



# Energy Transition Briefing

1<sup>ST</sup> March 2024

Mitsubishi Heavy Industries, Ltd.

# Mitsubishi Heavy Industries Group at a Glance



**1884** Foundation  
over 130 years history



**77,283** Employees  
(Consolidated)



**254** Group Companies  
(Consolidated)



**¥4.2TN (\$31.1BN\*)** Revenue  
(FY2022, consolidated)



**Diverse products**  
On land, at sea, in the sky, in space

Note: The U.S. dollar revenue figure was converted from Japanese yen using the FY2022 average exchange rate, JPY 134.9/USD.



Gas turbines



Compressors



Aero engines



CO<sub>2</sub> capture plants



Metals machinery



Chemical plants



Transportation



Waste-to-energy



Turbochargers



Aerospace



Rocket engines



Defense



# 1. MHI Initiatives and solutions for Energy Transition



## Three Pillars to realize “Mission Net Zero”



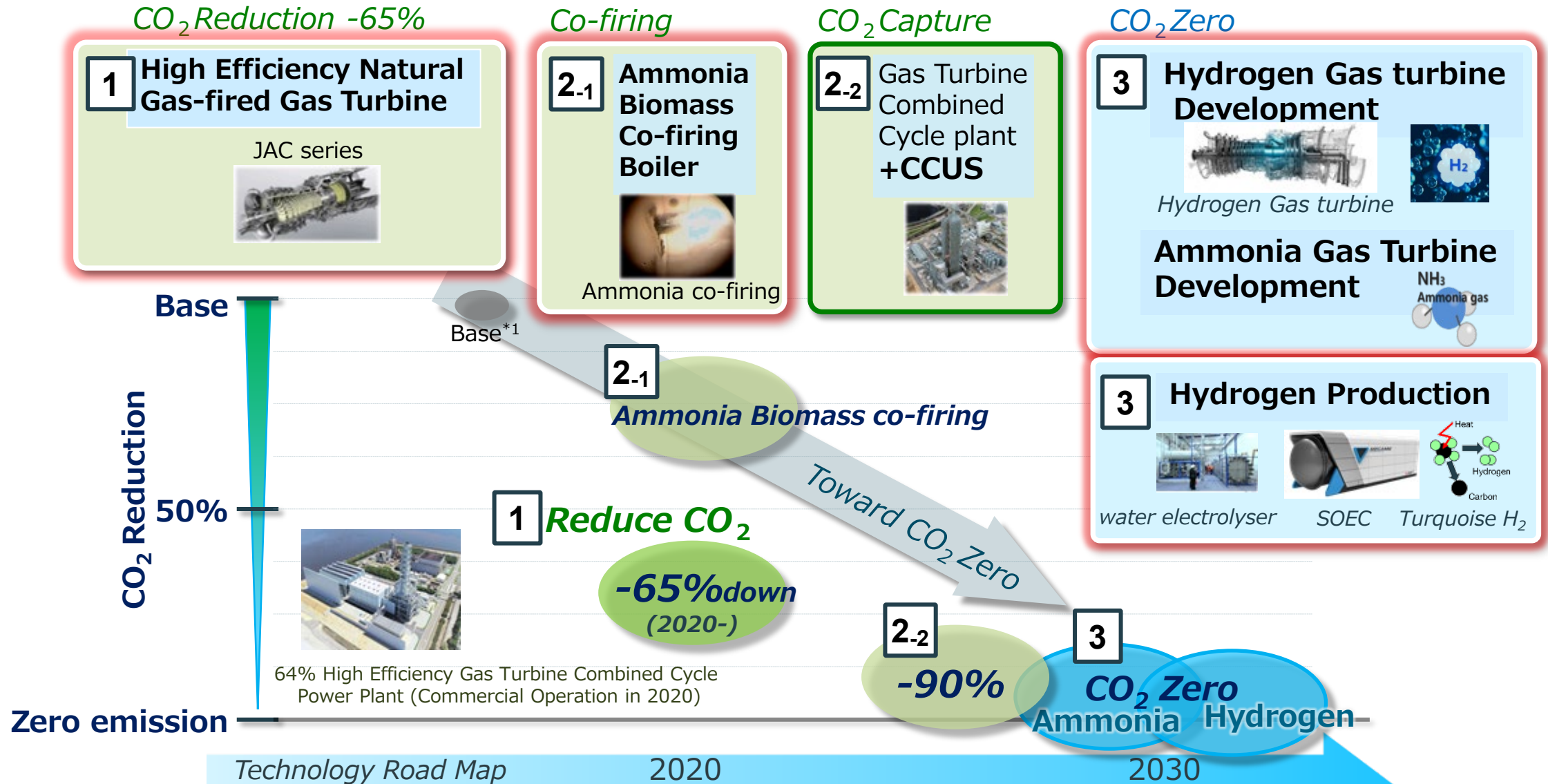
## 2. Realizing a Decarbonize existing infrastructure and Hydrogen Solutions Ecosystem



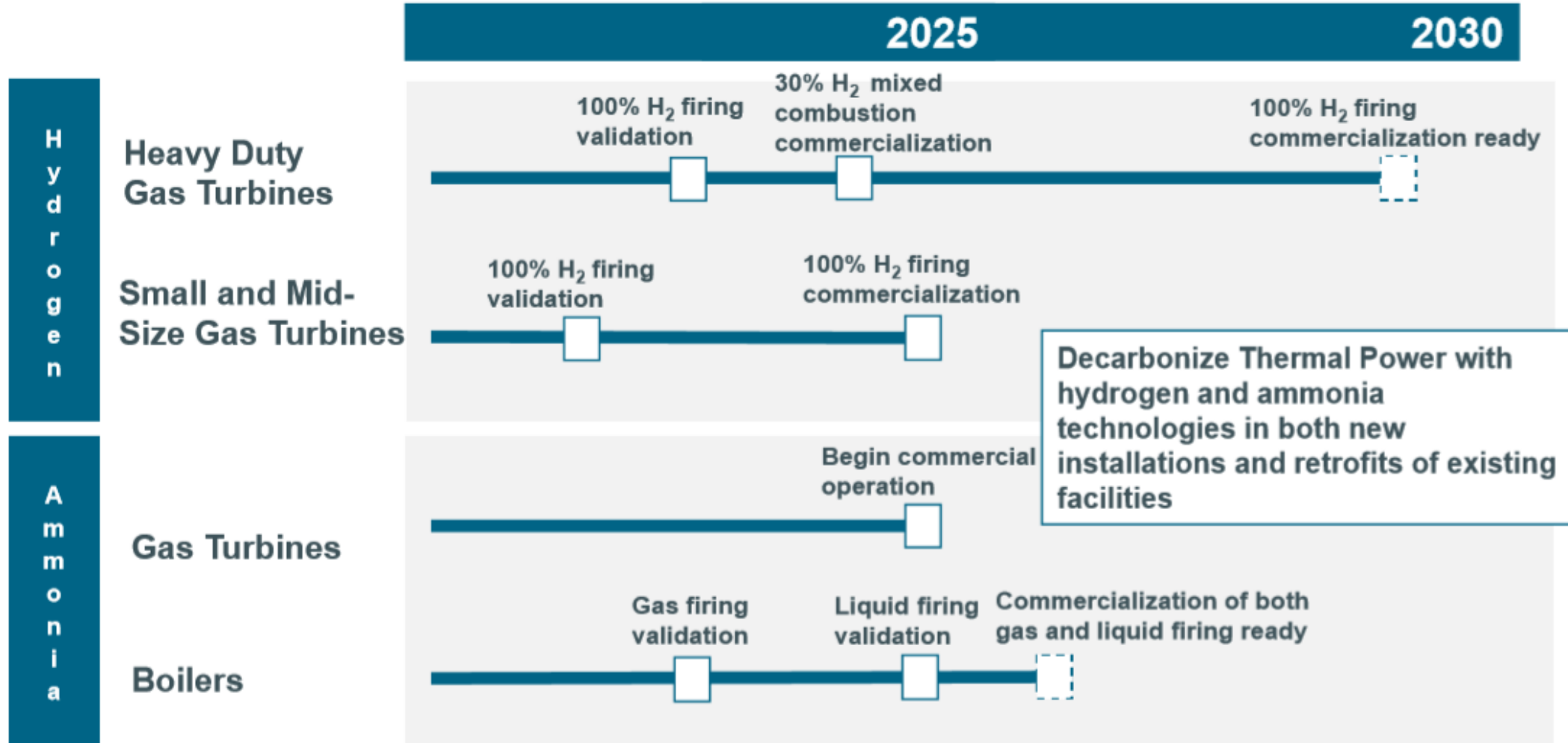


# CO2 Zero power generation technology Roadmap

Reduce CO<sub>2</sub> by High Efficiency Gas Turbine → ZERO CO<sub>2</sub> by Hydrogen Gas Turbine



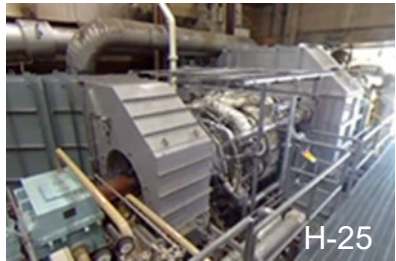
Validate and begin commercializing carbon-free power generation using hydrogen and ammonia by 2025



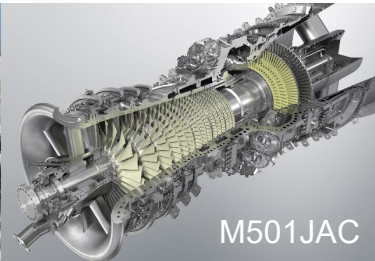
# Takasago Hydrogen Park

■ Integrated validation of hydrogen production, storage, and utilization began at Takasago Machinery Works in 2023

## Hydrogen Utilization (Power Generation)

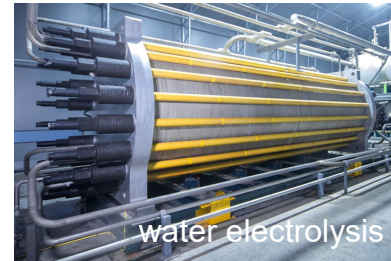


H-25



M501JAC

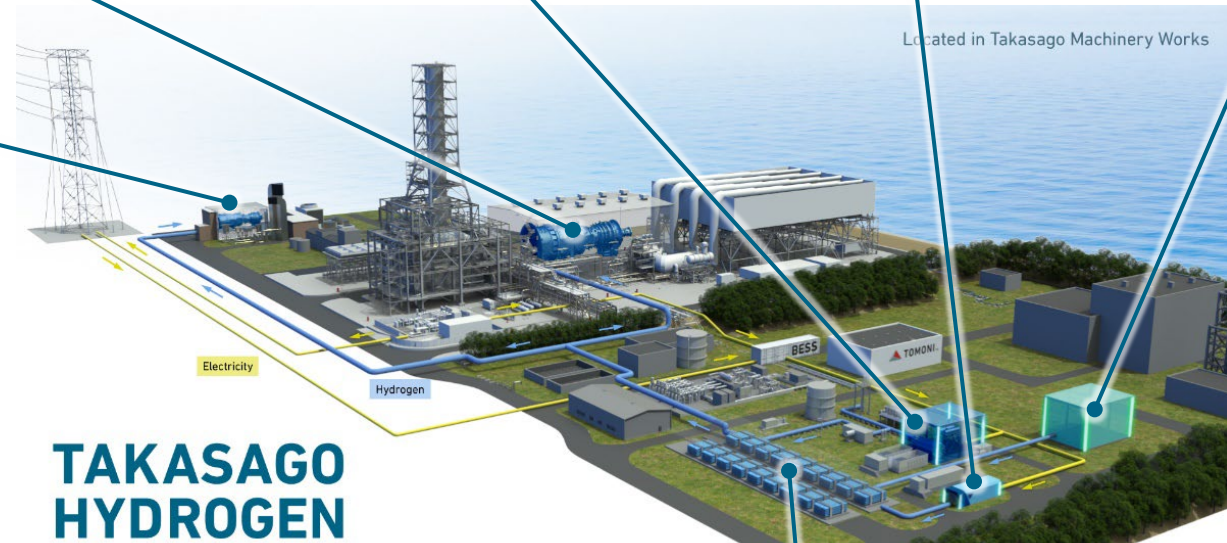
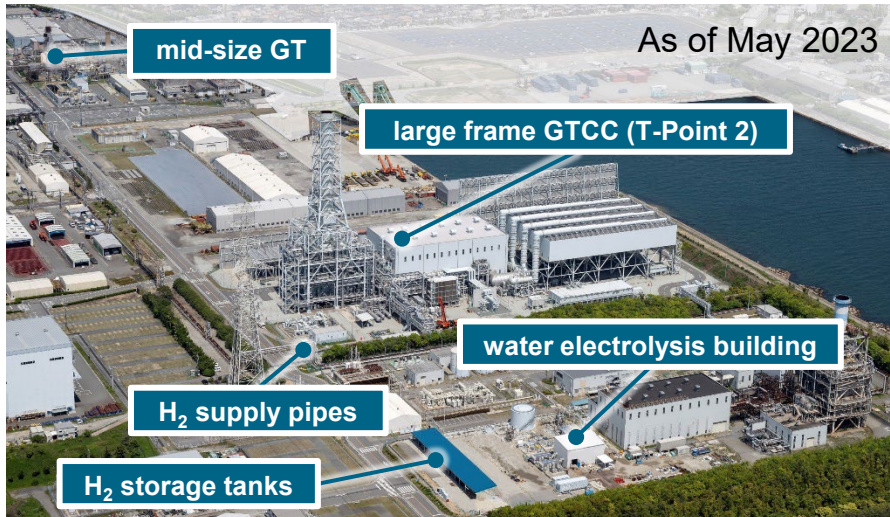
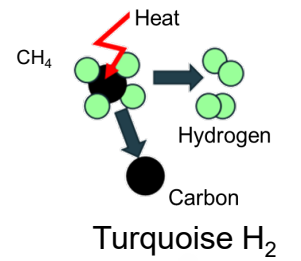
## Hydrogen Production



water electrolysis



SOEC



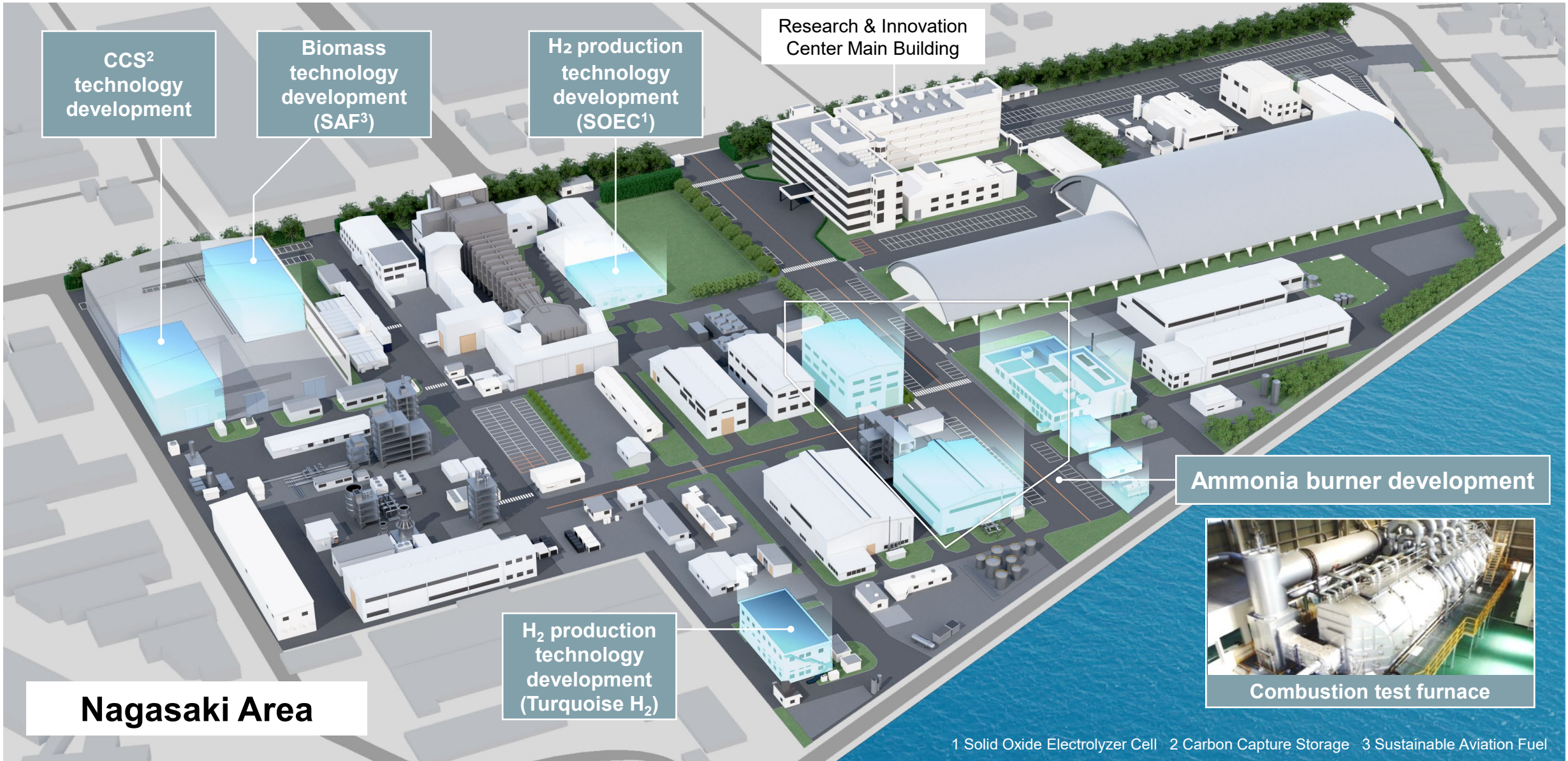
## TAKASAGO HYDROGEN PARK

Image figure (Partly different from the actual layout and configuration)

## Hydrogen Storage



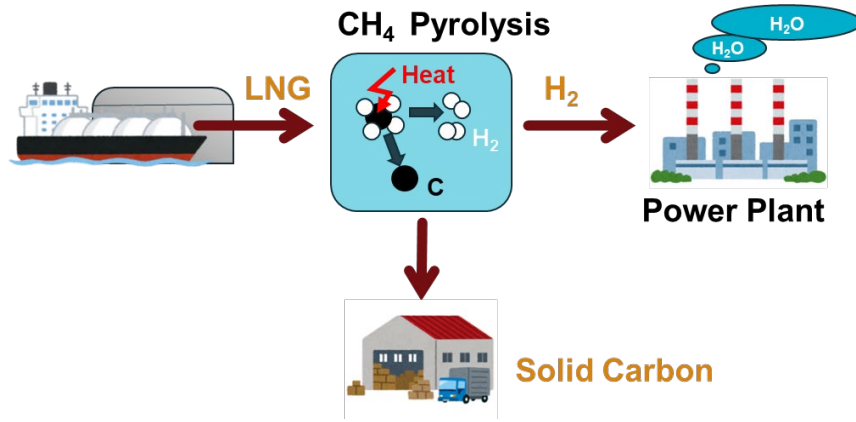
# Nagasaki Carbon Neutral Park



# Status of Hydrogen Production Technology Development

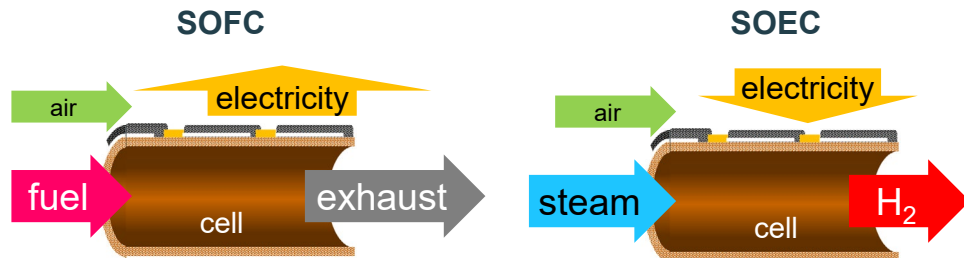
## Turquoise Hydrogen

- Produce hydrogen by methane pyrolysis with catalyst. Recover carbon as a solid.
- Low-cost supply of carbon-free H<sub>2</sub> at scale utilizing existing LNG infrastructure



## SOEC

- SOEC (Solid Oxide Electrolysis Cell) produces hydrogen using steam and electricity
- Able to apply cell technology by reversing SOFC (Solid Oxide Fuel Cell) reaction



- Planning to start validation of MHI-developed SOEC during FY2023
- Executing development and validation aiming for commercialization in FY2026 or thereafter

2023

2024

2025

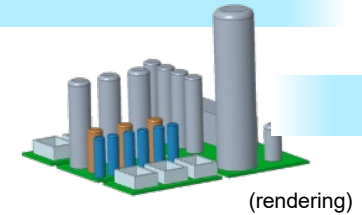
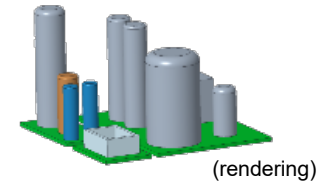
2026-

## Turquoise H<sub>2</sub>

Elemental testing

Development & validation

Commercialization

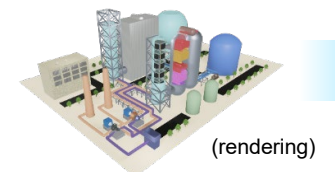
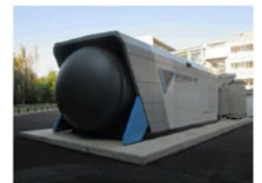


## SOEC

Elemental testing

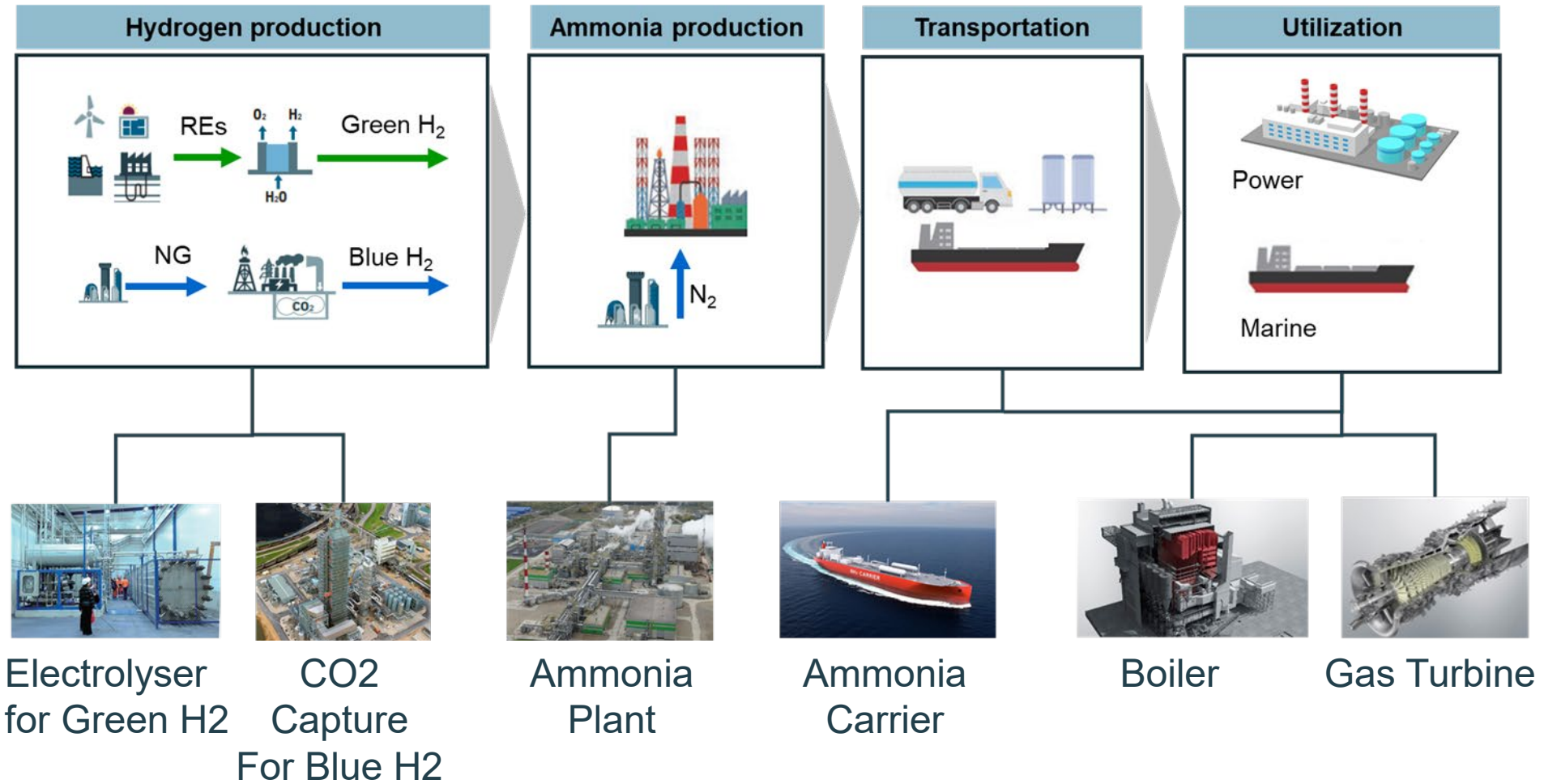
Development & validation

Commercialization





MHI has variety of products that contribute to the establishment of Hydrogen / Ammonia Value Chain.



# MHI H2/NH3 power generation projects

Hydrogen related projects

Ammonia related projects

## Zero Carbon Humber (H2H Saltend)

M701F, 1,200MW (3 CCGT)  
Hull, Humber, UK (after 2026)

## Magnum

M701F, 440MW (1 CCGT out of 3 CCGT)  
Eemshaven, the Netherlands (TBD)

## Linkou Steam Power Plant

NH<sub>3</sub> co-firing, 800MW×3units,  
New Taipei, Taiwan (FS)

## BLCP Steam Power Plant

NH<sub>3</sub> co-firing, 700MW×2units,  
Map Ta Phut, Thailand (FS)

## Intermountain Power

M501JAC, 840MW (2 CCGT)  
Delta, Utah, USA  
(30vol% H<sub>2</sub> firing in 2025, 100% firing in 2045)

## McDonough

M501G, 2,520MW (3 CCGT)  
Smyrna, Georgia, USA  
20vol% hydrogen co-firing  
validated (in 2022)

## Meranti Power

M701F, 340 MW x 2 (in 2025)

## Keppel Infrastructure

M701JAC, 600 MW (in 2026)

## Sembcorp Industries

M701JAC, 600 MW (in 2026)

## Keppel Data Center

CCGT Singapore (TBD)

## ADNOC

MOU for Blue Hydrogen,  
Ammonia and CCS

## Advanced Clean Energy Storage

Green Hydrogen Production and Storage  
Delta, Utah, USA (in 2025)

## Energy Decarbonization

Decarbonizing Entergy' utilities Texas, USA  
M501JAC (2 CCGT) (in 2026)

## EMA/ MPA

Ammonia bunkering & power  
generation

## Port of Newcastle

Under discussion to establish H2  
HUB and clean energy economy

## Keramasan CCGT Project

H-25, 80MW (2 CCGT),  
South Sumatra, Indonesia (FS)

## Suralaya Steam Power Plant

NH<sub>3</sub> co-firing, 600MW×3units,  
Cilegon, Indonesia (FS)

## Guacolda Steam Power Plant

NH<sub>3</sub> co-firing, 150MW×5units,  
Atacama, Chile (FS)



## 3. Realizing a CO<sub>2</sub> Solutions Ecosystem



Build a CO<sub>2</sub>  
solutions ecosystem



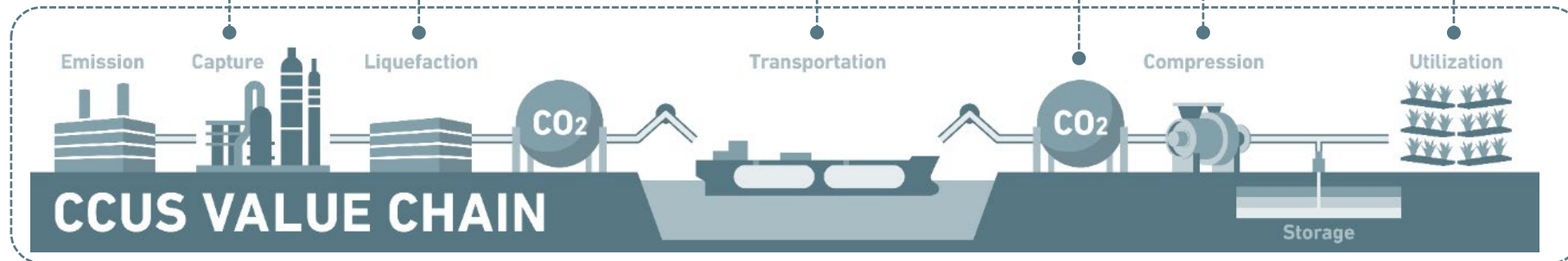
## Capture, Transport, Utilization.. Entire CCUS Value Chain Solution



CCUS Digital Platform

CO<sub>2</sub>NNEX

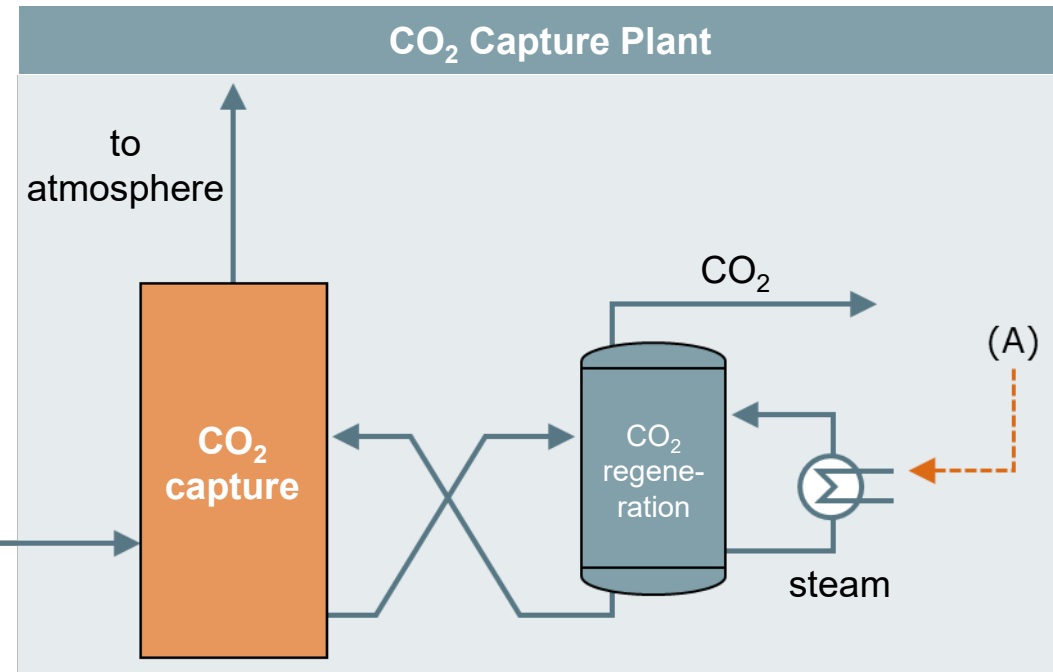
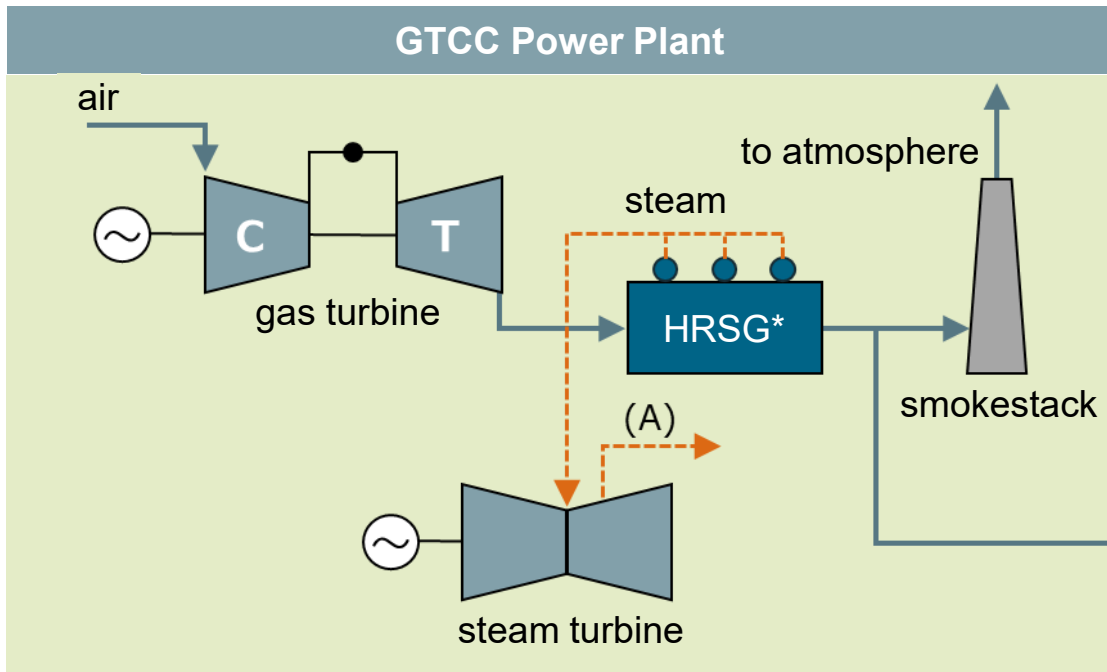
Example : Fertilizer plant





# High-Efficiency GTCC + CO<sub>2</sub> Capture

■ By applying a CO<sub>2</sub> capture system to a GTCC plant, it is possible to capture over 90% of CO<sub>2</sub>



- Awarded Front End Engineering Design (FEED) contract for CO<sub>2</sub> capture plant to be applied to a natural gas-fired GTCC power generation facility in Alberta, Canada
- Supporting customers' decarbonization efforts with both GTCC and CO<sub>2</sub> capture systems

<https://www.mhi.com/news/220711.html>

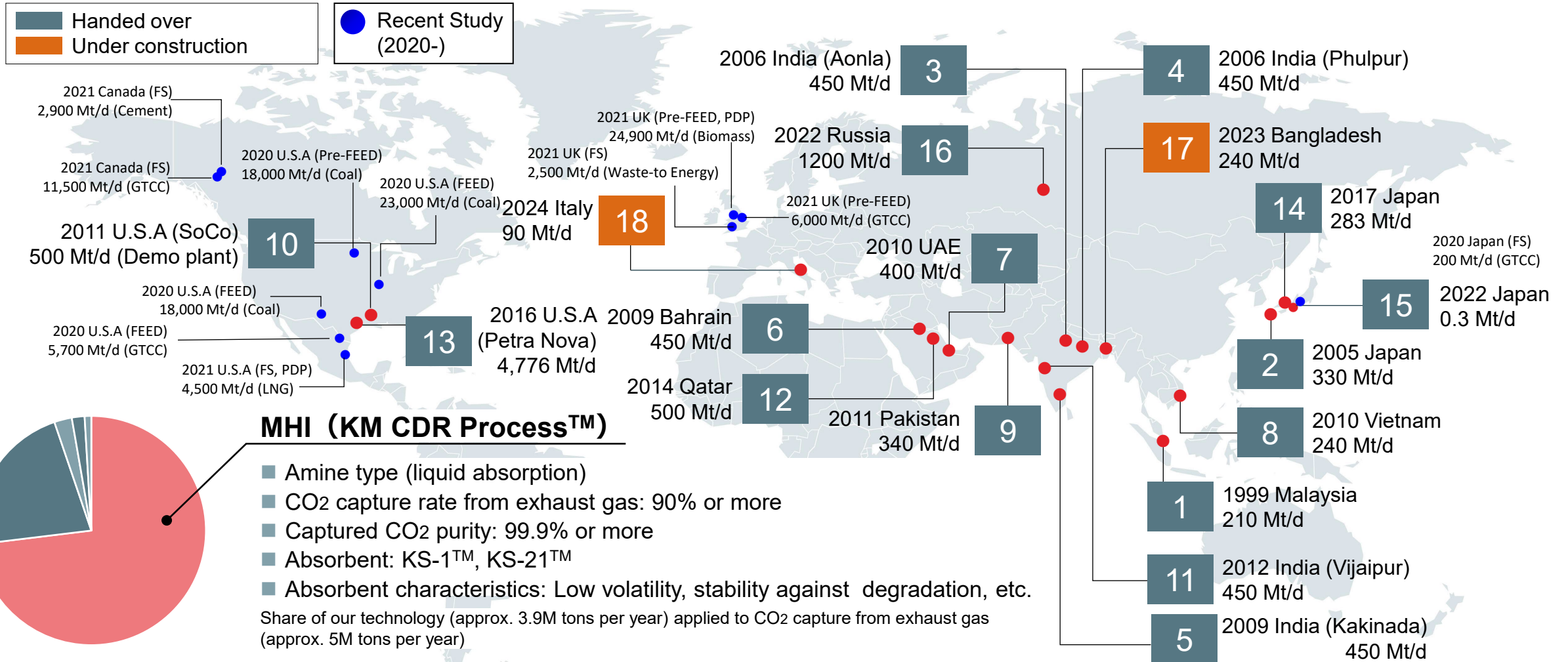


- Awarded FEED contract for GTCC power generation facility and CO<sub>2</sub> capture plant in Scotland
- Supporting commercial-scale CCS implementation, contributing to UK's achievement of Net Zero by 2050

<https://www.mhi.com/news/22083001.html>

# Building a CCUS Ecosystem – Global initiative in CO<sub>2</sub> Capture

MHI's experienced global KM CDR Process™ team stands ready to meet customer requirements for commercial CO<sub>2</sub> capture plants on various exhaust from conceptual design through detailed engineering and project delivery.





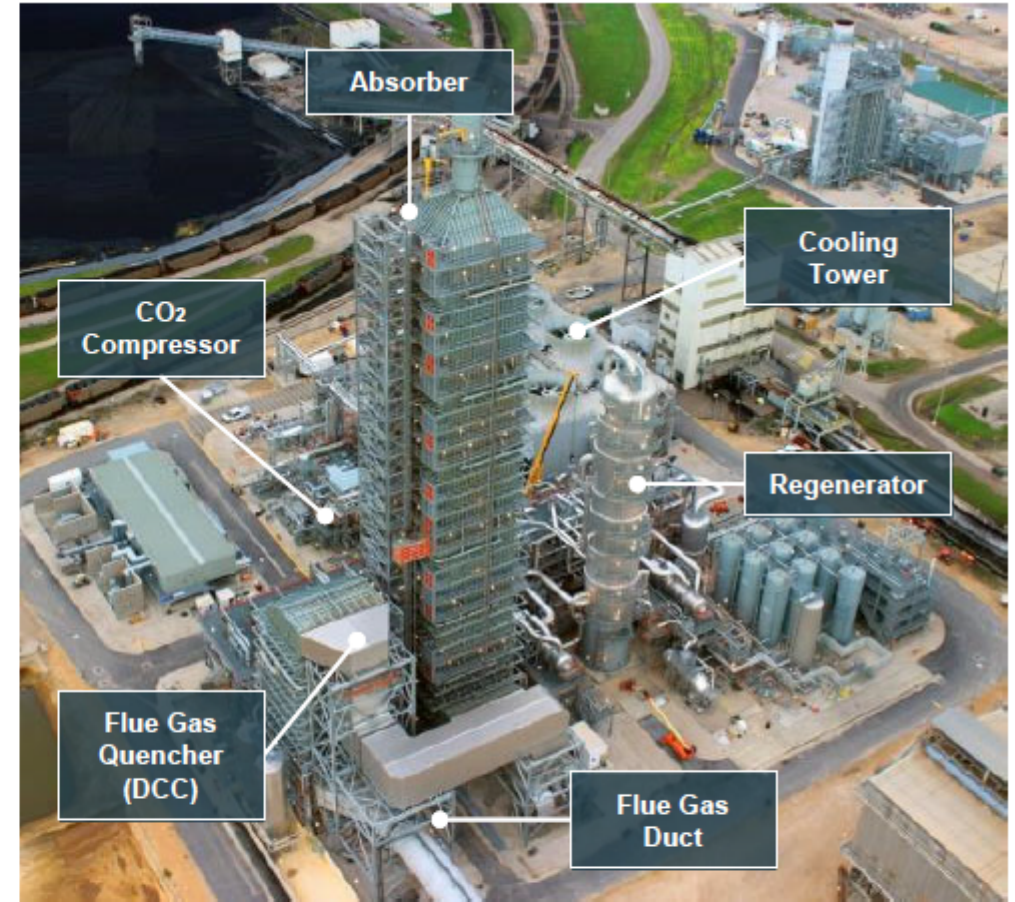
## Petra Nova Project

The World's Largest Post-Combustion Carbon Capture Plant

### EPC full turnkey project

- MHI has provided the world's largest carbon capture plant on coal-fired flue gas delivered in December 2016 for Petra Nova Project
- Supported by DOE (U.S. Department of Energy) grant program (CCPI\* Round 3) and Japanese government finance (JBIC / NEXI)

Project Formation	<ul style="list-style-type: none"> <li>• Consortium of MHI / Kiewit / The Industrial Company (TIC)</li> <li>• MHI: Engineering and Procurement for Carbon Capture Plant</li> <li>• Kiewit: Utility and balance of plant</li> <li>• TIC: Construction</li> </ul>
Plant location	NRG WA Parish Power Plant (Thompsons, TX)
Project owner	Petra Nova - partnership between NRG Energy and JX Nippon Oil&Gas Since 2022, full ownership under JX Nippon Oil&Gas
Plant scale	240 MW <sub>eq</sub>
CO2 capacity	4,776 Mt/d (1.4 MMT/y)



Carbon Capture Plant

\*Clean Coal Power Initiative

\*U.S. Department of Energy "W.A. Parish Post-Combustion CO<sub>2</sub> Capture and Sequestration Project Final Environmental Impact Statement Volume I" (Feb, 2013), DOE/EIS-0473

Source: Press Release by MHI

