Japan is forced to rely on thermal power generation. This challenge has given rise to the possibility of making great strides the potential to bring about a major step forward in the realization of a decarbonized society in the world is emerging.

Convert existing thermal power plants to zero GHG emissions Energy Transition.

Toward Zero-Emission Thermal Power Plants

Japan will continue sharing technologies and know-hows of zero-emission conversion, to contribute toward achieving carbon neutrality for the entire world.







What's a Zero-emission Thermal Power Plant ?

The majority of the world's Green House Gas emissions come from fossil fuels, therefore energy issues are closely linked to the realization of a decarbonized society.

Given the low renewable energy potential and the narrowness of the grid, Japan and the rest of Asia will have to continue to rely on thermal power generation to ensure a secure, stable, and high quality power supply, and GHG emission-free thermal power plants = GHG Zero-emission thermal power generation technology is essential.

In Japan, the public and private sectors are working together to develop key technologies for zero-emission thermal power plants, and are currently in the demonstration stage.

4 Technologies Supporting Zero-Emission Thermal Power Plants

We propose these 4 key technologies that will contribute to zero-emission of thermal power plants.

Hydrogen Energy

As a key technology for carbon neutrality Energy that the world is watching.

🕨 Fuel ammonia

In addition to its carbon-free properties, it is a cheaper/safer energy source to produce, transport, and use than hydrogen.

CCS

Technology that directly contributes to CO₂ reduction by separating, capturing, and storing CO₂.

Carbon recycling/CCUS

Technology to effectively utilize CO₂ as a resource. Concrete by mineralization and Reuse as fuels and chemicals to reduce atmospheric CO₂ emissions.



Zero-emission Thermal Power Plant

Japan will strongly support energy transitions in Asia, where the use of fossil fuels are expected to increase in the future, with this "zero-emission thermal power plant" as a centerpiece.

To this end, in 2021, Japan joined forces with other volunteer countries in Asia and announced the Asian Energy Transition Initiative (AETI), a "community aiming for net-zero emissions." In addition to providing technical support in a various fields, including the formulation of roadmaps for the realization of carbon neutrality in Asian countries, individual projects in a wide range of fields such as energy management, hydrogen, ammonia, and CCUS, and human resource development.

We will also provide financial support through the Asia Transition Finance and other programs and continue to engage with each country.

Supporting zero-emission initiatives in Asia would also be an opportunity to capture a large energy market in the long term.

Japan will contribute to zero-emission initiatives in Asia, which holds the key to global decarbonization, by leveraging its achievements and expertise in technology development and institution building throughout Asia.

We recognize that this is Japan's role for the international community.

Contents of Asian Zero Emission Community

Development of zero-emission technologies

From roadmap formulation to demonstration testing, support for zero-emission thermal power technology development.

International co-investment/co-financing

Formulate financing rules and provide financing for individual projects in Asia.

Technology Standardization

Develop international standards/climate rules, and digital infrastructure in human resource networking and sharing promotion.



Carbon Credit Market

Scale-up and utilization of JCM / Carbon credit creation / distribution using private financing.

1. Hydrogen Energy



Hydrogen, an energy source that is attracting worldwide attention as a key carbon-neutral technology that can be utilized in a wide range of fields including power generation, industry, and transportation.

Japan is one of the first countries to announce a national strategy, the "Basic Hydrogen Strategy," in 2017.

The public and private sectors are working together to advance technological innovation, and Japan leads the world in number of patents related to fuel cells. Currently, a number of technologies are in the demonstration phase of building a hydrogen supply chain.

" Hydrogen Energy Ministerial Meetings " are being held around the world, and through the exchange of opinions and collaboration among countries, technological innovation is underway on a global scale.

The movement toward the realization of a de-carbonized hydrogen society is accelerating.

Zero-emission Thermal Power Plant Role of Hydrogen

Japan is proposing zero-emission thermal power plant, in which hydrogen can be utilized as a fuel in power generation.

By either mono-fuel combustion or mixed combustion with natural gas, Hydrogen,

which does not emit CO₂ during thermal power generation and has a regulating force inertial force function as thermal power, can be said so be an excellent fuel.

By combining CCS and CCUS technologies, "Blue Hydrogen," which reduces CO₂ emissions in the production process, and "green hydrogen," a renewable energy source that does not emit CO₂ in the manufacturing process, a thermal power plant with virtually zero CO₂ emissions can be realized.

Japan Hydrogen Energy Policy

We will accelerate social implementation/commercialization of Hydrogen. In order to reduce costs and secure supply, we will continue to support building hydrogen supply chains in collaboration with other countries, including the use of low-cost hydrogen from overseas and production infrastructure utilizing domestic resources, through the Green Innovation Fund, etc, for practical application.

By 2050, we aim to increase the installation amount of hydrogen from the current 2 million tons per year, to reach around 20 million tons/year, which would be at a level sufficiently competitive with fossil fuels. In addition, Japan contributes to the global efforts to practicalize hydrogen power generation, and together with the rest of the world, aim to achieve "green growth" with both decarbonized society and economic growth.



2. Fuel ammonia



Ammonia, which is easily transportable, and positioned as an effective hydrogen carrier, is now in the limelight as a zero-emission fuel "fuel ammonia" due to recent technological developments.

Not only it is carbon-free, it is also cheaper and safer to produce, transport, and use than hydrogen, enabling to be used as an energy source directly in thermal power generation, industrial furnaces, vessels, etc.

In Japan, the basic technology for a mixed combustion burner that suppresses NOx emissions was developed from 2014 to 2018, and expectations towards single fuel combustion is also high to achieve zero CO₂ emissions.

In addition, fuel ammonia, which is mostly produced from fossil fuels such as natural gas, is expected to be supplied through the existing supply chain, expanding the market on a global scale, aiming to be produced/imported in various regions of the world.

Zero-emission Thermal Power Plant Role of Ammonia

In zero-emission thermal power plants, fuel ammonia serves as a fuel as well as hydrogen. In particular, the realization of ammonia-only combustion (ammonia-fired power generation) is expected to have a significant impact on reducing CO₂ emissions from power generation facilities. The first step in the process toward ammonia combustion is the early realization of mixed combustion technology, but since ammonia can be easily co-fired with coal, it is expected to be utilized for coal-fired power generation first.

If a coal-fired power plant is converted to 20% ammonia co-firing, CO₂ emission reduction amount is estimated to be approximately 1 million tons per unit, therefore would save approximately 40 million tons if it is implemented at all coal-fired power plants in Japanese major power companies.

Japan Fuel Ammonia Policy

By 2030, introduction and diffusion of co-firing with 20% ammonia to reach domestic introduction volume of 3 million tons is set as a goal.

Toward 2050, while we will aim to achieve the domestic introduction volume of 30 million tons by expanding the introduction of ammonia combustion technology, we will establish an international fuel ammonia supply chain, and deploy ammonia combustion technologies mainly in Asia.

We hope to support the global fuel ammonia market as it moves toward decarbonization, both technologically and financially, by taking the lead in international standardization of NOx emissions and other issues.



3. CCS



CCS is a technology that separates/captures emitted CO₂ and stores/injects it deep underground, and the reason it is receiving attention is because it can substantially reduce CO₂ emissions, especially from coal-fueled and natural gas-fueled thermal power plants.

To date, CCS has not yet been put to practical use in the world, but there are 135 CCS projects underway worldwide.

In Japan, a large-scale CCS project has been underway since 2012 in Tomakomai, Hokkaido, with a vision of commercialization and social implementation by 2030. The CO₂ capture plant achieved the goal of 300,000 tons of injection in 2019, to be the first CO₂ capture plant in the world to achieve this goal. Japanese companies hold the top share of the market and have acquired numerous patents. Having overcome challenges such as cost reduction, we are now on the verge of commercialization.

Zero-emission Thermal Power Plant Role of CCS

Thermal power generation, which is not affected by weather conditions and can generate electricity quickly, is an essential power source for ensuring a stable supply of energy, generates more than 60% of the world's power at thermal power plants.

CO₂ capture and storage contributes directly to CO₂ reduction.

CO₂ emissions can be minimized during the production of hydrogen and fuel ammonia, which will be used as fuels in the future, therefore this technology is indispensable for the realization of zero-emission thermal power plants.

Japan CCS Policy

Japan developed a long-term CCS roadmap towards 2030, for technological establishment, cost reduction, site development, and environmental improvement for commercialization.

IEA estimates the annual storage capacity of CCS in Japan would be approximately 120 to 240 million tons per year in 2050.

If CCS is to be installed in 2030, it will be necessary to increase the number of injection wells by 12~24 wells each year for 20 years until 2050.

In order to start the CCS project during 2030, feasibility studies by operators will begin in FY2023, to make final investment decision by FY2026.

In the future, we aim to achieve a 30% share of the annual 10 trillion yen global CCS market (equivalent to about 2.5 billion tons of CO₂).



4. Carbon recycling/CCUS



Carbon recycling is a technology that effectively utilizes CO₂ as a resource, by reusing them for concrete through mineralization, fuel, and chemicals, reducing CO₂ emissions into the atmosphere, enabling initiatives into various business fields.

In Japan, Carbon Recycling Fund was established in 2019.

Also, we are hosting the Industry-Academia-Government International Conference on Carbon Recycling to promote international collaboration.

We are actively promoting technological innovation and practical application through collaboration and cooperation.

Zero-emission Thermal Power Plant Role of Carbon recycling/CCUS

Carbon recycling is a process to reduce CO₂ by separating and capturing CO₂ emitted from thermal power plants.

Captured CO₂ can be used to produce variety of industrial products and plastic raw materials, contributing to CO₂ reduction by replacing existing products.

In the future, CO₂ itself can be used as energy if methane can be generated at low cost by reacting hydrogen derived from renewable energy with recovered CO₂, and be used as fuel.

Japan Carbon recycling/CCUS Policy

Many of the carbon recycling technologies require hydrogen, therefore, low-cost CO₂-free hydrogen is essential for these technologies to become widespread.

Currently, in Japan, carbon recycling demonstration test sites are being established in Hiroshima and Tomakomai to demonstrate the technology for hydrogen production from renewable energy and to establish/promote the technology in various fields.

Until the plant delivery price of hydrogen reduces to 20 yen per Nm3 of hydrogen, we will promote technologies such as hydrogen-free synthesis, and the development of high value-added products that can absorb the high-cost of hydrogen.





Zero Emission Thermal Power Plant Partners

Hydrogen Energy Technology Partners	
IHI Corporation	 H2TAS Project https://www.woodside.com.au/docs/default-source/media-releases/wood side-driving-forward-renewable-hydrogen-in-tasmaniaf04b8c94-f289-46 70-96ff-67d1069edeb9.pdf?sfvrsn=8a16962a_3
Toshiba Energy Systems & Solutions Corporation	 Power to Gas Hydrogen Supply Chain System at Fukushima Hydrogen Energy Research Field (FH2R) https://www.global.toshiba/ww/news/energy/2020/09/news-20200915-01. html
Chiyoda Corporation	A Global Hydrogen Supply Chain System utilizing SPERA Hydrogen™ Technology contributes to a Zero Carbon Emission Society ▶ https://www.chiyodacorp.com/en/service/spera-hydrogen/
Asahi Kasei Corporation	Green Innovation Fund /Hydrogen Production by Water Electrolysis Using Renewable Energy / Large-scale Alkaline Water Electrolysis System Development and Green Chemical Plant Demonstration https://www.asahi-kasei.com/news/2021/e210826.html
JGC Group	Green Innovation Fund /Hydrogen Production by Water Electrolysis Using Renewable Energy / Large-scale Alkaline Water Electrolysis System Development and Green Chemical Plant Demonstration https://www.jgc.com/en/news/assets/pdf/20210826e.pdf
JGC Group	HiGHGuard / Quantification service for GHG emissions by using MRV https://www.jogmec.go.jp/english/news/release/news_10_00005.html
Toyo Engineering Corporation	Highly Efficient and Safe Artificial Photosynthetic Hydrogen Production https://www.toyo-eng.com/jp/en/company/news/?n=585&by=2021
JERA Co., Inc.	Hydrogen Utilization Demonstration Project at an LNG Thermal Power Plant in Japan https://www.jera.co.jp/english/information/20210826_748
Toshiba Energy Systems & Solutions Corporation	 Pure Hydrogen Energy Fuel Cell Systems https://www.global.toshiba/ww/products-solutions/hydrogen/products-technical-services/fuel-cell.html
INPEX CORPORATION	Blue hydrogen and ammonia production demonstration project in Niigata Prefecture
Kawasaki Heavy Industries, Ltd.	Development of innovative liquefaction technologies
Kawasaki Heavy Industries, Ltd.	Kawasaki Hydrogen Road ▶ https://global.kawasaki.com/en/hydrogen/
Mitsubishi Heavy Industries, Ltd.	Hydrogen co-firing demonstration of large gas turbines at Takasago Hydrogen Park https://power.mhi.com/news/20220222.html

Zero Emission Thermal Power Plant Partners

Fuel Ammonia Technol	ogy Partners
INPEX CORPORATION	Clean ammonia production from natural gas-derived hydrogen in Abu Dhabi
	https://www.inpex.co.jp/english/news/assets/pdf/20210708.pdf
JERA Co., Inc.	Development and technical demonstration of a new catalyst for ammonia production
	https://www.jera.co.jp/english/information/20220107_824
JERA Co., Inc.	Demonstration Project at Coal-fired Plant with Ammonia Single-fuel Burner
	https://www.jera.co.jp/english/information/20220107_823
JERA Co., Inc.	Demonstration Project for Establishment of Technology to Increase the Ammonia Co-firing Rate at Commercial Coal-fired Power Plant
	https://www.jera.co.jp/english/information/20220107_822
Mitsubishi Heavy Industries, Ltd.	Development and technical demonstration of a new catalyst for ammonia production
Mitsubishi Heavy Industries, Ltd.	Demonstration Project at Coal-fired Plant with Ammonia Single-fuel Burner
	https://www.mhi.com/news/22010702.html
IHI Corporation	Research and Development of Ammonia-Fueled Zero Emission Gas Turbine
	https://www.ihi.co.jp/ihi/technology/review_library/review_en/2020/53_01. html
IHI Corporation	Demonstration Project for Establishment of Technology to Increase the Ammonia Co-firing Rate at Commercial Coal-fired Power Plant
Tsubame BHB Co., Ltd.	Decentralized Ammonia Production by unique electride catalyst technology
	https://www.ammoniaenergy.org/articles/small-scale-ammonia-synthesis -technology-on-track-for-2021/
Idemitsu Kosan Co., Ltd.	Development of ammonia production under room temperature and normal pressure
	https://www.idemitsu.com/jp/news/2021/220107.html
Toyo Engineering Corporation	Low-carbon ammonia for fuel - Reducing manufacturing and transportation costs / Secure a stable supply base in a decentralized manner
	https://www.toyo-eng.com/jp/en/solution/fuel-ammonia/
JGC Group	Initiatives for Early Social Implementation of Fuel Ammonia https://www.jgc.com/en/business/hydrogen/#4
JGC Group	HiGHGuard / Quantification service for GHG emissions
	by using MRV https://www.jogmec.go.jp/english/news/release/news_10_00005.html
Toyo Engineering Corporation	Approach for Green ammonia production for each of Existing and Grassroots plants
	https://www.toyo-eng.com/jp/en/solution/fuel-ammonia/
Toyo Engineering Corporation	Blue Ammonia Value Chain KBR Purifier/Purifier Plus Process https://www.toyo-eng.com/jp/en/solution/fuel-ammonia/
Toyo Engineering Corporation	Ammmonia Alliance Japan ("AAJ") https://www.toyo-eng.com/jp/en/company/news/?n=622&by=2022

Zero Emission Thermal Power Plant Partners

CCS Technical Partner	S
Toyo Engineering Corporation	Natural Gas Processing Technology using TarT Process https://www.toyo-eng.com/jp/en/company/news/?n=569&by=2021 (Press Release)
JGC Group	Construction of CCS Facilities and Development of CO2 Separation/Recovery Technologies https://www.jgc.com/en/business/CCS/#2
INPEX CORPORATION	CO2 EOR Pilot Project at the Minami-Aga Oil Field https://www.inpex.co.jp/english/news/assets/pdf/20210604.pdf
JGC Group	Thai Carbon Capture & Storage Initiative https://www.jgc.com/en/news/2022/20220425_03.html

Carbon Recycling/CCUS Technology Partners THE CHUGOKU ELECTRIC CO₂-TriCOM: Triple C Capture Material **POWER CO., INC.** (CO₂, Coal ash Concrete waste) **Carbon Recycling Fund Institute** Creating "Sustainable Carbon Society" by CO2 Utilization and Carbon Recycling https://carbon-recycling-fund.jp/aboutus/en.php (Compay Homepage) **Toyo Engineering Corporation** g-Methanol® https://www.toyo-eng.com/jp/ja/solution/g-methanol/ THE CHUGOKU ELECTRIC Hi-Beads (Granulated coal ash, altenative sea sand) **POWER CO., INC. INPEX CORPORATION** Carbon neutralization of city gas https://www.inpex.co.jp/english/news/assets/pdf/20211015.pdf **Toyo Engineering Corporation** P2C (Power to Chemical), SAF from CO₂ using CO₂ Electrolysis & FT Synthesis https://www.toyo-eng.com/jp/en/company/news/?n=593&by=2021 (Press Release) **Toyo Engineering Corporation** NEDO Green Innovation Fund / Pilot Project Aimed at Commercial Use of Fuel Ammonia to Naphtha Crackers https://www.nedo.go.jp/koubo/EF3_100176.html Idemitsu Kosan Co., Ltd. Idemitsu's Black pellet production project **Osaki Coolgen Corporation** Osaki Coolgen Project Idemitsu Kosan Co., Ltd. Development of CCUS Technology by Carbonate https://www.idss.co.jp/whatsnew/2020/1023.html