



JAPAN CARBON FRONTIER ORGANIZATION

*JAPAN CARBON FRONTIER ORGANIZATION
WITH INNOVATIVE TECHNOLOGIES (JCOAL)*



<http://www.jcoal.or.jp/eng>

Our Vision

Coal, with its reserves abundantly available and being distributed all over the world as well as affordability, has been bolstering steady growth of the globe in various fields for development. World Energy Outlook 2023 by IEA indicates while global coal usage is anticipated to decrease toward 2050, in all scenarios coal remains crucial in many emerging economies, especially in Asia. Let us emphasize afresh that we are to head toward carbon neutrality by promoting low emission and zero emission activities in all fields instead of through "away from coal".

Japan has set an ambitious target to reduce greenhouse gas emissions by 46% against 2013 level toward 2030 with a carbon neutrality target by 2050. In addition, Japan has been making strenuous efforts in forging unique frameworks that are conducive to global climate change endeavors, such as long-standing JCM (Joint Crediting Mechanism), Climate Transitional Bond under the umbrella scheme of GX (Green Transformation), and AZEC (Asia Zero Emission Community).

As known, we have long been engaging in working on R&D of clean coal technology (CCT) and its dissemination throughout the entire value chain, as well as in collaborating with and bridging between countries, institutions, organizations and companies in and outside Japan. In recent years in intensifying our efforts to carbon neutrality, we have stretched our line of business, in addition to the original areas we had been working on, to new areas such as biomass cofiring/dedicated firing, ammonia cofiring, hydrogen utilization and CCUS (carbon capture, utilization and storage), which is represented by our new organization name Japan Carbon Frontier Organization. Our new focus among others is participating in management and operation of government-designated carbon recycling demonstration research centers and development of SAF (sustainable aviation fuel) synthesis technology.

We are determined to work together with our collaborative partners, both existing and incoming, around the globe with our knowledge, technology, network and creativity, toward the future carbon neutrality and sustainability.

Board of Directors

Chairperson

WATANABE
Toshifumi
Assumed:
June 18, 2024



Vice
Chairperson

HARADA
Eiichi



Vice
Chairperson

HANAMOTO
Yuzo



President

TSUKAMOTO
Osamu



Senior
Executive
Director

HASHIGUCHI
Masamichi



Executive
Director

HOKANO
Masahiko



Organization Outline

History

Established March 10, 1948

Japan Coal Association

Established February 1, 1960

Coal Mining Research Center
Japan

Established October 16, 1990

Japan Technical Cooperation Center
for Coal Resources Development

Merged July 1, 1997

Japan Coal Energy Center

Established June 16, 1989

Center for Coal Utilization Japan

Merged April 1, 2005

Japan Coal Energy Center

Transitioned April 1, 2012

Japan Coal Energy Center

Renamed April 1, 2021

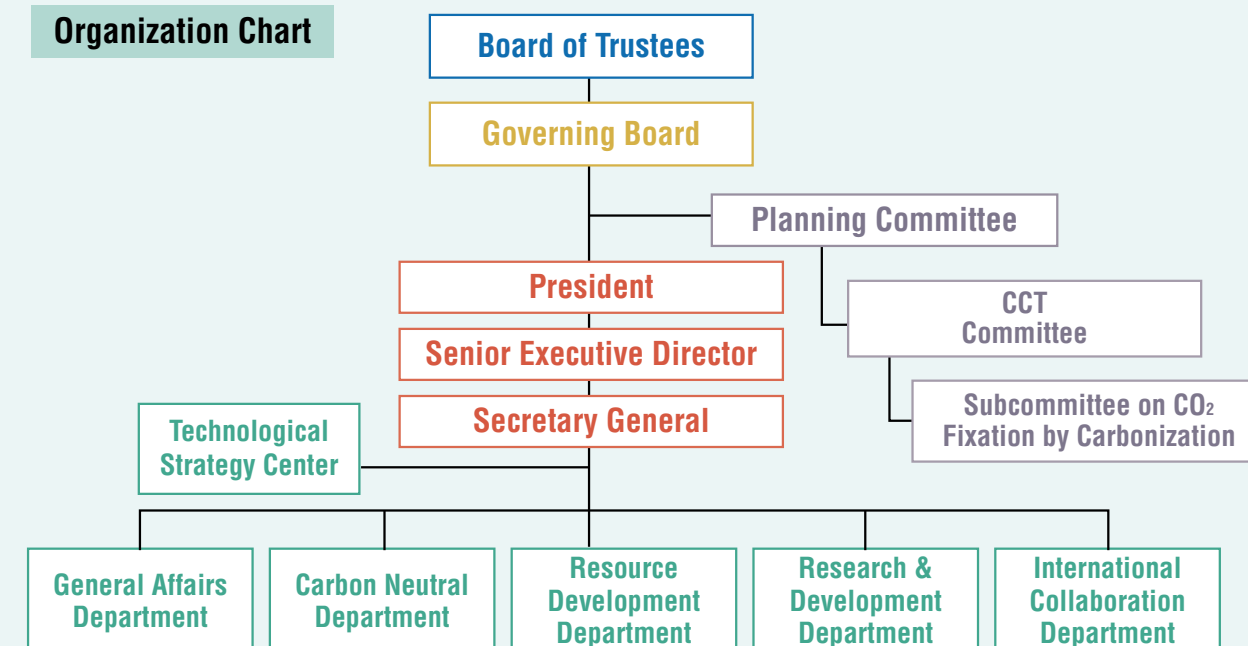
Japan Coal Frontier Organization

Renamed April 1, 2023

Japan Carbon Frontier Organization

*In 1991, the Coal Utilization Technology Division of Coal Mining Research Center Japan was transferred to Center for Coal Utilization Japan.

Organization Chart



Various committee activities

CCT Committee formulates and reviews roadmaps aimed at promoting and supporting the development of CCT and carbon recycling technologies, and holds seminars on individual technical themes.

(Reference: Themes of Seminary held in 2023)

- Carbon neutrality in general industries (steel, cement, etc.)
- Biomass fuel
- Ammonia and hydrogen production and utilization technology
- Carbon neutrality in the concrete engineering field

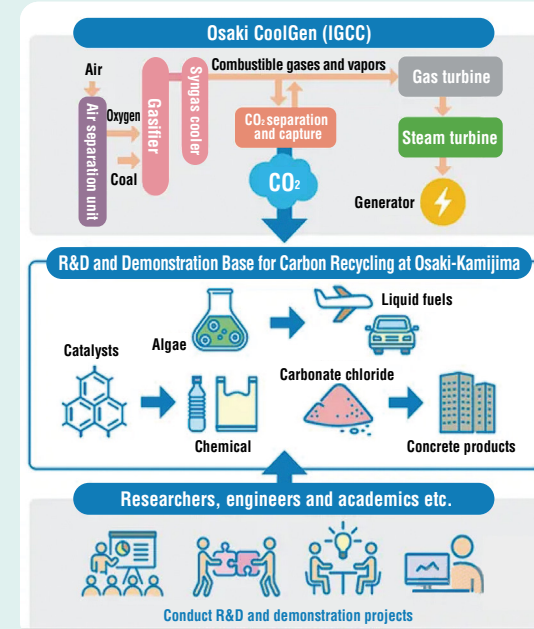
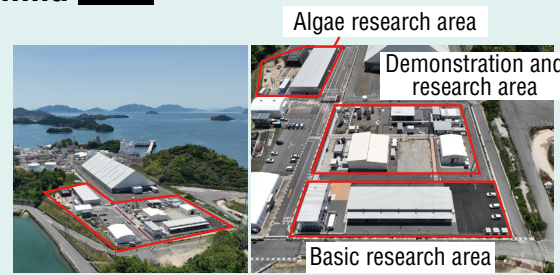
Promotion of Carbon Recycling Activities

Development of a Carbon Recycling (CR) Demonstration Research Center at Osaki-kamijima, Hiroshima NEDO

At the Carbon Recycling (CR) Demonstration Research Center, the Osaki CoolGen (an integrated coal gasification fuel cell combined cycle power generation demonstration project) separates and captures CO₂ (actual gas) which is then transported by pipeline and used as the raw material for the demonstration of the production of fuels, chemicals, and minerals etc.

This Center consists of three areas; a Demonstration Research Area, an Algae Research Area, and a Basic Research Area. The Demonstration Research Area conducts pilot tests on the production of fuel, Compounds and Chemicals. The Algae Research Area researches the derivation of SAF (Sustainable Aviation Fuel) from microalgae. The Basic Research Area has a common and a research building, with the common building including an analysis lab, and the research building containing six labs for elemental research on CR technology, providing a place for researchers to discuss and perform PR activities.

We operate and manage this facility to support the research and development conducted at the center, and contributes to the enhancement and dissemination of CR by sharing the results throughout Japan and internationally. This research building also conducts R&D (Research and Development) on the use of diamond electrodes for the electrochemical reduction of CO₂ to produce formic acid.

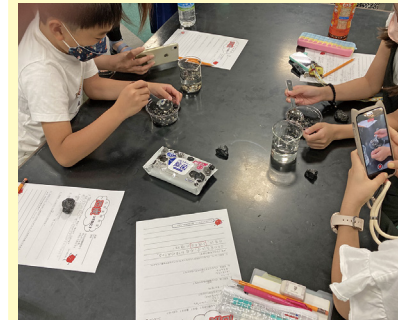


Technical assistance for building relationships with coal-mining countries to secure stable coal supplies



Dissemination of bio-coal briquettes (Mozambique)

Making policy proposals and promoting PR activities

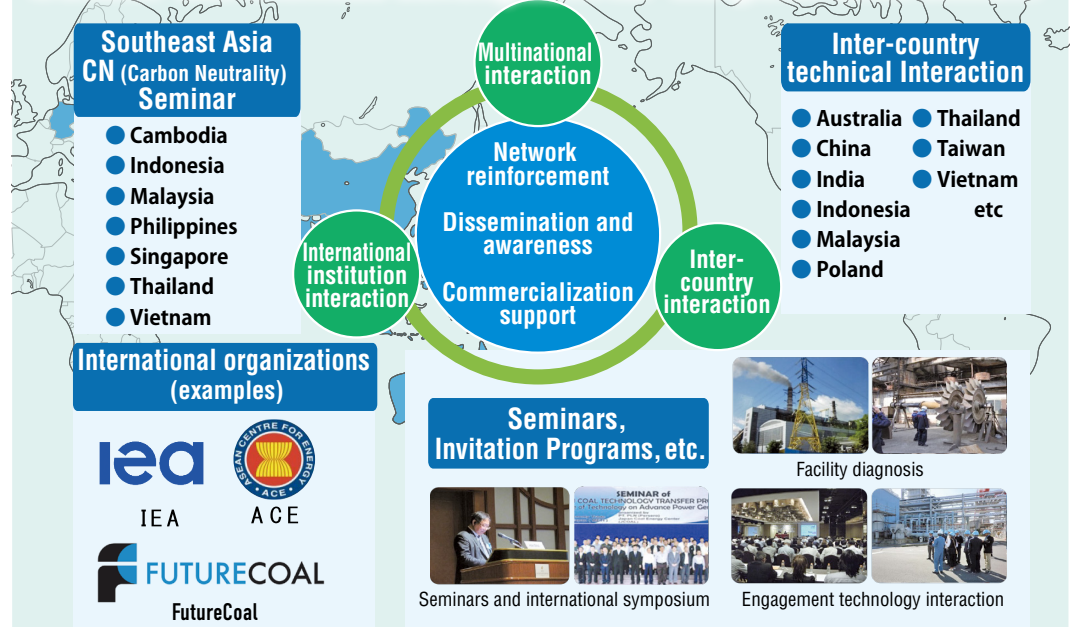


Coal experimentation classes



Zero Emission Thermal Power Generation EXPO

International collaboration projects such as technology transfer and business development for the global environment



Clean Coal Day (CCD) International Symposium



We co-host the CCD International Symposium with METI (Ministry of Economy, Trade and Industry), NEDO (New Energy and Industrial Technology Development Organization), and JOGMEC (Japan Oil, Gas and Metals National Corporation). This international symposium features presentations and panel discussions on topics such as decarbonization technologies, with participants including government agencies, corporate representatives, academia, and international organizations from Japan, India, Indonesia, Australia, and other countries. The outcomes of the symposium are disseminated domestically and internationally as JCOAL's STATEMENT.

Energy Security with Decarbonization Symposium



In FY2023, we held the "Energy Security with Decarbonization Symposium" in collaboration with JOGMEC, focusing on the decarbonization of the upstream sector and the energy sector. This symposium took place the day after the CCD International Symposium. We had presentations from the FutureCoal, as well as representatives from government agencies, corporate representatives, academia, and international organizations from countries such as Australia, China, and India, etc.

Production of key substances from CO₂ in coal-fired flue gas using diamond electrodes NEDO Implementation period: FY 2022-2024

This project is developing important technology in CR, such as artificially fixing CO₂ in the atmosphere. Specifically, compared to other electrode materials, diamond electrodes (conductive diamond; manufactured by boron doping and using the CVD (Chemical Vapor Deposition) method) has a wider reduction area and are superior in durability and stability. The development will include research in electrochemically reduce CO₂ to produce formic acid. Japan Carbon Frontier Organizatio, Keio University and Tokyo University of Science have conducted basic research aimed at establishing a technology to directly decompose CO₂ using renewable energy and produce chemical raw materials with high efficiency.

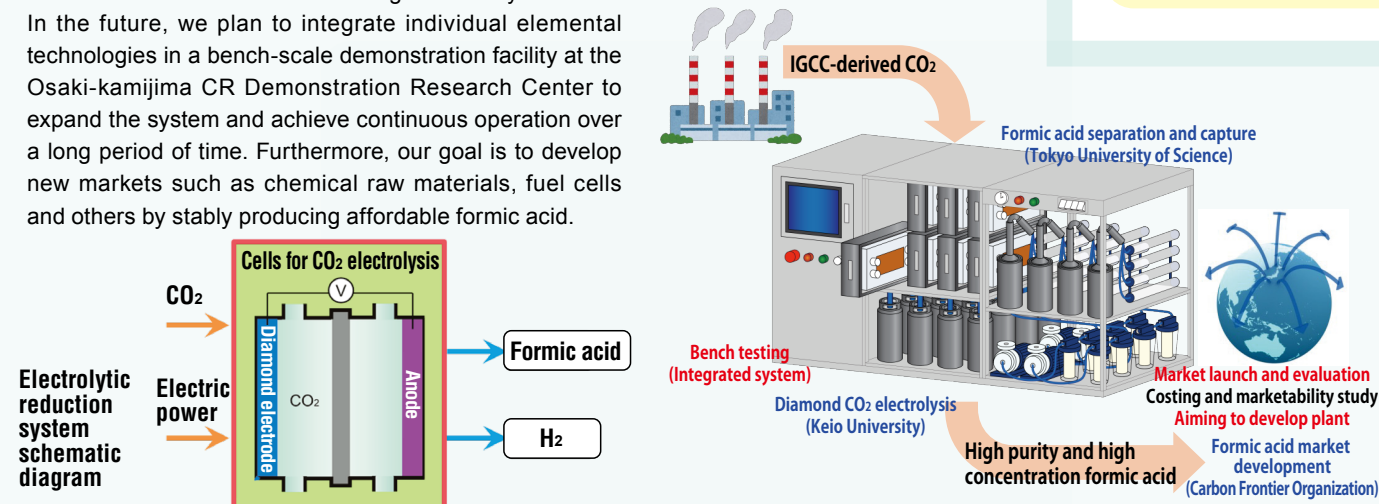
In the future, we plan to integrate individual elemental technologies in a bench-scale demonstration facility at the Osaki-kamijima CR Demonstration Research Center to expand the system and achieve continuous operation over a long period of time. Furthermore, our goal is to develop new markets such as chemical raw materials, fuel cells and others by stably producing affordable formic acid.

Human resource development

- Training programs for young coal workers in Japan
- Training programs for overseas mineral and resource professionals

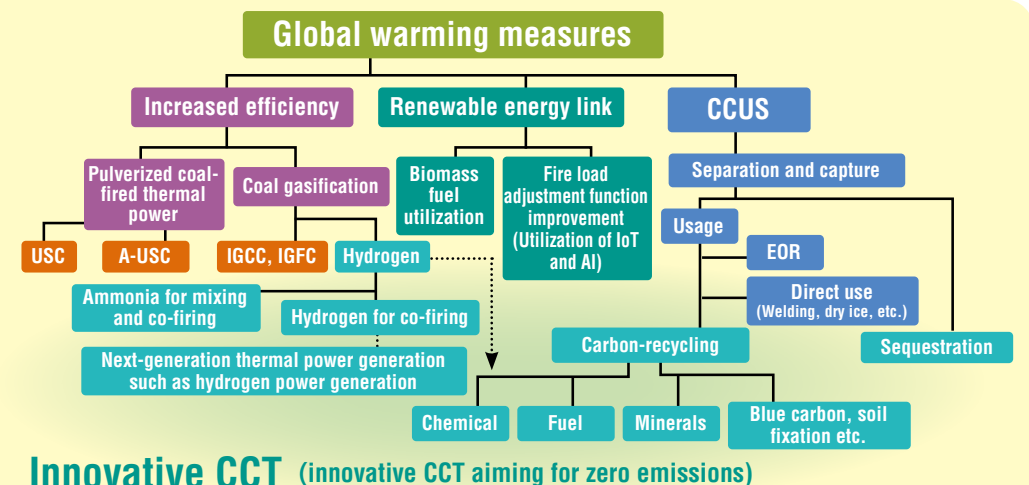


Domestic on-site training (Hokkaido)



Innovative CCT

To achieve carbon neutrality, it is important to establish a cooperative system among industry, government and academia towards the development of technologies such as CCUS/carbon-recycling in the power and non-power sectors that utilize coal. We are working to develop "innovative clean coal technologies" including innovations in fields such as CCUS/carbon recycling, while also working to reduce costs associated with CO₂ emissions.



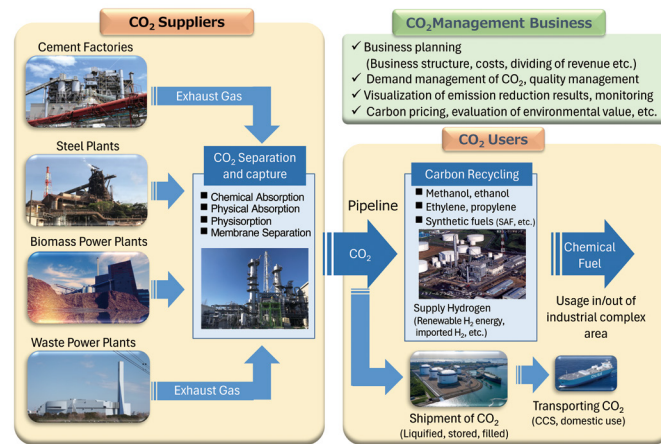
Technological development for the realization of carbon neutrality

1 Promoting Carbon Recycling Technology Implementation Through Inter-Industry Cooperation **NEDO**

Implementation period:
FY 2024-2025

Promotion of Carbon Recycling Business Via Inter-Industry Collaboration

In the domestic petrochemical industrial complex area, there are multiple industries producing a variety of products. In this study subjected to specific industrial complex with a large industrial concentration and in cooperation with multiple industries located in the area, we will investigate the feasibility of a carbon recycling business that can lead to a significant reduction in CO₂ emissions and lower costs through the flexible use of existing infrastructure, unused energy, CO₂ and hydrogen (H₂), etc. Furthermore, the roles required of CO₂ management businesses, assuming there is cooperation between multiple CO₂ suppliers and users, will be examined and the implementation of such projects will be promoted. (Implement together with the Research Association of Refinery Integration for Group-Operation and companies located in the subjected complexes)



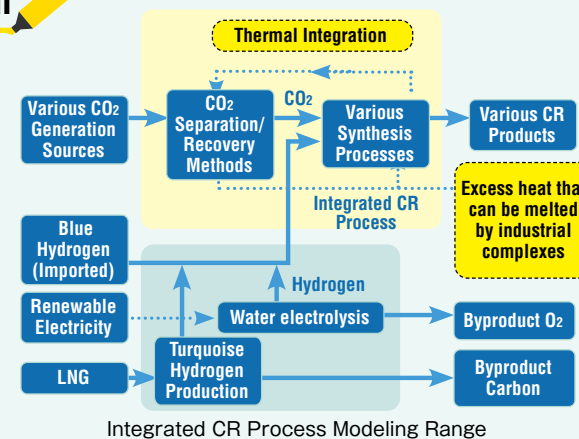
1-2 Optimization Study of CO₂ Separation and Recovery Technology

Investigation of Optimal Systems through Process Simulation and Identification of Challenges for Social Implementation

In the "Carbon Recycling Roadmap Review Meeting" held by the Ministry of Economy, Trade and Industry in June 2023, it was noted that inter-industry collaboration to connect CO₂ emitters and users (building a CO₂ supply chain) is necessary. By 2030, the goal is to "develop a societal system that considers combinations of CO₂ sources, separation and recovery technologies, and CO₂ purity suitable for various applications."

In petrochemical complexes, multiple fossil fuel-based facilities such as thermal power plants, steel mills, cement plants, oil refineries, and chemical plants operate. This project aims to decarbonize these complexes by constructing an integrated carbon recycling (CR) process comprising "CO₂ emission sources," "CO₂ separation and recovery technologies suitable for these sources," and "synthetic processes utilizing CO₂." We will conduct optimization studies to achieve energy efficiency and cost reduction, while exploring the challenges for social implementation.

Implementation period:
FY 2024-2025



2 Demonstration of advanced agricultural technology with ammonia micro gas turbines utilization

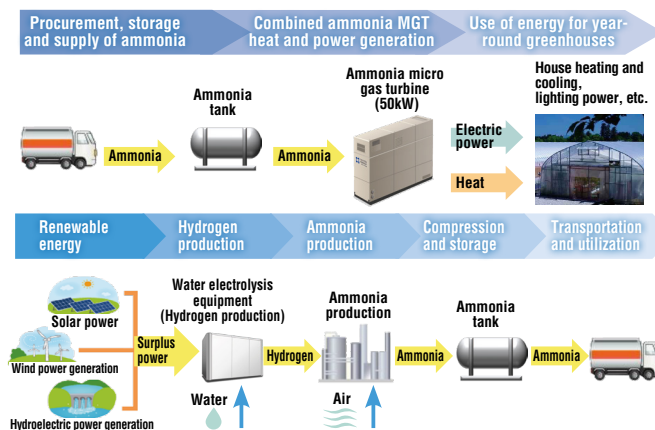
Ministry of the Environment

Zero emissions agriculture by using ammonia

Implementation period:
FY 2023-2024

A continuation of the project started in May 2021 as a technology demonstration project to supply electricity and hot water necessary for agricultural greenhouses using a 50kW ammonia-fired micro gas turbine (MGT). By developing an optimum cultivation management system in greenhouses, the project's objective is to realize year-round cultivation regardless of climatic conditions, and to optimize the supply of heat and electricity by using an MGT cogeneration system fueled by ammonia, which does not emit CO₂ in the previous project. We demonstrated that ammonia MGT could be used safely in agriculture with results as planned. In the ongoing project, we are pursuing further economic efficiency, including cost reduction of MGT, summer cooling with an absorption refrigerator using exhaust heat, and commercialization of out-of-spec product with a warm-air dryer, as well as shipment adjustment according to market prices. The project will also develop a supply chain and commercialization plan for the production of CO₂-free ammonia (ammonia from renewable energy) in Akita Prefecture.

(With Toyota Energy Solutions as the representative, the project is being implemented by five organizations: Japan Carbon Frontier Organization, Akita Agricultural Sales, Akita Prefectural University, and the National Institute of Advanced Industrial Science and Technology (AIST)).



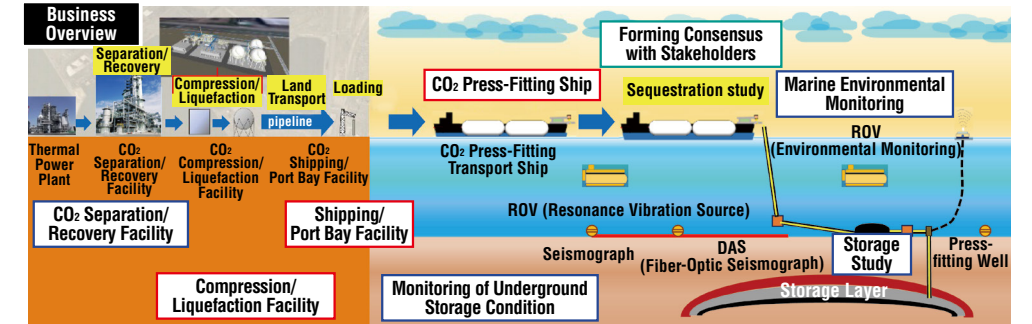
3 Environmentally-conscious CCUS - Integrated demonstration facility and supply chain construction project Ministry of the Environment

Implementation period:
FY 2021- 2025 (Scheduled)

Study to Demonstrate CCS from Offshore

In Japan, CO₂ sources are not always located near sequestration sites. Therefore, it is necessary to transport the CO₂ to the sequestration site. This project involves study of an integrated demonstration to monitor the behavior of sequestered CO₂ which has been separated and captured at the power plant, then compressed liquefied and loaded

This project examines methods of transporting liquefied CO₂, injecting it from the sea, surveying sequestration sites, drilling, and monitoring, as well as summarizing the benefits, challenges, and risks from economic and environmental perspectives. (A consortium of 9 organizations, including the Japan Carbon Frontier Organization is being formed for implementation)



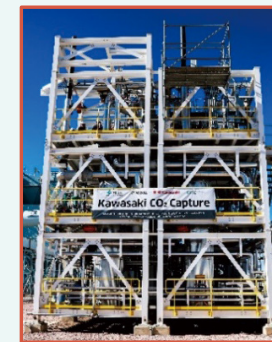
4 Demonstration of CO₂ separation and capture using solid absorbents Ministry of the Environment

Implementation period:
FY 2021 - 2024

International efforts to prevent global warming

CO₂ separation and capture technology using solid amine absorbents consumes less energy than the conventional absorbent method. The absorbent can be regenerated using waste heat energy from power plants.

A demonstration test facility at the Integrated Test Center (ITC) in Wyoming, USA, was constructed. This demonstration project is to study the environmental impact of CO₂ separation and recovery technology using actual emissions from Dry Fork coal-fired power plant next door.
(Joint implementation with Kawasaki Heavy Industries)



Panoramic view of the Dry Fork Power Plant and Integrated Test Center (ITC)

5 Highly efficient production system for woody biomass fuel using fast-growing trees **NEDO**

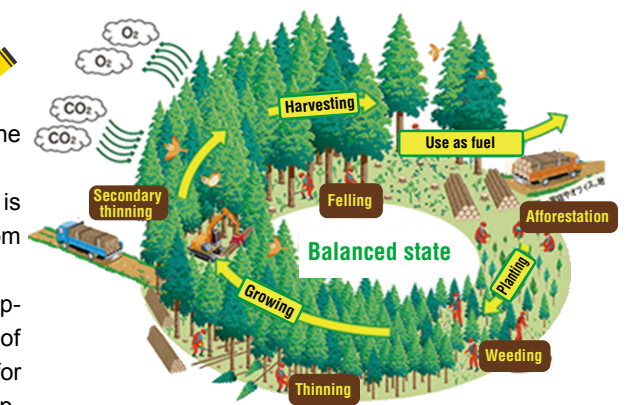
Implementation period:
FY 2021 - 2024

Contributing to regional development through the local production and consumption of biomass

One of the main subjects for domestic biomass power generation are the stable supply of biomass and the reduction of procurement costs. In Iwaki City, Fukushima Prefecture, a highly efficient production system is being developed for the stable supply of domestic woody biomass fuel from fast-growing trees (such as "Chinese Fir").

By replacing existing Japanese cedar forests with fast-growing trees, applying GIS (Geographic Information System) and cloning technologies of superior seedlings, we will develop a clear-cutting and renewal system for fast-growing trees grown specially for fuel wood production. The development will contribute to the revitalization of local economies through locally produced and consumed biomass fuel.

(Joint implementation with Toono Kousan and Furukawa Ringyo)



(Source: Forestry Agency “Annual Report on Forest and Forestry in Japan”)
Illustration of the creation of “Energy Forests”

Introduction of Initiatives

Technological development for the realization of carbon neutrality

6 Feasibility Study on Small-scale Distributed SAF Production Technology using Biomass Gasification and FT Synthesis **NEDO**

Implementation period:
FY 2024

Production of SAF (Sustainable Aviation Fuel) from regional biomass using small-scale gasification and FT synthesis reactors

In recent years, there has been international momentum in developing SAF (Sustainable Aviation Fuel) derived from low-carbon sources such as algae and biomass. Considering the current energy landscape, it is crucial to develop technologies for a broad range of SAF sourcing, utilizing both domestic and foreign raw materials.

There are several methods for SAF production, but using synthetic gas from biomass gasification as feedstock and employing FT (Fischer-Tropsch) synthesis are highlighted. Miniaturization of gasification and FT synthesis reactors is pivotal as it can reduce plant costs and potentially establish a stable and cost-effective decentralized fuel supply chain.

This study focuses on biomass gasification and FT synthesis, investigating the feasibility of establishing small-scale SAF production plants and decentralized supply chains at the regional level. It also explores challenges for implementing these technologies socially.

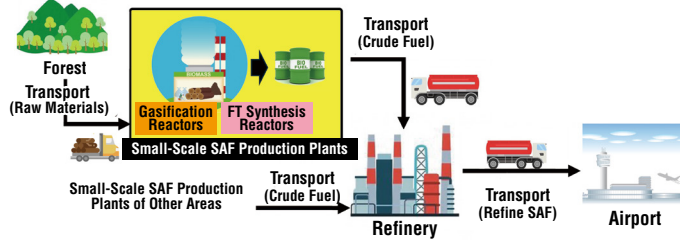


Figure image of domestic SAF supply chain for small scale distributed biomass utilization

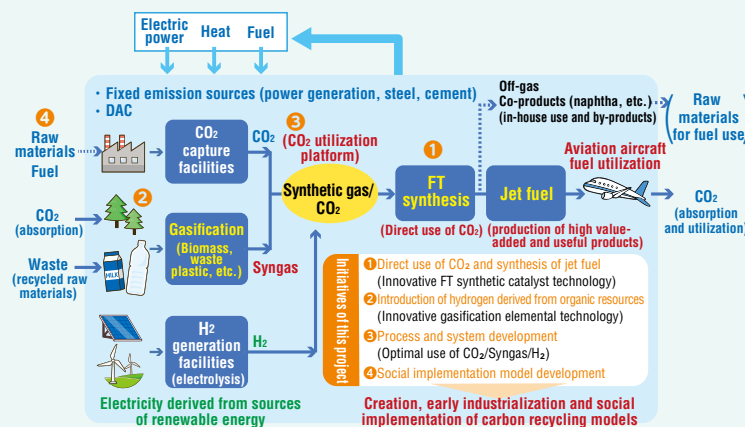
7 Joint international R&D into carbon-recycling with the direct use of CO₂ jet fuel synthesis Developing Sustainable Aviation Fuel (SAF) **NEDO**

Implementation period:
FY 2021 - 2024

Hydrogen is necessary for the production of synthetic fuels from the CO₂ emitted from power plants and steelworks, but there is an issue with the high cost of producing hydrogen from renewable energy-derived electricity and water electrolysis. As an alternative to renewable energy and hydrogen, gasified biomass and waste plastics in the form of syngas (H₂, CO etc.) is used to produce jet fuel from a wide range of synthetic gases including CO₂. Also, a commercialization, catalyst and process studies are being conducted. This study is being carried out as an international collaboration with the University of Toyama, Chulalongkorn.

This study is being carried out as an international collaboration with the University of Toyama, Chulalongkorn University, Thailand, while we will study producing hydrogen from gasification using mixed biomass feedstock with plastics as well as considering the entire supply chain from procurement to utilization.

(Jointly conducted by the University of Toyama and Chulalongkorn University, Thailand)



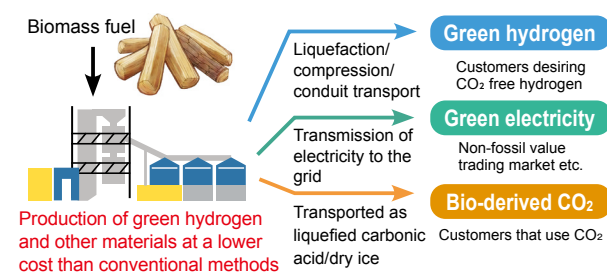
8 Chemical looping combustion and poly-generation technology development **NEDO**

Green power sources and hydrogen production with the application of biomass fuels

Chemical looping combustion technology utilizes the oxygen that exists in metal oxides such as iron oxide to combust coal and biomass. The combustion generates heat which turns a steam turbine to generate electricity and adding steam to the iron oxide that is used for hydrogen generating through reduction process. When exhaust gas is degassed, it forms CO₂ and water vapor, which, if cooled, allows the CO₂ to be easily separated and captured. Therefore, when biomass is used as fuel, green electricity and green hydrogen can be produced. Osaka Gas and Japan Carbon Frontier Organization are currently working together on 300 kW large-scale cold model test rig to acquire various operational data and to conduct system evaluations, while designing a hot model test rig.

Implementation period:
FY 2020 - 2024

300kW large-scale Cold Model test rig (Osaka Gas Carbon Neutral Research Hub) (Joint implementation with Osaka Gas)



9 Promotion of coal ash use in shallow water areas **NEDO**

Implementation period:
FY 2021 - 2025

Global warming measures utilizing the marine ecosystem

Japan, a country surrounded by the sea, is a nation with the world's sixth largest ocean area. By making use of our rich sea area and installing blocks, substrates, and artificial stones made from coal ash in shallow waters, various installments can be developed, such as restoring seaweed beds, improving fishing grounds for clams, and preventing scouring of structures such as offshore wind turbines. Furthermore, we can expect that the installed blocks and artificial stones will improve the growth environment of marine organisms as well as preserve the marine environment. In the future, it can contribute to enhancing the ability to incorporate atmospheric CO₂ into ecosystems. We will conduct an economic and business feasibility evaluation through an actual marine trial, as well as an evaluation of the potential of CO₂ absorption and fixation for future implementation.

(Jointly conducted by the Central Research Institute of the Electric Power Industry, Tokyo Power Technology and Toyo Construction)



Sandfish eggs laid on seaweed (Iwadate Fishing Port, Akita)

Introduction of Initiatives

A Project Our Organization Supports

Expanding from Coal Ash Utilization and Supply of Disaster Reconstruction Materials

Ministry of Economy, Trade and Industry, and others

Contributing to Civil Engineering and Environmental Fields with Locally Produced and Consumed Coal Ash Products

In Minamisoma City, Fukushima Prefecture, we operate a manufacturing and sales business of civil engineering materials using coal ash (fly ash) through Fukushima EcoCrete Co., Ltd., a joint venture established (commencing production in 2018). Aimed at recycling coal ash in Fukushima Prefecture, we produce approximately 90,000 tons annually of roadbed materials alternative OR Crete (Odaka Revive (Recycle) Crete). As part of our business expansion efforts, we also utilize combustion ashes from biomass power plants.

Following the publication of technical guidelines by the Japan Society of Civil Engineers on the use of coal ash blended materials (March 2021), we promote the widespread adoption of effective coal ash utilization products in the civil engineering and environmental fields. We actively implement initiatives such as applying carbonation technology to achieve CO₂ reduction.

(Joint project with Japan Land Development and Shinwa Trading Co., Ltd.)

Product Image (OR Crete)



Entire view of Fukushima EcoCrete Plant

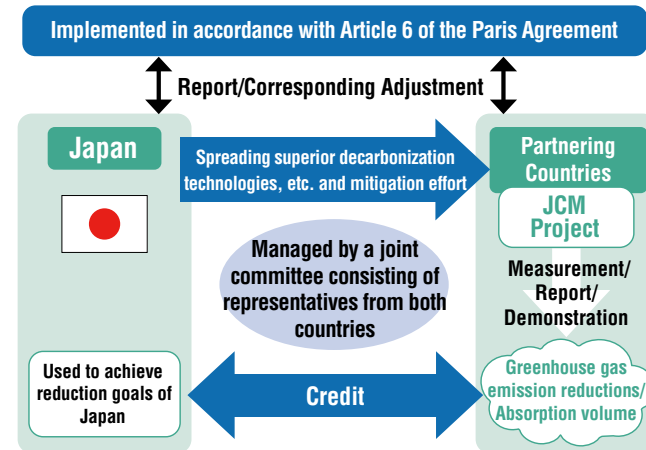
Introduction of Initiatives

Contributing to Global Carbon Neutrality with Japanese Technology

1 Promoting Innovative CCT Globally

Japan's Initiative to Obtain Carbon Credits (Environmental Economy Office Activated)

As countries and companies worldwide work towards carbon neutrality by reducing CO₂ emissions, attention is turning to carbon pricing as a cost-effective method. Carbon pricing options include carbon taxes, emissions trading, and carbon credits. Among these, carbon credits through the private-led Joint Crediting Mechanism (JCM) are particularly promising for promoting emission reductions through bilateral credit projects. At JCOAL, we not only support the global promotion of innovative CCT (Clean Coal Technologies) but also collaborate with Japanese government agencies to actively contribute to private sector initiatives for CO₂ reduction abroad. Our aim is to facilitate the issuance of carbon credits through technology dissemination, thereby supporting global efforts towards carbon neutrality.



Source: Materials of Ministry of the Environment

2 Overseas expansion of Innovative CCTs NEDO ERIA

While the goal of achieving carbon neutrality is shared globally, it is essential to tailor efforts to the specific circumstances of each country and region. Therefore, by engaging with international organizations and hosting international conferences and seminars, we identify global needs and diverse pathways. We then propose and promote Japanese technologies suited to these requirements, contributing to global efforts towards carbon neutrality.

Multinational interaction

- Clean Coal Day (CCD) International Symposium (1,500 participants from 25 countries in 2023)
- Southeast Asia CN(Carbon Neutrality) Seminar

We invited representatives from relevant agencies (policy, electricity, steel, cement, chemicals, and plant sectors) of seven Southeast Asian countries to introduce Japanese technologies that contribute to carbon neutrality. These include decarbonization technologies and near-commercial CCUS/CR technologies. The event facilitated business matching, with approximately 250 participants from eight countries

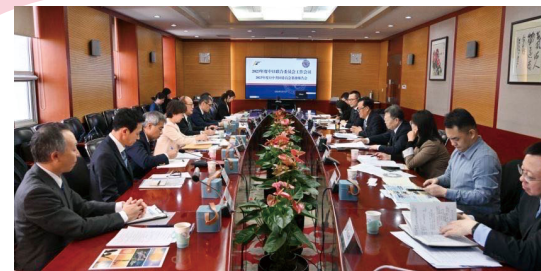


2024 CN Seminar (February 2024)

Network reinforcement
Dissemination and awareness
Commercialization support

Inter-country interaction

- Various seminars and invitational programs (India, Vietnam, China, Indonesia, etc.)



Japan-China Joint Committee (March 2024, Beijing)

International Institution Interaction And Cooperation

- International Energy Agency (IEA)
- FutureCoal
- ASEAN Centre for Energy (ACE)
- Economic Research Institute for ASEAN and East Asia(ERIA) and others

A working-level meeting on coal among ASEAN governments. Discussions covered resource and technology information systems, as well as the role of coal-fired power during the transition period.



ASEAN Forum on Coal (AFOC) Board of Directors Meeting (May 2023)

Introduction of Initiatives

Development of Coal Resources - Towards stable coal supply

1 Building relationships with coal-mining countries

A stable energy supply is essential for coal importing countries

Japan's energy policy is based on "S+3E," placing an emphasis on Safety, and pursuing the goals of increasing self-sufficiency and ensuring a stable supply system (Energy Security), reducing costs (Economic Efficiency) and reducing CO₂ emissions (Environment).

To achieve carbon neutrality, it is necessary to reduce the consumption of fossil fuels. However, fossil fuels, including coal, is still needed to produce thermal power to coordinate with fluctuations in renewable energy. It is important to establish win-win relationships with coal-producing countries to secure a stable supply of coal, and we have implemented the following initiatives so far in this regard.

Bio-coal Briquette Dissemination Program in Mozambique (JOGMEC)

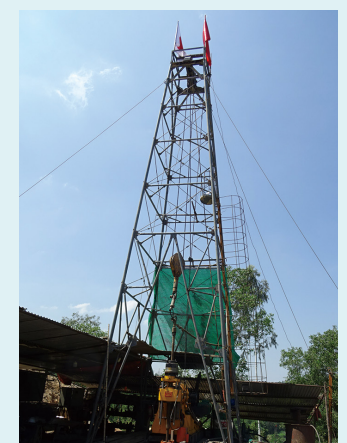


More than 90% of the people of Mozambique use firewood and charcoal as household fuel and it causes serious deforestation.

The use of bio-coal briquettes made from coal and agricultural waste which cannot be exported is being promoted as an alternative fuel to address these household fuels.

Overseas Geological and Geophysical Survey (JOGMEC)

To secure a stable supply of coal, we are conducting coal exploration jointly with coal-producing countries. Up till now, we have conducted drilling exploration in Australia, Mozambique, Indonesia, Vietnam, and other countries.



2023 Exploration for Anthracite Coal in Vietnam

2 Human resource development initiatives

Educating young human resources to lead the future

We provide on-site training at coal mines and coal-related facilities in coal-producing countries for young employees at member companies and college students, and also holds a "Seminar on Coal Basics." We are also committed to building human networks through the implementation of capacity building training and collaboration programs for young and mid-career professionals in Asian and African countries.



Seminar on Coal Basics (Tokyo)



Internships for Japanese students (Open-pit coal mine in NSW, Australia)



X (Twitter)



Web



Instagram



Office: 3F Daiwa Nishi-Shimbashi Bldg.
3-2-1 Nishi-Shimbashi, Minato-ku,
Tokyo 105-0003, Japan
Tel: 03-6402-6100
Fax: 03-6402-6110

Access

JR	Shimbashi Station	Karasumori Exit
Marunouchi Line	Kasumigaseki Station	Exit G3
Mita Line	Onarimon Station	Exit A5
Ginza Line	Toranomon Station	Exit B1
Hibiya Line	Toranomon Hills Station	Exit A1b