



R&D and Demonstration Base for Carbon Recycling at Osaki-Kamijima

New Energy and Industrial Technology Development Organization

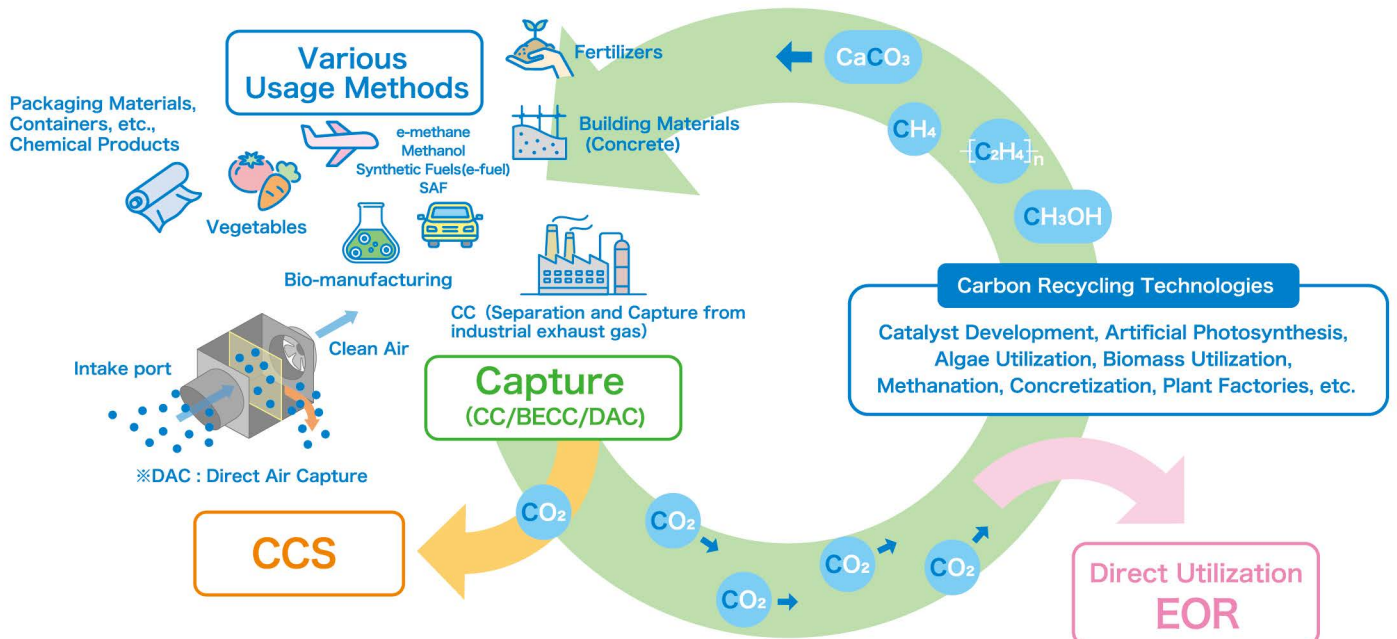
What is Carbon Recycling?

In efforts to curb global warming, reducing CO₂ emissions has become a global challenge. Japan has set a goal of becoming carbon neutral by 2050, aiming to reduce greenhouse gas emissions by 46% from 2013 levels by 2030 and take on the challenge of reaching the 50% mark. Carbon Recycling is currently attracting attention as a way to reduce CO₂ emissions into the atmosphere by reusing CO₂ as a resource for materials, fuel, and other purposes.

So at the Davos meeting in January 2019, Japan referred to the need to recycle CO₂, and in June of the same year, the Ministry of Economy, Trade, and Industry (METI) formulated the Roadmap for Carbon Recycling Technologies, a policy which considers CO₂ as a resource, separates and recovers it, and reuses it in form of various products such as concrete, chemicals, and fuels to curb CO₂ emissions into the atmosphere. The Ministry presented the "3C Initiative for Carbon Recycling" in September of the same year, and the "Innovative Strategy for Environmental Innovation (adopted by the Council for the Promotion of the Integrated Innovation Strategy)" in January 2020. They have announced the development of Osakikamijima city in Hiroshima Prefecture to build a demonstration and research center for carbon recycling technology, as part of a demonstration project for an Integrated Coal Gasification Combined Cycle (IGCC)/ Integrated Coal Gasification Fuel Cell Combined Cycle (IGFC). The center opened in September 2022. In December 2020, the Ministry of Economy, Trade and Industry took the lead in formulating the "Green Growth Strategy Accompanying Carbon Neutrality in 2050" in collaboration with related ministries and agencies. In this strategy, carbon recycling is positioned as a key technology in one of the significant areas to achieve a carbon neutral society. In addition, the Ministry of Economy, Trade and Industry formulated the "Carbon Recycling Roadmap" in June 2023 which outlines goals and issues for social implementation as well as technology.

January, 2019	Japan mentioned the need for CO ₂ recycling (A speech of Prime Minister at the Davos Conference)
June, 2019	"Roadmap for Carbon Recycling Technologies" announced
September, 2019	"Carbon Recycling 3C Initiative" announced
January, 2020	"Progressive Environmental Innovation Strategy" announced
October, 2020	"Achieving Carbon Neutrality in 2050" declared
December, 2020	"Green Growth Strategy Through Achieving Carbon Neutrality in 2050" announced
July, 2021	Carbon Recycling Technology Roadmap Revised
September, 2022	Carbon Recycling Demonstration and Research Center on Osakikamijima city, Hiroshima Prefecture Opened
June, 2023	Carbon Recycling Technology Roadmap Established

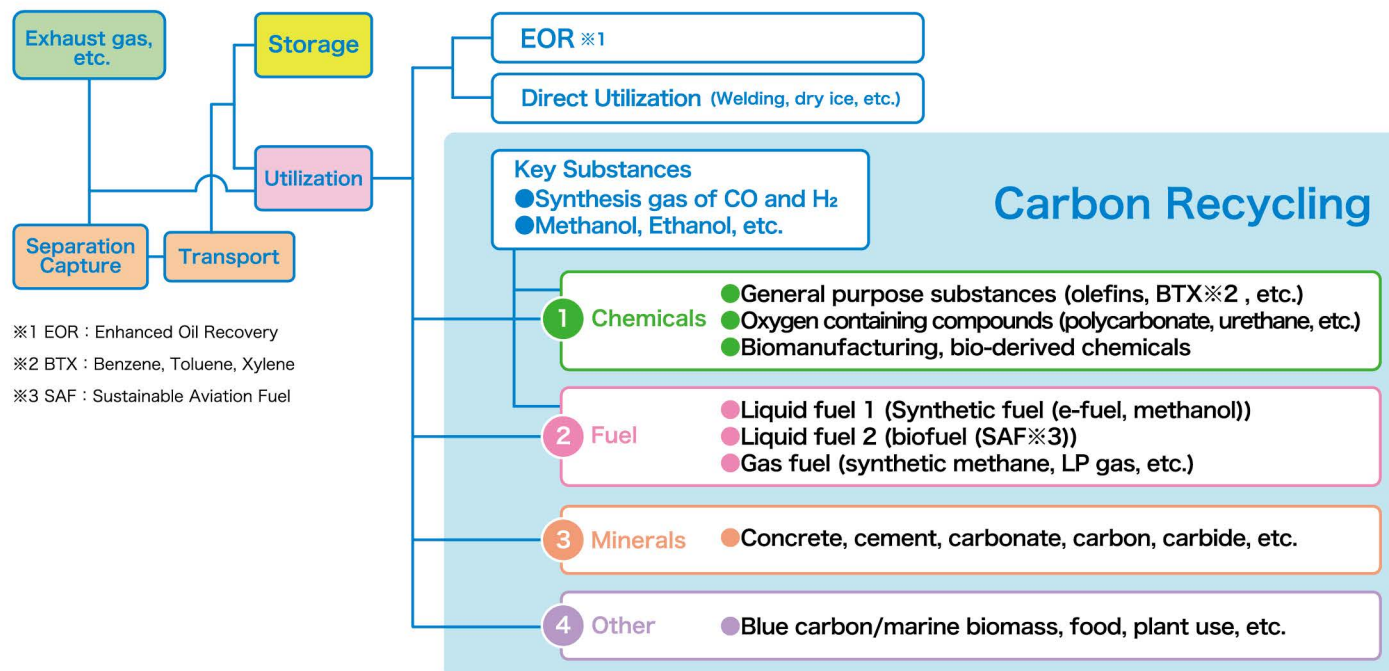
Carbon Recycling, which effectively utilizes CO₂ as a resource, can be used in various fields such as chemicals, concrete/cement, machinery, engineering, fuels for transportation and biotechnology, giving Japan a competitive edge. As Carbon Recycling technology is established, its use is expanded, and costs are lowered, it is expected to develop into a new Japanese industry that will be a major key to reducing the use of fossil fuels and thus helping to prevent global warming in the future.



What is the Use of Carbon Recycling?

At present, the use of Carbon Recycling is mainly assumed in the following categories :

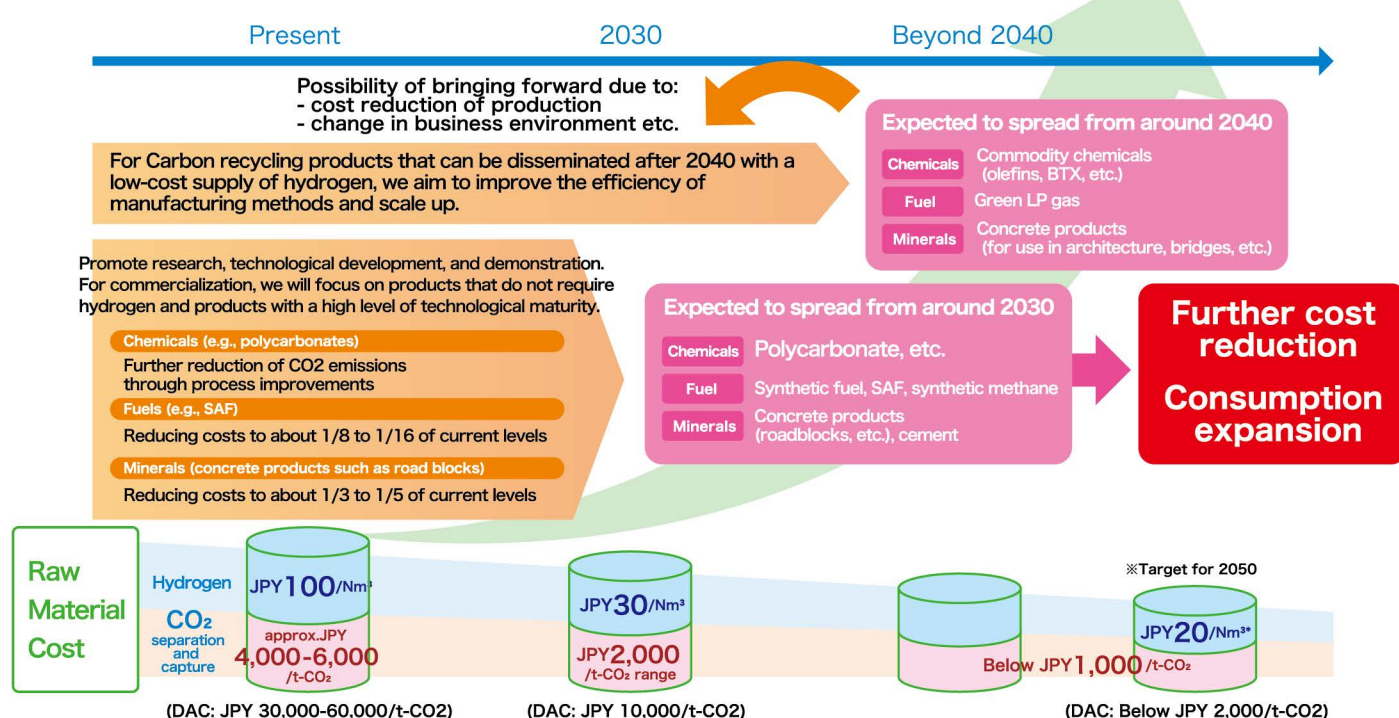
【① chemicals】 , 【② fuels】 , 【③ minerals】 , and 【④ others】 .



Source: Prepared by NEDO based on "Carbon Recycling Roadmap" (Ministry of Economy, Trade and Industry)

Carbon Recycling Roadmap

The "Carbon Recycling Technology Roadmap" was originally formulated in June 2019 and revised in July 2021. It was further developed into "Carbon Recycling Roadmap" mainly by experts for promoting carbon recycling by organizing its significance and issues and formulated in June 23 by the Ministry of Economy, Trade and Industry (METI) in cooperation with the Cabinet Office, Ministry of Education, Culture, Sports, Science and Technology (MEXT), Ministry of Land, Infrastructure, Transport and Tourism (MLIT), and Ministry of the Environment (MOE). While taking into account the procurement environment for hydrogen and the maturity of the technologies, the aim is to establish technologies as early as possible in each product field, reduce costs, and promote widespread use. This will be achieved through technological advancement, development and demonstration.



Source: Prepared by NEDO based on "Carbon Recycling Roadmap" (Ministry of Economy, Trade and Industry)

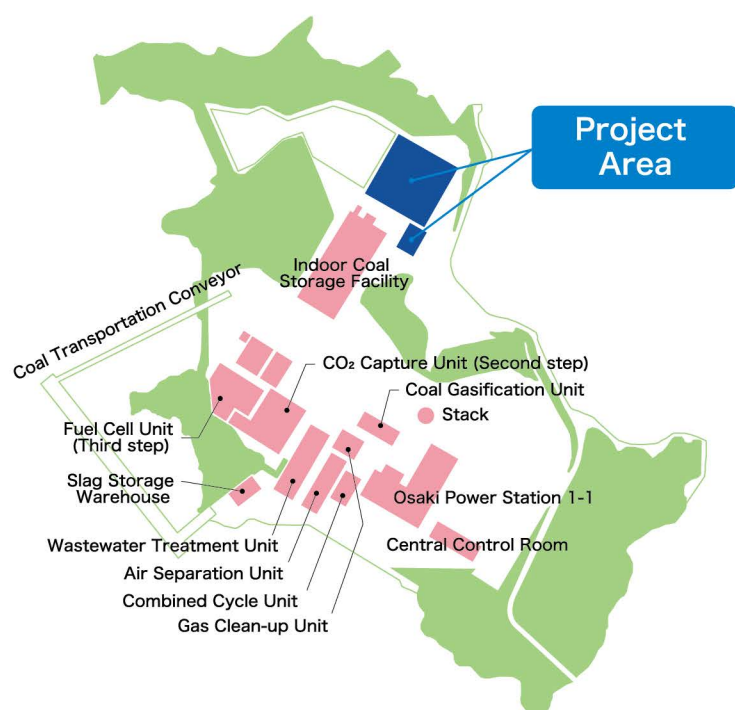
R&D and Demonstration Base for Carbon Recycling -- Our Activities at Osaki-Kamijima --



At Osaki-Kamijima Island, Hiroshima, located in the middle of the scenic Seto Inland Sea, a center of activity was established based on “Carbon Recycling 3C Initiative” announced by METI in 2019. This center offers companies and universities, aiming to realize a carbon-neutral and decarbonized society, hub of activity to promote their R&D activities. Our aim is to accelerate innovation and practical application of Carbon Recycling by conducting underlying technology development and demonstration in a concentrated and extensive manner. Furthermore, through showcasing the details and results of their activities we will share Japan’s cutting-edge technologies to the world.

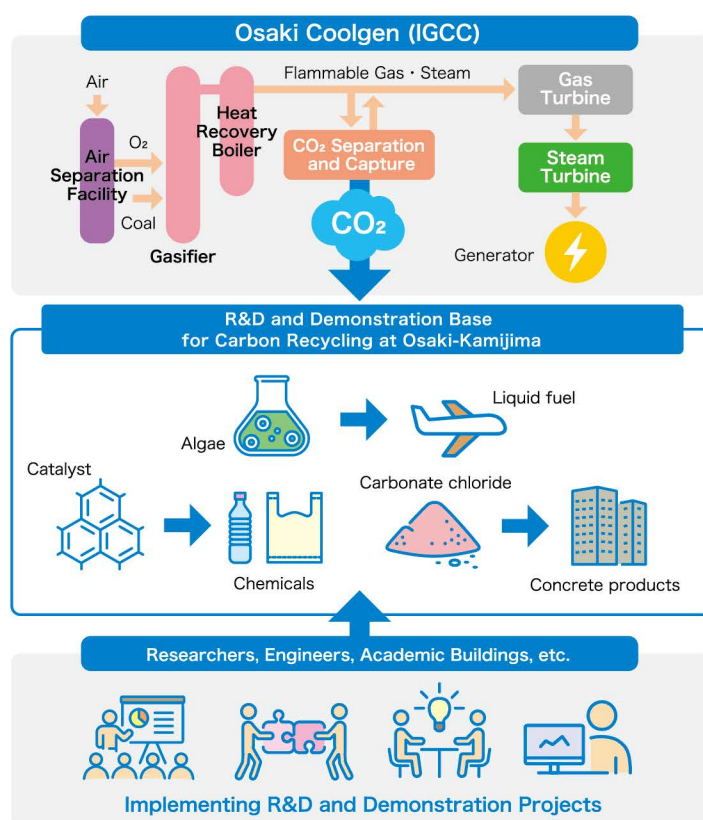
Layout

At the Osaki Power Station (operated by Osaki CoolGen), where demonstration tests of coal-fired thermal power generation combined with IGFC cycle and CO₂ separation and capture technologies are being conducted, an environment will be created to enable centralized research and development of technologies that are world-leading and expected to be soon commercialized.



Diagram

Researchers in algae biotechnology, catalysts, carbon dioxide chloride, etc. will be brought together to conduct underlying technology development and demonstration research in a concentrated and extensive manner.



About the Facilities

The center consists of three areas: the Demonstration Research Area, Algae Research Area, and the Basic Research Area. The CO₂ separated and collected at Osaki CoolGen is transported by pipeline, with the underlying technology development and demonstration research on Carbon Recycling using said CO₂ conducted at each facility.

Demonstration Research Area



Carbon recycling technology demonstration and R&D with co-production of multiple valuable commodities by using seawater (Fiscal year 2023~)

Demonstrate CO₂ fixation technology to Magnesium Carbonate by using 20 ton/day of seawater.



Research of Selective Synthesis Technology of Chemical Products for Carbon Recycling

Develop catalysts and processes for efficient production of paraxylene, a raw material for PET bottles, etc. from CO₂.



Development of Gas-to-Lipids Bioprocess

Develop biorefinery technology using a two-step fermentation process to produce acetic acid from CO₂ and synthesize high-value-added lipids and chemical raw materials.

Algae Research Area



Establishing a Research Base and Developing Technologies that Lead to Increased CO₂ Utilization Rate for the Production of Microalgae-Derived SAF

Establish a base where technology verification can be conducted to improve basic technology for microalgae, leading to the industrialization of microalgae-derived SAF production.

Basic Research Area



Research Building

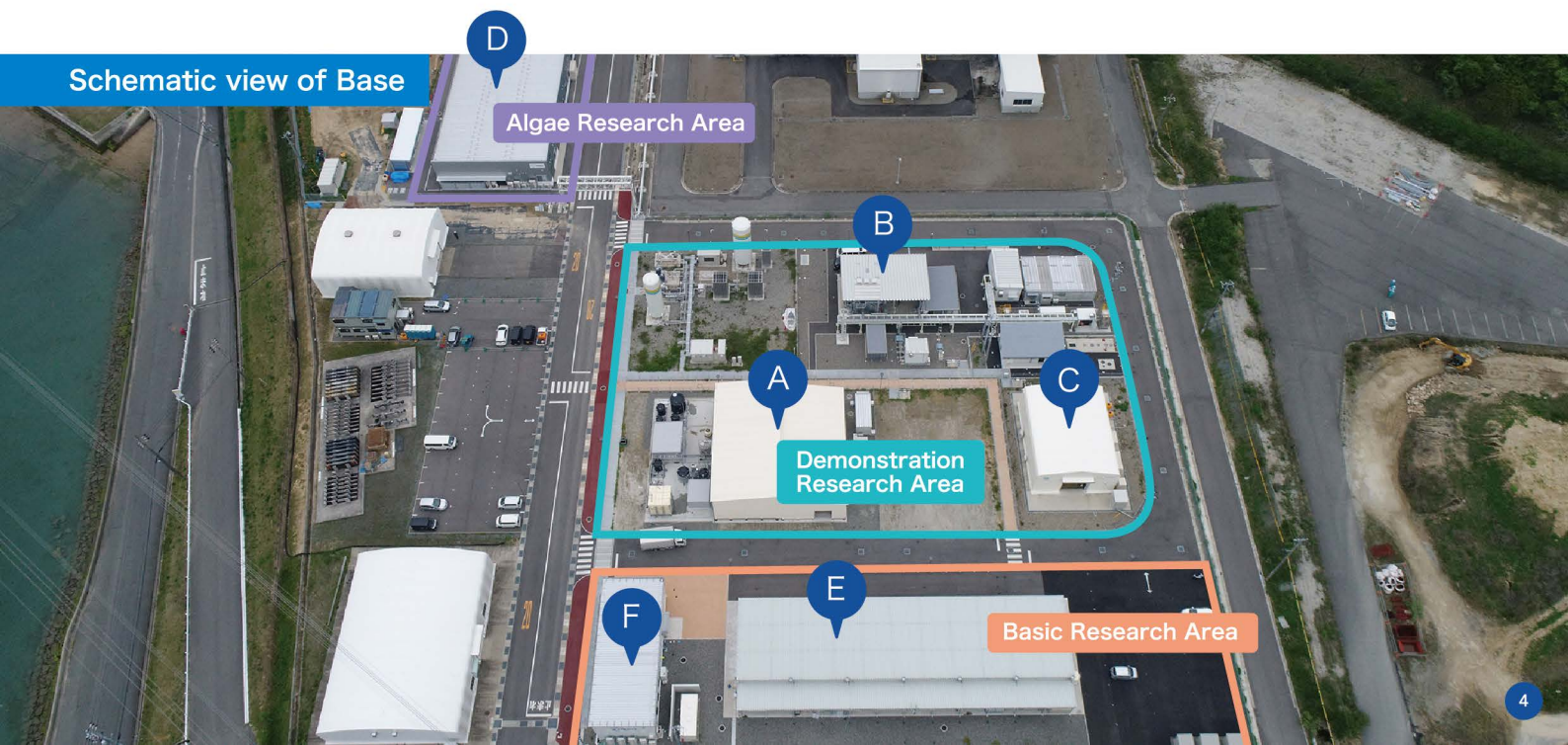
Consists of 6 laboratories that are convenient for multiple companies and universities to conduct basic and advanced research efficiently and safely.



Common Use Building

Conference rooms, analysis rooms, and other facilities are available. Also we display information of the Facilities for visitors.

Schematic view of Base

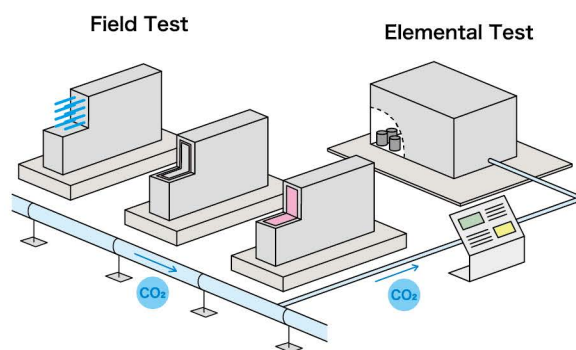
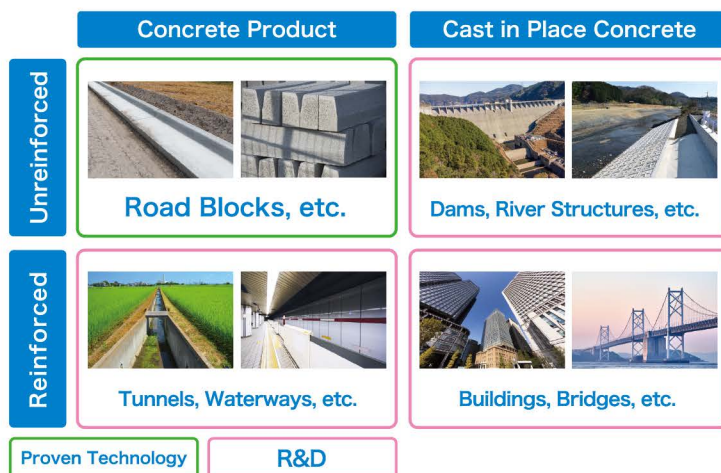


Introduction of R&D and Demonstration Themes

Development of Efficient CO₂-Use Concrete

Project ended

In this project, we will develop technologies to expand the scope of application of concrete that effectively utilizes CO₂. The CO₂ effective use concrete has already been put to practical use in some products, but its scope of application is limited. This is due to technical constraints such as "the process to absorb CO₂ is required in a tank filled with CO₂" and "concerns about rebar corrosion". At this base, as empirical studies of carbonation technology for various concrete such as cast-in-place and reinforced concrete, we manufacture actual large-scale specimens and conduct various tests. In this project, we will strive for the social implementation of Carbon Recycling technology in the concrete field.



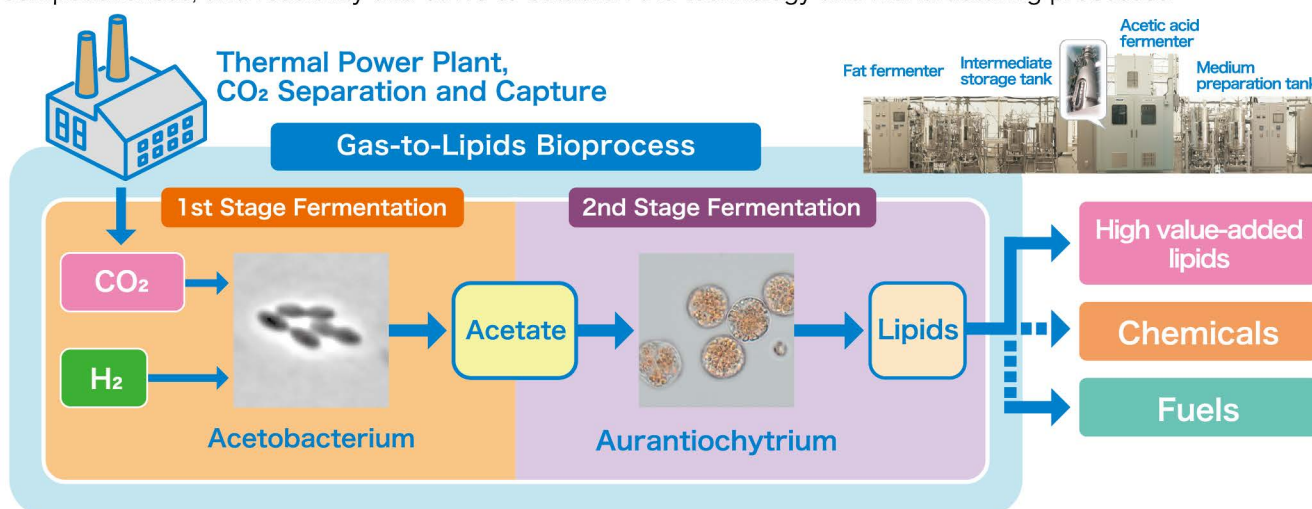
Schedule Fiscal year 2020-2022

Organization



Development of Gas-to-Lipids Bioprocess

To establish a technology for effective utilization of CO₂ separated and recovered in next-generation thermal power generation, we developed a biorefinery technology called "Gas-to-Lipids Bioprocess" via two-stage fermentation, which consists of a process to generate acetic acid by immobilizing CO₂ and one to synthesize high value-added lipids and chemical raw materials from the acetic acid. While conducting bench-scale tests of individual and integrated manufacturing processes, we will evaluate their environmental impact, technological competitiveness, and feasibility and strive to establish the technology and manufacturing processes.



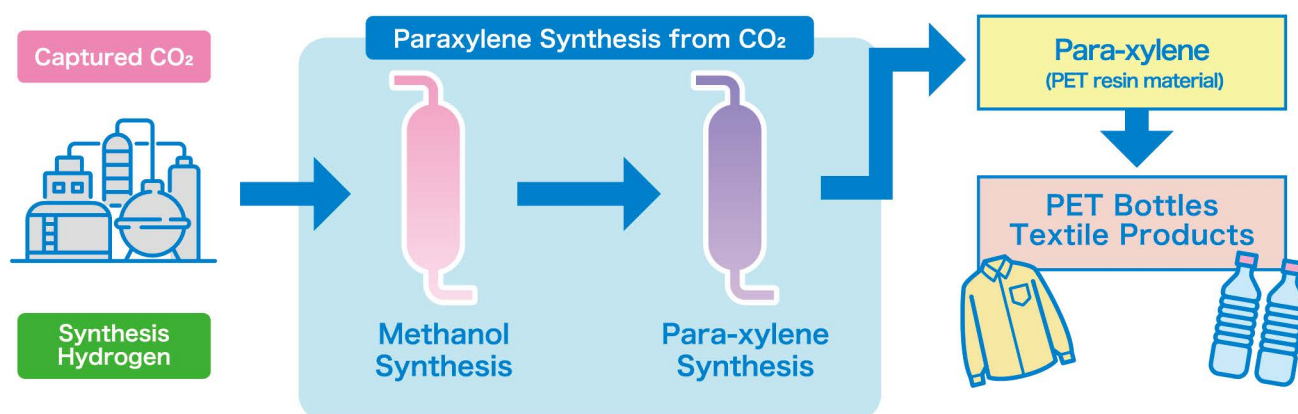
Schedule Fiscal year 2020-2024

Organization



Research of Selective Synthesis Technology of Chemical Products for Carbon Recycling

It has been required that we use CO₂ for producing chemical products in an effort to transform ourselves into a decarbonized society in the future. In line with this objective, our focus is now on attaining a synthesizing technique by using CO₂, to be more specific, a technology for synthesizing para-xylene, a raw material whose demand is expected to grow in the future due to its use for fiber production, etc., by using CO₂. This project aims to develop technologies for producing para-xylene by using the methanol being synthesized from CO₂ and H₂. The technologies include higher-performance catalysts for synthesizing methanol from CO₂ and H₂ as well as catalysts with an improved formation ratio of para-xylene, the useful product among the xylenes.



Schedule Fiscal year 2020-2024

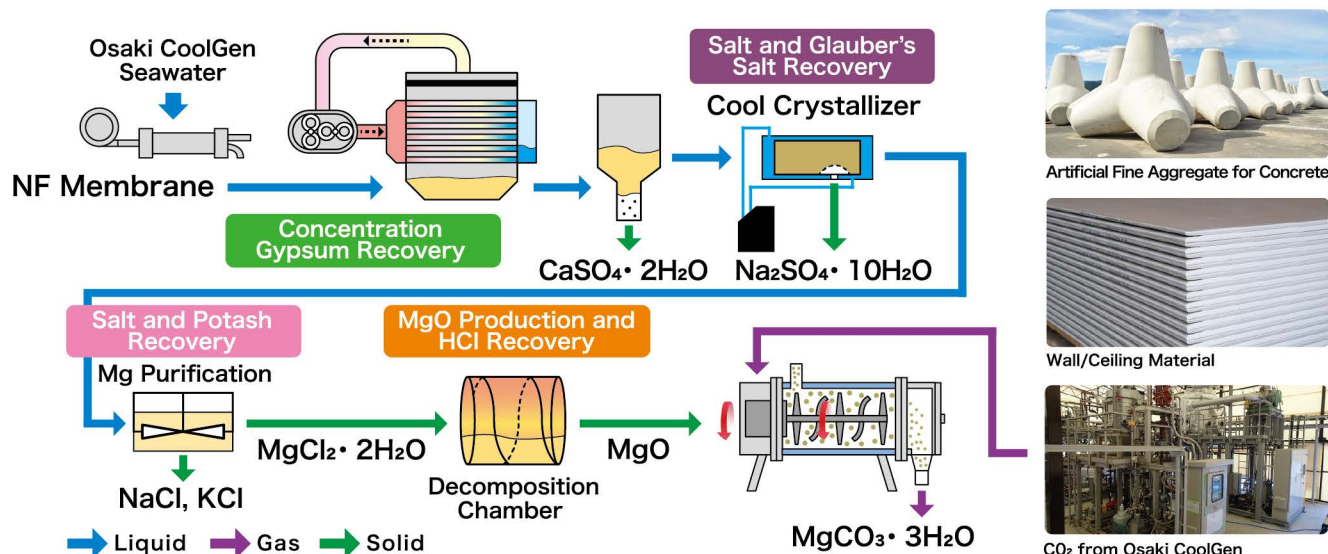
Organization

Kawasaki
Powering your potential

大阪大学
OSAKA UNIVERSITY

Carbon recycling technology demonstration and R&D with co-production of multiple valuable commodities by using seawater

In the demonstration research area of Osaki, we will demonstrate CO₂ fixation technology to Magnesium Carbonate by using 20 ton/day of seawater. Magnesium Carbonate will be used for concretes and building materials such as wall materials, and the manufacturing method for these materials will also be developed at the same time. As a summary of this project, feasibility study will be conducted based on the results obtained in the demonstration, and an economic evaluation will be conducted.



Schedule Fiscal year 2022-2024

Organization

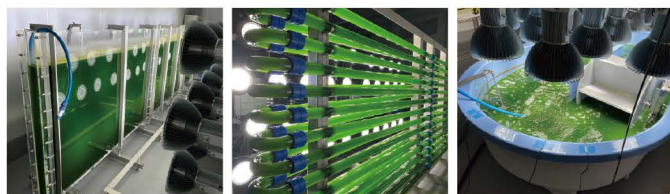
早稲田大学
WASEDA University

SASAKURA
SERVICE CENTER CO., LTD.

Establishing a Research Base and Developing Technologies that Lead to Increased CO₂ Utilization Rate for the Production of Microalgae-Derived SAF

Some species of microalgae store oils and fats during growth, which can be extracted and reformed to produce sustainable aviation fuel (SAF). In particular, the production of SAF from microalgae is positioned as a Carbon Recycling technology as it utilizes a mechanism that absorbs carbon dioxide from the atmosphere through photosynthesis. If a production technology for microalgae-derived SAF can be established, it is expected to contribute to the reduction of fossil-derived fuels and help prevent global warming. In order to do so for microalgae-derived SAF and further develop it as an industry, we will establish a research center capable of verifying production and cultivation technologies of various microalgae and work on measurement/analysis methods of microalgae for systematizing research results as well as the standardization of condition settings.

① Establishment of Microalgal Research Testbed



Flat Panel Photobioreactor

Tubular Photobioreactor

Raceway Pond

Environmental regulation will enable production and cultivation tests of diverse microalgae species in environments that simulate various climates, as well as trials of multiple drying and extraction processes.

② Standardization of Measurement/Analysis Methods and Condition Settings



Promote research and systematization of results through standardization of methods and conditions of measurement/analysis and of cultivation.

Schedule

Fiscal year 2020-2024

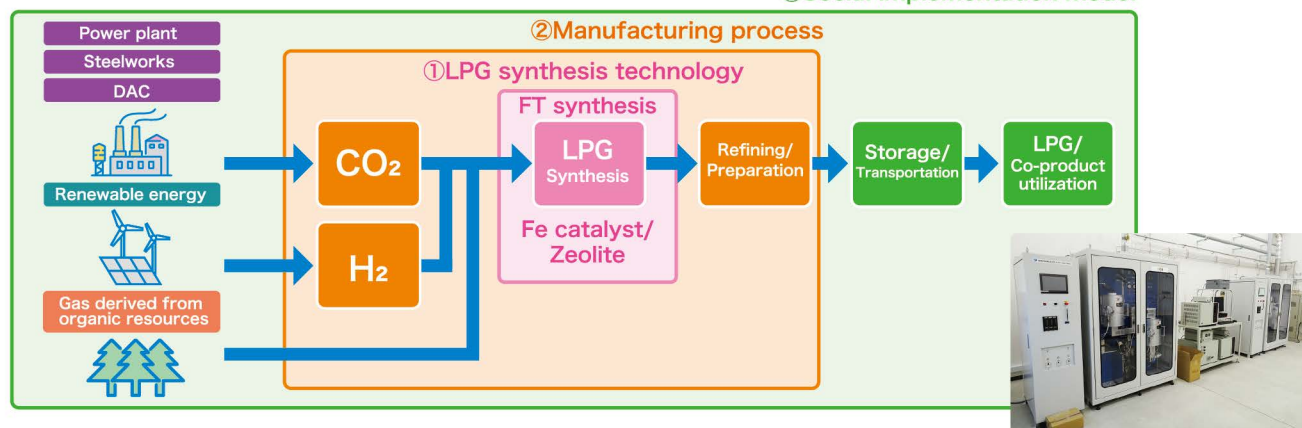
Organization



Research and development of carbon recycled LP gas manufacturing technology and process

In this research, we will develop catalyst and process technologies and review a social implementation model to produce Carbon Recycling LPG using Fischer-Tropsch (FT) synthesis, a method for synthesizing liquid fuels from carbon monoxide and hydrogen. Specifically, we will use carbon monoxide and hydrogen, which are emitted from power plants or are derived from biomass-based carbon dioxide, as source gases to 1) develop catalyst technology suitable for LP gas production by FT synthesis; 2) review the entire production process from source gas to LPG production, purification, and preparation; and 3) review an overall social implementation model from the procurement of raw materials such as biomass resources and storage/transportation of produced LP gas to the use of non-LPG products obtained through FT synthesis.

③ Social implementation model



Schedule

Fiscal year 2022-2024

Organization

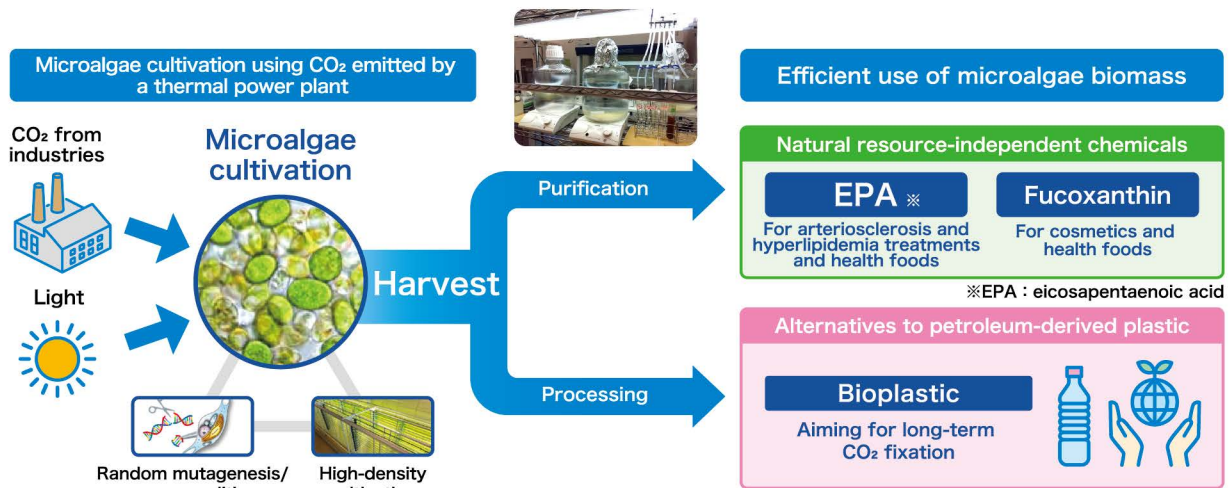
ENEOS グローブ株式会社

NIPPON STEEL
日本製鉄株式会社

富山大学
UNIVERSITY OF TOYAMA

Research & Development of CO₂ Fixation by Microalgae and High-Value Ingredients Production

When supplied with CO₂ and light energy, microalgae fix carbon in various forms in their cells via photosynthesis. For this research theme, we breed marine microalgae using a combination of random mutagenesis and genome editing to create strains with high productivity. We develop high-density culture techniques using selected algal strains. Useful chemicals (EPA, fucoxanthin) are extracted from the biomass harvested from the large-scale cultivation. Using the residues after extraction of the chemicals, we develop bioplastics which enable long-term CO₂ storage. We aim to integrate these technologies to propose an algae biomass production system for power plants and various factories.



Schedule Fiscal year 2022-2024

Organization

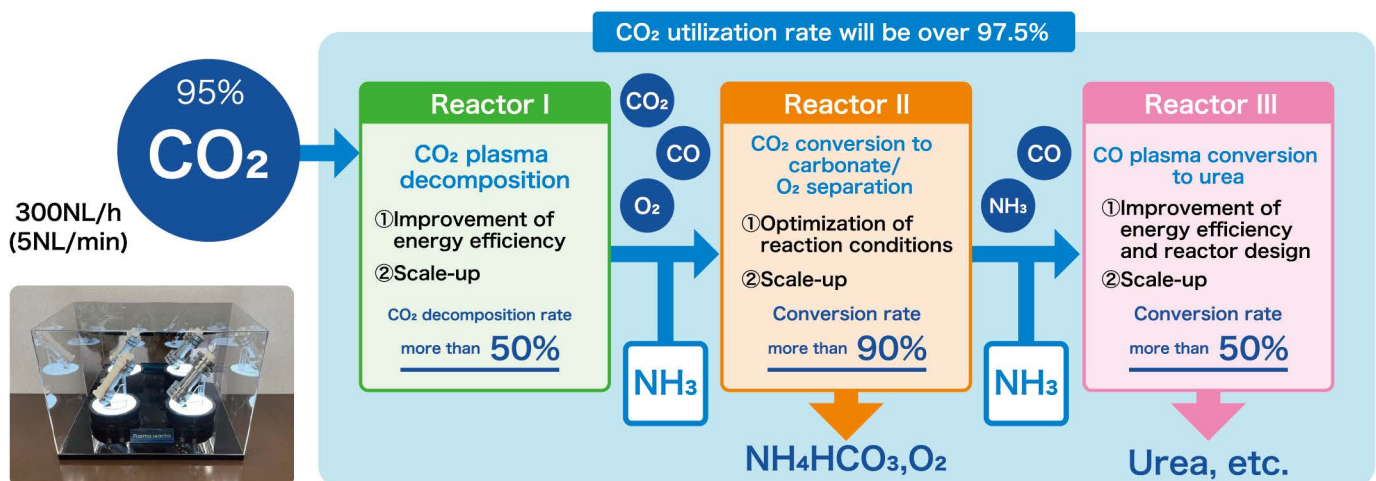


algal bio

関西電力
power with heart

Development of a CO₂ decomposition and reduction process using atmospheric pressure plasma

While generating CO by directly decomposing CO₂ using renewable energy and recovering the unreacted CO₂ as carbonate, we will conduct leading research on a new process for the direct synthesis of urea, etc. from CO. In other words, optimization of reaction conditions and reactor structure, as well as scale-up research, will be conducted for a reactor that efficiently decomposes CO₂ into CO using atmospheric pressure plasma (Reactor I), one that efficiently converts unreacted CO₂ into carbonate (Reactor II), and one that efficiently directly synthesizes urea, etc. from CO using atmospheric pressure plasma (Reactor III) to develop a novel CO₂ decomposition and reduction process and evaluate its feasibility.



Schedule Fiscal year 2022-2024

Organization



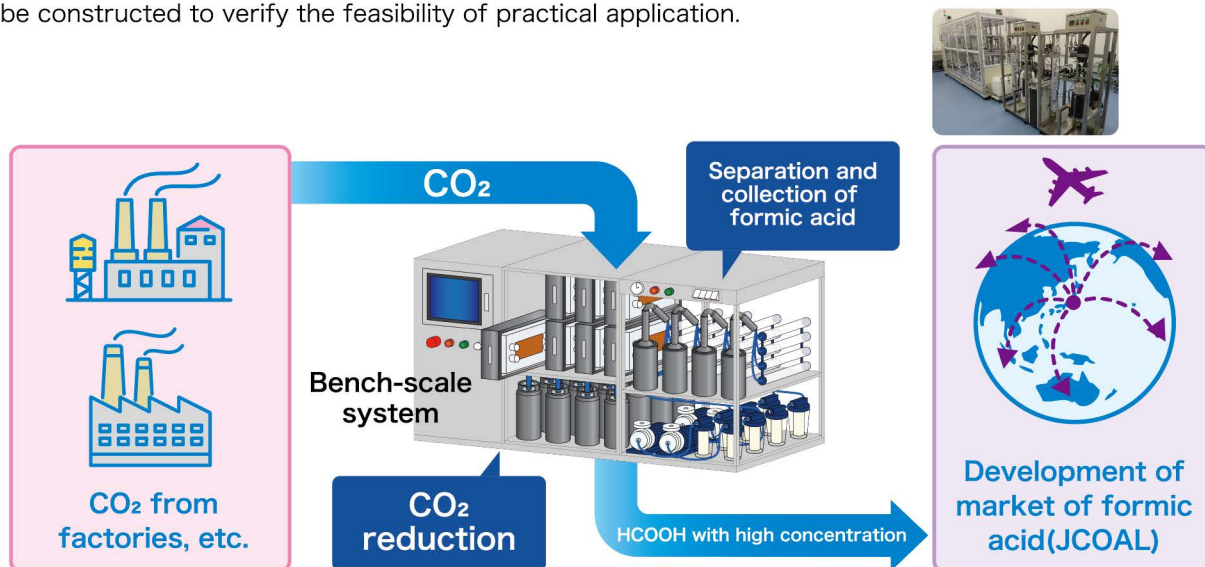
MAKE NEW STANDARDS
東海国立
大学機構

岐阜大学

KAWADA
INDUSTRIES, INC.

Production of Value-added Chemicals from CO₂ Using Boron-doped Diamond Electrodes

Diamond electrode, a next-generation electrode material, has excellent durability and unique electrochemical properties, and can selectively and efficiently produce formic acid by electrolytic reduction of CO₂. In this project, we will integrate the elemental technologies for formic acid production by electrolytic reduction of CO₂ using diamond electrodes as well as its separation and recovery, and construct a laboratory-scale integrated system that can continuously produce formic acid. In addition, a bench-scale integrated system will be constructed to verify the feasibility of practical application.



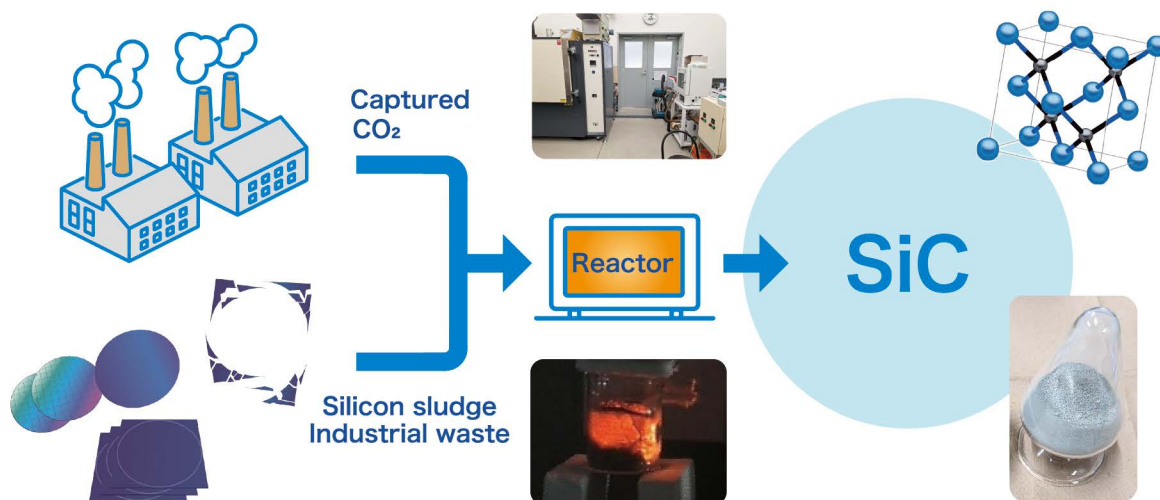
Schedule Fiscal year 2022-2024

Organization



R&D for synthesis of silicon carbide derived from industrial waste using CO₂ as a carbon source

In this project, we will promote verification research on the synthesis of silicon carbide derived from industrial waste using CO₂ as a carbon source, with "the technology for synthesizing silicon carbide using CO₂ as a carbon source," developed as the seed. The developed technology can synthesize silicon carbide while absorbing CO₂ and can produce SiC, a valuable material, by reacting silicon sludge, an industrial waste, with CO₂, thus contributing to the construction of an advanced recycling-oriented society (SDG 12: Responsible consumption and production) and promoting decarbonization.



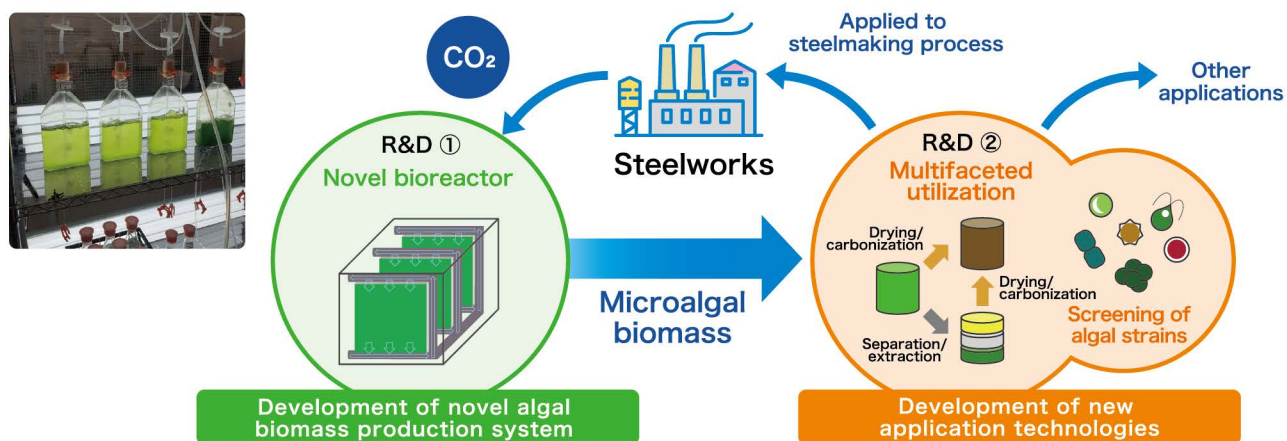
Schedule Fiscal year 2022-2024

Organization



東北大学
TOHOKU UNIVERSITY

In this project, we will conduct R&D on both the production and utilization of algae biomass. In the former, a cultivation system will be developed using solid surface cultivation for algae in the gas phase as an elemental technology, which is characterized by its ability to efficiently utilize CO₂ and sunlight and is expected to lead to a high-yield algae biomass production system. In the latter, R&D will be conducted for utilization technologies with steelmaking set for algae biomass purposes. On top of applying algae biomass only to the steelmaking process, we will also consider multifaceted utilization that combines multiple applications for each component. In addition, a search for algae strains with superior usability will be conducted in parallel.



Schedule

Fiscal year 2022-2024

Organization

NIPPON STEEL

日本製鉄株式会社



Location

Directions from Tokyo, Osaka, and Hiroshima

Air



JR



Car



Directions from Shikoku

JR



Address

6208-1 Nakano, Osaki-Kamijima-cho, Toyota-gun, Hiroshima Prefecture 725-0301, Japan



Hiroshima Prefecture

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- Omishima Blue Line (Imabari) : +81-898-32-6713
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Contact Us

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Contact Us

+81-44-520-5293

Reception hours: 10:00 ~ 12:00/13:00 ~ 17:00 (on weekdays)

Website

<https://www.nedo.go.jp>

Map of Surrounding Area



Access

- 3 min. from JR Kawasaki Station West Exit.
- 5-10 min. from Keihinkyukou Kawasaki Station West Exit.

Latest information will be updated on the official website.

<https://osakikamijima-carbon-recycling.nedo.go.jp/en/>

