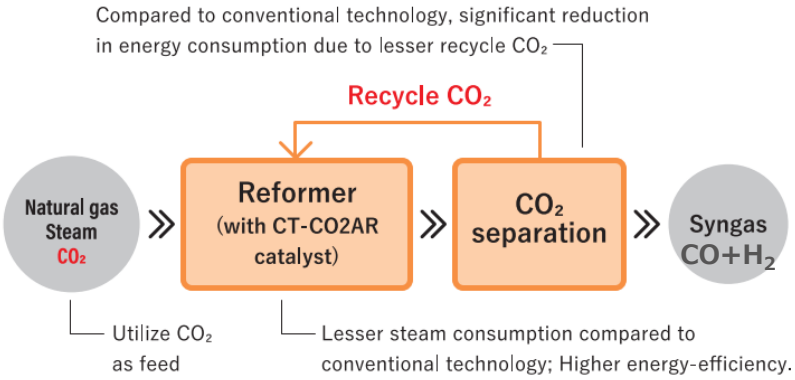


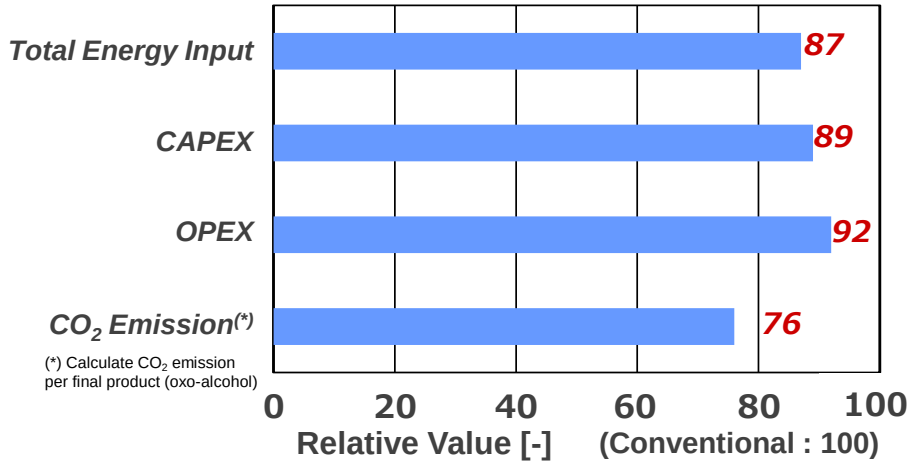
Press Release: https://www.chiyodacorp.com/media/200909_e.pdf
URL (Project) : https://www.innovation-riken.jp/moonshotPJ00/

7. Reformer [CT-CO2AR™] using CO_2 as Feedstock (Commercialized)

- Chiyoda has commercialized a reforming catalyst using less H_2O and CO_2 as feedstock
- Synthesis gas with wide range of H_2/CO ratio can be produced.
- This Chiyoda technology is currently being used by a chemical company in Japan.

Conceptual Diagram of CT-CO2AR





By adjusting CH_4/H_2O and CH_4/CO_2 ratios in the reformer feed, synthesis gas with a wide range of H_2/CO ratios can be produced.

Example: H_2/CO=1.0 for chemicals (ex. oxo-alcohol)
H_2/CO<1.0 for carbon monoxide (ex. as a feedstock of acetic acid)

When the H_2/CO ratio =1.0 (for oxo-alcohol production), CO2 emissions are reduced by 24%.

https://www.chiyodacorp.com/jp/service/gtl/co2-reforming/

https://www.youtube.com/watch?v=f6TtfF_vm-E

Thank you