

# Carbon Recycling Technology at NEDO

*The 31<sup>st</sup> Clean Coal Day 2022 International Conference  
Keynote Address for Session II (ii)*

September 6<sup>th</sup>, 2022

**SUZUKI Kyoichi**

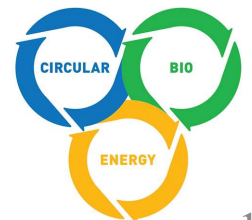
Director General, Environment Department  
New Energy and Industrial Technology Development Organization (NEDO)



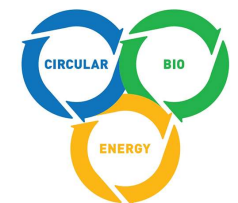
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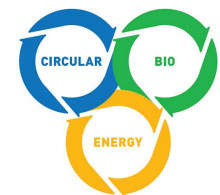
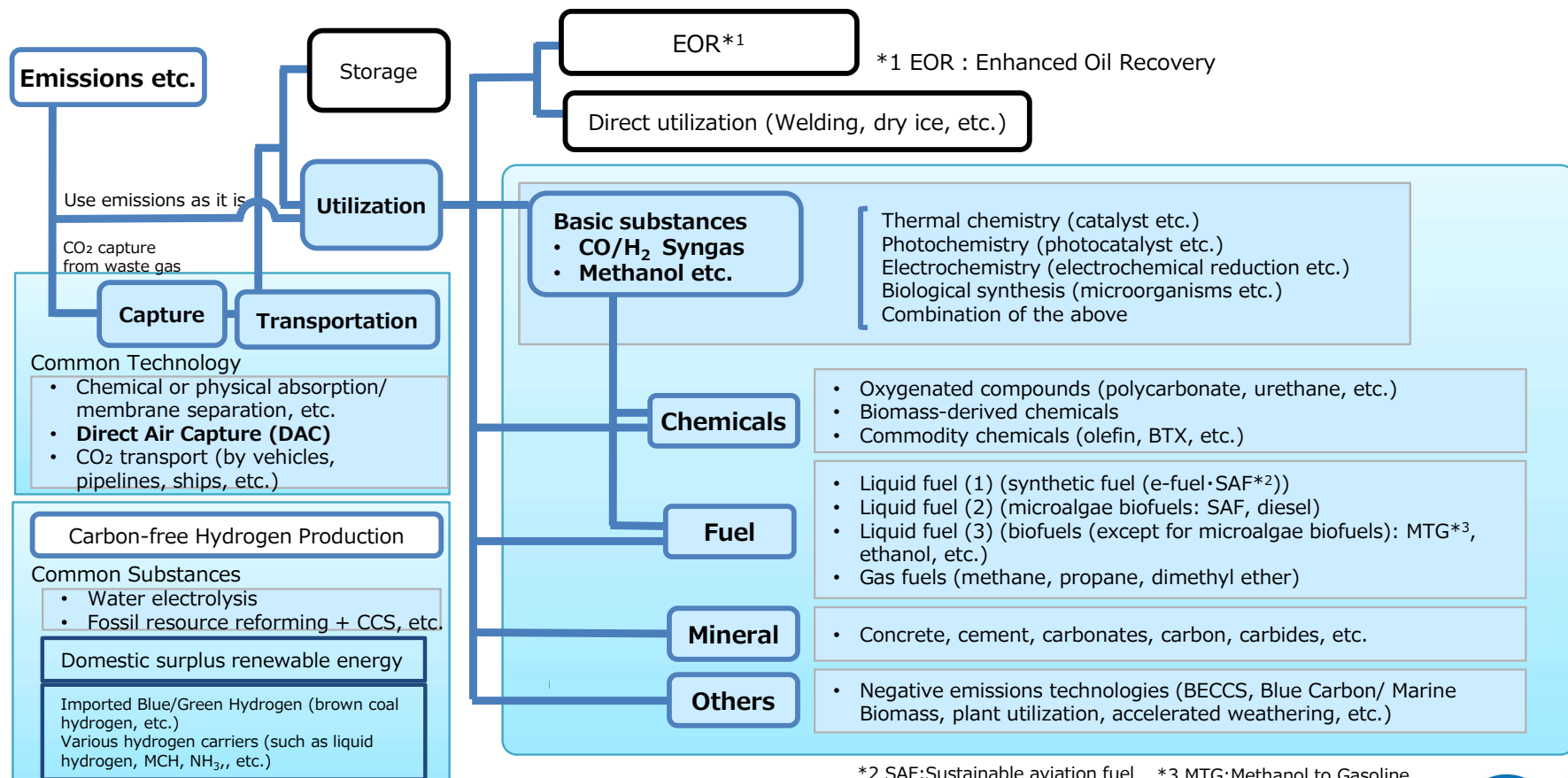


- ◆ In order to contribute to the resolution of social issues, NEDO formulates technology strategies and project plans and, as part of its project management, establishes project implementation frameworks by combining the capabilities of industry, academia, and government.
- ◆ NEDO also promotes technology development by carrying out, evaluating, and allocating funding to promising projects to accelerate the practical application of project results.



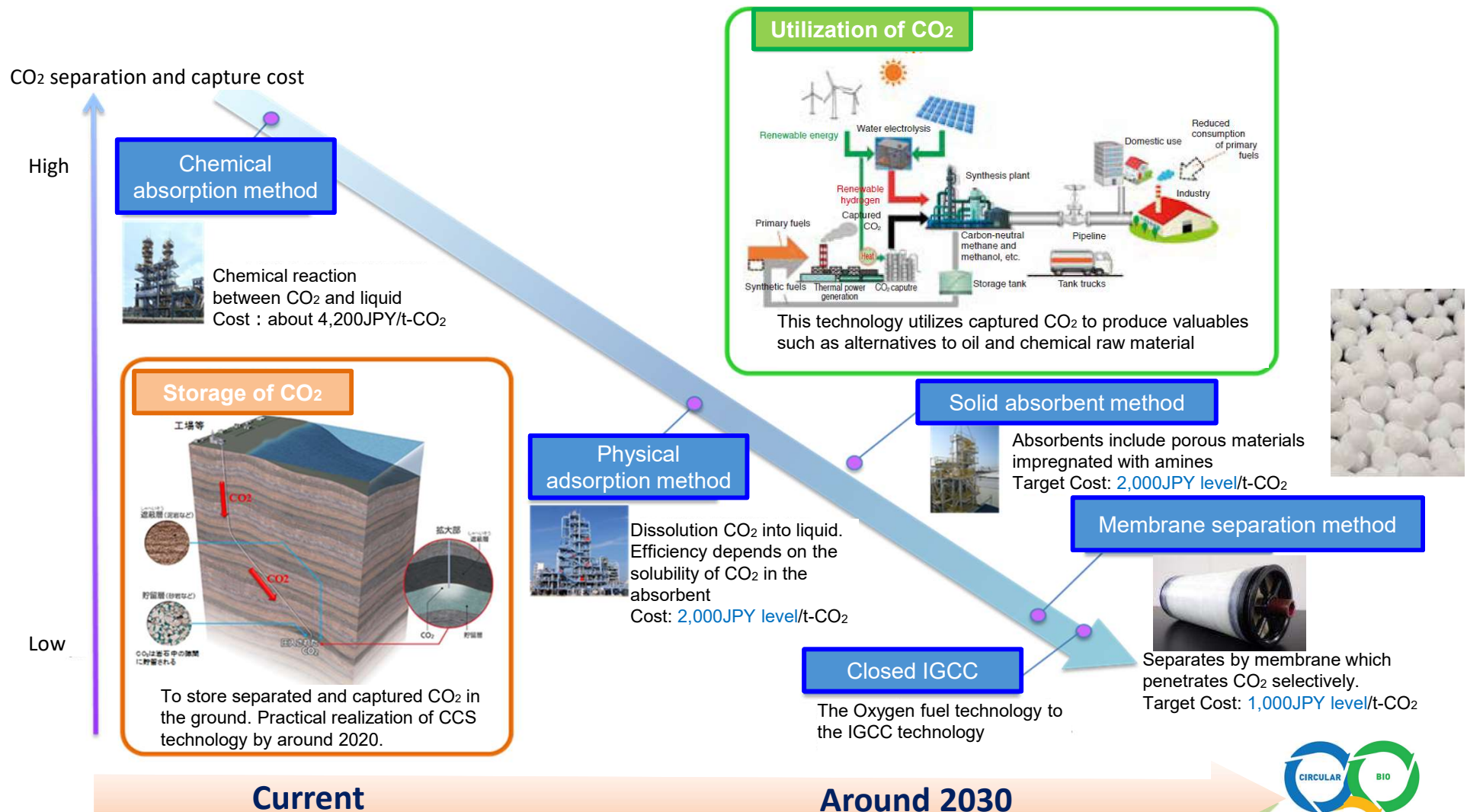
# Overview of Carbon Recycling

**Carbon Recycling:** Considering CO<sub>2</sub> as a resource, capture CO<sub>2</sub> and reuse it for concrete etc. by mineralization, for chemicals by artificial photosynthesis etc. and for fuel by methanation etc. to reduce CO<sub>2</sub> emissions into the atmosphere.



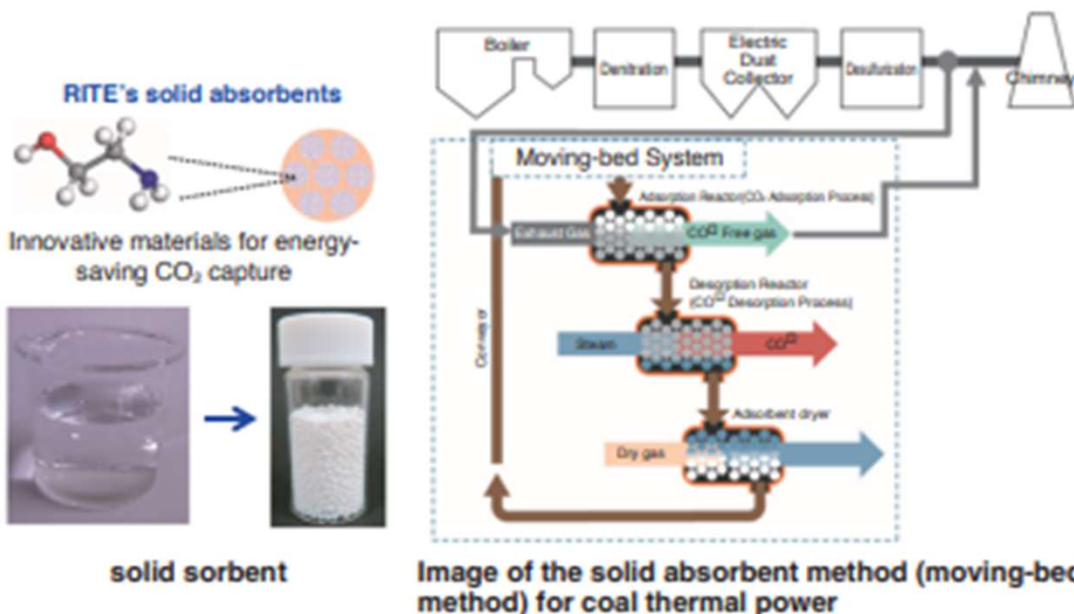
# CO<sub>2</sub> capturing and related technology : Outlook

- ◆ As a first step of CR, cost reduction of CO<sub>2</sub> capturing technologies is critical.
- ◆ Projects on solid absorbent and membrane separation are on going.



# CO<sub>2</sub> capturing and related technology: Practical research and development of CO<sub>2</sub> solid sorbents

- ◆ NEDO aimed to lower costs and expand scale by developing a massive synthesis method for materials and conducting a bench-scale test using a moving-bed system since FY2018.
- ◆ Through a pilot-scale test at Kansai Electric Power Co., Inc's Maizuru Power Plant, which is scheduled to start up in 2023, NEDO aims to put technology for capturing CO<sub>2</sub> with solid sorbents into practical use.



< **Period** >

2018-2024

< **Contractors** >

Kawasaki Heavy Industries,  
RITE

◆ For the purpose of the safe and efficient transportation of CO<sub>2</sub> captured at factories and/or thermal power plants, etc., for carbon recycle or CCS, NEDO has started development of the integrated maritime transportation system.

Liquefied CO<sub>2</sub> carrier and terminal (image)

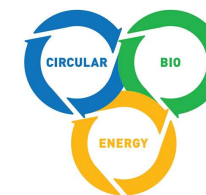


**< Project period >**

August 2021 ~ March 2027

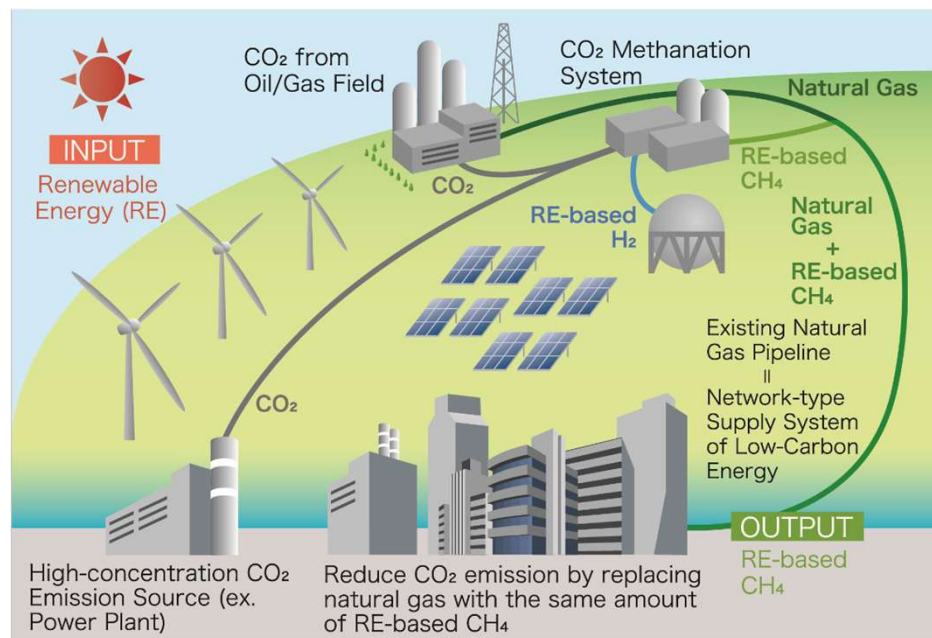
**< Contractors >**

Japan CCS Co., Ltd., Engineering Advancement Association of Japan, ITOCHU Corporation, Nippon Steel Corporation



# Carbon Recycling : Methanation project

- ◆ Pilot-scale methanation project (8 Nm<sup>3</sup>-CO<sub>2</sub>/h) was successfully concluded in 2021 and large-scale demonstration (targeting 400 Nm<sup>3</sup>-CO<sub>2</sub>/h) will start shortly.
- ◆ Methane produced by this project will be supplied through existing gas pipeline.



**Reduction of CO<sub>2</sub> by substituting natural gas with carbon-neutral methane**



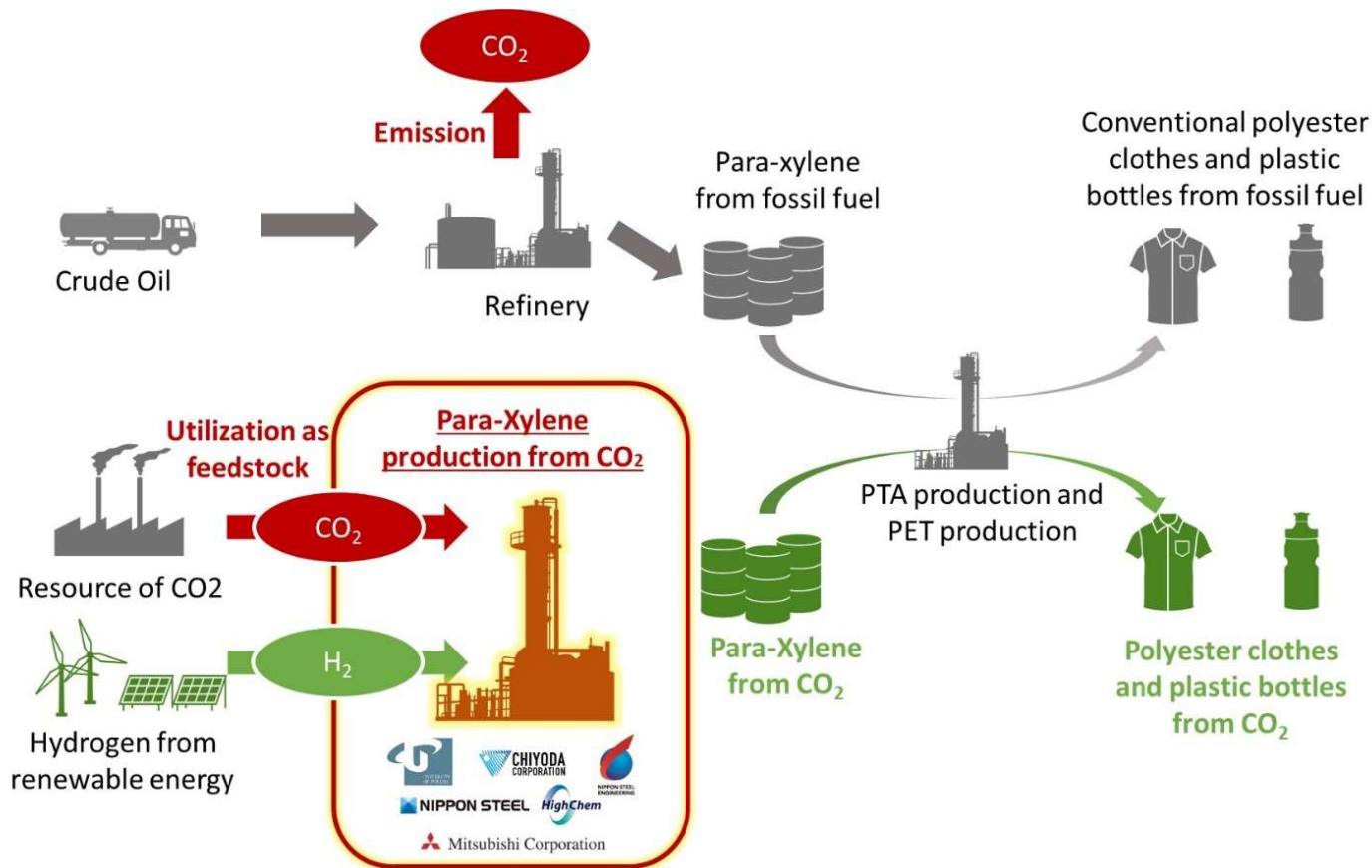
**Methanation test facility**

(Pilot-scale: 8 Nm<sup>3</sup>-CO<sub>2</sub>/h, at Nagaoka, Niigata)



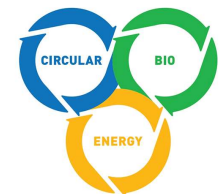
# Carbon Recycling : Para-xylene

- ◆ Chemical product is one of possible target when utilizing carbon in CO<sub>2</sub>.
- ◆ Potentially, 160 mil tons of CO<sub>2</sub> could be reduced when annual world para-xylene demand is replaced by Carbon Recycling technology.
- ◆ Finding innovative catalyst for mass production is required.







< Period > FY2020~FY2023

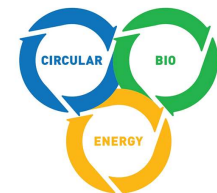
< Contractors > University of Toyama, Chiyoda Corporation, Nippon Steel Engineering Co., Ltd., Nippon Steel Corporation, HighChem Company Limited, Mitsubishi Corporation



# Carbon Recycling : Carbonate, Concrete

- ◆ Carbonate, concrete products, and concrete structures have a high potential for immobilization by CO<sub>2</sub> utilization technology due to their high usage, and the products after immobilization are stable.
- ◆ In addition, unlike CO<sub>2</sub> utilization technologies for fuels and chemicals, the cost of hydrogen raw materials is not required, so there are high expectations for carbon recycling technologies, and early social implementation is desired.

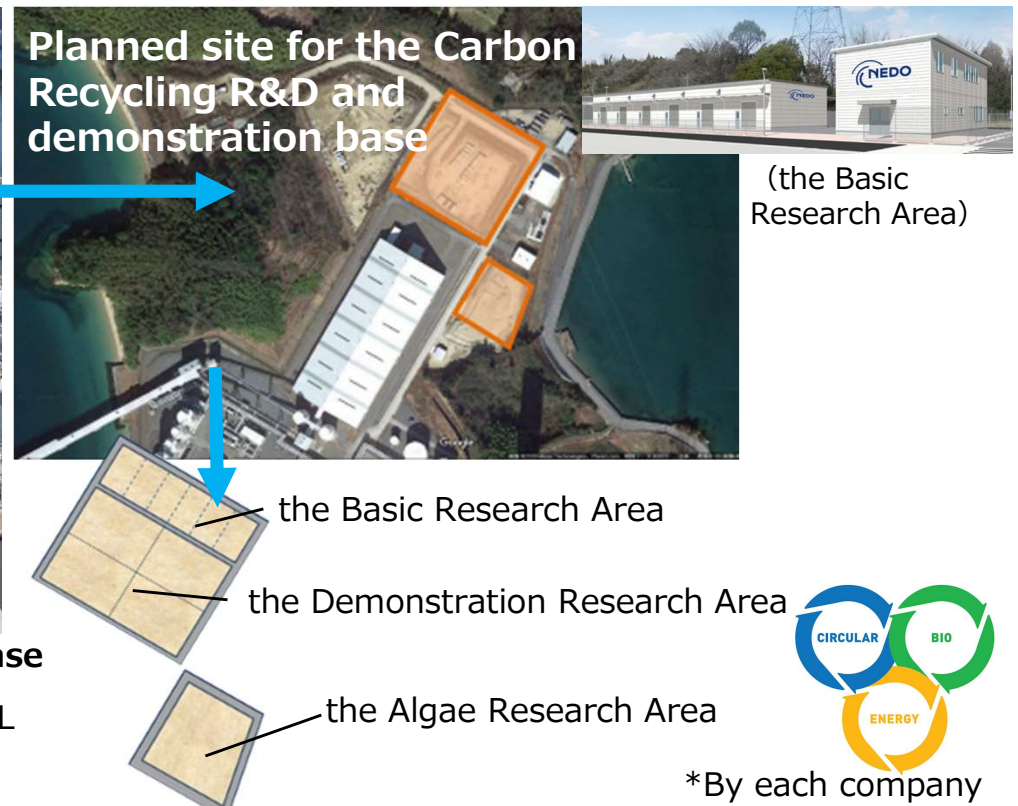
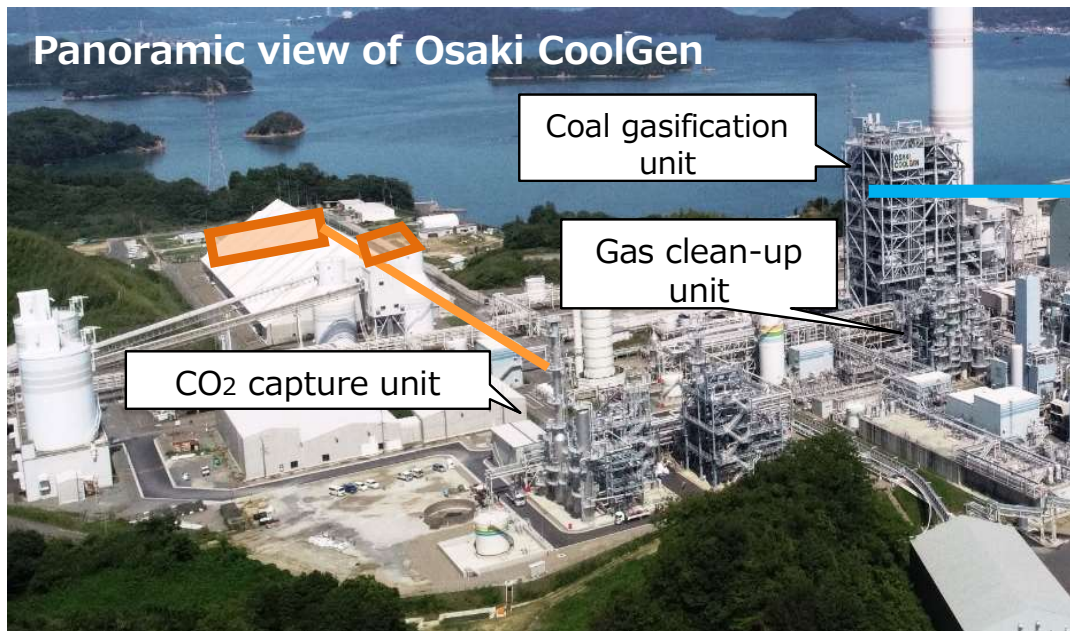
	Concrete Products	Casting Concrete on site	
Unreinforced	 <p>Road Block etc.</p>	 <p>Dam, River Structure etc.</p>	<div style="border: 1px solid green; padding: 5px; display: inline-block;">Practicalized</div> <div style="border: 1px solid red; padding: 5px; display: inline-block;">Development</div>
	 <p>Underpass, Waterway etc.</p>	 <p>Building, Pillar etc.</p>	<div style="border: 1px solid blue; padding: 5px;"> <p>&lt; Period &gt; Sep 2020 ~ March 2023</p> <p>&lt; Contractors &gt;                      The Chugoku Electric Power Co.,INC.                      Kajima Corporation                      Mitsubishi Corporation</p> </div>



# Carbon Recycling : Osaki CoolGen Project R&D and demonstration base



- ◆ In order to bring innovations in CR technologies, it is necessary to keep an easy access to certain amount of CO<sub>2</sub> as a research resource.
- ◆ Coordinating with other NEDO project; Osaki CoolGen (IGCC demonstration plant), captured CO<sub>2</sub> has been supplied to CR research and demonstration facilities via pipeline.



The image of the Carbon Recycling R&D and demonstration base

Implementers of development and operation: Osaki CoolGen, JCOAL

## <Project Schedule>

	FY2020	FY2021	FY2022	FY2023	FY2024
Development and operation of a CO <sub>2</sub> effective utilization base	Development of bases		Operation, Maintenance, and Support of bases		
Development of technology for effective use of CO <sub>2</sub> at research base	Pre-demonstration research*		Technology development and demonstration at base		
Development of basic technology for microalgae	Technology development at base*				

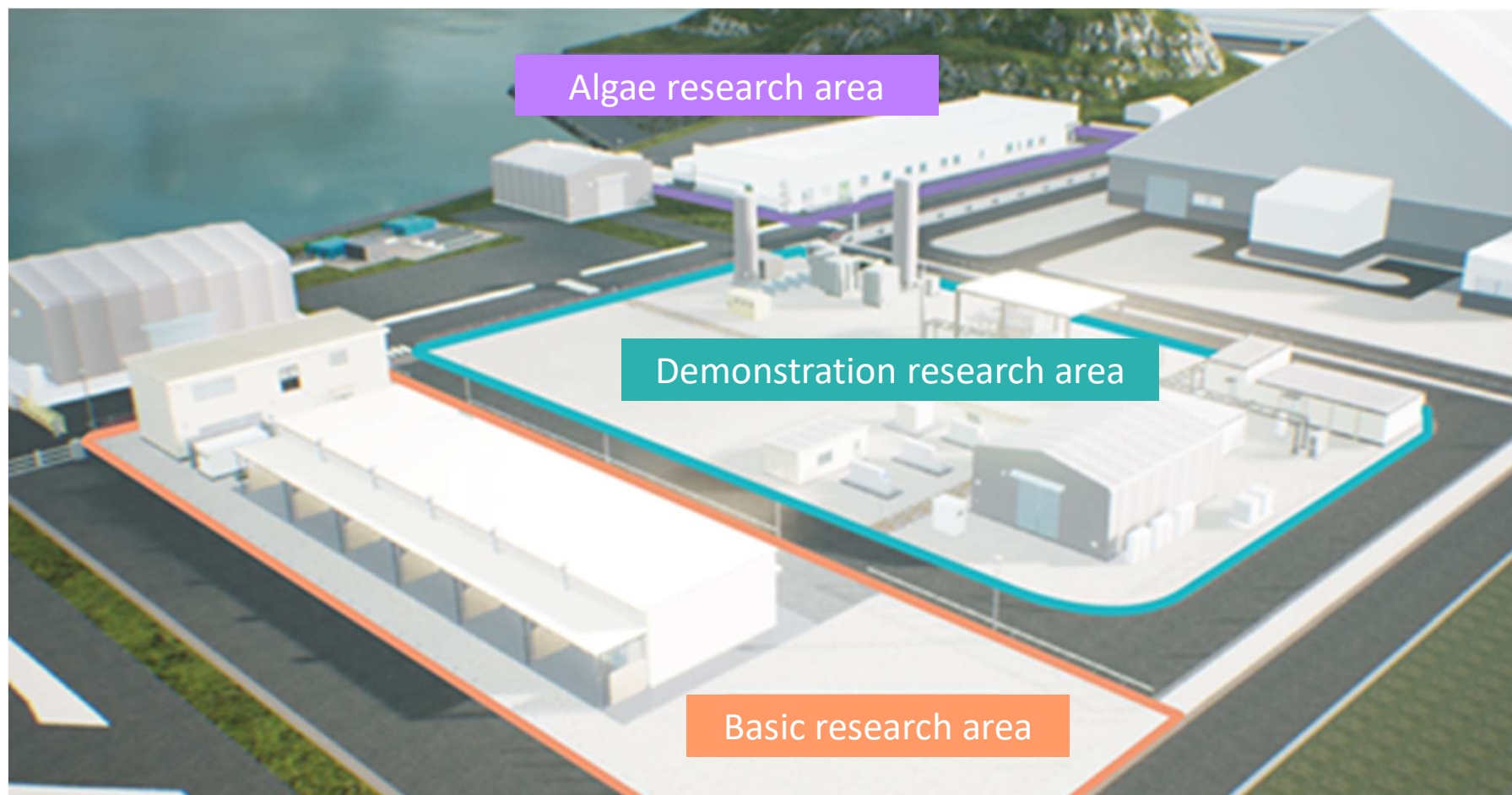
\*By each company

# Carbon Recycling : Osaki CoolGen Project Location



# Carbon Recycling : Osaki CoolGen Project

## Three Areas in the Base

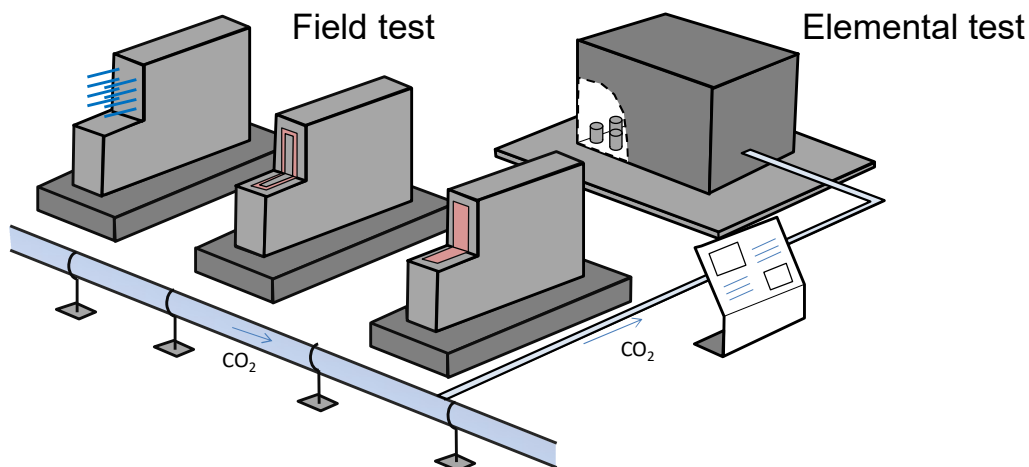


Contractors for the base development and operation:  
OSAKI CoolGen Corporation and JAPAN COAL FRONTIER ORGANIZATION (JCOAL)

# Carbon Recycling : Osaki CoolGen Project

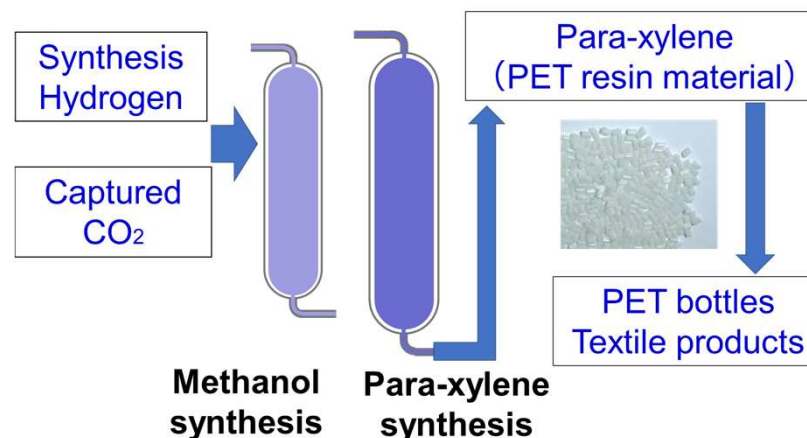
## Sub-projects in Demonstration Research Area and Algae Research Area

### Development of Efficient CO<sub>2</sub>-Use Concrete



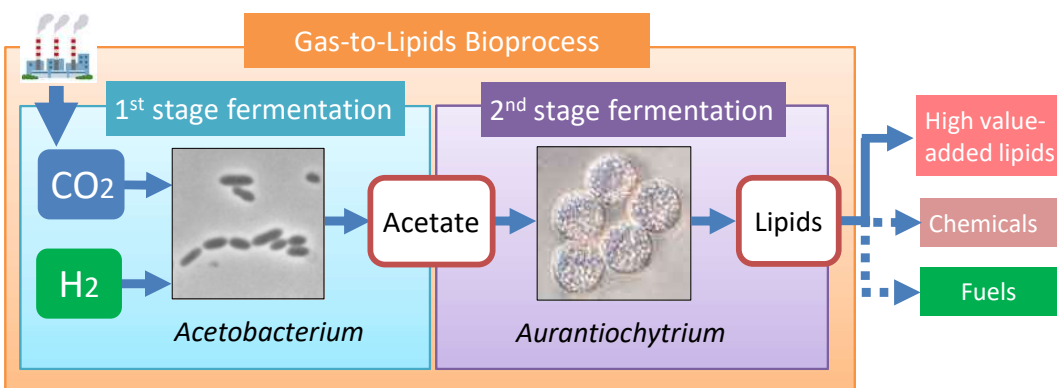
Contractors: The Chugoku Electric Power Co., Inc, Kajima Corporation and Mitsubishi Corporation

### Research on selective synthesis technology of chemical products for carbon recycling



Contractors: Kawasaki Heavy Industries, Ltd. and Osaka University

### Development of Gas-to-Lipids Bioprocess



Contractors: Hiroshima University and Chugoku Electric Power Co., Inc.

### Establishment of a Research & Technology Center for Industrialization of Bio-Jet Fuel and Improvement of CO<sub>2</sub> Utilization Efficiency with Microalgae



Contractor: Institute of Microalgal Technology, Japan (IMAT)

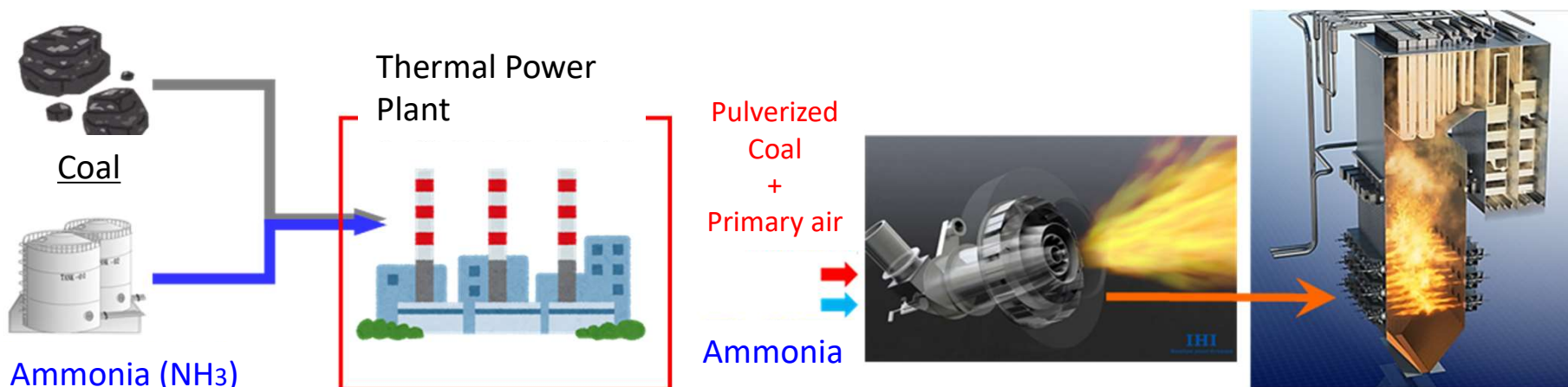


# Carbon Recycling : Osaki CoolGen Project

## Sub-projects in Basic Research Area

Sub-projects	Contractors
Producing key raw materials using diamond electrode from CO <sub>2</sub> in the coal power plant emission gases	Keio University, Tokyo University of Science and JCOAL
R&D on the methods for CO <sub>2</sub> decomposition / reduction processes using atmospheric pressure plasma	Tokai National Higher Education & Research System and Kawada Industries, Inc.
Development of the technologies for production and utilization of Algal biomass for efficient utilization of CO <sub>2</sub>	Nippon Steel Corporation
Synthesis of silicon carbide from industrial waste using CO <sub>2</sub> as carbon source	Tohoku University
R&D of the technologies and processes for carbon-recycled LPG production	ENEOS GLOBE Corporation, Nippon Steel Corporation and Toyama University
R&D on CO <sub>2</sub> fixation and useful chemicals production using microalgae	Algal Bio Co., Ltd. and Kansai Electric Power Co., Inc.

Looking to reduce future environmental impact, the demonstration project aims to establish ammonia co-firing technology by co-firing coal and ammonia at a large-scale commercial coal-fired power plant and evaluating both boiler heat absorption and environmental impact characteristics such as exhaust gases. Co-combustion of ammonia at a level of 20% in coal-fired power generation is progressing, and development of technologies will be pursued for high-ratio co-combustion and single fuel firing of ammonia. Assuming there is demand for replacing coal-fired power plants, technology necessary for single fuel firing of ammonia in gas turbines will also be developed.



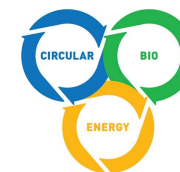
Co-firing of ammonia and coal at a thermal power plant

Conceptual image of an ammonia co-firing burner and boiler (courtesy of IHI Corporation)

**< Period >** FY 2021 ~ FY 2028  
**< Contractors for Boiler development >**  
IHI Corporation, MHI Ltd., and JERA Co., Inc.

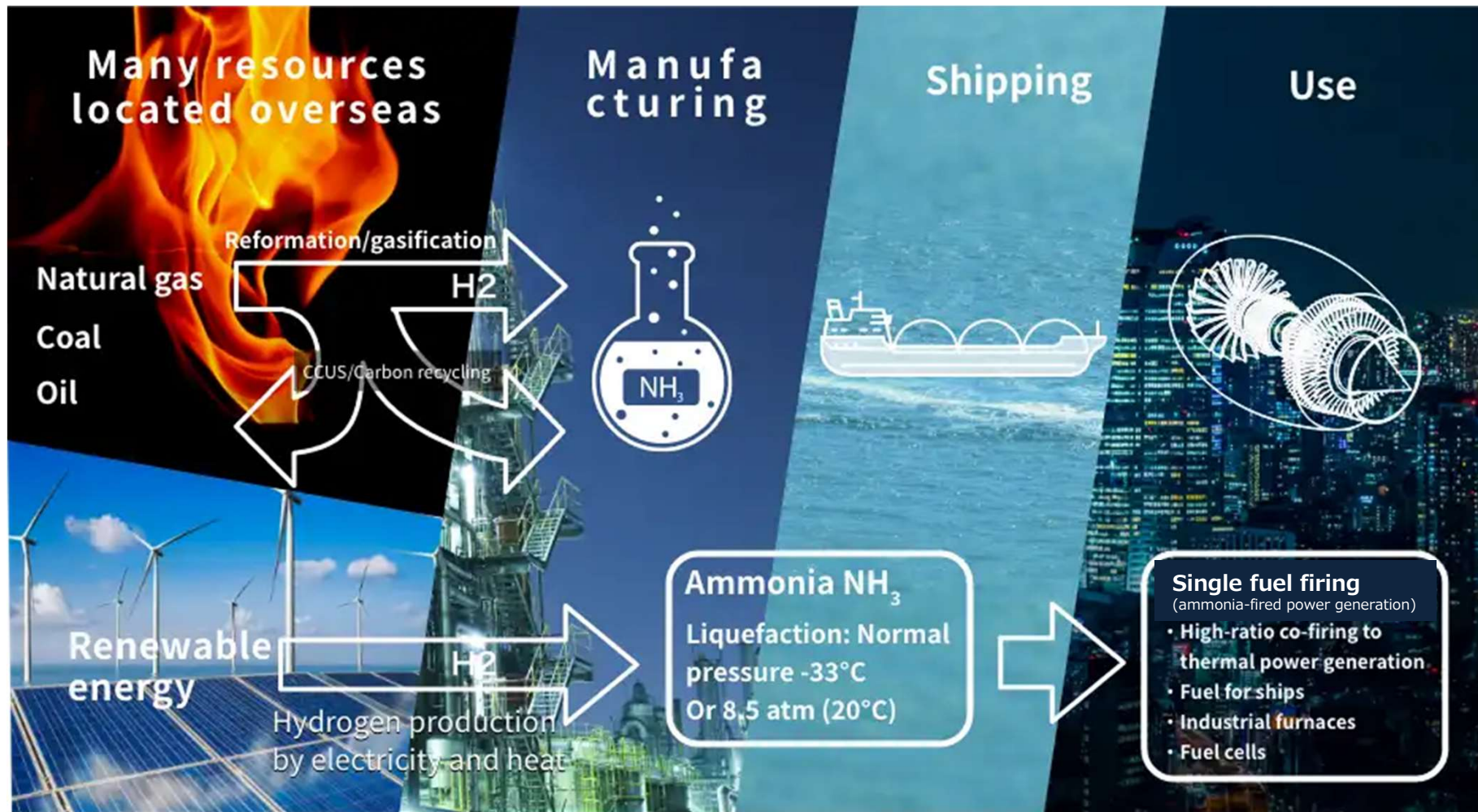
**< Period >** FY 2021 ~ FY 2027  
**< Contractors for Turbine development >**  
Tohoku university and AIST

Source: NEDO HP pamphlet "NEDO's Environmental Technology Activities in 2021"  
NEDO Projects



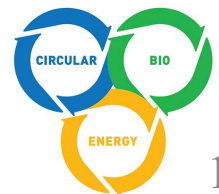


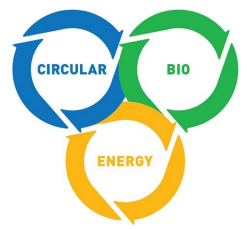
## Fuel Ammonia Supply Chain Establishment



### Project Features:

- ✓ Reduction of ammonia supply chain cost
- ✓ High-ratio co-combustion and single fuel firing needed for ammonia power generation





**Thank you for your attention.**