

A collage of four images arranged in a diamond pattern: a modern city skyline with skyscrapers (top right), a vibrant underwater scene with blue fish and coral (center), a night view of a city with the Tokyo Tower (bottom left), and an industrial facility with large storage tanks (bottom left, partially obscured).

Coal, a Precious Resource

JCOAL

*~Towards More Efficient and
Environmentally Friendly Utilization~*

©kawasaki Heavy Industries, Ltd.

Japan Coal Frontier Organization (JCOAL)

一般財団法人 石炭フロンティア機構

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

Top Message

We continue to take on the frontier of coal utilization, that is, “zero emissions coal utilization”.

Coal provides a variety of support for the foundations of society in fields such as power generation, steel, cement, and the chemical industry, so we believe it is important to take on this challenge towards carbon neutrality, which means reducing CO₂ emissions to net zero while using coal as a resource and energy source.

In particular, given the realities in Japan that there is no single perfect energy source that satisfies S (safety) + 3E (Energy Security, Economic Efficiency, and Environment), it is important to utilize diverse energy sources in a balanced manner. Therefore we need to retain as many options as possible while taking on the technological innovations for cost saving in CO₂ emissions reduction and the social implementation of low/zero emission technologies.

We are committed to working towards the resolution of two critical issues for humanity - improving energy access for everyone around the world and addressing climate change - in order to achieve a sustainable, diverse, and inclusive society that leaves no one behind, as stated by the Sustainable Development Goals (SDGs).

Masayoshi Kitamura

Chairperson

Japan Coal Frontier Organization

Board of Directors

Chairperson

Masayoshi
Kitamura



Vice
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Director

Masamichi
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Executive
Director

Masahiko
Hokano





Our Mission

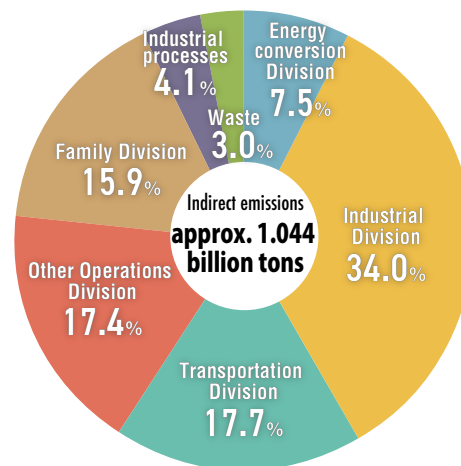
Towards carbon neutrality in coal utilization

In order to achieve carbon neutrality (net zero greenhouse gas emissions) by 2050, it will be essential to develop technologies that reduce carbon dioxide (CO₂) emissions in the power generation sector and various other industrial sectors such as steelmaking, cement, and chemicals.

It will be important to introduce high-efficiency coal-fired power generation in the field of coal-fired power generation and utilize existing plants using cofiring technology, etc., while actively promoting the introduction of biomass/ammonia fuels. It will be possible to combine the CO₂ emitted from the coal and biomass in this process with appropriate CCUS (CO₂ capture, effective utilization, and sequestration) to achieve carbon-neutral thermal power generation by 2050.

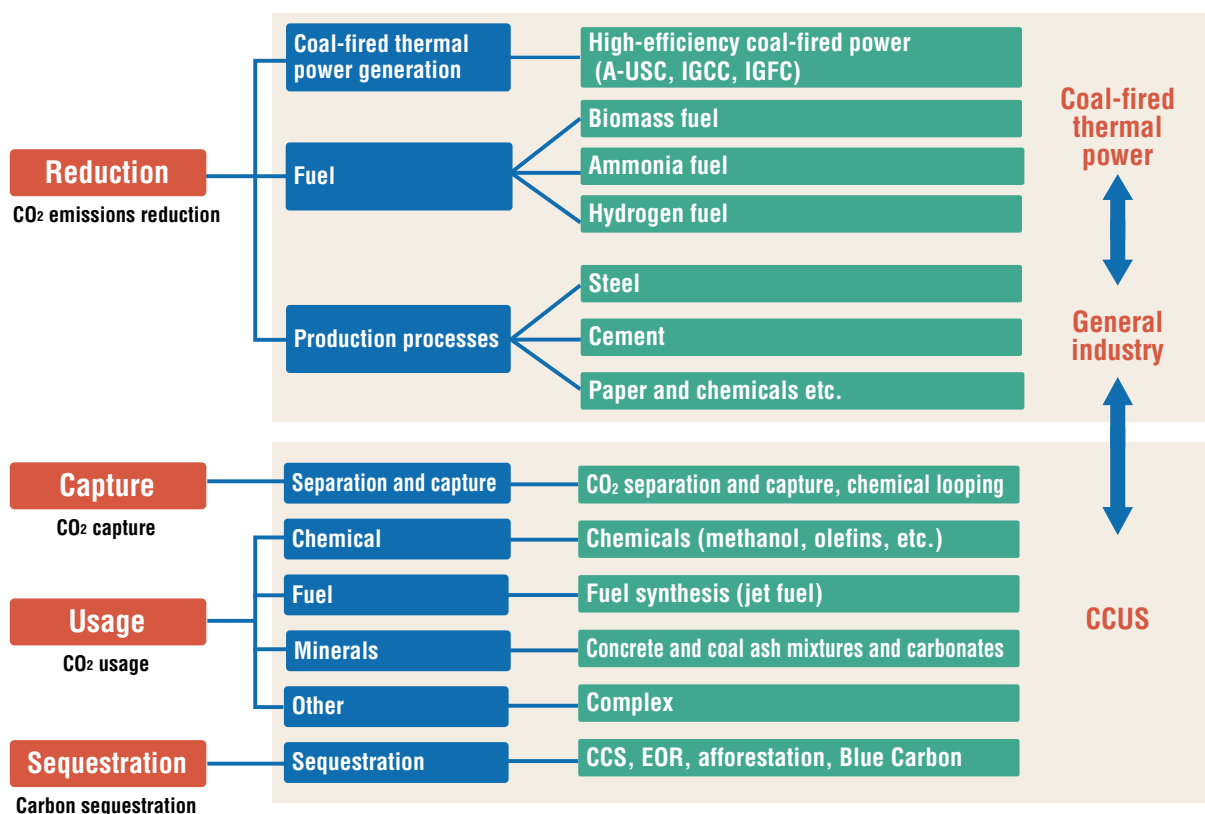
Coal utilization as a fuel and raw material continues to play an important role in manufacturing processes in general industry, providing a stable supply of various materials that support social infrastructure and creating a recycling-based society for resources and waste. By offsetting CO₂ emissions in combination with appropriate CCUS, we will support for achieving carbon neutrality in each industry by 2050.

CO₂ emissions by Sector (Japan, 2020)



Source: Greenhouse Gas Inventory Office/Japan Center for Climate Change Actions website

Efforts toward carbon neutrality in all aspects of coal use



JCOAL works together with the government and member companies to achieve carbon neutrality using the best possible measures, while considering the perspectives of economic efficiency and energy security.



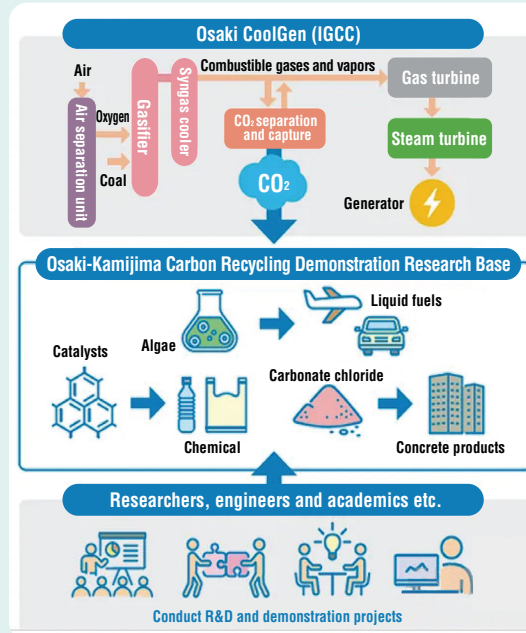
Promotion of Carbon Recycling Activities

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.

JCOAL operates and manages 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



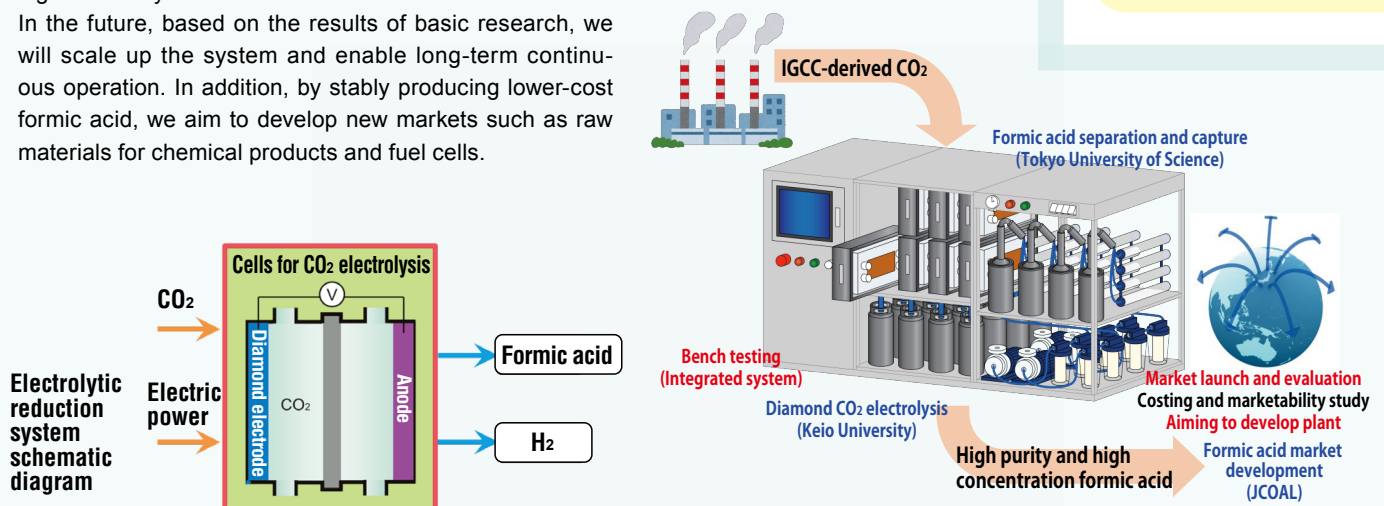
Dissemination of bio-coal briquettes (Mozambique)

Towards Neutrality – JCOAL

Production of key substances from CO₂ in coal-fired flue gas using diamond electrodes **NEDO**

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. JCOAL, 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

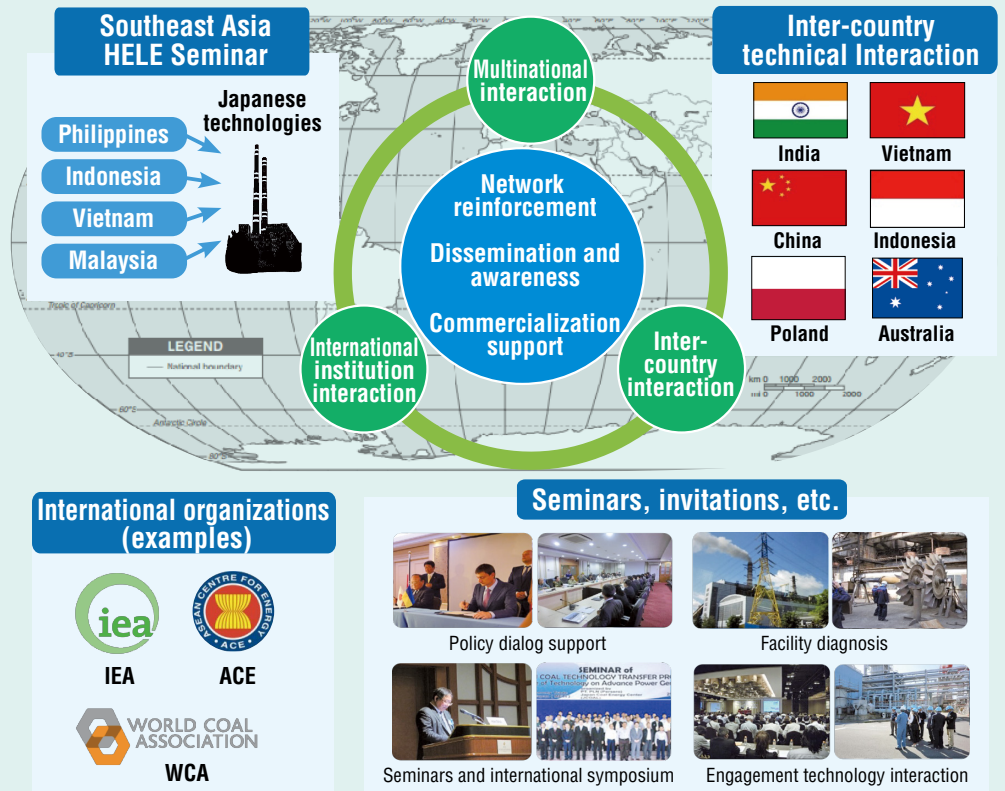


Coal experimentation classes



Zero Emission Thermal Power Generation EXPO

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



Carbon in Coal Use Activities -



Overseas on-site training (Australia)

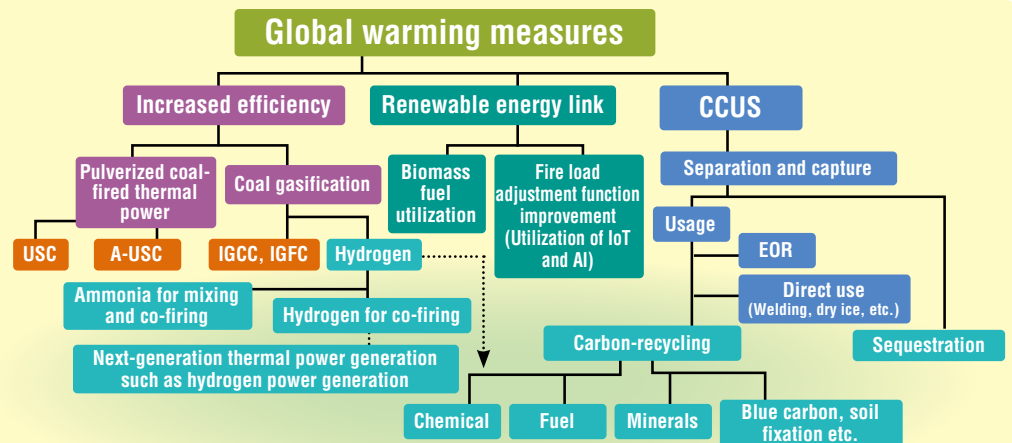
Clean Coal Day (CCD) International Symposium



The CCD International Symposium is organized by JCOAL, together 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). The government, academia and private sectors worldwide gathered in this symposium to discuss on energy/coal policy, technology R&D. JCOAL publishes 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. JCOAL is 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**

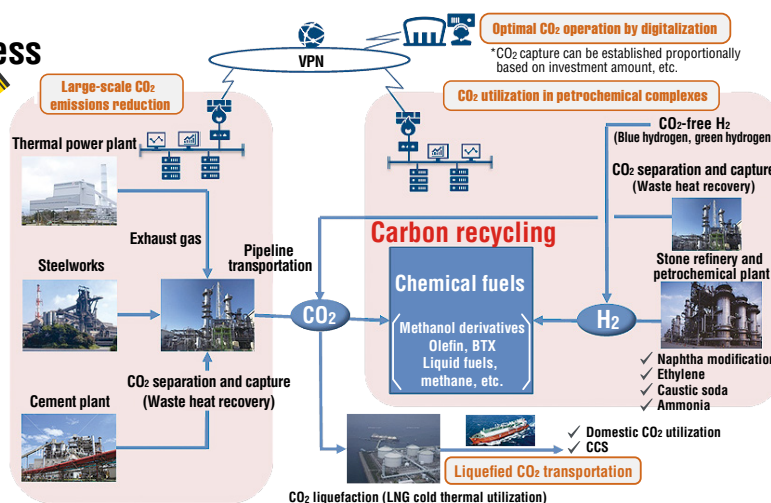
Implementation period:
February 2021 - March 2023

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

In petrochemical complexes in Japan, multiple industries exist to produce a variety of products.

This project will investigate the potential for a carbon-recycling business that can lead to a significant reduction in CO₂ emissions with lower costs, 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 **Ministry of the Environment**

Implementation period:
May 2021 - March 2023

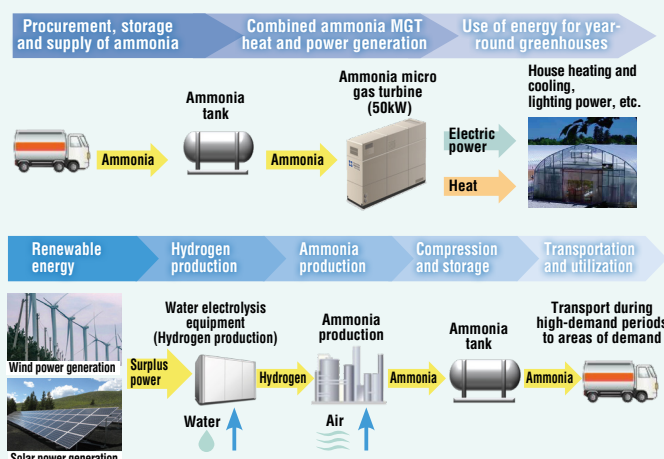
Zero emissions agriculture by using ammonia

This is a technology demonstration project to supply the electricity and warm water needed for agricultural greenhouses with using ammonia-fired 50kW Micro Gas Turbines (MGT).

Aims to achieve year-round cultivation regardless of climatic conditions by developing an optimal cultivation management system in greenhouses, this project will provide optimal heat and electricity with an MGT cogeneration system fueled by ammonia, which emits no CO₂. Especially for colder regions where kerosene and other fuels have been used conventionally, the system may result in the reduction of emissions and increased harvests.

This project will also develop a commercial plan for CO₂-free ammonia (ammonia from renewable energy) utilization.

(The project operator is Toyota Energy Solutions, operating together with JCOAL, Akita Agricultural Sales, Akita Prefectural University, National Institute of Advanced Industrial Science and Technology (AIST), and Tohoku University)



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

Implementation period:
2021 - 2025

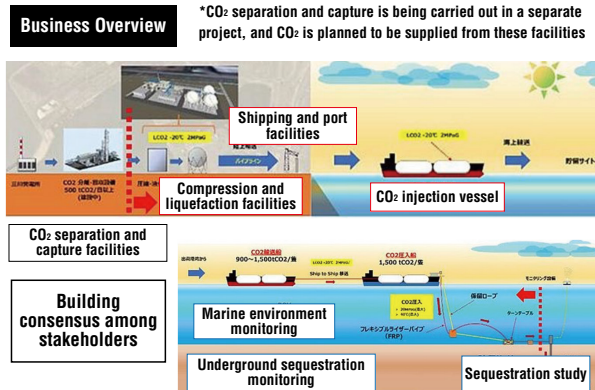
Efforts to CCS commercialization in Japan

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, compressing it from the sea, surveying sequestration sites, drilling, and monitoring, with the view of economic and environmental perspectives.

(A consortium of 13 organizations, including JCOAL and Toshiba Energy Systems & Solutions Corporation, is being formed to carry out this project)

Environmentally-conscious CCUS - Integrated demonstration base and supply chain construction project (transportation and sequestration technology demonstration)



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

Implementation period:
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:
2021 - 2024

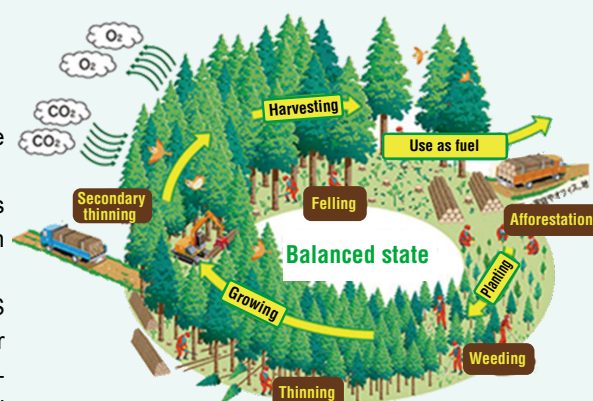
Contributing to regional development through the local production and consumption of biomass

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"

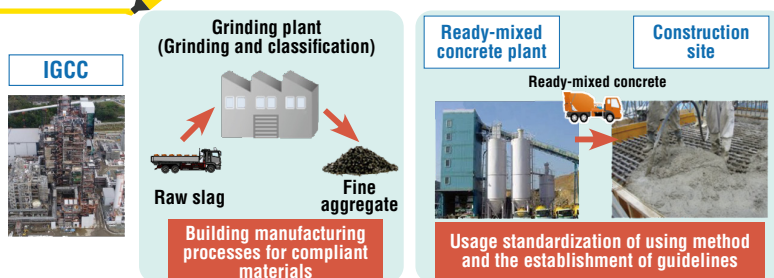
6 Promotion of the effective use of coal gasification slag **NEDO**

Implementation period:
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 are continuing to develop design and construction guidelines for the Japan Society of Civil Engineers and the Architectural Institute of Japan, as well as confirming their 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)

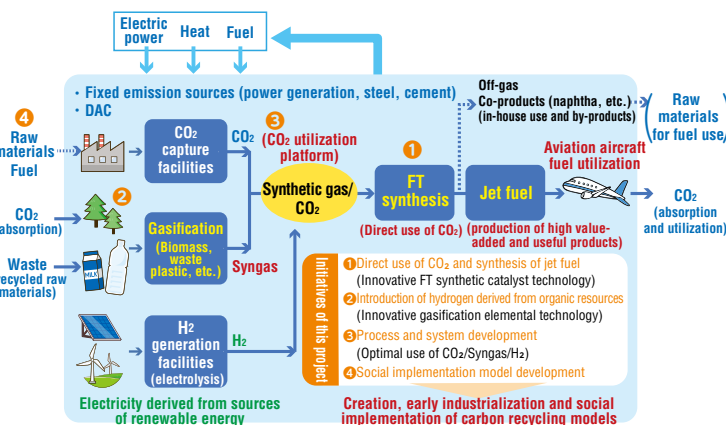
7 Joint international R&D into carbon-recycling with the direct use of CO₂ jet fuel synthesis **NEDO**

Implementation period:
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 between the University of Toyama, Chulalongkorn University, Thailand, and JCOAL. JCOAL is 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)



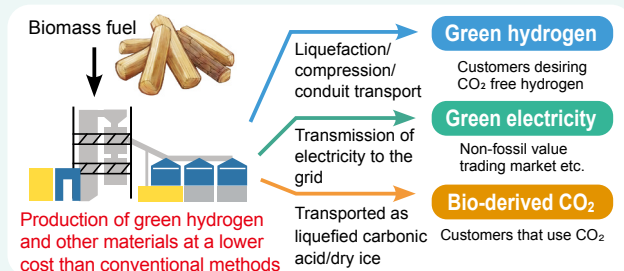
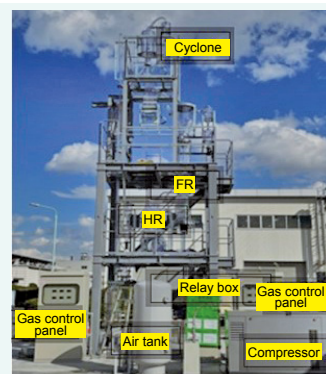
8 Chemical looping combustion and poly-generation technology development **NEDO**

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 JCOAL 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:
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

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)

Implementation period:
April 2021 - March 2023



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

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. JCOAL contributes 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

Inter-country interaction

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

Network reinforcement

Dissemination and awareness
Commercialization support



Polish State Electric Company (ENEA)

		2017	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: 2017-2021)

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 mining countries to secure a stable supply of coal, and JCOAL is implementing the following initiatives.

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, PM_{2.5}, 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

JCOAL provides on-site training at coal mines and coal-related facilities in coal-mining countries for young employees from member companies as well as holding a "Seminar on Coal Basics." JCOAL is also committed to building human networks through capacity building training and collaboration programs for young and mid-career professionals in Asian and African countries.



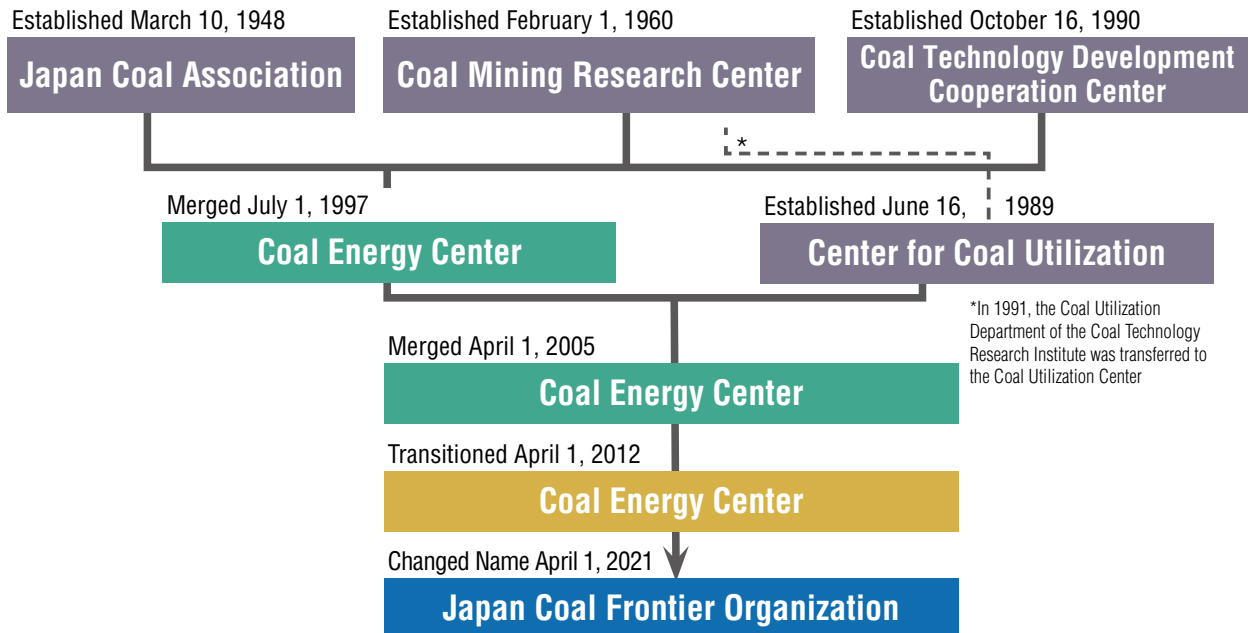
Seminar on Coal Basics (Tokyo)



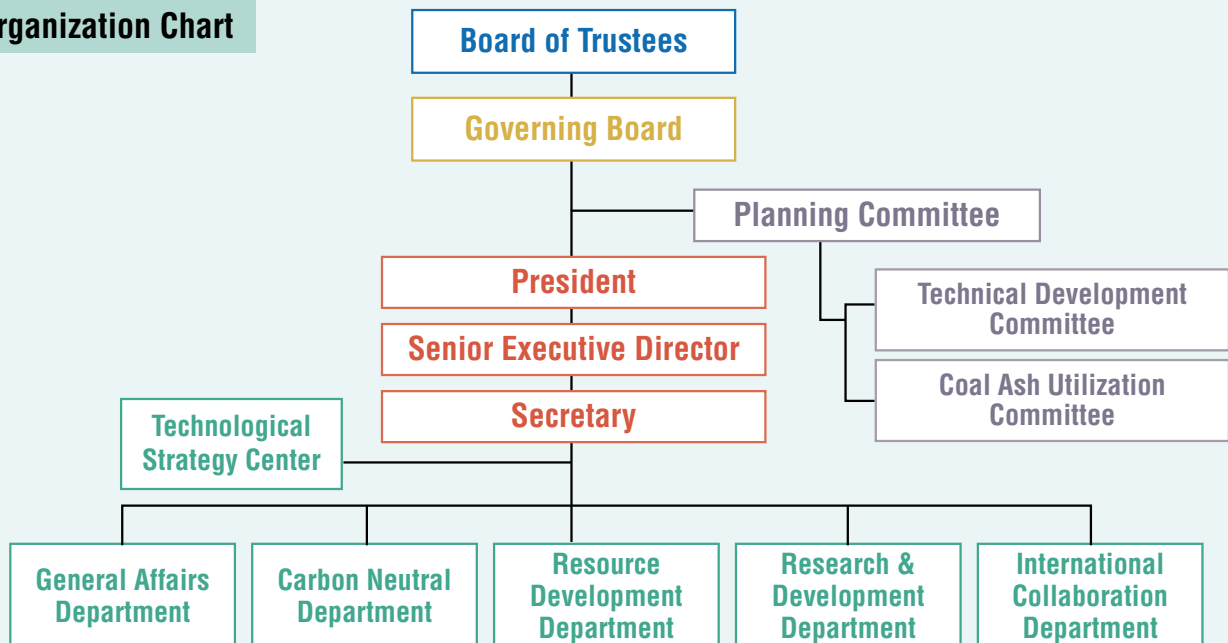
Internships for overseas students
(open-pit coal mine in NSW, Australia)

Organization Outline

History



Organization Chart



Various committee activities

The Planning Committee has its purpose for facilitating project operation and providing information to member companies. The committee compiles policy proposals and formulates medium-term plans.

The Technology Development Committee examines JCOAL Roadmap and holds seminars with a variety of technological themes for promoting and supporting CCT development.

(Example; Several themes from seminars held in 2021)

- Role of thermal power adjustment at the time of mass injection of renewable energy
- The road to social implementation of CCS(Carbon dioxide Capture and Storage)
- CO₂-free hydrogen production
- Current status and issues on woody biomass



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Web



Instagram



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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