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

New Energy and Industrial Technology Development Organization

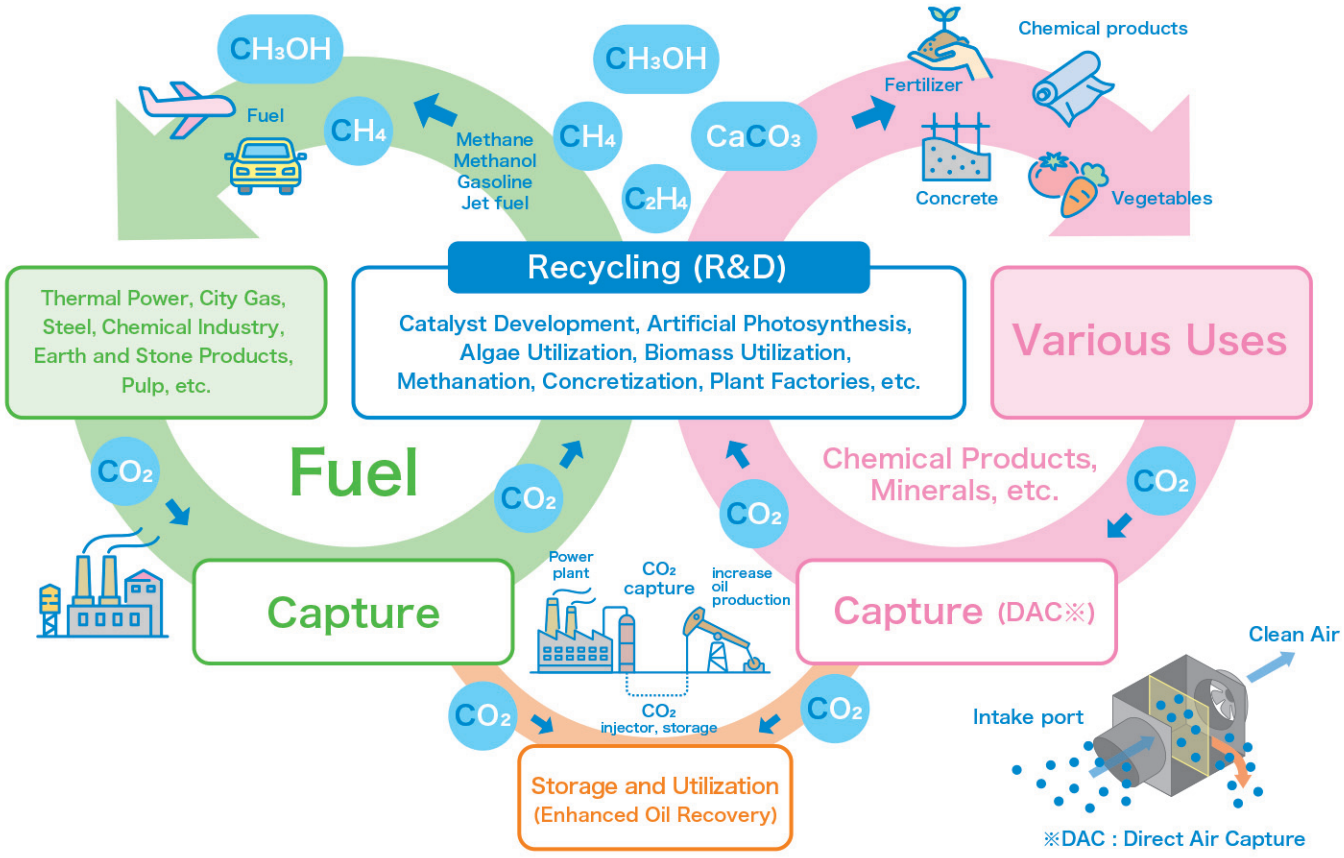
What is Carbon Recycling?

In efforts to curb global warming, reducing CO_2 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 CO_2 emissions into the atmosphere by reusing CO_2 as a resource for materials, fuel, and other purposes.

So at the Davos meeting in January 2019, Japan referred to the need to recycle CO_2, 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 CO_2 as a resource, separates and recovers it, and reuses it in form of various products such as concrete, chemicals, and fuels to curb CO_2 emissions into the atmosphere. In the Carbon Recycling 3C Initiative presented by the Ministry in September 2019 and the Environment Innovation Strategy (by Integrated Innovation Strategy Promotion Council) formulated in January 2020, a project was announced to develop Osaki-Kamijima Island in Hiroshima, where such projects on integrated gasification combined cycle (IGCC) and integrated gasification fuel cell cycle (IGFC) are underway, as a demonstration and research center for Carbon Recycling. In December of the same year, METI took the lead in formulating the Green Growth Strategy towards 2050 Carbon Neutrality in collaboration with related ministries and agencies. In particular, Carbon Recycling will be positioned as one of the key technology areas to realize a carbon-neutral society.

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

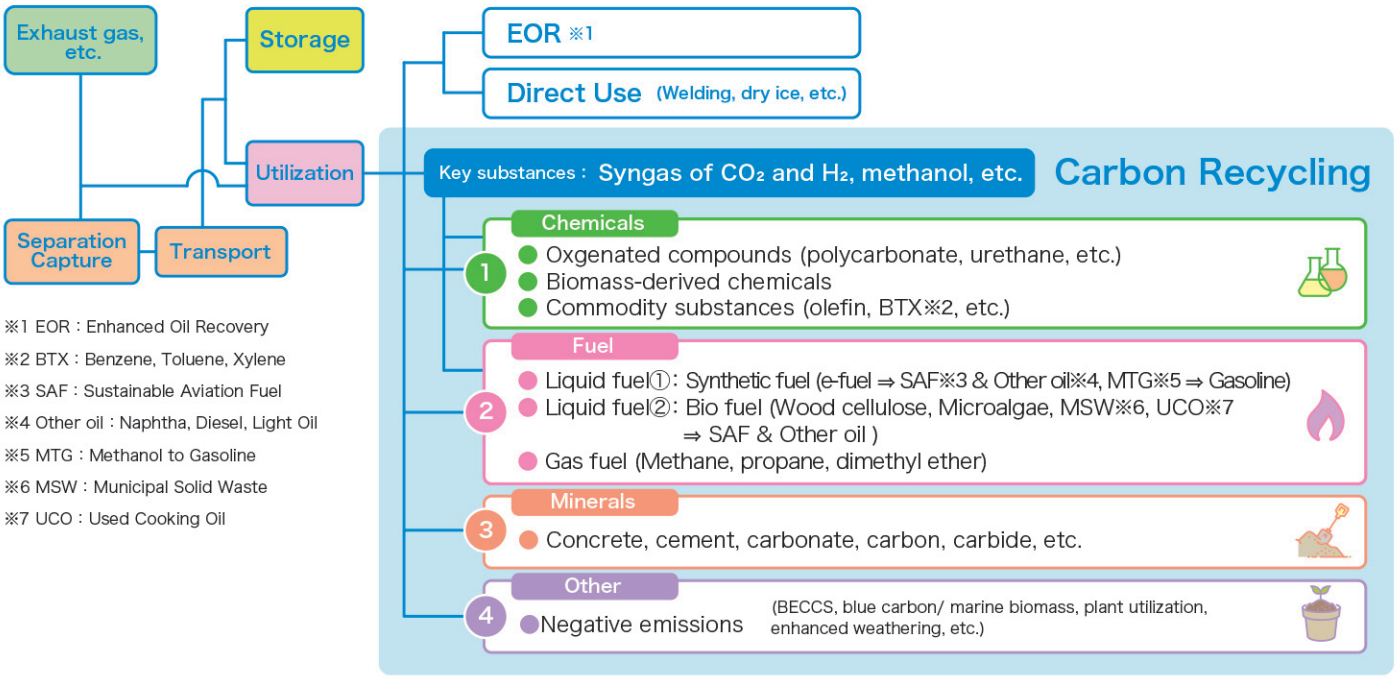
Carbon Recycling, which effectively utilizes CO_2 as a resource, can be used in various fields such as chemicals, concrete/cement, machinery, engineering, fuels for transportation and biotechnology, giving Japan a competitive edge. As Carbon Recycling technology is established, its use is expanded, and 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.



Source: Prepared by NEDO based on "Dream Technology for CO_2 Reduction! Development and Implementation of Carbon Recycling in Progress"
(Agency for Natural Resources and Energy, METI)

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】.

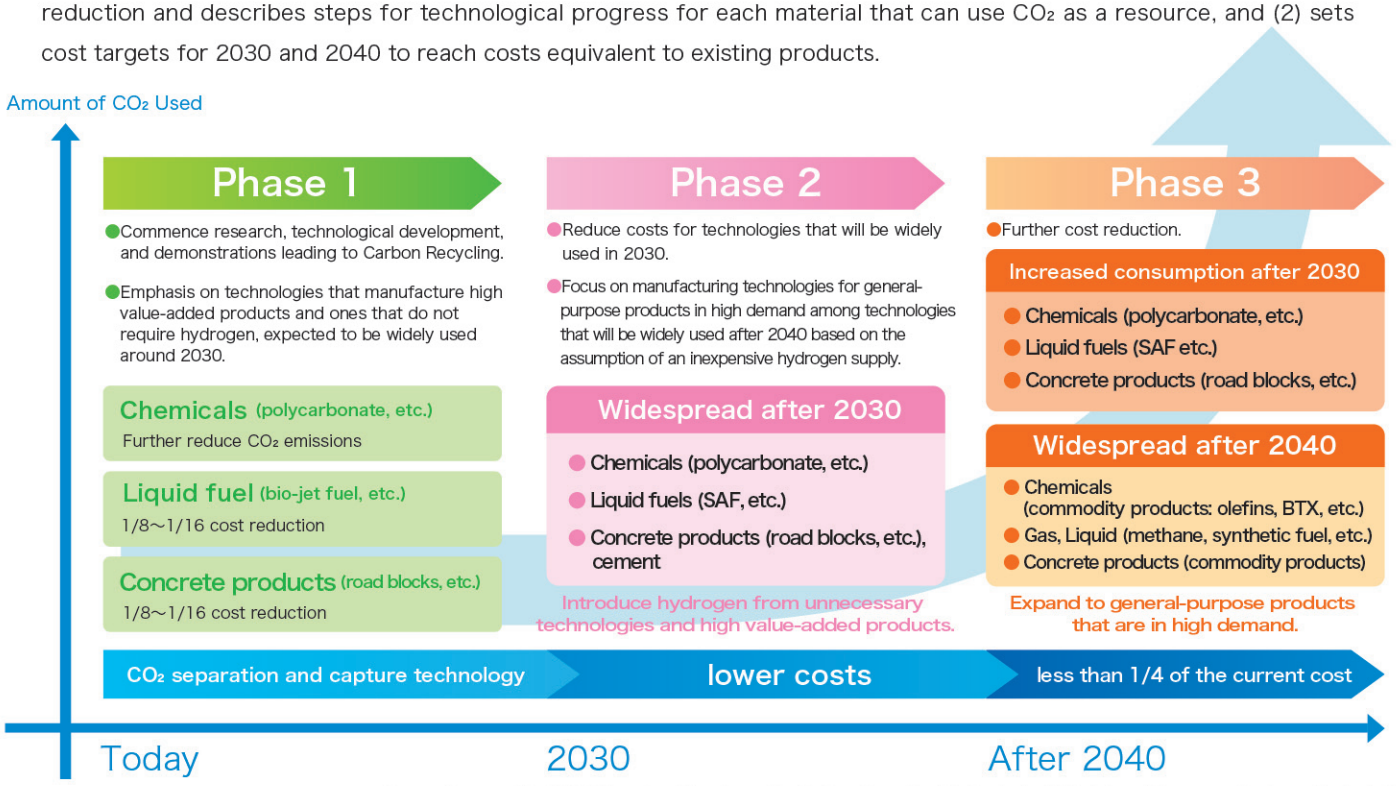


※1 EOR : Enhanced Oil Recovery
※2 BTX : Benzene, Toluene, Xylene
※3 SAF : Sustainable Aviation Fuel
※4 Other oil : Naphtha, Diesel, Light Oil
※5 MTG : Methanol to Gasoline
※6 MSW : Municipal Solid Waste
※7 UCO : Used Cooking Oil

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

Roadmap for Carbon Recycling Technologies

Designed to accelerate innovation by setting targets, technical issues, and timeframe for Carbon Recycling technologies and sharing them across governments, private companies, investors, researchers, and other stakeholders in Japan and abroad, the Roadmap for Carbon Recycling Technologies was formulated in June 2019 and revised in July 2021 by METI for academics and engineers in various technical fields with the cooperation of the Cabinet Office, the Ministry of Education, Culture, Sports, Science and Technology (MEXT), and the Ministry of the Environment, Japan (MOEJ). To accelerate innovation in Carbon Recycling technologies, it (1) clarifies the current state of technologies and issues for cost reduction and describes steps for technological progress for each material that can use CO_2 as a resource, and (2) sets cost targets for 2030 and 2040 to reach costs equivalent to existing products.



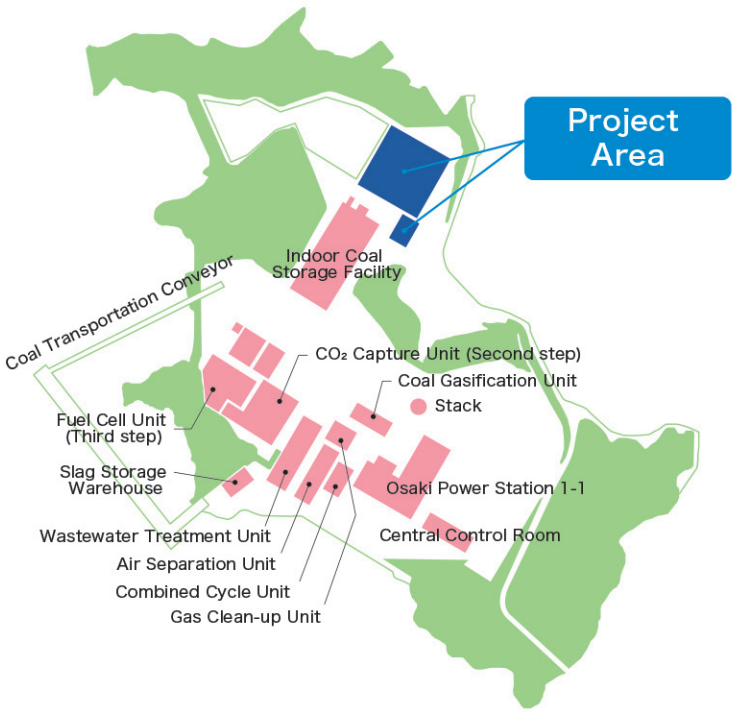
Source: Prepared by NEDO based on "Roadmap for Carbon Recycling Technologies" (Ministry of Economy, Trade and Industry)

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.

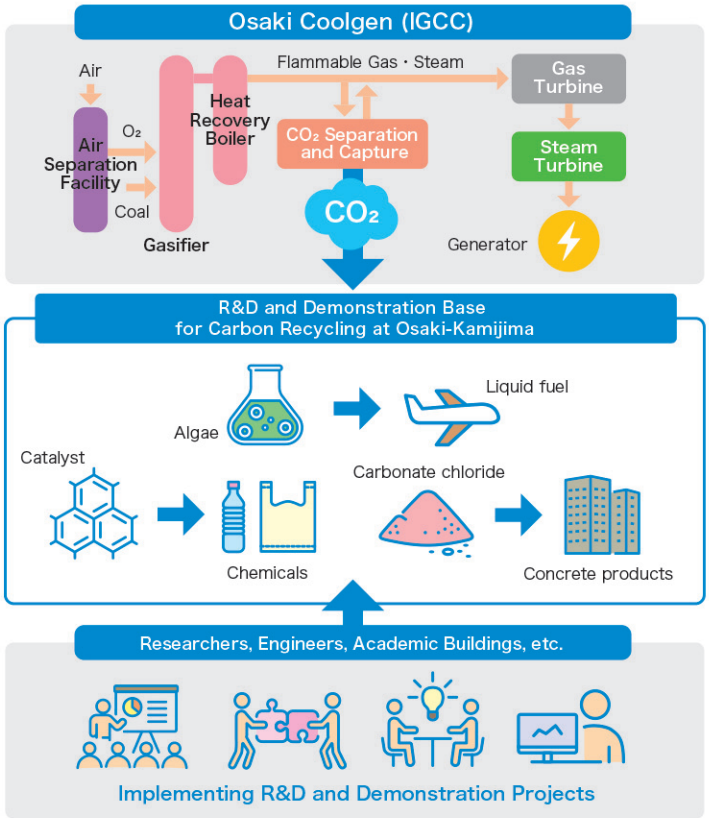
Layout

At the Osaki Power Station (operated by Osaki CoolGen), where demonstration tests of coal-fired thermal power generation combined with IGFC cycle and CO_2 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.



Source: Prepared by NEDO based on "Progressive Environmental Innovation Strategy" (Ministry of Economy, Trade and Industry)

About the Facilities

The center consists of three areas: the Demonstration Research Area, Algae Research Area, and the Basic Research Area. The CO_2 separated and collected at Osaki CoolGen is transported by pipeline, with the underlying technology development and demonstration research on Carbon Recycling using said CO_2 conducted at each facility.

Demonstration Research Area

Theme ①

Development of Efficient CO_2-Use Concrete

Develop technology to fix CO_2 to reinforced concrete used in cast-in-place concrete structures such as buildings.

Theme ②

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 CO_2.

Theme ③

Development of Gas-to-Lipids Bioprocess

Develop biorefinery technology using a two-step fermentation process to produce acetic acid from CO_2 and synthesize high-value-added lipids and chemical raw materials.

Algae Research Area

Theme ④

Establishing a Research Base and Developing Technologies that Lead to Increased CO_2 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

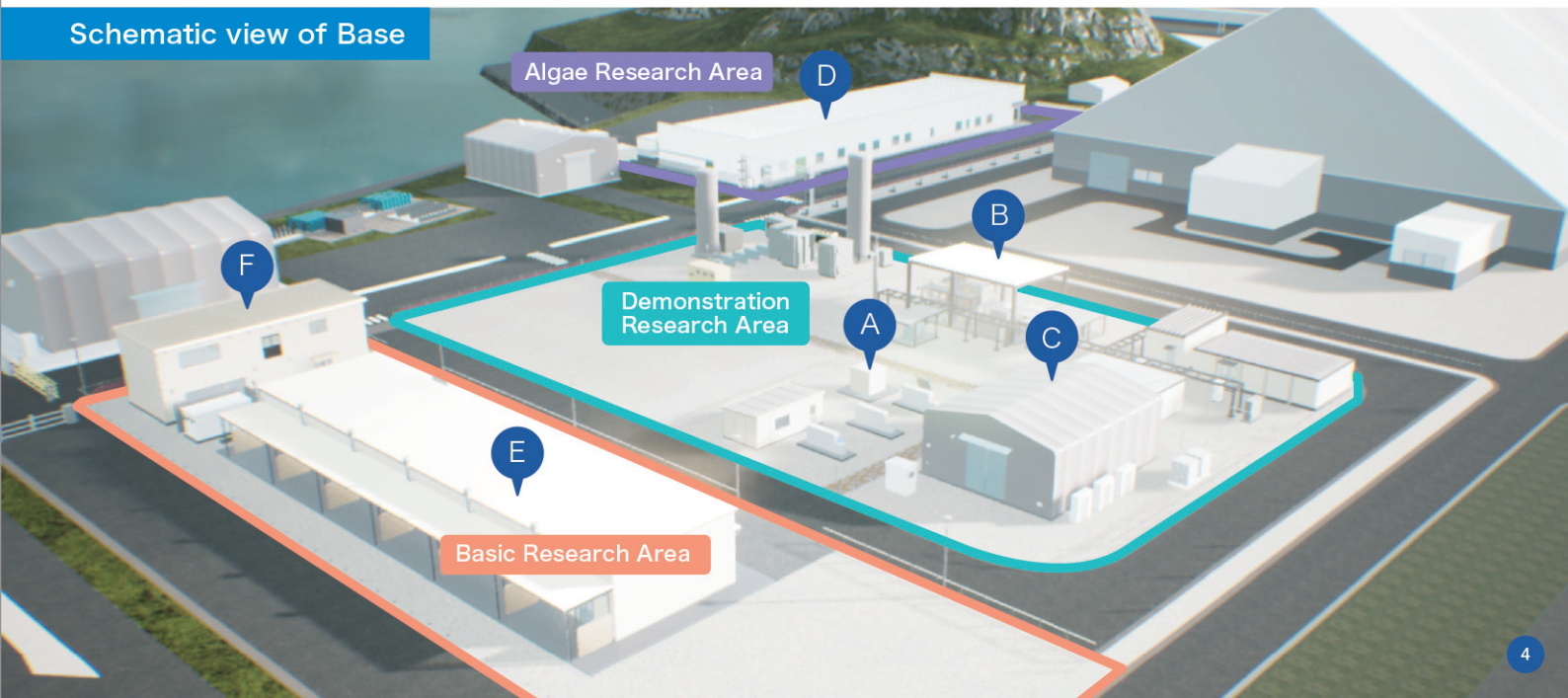
Research Building

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.

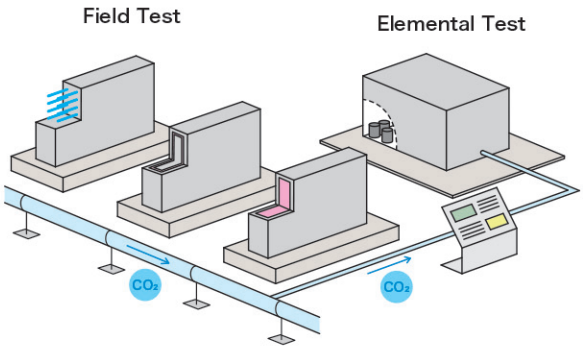
Schematic view of Base



Introduction of R&D and Demonstration Themes

Development of Efficient CO_2-Use Concrete — Theme ①

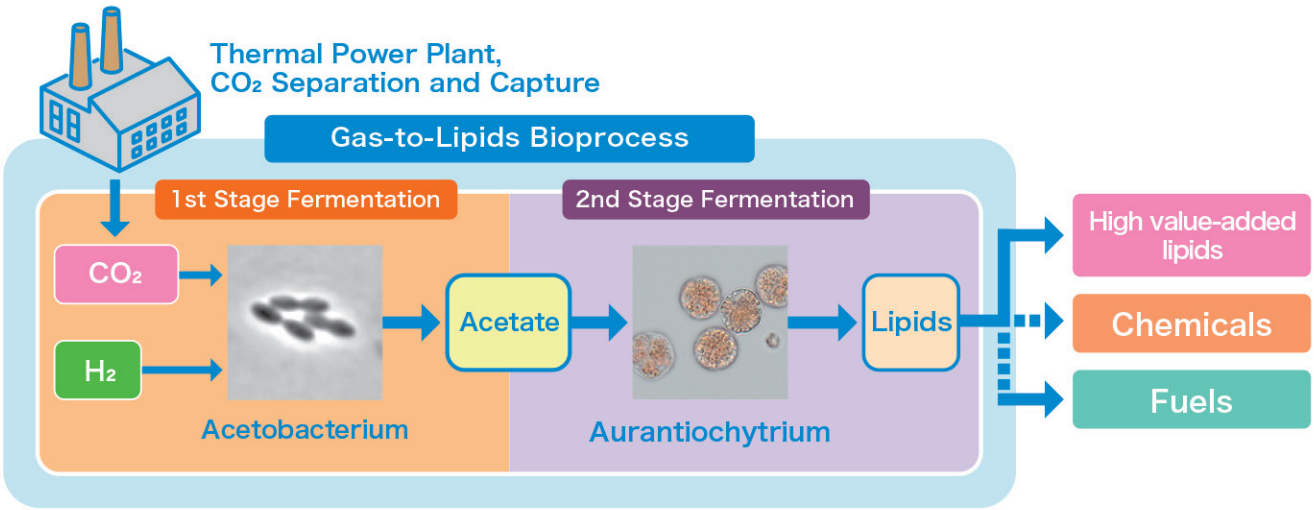
In this project, we will develop technologies to expand the scope of application of concrete that effectively utilizes CO_2. The CO_2 effective use concrete has already been put to practical use in some products, but its scope of application is limited. This is due to technical constraints such as "the process to absorb CO_2 is required in a tank filled with CO_2" 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 Energia 中国電力 100年をつくる会社 鹿島 三菱商事

Development of Gas-to-Lipids Bioprocess — Theme ③

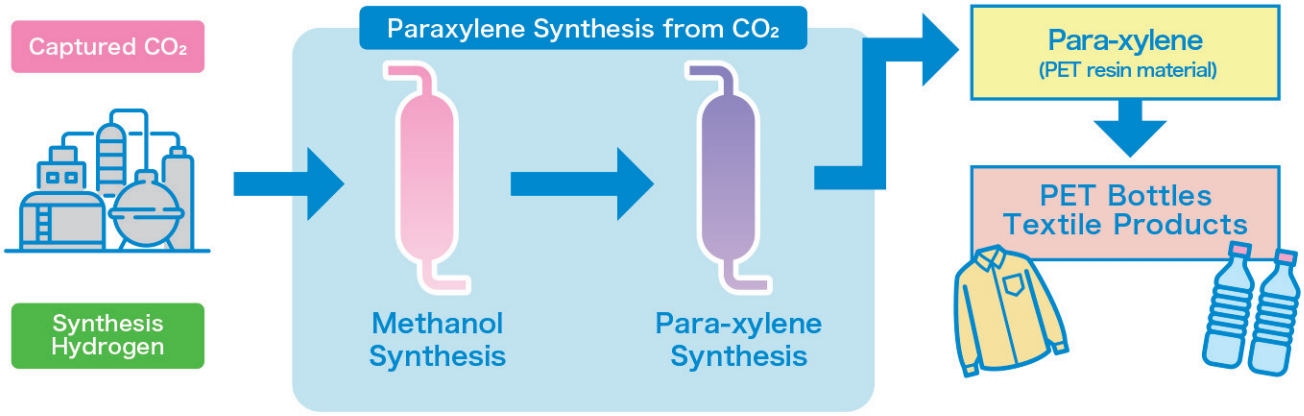
To establish a technology for effective utilization of CO_2 separated and recovered in next-generation thermal power generation, we developed a biorefinery technology called "Gas-to-Lipids Bioprocess" via two-stage fermentation, which consists of a process to generate acetic acid by immobilizing CO_2 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 2020-2023 Organization 広島大学 Energia 中国電力

Research of Selective Synthesis Technology of Chemical Products for Carbon Recycling — Theme ②

It has been required that we use CO_2 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 CO_2, 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 CO_2. This project aims to develop technologies for producing para-xylene by using the methanol being synthesized from CO_2 and H_2. The technologies include higher-performance catalysts for synthesizing methanol from CO_2 and H_2 as well as catalysts with an improved formation ratio of para-xylene, the useful product among the xylenes.



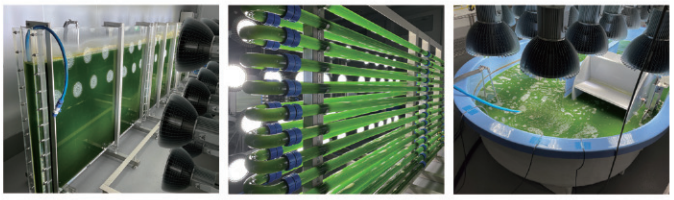
Schedule: Fiscal year 2020-2024

Organization: Kawasaki Powering your potential / 大阪大学 OSAKA UNIVERSITY

Establishing a Research Base and Developing Technologies that Lead to Increased CO_2 Utilization Rate for the Production of Microalgae-Derived SAF — Theme ④

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.

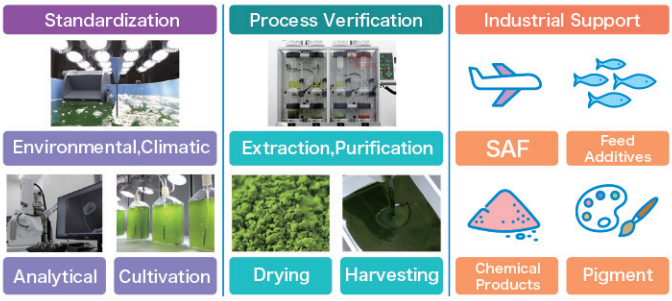
①Establishment of Microalgal Research Testbed



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



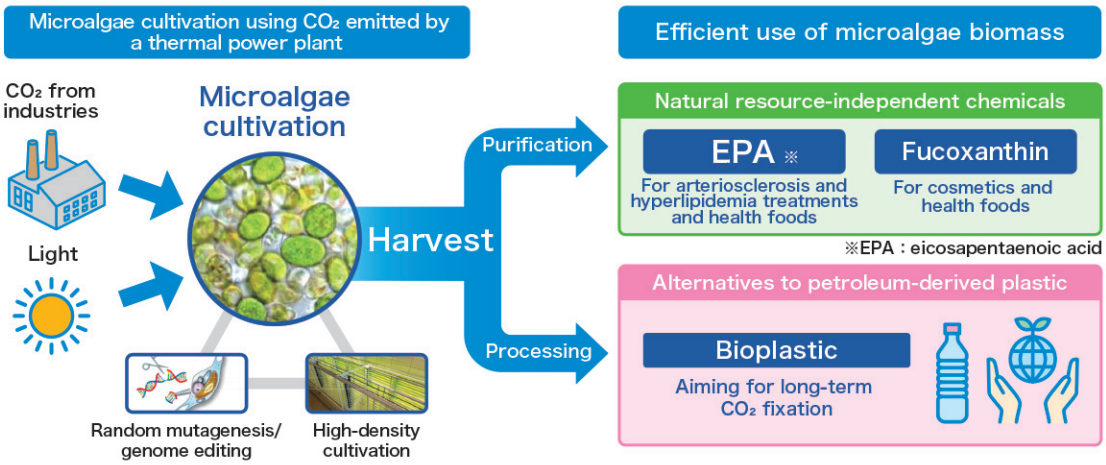
Promote research and systematization of results through standardization of methods and conditions of measurement/analysis and of cultivation.

Schedule: Fiscal year 2020-2024

Organization: IMAT 日本微細藻類技術協会

Research & Development of CO_2 Fixation by Microalgae and High-Value Ingredients Production — Theme⑤

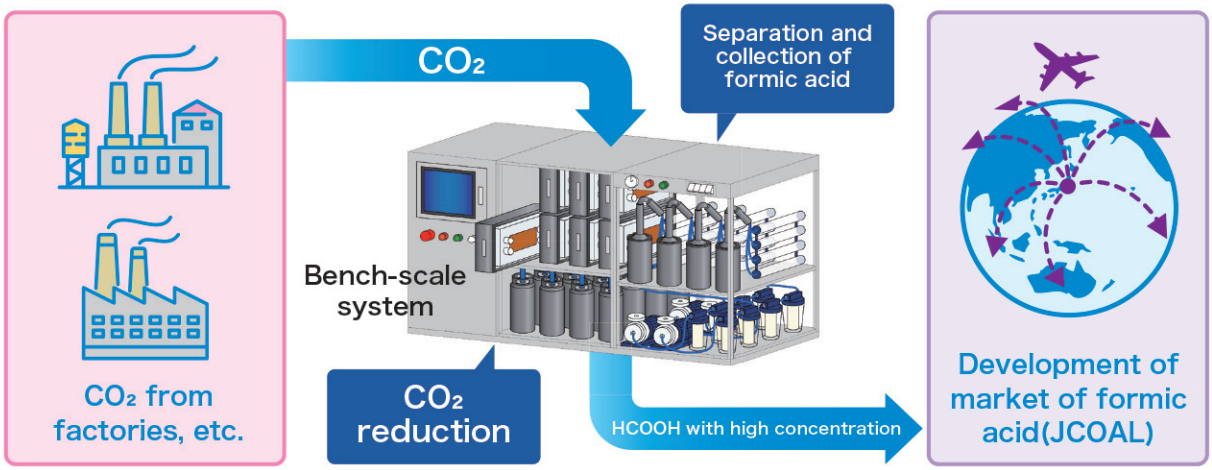
When supplied with CO_2 and light energy, microalgae fix carbon in various forms in their cells via photosynthesis. For this research theme, we breed marine microalgae using a combination of random mutagenesis and genome editing to create strains with high productivity. We develop high-density culture 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 CO_2 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

Production of Value-added Chemicals from CO_2 Using Boron-doped Diamond Electrodes — Theme⑦

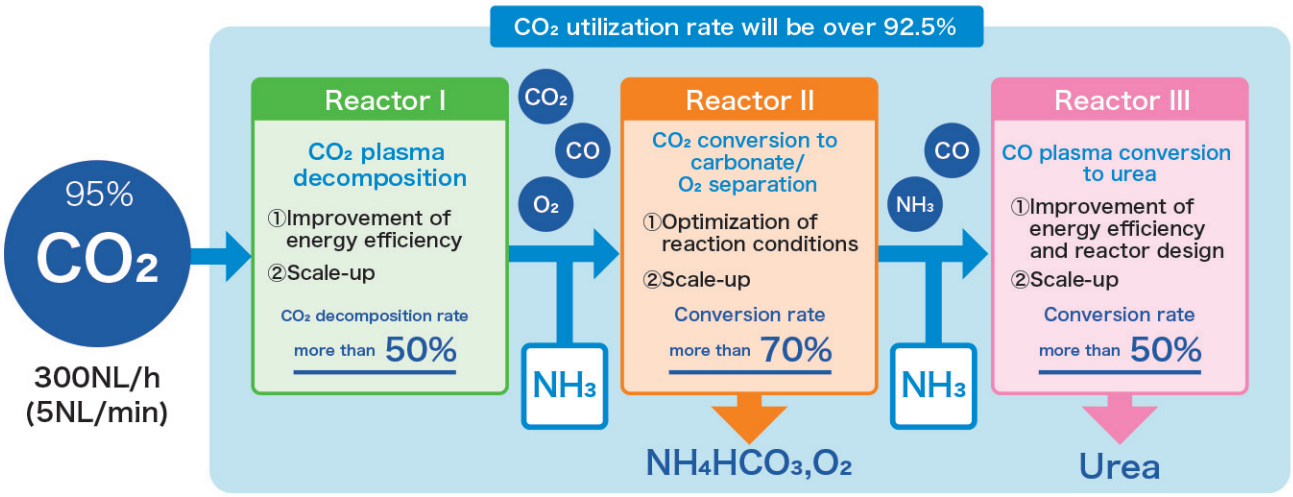
Diamond electrode, a next-generation electrode material, has excellent durability and unique electrochemical properties, and can selectively and efficiently produce formic acid by electrolytic reduction of CO_2. In this project, we will integrate the elemental technologies for formic acid production by electrolytic reduction of CO_2 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 慶應義塾 Keio University 東京理科大学 TOKYO UNIVERSITY OF SCIENCE J-COAL

Development of a CO_2 decomposition and reduction process using atmospheric pressure plasma — Theme⑥

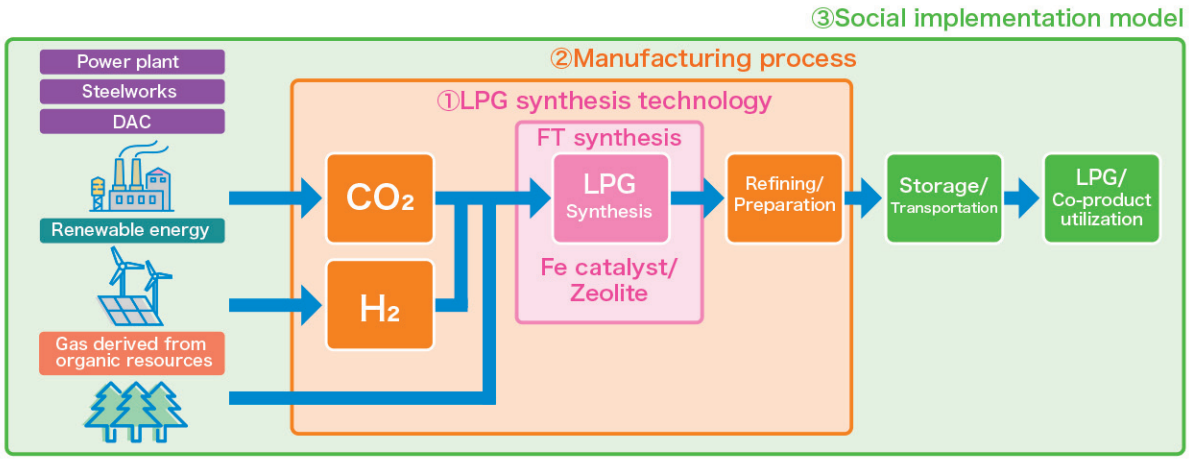
While generating CO by directly decomposing CO_2 using renewable energy and recovering the unreacted CO_2 as carbonate, we will conduct leading research on a new process for the direct synthesis of urea from CO. In other words, optimization of reaction conditions and reactor structure, as well as scale-up research, will be conducted for a reactor that efficiently decomposes CO_2 into CO using atmospheric pressure plasma (Reactor I), one that efficiently converts unreacted CO_2 into carbonate (Reactor II), and one that efficiently directly synthesizes urea from CO using atmospheric pressure plasma (Reactor III) to develop a novel CO_2 decomposition and reduction process and evaluate its feasibility.



Schedule Fiscal year 2022-2024 Organization 東海国立大学機構 KAWADA INDUSTRIES,INC.

Research and development of carbon recycled LP gas manufacturing technology and process — Theme⑧

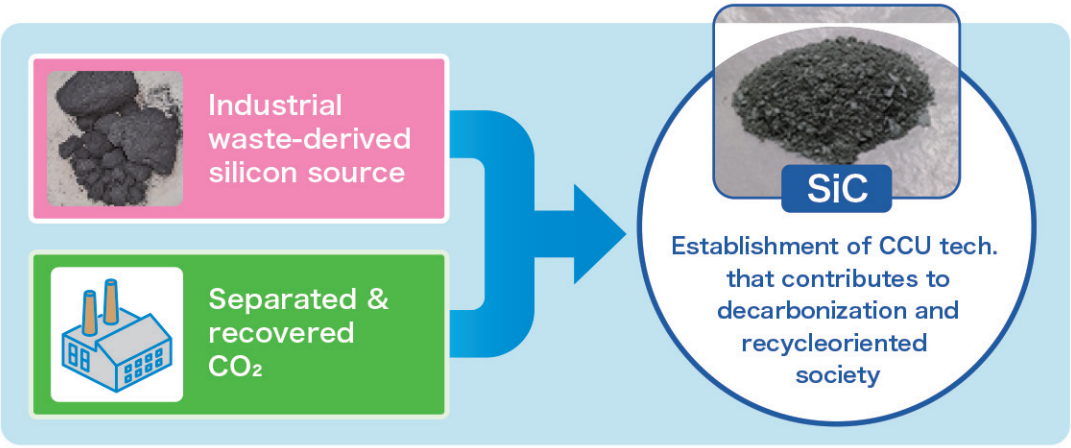
In this research, we will develop catalyst and process technologies and review a social implementation model to produce Carbon Recycling LPG using Fischer-Tropsch (FT) synthesis, a method for synthesizing liquid fuels from carbon monoxide and hydrogen. Specifically, we will use carbon monoxide and hydrogen, 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.



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

R&D for synthesis of silicon carbide derived from industrial waste using CO_2 as a carbon source — Theme⑨

In this project, we will promote verification research on the synthesis of silicon carbide derived from industrial waste using CO_2 as a carbon source, with "the technology for synthesizing silicon carbide using CO_2 as a carbon source," developed as the seed. The developed technology can synthesize silicon carbide while absorbing CO_2 and can produce SiC, a valuable material, by reacting silicon sludge, an industrial waste, with CO_2, thus contributing to the construction of an advanced recycling-oriented society (SDG 12: Responsible consumption and production) and promoting decarbonization.

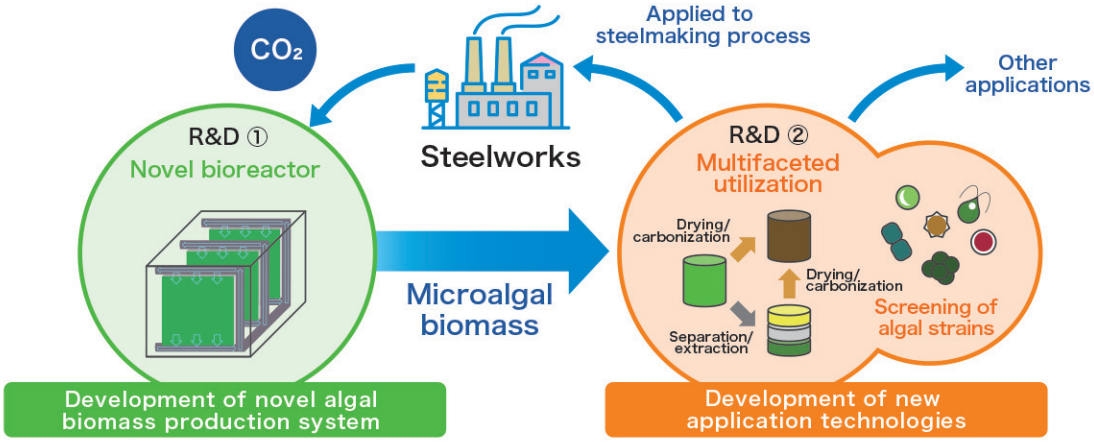


Schedule: Fiscal year 2022-2024

Organization: 東北大学 TOHOKU UNIVERSITY

Development of algal biomass production and application technologies enabling high efficient CO_2 utilization — Theme⑩

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 CO_2 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

Hiroshima Airport → 30min Bus/Taxi → Takehara Port → 30min Ferry → Tarumi Port → 15min Taxi → Destination

JR

Sanyo Shinkansen Hiroshima Station → 70min Bus → Takehara Port → 30min Ferry → Tarumi Port → 15min Taxi → Destination

Sanyo Shinkansen Mihara Station → 35min Train → JR Kure Line Takehara Station → 8min Bus/Taxi → Takehara Port → 30min Ferry → Tarumi Port → 15min Taxi → Destination

Car

Sanyo Expressway Kochi IC → 25min Car → Takehara Port → 30min Ferry → Tarumi Port → 15min Car → Destination

Sanyo Expressway Kochi IC → 30min Car → Akitsu Port → 35min Ferry → Onishi Port → 5min Car → Destination

Directions from Shikoku

JR

JR Yosan Line Imabari Station → 10min Bus/Taxi → Imabari Port → 55min Ferry → Munagata Port → 15min Ferry → Tenman Port → 10min Taxi → Destination

Address

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

Ferry to Osaki-Kamijima

- Sanyo Shosen (Takehara) : +81-846-22-2133
- Osaki Kisen (Takehara) : +81-846-22-2390
- Habu Shosen (Takehara) : +81-845-22-1337
- Akistu Ferry (Akitsu) : +81-846-45-0462
- Omishima Blue Line (Imabari) : +81-898-32-6713

Taxi In Osaki-Kamijima

- Osaki Taxi : +81-846-64-2084
- Higashino Taxi : +81-846-65-2091

Contact Us

New Energy and Industrial Technology Development Organization

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Contact Us

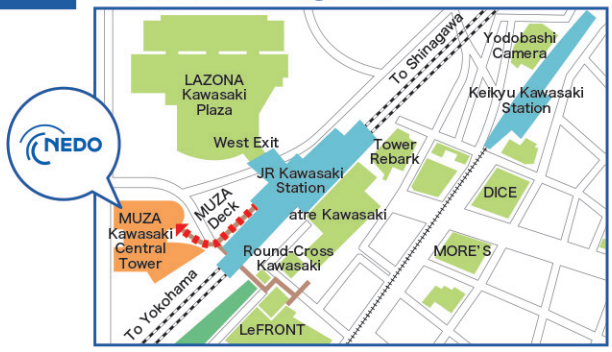
+81-44-520-5293

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/


NEDO