



# Next Hydrogen Generation eFuel to Power the Green Transition Global Value Chains on Hydrogen

Mitsubishi Corporation  
March 25, 2022



## Table of Contents

### **I. Mitsubishi Corporation related information**

1. Roadmap to a Carbon Neutral Society and EX Strategy
2. Organization & Global Network
3. MC's Hydrogen / Ammonia related business

### **II. SPERA Hydrogen<sup>®</sup>: Solution for Global Hydrogen Networks**

1. What is the SPERA Hydrogen<sup>®</sup>
2. SPERA H2 Supply Chain Development

# I. MC related information

# Roadmap to a Carbon Neutral Society

- ✓ Mitsubishi Corporation (MC) has announced its roadmap on Oct, 2021 which includes new GHGs emissions reduction targets and energy-transformation (EX) investment guidelines

## Towards a Carbon Neutral Society

Climate change is an urgent global issue affecting industries and communities alike.

This Roadmap sets out our steps towards achieving a carbon neutral society; fulfilling our responsibility as an active player in industries including resources and energy by maintaining stable energy supply, such as natural gas, while providing decarbonization solutions.

### Roadmap: Three Core Points



Greenhouse Gas Reduction Targets

**Halve by FY2030, Net Zero by 2050**

(FY2020 baseline)



By FY2030

**Approx. 2 trillion yen of EX-related investment**

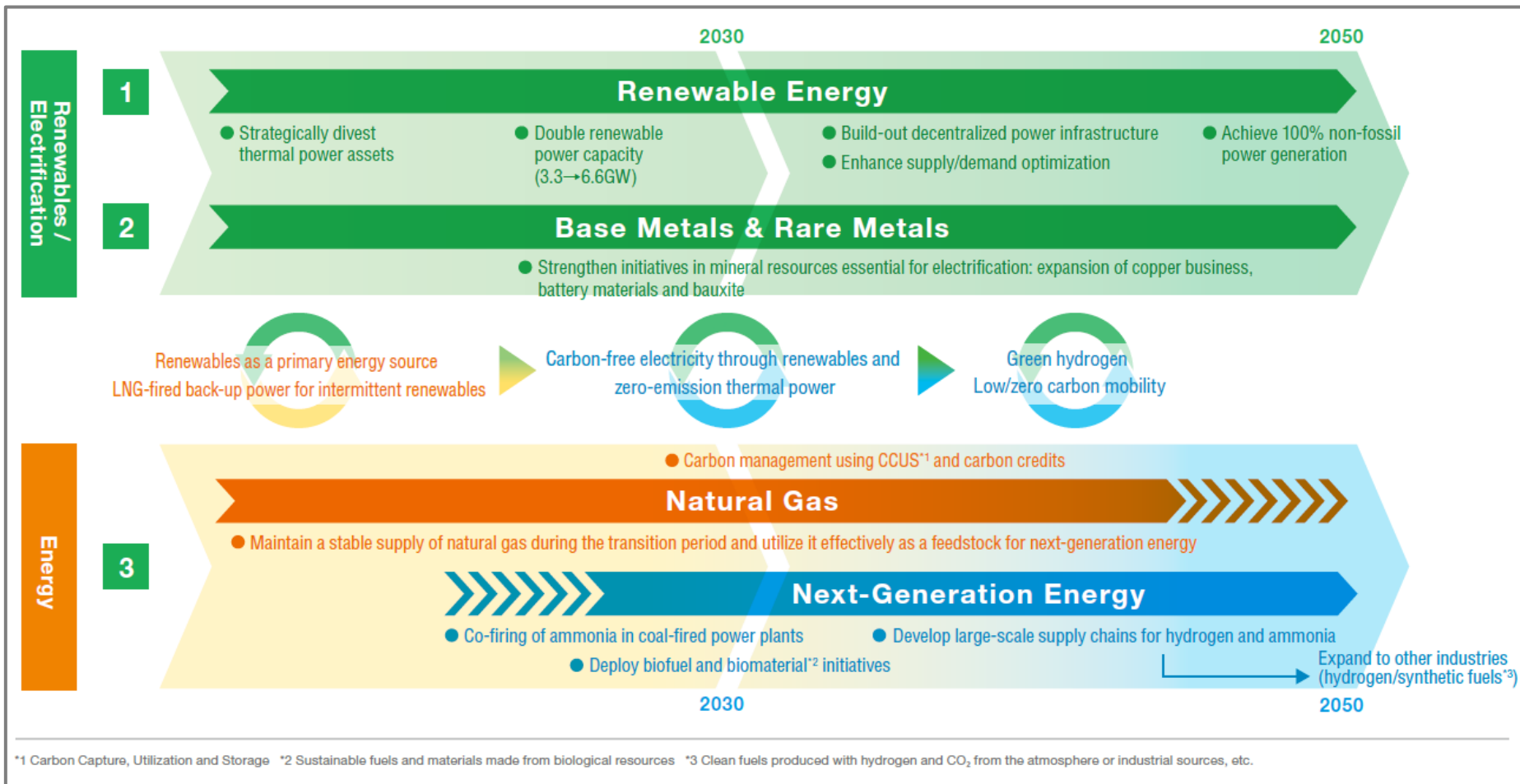
(Energy Transformation)



**Integrated EX/DX initiatives to “Create a New Future”**

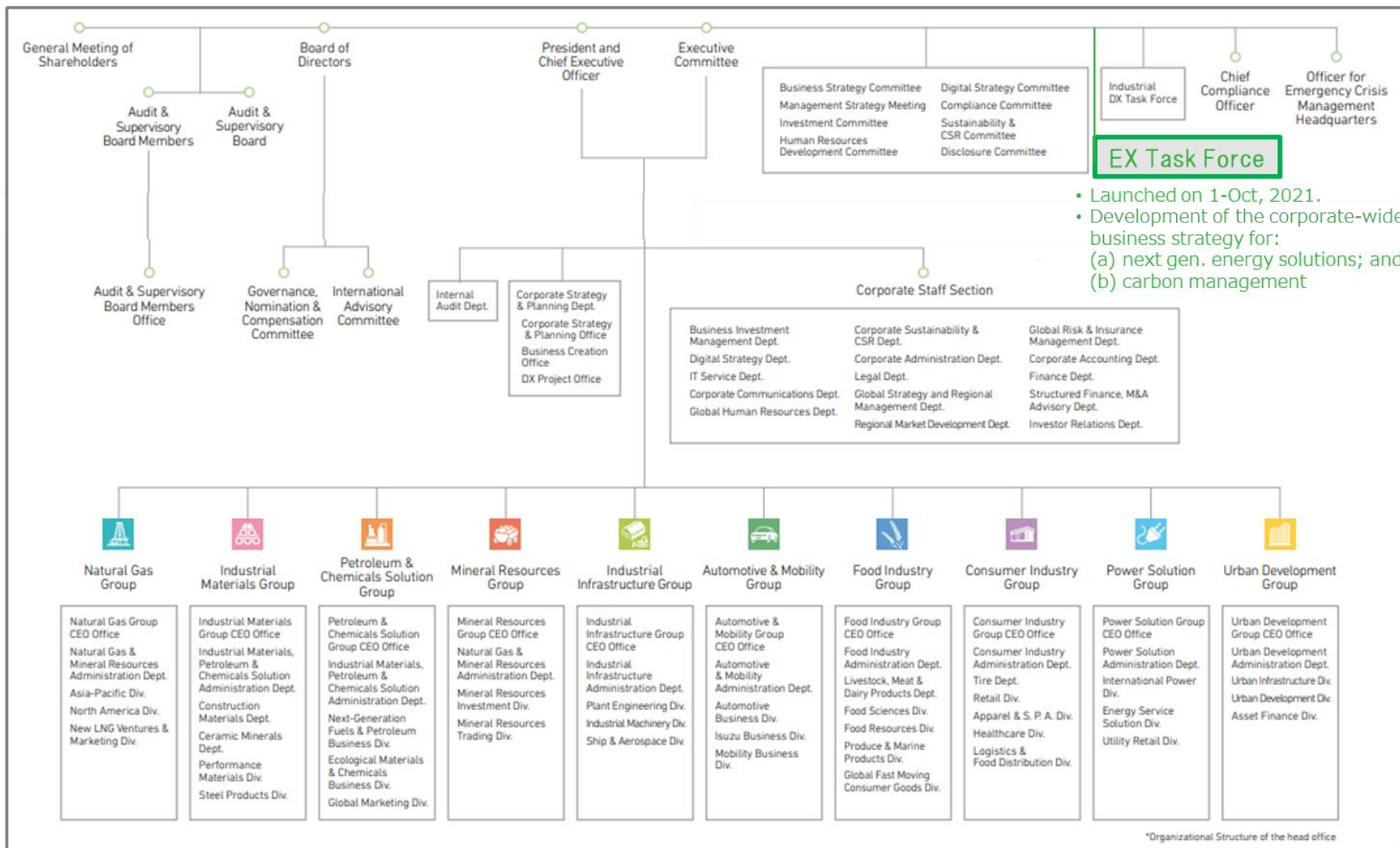
# MC's Approach to EX (Energy Transformation)

- ✓ While fulfilling our societal responsibility as a reliable supplier of energy, MC will pursue global initiatives to double renewable power capacity and create next-generation energy supply chains.
- ✓ **MC aims to invest JPY2 trillion (USD18 billion)** by FY2030, in areas including renewable energy, base/rare metals, natural gas, hydrogen and ammonia.



# Organization Chart

- ✓ **Multiple business groups** within MC, together with **EX Task Force** launched Oct 2021, are pursuing Energy Transformation (“EX”)- related business opportunities in collaboration with each other.

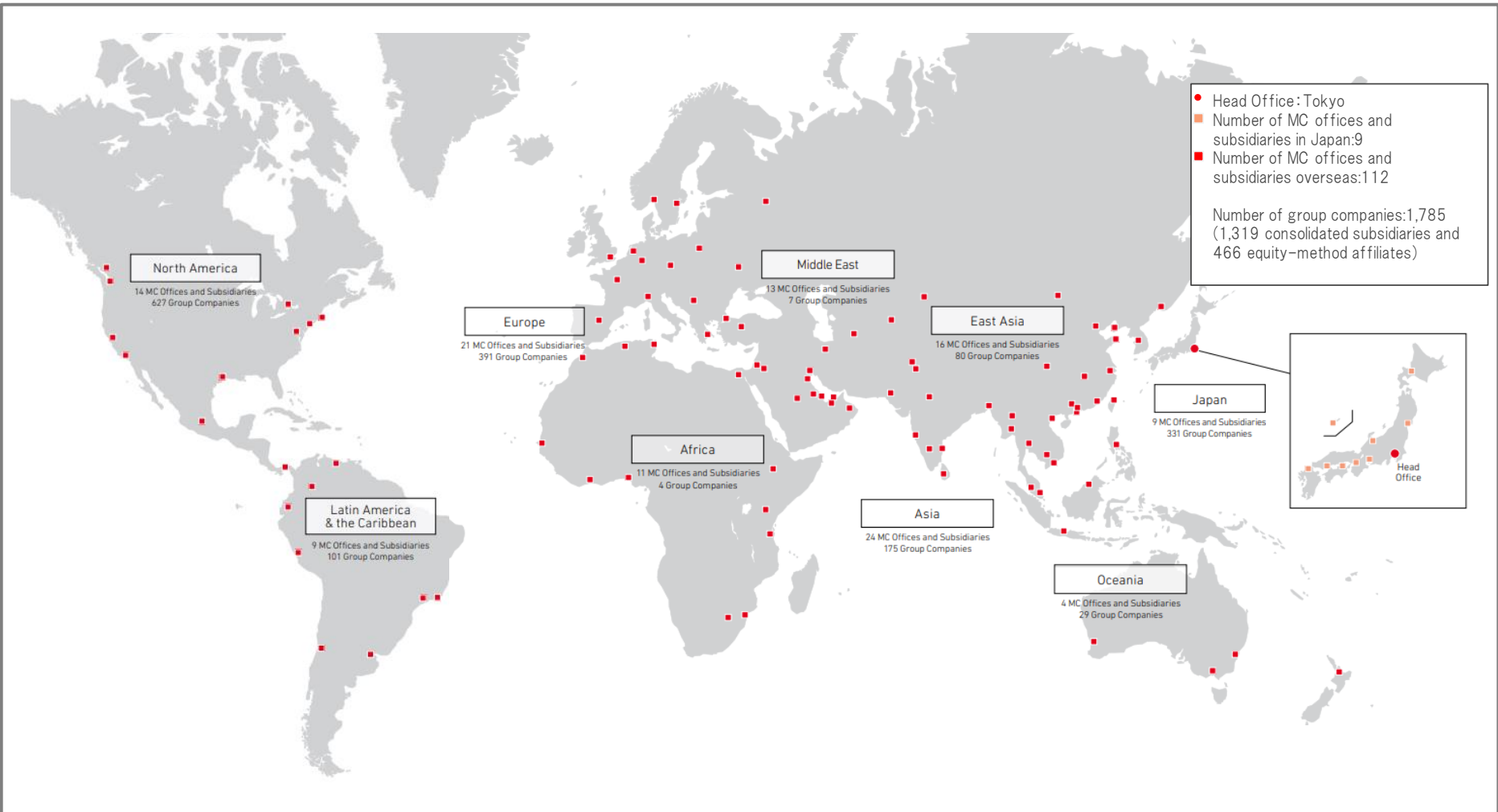


- Launched on 1-Oct, 2021.
- Development of the corporate-wide business strategy for:
  - (a) next gen. energy solutions; and
  - (b) carbon management

\*Organizational Structure of the head office

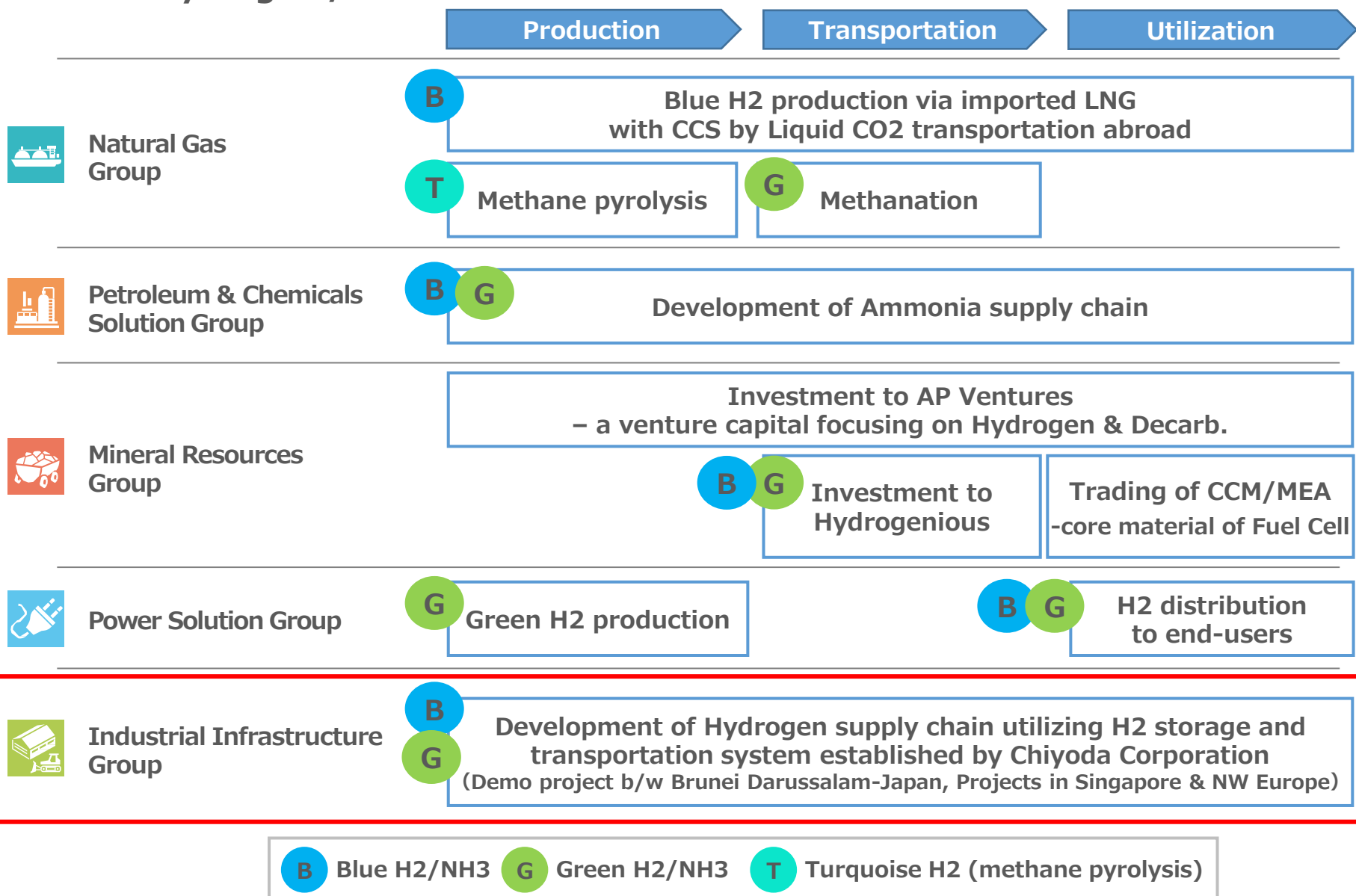
# Global Network

- ✓ MC is one of the largest trading and investment company in Japan and leverages its global network, which includes regional offices approximately in **90 countries** and regions worldwide, for **real-time business intelligence and develop regional markets** in relation to EX.



# Hydrogen related Activities by each Business Group

## ✓ MC's Hydrogen / Ammonia related business

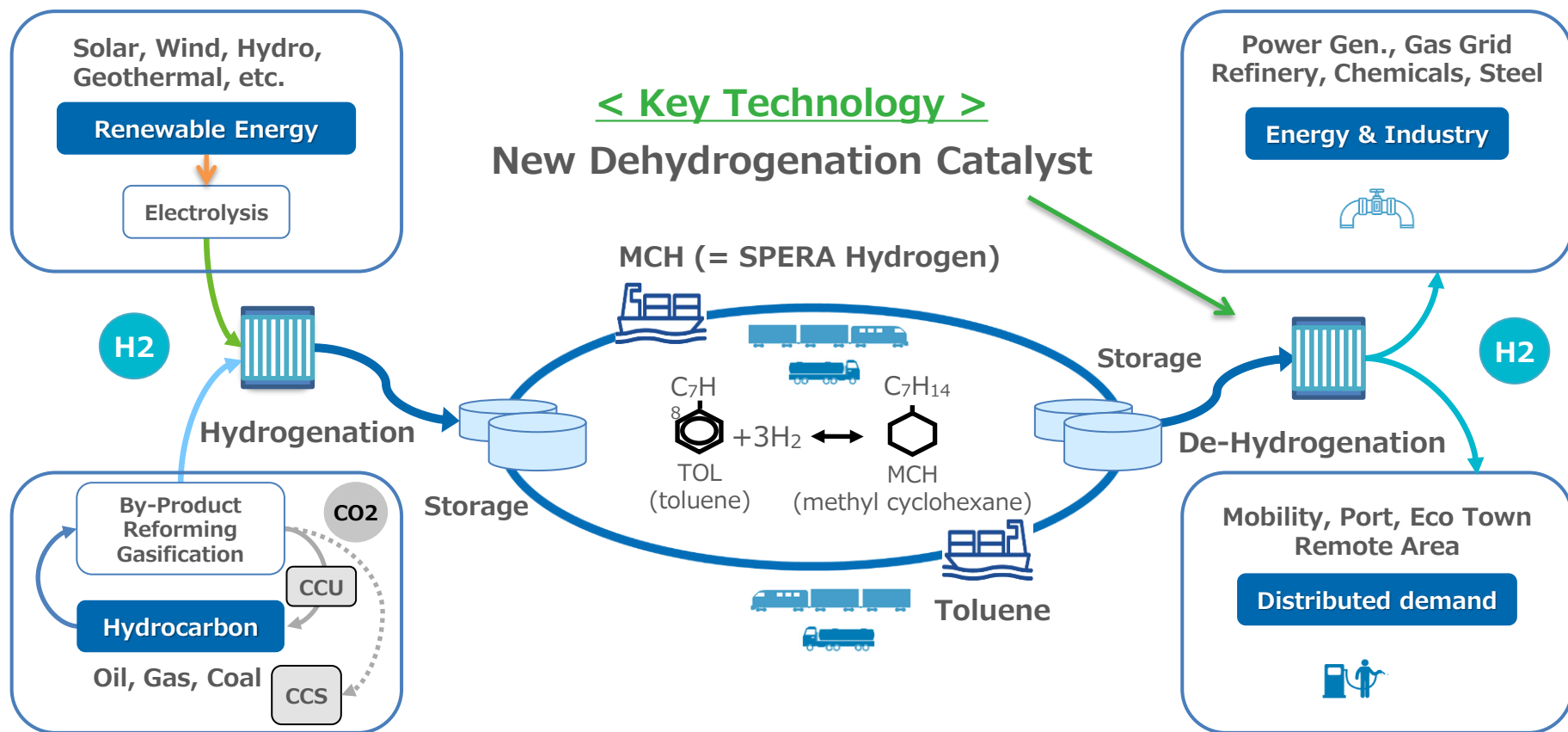




## **II. SPERA Hydrogen<sup>®</sup>: Solution for Global Hydrogen Networks**

# Hydrogen Supply Chain Technology Overview

- ✓ Chiyoda Corporation (MC's group company), has established a large and efficient H<sub>2</sub> storage and transportation system.
- ✓ Methylcyclohexane (MCH), an H<sub>2</sub> carrier, remains a liquid under ambient temperature and pressure (**SPERA Hydrogen®**).



# Key Features of SPERA Hydrogen<sup>®</sup> Technology

Long term storage  
& long distance  
transportation

**Chemically stable, minor MCH (H<sub>2</sub>) loss** during extended storage and long-distance transportation

Easy to handle

**Liquid under ambient temperature and pressure**  
Approximately **1/500** in volume

Use of  
existing oil  
infrastructure

Physical properties **similar to petroleum products**

Storage and  
transportation risk  
equivalent to  
petroleum products

Risk during **storage and transportation**  
is **equivalent to that of petroleum products**

Combination of  
new and  
proven technologies

**Combination of conventional equipment**  
and **new dehydrogenation catalyst technology**



# Global Hydrogen Supply Chain Demonstration

- ✓ MC, Chiyoda and other partners established the Advanced Hydrogen Energy chain Association for technology Development (“AHEAD”) and completed **the world’s first global hydrogen supply chain demonstration project.**

Description	
Scale	210 tons/year (maximum)
Duration	March 2020 - December 2020
Hydrogen Supply	Brunei Darussalam (Hydrogen Production)
Hydrogen Demand	Kawasaki City (fuel for gas turbine power plant)
Transportation	ISO tank container (container ship/truck)
Business Scheme	Establishment of the Association for Technology Development. NEDO Funded Project*



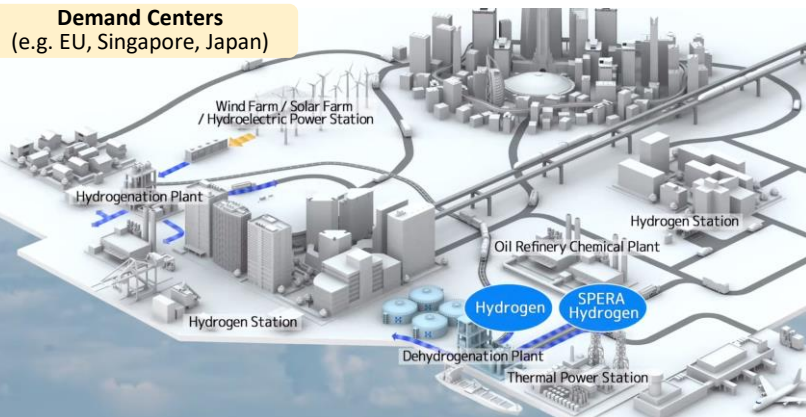
\* Technology Development for the Realization of a Hydrogen Society (funded by NEDO)  
 “Demonstration of the Hydrogen Supply Chain by the Organic Chemical Hydride Method Utilizing Unused Energy”

# What we are doing

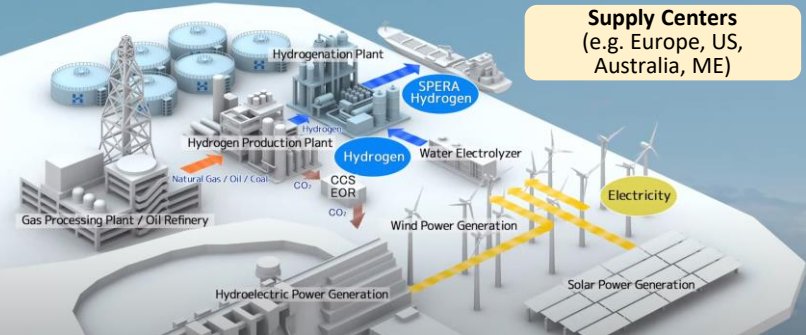
- ✓ As the first-ever developer of global scale Hydrogen supply chain, **MC/Chiyoda are initiating discussions with multiple stakeholders or buyers in potential demand centers, seeking for cost competitive clean hydrogen sources in the globe and prospective governmental supports.**

## Hydrogen Supply Chain Concept

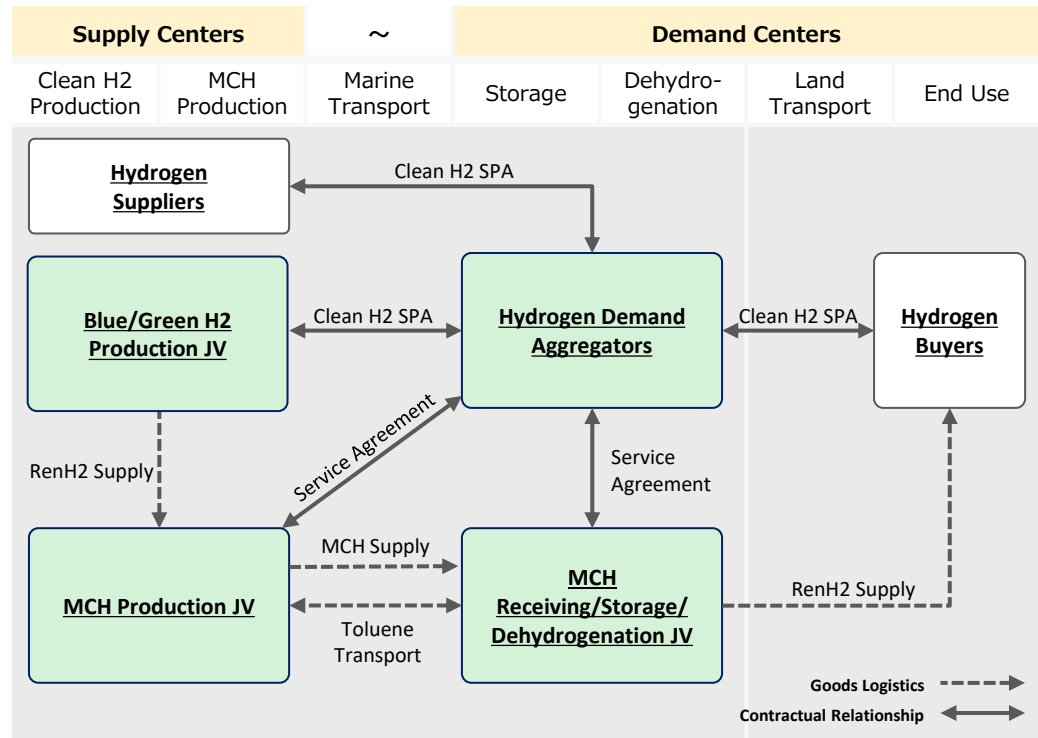
**Demand Centers**  
(e.g. EU, Singapore, Japan)



**Supply Centers**  
(e.g. Europe, US, Australia, ME)



## Business Model Concept



# SPERA Hydrogen Use Case: Port of Rotterdam

✓ To contribute to Northwest Europe’s ambitious carbon neutral strategies, MC, Chiyoda, the Port of Rotterdam Authority, Koole Terminals have signed **MOU on July 2021 for the joint-study of commercial-scale imports of hydrogen to NW Europe** via the Port of Rotterdam utilizing SPERA Hydrogen®.

- ❑ Semi-commercial scale: 100 ~ 200kt-H2/year by 2026
- ❑ Full-commercial scale: 300 ~ 400kt-H2/year by 2030



Matching with H2 offtakers

The biggest port authority in Europe located in the Netherlands. Port of Rotterdam announced its hydrogen strategy in May 2021 and aims to be the hydrogen hub to handle 20mil ton p.a. hydrogen by 2050.



Source: Port of Rotterdam web site

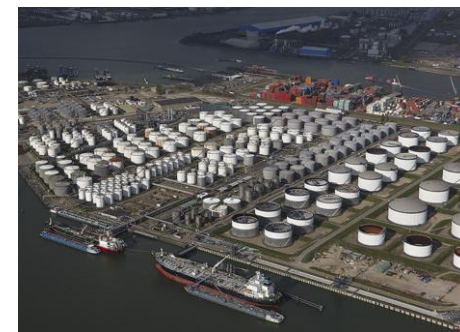
## Joint Study of Commercial Scale Hydrogen Import using SPERA Hydrogen



MCH·TOL Storage Infrastructure



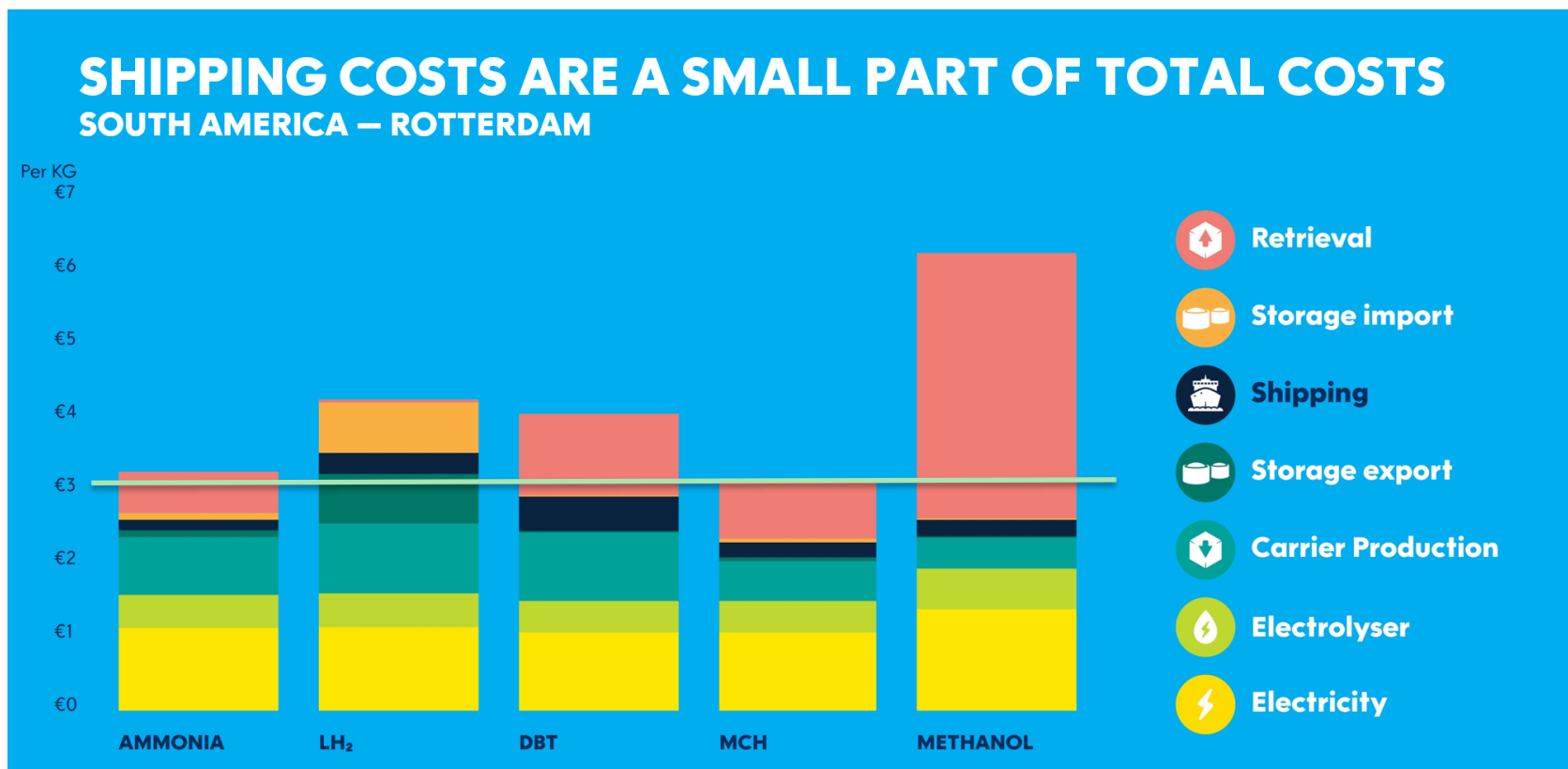
Tanks at Port of Rotterdam



Source: Koole Terminals web site

## H2 carriers comparison : Supply Chain Cost

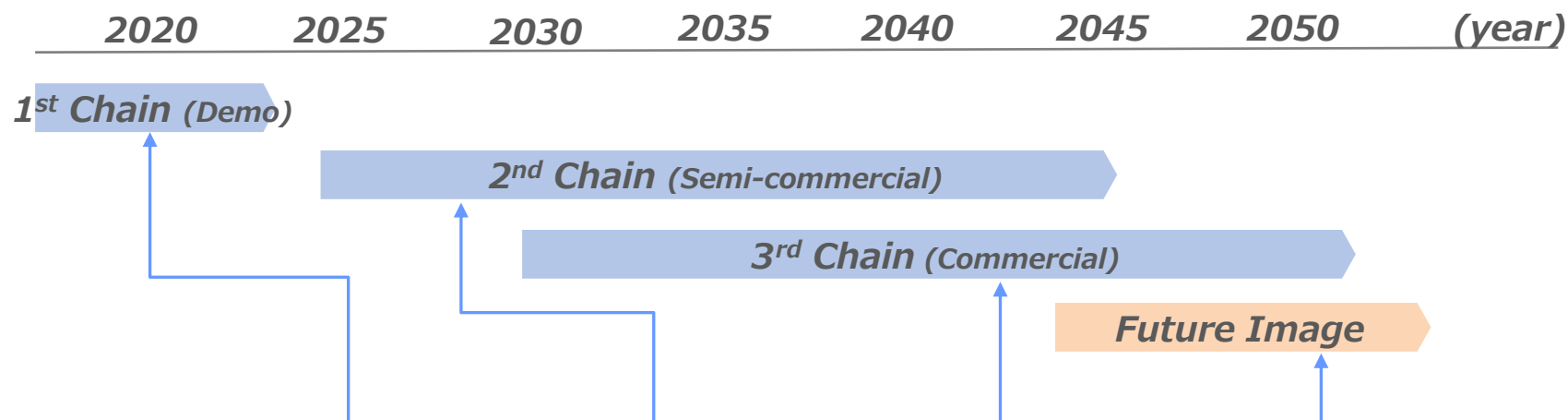
- ✓ Port of Rotterdam showed the overall supply chain costs of producing green hydrogen in South America and shipping it to Rotterdam in different forms: LH2, Ammonia and two LOHC's (MCH & DBT). SPERA Hydrogen® = MCH



(Source) Keynote speech Allard Castelein, CEO Port of Rotterdam Authority, at the 2nd World Hydrogen Summit.

# SPERA H2 Supply Chain Development Scenario

- ✓ Start semi-commercial project (2nd Chain) from mid-2020's and full-commercial project (3rd Chain) from 2030.

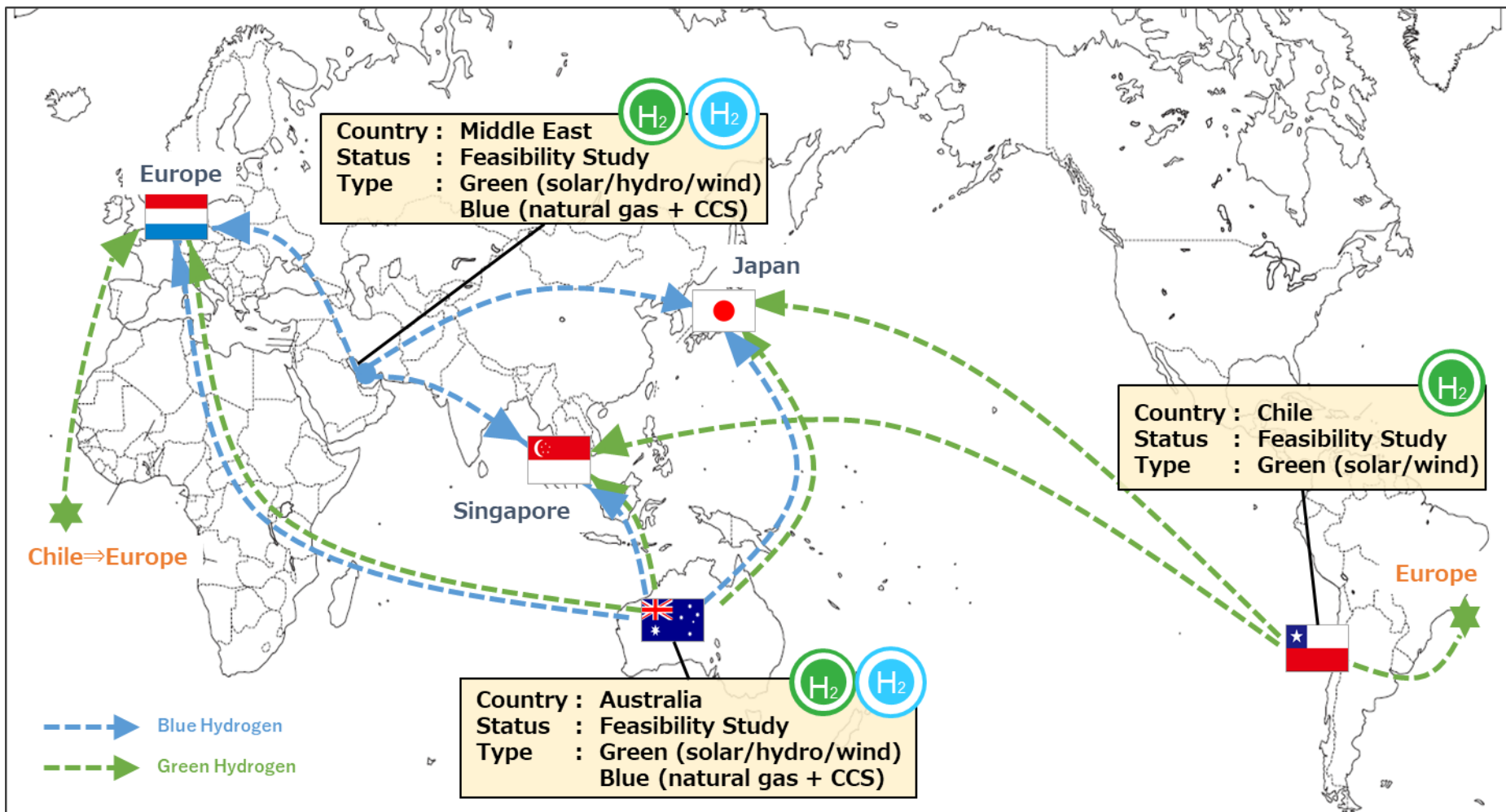


	1 <sup>st</sup> Chain	2 <sup>nd</sup> Chain	3 <sup>rd</sup> Chain	Future Image
<b>Hydrogen Source</b>	Gray Hydrogen	Blue or Green Hydrogen	Blue or Green Hydrogen	Green Hydrogen
<b>Target Price</b>	N.A.	USD 5-6/kg	below USD 3-4/kg	below USD 2-3/kg
<b>H2 Production cost</b>	N.A.	USD1.5-1.7/kg	USD1.2-1.3/kg	USD0.7-0.8/kg
<b>Capacity</b>	210 tpa	30K - 50K tpa	100K - 300K tpa	Upon H2 demand
<b>Supply to</b>	GTCC (partially)	Industries (Refinery, Petrochemical, Steel), Power, Mobility	Industries (Refinery, Petrochemical, Steel), Power, Mobility	Industries (Refinery, Petrochemical, Steel), Power, Mobility



# Status of H2 Production Projects by SPERA Hydrogen®

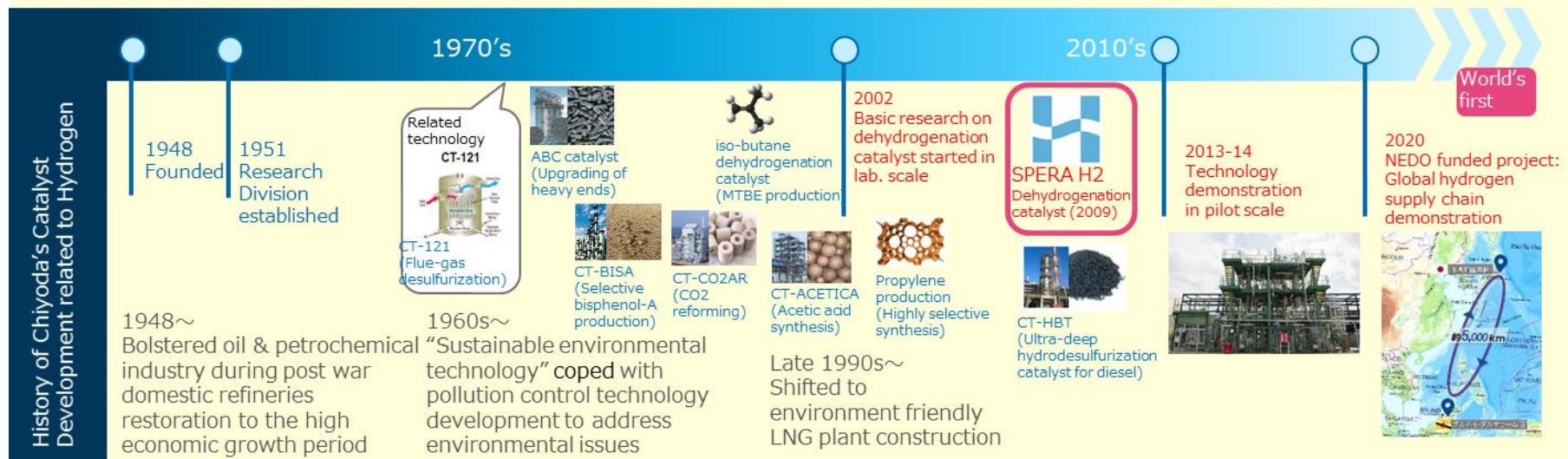
- ✓ MC and Chiyoda have been jointly studying cost-competitive H2 supply and logistics to demand side, i.e., Singapore, Europe and Japan.



# APPENDIX

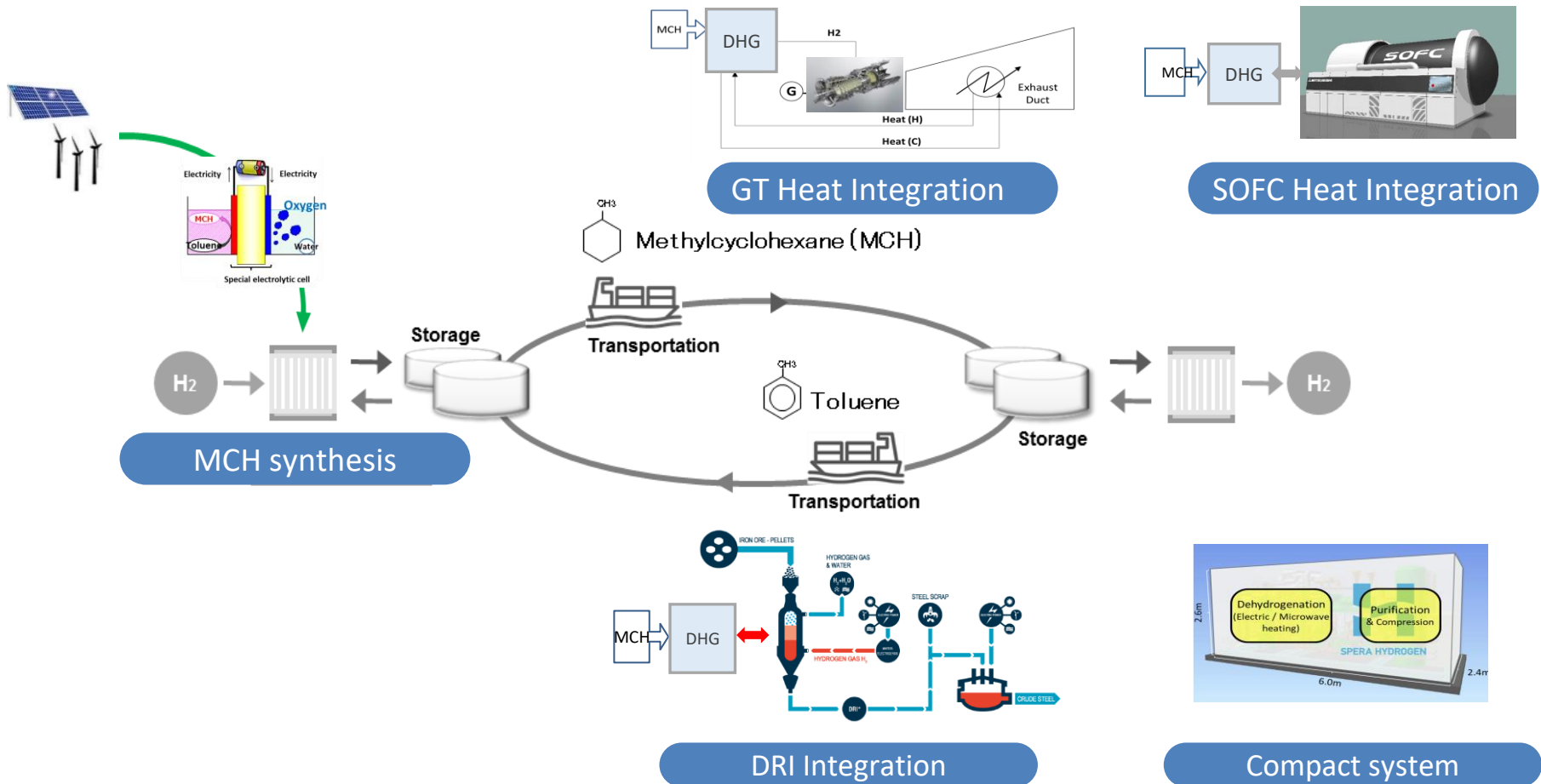
# History of Technology Development

- ✓ Based on Chiyoda's corporate philosophy "Harmony between energy and the environment", Chiyoda continues to develop proprietary catalysts, catalytic processes in line with the market.
- ✓ SPERA hydrogen was born in Chiyoda's R&D Center, as one of key enablers to develop hydrogen economy toward low carbon society.



# SPERA H2 Cost Reduction Technology

- ✓ We are further developing technologies and system integration from upstream to downstream to achieve the H2 cost target in 2030 and future.



# SPERA Hydrogen Use Case: Singapore

- ✓ To contribute to Singapore's Long-Term Low-Emission Development Strategy, MC, Chiyoda and Singaporean partners have signed **MOU on March 2020 for development of commercial scale hydrogen import project in Singapore** utilizing SPERA Hydrogen®.

- ❑ Semi-commercial scale: 20 ~ 40kt-H2/year by 2026
- ❑ Full-commercial scale: 300 ~ 400kt-H2/year by 2030

