



Session 2

# Hydrogen-Related Business Progress and Future Outlook

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Teruaki Tsukamoto  
Division Executive, CP Hydrogen strategic business unit

Looking ahead,  
going beyond expectations  
*Ahead > Beyond*

EBARA CORPORATION

# Global Greenhouse Gas Reduction/Carbon Neutrality (CN) Efforts and the Role of Hydrogen



- Reducing 88.2% of global CO<sub>2</sub> emissions in 154 countries and regions worldwide

■ Countries with commitments by 2050 (144 countries/regions, 42.2% reduction in CO<sub>2</sub>)

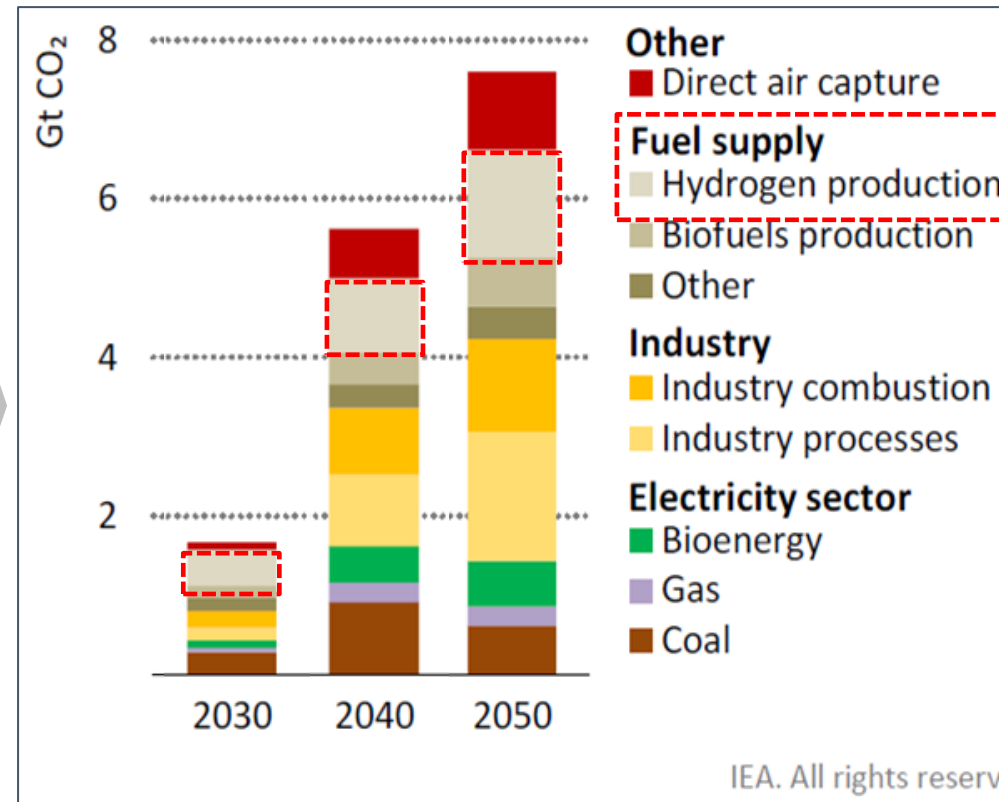
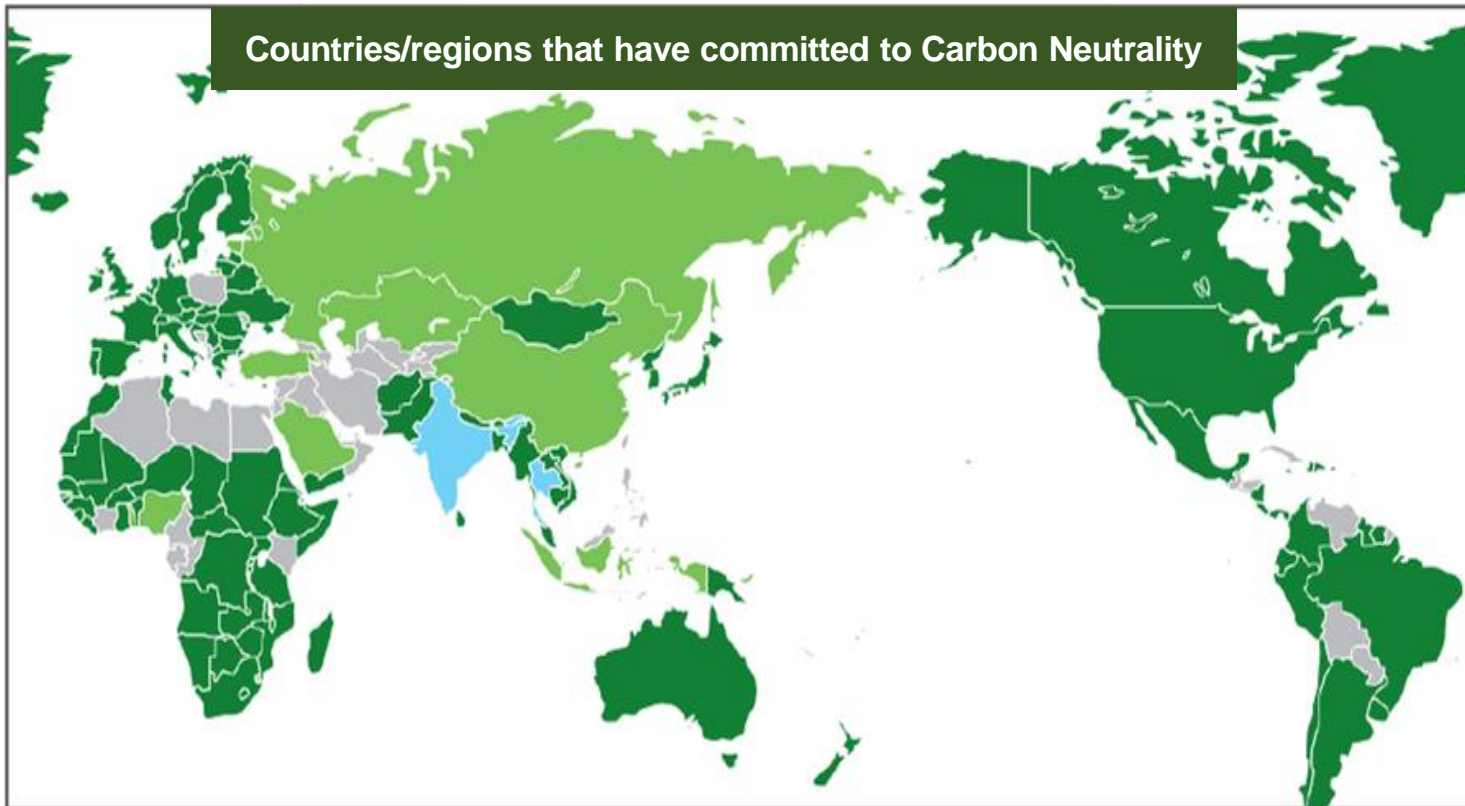
■ Countries with commitments by 2060 (China: 28.4%, Russia: 4.2%, etc.)

■ Countries with commitments by 2070 (India: 6.9%, etc.)

- Hydrogen will contribute to roughly 20% of global CO<sub>2</sub> reductions

■ 0.46Gt in 2030, roughly 150 times the 0.003Gt of 2020

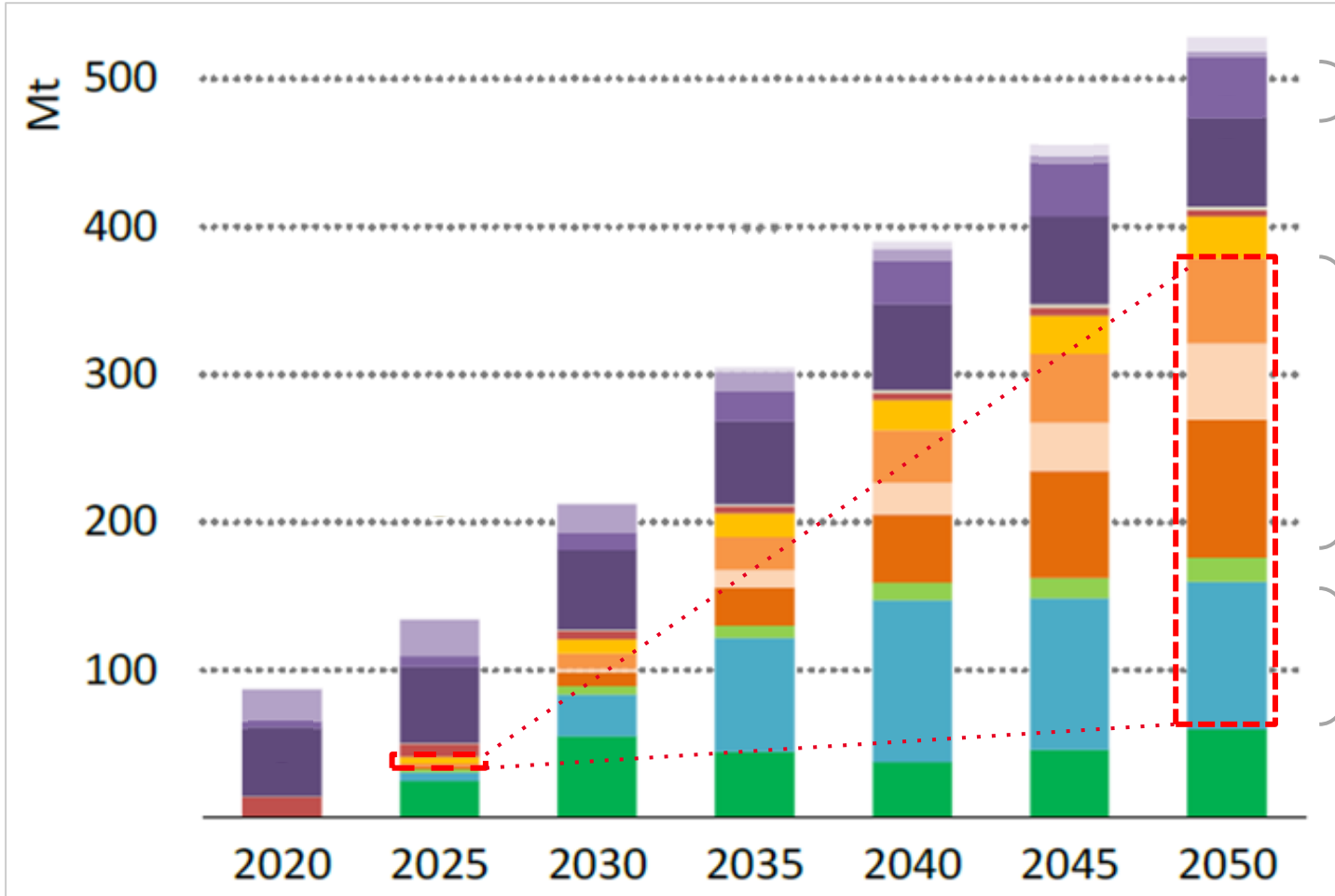
■ Increase to 1.36Gt in 2050, roughly 20% of the total



# Direction of Global Hydrogen-related Energy Utilization



- Hydrogen use will increase by more than six-fold in 2050 compared to 2020
- The fields of power generation and transportation are projected to account for nearly 60% of all hydrogen consumption

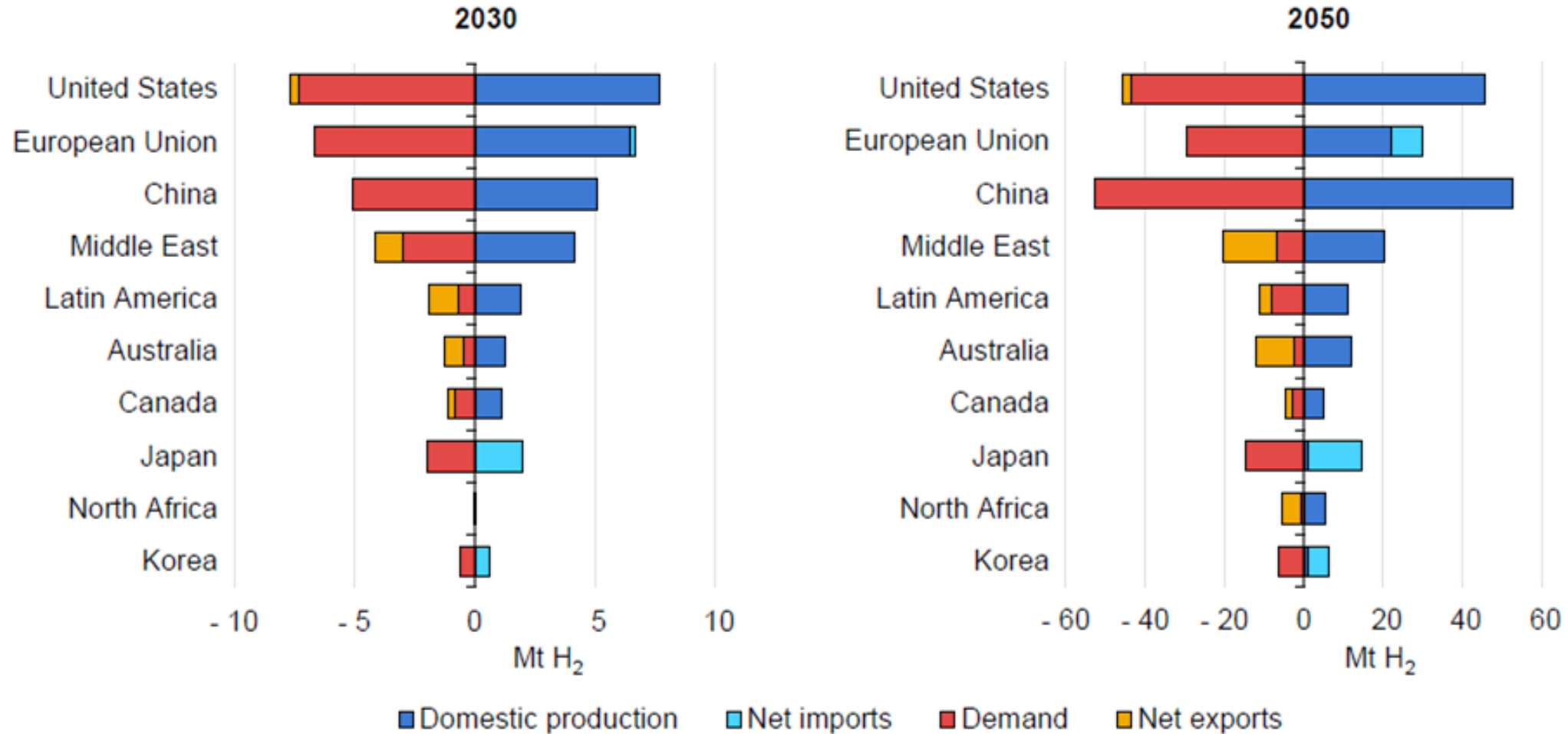


## Usage destinations for each main category

- Steel ⇒ From blast furnace to green steel
- Ships (hydrogen carriers, hydrogen fuel ships)
- Aviation (hydrogen aircraft (combustion type, FC type))
- Automobiles (commercial vehicles, trucks, buses, etc.)
- Buildings (fuel cells, air conditioning, etc.)
- Power generation (hydrogen gas turbines (including ammonia))

# Global Supply and Demand Balance for Hydrogen

- Demand for hydrogen-related energy is expected to increase by 5x to 10x in each region
- Exporters include North America, Middle East, Latin America, Australia, Canada, and North Africa.  
Importers are Europe, Japan, South Korea



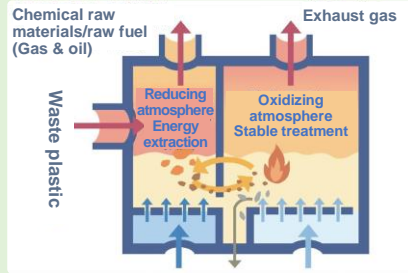
# Main Hydrogen-related Technologies Promoted by our Group



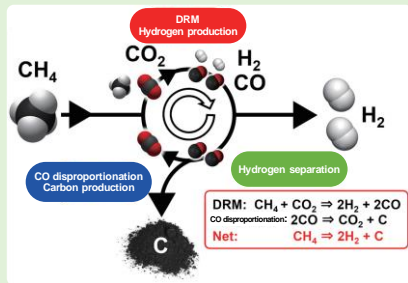
## Make

## Transport

## Use



Waste plastic, etc. chemical recycling



Turquoise hydrogen production

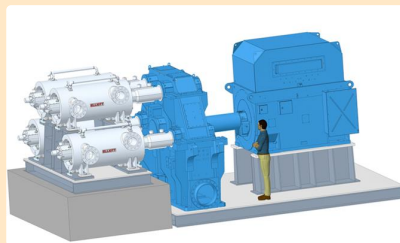
Converting methane (CH<sub>4</sub>) to hydrogen (H) and carbon (C)



-253°C Liquid hydrogen centrifugal pump



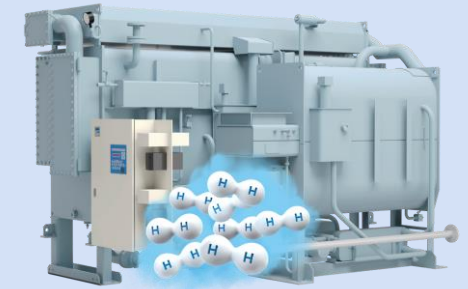
Ultra high-pressure plunger pump



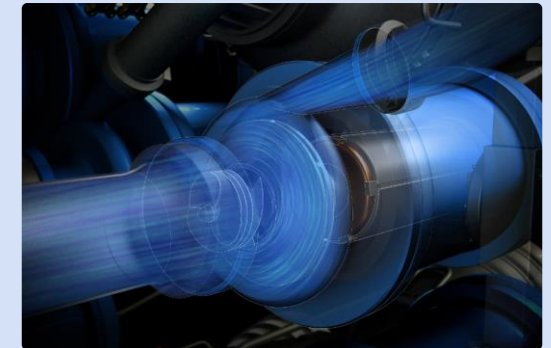
Hydrogen gas compressor



leak-free ammonia pump



Hydrogen-powered absorption chiller/heater

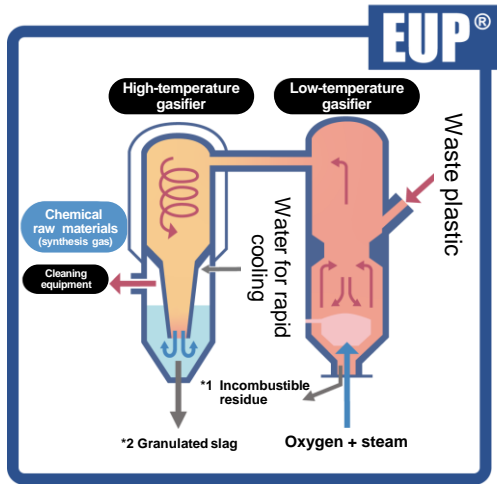


Rockets/hydrogen aircraft pumps

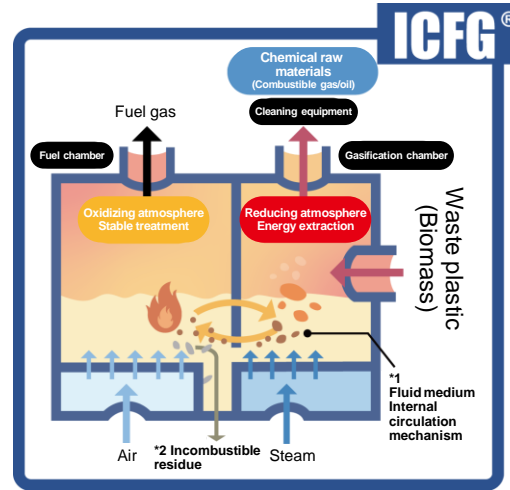
# Process Development to “Make” Clean Hydrogen

## Two types of chemical recycling to make hydrogen

**EUP®\*1** (development completed)  
(Ebara-Ube Process)

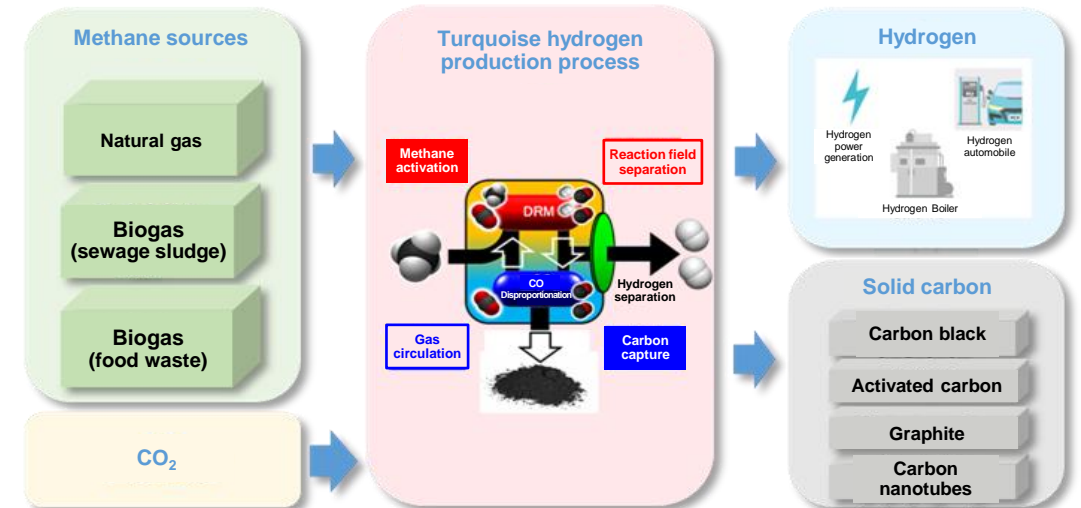


**ICFG®\*2** (undergoing validation)  
(Internally Circulating Fluidized-bed Gasifier)



## Separates clean hydrogen and carbon from methane

**Turquoise Hydrogen Production** (in development)



- License granted to JGC HD
- Project for hydrogen production from waste plastic
- **Currently receiving inquiries concerning projects, etc.**

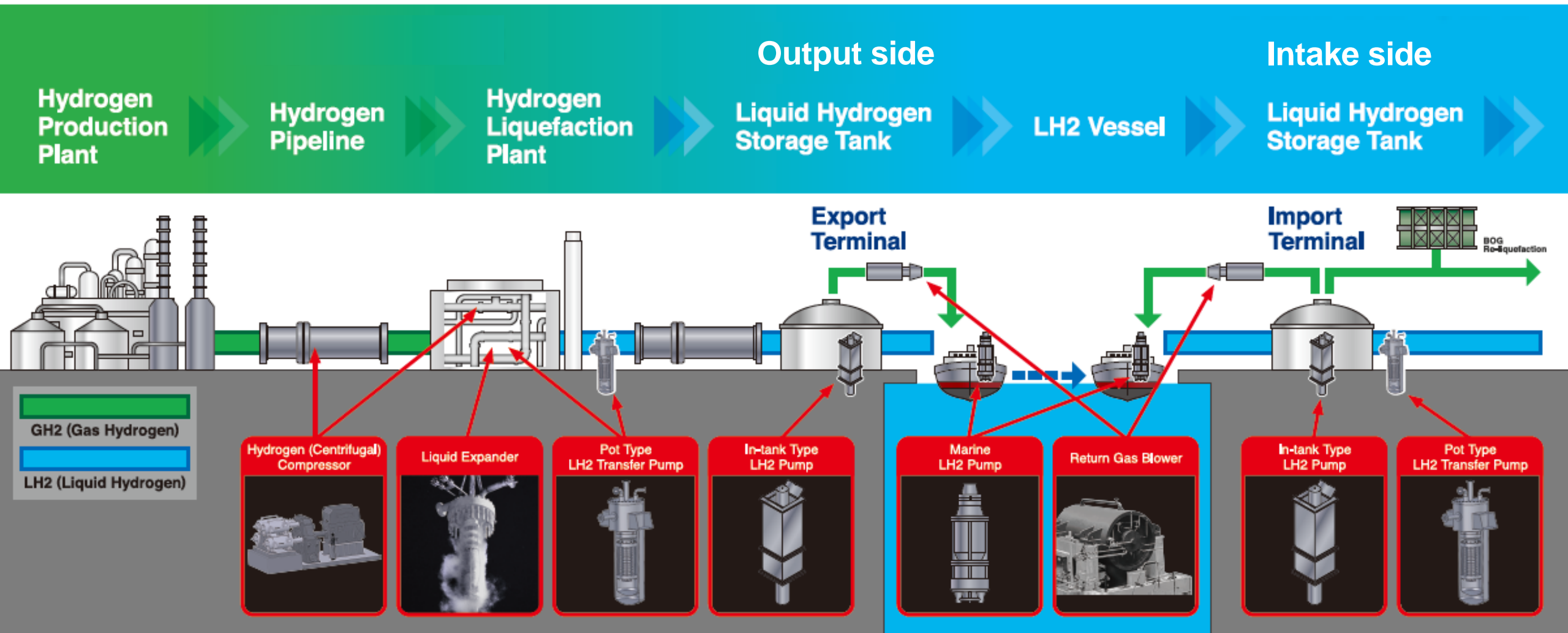
- Garnering attention as a recycling technology to replace waste-fueled power generation
- **Pilot test facility** is currently being constructed on Ebara land in Sodegaura, Chiba Prefecture

- Confirmed that hydrogen and solid carbon can be separated
- **Achieved continuous operation** of DRM reactor for **50 hours** (2024 goal of 100 hours)

# Rotating Equipment is Essential in the Hydrogen Transport Supply Chain

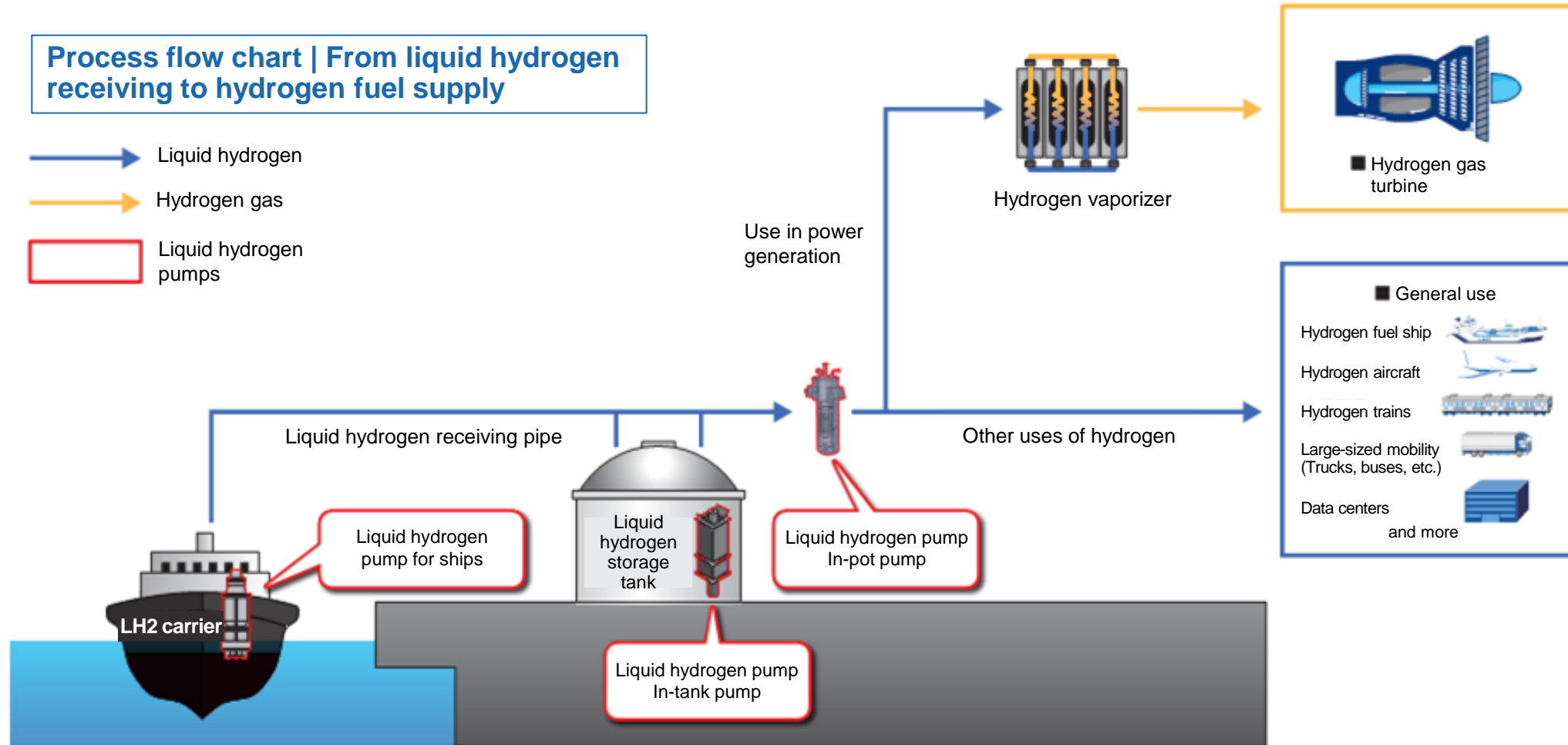


- Building a liquid hydrogen supply chain is essential for shifting to liquid hydrogen from the utilization and export/import of LNG
- "Connect" with  $-253^{\circ}\text{C}$  liquid hydrogen pump,  $-240^{\circ}\text{C}$  return gas blower, hydrogen gas compressor, etc.



# Liquid Hydrogen Boost Pump for Hydrogen Gas Turbine Power Generation (example)

- There are expectations that LNG power plants will shift to hydrogen mixed-fuel and hydrogen-only combustion, particularly in Japan. Liquid hydrogen pumps will play an important role in this shift
- Hydrogen gas turbines require high-pressure supply, and high-pressure liquid hydrogen pumps developed by Ebara will prove to be essential

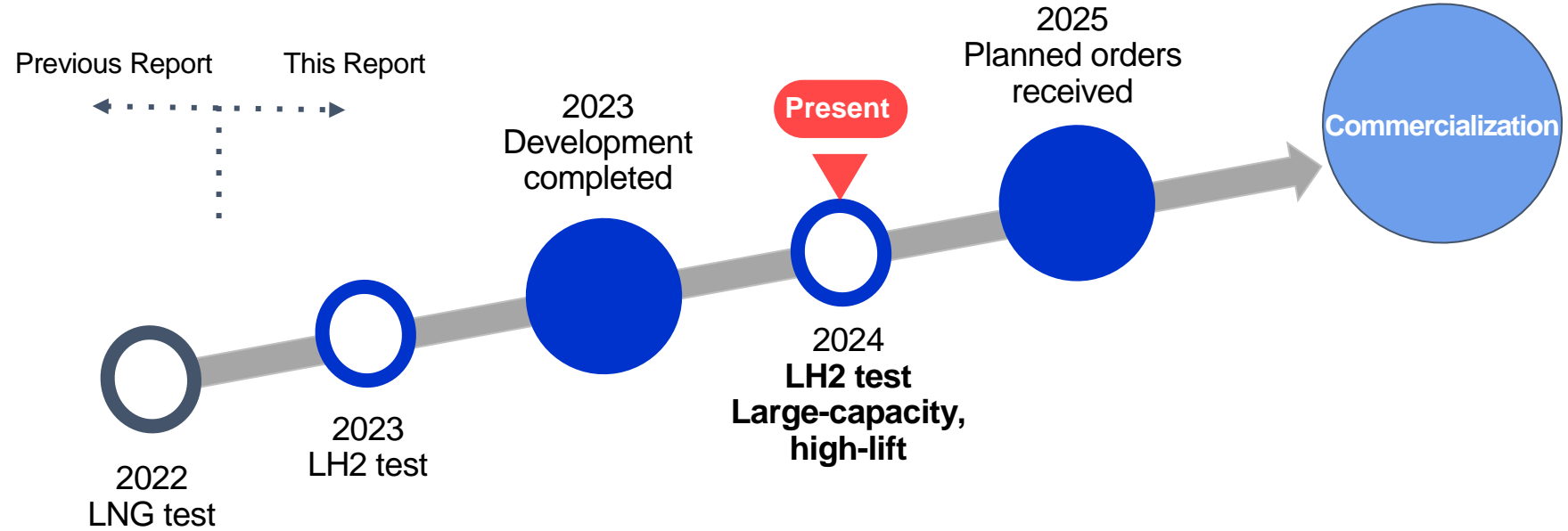




# Development Progress for Liquid Hydrogen Pumps (Centrifugal)



- Since 2023, we are conducting advanced development to capture global needs for liquid hydrogen pumps
- Anticipating demand for liquid hydrogen pumps in various applications, including small-flow, large-flow, and high-pressure, as well as for use on land and ships



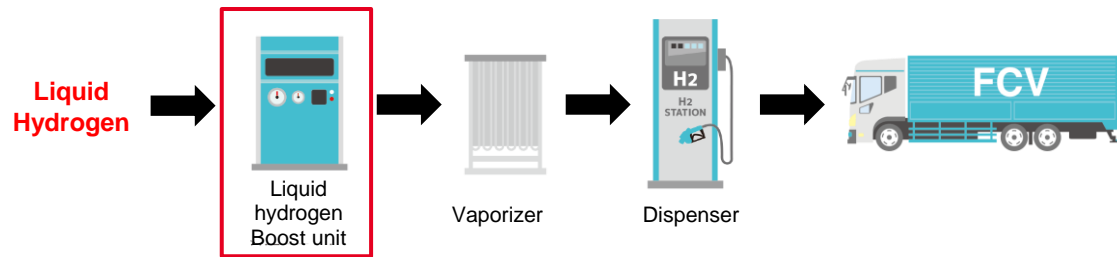
## Update Information

- 2023 LH2 test: Real fuel test (-253°C) conducted at JAXA Noshiro Rocket Testing Center
- 2023 completed development: Conducted data verification and product design, and launched sales of first model
- 2024 LH2 test: Development and testing carried out to meet needs for higher pressure and larger capacity
- **2025 Orders received: Aiming to receive orders for real-world projects**

# Progress on Plunger Pump (Reciprocating Type) for Hydrogen Stations

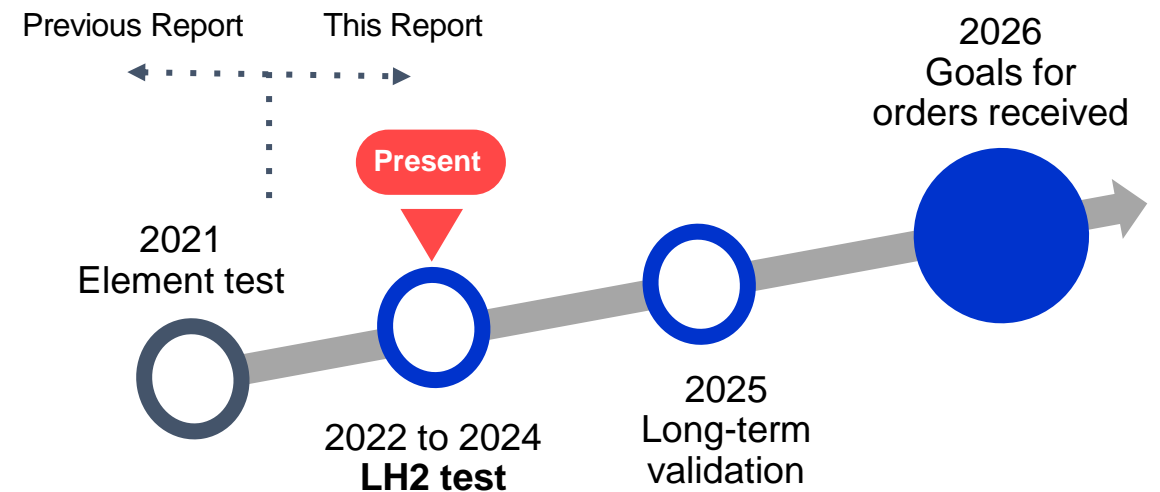


- Start liquid nitrogen and liquid hydrogen tests between 2023 and 2024, and aim for long-term validation in 2025
- The station market to trend upward from 2025 in North America (especially California), the EU, South Korea, etc.



## Expectations for large-sized and commercial vehicles

Compared to gas pressure models, liquid models are superior in terms of space efficiency, continuous filling capacity, reduced filling time, and energy savings, making them advantageous for large-scale mobility applications



## Update Information

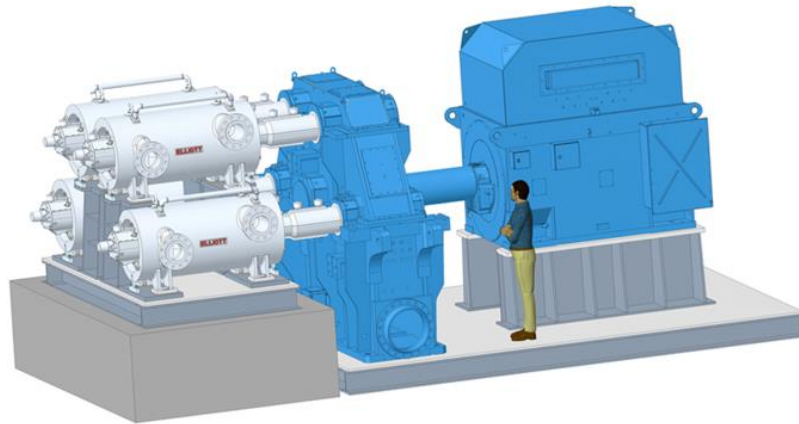
- 2022-2023: Liquid hydrogen test conducted using actual model
- 2024: Planning element tests and liquid nitrogen tests using improved model
- 2025: **Aiming for long-term validation through liquid hydrogen test** using improved model

# Progress on Hydrogen Compressors and Ammonia Pumps (Energy Company)



## Pipeline connecting compressors

👉 Expectations for hydrogen gas pipelines in wide-area supply chains such as North America



- Elliott developed Flex-OP hydrogen compression solution in 2022
- **Our Group is collaborating to develop a next-generation model** that enables 100% hydrogen
- Currently conducting sales to receive orders and build a regional supply chain

## Leak-free ammonia canned pump

👉 Global expectations for ammonia power generation and large capacity hydrogen carrier

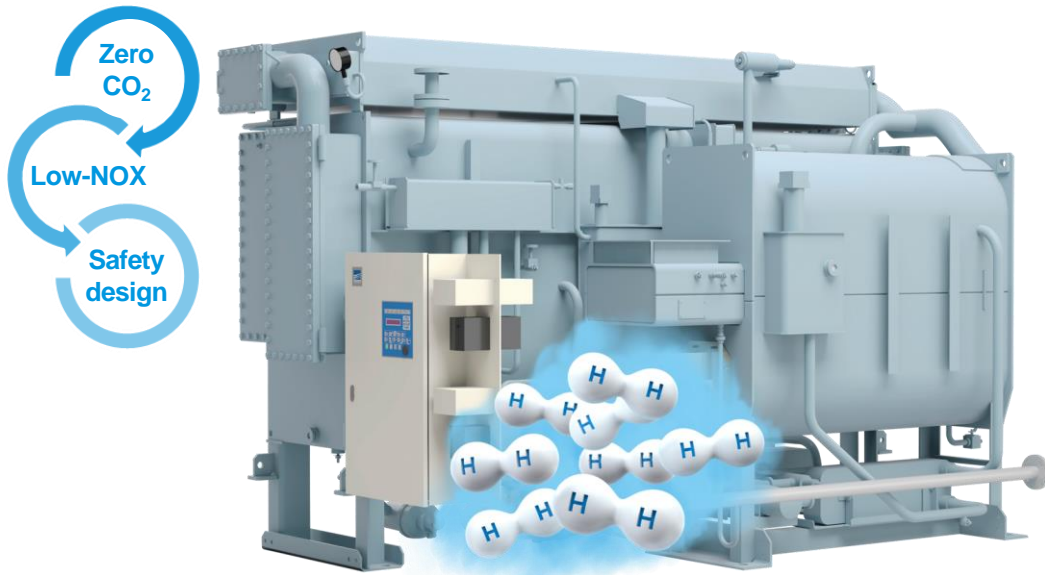


- 2023: Developed a leak-free ammonia pump
- 2023: Successful LPG test of in-tank pump for ammonia
- 2024: **Successful fueled operation** at demonstration plant

# “World’s First” Hydrogen-powered Absorption Chiller/Heater that Uses Hydrogen in Building Air Conditioning



- Collaborated with EBARA REFRIGERATION EQUIPMENT & SYSTEMS (ERS) to develop the world's first hydrogen-powered absorption chiller/heater in 2023
- Achieving zero CO<sub>2</sub> emissions by changing the fuel of conventional gas and oil absorption chiller/heater to hydrogen



Zero CO<sub>2</sub> emissions from fuel combustion

Safe design (low NO<sub>x</sub>, blowback prevention)

Packaged and equipped with energy saving controls

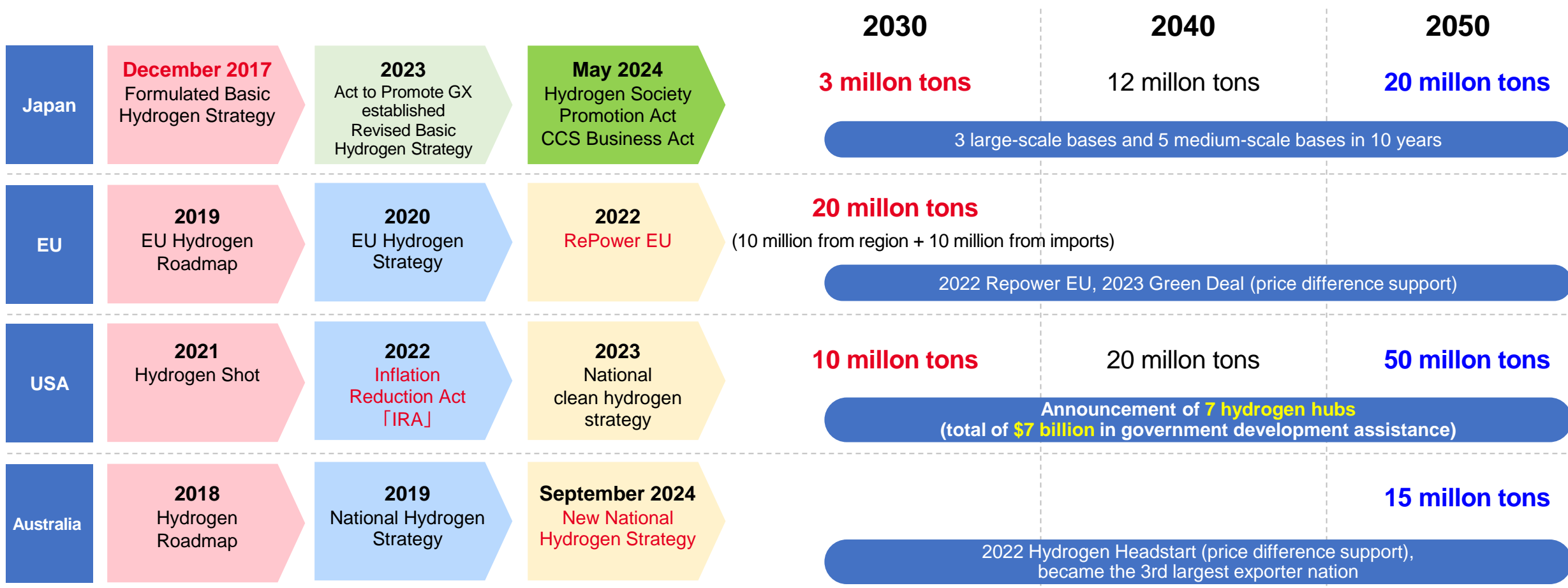
## Update Information

- Developed hydrogen-powered absorption chiller/heater in 2023
- **Conducting continuous test run since August 2024**  
(Tokuyama Cultural and Sports Center, Shunan City, Yamaguchi Prefecture)
- Increasing number of inquiries from local governments, developers, and private companies regarding use in next-generation air conditioning equipment
- Scheduled to start selling as a system (ERS) that is ready for hydrogen use

# Global Hydrogen Strategy and Hydrogen Market Growth



- Starting with Japan's Basic Hydrogen Strategy in 2017, hydrogen strategies were formulated around the world
- In particular, the EU, the United States, and Australia established numerical targets and supplementary budgets for 2030 and beyond, accelerating the social adoption of hydrogen
- South Korea, the Middle East, and China also developed hydrogen strategies to boost growth



# Establishing the World's First Full-scale Commercial Product Testing and Development Center



- Establishing the world's first full-scale commercial product testing and development center fully equipped with fueled testing equipment for liquid hydrogen pumps

## (Provisional name) Ebara - Hydrogen Equipment Test and Development Center (E-HYETEC)



- Location:** Futtsu City, Chiba Prefecture (company-owned land)  
**Site area:** Approx. 18,000m<sup>2</sup> (Building area approx. 2,800m<sup>2</sup>)  
**Completion:** June 2026 (planned)  
\*Certain test facilities scheduled to begin operations in 2025

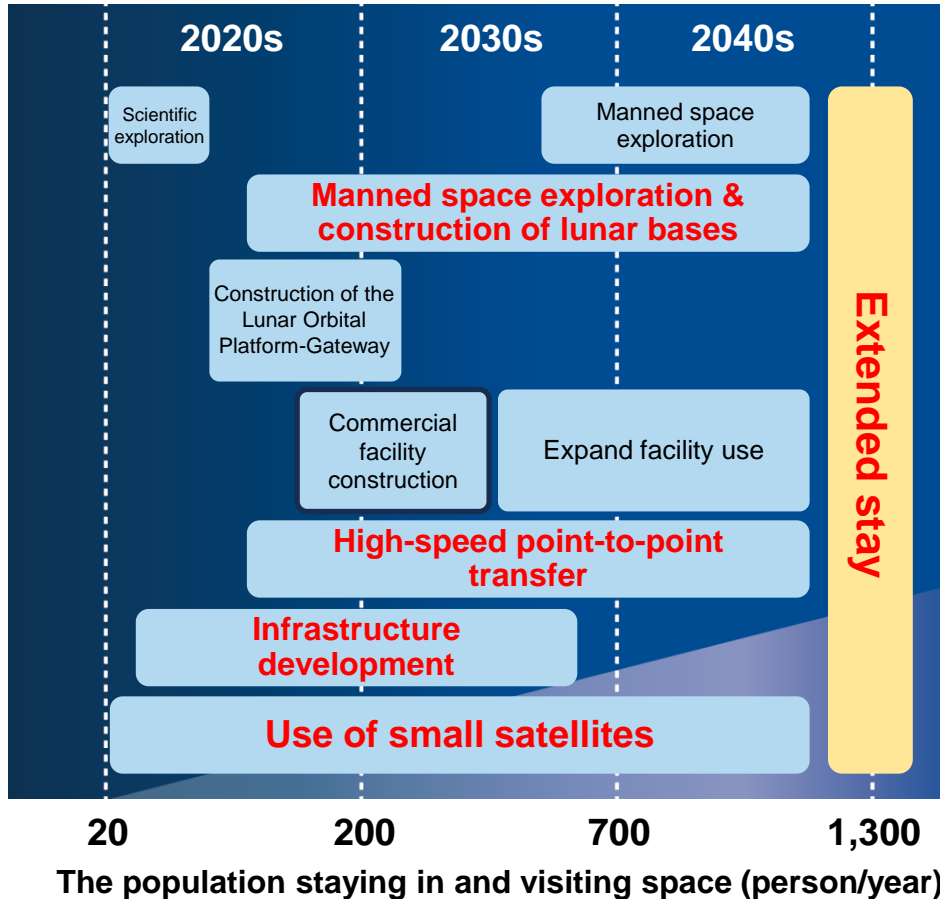


- Liquid hydrogen pump product performance testing (centrifugal pumps, plunger pumps)
- Development of related foundational technology

# Challenge Ourselves to New Business Fields: Into the Aerospace Industry



- Contributions on the ground, transport of goods, and lunar surface/space ST infrastructure
- Contribute to the evolution of humankind by connecting Earth and space, anywhere and faster



Red: Main target domain

Blue: Development implementation phase

## Step 3 (from 2040)

**Lunar surface/space ST infrastructure  
(Water treatment, energy, life infrastructure)**

- ▶ Low-gravity environmental transport technology (pumps for space infrastructure), hydrogen technology

## Step 2 (from 2027)

**Transport of goods in space  
(Orbital transport, high-speed point-to-point transport)**

- ▶ **Satellite thruster pumps**  
Thrusters (satellite/debris removal)

## Step 1 (from 2024)

**Contribution on the ground  
(Transport small satellites between low earth orbits)**

- ▶ **Pumps for space rocket engines** (supply system)

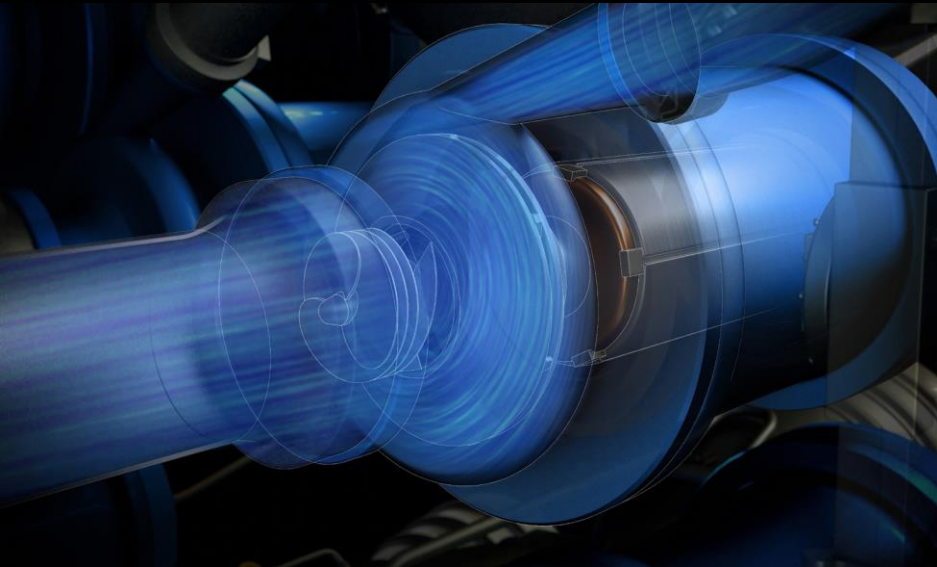
# Pumps for Space Rocket Engines | Status of Development

## Electric Pump

Unlike conventional turbo pumps, an electric motor is used as the drive machine, providing new value in engine maintainability and thrust control

## Target markets

- Space rocket engines
- Artificial satellites
- Point-to-point high-speed transport (P2P)
- Transport of goods in space
- Debris removal



July 2024 : Prototype of electric pump for rocket completed

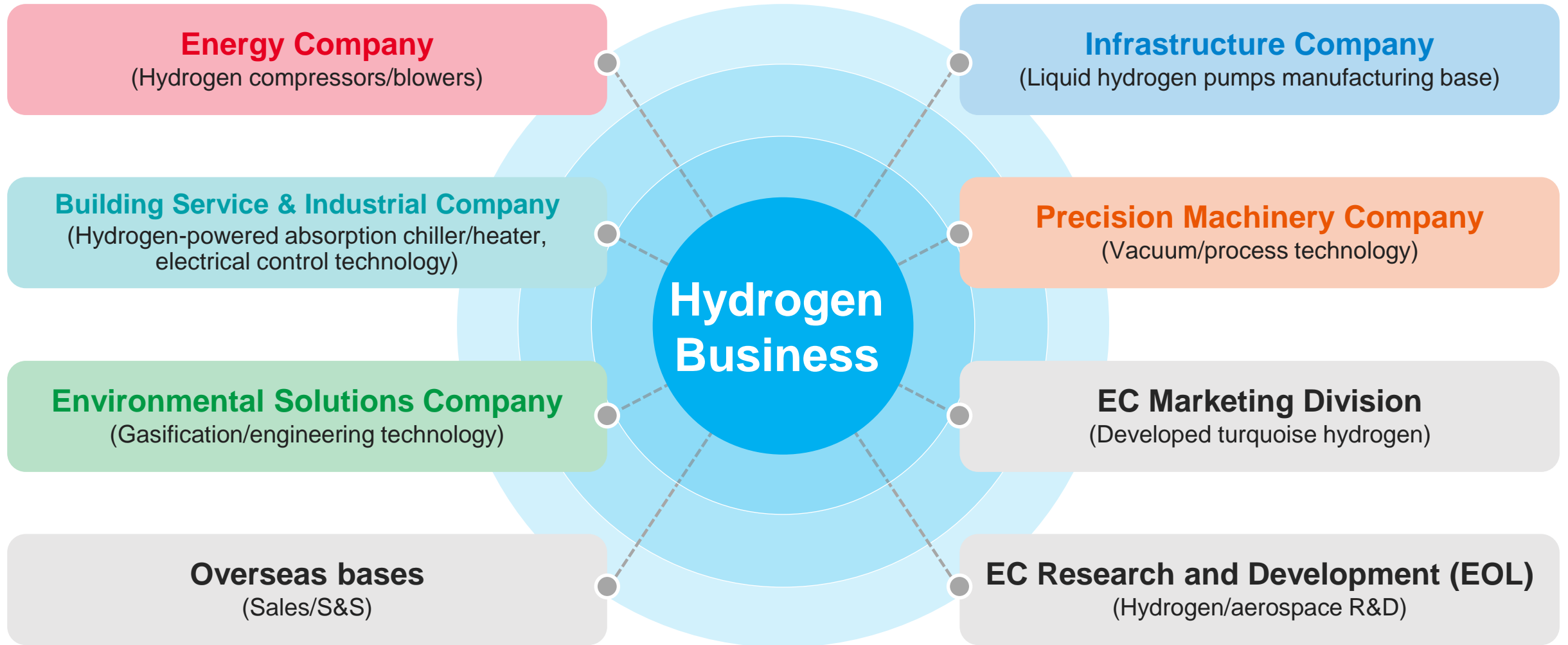
September 2024 : -196°C liquid nitrogen test completed

2025 : Liquid methane fueled test planned

Aiming for inclusion in launch plans from 2027

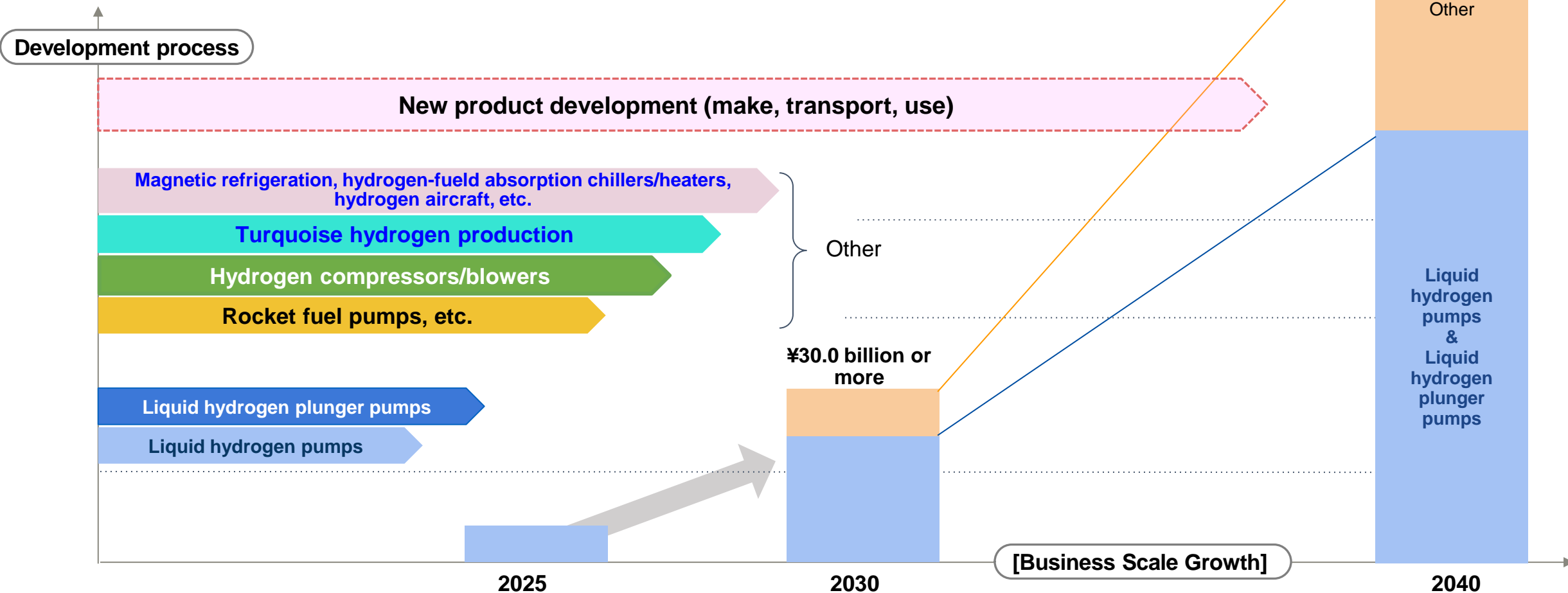


# Creating Technology Synergy with the Hydrogen Business Across the Entire Ebara Group

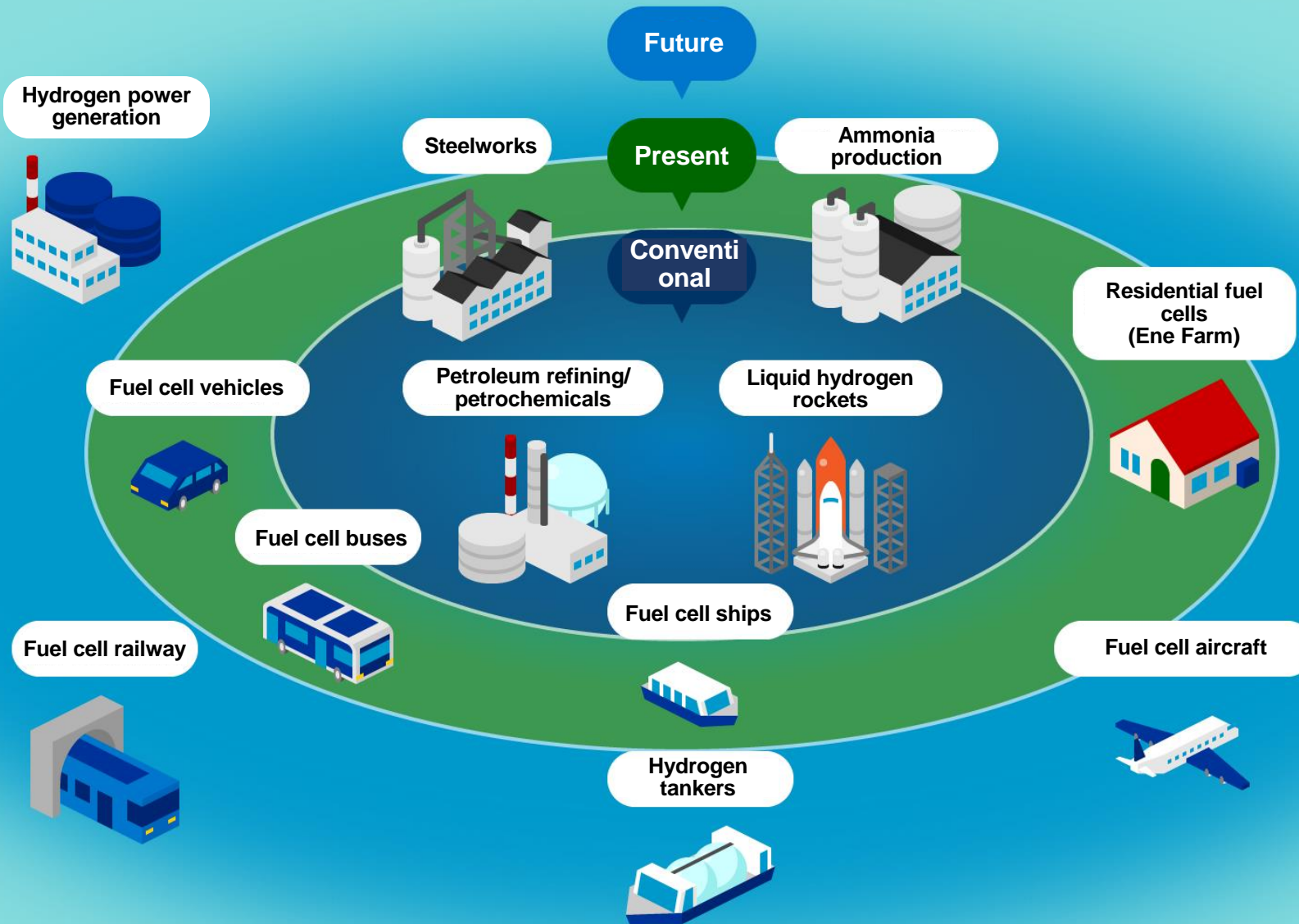


# About Hydrogen Market Business Growth

- Market assumptions and development progress are generally in line with expectations
- Secure business growth opportunities by investing ahead of other companies (advantage of being first)
- By 2040, create additional added value and grow the business to a scope of 200 billion and beyond yen



# Hydrogen Technology is Expected to be Used in a Variety of Ways (from the Ministry of the Environment website)



By building Ebara's new technology and businesses, we can make contributions in all hydrogen-related domains



We will pursue upfront investments and technology development to take on the challenge of realizing a hydrogen society

Source: Ministry of the Environment website  
[https://www.env.go.jp/seisaku/list/ondanka\\_aisei/lowcarbon-h2-sc/about-hydrogen/index.html](https://www.env.go.jp/seisaku/list/ondanka_aisei/lowcarbon-h2-sc/about-hydrogen/index.html)

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