

NEDO-NSTDA 3rd Webinar

Introduction to Chiyoda's Carbon Recycling Activities

Chiyoda Corporation



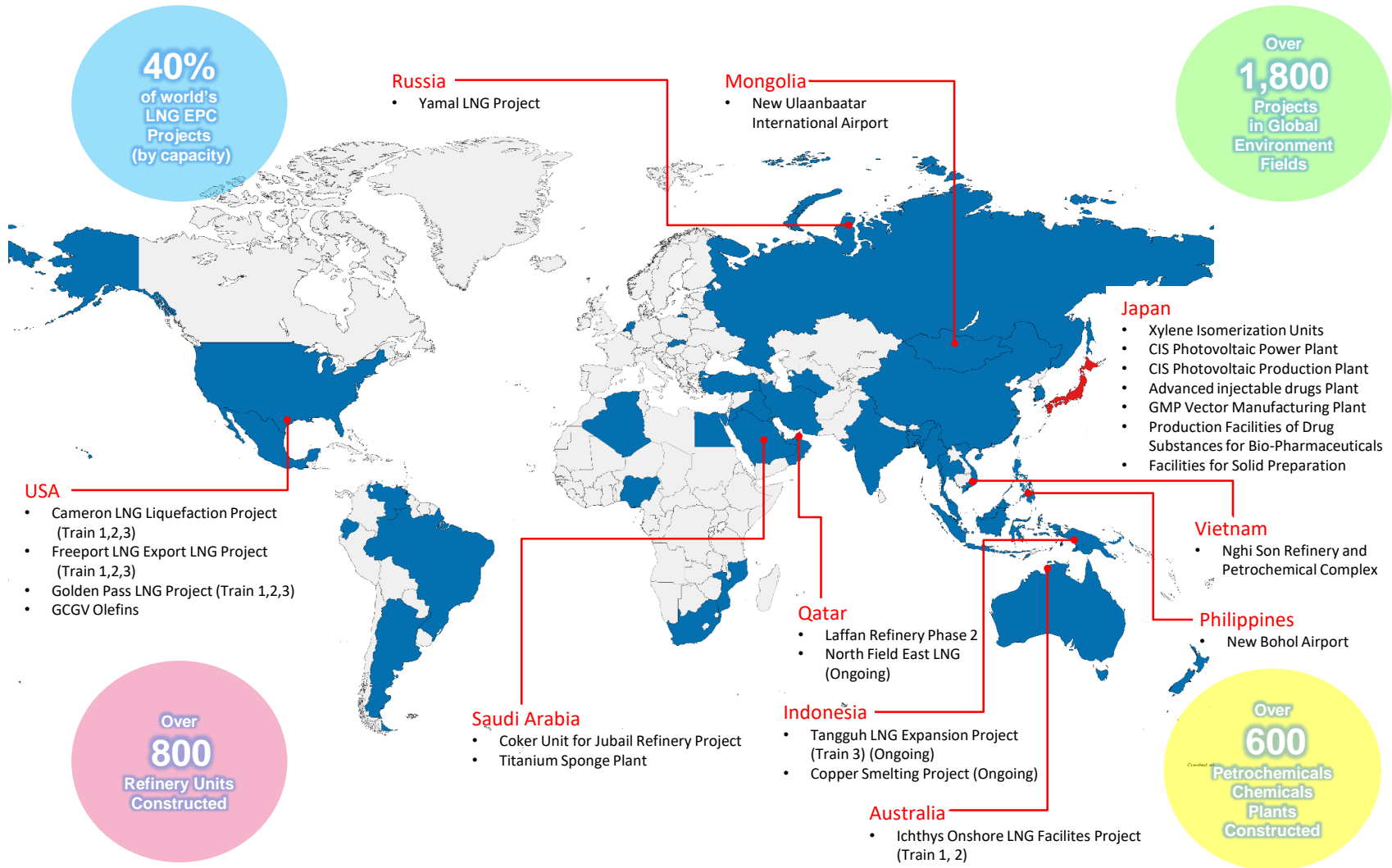
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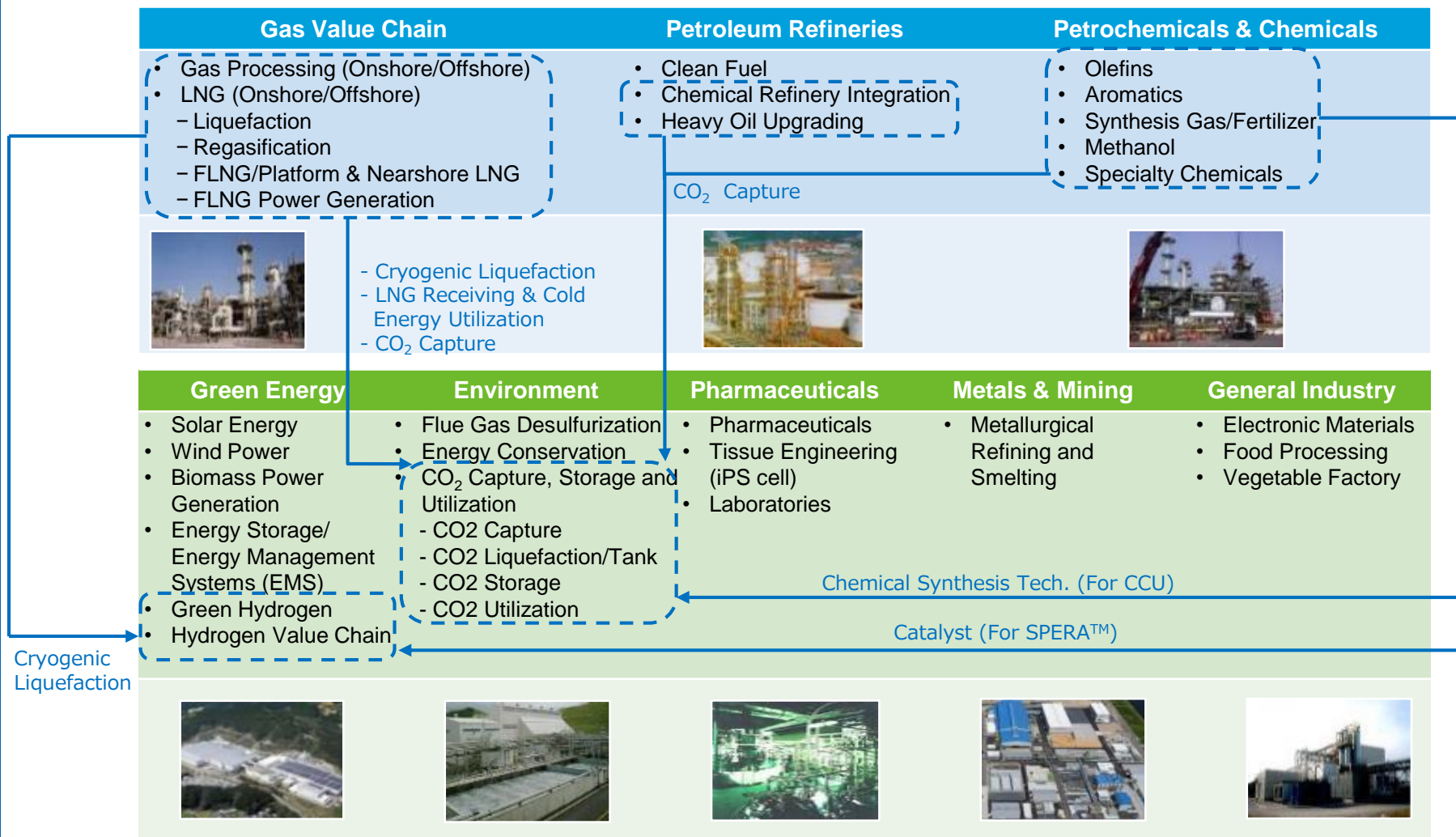
1. Introduction of Chiyoda
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1. Introduction of Chiyoda

Chiyoda's Project Foot Prints

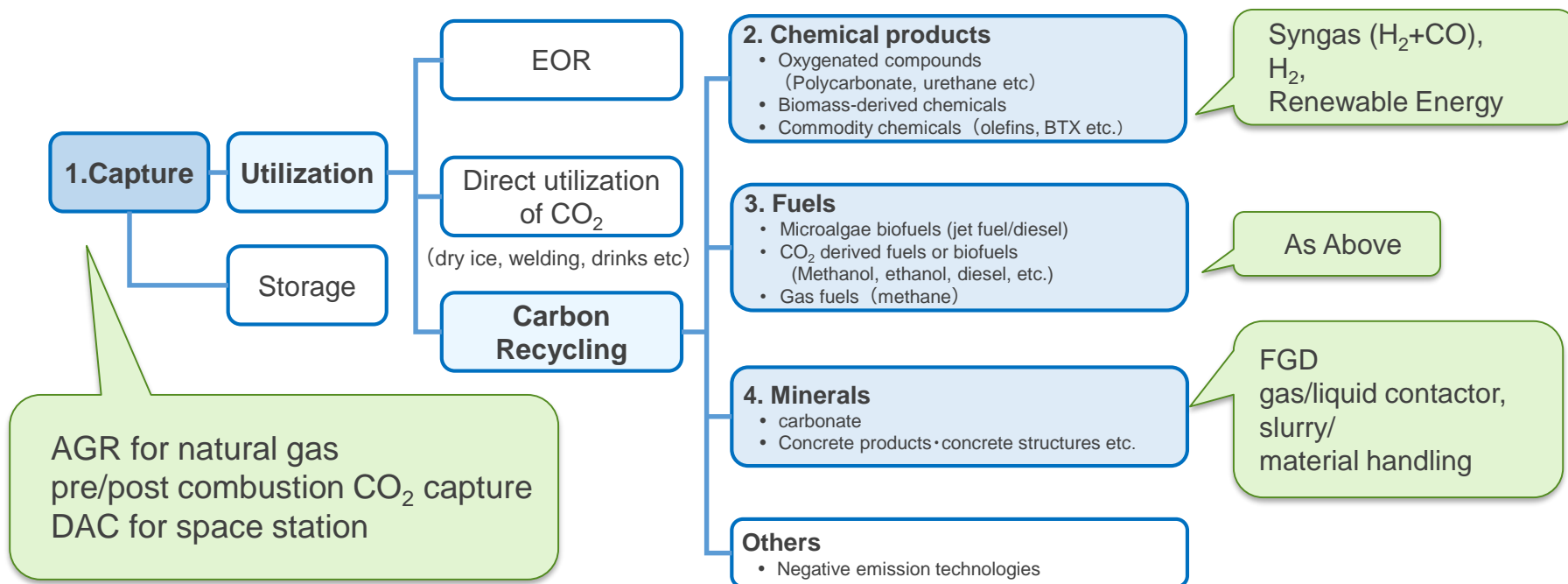


Current Business Portfolio



2. Chiyoda's Carbon Recycling Activities

Classification of Carbon Recycling Technologies



【Records & Base Technology】

- CO₂ Capture
- Syngas, Hydrogen
- Renewable Energy
- FGD (Chiyoda Technology)



【Synergy with Carbon Recycling】

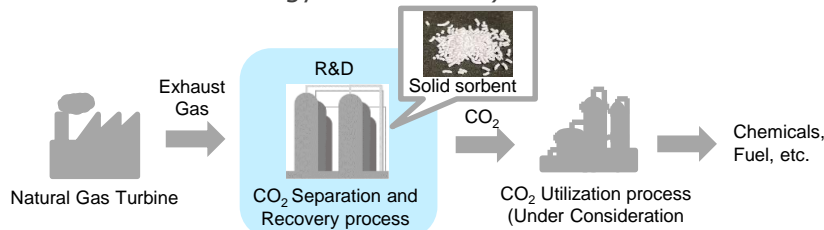
- Chemical products & fuels have synergy with syngas, H₂ and renewable energy
- Minerals has synergy with FGD

Chiyoda's Carbon Recycling Activities (Summary)

- Chiyoda's Carbon Capture and Utilization (CCU) business from CO₂ capture to utilization.
- Chiyoda is aiming to establish a Carbon Recycle Supply Chain in the near future.

CO₂ Capture

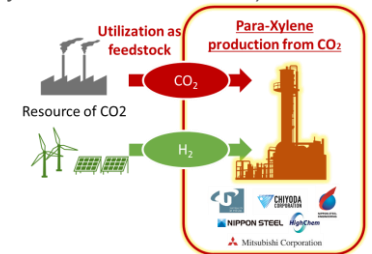
- ◆ Large-scale CO₂ separation and recovery from gas-fired power generation exhaust gas
- R&D stage in NEDO's Green Innovation Fund project (FY2022–2030)
- Partnership with JERA Co. Inc., RITE (The Research Institute of Innovative Technology for the Earth)



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

Para-xylene (Polyester clothes/plastic bottles)

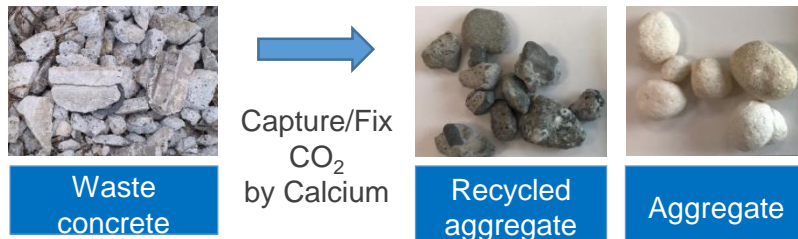
- ◆ Para-xylene production from CO₂ and H₂
- Para-xylene is essential to manufacture polyester clothes and drink bottles
- R&D stage in NEDO project (July 2020 – March 2024)
- Partnership with University of Toyama, Nippon Steel Engineering Co., Ltd., Nippon Steel Corporation, HighChem Company Ltd. and Mitsubishi Corporation



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

NEDO project scope

Carbonate (Concrete)

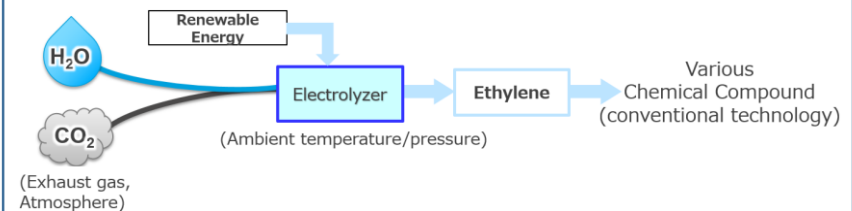


- ◆ Technology by Blue Planet (a start-up company in the USA).
- ◆ Chiyoda has entered into an MOU with Blue Planet and Mitsubishi Corporation.
- ◆ Chiyoda participates in a demonstration project in the USA, providing technical support and accelerating commercialization.

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

Ethylene

- ◆ Ethylene production from CO₂ + H₂O 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

Post Combustion CO₂ 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 (Green Innovation Fund project).

Organization

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

Project Period

Fiscal year 2022~2030 (Nine years)

Scope

Solid sorbent **Process** **Pilot test**



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

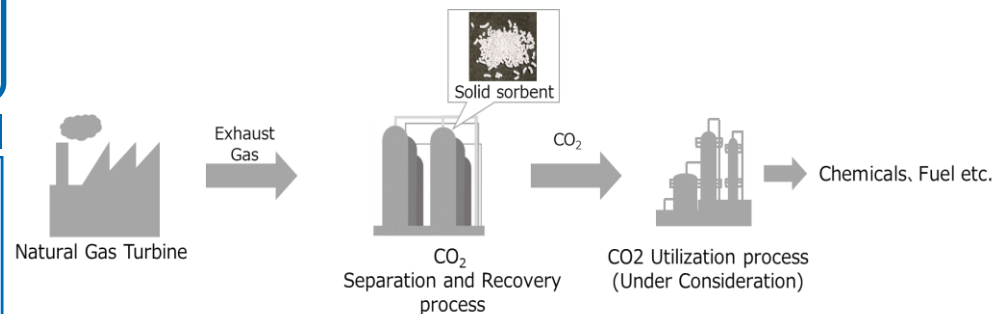
Overall system study and long term operation demonstration

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%)

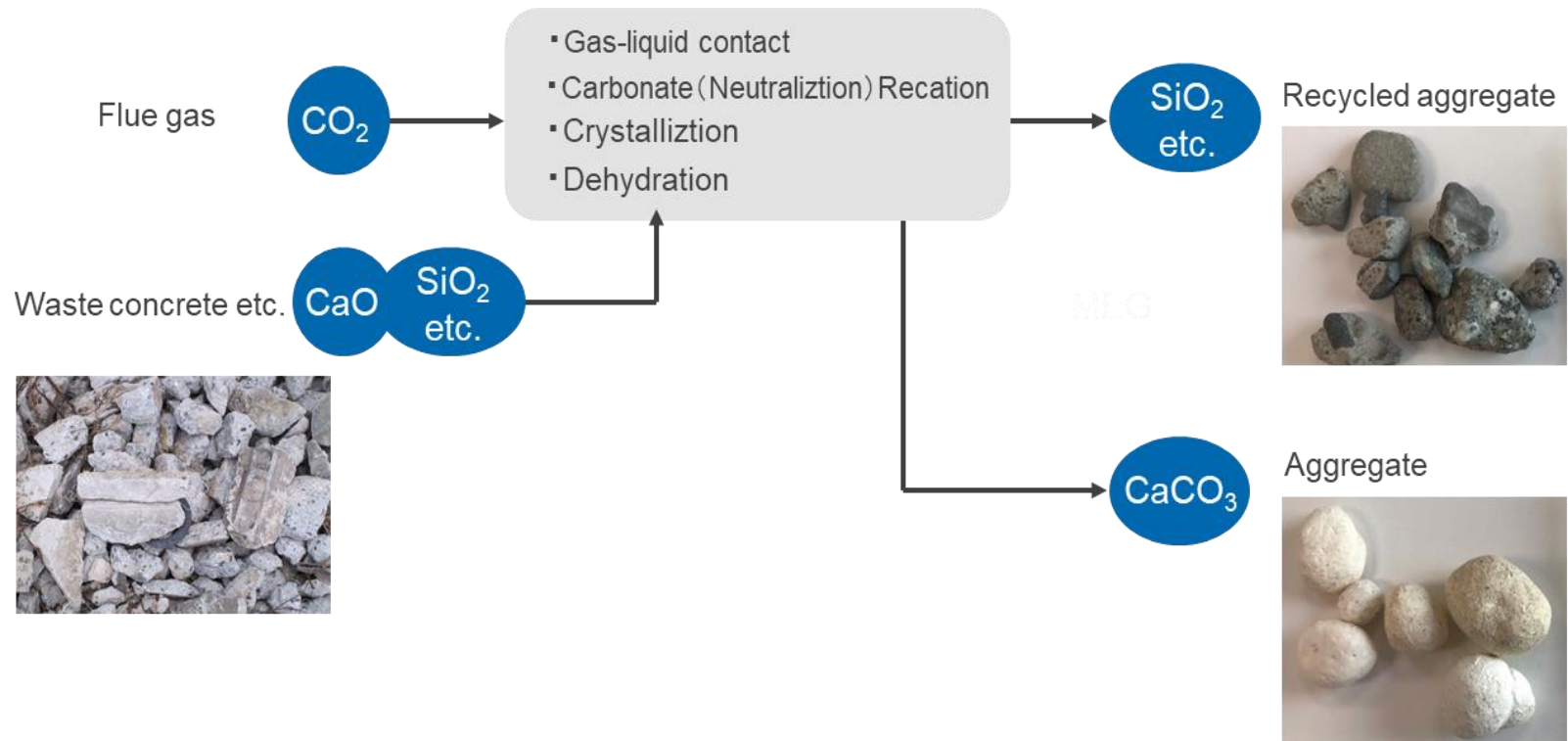


Conceptual image of CO₂ separation and recovery process from natural gas combustion exhaust gas

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

Mineralization (R&D)

- CO₂ is sequestrated as the mineral, CaCO₃.
- 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



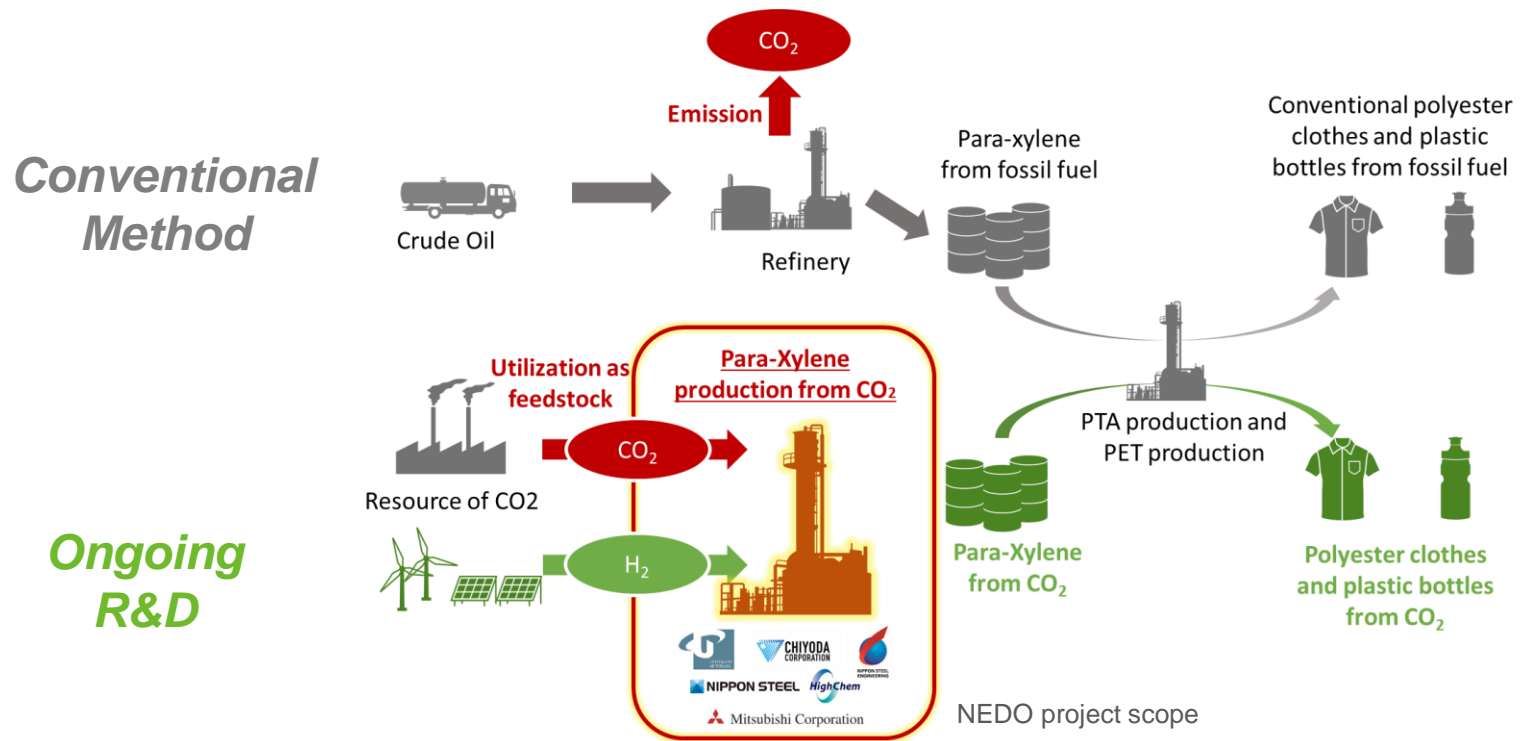
Press Release: https://www.chiyodacorp.com/media/210205_e.pdf

SiO₂: Silicon Dioxide, CaCO₃: Calcium Carbonate, CaO: Calcium Oxide

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Para-xylene Synthesis (R&D)

- Para-xylene synthesis from CO₂ and H₂ (e-PX) to substitute existing fossil fuel-derived chemicals.
- This R&D project is fully funded by NEDO. (Duration: July 2020 to March 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.



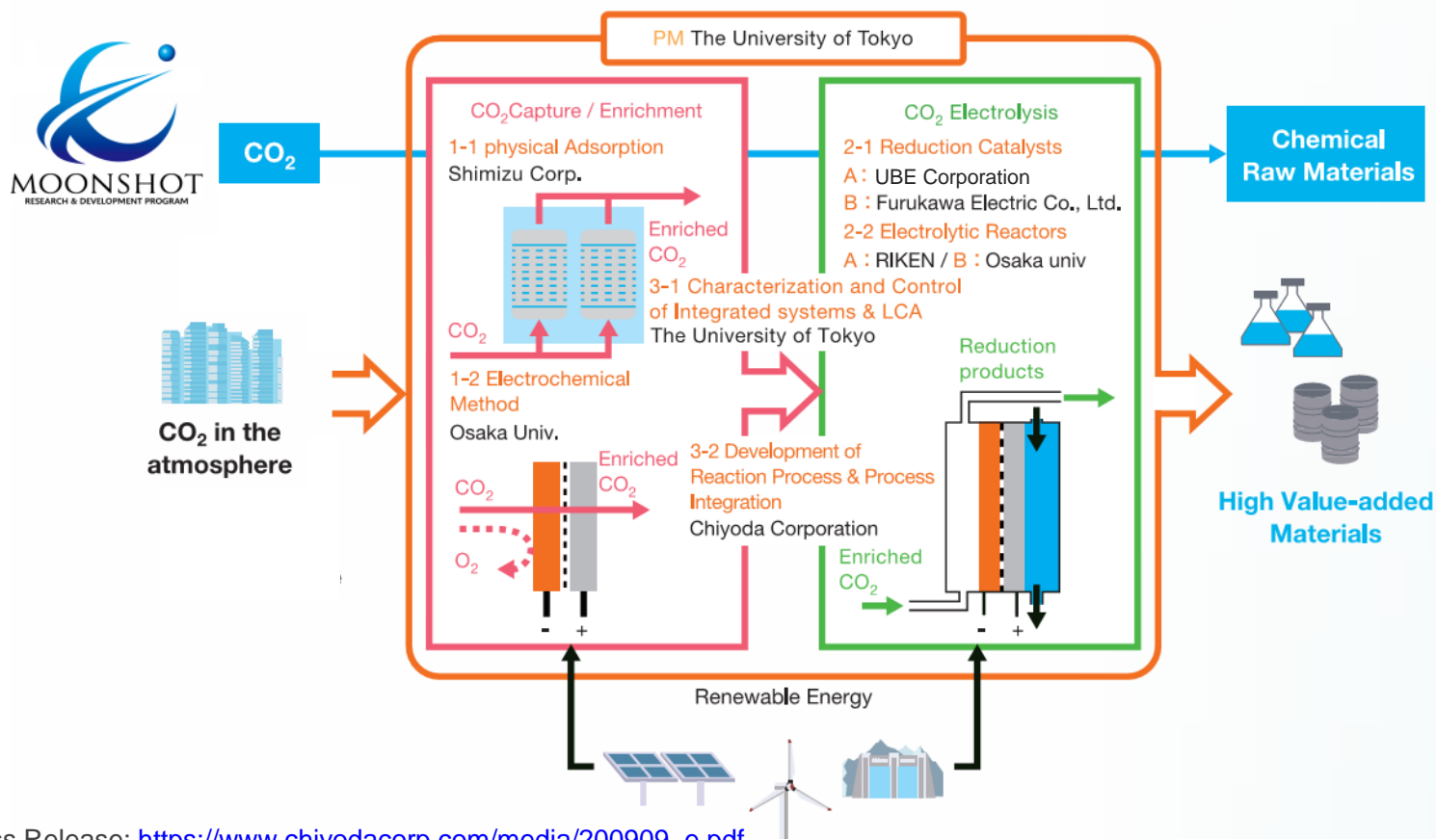
Press Release: https://www.chiyodacorp.com/media/200714_e.pdf

e-PX: Para-Xylene from CO₂ and H₂

PTA: Pure Terephthalic Acid
PET: Poly Ethylene Terephthalate

Ethylene Electrochemistry Synthesis (R&D)

- Ethylene production from $\text{CO}_2 + \text{H}_2\text{O}$ by Integrated Electrochemical Systems.
- Funded by NEDO Moonshot Research & Development Program
- Duration: Maximum 10 years from August 2020



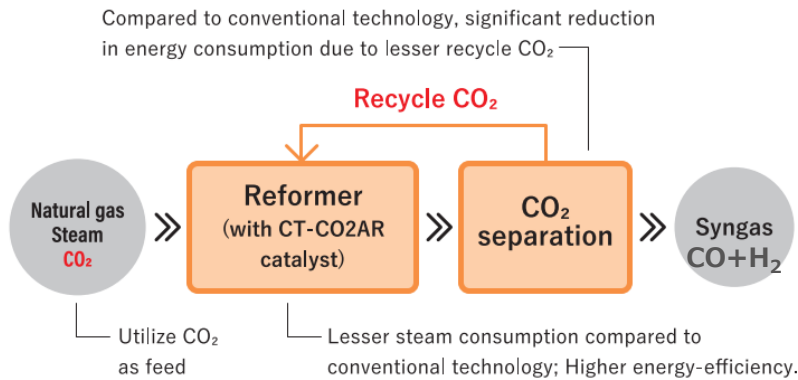
Press Release: https://www.chiyodacorp.com/media/200909_e.pdf

URL (Project) : https://www.innovation-riken.jp/moonshotPJ00_en/

Reformer [CT-CO2AR™] using CO₂ as Feedstock (Commercialized)

- Chiyoda has commercialized a reforming catalyst using less H₂O and CO₂ as feedstock
- Synthesis gas with wide range of H₂/CO ratio can be produced.
- This Chiyoda technology is currently being used by a chemical company in Japan.

Conceptual Diagram of CT-CO2AR

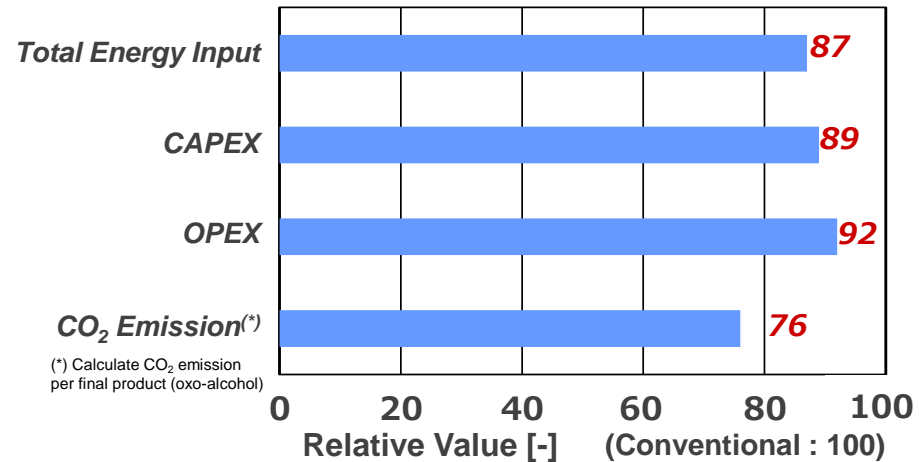


By adjusting CH₄/H₂O and CH₄/CO₂ ratios in the reformer feed, synthesis gas with a wide range of H₂/CO ratios can be produced.

Example: H₂/CO=1.0 for chemicals (ex. oxo-alcohol)
 H₂/CO<1.0 for carbon monoxide
 (ex. as a feedstock of acetic acid)

<https://www.chiyodacorp.com/en/service/gtl/co2-reforming/>

https://www.youtube.com/watch?v=f6Ttf_vm-E



When the H₂/CO ratio =1.0 (for oxo-alcohol production), CO₂ emissions are reduced by 24%.

3. Chiyoda's Activities in Thailand

Chiyoda's activities in Thailand

MOU for development of CCUS technologies at Coal-Fired Power Plant

- Location: Rayong, Thailand
- Collaboration among BLCP Power Limited, Mitsubishi Corporation and Chiyoda
- Plan to conduct Feasibility Study for lowering carbon emissions at BLPC's coal-fired power plant, particularly in developing technologies that produce carbon-dioxide-derived chemical and fuels.



MOU signing ceremony at the 5th JTEPD

Chiyoda's activities in Thailand

MOU for the development of Clean Hydrogen/ Ammonia Value Chain

- Location: Southern provinces of Thailand
- Collaboration among EGAT, Mitsui O.S.K Lines, Mitsubishi Thailand Limited and Chiyoda
- Plan to conduct Feasibility Study for the value chain of clean hydrogen/ ammonia including the production, storage, transportation and utilization.



Photo at AZEC Ministerial Meeting

Chiyoda's activities in Thailand

Links (Videos) for more detail about CCUS and Hydrogen

Chiyoda's solution

<https://www.chiyodacorp.com/en/service/>

CO₂ Utilization Catalyst for the Sustainable Future: CT-CO2AR

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

Chiyoda's Way for Future LNG

<https://www.youtube.com/watch?v=GzgGRIHmtfA>

SPERA Hydrogen PV_202006

<https://www.youtube.com/watch?v=4umkve6kAAk>

For more information, please contact us through

- [CHIYODA CORPORATION](https://www.chiyodacorp.com) (our website)
- gx-asia-bd@chiyodacorp.com (E-mail address)

Thank you



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