



JAPAN CARBON FRONTIER ORGANIZATION

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



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



Message from Chairperson

As countries around the world accelerate their efforts to achieve carbon neutrality by 2050, resource prices have soared because of the Russian conflict with Ukraine which began in February 2022. This situation has reaffirmed us the magnitude of the risk of dependency on specific country or region for energy resources or for a particular type of energy, and the importance of a key priority of Japan's energy policy, that is, diversification of energy sources for energy security.

Among the fossil fuel energy resources, coal has been constituted a crucial part of energy supporting economic and social development of many economies in a broad range of sectors, as it is reliable both in terms of wide distribution, abundance and affordability. In every forecast scenario of IEA's World Energy Outlook 2022, the global demand for coal will steadily continue, particularly in Asia and Oceania while coal consumption is expected to decrease toward 2050. It is quite understandable as they are one of the highly growing regions. This significantly implies what is required for us is to work together toward coal utilization with low and zero where possible CO₂ emissions, instead of decarbonization only by coal phase out.

While having been engaged in facilitating advanced technologies for clean coal utilization and relevant knowledge sharing as well as enabling institutional arrangement, we are shifting our key priorities to the other energy transition related technology areas, such as CCS and carbon recycling with focus on research and development as well as demonstration, which we believe will firmly contribute to carbon neutrality.

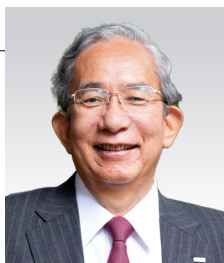
That is why as of April 1, 2023 our corporate name has been changed to Japan Carbon Frontier Organization as we work toward zero emissions while continuing utilization of fossil fuels and any other available energy resources.

April 2023
KITAMURA Masayoshi
Chairperson
Japan Carbon Frontier Organization

Board of Directors

Chairperson

KITAMURA
Masayoshi



Vice
Chairperson

HARADA
Eiichi



Vice
Chairperson

HANAMOTO
Yuzo



President

TSUKAMOTO
Osamu



Senior
Executive
Director

HASHIGUCHI
Masamichi



Executive
Director

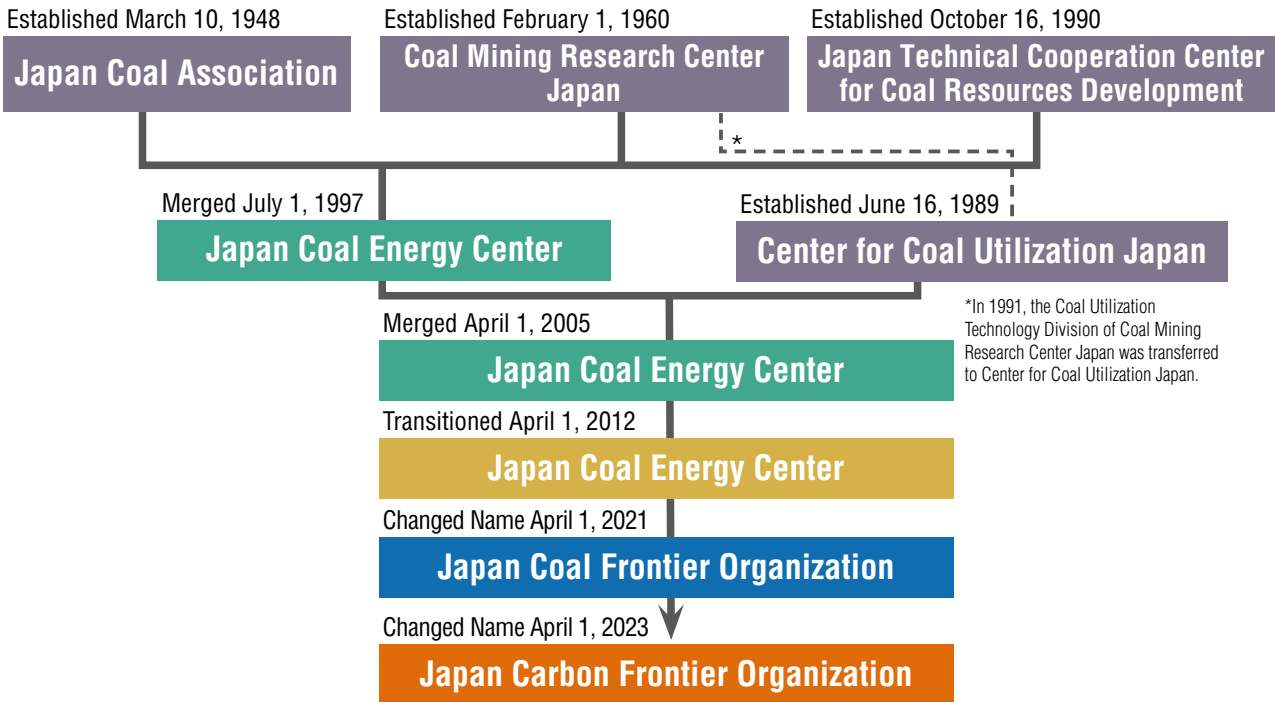
HOKANO
Masahiko



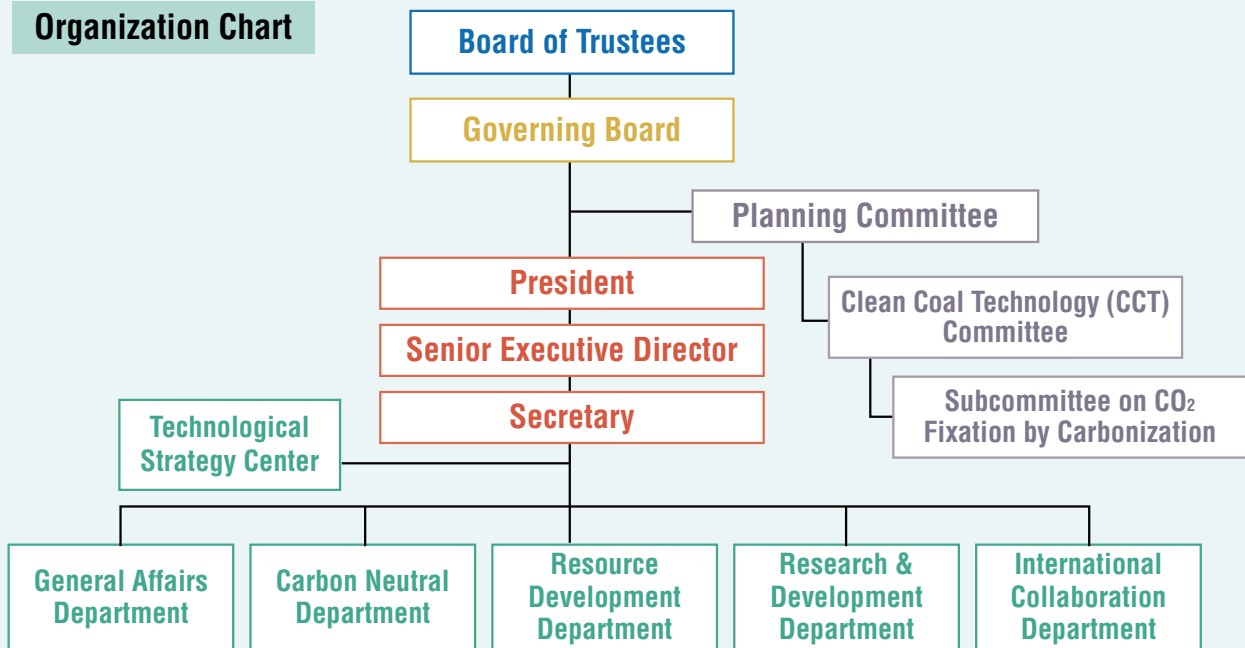


Organization Outline

History



Organization Chart



Various committee activities

The Clean Coal Technology (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 2022)

- Coal ash utilization and carbonation technologies
- Biomass energy and power generation facilities
- CO₂ separation and capture technologies
- Examples of efforts to develop carbon recycling technologies



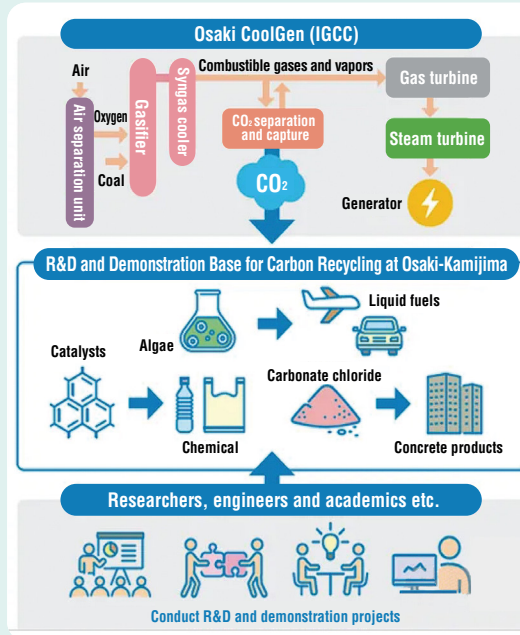
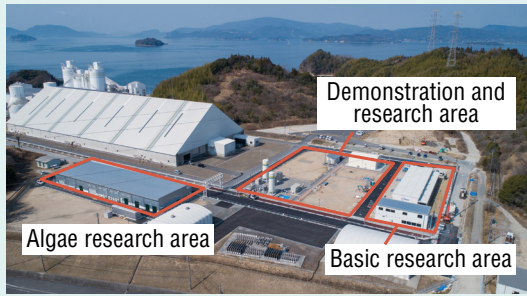
Promotion of Carbon Recycling Activities

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 (a combined cycle coal gasification fuel cell and 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 concrete, fuel 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



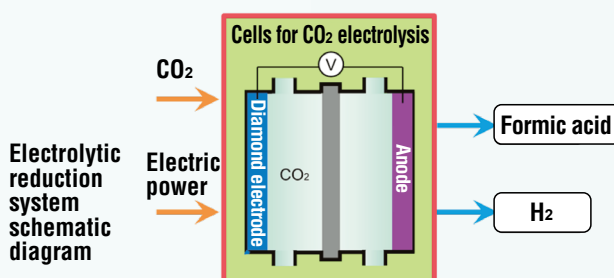
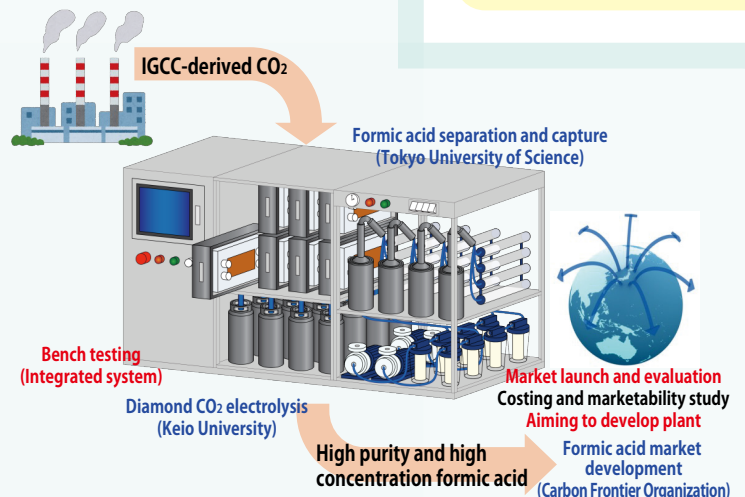
Dissemination of bio-coal briquettes (Mozambique)

Towards Neutrality

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 Organization, 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, based on the results of basic research, we will scale up the system and enable long-term continuous operation. In addition, by stably producing lower-cost formic acid, we aim to develop new markets such as raw materials for chemical products and fuel cells.



Human resource development

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

Making policy proposals and promoting PR activities

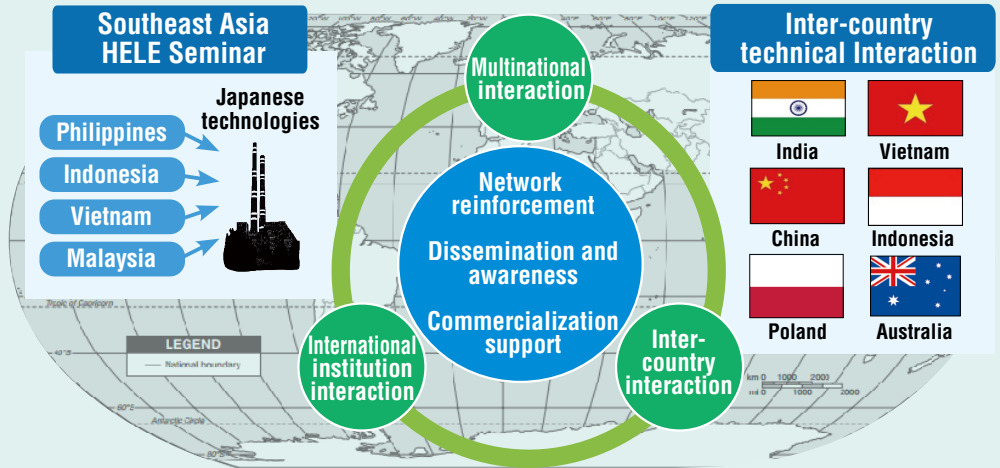


Coal experimentation classes



Zero Emission Thermal Power Generation EXPO

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



International organizations (examples)



Seminars, invitations, etc.



Carbon in Coal Use



Overseas on-site training (Australia)

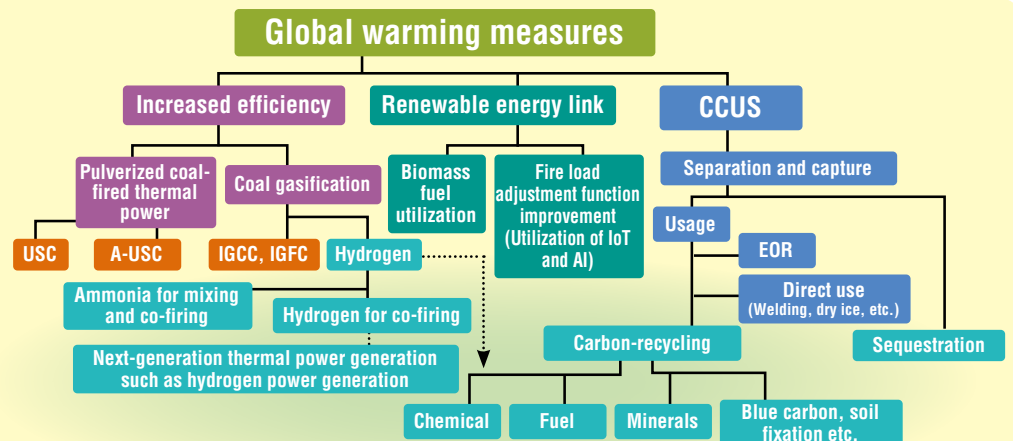
Clean Coal Day (CCD) International Symposium



The CCD International Symposium is organized by Japan Carbon Frontier Organization, together with METI (Ministry of Economy, Trade and Industry), NEDO (New Energy and Industrial Technology Development Organization), and JOGMEC (Japan Organization for Metals and Energy Security). The government, academia and private sectors worldwide gathered in this symposium to discuss on energy/coal policy, technology R&D. We publish the result of the symposium as "JCOAL's Statement" worldwide.

Innovative Clean Coal Technologies (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.



Innovative CCT (innovative CCT aiming for zero emissions)

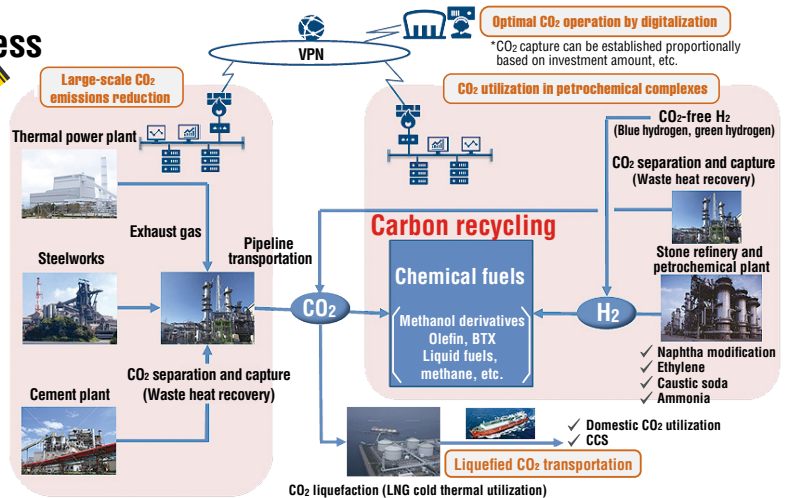
Technological development for the realization of carbon neutrality

1 Study on the inter-industrial collaboration of major petrochemical complexes NEDO

Implementation period:
FY 2020-2022

Formulation of a carbon-recycling business through inter-industrial collaboration

In petrochemical complexes in Japan, multiple industries exist to produce a variety of products. We investigate the potential for a carbon-recycling business that can lead to a significant reduction in CO₂ emissions and lower cost through collaboration among multiple industries in the complex with the flexible use of existing infrastructure, unused energy, CO₂, hydrogen (H₂), and other resources.
(Joint implementation with the Research Association of Refinery Integration for Group-Operation)

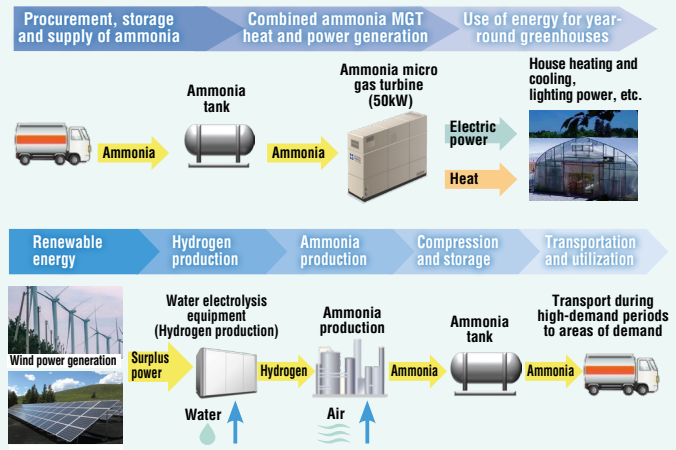


2 Demonstration of advanced agricultural technology with ammonia micro gas turbines utilization The Ministry of Environment

Implementation period:
FY 2023-2024 (Scheduled)

Zero emissions agriculture by using ammonia

This is an evolutionary project from May 2021 of a technology demonstration project to supply the electricity and hot water needed for agricultural greenhouses using ammonia-fired 50kW micro gas turbines (MGT). It aims to achieve year-round cultivation unaffected by climate changes utilizing an optimal cultivation management system in greenhouses without CO₂ emission even in colder regions like Akita where kerosene and other fuels have been used conventionally. The cogeneration system providing optimal heat and electricity with an MGT fueled by ammonia can increase harvests in agriculture with predictable results under less emissions and safely as demonstrated. In this evolutionary project, further economic efficiency will be pursued first by the reduction of MGT costs, and harvest increase by summer air conditioning from absorption chillers utilizing waste heat out of MGT, and also the commercialization of out-of-grade products by hot air drying in order to adjustment of shipping according to market prices. The project will also study a feasibility proposal for the production of CO₂-free ammonia (ammonia from renewable energy) in Akita. (The project operator is Toyota Energy Solutions and five co-operators with the Japan Carbon Frontier Organization, Akita Agricultural Sales, Akita Prefectural University, and National Institute of Advanced Industrial Science and Technology (AIST))

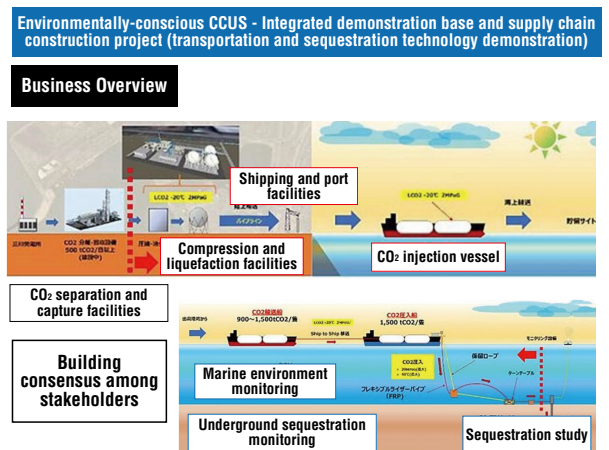


3 Environmentally-conscious CCUS - Integrated demonstration base and supply chain construction project The Ministry of Environment

Implementation period:
FY 2021- 2025 (Scheduled)

Efforts to CCS commercialization in Japan

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 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 onto a CO₂ carrier using shipping equipment for transport to a sequestration site. This project will examine methods of transporting liquefied CO₂, injecting it from the sea, surveying sequestration sites, drilling, and monitoring, with the view of economic and environmental perspectives. (A consortium of 13 organizations, including the Japan Carbon Frontier Organization and Toshiba Energy Systems & Solutions Corporation, is being formed to carry out this project)



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

Implementation period:
FY 2021 - 2023

International efforts to prevent global warming

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

A demonstration test facility has been constructed at the Integrated Test Center (ITC) in Wyoming, U.S.A. The demonstration project is taking an environmental impact assessment after CO₂ in the actual exhaust gas from the adjacent Dry Fork coal-fired power plant is separated and captured by solid absorbent.

(Joint implementation with Kawasaki Heavy Industries)



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

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

Implementation period:
FY 2021 - 2024

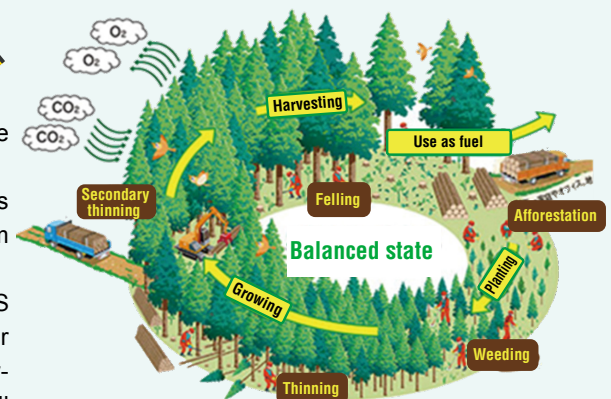
Contributing to regional development through the local production and consumption of biomass

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 "Koyozan").

By replacing existing 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)



(Sources: Forestry Agency, "Forest and Forestry White Paper 2015", etc.)

Illustration of the creation of "Energy Forests"

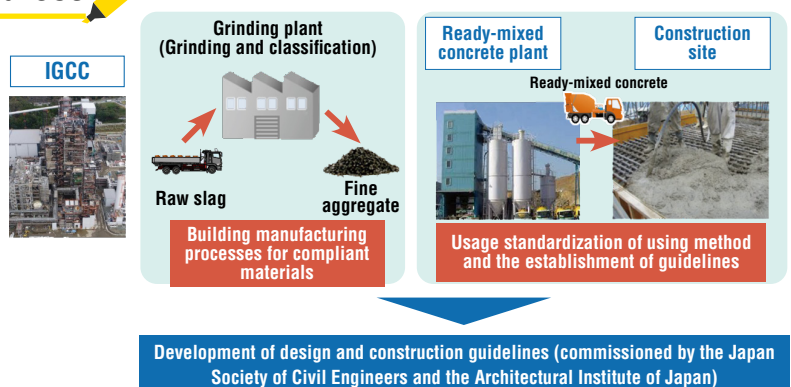
6 Promotion of the effective use of coal gasification slag NEDO

Implementation period:
FY 2019 - 2022

Challenge of transforming waste into resources

A JIS standard (slag aggregate for concrete) has been published for coal gasification slag (IGCC slag) generated by integrated coal gasification combined cycle (IGCC). In order to expand the use of IGCC slag aggregate in both the civil engineering and construction fields, we have continued to develop design and construction guidelines for the Japan Society of Civil Engineers and the Architectural Institute of Japan (published in 2023), while confirming the reliability through data obtained from full-scale construction.

(Joint implementation with Shimizu Corporation and Nakoso IGCC Power G.K.)



Development of design and construction guidelines (commissioned by the Japan Society of Civil Engineers and the Architectural Institute of Japan)

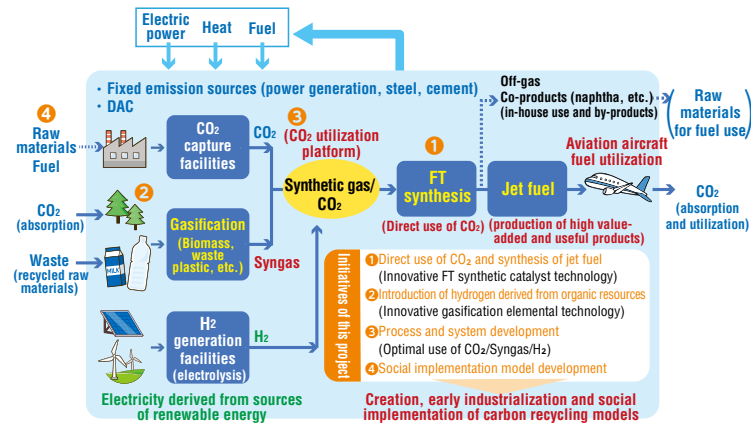
7 Joint international R&D into carbon-recycling with the direct use of CO₂ jet fuel synthesis **NEDO**

Implementation period:
FY 2021 - 2023

Developing Sustainable Aviation Fuel (SAF)

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 University, Thailand, with Japan Carbon Frontier Organization investigating hydrogen production from the gasification of biomass and other resources, and the entire supply chain from procurement to utilization.

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



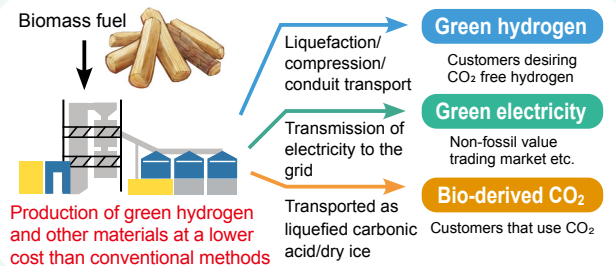
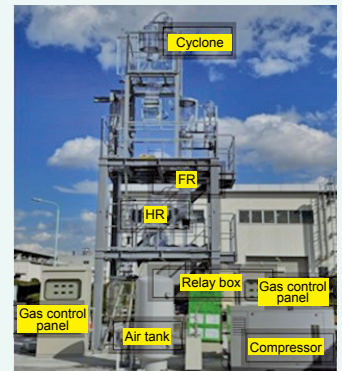
8 Chemical looping combustion and poly-generation technology development **NEDO**

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**

Global warming measures utilizing the marine ecosystem

Implementation period:
FY 2021 - 2025

Japan is a maritime nation which has the sixth largest sea area in the world. Blocks, foundations and stones made of coal ash are being installed in shallow waters to take advantage of this maritime location, to improve the growing environment for marine organisms. This allows the ecosystem to capture the CO₂ (blue carbon) in the atmosphere. We are expected to promote marine environment conservation by restoring seaweed beds, improving clam fisheries and preventing scouring for offshore wind power etc.

For practical use, the potential of CO₂ absorption and fixation are being evaluated, along with rational material manufacturing methods, economic efficiency and business feasibility. (Jointly conducted by the Central Research Institute of the Electric Power Industry, Tokyo Power Technology and Toyo Construction)



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

Introduction of Initiatives

Contribution of Japanese technologies to global carbon neutrality

Overseas expansion of Innovative CCTs **NEDO**

In Japan, various technological developments are underway with government's initiatives towards the achievement of carbon neutrality by 2050. In particular, the development of Innovative CCTs is promoted from the perspective of securing energy supply, assuming that a certain amount of fossil fuels such as coal will be needed.

On the other hand, the energy circumstances in foreign countries and regions are varied. Therefore, for achieving carbon neutrality is the same, each country and region needs to consider its own situation for the target. We contribute to global efforts towards carbon neutrality by identifying each country's needs and proposing Japanese technologies that meet their needs.

● Clean Coal Day (CCD) International Symposium

● Southeast Asia HELE* Seminar

*High Efficiency, Low Emission



Participating countries in the 3rd HELE Seminar (2021)

Governments and electric power officials are invited from the Southeast Asia region for HELE seminar to discuss policy and technology related HELE technology that contributes to carbon neutrality. Each company introduces their measurements and technological trends for the achievement of carbon neutrality.



International institution interaction

(Examples)

- International Energy Agency (IEA)
- World Coal Association (WCA)
- ASEAN Centre for Energy (ACE)

ACE/JCOAL Joint Report (August 2021)



Mineral Council of Australia (MCA)

Multinational interaction

Network reinforcement

Dissemination and awareness

Commercialization support

Inter-country interaction

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



Polish State Electric Company (ENEA)

	2017 Advanced firepower and talent development	2018	2019	2020	2021	Details of the interaction
East Asia	Mongolia	●				HLG, invitation
	China	●	●		●	Joint Committee WG etc.
	Taiwan	●	●			Seminars, invitations
Southeast Asia	Indonesia	●		●	●	Seminars, invitations
	Vietnam	●	●		●	Seminars, invitations
	Myanmar		●	●		Seminars
South Asia	India	●	●	●	●	Seminars, invitations
Eastern Europe	Poland	●	●			Seminars, invitations
	Serbia	●				Seminars
	Romania	●	●			Seminars
	Bulgaria		●			Seminars

Inter-country technical interaction (Reference: FY2017-2021)

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.

Capacity Development Project for Air Pollution Control in Ulaanbaatar City (JICA)



In Mongolia, air pollution is becoming a serious problem in the winter, particularly in the capital of Ulaanbaatar. One of the main reasons is exhaust gas (PM10, PM2.5, SO₂) from coal stoves that burn in traditional Mongolian ger dwellings. Technical support is provided to the Mongolian government as it aims to develop and promote environment-friendly improved coal as an alternative to the raw coal burned in coal stoves.

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 overseas students
(open-pit coal mine in NSW, Australia)



Twitter



Web



Instagram



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 Tokyo 105-0003, Japan
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Access		
JR	Shimbashi Station	Karasumori Exit
Marunouchi Line	Kasumigaseki Station	Exit G3
Mita Line	Onarimon Station	Exit A5
Ginza Line	Toranomon Station	Exit 1
Hibiya Line	Toranomon Hills Station	Exit A1