The 42nd JCCP International Symposium

# Chiyoda Solutions and Technology Development for realizing Carbon Neutrality

**MORIKAMI Satoshi**

**General Manager, Technology Development Department**

**Chiyoda Corporation / Japan**

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# Company Profile

## Corporate Philosophy

Enhance our business in aiming for harmony between energy and the environment and contribute to the sustainable development of a society as an integrated engineering company through the use of our collective wisdom and painstakingly developed technology.

## Business Vision

**— A Grand Opportunity for the Future —**

The Chiyoda Group is committed to being an "Innovative" Engineering Company, shaping the future of energy and the global environment with passion and cutting-edge technology.

### Revenues by Overseas/Domestic

Overseas : 62% Domestic : 38%

### Revenues

311.1 Billion JPY

(Consolidated Fiscal Year 2021)

### Revenues composition by Category


### Project Achievement

Over 60 Countries in the World

### Established

1948 Year

### Number of Employees

(Including Consolidated and Equity Method Companies)

5,061 People

(March 2022)

# Chiyoda's Philosophy

Chiyoda has provided pioneering engineering solutions for each generation since 1948, and under the current philosophy 'Energy and Environment in Harmony', continues our vision of 'serving society through technology'.

From Coal to Oil, Oil to Gas, Gas to Renewables and New Energy

**1948–1970** **1971–1990** **1991–2000** **2001–2010** **2011–2020** **2030**


**1960**
Mitsubishi Oil Co., Ltd.
Mizushima grassroots refinery


**2004**
LNG plants for Qatargas Operating Company Limited


**1973**
Flue-gas desulphurization unit in Sendai, Japan


**2018**
World's largest battery power storage system project in Hokkaido, Japan


**2015-2020**
World's first global hydrogen supply chain demonstration project

**Mirai Engineering**


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# Chiyoda solutions for realizing Carbon Neutral Society

## Various approaches to contribute on sustainable society

### Carbon Capture

- Pre/post-combustion capture facilities
- $CO_2$ Capture by Solid absorbent
- Direct Air Capture for space station

### CCU Chemicals

- $CO_2$ Reforming (CT-$CO_2$AR)
- $CO_2$ to Mineral
- $CO_2$ to Para-Xylene
- $CO_2$ to Ethylene
  by Electrochemistry Synthesis

***Energy and Environment in Harmony***

### Carbon Free Fuel

- SPERA Hydrogen Supply Chain
- Liquified H2
- Ammonia
- e-Fuel
- e-Methane


### Energy Management

- Energy as a Service (EaaS)
- Virtual Power Plants (VPP)
- Improve productivity of facility/plant
- Battery storage & supply and demand balance for future renewable energy

### Digital Transformation

- EFEXIS™(Engineering x Digital)
- LNG Plant AI Optimizer
- FCC AI Optimizer
- PlantStream


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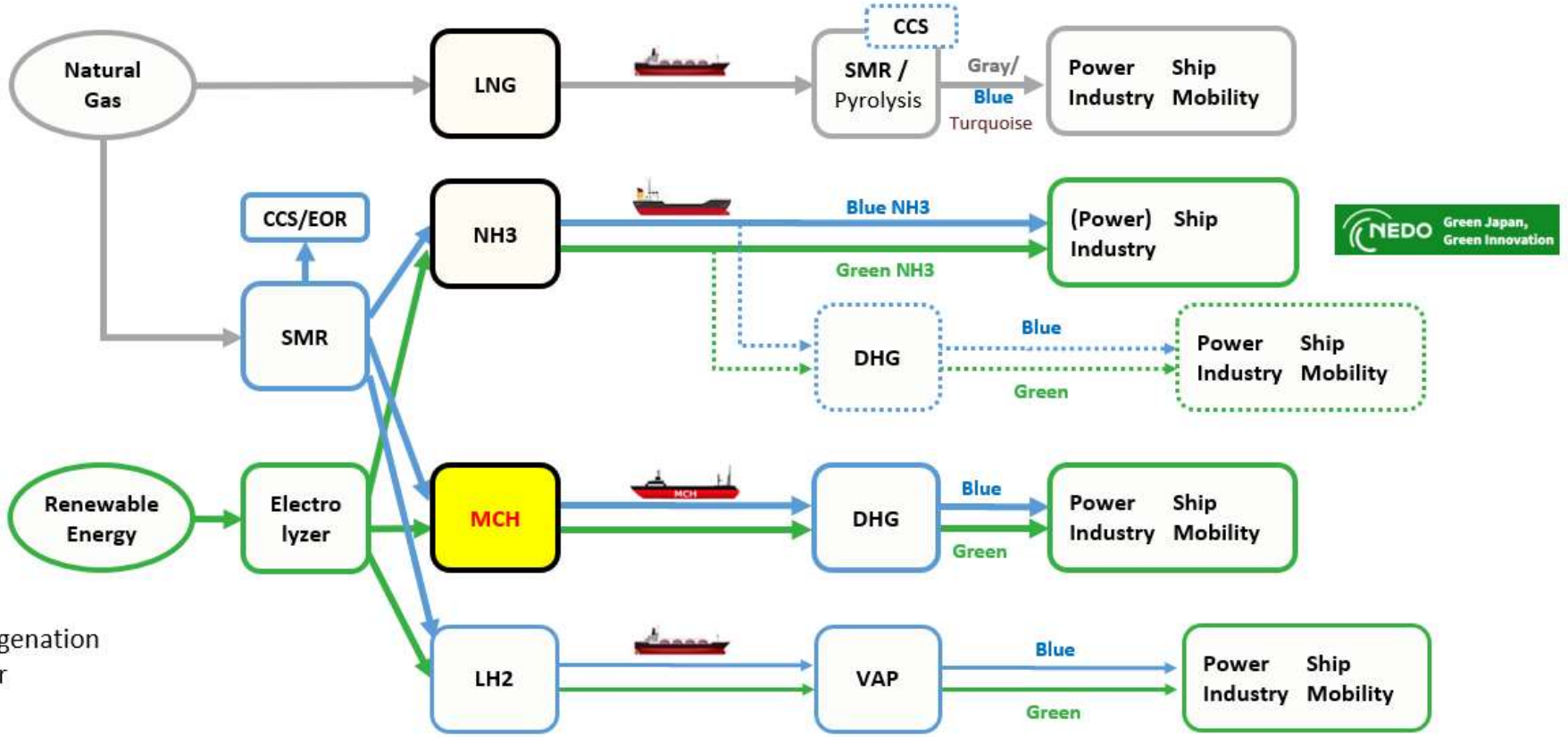
# Landscape of Hydrogen Carriers

For large scale global $H_2$ supply chain, methylcyclohexane (MCH) as $H_2$ carrier and direct use of ammonia ($NH_3$) are proven, realistic solution now, while Liquified $H_2$ and $NH_3$ with dehydrogenation would co-exist after 2030s.



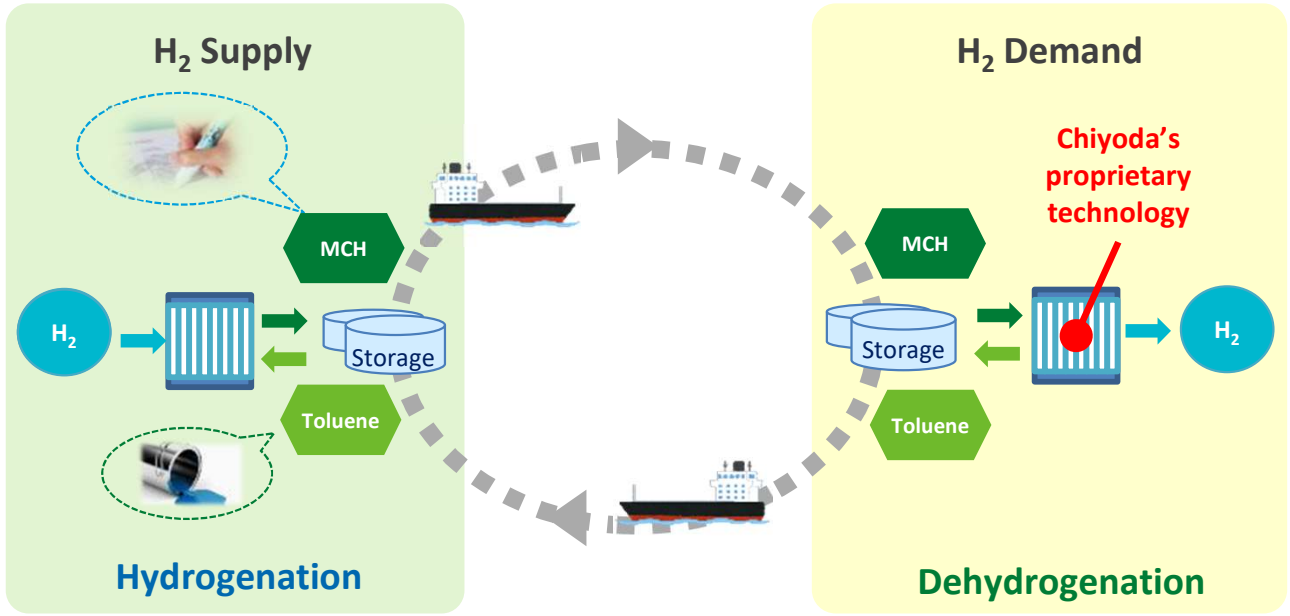

【Note】
DHG : dehydrogenation
VAP : vaporizer

# Way of Hydrogen Ocean Transportation

## - LOHC-MCH : Technology at a Glance

Chiyoda's LOHC-MCH (SPERA Hydrogen™) technology uses MCH as the hydrogen carrier in a LOHC (*) system, enabling the safe, efficient and commercially viable storage and transportation of hydrogen on a global scale.

### LOHC : Liquid Organic Hydrogen Carrier

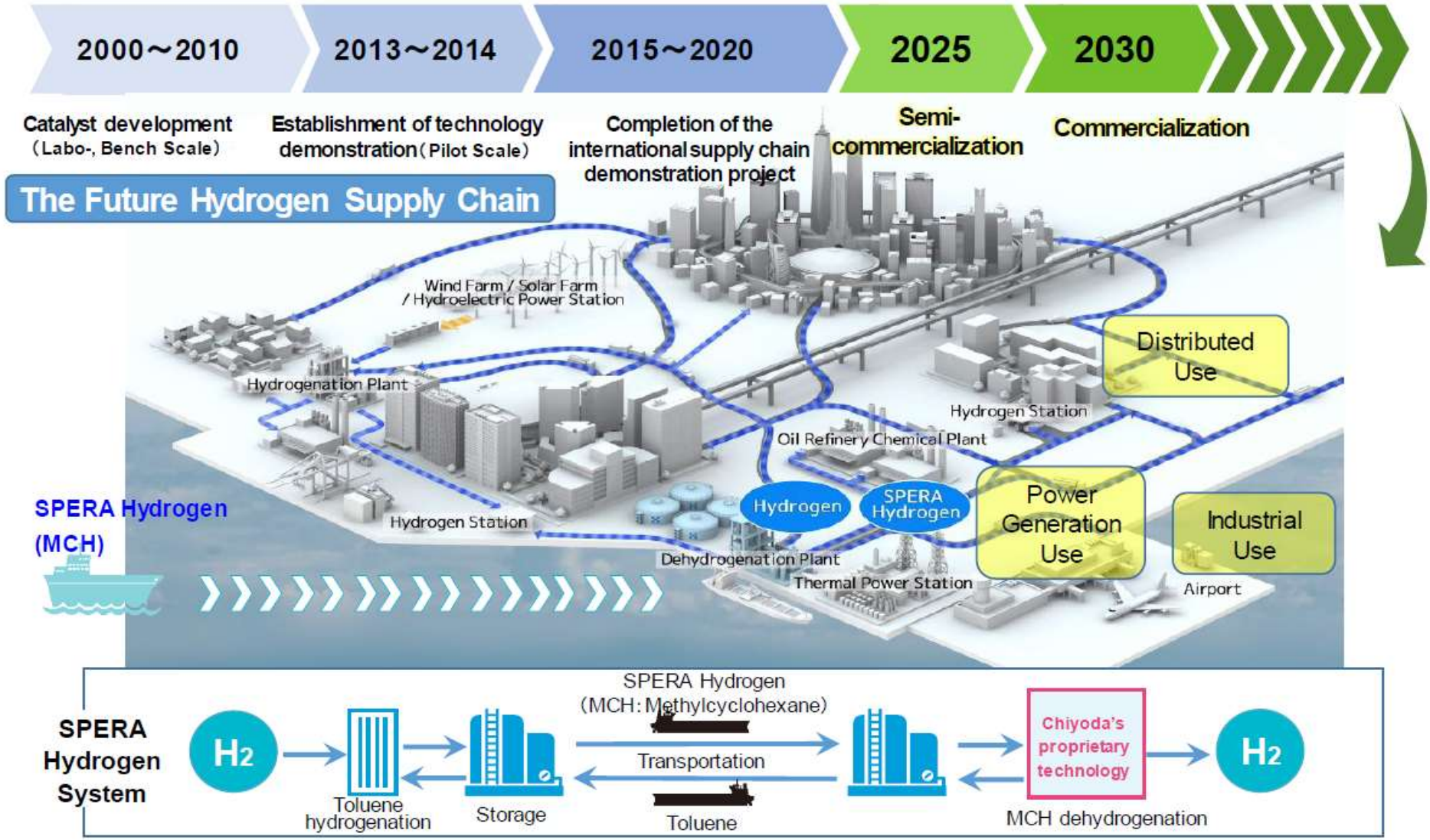



* MCH : Methylcyclohexane

### Key Features

1. **Easy to Handle**: SPERA Hydrogen, a stable liquid at ambient temperature and pressure, is as easy to handle as petroleum, and suitable for long term storage and long distance transportation.
2. **Existing Infrastructure:** Possible to repurpose, utilize existing petroleum transportation and storage facility (tanks, tanker, pipeline, tank lorry, etc.), standard and regulation, to minimize investment for $H_2$ infrastructure.
3. **Safe with Lower risk:** Safe transportation and storage that is equivalent level to petroleum products, that has already been managed in the society for long term.
4. **Circular System:** Toluene is recovered after Dehydrogenation and reused as hydrogen carrier for sustainable $H_2$ supply chain.

# Advancing from Demonstrating to Implementing the Hydrogen Value Chain - Commercializing SPERA Hydrogen™ -



# 1st Global Hydrogen Supply Chain Demonstration

Hydrogenation@Brunei

MCH Transport (Inland)

MCH Transport (Marine)


Dehydrogenation @Japan

Dehydrogenation Section

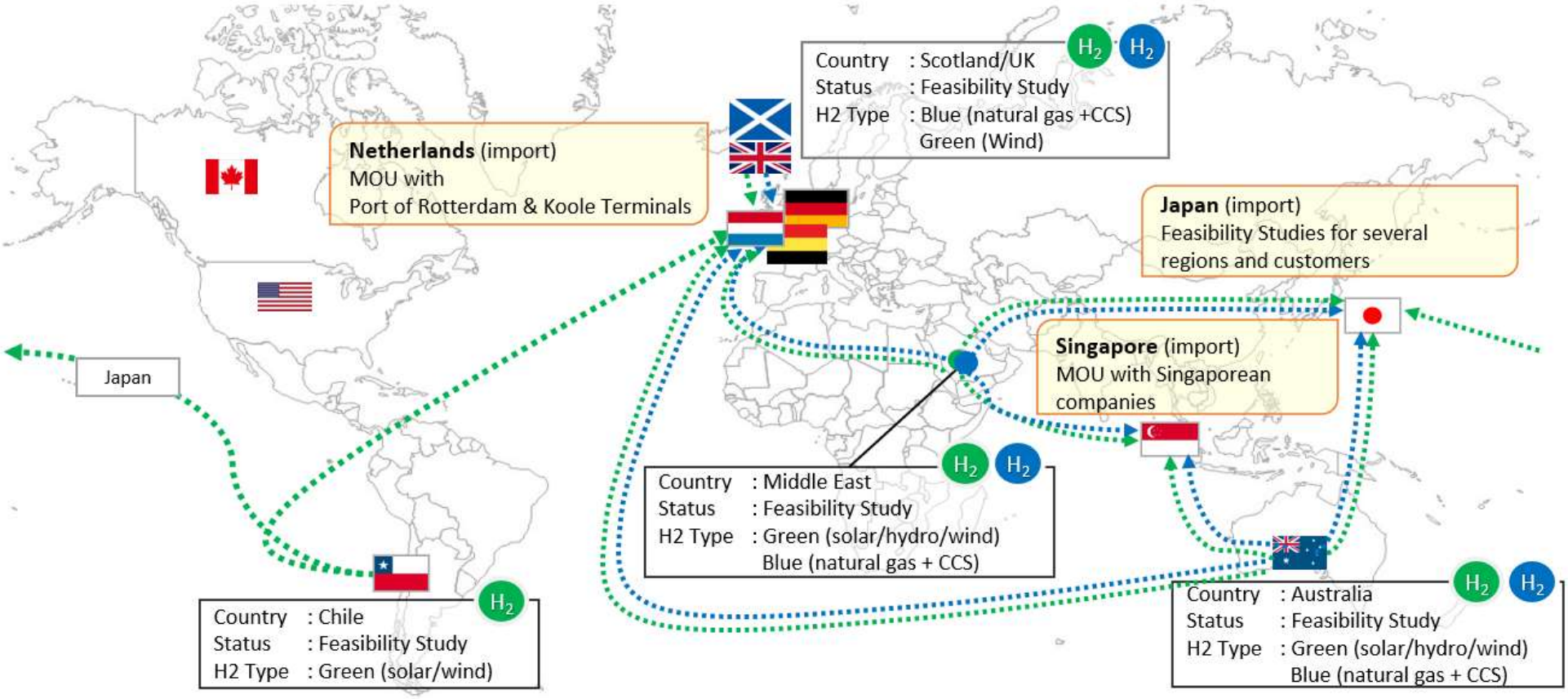
Chiyoda's proprietary catalyst

H2 mixed Power Generation


Utilize hydrogen for GT fuel from dehydrogenation as Japan's first

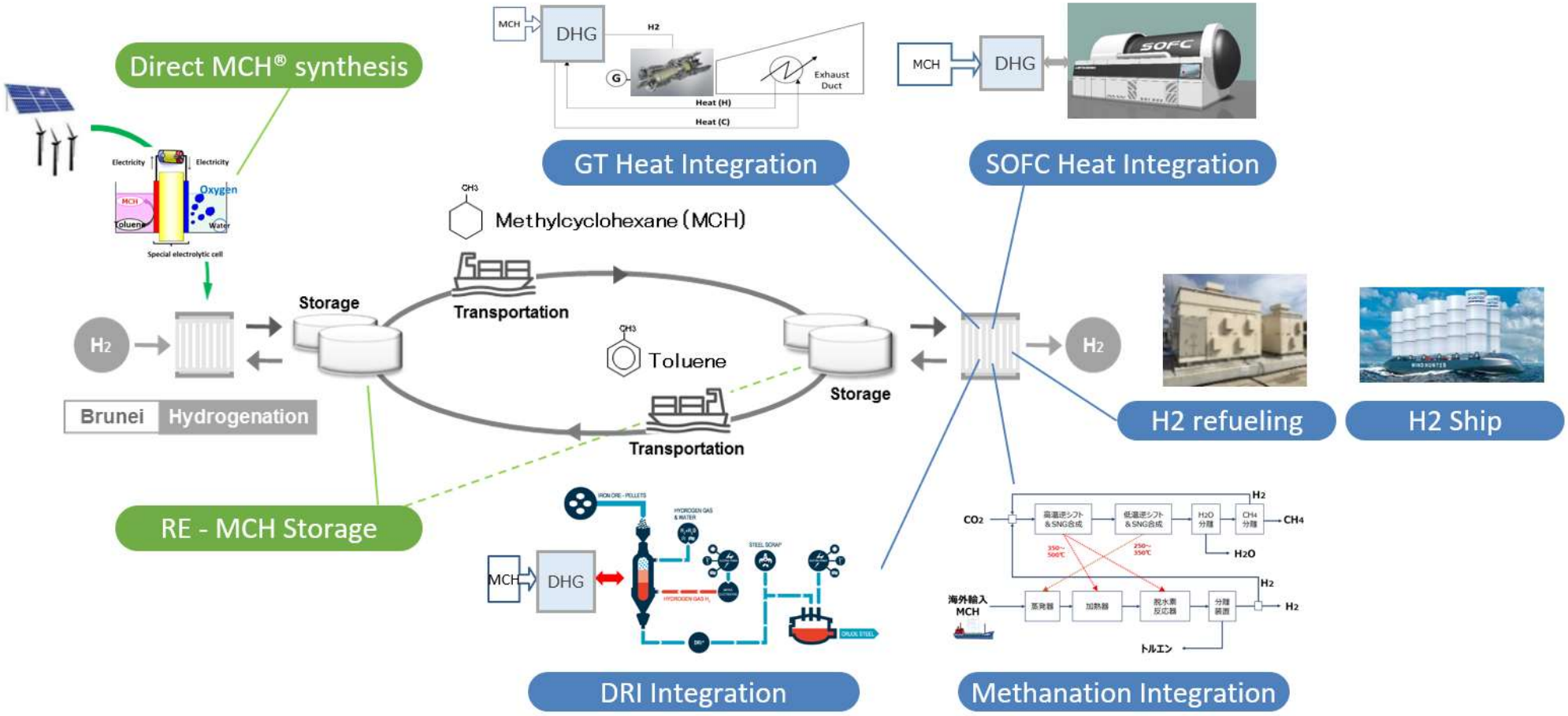
# Global H2 Supply Chain Projects

Global supply chains are fundamental for SPERA Hydrogen.
Studies/discussions are ongoing to identify cost-competitive and feasible $H_2$ supply/logistics to demand countries (ie: Europe, Singapore, Japan)



# Further MCH Technology Development

Chiyoda is further developing technologies and system integration from upstream to downstream to optimize and reduce total $H_2$ value chain cost



# Development and Demonstration of the New Ammonia Synthesis Catalysts & New Technologies for Ammonia Production

## Project for the Green Innovation Fund/Fuel Ammonia Supply Chain Establishment Project
## Reduction of Ammonia Supply Costs

### Summary

1. To develop Japanese independent ammonia synthesis technologies, based on the development of innovative catalysts, to enhance the use of ammonia through lower production costs
2. To demonstrate the developed technologies utilizing the catalysts for lower temperature and pressure synthesis process through a competitive development strategy between three (3) industry/academia teams, by bench and pilot tests with test plants scaled down from expected commercial scale plants for earlier social implementation

### Contractors

Chiyoda Corporation, Tokyo Electric Power Company Holdings, JERA Co., Inc.
(Subcontractors: Kyushu University, Kyoto University, Tsubame BHB Co., Ltd., Tokyo Institute of Technology, Nagoya University, National Institute of Technology, Numazu College)

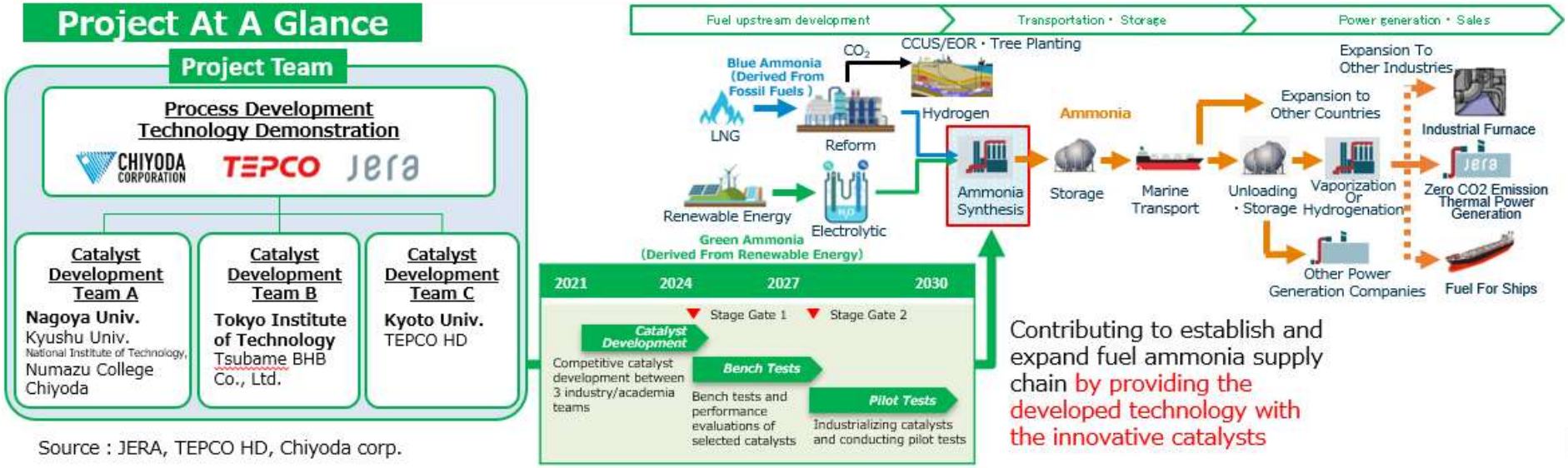
### Project Scale

Total Project Cost: Approx. 24 Billion Japanese Yen
Support Budget: Approx. 20.6 Billion Japanese Yen

### Period

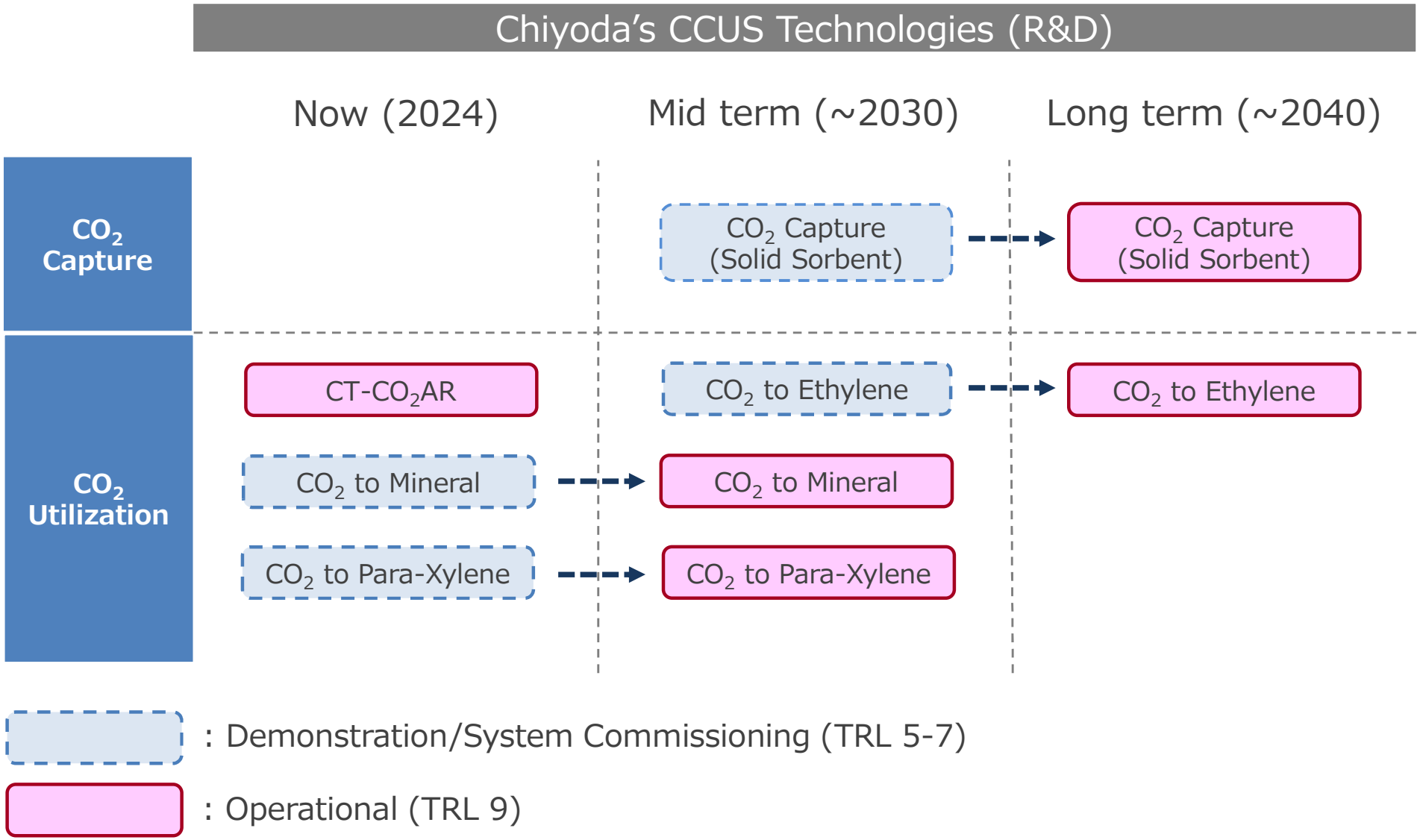
FY2021 ~ FY2030 (ten (10) years)

### Project At A Glance



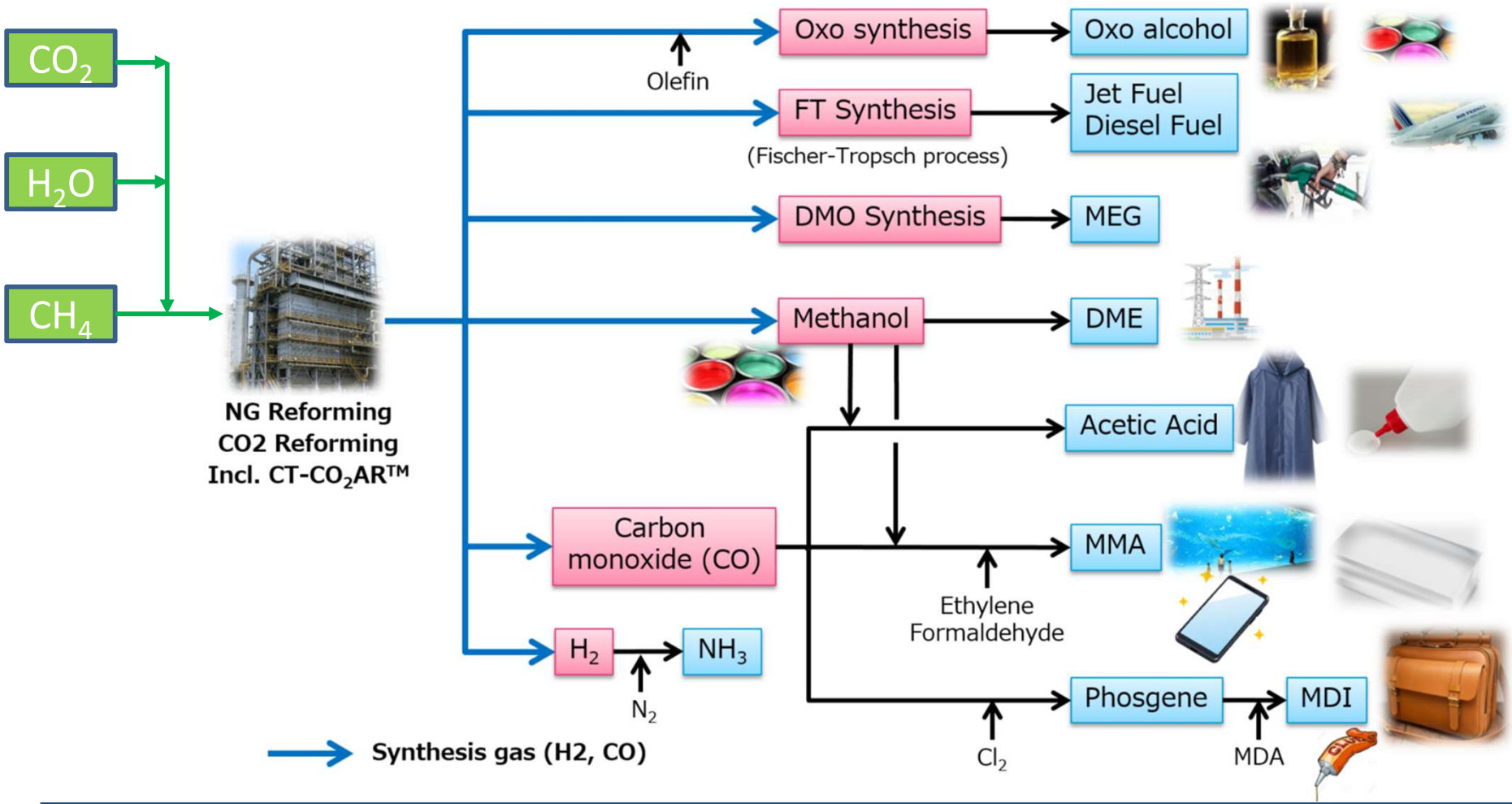

Source : JERA, TEPCO HD, Chiyoda corp.

# CCUS Technology Research and Development



# Chiyoda Patent/Own license / CT-$CO_2$AR™
## - Chemistry via Synthesis Gas

CT-$CO_2$AR™ contributes to reduction of steam($H_2O$) and $CO_2$ as feedstocks and energy conscious syngas production.  CO2 emission reduces 24% compared with conventional way. This technology(proven) should be remarkably suitable in the decarbonation transition.



# CCUS Technology Development

◆ Technology and business development of $CO_2$ capture and utilization is on going, to establish Carbon Recycle Supply Chain.

## $CO_2$ capture

◆ Under technology development of $CO_2$ Capture by Solid Sorbent. (**Green Innovation Fund/NEDO**)

・Target $CO_2$: Combustion exhaust gas ($CO_2$) of LNG power plants

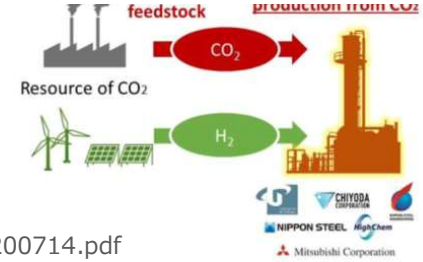
## Para-xylene (Polyester clothes/Plastic bottles

◆ 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 the University of Toyama, Nippon Steel Engineering Co., Ltd., Nippon Steel Corporation, HighChem Company Ltd., and Mitsubishi Corporation




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

## Carbonate (Concrete)

Waste concrete

Capture/Fix $CO_2$ by Calcium

Recycled aggregate

Aggregate

◆ **Technology by "Blue Planet" (start-up company in America)**.

◆ Chiyoda has entered into MOU with Blue Planet and Mitsubishi Corporation.

◆ Chiyoda participates in demonstration project (@U.S.) to provide technical support and accelerate commercialization.

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

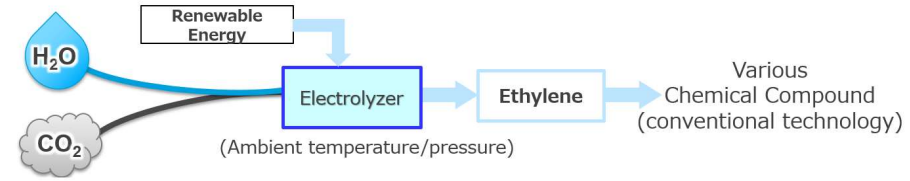
## Ethylene (Chemical products)

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

・Reaction is under ambient pressure/temperature

・Ethylene could be made into various chemical products such as e-fuel.

・**R&D stage in NEDO project (July 2020 – March 2030)**




https://www.chiyodacorp.com/media/200909%20.pdf

Blue Planet: Blue Planet Systems Corporation

NEDO: New Energy and Industrial Technology Development Organization

# Thank you for your attention

morikami.satoshi@chiyodacorp.com