

## Environment: Executive Summary

The JFE Group strives to maintain its businesses in harmony with the environment for the prosperity of society. We have positioned climate change as a key management concern and formulated the JFE Group Environmental Vision for 2050 toward achieving carbon neutrality by 2050. To this end, we are exploring ways to reduce CO<sub>2</sub> emissions in steelmaking processes and expand our contribution to reducing CO<sub>2</sub> emissions in society as a whole. The entire Group is working in concert to establish a framework for environmental management and address climate change and other environmental issues such as environmental protection and the effective use of resources.

The JFE Group systematically addresses climate change by reflecting the TCFD's philosophy in its management strategies.

In the steel business, we created a roadmap for achieving carbon neutrality by 2050 and are working on CO<sub>2</sub> emission reduction initiatives toward short-, medium-, and long-term targets. Our overall goals are to reduce CO<sub>2</sub> emissions by 18% by the end of FY2024, compared to FY2013, and by more than 30% in FY2030. Until 2030, we will continue to shift to low-carbon steelmaking processes and at the same time develop ultra-innovative technologies, mainly the carbon-recycling blast furnace, to achieve carbon neutrality by 2050. This year, we started construction work for test furnaces for verifying each technology. In the first half of FY2023, we started supplying the JGreeX™ brand, a variety of green-steel products that will significantly lower CO<sub>2</sub> emissions in the steel manufacturing process, compared to conventional products.

In the engineering business, we plan to contribute 25 million tonnes of CO<sub>2</sub> reduction to society as a whole in FY2030 by provisioning renewable energy power generation facilities. We also intend to further expand our renewable energy power generation by leveraging the Group's collective strength and accelerating the offshore wind power generation business. This year, we started constructing the country's first monopile manufacturing plant toward starting production in April 2024.

We are developing and providing environmentally sound processes and products as part of our contribution to the environment through our businesses, including the reduction of our environmental impact as stated in our environmental policy. In addition, we have set aggressive targets to manage initiatives such as effectively using resources in the mainstay steelmaking processes, preventing air and water pollution, and efficiently using water resources, and we are actively addressing these concerns. Furthermore, we are striving to minimize the impact on the ecosystem surrounding our business sites and analyzing the impact on diversity of using our steel slag products.

Targets and Results for Environment-related Material Issues of Corporate Management

► [Material Issues of Corporate Management and KPIs](#) (P.20)

### Key Initiatives

- Promoting the acquisition of Environment Management System certification, conducting internal and external environmental audits
- [Formulation of the JFE Group Environmental Vision for 2050](#) and roadmap (P.53) for achieving carbon neutrality
- [Started supplying JGreeX™ green steel products](#) (P.61)
- [Development of ultra-innovative technologies](#) (P. 62), mainly the carbon-recycling blast furnace
- Group-wide effort to accelerate the commercialization of [the offshore wind-power generation business](#) (P.77)
- Development and provision of environmentally sound products and processes
- Development of products that take advantage of steel's excellent recyclability, contribution to reducing plastic waste
- [Effective use of water resources](#) (P.136) in steelmaking processes (high recirculation rate)
- Improvement and assessment of the environment at and around business sites, [contribution to biodiversity](#) (P.144) from using steel slag products

## Environmental Management

### Basic Policy

JFE Group companies are developing innovative technologies and international cooperation for the protection of the global environment by operating in harmony with the global environment, as well as protecting it, in accordance with the Group's environmental philosophy and policy.

### Environmental Philosophy

The JFE Group puts top priority on protecting and enhancing the global environment to maintain its business in harmony with the environment and ultimately for the prosperity of society as a whole.

### Environmental Strategies

1. Reduce the environmental impact of all businesses
2. Contribute through technologies and products
3. Contribute through businesses for resource conservation and energy efficiency
4. Communicate with society
5. Facilitate international cooperation

## Management Structure

### Framework for Environmental Management

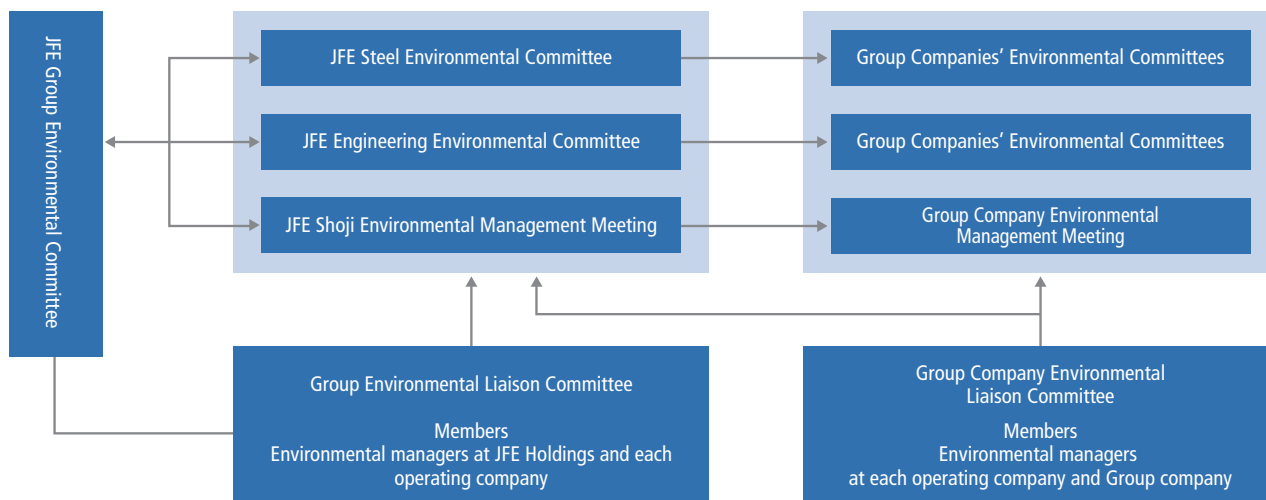
The JFE Group Environmental Committee, chaired by the president of JFE Holdings and operating under the JFE Group Sustainability Council, sets goals for environmental protection, monitors the progress of these initiatives and works to improve the Group's overall environmental performance. Key issues for corporate management such as climate change are deliberated at the Group Management Strategy Committee as well and reported to the Board of Directors. The board oversees environmental challenges by discussing the reported material. Additionally, specialized committees set up by JFE Group operating companies and affiliates implement specific activities.

In our Seventh Medium-term Business Plan, we positioned climate change as a top-priority business concern and formulated the JFE Group Environmental Vision for 2050. To this end, we are aggressively pushing forward to achieving our CO<sub>2</sub> reduction targets and achieving carbon neutrality by 2050.

For further details, refer to:

- [System for Promoting Sustainability](#) (P.24)
- [Seventh Medium-term Business Plan](#) (P.12)
- [JFE Group Environmental Vision for 2050](#) (P.53)

## ■ Environmental Management System



## Initiatives

### Environmental Management System

Acquiring ISO 14001 certification is a key part of every JFE Group company's environmental program. All global production sites of JFE Steel and JFE Engineering and major offices of JFE Shoji have been certified, encompassing 67% of 43,848 employees at 84 companies covered in this report and 52% of all sites. In FY2022, there were no major violations of environmental laws or regulations by Group companies (air, water, soil, etc.) that resulted in a fine or other penalty.

For quantitative data related to ISO 14001 for each business, please refer to the following information.

▶ [List of ISO 14001-certified companies](https://www.jfe-holdings.co.jp/en/csr/environment/env_manage/pdf/iso14001.pdf) (https://www.jfe-holdings.co.jp/en/csr/environment/env\_manage/pdf/iso14001.pdf)

#### **ST** JFE Steel

JFE Steel maintains Environment Management Departments at its head office and in each business office, as well as an Environmental Committee, chaired by its president and Environment Management Committees in each local office.

▶ [Environmental Management System](https://www.jfe-steel.co.jp/research/environment.html) (Environmental Strategies) (Japanese only)(https://www.jfe-steel.co.jp/research/environment.html)

#### **EN** JFE Engineering

JFE Engineering maintains an Environment Management Department at each of its major locations, including production sites and branch offices as well as all divisions in charge of products. The Environmental Committee, chaired by the president, oversees environmental management for the entire company. Under its Environmental Management System, JFE Engineering works to minimize environmental impact at production sites, branch offices and construction sites and contribute to environmental protection through all products and services. The major strategies for FY2023 are (1) promote environmental contribution through products for mitigating global warming and climate change, (2) promote environmental protection, effective energy conservation, and resource recycling in business activities, and (3) ensure thorough compliance with environmental laws and regulations.

## SH JFE Shoji

JFE Shoji obtained ISO 14001 certification for its head office, Osaka branch, and Nagoya branch in 2000 and later expanded the scope of certification to all domestic offices. JFE Shoji also applies the same environmental management system to domestic Group companies, promoting the same environment management activities and striving for the same certification. Overseas coil centers are also planning to acquire ISO 14001 certification.

## Environmental Audit

In addition to the regular internal and external audits at ISO 14001-certified sites, the audit and environment departments at each operating company's head office conduct independent environmental audits at their production sites.

## ST JFE Steel

Once a year, JFE Steel's Audit Department and the Environment, Disaster Prevention and Recycling Department conduct an environmental audit at each operational site. JFE Steel categorizes Group companies based on the result of risk assessment considering owned equipment and conducts detailed audits every one to five years using checklists.



Document audit at a domestic Group company on-site audit at a domestic Group company



On-site audit at a domestic Group company

## EN JFE Engineering

JFE Engineering places a top priority on complying with environmental laws and regulations.

The Safety and Environment Department conducts annual audits at about 50 locations selected from the manufacturing sites, construction sites in Japan, and Group companies to confirm compliance with environmental laws and regulations. JFE Engineering also conducts internal audits on its own environmental management system to evaluate and enhance the effectiveness of various environment-related initiatives. Furthermore, environmental inspections are conducted at all construction sites by the department responsible for construction to verify compliance with the laws and regulations, and annual self-checks are conducted at the Tsurumi and Tsu manufacturing sites to confirm legal compliance.

## JFE Shoji

At JFE Shoji, the ISO Environmental Audit Department annually confirms that processing centers and warehouses of ISO 14001-certified Group companies comply with relevant environmental laws and regulations. For non-certified Group companies, the department conducts an environmental audit every three years.

For quantitative data related to environmental audits, please refer to the following information.

▶ [Environmental Data](#) (P.225)

## Environmental Education

The JFE Group actively provides education to foster a corporate culture of environmental protection. Education at operating companies includes training for new recruits and newly promoted employees as well as specific environmental-protection training by position and job.

For Group-wide environmental training, we hold an annual Review Session on Environment-Related Laws and Regulations, to which lawyers specialized in environment-related laws and regulations are invited to give lectures on the latest information related to the enactment and revision of these laws, as well as associated violations and court decisions. Employees from wide-ranging departments, including the environment, disaster prevention, legal affairs, general affairs, and manufacturing departments of the operating companies and their group companies, who are involved in environment-related activities, attend these annual sessions as the basis for planning their activities, such as educating employees and raising awareness about the Group's policies and initiatives.

## JFE Steel

JFE Steel encourages employees to obtain qualifications as pollution-control managers. A training program for environmental managers at group companies was launched in FY2011. In addition, JFE Steel provides employees with training to ensure compliance with environmental laws, disseminates information about regulatory revisions at its Environmental Liaison Committee meetings for Group companies, and organizes brush-up training in waste management skills for on-site personnel.

## JFE Engineering

JFE Engineering educates all employees about environmental issues to increase their understanding of the company's policies and initiatives. To ensure proper environmental management at production and construction sites, training is often tailored to specific employee operations, helping to enhance their capabilities. In FY2022, JFE Engineering expanded its remote training opportunities and focused on practical application grounded in actual business operations, such as responding to changes in laws and regulations.

## JFE Shoji

JFE Shoji provides all employees with general environmental training in compliance with ISO 14001 and specialized training for internal audit staff.

All employees within the scope of certification receive a pocket-size ISO Employee Card to carry with them so they can check the details of ISO 14001 activities at any time. In addition, each company performs a self-check using its own extensive checklist to ensure understanding and rigorous compliance with environmental laws. Also, JFE Shoji provides environmental training to new executives and information about revised laws and regulations to environmental management personnel.

For quantitative data related to environmental education, please refer to the following information.

▶ [Environmental Data](#) (P.225)

## Environmental Accounting

### Basic Policy

The JFE Group is saving energy and reducing its environmental impacts by making its production facilities increasingly efficient and introducing more environmentally friendly equipment. Any equipment or facilities related to energy conservation and environmental protection are categorized as environmental investment, while all activities related to environmental protection and impact reduction are categorized as environmental expenses.

### Environmental Investment and Expenses

Environmental capital investment totaled 32.7 billion yen and expenses amounted to 121.5 billion yen in FY2022. Capital investment included 15.9 billion yen to address air pollution, 5.5 billion yen to prevent global warming (addressing climate change), and 4.3 billion yen to prevent water pollution. Environmental capital investment was roughly 76% of overall capital investment.

Environmental expenses for environmental activities included 35.9 billion yen for global warming countermeasures (addressing climate change), 31.2 billion yen to prevent air pollution, and 21.6 billion yen for industrial water recycling. Environmental R&D expenses (air, water, soil, etc.) came to 10.5 billion yen.

### Capital Investment

The JFE Group invests in environmental technologies for plants and equipment to save energy and reduce environmental impacts stemming from production. Cumulative investment in energy savings, totaling 570.8 billion yen since 1990, has enabled the company to achieve energy efficiencies that are among the highest in the world. In total, the Group has invested 797.1 billion yen in environmental protection since 1973.

### Results of Environmental Activities

Through these environmental investments and expenses, we are working to lower unit-based CO<sub>2</sub> emission to prevent global warming and to reduce final-disposal waste by maintaining a high recycling rate to effectively use natural resources. We are also striving to reduce emissions of pollutants into the water and air, which contributes to environmental protection and ensures thorough compliance with statutory regulations concerning exhaust gas emissions and discharged water.

The monetary value of energy savings realized through environmental capital investments and expenses in FY2023 is about 2.2 billion yen.

## ■ Breakdown of Environmental Costs

Main Items		FY2022	
		Investment (billion yen)	Cost (billion yen)
Management	Impact monitoring and measurement, and EMS expenses and education	1.4	2.7
Global warming countermeasures	Saving and efficiently using energy	5.5	35.9
Conservation of natural resources	Recycling industrial water	3.2	21.6
	Recycling and waste management of internally generated materials, etc.	1.4	6.2
Environmental protection	Air pollution countermeasures	15.9	31.2
	Water pollution countermeasures	4.3	10.7
	Prevention of soil contamination, noise, vibration, and land subsidence	0.0	0.5
Other	Charges, etc.	—	1.4
R&D	Technologies for protecting the environment, saving energy, and preventing global warming, air pollution, and water pollution	1.0	10.5
Societal activities	Support for nature preservation and forestation, information disclosure, exhibitions, and public relations	—	0.7
Total		32.7	121.5

Note: Data cover all investment activities of JFE Steel Corporation and R&D activities of JFE Engineering Corporation.

For quantitative data related to environmental accounting, please refer to the following information.

▶ [Environmental Data](#) (P.225)

### Related Links

▶ [Material Flow](#) (P.225)

▶ [JFE Steel: Environmental Initiatives](#) (Japanese only) (<https://www.jfe-steel.co.jp/research/environment.html>)

▶ [JFE Engineering: 360° JFE Engineering—Protecting Natural Environments](#) ([https://www.jfe-eng.co.jp/en/360\\_jfe\\_engineering/#env](https://www.jfe-eng.co.jp/en/360_jfe_engineering/#env))

▶ [JFE Shoji: Environment Management](#) (<https://www.jfe-shoji.co.jp/en/csr/environment/>)

## Climate Change

### Basic Policy

Climate change is a critical business concern for the JFE Group from the perspective of business continuity. Our steel business, which emits 99.9% of the Group's total CO<sub>2</sub> emissions, has been developing various technologies for saving energy and reducing these emissions. We have applied these technologies to steel manufacturing processes to enable production with low levels of CO<sub>2</sub> emission intensity.

Furthermore, we have developed and maintained a variety of eco-friendly products and technologies, including high-performance steel materials that help save energy when customers use them, as well as renewable energy power generation.

We will continue to develop and promote the widespread use of these processes and products. We consider this as an opportunity to apply the technologies we have fostered across the globe and at the same time contribute to tackling climate change.

JFE announced **its endorsement for the TCFD recommendations in May 2019** and has identified climate change-related issues based on the scenario analysis advocated in the TCFD to formulate strategies for sustainable growth. In September 2020, JFE disclosed its target of reducing CO<sub>2</sub> emissions in FY2030 in the steel business, which accounts for most of the Group's CO<sub>2</sub> emissions. It also announced **its intention to achieve carbon neutrality by 2050**, ahead of the Japanese government's announcement of the same goal.

In February 2022, **the target of reducing CO<sub>2</sub> emissions in FY2030 was revised upward to 30% or more, compared to FY2013**, considering advances in measures for carbon neutrality and improvement of external surroundings in the steel sector.

### JFE Group Environmental Vision for 2050

The JFE Group intends to strengthen sustainability through solutions that address global climate change issues while restructuring its business in response to changes in the environment surrounding the steel business. We regard 2020 as a milestone year for further reinforcing our efforts to tackle climate change, and we are actively promoting initiatives for reducing CO<sub>2</sub> emissions.

In 2021, we positioned climate change as a top-priority issue in the Seventh Medium-term Business Plan and **formulated the JFE Group Environmental Vision for 2050 toward achieving carbon neutrality by that year.**

We will systematically address climate change by **reflecting the TCFD's principles in the business strategies** of our JFE Group Environmental Vision for 2050. In the steel business, we **will reduce CO<sub>2</sub> emissions by 18% from FY2013 levels by the end of FY2024.** In addition, we announced that **the target of reducing CO<sub>2</sub> emissions in FY2030 is 30% or more, compared to FY2013, in the steel business.** To explore all possibilities for realizing carbon neutrality in 2050, we will take on the challenge of developing ultra-innovative technologies such as **carbon-recycling blast furnaces developed with our proprietary technology** while also adopting a multitrack approach for pursuing other technologies. In our engineering business, we will widen our contribution to the reduction of CO<sub>2</sub> in society as a whole by expanding and advancing renewable power generation and carbon-recycling technologies, supplying high-performance steel products, and other initiatives. Furthermore, we will apply Group strengths to accelerate the commercialization of **our offshore wind-power business.**



## JFE Group Environmental Vision for 2050

- **Climate change is a critical business concern for JFE, and we are aiming to achieve carbon neutrality by 2050.**
- **We will accelerate our research and development of new technologies and pursue ultra-innovative technologies.**
- **We will seek business opportunities that allow us to enhance corporate value by contributing to CO<sub>2</sub> emissions reduction across society.**
- **The principles of TCFD will be reflected in our business strategies and systematically deployed.**

### The Target of Reducing CO<sub>2</sub> Emissions in FY2024 (Seventh Medium-term Business Plan Initiatives)

- ▶ Reduce steel-business CO<sub>2</sub> emissions in FY2024 by 18%, compared to FY2013 (steel business)

### The Target of Reducing CO<sub>2</sub> Emissions in FY2030

- ▶ Reduce steel-business CO<sub>2</sub> emissions in FY2030 by 30% or more, compared to FY2013 (steel business)

### Initiatives for Carbon Neutrality by 2050

#### **(1) Reduce steel-business CO<sub>2</sub> emissions**

- ▶ Pursue ultra-innovative technology for carbon-recycling blast furnaces and CCU.
- ▶ Develop hydrogen-based ironmaking (direct reduction) technology.
- ▶ Leverage top-in-class electric arc furnace technology for high-quality, high-performance steel manufacturing, high efficiency, etc.
- ▶ Develop transitional technologies for carbon neutrality, including ferro coke, increased use of steel scrap in converters, energy savings, and low-carbon energy transformations.

#### **(2) Expand contributions to CO<sub>2</sub> emissions reduction in society**

- ▶ JFE Engineering: Expand and develop renewable energy power generation and carbon-recycling technologies. (Reduce CO<sub>2</sub> emissions by 12 million tonnes in FY2024 and 25 million tonnes in FY2030)
- ▶ JFE Steel: Develop and market eco-products and eco-solutions.
- ▶ JFE Shoji: Increase trading in biomass fuels, steel scrap, etc., and strengthen business in supply chain management (SCM) for eco-products.

#### **(3) Offshore wind-power generation business (Group-wide effort to accelerate commercialization of the offshore wind-power business)**

- ▶ JFE Engineering: Manufacture monopiles and other seabed-fixed structures for offshore wind-power generation.
- ▶ JFE Steel: Produce large and heavy plates by using new continuous casting machine in Kurashiki.
- ▶ JFE Shoji: Carry out SCM for steel materials and processed products.
- ▶ Japan Marine United Corporation: Manufacture offshore wind-power generation floating structures and construct work vessels.
- ▶ Group-wide: Operation and maintenance (O&M) making maximum use of Group resources.

#### Notes.

- Carbon-recycling blast furnace: A technology that converts CO<sub>2</sub> from the blast furnace into methane, which is then used as reducing material in the blast furnace
- CCU: Carbon dioxide capture and utilization
- Transitional technologies: Technologies that advance the transition to carbon neutrality
- Ferro coke: Innovative blast furnace raw material that improves the reduction efficiency of iron ore and reduces CO<sub>2</sub> generation from the blast furnace

▶ [Seventh Medium-term Business Plan](#) (P.12)

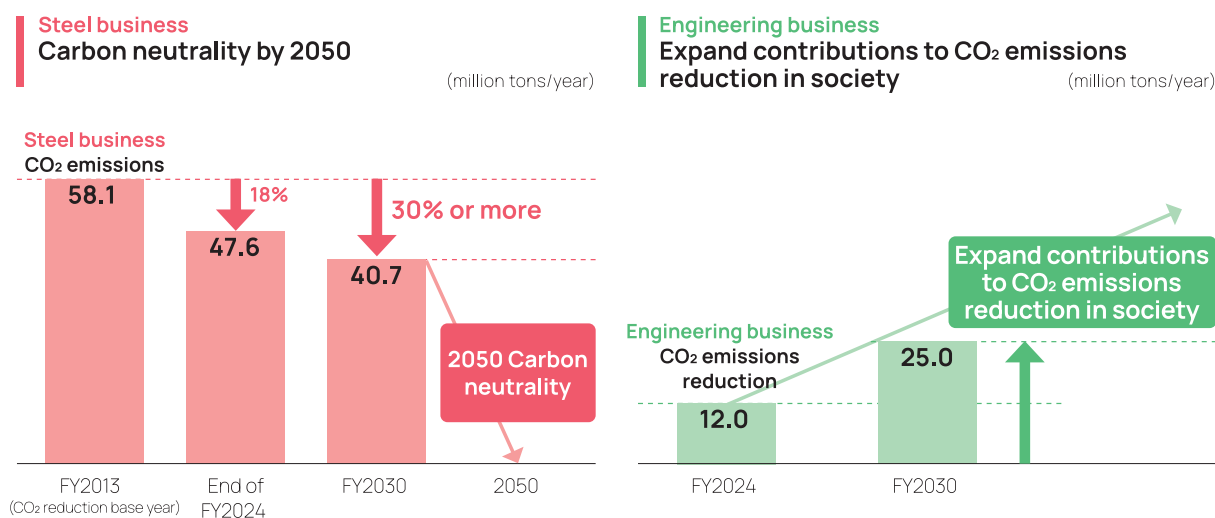
▶ [JFE Group Environmental Vision for 2050, Presentation Material](#)

(<https://www.jfe-holdings.co.jp/en/investor/zaimu/g-data/2020/May2021-210525-release01.pdf>)

Developing processes to mass produce high-quality, high-performance steel with zero CO<sub>2</sub> emissions is essential for a sustainable world. Huge R&D and equipment replacement costs will be inevitable as JFE executes strategies targeting carbon neutrality. Society must decide how these costs should be shouldered, including government support.

Working toward the lofty goal of carbon neutrality by 2050, JFE is focusing on establishing the necessary decarbonization technologies as quickly as possible, ahead of global competitors, assuming that we have the decarbonization infrastructure in place and ability to compete on an equal footing globally.

### ■ JFE Group's Activities for Carbon Neutrality



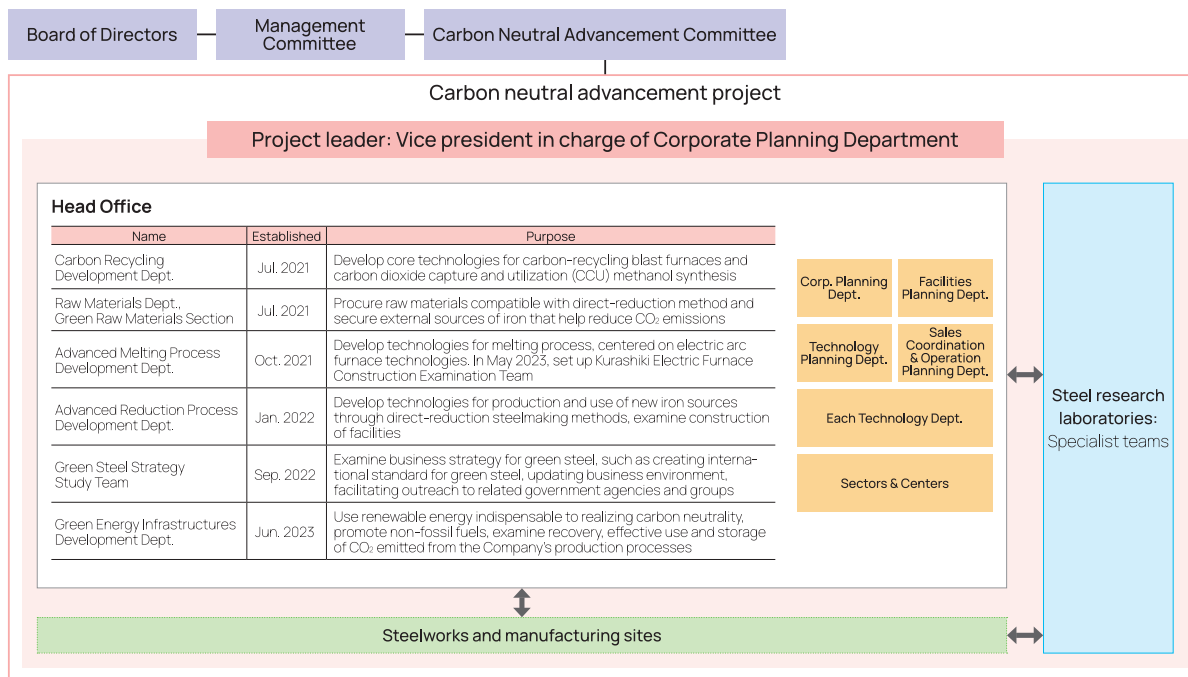
## Management Structure

### JFE Steel's Management Structure to Promote Carbon Neutrality

In May 2023, JFE Steel established the Kurashiki Electric Furnace Construction Examination Team within the Advanced Melting Process Development Department to quickly and efficiently introduce a new high-efficiency, large-scale electric furnace at the West Japan Works (Kurashiki district). In addition, we dissolved the CCUS\* & Green Infrastructure Study Team and established the Green Energy Infrastructures Development Department in June 2023 to promote the use of renewable energy and non-fossil fuels toward achieving carbon neutrality by 2050 and to rapidly promote the capture, effective use, and storage of CO<sub>2</sub> emitted from our production processes.

\*Carbon dioxide capture, utilization and storage

### JFE Steel's Management Structure to Promote Carbon Neutrality



### Information Disclosure Based on TCFD Recommendations

On May 27, 2019, JFE Holdings announced its endorsement for the final report of the Task Force on Climate-related Financial Disclosures (TCFD)\*.



\*The TCFD was established by the Financial Stability Board (FSB) at the request of G20 finance ministers and central bank governors.

Climate-related risks and opportunities will significantly impact medium- to long-term corporate finance. To reduce the risk of instability in the financial market, the G20 called on the FSB to establish the TCFD. The TCFD considers disclosure methodologies that can be used to appropriately assess climate-related risks and opportunities and releases its findings as a final recommendations report.

It is important for investors to accurately understand the financial impact of climate-related risks and the opportunities of investee companies when they make financial decisions. In this context, the task force recommends disclosures to be made in four core elements of organizational management: governance, strategy, risk management, and metrics and targets.

For the TCFD content index, click on the following link.

▶ [Guideline Content Indices](#) (P. 268)

## Governance

Under the JFE Group Standards of Business Conduct, the JFE Group actively strives to exist in harmony with the global environment and create a society that is comfortable and convenient. We are aware that efforts to protect the global environment, such as reinforcing our environmental protection activities and addressing climate change issues, are extremely important for creating a sustainable society.

In FY2016, we identified the mitigation of global warming as a material CSR issue to facilitate the PDCA cycle and promote appropriate management of ongoing initiatives, such as reducing CO<sub>2</sub> in the iron and steelmaking processes and developing and providing eco-friendly products. In 2021, we relaunched the initiative as a top priority by adding economic perspectives to the material issues and by selecting other vital matters of importance. As part of this effort, we set our goal for helping to address climate change (initiatives to achieve carbon neutrality by 2050) as an area of focus and identified reducing the JFE Group's CO<sub>2</sub> emissions and contribution to CO<sub>2</sub> emissions reduction in society as two material issues. The JFE Group Environmental Committee, chaired by the president of JFE Holdings and operating under **the JFE Group CSR Council**, supervises and guides these initiatives by deliberating goals, monitoring progress, and improving the Group's overall environmental performance.

The JFE Group Environmental Committee, chaired by the president of JFE Holdings and operating under the JFE Group Sustainability Council, supervises and guides these initiatives by deliberating goals, monitoring progress, and improving the Group's overall environmental performance.

Key managerial issues such as climate change and other environmental challenges are deliberated at **the Group Management Strategy Committee** as well and reported to **the Board of Directors**. The board discusses and makes decisions on the matters reported.

### ■ Examples of Climate Change-Related Agenda Items Involving Board of Directors Decisions and Reports

- Declaration of endorsement for the final TCFD recommendation report
- Information disclosure consistent with TCFD recommendations (scenario analysis and other information)
- Formulation of the Seventh Medium-term Business Plan, JFE Group Environmental Vision for 2050
- Review the CO<sub>2</sub> emissions reduction target for FY2030
- Use of climate-related metrics to determine executive remuneration

➤ [Corporate Governance System](#) (P.205)

➤ [Framework for Environmental Management](#) (P.47)

## Addressing Climate Change Issues

### Contribute to the realization of a carbon-neutral society by developing decarbonization processes, supplying green steel products, and expanding technologies that reduce CO<sub>2</sub> emissions

Having positioned climate change as a top management concern, JFE Group formulated the JFE Group Environmental Vision for 2050 and presented an actionable roadmap for achieving carbon neutrality by 2050. We have positioned the timeframe up to 2030 as the transition phase for shifting to low-carbon manufacturing processes and up to 2050 as the innovation phase in which to establish and implement our ultra-innovative technologies and achieve carbon neutrality. We have accordingly developed a concrete CO<sub>2</sub> reduction plan and are working on initiatives for achieving it. In the steel business, we have decided to strengthen the operation of the electric furnace at the Sendai Works and introduce an electric furnace in the stainless steel manufacturing process in the Chiba district to achieve a reduction by 30% or more by FY2030 (compared to FY2013), in addition to introducing a process that increases the volume of scrap for use in converters at all sites. We are also considering the introduction of a high-efficiency, large-scale electric furnace in the Kurashiki district, and we will continue to steadfastly make the necessary capital investments to achieve our 2030 target. To advance our multi-track development of technologies for a carbon recycling blast furnace, hydrogen steelmaking (direct reduction), and a high-efficiency, large-scale electric furnace, we started constructing test furnaces for verifying each technology in the Chiba district in FY2023. These test furnaces are important first steps in the long-term development of carbon-neutral ironmaking and will boost the efficiency of developing ultra-innovative technologies and help to quickly realize applications.

In addition, as the demand for decarbonization accelerates throughout the supply chain, the demand for green products that emit less CO<sub>2</sub> in the manufacturing process is also rising. In the first half of FY2023, JFE Steel began supplying JGreeX™, a brand of green steel products that significantly reduce CO<sub>2</sub> emissions in the steel manufacturing process compared to conventional products. JGreeX™ products have already been adopted for a variety of applications. In the initiative to use JGreeX™ for the construction of dry bulk carriers (large cargo ships), we constructed the world's first business model for sharing the associated cost of reducing CO<sub>2</sub> emissions across the supply chain, and we are allowed to charge a green premium of about 40% for the product. The widespread recognition of the environmental value of green steel products is important for helping us obtain the necessary funding for the capital investment and development of ultra-innovative technologies for achieving carbon neutrality. We will strive to create a market for green steel products that can contribute to realizing a carbon-neutral society.

Another area of focus in the JFE Group Environmental Vision for 2050 is to expand our contribution to reducing CO<sub>2</sub> emissions in society as a whole. In the engineering business, in addition to expanding our renewable power generation plant businesses, we have started the commercial operation of the PET bottle recycling raw material manufacturing plant (West Japan PET Bottle MR center). This is a bottle-to-bottle business initiative, and the plant has the capacity to recycle approximately 10% of the total number of PET bottles shipped nationwide. In the steel business, we have decided to bolster the manufacturing capacity at the West Japan Works (Kurashiki district) for high-grade, non-oriented electromagnetic steel sheets, for which demand is expected to expand for electric vehicles. In the trading business as well, we will reinforce our supply system for electromagnetic steel sheets to ensure that we capture the growing demand. We consider this as a fresh business opportunity for applying our advanced technologies to contribute to creating a sustainable society, and we will take advantage of these opportunities to grow our businesses and enhance our corporate value.

Furthermore, we are working on an initiative for contributing to the offshore wind-power generation business by applying the strengths of the Group. With JFE Engineering as the main driver, we started constructing the manufacturing plant for monopiles and other seabed-fixed structures and plan to start production in 2024. Offshore wind-power generation business can take full advantage of the capabilities of all our operating companies, and so we will continue to make a Group-wide effort to accelerate this business.

Our key strategies for achieving carbon neutrality by 2050 are to reduce CO<sub>2</sub> emissions at JFE Steel and expand contributions to CO<sub>2</sub> reduction for society as a whole. We view society's shift toward decarbonization as a business opportunity and are committed to playing our part in realizing a sustainable society developing and quickly implementing decarbonizing technologies and creating products and services that contribute to a decarbonized society.



Seiya Kitajima  
Senior Executive Officer,  
JFE Holdings, Inc.

## JFE Group's Climate Change Strategy

Various risks and opportunities related to climate change are integrated into the JFE Group's business strategy. The Group formulated the Seventh Medium-term Business Plan as the main guide for business operations from FY2021 to FY2024, and we positioned efforts to address climate change as the key to achieving sustainable growth and increased value over the medium to long term. Under the plan, the Group defined ensuring environmental and social stability as a core strategy and **formulated the JFE Group Environmental Vision for 2050 for achieving carbon neutrality by 2050**. Then we concentrated our efforts on our business strategy and **reflected the principles of the TCFD recommendations in our management strategy**, enabling us to systematically address climate change. Furthermore, we are disclosing information based on the TCFD recommendations, including the scenario analysis, leveraging them to identify and evaluate risks and opportunities, and reflecting them in our management strategy.

For further details on the Results of Scenario Analysis and the JFE Group Environmental Vision for 2050, refer to the following source material.

- ▶ [Scenario Analysis in Line with the TCFD Recommendations](#) (P.91)
- ▶ [JFE Group Environmental Vision for 2050, Presentation Material](#)  
(<https://www.jfe-holdings.co.jp/en/investor/zaimu/g-data/2020/May2021-210525-release01.pdf>)

In the JFE Group Environmental Vision for 2050, our efforts to achieve carbon neutrality are based on the following three key strategies: reduce CO<sub>2</sub> emissions at JFE Steel, expand contributions to the reduction for society as a whole, and accelerate Group-wide commercialization of the offshore wind-power business. In the steelmaking process, along with efforts to reduce CO<sub>2</sub> emissions, we will also actively work on reducing environmental impact through reusing water resources and energy, developing environmentally sound products and process technologies, and providing resource recycling solutions.

### Reduce CO<sub>2</sub> Emissions at JFE Steel

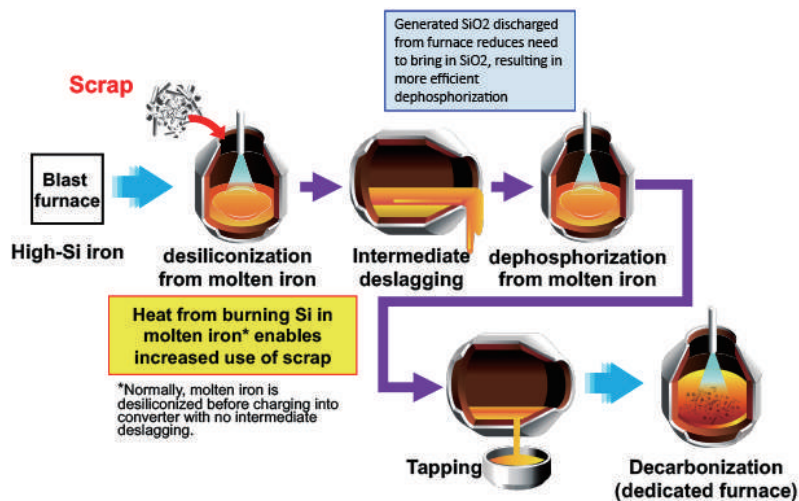
The JFE Group has adopted a multipronged approach, including the development of ultra-innovative technologies, to achieve carbon neutrality by 2050. In the steel business, we have set a target for reducing CO<sub>2</sub> emissions by 18% as of the end of FY2024 and by 30% or more by FY2030, compared to FY2013. We have defined the period up to 2030 as a transition phase and the period after that as an innovation phase. In the transition phase, we will focus more on initiatives to reduce emissions through an expanded application of low-carbon technologies to steadily advance toward achieving the CO<sub>2</sub> reduction target in FY2030. In this phase, we will also accelerate the development of ultra-innovative technologies to prepare for the innovation phase. In the innovation phase, we will advance initiatives for the wise use of resources, including the commercialization of carbon-recycling blast furnaces that leverage our proprietary carbon-recycling technology and direct-reduction steelmaking, as well as the expansion of CCU applications. Furthermore, we will undertake CO<sub>2</sub> sequestration through CCS to create a carbon-neutral society together with local communities and industrial complexes. We will achieve carbon neutrality through initiatives under these three themes.

#### Increased Use of Scrap Iron in Steelmaking

JFE Steel completed introducing the Double-slag Refining Process (DRP<sup>®</sup>), an eco-friendly converter-type molten-iron pretreatment process, in all of its sites in 2021. This increased the amount of scrap iron to be used in converters, leading to reduced CO<sub>2</sub> emissions.

DRP makes full use of silicon in molten iron as a heat source, thereby increasing the amount of scrap iron to be used in converters. It allows reducing the molten-iron blending ratio (molten iron vs. scrap charged into the converter) to 82%, down from 90% through conventional methods. The Company introduced this process in all of its steelmaking facilities, and the increased use of scrap iron in converters enabled us to reduce CO<sub>2</sub> emissions by approximately 0.17 million tons per year in FY2021. In the future, we will develop technologies to increase heating margins to further boost the use of scrap and invest in facility expansion to reduce CO<sub>2</sub> emissions by about 2 million tons per year by FY2030.

### ■ Eco-friendly converter-type molten iron pretreatment process DRP®: Double-slag Refining Process

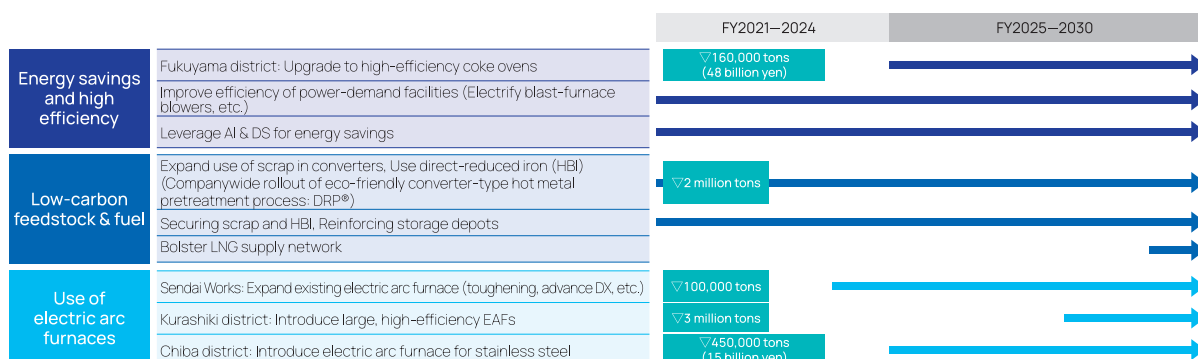


### East Japan Works (Chiba District) to Produce Stainless Steel with Electric-Arc Furnace

JFE Steel has decided to install a new electric-arc furnace at the No. 4 steelmaking shop at the East Japan Works (Chiba district) in the second half of FY2025 (planned). Scrap melting capacity is expected to increase by up to six times compared to the conventional process, to approximately 300,000 tonnes per year (planned), and CO<sub>2</sub> emissions are expected to be reduced by up to about 450,000 tonnes per year. We have defined the period up to 2030 as a transition phase toward carbon neutrality and consider the electric furnace process to be an effective means of reducing CO<sub>2</sub> emissions. Looking ahead, we will continue to develop ultra-innovative technologies in a multi-pronged approach and make steady progress toward realizing carbon neutrality.

### Transition to Low-Carbon Steel Processes

Our multi-pronged approach includes developing ultra-innovative technologies for achieving carbon neutrality by 2050. We have defined the period up to 2030 as a transition phase and the period after that as an innovation phase. In the transition phase, the steel business is promoting energy-saving and high-efficiency improvements in existing processes and the use of electric furnace technology. We anticipate that achieving the CO<sub>2</sub> reduction target for FY2030 may require investments and loans of around one trillion yen, and approximately 110 billion yen has been approved by FY2022. We intend to steadily advance toward obtaining the necessary investments and loans to achieve the reduction target.



## Started supplying JGreeX™ green steel products



■ Name origin: JFE + Green + GX

We invited the relevant departments to propose names and selected this name from the suggestions because it clearly expresses being a green steel product provided by JFE Steel.

■ Logo design:

The logo combines the letter X with an arrow to express our intention to move forward toward carbon neutrality.

In the first half of FY2023, JFE Steel began supplying JGreeX™, a brand of green steel products that significantly reduce CO<sub>2</sub> emissions in the steel manufacturing process compared to conventional products. At present, it is difficult to immediately supply green steel products with significantly lower or zero emissions, so the reductions created by our technologies are allocated to specific steel products by applying the mass balance method\*1 and then supplied as green steel products. With regard to the amount of CO<sub>2</sub> emission reductions and the emission intensity of each product, we have obtained a third-party certification from Nippon Kaiji Kyokai (ClassNK), which verified 520,000 tonnes of CO<sub>2</sub> emission reduction in FY2022.

JGreeX™ green steel products have been selected by Tsuneishi Shipbuilding Co., Ltd. for the planned construction of tugboats fitted with hydrogen co-combustion engines. JFE Steel will start supplying JGreeX™ products to Tsuneishi from September 2023.

In addition, JGreeX™ green steel products have been selected for constructing new dry bulk carriers\*2, a joint initiative with eight participating companies: NYK Bulk & Projects Carriers, Ltd., MOL Drybulk Ltd., Toko Kaiun Kaisha, Ltd., Kawasaki Kisen Kaisha, Ltd., Kawasaki Kinkai Kisen Kaisha, Ltd., Daiichi Chuo Kisen Kaisha, Ltd., Daiichi Chuo Kinkai Kaisha, Ltd., and Eastern Car Liner, Ltd.

All of the steel materials\*3 to be used in the construction of these ships will be exclusively JGreeX™, which generates net zero CO<sub>2</sub> emissions in the manufacturing process, making these ships the first in the world to use only green steel materials. This is also the first time that shipping companies and JFE Steel, which also engages in shipping activities, have jointly established a new business model (see diagram below) in which the costs of CO<sub>2</sub> reduction are shared across the entire supply chain.

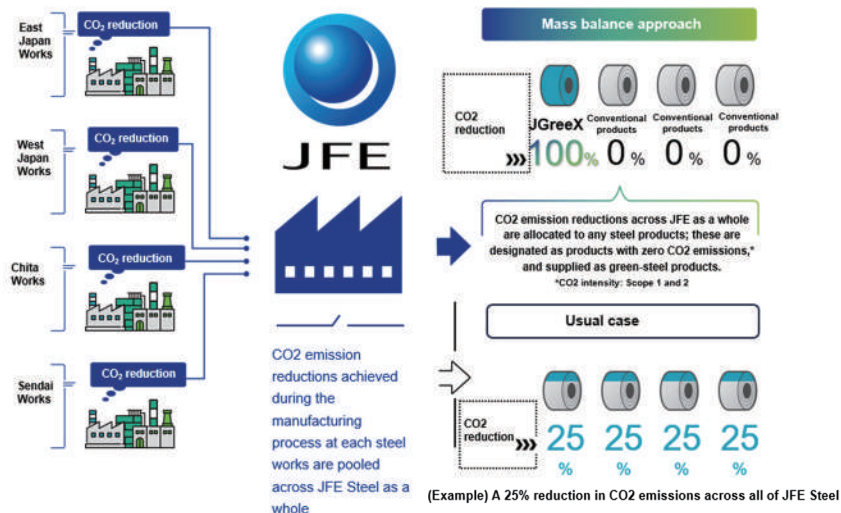
In FY2023, JFE Steel expects to deliver 14,000 tons of JGreeX™ products to two shipbuilders, Onomichi Dockyard Co., Ltd and Higaki Shipbuilding Co., Ltd., for use in four vessels to be commissioned between September 2024 and January 2025 by shippers NYK Bulk & Projects Carriers, MOL Drybulk, and Toko Kaiun.

Reduction of CO<sub>2</sub> throughout the supply chain is rapidly progressing. JFE Steel will contribute to the decarbonization of society by expanding its capacity for supplying JGreeX™ and further reducing CO<sub>2</sub> emissions through the use of advanced low-carbon technologies as well as energy-saving, high-efficiency technologies.

### ■ JGreeX™ supply overview

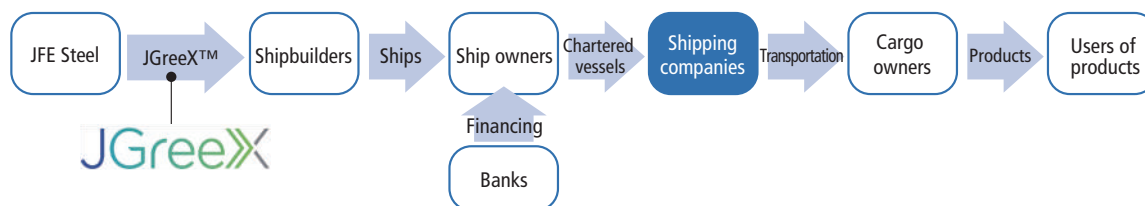
Start of supply	First half of fiscal 2023
Supply capacity in fiscal 2023	Approximately 200,000 tons
Applicable products	All steel products manufactured by JFE
Certification organization	Nippon Kaiji Kyokai

### ■ Concept of Green Steel JGreeX™





■ JGreeX™ supply overview



\*1 Consolidate the environmental value of CO<sub>2</sub> emission reduction from the entire product manufacturing process, allocate the value to some steel products, and regard them as having low CO<sub>2</sub> emission intensity.

\*2 Cargo ships that transport large quantities of dry cargo

\*3 Steel products purchased directly by shipbuilding companies

**Demonstration Tests for NEDO Project: Hydrogen Utilization in Iron and Steelmaking Processes**

In preparation for the innovation phase, we are researching and developing ultra-innovative technologies such as carbon-recycling blast furnaces and hydrogen steelmaking (direct reduction), for achieving carbon neutrality by 2050.

To this end, the company formed a consortium with Nippon Steel Corporation, Kobe Steel, Ltd., and the Japan Research and Development Center for Metals and jointly commissioned the New Energy and Industrial Technology Development Organization's (NEDO's) Green Innovation Fund Project: Hydrogen Utilization in Iron and Steelmaking Processes.

In order to further advance the development of ultra-innovative technologies to achieve carbon neutrality by 2050, JFE Steel has decided to construct all the necessary facilities for the demonstration tests for the project centrally in the East Japan Works (Chiba district) to increase the efficiency of the development effort. We will work together with consortium members to accelerate the development of ultra-innovative technologies.

**Details of the Planned Demonstration Tests**

- **Carbon-recycling pilot blast furnace (150m<sup>3</sup>)**  
Start construction in 2023, start demonstration tests in April 2025, complete demonstration tests by 2026
- **Direct reduction compact bench pilot furnace**  
Start construction in 2023, start demonstration tests in 2024, complete demonstration tests by 2026
- **Pilot electric arc furnace (10 t pilot furnace)**  
Start construction in 2023, start demonstration tests in 2024, complete demonstration tests by 2025

Details for each are as follows.

**Carbon-Recycling Blast Furnaces (CR Blast Furnace)**

We will work on developing carbon-recycling blast furnaces (CR blast furnaces), hydrogen steelmaking (direct reduction), and electric arc furnace process (high-efficiency, large-scale electric arc furnaces) while also striving to achieve carbon neutrality by 2050, as announced in the JFE Group Environmental

Vision for 2050. We are particularly focused on a technology that combines a CR blast furnace and CCU\*, which allows us to efficiently mass produce high-grade steel and reuse the CO<sub>2</sub> in the blast furnace. This technology is focused on achieving virtually zero emissions by using the remaining CO<sub>2</sub>, which cannot be fully reused to manufacture basic chemicals such as methanol.

\*Carbon dioxide capture and utilization

### Technical Features of a CR Blast Furnace

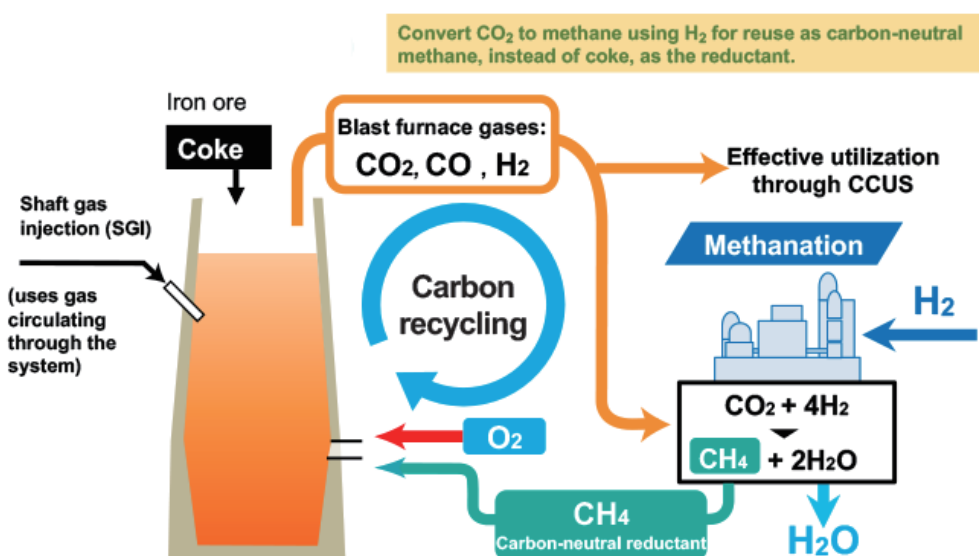
The CR blast furnace incorporates an ultra-innovative technology that converts CO<sub>2</sub> in the furnace exhaust gas into carbon-neutral methane through methanation, which is then reused as reducing material in the furnace. The technology is expected to reduce CO<sub>2</sub> by 50% in the blast furnace process and to ultimately help achieve carbon neutrality by leveraging CCU/CCUS\*. The thermal efficiency of the process can be further enhanced by replacing the air blown into the blast furnace with pure oxygen, as the energy used to heat the nitrogen in the air can then be used to heat methane. In addition, the lack of nitrogen facilitates the separation of CO<sub>2</sub>, so the equipment necessary to separate CO<sub>2</sub> for methanation can be more compact and efficient while more effectively using gas at CCUS.

### Overview of the Demonstration Tests

We are planning to develop a process that converts the CO<sub>2</sub> produced in the blast furnace into methane using hydrogen, allowing the carbon to be repeatedly used in the furnace as a reducing agent and thus reducing CO<sub>2</sub> emissions. We will verify the following during demonstration tests.

- Methods for blowing a large volume of methane along with oxygen into the furnace
- Applications for the heating burner that uses the circulation gas
- Methods for linking the operations of the furnace and the methanation facility that converts CO<sub>2</sub> from the blast furnace gases to methane

### ■ Overview of Carbon-recycling Directs Furnaces



## Development of Direct Hydrogen Reduction Technology (Carbon-Recycling Direct Reduction Process)

Hydrogen reduction ironmaking technology is another steelmaking process that the JFE Group is working on to achieve carbon neutrality. With this technology, the natural gas currently used in direct reduction ironmaking is replaced by 100% hydrogen to eliminate CO<sub>2</sub> emissions when iron ore is reduced.

### Technology for Processing Raw Materials

Currently, the only raw material that can be used for direct reduction ironmaking is high-grade iron ore. Its production volume, however, is limited, and we expect it will become even more difficult to obtain in the future if direct reduction ironmaking were to expand worldwide.

To address this, JFE and one of its iron ore suppliers, BHP, are collaborating in the development of a new raw material processing technology for low- and medium-grade ores, which are currently used as raw materials for blast furnaces due to their large production volume. We are hoping that this new technology will allow us to use low- and medium-grade ores as raw materials for direct reduction ironmaking, thus expanding the raw material sourcing for direct reduction ironmaking.

### Technology for Pre-Heating Raw Materials, Technology for Heating Hydrogen Gas

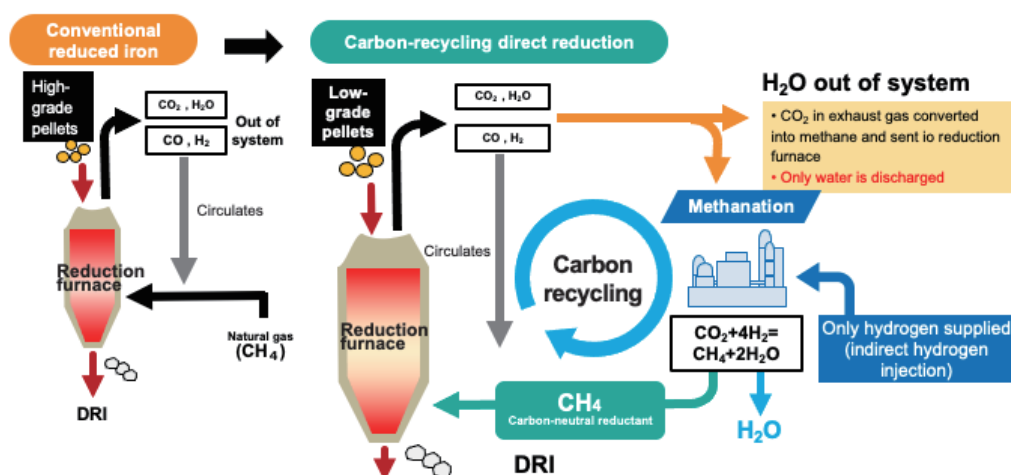
One challenge of hydrogen reduction is that the reduction of iron ore by hydrogen is an endothermic reaction, which means that heat must be applied externally for the reaction to proceed. A sufficient reduction reaction may not take place if there is not enough heat. Thus, technologies for heating raw materials and hydrogen gas must be developed.

### Overview of the Demonstration Tests

We are developing a process to convert the CO<sub>2</sub> produced in the direct-reduction furnace into methane using hydrogen, allowing the carbon to be repeatedly used in the furnace as the reducing agent and thus reducing CO<sub>2</sub> emissions. We will verify the following during demonstration tests.

- Optimal methods for recycling CO<sub>2</sub> through methanation
- Methods for using low-grade ores

### Carbon-Recycling Direct Reduction Process



## Development of Electric Arc Furnace Process Technology

An electric arc furnace process is one of the JFE Group's development efforts in steelmaking technologies for carbon neutrality. With this technology, steel products are manufactured by melting steel scrap and direct-reduced iron in an electric arc furnace. So far, we have managed to reduce CO<sub>2</sub> emissions from this steelmaking process down to one-quarter of that of the blast furnace-converter method. We are striving to eliminate CO<sub>2</sub> emissions generated by the electric arc furnace process in the future by using the aforementioned hydrogen-reduced iron as the raw material and green electricity.

Although the electric arc furnace process has the advantage of reducing CO<sub>2</sub> emissions, there are two major problems compared to the blast furnace-converter method: the productivity of the electric arc furnace process in general is about 30% lower than that of the blast furnace-converter method, and the use of scrap as the raw material inevitably increases the concentration of impurities, which limits the production of high-quality, high-performance steel products. We are working to address these issues and striving to establish technologies that will enable the production of high-quality, high-performance steel with high productivity using the electric arc furnace process.

### Use Electric Arc Furnaces to Increase the Use of Scrap

JFE Steel is planning to increase the production capacity of the electric arc furnaces in the Sendai Works by approximately 0.14 million tonnes per year by FY2024 through reinforcing the electric arc furnaces in the Sendai Works, implementing capacity-boosting DX measures, and improving the load handling equipment. This is expected to result in a reduction of approximately 0.10 million tons of CO<sub>2</sub> emissions per year.

We are planning to install a new electric arc furnace in the Chiba district for stainless steel production. This will allow the facility to replace part of the feedstock from molten iron from blast furnaces with scrap and thus reduce CO<sub>2</sub> emissions. This could increase by up to six times the volume of scrap used, and we expect to reduce CO<sub>2</sub> emissions by a maximum of about 450,000 tons per year.

Furthermore, in the Kurashiki district, we are considering switching to a newer process technology by replacing one of the blast furnaces, which needs to undergo preventive maintenance within the period of 2027–2030, with a large, high-efficiency electric arc furnace.

### Feasibility Study on New Venture Business to Secure Reduced Iron Supply

In the transition phase up to 2030, we expect a shortage in domestic scrap supply. The use of direct-reduced iron is considered an effective way to supplement this in the production of high-quality steel using electric arc furnaces and in the reduction of CO<sub>2</sub> emissions from blast furnaces.

JFE Steel has agreed with Emirates Steel Arkan (Emirates Steel), the largest steel producer in the UAE, and ITOCHU Corporation (ITOCHU) to jointly conduct detailed feasibility studies on the establishment of a supply chain of reduced iron with low carbon emissions. Under a joint venture to be established in the UAE, we are focusing on producing direct-reduced iron with low carbon emissions from the second half of FY2025 using CCUS (EOR\*), which takes full advantage of the geographic location of the UAE.

### Collaboration to Establish a Supply Chain of Ferrous Raw Material for Green Ironmaking with Low Carbon Emissions

JFE Steel has signed a memorandum of understanding (MOU) with ITOCHU, Emirates Steel, and the Abu Dhabi Ports Group (ADPG) to develop collaborative systems for the establishment of a supply chain to handle ferrous raw material for green ironmaking with low carbon emissions. The four companies exchanged their MOU in the presence of Japanese Prime Minister Fumio Kishida at the Japan-UAE Business Forum that was held on July 17.

We view Direct Reduced Iron as a key initiative for CO<sub>2</sub> emissions reduction and are participating with Emirates Steel and Itochu as core members in the establishment of a supply chain of Green Ferrous Material. The companies are jointly promoting a detailed feasibility study at the planned project site in Abu Dhabi.

ADPG, the state-owned port operator and economic and industrial zones developer in Abu Dhabi in which the project is planned to be developed, owns 10 ports and 550km<sup>2</sup> of economic and industrial areas.

The parties have agreed that ADPG will participate fully in project-related port development and operations, land leasing and services, and infrastructure development. Collaboration with ADPG will provide the undertaking with access to a suitable site for building a distribution and logistics system capable of stably importing raw materials and shipping products for the envisioned supply chain.

\*Enhanced oil recovery

- Overview of Emirates Steel

Company name: Emirates Steel Arkan

Representative: HE Engineer Saeed Ghumran Al Remeithi (Group CEO)

Business: Steel

- Overview of ADPG

Company name: Abu Dhabi Ports Group

Representative: Captain Mohamed Juma Al Shamisi

Business: Port operations, shipping, logistics and special economic zone development



### Improve productivity of the electric arc furnace process

To improve productivity of the electric arc furnace process, the JFE Group have developed ECOARC™, our proprietary, eco-friendly, high-efficiency electric arc furnace, and installed it at our operating companies. With this technology, a shaft is attached to the upper part of the electric arc furnace and is used to continuously feed scrap materials into the furnace. It uses the high-temperature exhaust gas from the furnace to preheat the scrap material, allowing for subsequent high-efficiency and high-speed melting. As well as improving the productivity of the electric arc furnaces, the technology also reduces the energy (electricity) required for the melting process.

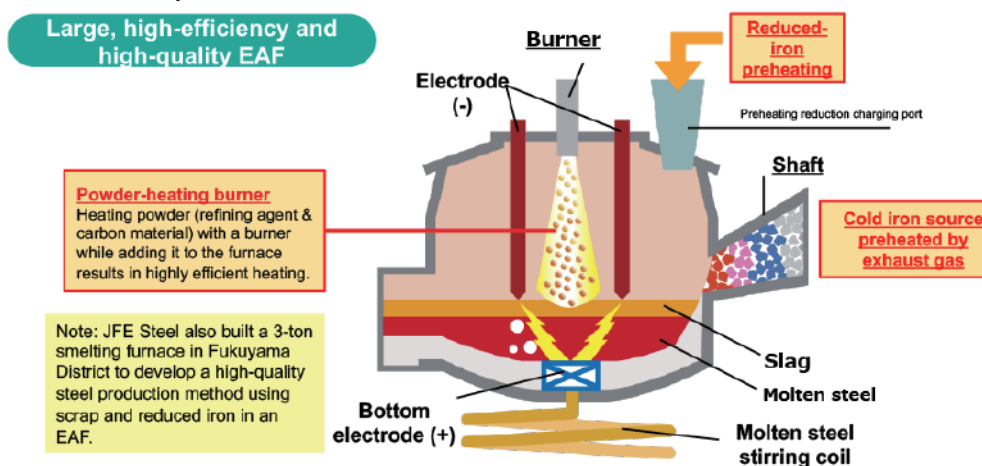
The Group already has achieved industry-leading productivity and energy (electricity) efficiency with these technologies, but we are working to raise productivity even further.

### Overview of the Demonstration Tests

We are developing a process that reduces the electric arc furnace's melting power consumption and also enables high-speed melting of cold iron sources (scrap and reduced iron). We will verify the following during demonstration tests.

- Optimal methods for preheating and feeding reduced iron
- Methods for using heating burners
- Optimal methods for molten steel stirring

### Research and Development for Electric Arc Furnaces



### Manufacturing Higher-Grade Steels Using the Electric Arc Furnace Process

The electric arc furnace process uses scrap and reduced iron as raw materials. The higher concentration of impurities in these materials, such as copper, causes material degradation, including surface defects and reduced workability in steel sheets and deterioration of properties in electrical steel sheets. We are working on two technologies to address the issue, one to remove impurities and another to detoxify impurities, so that we can use the electric arc furnace process to produce high-grade steel products such as steel sheets for automobiles and electrical steel sheets.

### Practical Applications of CO<sub>2</sub> Utilization Technologies

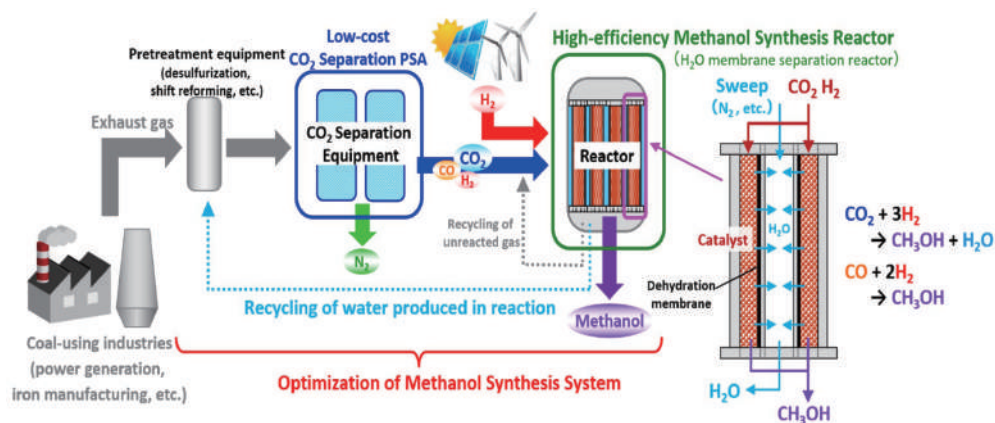
JFE Steel is working on the Optimum System for Methanol Synthesis Using CO<sub>2</sub>, an R&D project, in collaboration with the Research Institute of Innovative Technology for the Earth (RITE) (Figure 1). On-site construction of a test facility commenced in FY2022 in the Fukuyama district of the West Japan Works, with operations scheduled to start in FY2023 and integrated practical application tests to be completed by the end of FY2025. The project focuses on establishing an optimal overall methanol synthetic system, mainly by developing technologies for low-cost CO<sub>2</sub> separation and high-efficiency methanol synthesis. The ultimate goal is to combine this newly established system with carbon-recycling blast furnaces and other ironmaking processes to achieve large-scale CCU process.

JFE Steel is also working on an R&D project, Innovative CO<sub>2</sub> Sequestration Technology through Quick, Large-quantity Carbonation of Steel Slag, in collaboration with Ehime University (Figure 2). Construction for a practical application test facility is scheduled to commence in FY2023 in the Chiba district of the East Japan Works. The process principles will be verified by FY2022, and tests will be conducted during the FY2024–FY2025 period. The project will develop a new technology to sequester the CO<sub>2</sub> generated from ironmaking processes such as carbon-recycling blast furnaces and from nearby thermal power plants in slag, and at the same time verify technologies for recovering heat after carbon sequestration and for converting the steel slag to roadbed materials and other products.

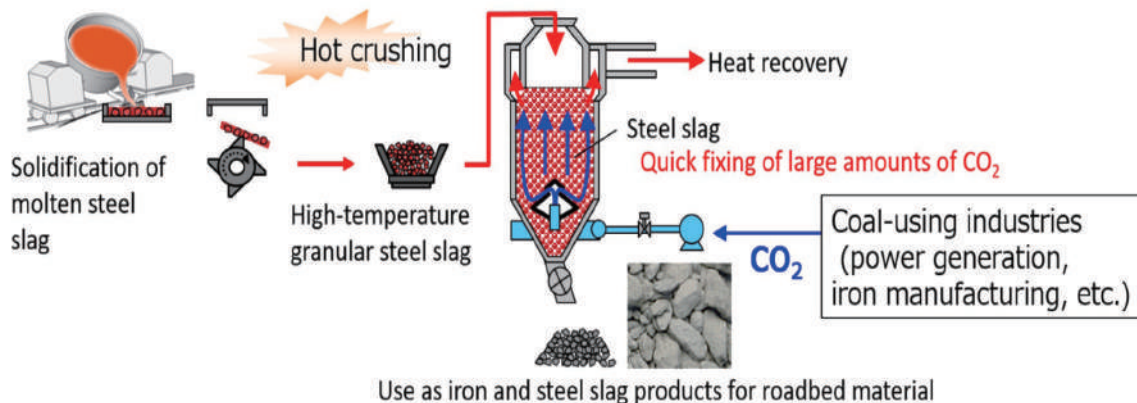
Furthermore, JFE Steel, Japan Petroleum Exploration Co., Ltd., JGC Holdings Corporation (JGC HD), and Kawasaki Kisen Kaisha, Ltd. ("K" LINE) have agreed to conduct a joint evaluation for establishing a CCS value chain originated from Japan, aligned with the joint study on CCS in Malaysia with Petroliaam Nasional Berhad (PETRONAS). Under this joint effort, the four companies will conduct evaluations to establish a CCS value chain, from CO<sub>2</sub> separation and capture at JFE's steelworks, to

marine transportation of liquefied CO<sub>2</sub> to the receiving points in Malaysia, including estimation of required facilities and costs. These evaluations will also be appropriately aligned with the study of CO<sub>2</sub> receipt and storage in Malaysia within the scope of the Study with PETRONAS. By establishing an international CCS value chain through this joint effort, JFE Steel, JAPEX, JGC Holdings, and "K" LINE aim to contribute to realizing carbon neutrality by 2050, including the realization of de-carbonized society in Asia targeted by Asia Energy Transition Initiative \*.

■ Figure 1



■ Figure 2



\*The Japanese Government's initiative announced in May 2021 for simultaneously achieving sustainable economic growth and carbon neutrality in Asia.

► **Development and Provision of Eco-friendly Processes and Products** (P.108)

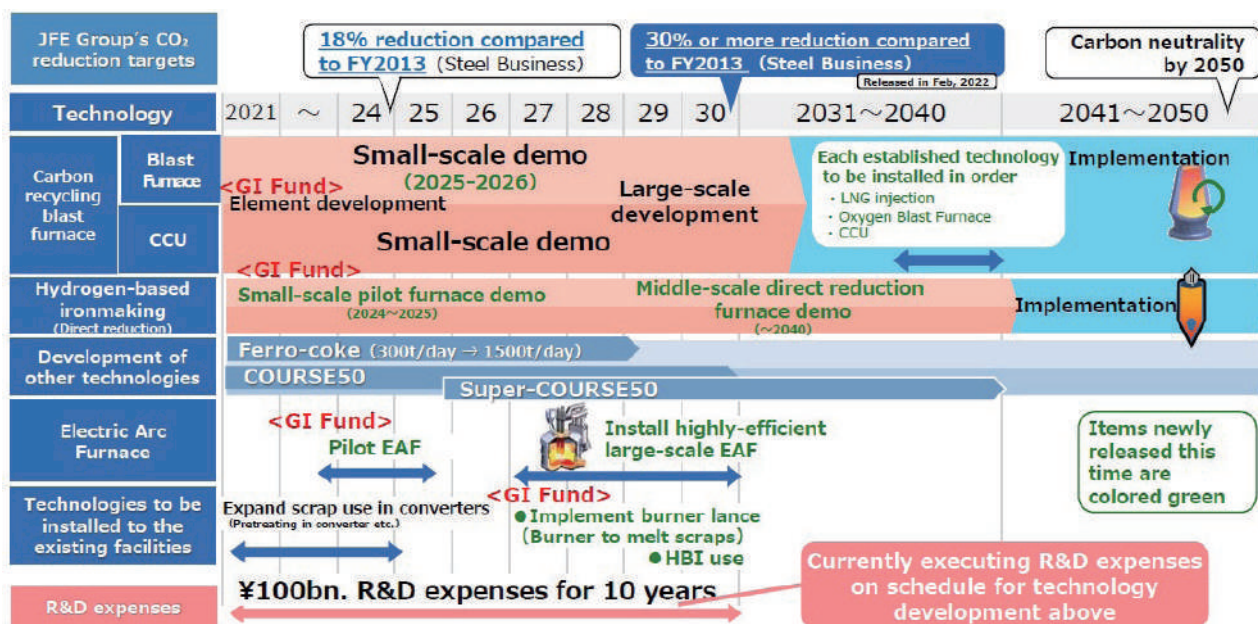
■ Related Products and Technologies

Reduce CO <sub>2</sub> Emissions at JFE Steel		
Carbon neutrality	Key Initiatives	<a href="https://www.jfe-steel.co.jp/en/company/pdf/carbon-neutral-strategy_220901_1.pdf">JFE Steel Carbon Neutrality Strategy Briefing</a> (https://www.jfe-steel.co.jp/en/company/pdf/carbon-neutral-strategy_220901_1.pdf)
		<a href="https://www.jfe-steel.co.jp/en/movie/#movie-gx">JFE Steel Challenge to Achieve Carbon Neutrality through Green Transformation</a> (https://www.jfe-steel.co.jp/en/movie/#movie-gx)
	Demonstration tests	<a href="https://www.jfe-steel.co.jp/release/2022/06/220615-2.html">Demonstration Tests for NEDO's Hydrogen Utilization in Iron and Steelmaking Processes project (Japanese only)</a> (https://www.jfe-steel.co.jp/release/2022/06/220615-2.html)
Green steel products	Begin supplying green steel products	<a href="https://www.jfe-steel.co.jp/en/release/2023/230508-2.html">JFE Steel to Begin Supplying JGreeX™ Green Steel</a> (https://www.jfe-steel.co.jp/en/release/2023/230508-2.html)
	Adoption of green steel products	<a href="https://www.jfe-steel.co.jp/en/release/2023/230620-1.html">JFE Steel's JGreeX™ Green Steel Selected by Tsuneishi Shipbuilding for Construction of Hydrogen-fueled Tugboats</a> (https://www.jfe-steel.co.jp/en/release/2023/230620-1.html)
		<a href="https://www.jfe-steel.co.jp/en/release/2023/230620-2.html">Large Cargo Ships to be Made Exclusively with JFE Steel's JGreeX™ Green Steel</a> (https://www.jfe-steel.co.jp/en/release/2023/230620-2.html)
Carbon-recycling blast furnace	Carbon-recycling blast furnace technology	<a href="https://www.jfe-steel.co.jp/en/company/pdf/carbon-neutral-strategy_220901_1.pdf">JFE Steel Carbon Neutrality Strategy Briefing: Reducing CO<sub>2</sub> via CR Blast Furnaces</a> (https://www.jfe-steel.co.jp/en/company/pdf/carbon-neutral-strategy_220901_1.pdf)
		<a href="https://www.challenge-zero.jp/en/casestudy/812">Challenge Zero: Challenge for development of super-innovative technologies focusing on Carbon-recycling Blast Furnace+CCU</a> (https://www.challenge-zero.jp/en/casestudy/812)
	CCU/CCUS	<a href="https://www.challenge-zero.jp/en/casestudy/391">Challenge Zero: Technology of CO<sub>2</sub> utilization</a> (https://www.challenge-zero.jp/en/casestudy/391)
New technology to process raw materials for hydrogen reduction ironmaking	Development of technology for direct hydrogen reduction	<a href="https://www.jfe-steel.co.jp/en/company/pdf/carbon-neutral-strategy_220901_1.pdf">JFE Steel Carbon Neutrality Strategy Briefing: Direct Hydrogen Reduction</a> (https://www.jfe-steel.co.jp/en/company/pdf/carbon-neutral-strategy_220901_1.pdf)
	Collaboration with a material supplier	<a href="https://www.jfe-steel.co.jp/en/release/2021/210210.html">JFE Steels and BHP to address decarbonization in steelmaking process</a> (https://www.jfe-steel.co.jp/en/release/2021/210210.html)
Expanded use of scrap and reduced iron	Eco-friendly converter-type molten iron pretreatment process DRP®	<a href="https://www.jfe-steel.co.jp/en/release/2022/220621.html">Increased Use of Scrap Iron in Steelmaking Process to Reduce CO<sub>2</sub> Emissions</a> (https://www.jfe-steel.co.jp/en/release/2022/220621.html)
	Feasibility study on new venture business to secure reduced iron supply	<a href="https://www.jfe-steel.co.jp/en/release/2022/220901.html">Feasibility Study on Building a Supply Chain of Reduced Iron with Low Carbon Emissions</a> (https://www.jfe-steel.co.jp/en/release/2022/220901.html)
		<a href="https://www.jfe-steel.co.jp/en/release/2023/230718.html">Collaboration to Establish a Supply Chain of Ferrous Raw Material with Low Carbon Emissions</a> (https://www.jfe-steel.co.jp/en/release/2023/230718.html)



Reduce CO <sub>2</sub> Emissions at JFE Steel		
Expanded use of scrap and reduced iron	Development of electric arc furnace process technology	<a href="https://www.jfe-steel.co.jp/en/company/pdf/carbon-neutral-strategy_220901_1.pdf">JFE Steel Carbon Neutrality Strategy Briefing: Large, High-efficiency EAFs</a>
	Adoption of electric arc furnace process technology	<a href="https://www.jfe-steel.co.jp/en/release/2023/230508-1.html">JFE Steel's Chiba District Facility to Produce Stainless Steel with Electric-arc Furnace</a>
CO <sub>2</sub> utilization and storage technology	CO <sub>2</sub> utilization technology	<a href="https://www.jfe-steel.co.jp/en/release/2021/211015.html">Novel Processes for Manufacturing Valuable Materials Using Coal-Derived CO<sub>2</sub> Selected for NEDO Projects</a>
	Testing for practical use	<a href="https://www.jfe-steel.co.jp/en/release/2022/220620-2.html">JFE Steel Moves Ahead with Testing CO<sub>2</sub>-utilization Technologies Aimed at Achieving Carbon Neutrality</a>
	Establish CCS value chain	<a href="https://www.jfe-steel.co.jp/en/release/2023/230619.html">Agreed on Joint Evaluation with JFE Steel Corporation to Establish CCS Value Chain Originated from Japan Aligned with CCS Study in Malaysia</a>

■ Related Products and Technologies



Source: Material for the JFE Group's investors' meeting held on May 6

➤ [Seventh Medium-term Business Plan](#) (P.12)

➤ [JFE Group Environmental Vision for 2050, Presentation Material](https://www.jfe-holdings.co.jp/en/investor/zaimu/g-data/2020/May2021-210525-release01.pdf)

## JFE Group Initiatives Aligned with the Paris Agreement

Under the JFE Group Environmental Vision for 2050, the JFE Group designed a roadmap for achieving carbon neutrality, which included our short-, medium-, and long-term CO<sub>2</sub> emission reduction targets. Until 2030, the Group will focus on fully using existing technologies to promote decarbonization while at the same time developing the ultra-innovative technologies needed to achieve carbon neutrality. The Group will then focus on commercializing the ultra-innovative technologies in the 2030s and 2040s, when we expect the required social infrastructure to be in place, to accelerate decarbonization toward achieving carbon neutrality by 2050.

The technology roadmap for Transition Finance toward decarbonization in the iron and steel sector, published by the Japanese Ministry of Economy, Trade, and Industry (METI), outlines a path for accelerating decarbonization and achieving carbon neutrality by introducing innovative technologies, with the same assumption that social infrastructure such as hydrogen supply and CCUS will be in place by the 2040s. This technology roadmap is aligned with Japan's Nationally Determined Contribution (NDC) based on the Paris Agreement, and is therefore aligned with the Paris Agreement.

In 2022, the JFE Group issued transition bonds through a public offering, which was selected as the first model example in the iron and steel sector for METI's Transition Finance Model Projects in FY2021. During the evaluation process for this issuance, the Group's initiatives were certified by a third party as being aligned with METI's roadmap. We can therefore deduce that they are also aligned with the Paris Agreement.

### ▶ [METI: Technology Roadmap for Transition Finance in the Iron and Steel Sector](https://www.meti.go.jp/policy/energy_environment/global_warming/transition/transition_finance_technology_roadmap_iron_and_steel_eng.pdf)

([https://www.meti.go.jp/policy/energy\\_environment/global\\_warming/transition/transition\\_finance\\_technology\\_roadmap\\_iron\\_and\\_steel\\_eng.pdf](https://www.meti.go.jp/policy/energy_environment/global_warming/transition/transition_finance_technology_roadmap_iron_and_steel_eng.pdf))

### ▶ [METI: Transition Finance Case Study](https://www.meti.go.jp/policy/energy_environment/global_warming/transition/transition_finance_case_study_jfeh_eng.pdf)

([https://www.meti.go.jp/policy/energy\\_environment/global\\_warming/transition/transition\\_finance\\_case\\_study\\_jfeh\\_eng.pdf](https://www.meti.go.jp/policy/energy_environment/global_warming/transition/transition_finance_case_study_jfeh_eng.pdf))

## Expand Contributions to CO<sub>2</sub> Emissions Reduction in Society

### Contribution to CO<sub>2</sub> Reduction through our Engineering Business

Demand is expected to rise for power generation plants using renewable energy sources that do not emit carbon. Through JFE Engineering, the JFE Group is handling the design, procurement, construction, and operation of various renewable energy generation plants including biomass, geothermal, solar, and onshore wind power. We are also working to increase the amount of power generated at waste treatment facilities in order to promote recycling and the effective use of resources.

Furthermore, we are actively engaged in the retailing of electricity, which uses these renewable energies as the main power source, supporting the establishment and operation of new regional electricity companies that focus on local production and consumption of energy using renewable sources, and in expanding the Multisite Energy Total Service (JFE-METS), which optimizes energy use for multiple sites within the same corporate group through centralized management.

As new initiatives for carbon neutrality, we are developing a technology to safely and efficiently transport large amounts of hydrogen, ammonia, and CO<sub>2</sub>, and working on demonstrating a process that separates and collects CO<sub>2</sub> for reuse from the exhaust gas of waste treatment facilities.

As new initiatives for material recycling, we are working on bottle-to-bottle, an effort through which collected PET bottles are recycled and used as raw material for bottles, and the recycling of solar panels that are discarded due to age-related deterioration.

These will contribute to reducing CO<sub>2</sub> emissions in society by 12 million tonnes by FY2024 and 25 million tonnes by FY2030.

The following key initiatives contributed to CO<sub>2</sub> reduction in FY2022.

#### Large-Scale Biomass Power Generation

**Started construction work for the Tahara Biomass Power Plant, one of the largest woody biomass combustion power plants in Japan, with an output of 112,000 kW.**

Tahara Biomass Power LLC, a joint venture between JFE Engineering Corporation, Chubu Electric Power Co., Inc., Toho Gas Co., Ltd., and Tokyo Century Corporation, has started construction work on the Tahara Biomass Power Plant. The plant, to be constructed in Tahara, Aichi Prefecture, is one of the largest woody biomass power plants in Japan, with an output of 112,000 kW, and is scheduled to start operation in September 2025.

## Food Waste Recycling Power Generation

### Construction of a new food waste recycling biogas power generation plant in Fukuoka, Fukuoka Prefecture: J&T Recycling's first food recycling business in Kyushu.

J&T Recycling Co., a subsidiary of JFE Engineering, and Kankyō Agency have jointly established Fukuoka Bio Food Recycle Co. Ltd. in Fukuoka City to engage in the food waste recycling and biogas power generation business, in which food waste is collected and fermented to produce methane gas, which is then used as fuel to generate power. The plant to be built for the project will accept up to 100 tonnes of food waste per day and generate electricity using methane gas produced by microbial fermentation as fuel (output: 1,560 kW, estimated annual generation: approx. 12,000 MWh). The project will also support the secondary use of fermented sludge and digested liquid generated in the treatment process on nearby agricultural land.

We have other projects for expanding our food waste power generation businesses throughout Japan, including Tohoku Bio Food Recycle Corporation, which is started its food waste power generation in Sendai in May 2022, and Sapporo Bio Food Recycle Corporation in Sapporo, which is constructing a new plant to expand its capacity.

## Multisite Energy Total Service (JFE-METS)

### The House Foods Group has agreed to adopt the Multisite Energy Total Service at 17 sites across 8 group companies, driving CO<sub>2</sub> reduction.

JFE Engineering has signed a basic agreement with House Foods Group Inc. to provide JFE-METS. We will install a gas cogeneration system at the House Foods Shizuoka Plant and use JFE-METS to supply surplus electricity from the system and electricity provisioned by the JFE Group to 17 sites across eight companies in the House Foods Group nationwide. The service is expected to reduce CO<sub>2</sub> emissions by approximately 12% and energy consumption by approximately 17% (compared to FY2020) at these sites. Operation is scheduled to commence in April 2024.

## CCUS

### Contract received for the construction of CO<sub>2</sub> liquefaction, storage and loading/unloading facilities, a large-scale, long-distance, lower cost transportation system for liquid CO<sub>2</sub> to realize a CCUS society.

JFE Engineering has received an order from Japan CCS Co., Ltd. to construct its CO<sub>2</sub> liquefaction, storage, and loading/unloading facilities (EPC project). The project will construct part of the facilities to be used in the NEDO project Research, Development and Demonstration of CCUS Technology / Large-scale CCUS demonstration testing at Tomakomai / Demonstration testing on CO<sub>2</sub> Transportation. We will be involved in the design and construction of onshore facilities capable of liquefying and storing 10,000 tonnes per year of CO<sub>2</sub> separated and recovered from coal combustion gas supplied by the Maizuru plant of Kansai Electric Power Co.

## PET Bottle Recycling (Bottle-to-Bottle)

### Kyoei J&T Recycling Corporation's West Japan PET Bottle MR Center to start full commercial operation.

Kyoei J&T Recycling, a subsidiary of JFE Engineering, after starting the operations of the flake manufacturing plant in October 2021, has completed the construction of the pellet production line and started full commercial operation at the PET bottle recycling raw material manufacturing plant (West Japan PET Bottle MR center) in Tsu, Mie Prefecture. With an annual processing capacity of 60,000 tonnes (approximately 10 million bottles per day), the plant can recycle approximately 10% of the total number of PET bottles shipped nationwide.

By producing flakes and pellets from used PET bottles and supplying them to bottle manufacturers, we contribute to the production of plastic bottles using 100% recycled materials, which generates 63% less CO<sub>2</sub> than the production of crude oil-derived pellets.

## Electrical Steel Sheets

Electrical steel sheets are widely used as core materials for electrical equipment such as motors and transformers and therefore play an important role in determining the performance of this electrical equipment. JFE Steel is contributing to reducing CO<sub>2</sub> emissions on a global scale by supplying high-performance electrical steel sheets.

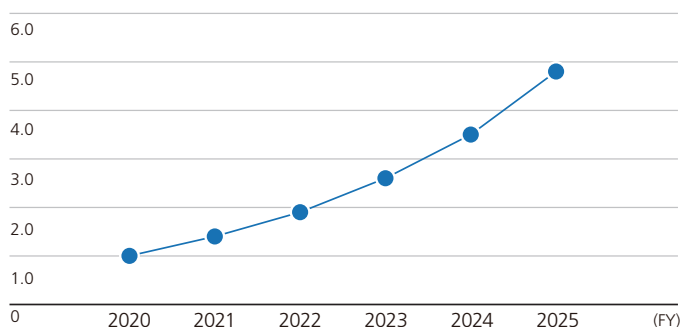
### Non-Oriented Electrical Steel Sheets

In order to achieve carbon neutrality for society as a whole, a major shift is required in the social structure, from a society that relies on fossil fuels for energy to one that primarily uses carbon-free energy sources. Transitioning to a future society in which electric vehicles (EVs) are the main mobility platform and where zero-emission electricity is the main energy source will depend on highly efficient motors, for which the key materials are high-performance, non-oriented electrical steel sheets.

Our high-grade non-oriented electrical steel sheets improve the performance of EV motors. Their excellent low iron loss property contributes to higher efficiency, while their high magnetic flux density supports downsizing. These characteristics are highly regarded, and many automobile manufacturers use them in products. Demand for such high-grade non-oriented electrical steel sheets is expected to grow rapidly, and to meet this demand, we are investing approximately 49 billion yen at the West Japan Works (Kurashiki district) to double its production capacity in the first half of FY2024.

Furthermore, as the shift toward EVs accelerates, we expect the demand for high-grade non-oriented electrical steel sheets to grow even more rapidly. We have therefore decided to further strengthen the production capacity high-grade non-oriented electrical steel sheets at the West Japan Works (Kurashiki district). Furthermore, we plan to make an additional investment of approximately 46 billion yen to triple the manufacturing capacity of high-grade non-oriented electrical steel sheets for EV main motors by the end of FY2026 (including the effect of the investment already made).

■ Demand for Non-Oriented Electrical Steel Sheets  
(Calculated by JFE, 2020 results = 1.0)



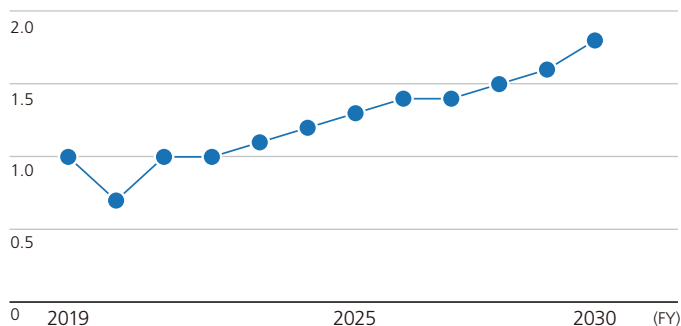
### Grain-Oriented Electrical Steel Sheets

The global demand for grain-oriented electrical steel sheets in transformers is expected to increase due to continuously growing demand for electric power and the expanding adoption of renewable energy. The demand for grain-oriented electrical steel sheets, particularly in India, is expected to increase by 1.8 times in 2030, compared to 2019.

To this end, in August 2023, JFE Steel and JSW Steel Limited (JSW) signed an agreement to establish a grain-oriented electrical steel sheet manufacturing joint venture company, JSW JFE Electrical Steel Private Limited. We will work with JSW to establish an integrated manufacturing system for this type of steel sheet in India. By locally manufacturing a full line-up of mainly high-grade, energy-efficient grain-oriented electrical steel sheets, in which JFE Steel has accumulated expertise over many years, the joint venture will contribute to the development of a greener power transmission and distribution infrastructure in India and to the remarkable growth of the Indian economy.

The total investment between the two companies is planned to be 670 million dollars, and we plan to begin full production in FY2027.

■ Demand for Grain-Oriented Electrical Steel Sheets in India  
(Calculated by JFE, 2019 results = 1.0)





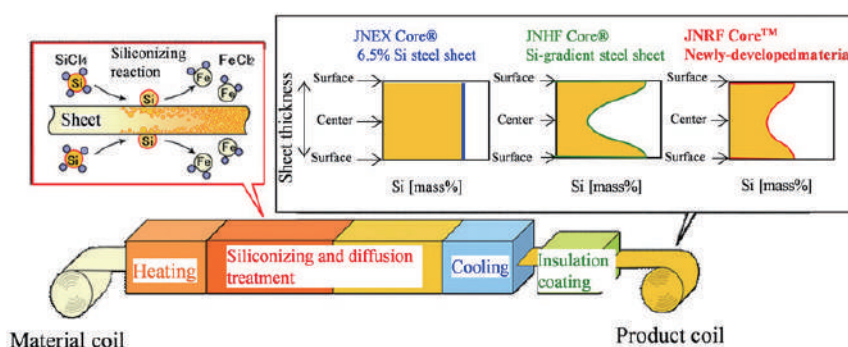
Signed an agreement to establish a grain-oriented electrical steel sheet manufacturing joint venture company

### Super Core

Motors are becoming ever smaller and faster for EVs, home appliances, drones, and other applications, and consequently require higher output and efficiency. At the same time, demand is growing to reduce high-frequency iron loss\*1 and increase magnetic flux density\*2 for the electrical steel sheets used as iron core materials for these products. Since silicon boosts the electrical resistance of steel, increasing the amount of silicon helps to realize these properties. Using our proprietary technology for CVD continuous siliconizing\*3, we worked on controlling silicon concentration distribution in the through-thickness direction by optimizing the siliconizing amount and diffusion conditions and controlling crystal orientation. These efforts have resulted in the development of a JNRF™ silicon-gradient steel sheet for high-speed motors, and JNRF™ helps to significantly increase motor efficiency to conserve energy while maintaining magnetic flux density (torque) equivalent to conventional non-oriented electrical steel sheets (3% silicon steel sheets).

- \*1 Iron loss refers to energy, mainly heat, lost when an iron core is excited by an alternating current. The energy loss that occurs when the iron core is excited at high frequency is called a high-frequency iron loss. The efficiency of high-speed motors increases as high-frequency iron loss is reduced.
- \*2 Magnetic flux density, which indicates a material's ease of magnetization, raises electromagnetic strength as density increases. In motors, larger torque (power) can be achieved with materials that offer high magnetic flux density.
- \*3 The chemical vapor deposition (CVD) process technology increases silicon concentration in steel. CVD, performed in a steel strip annealing line, causes a reaction between steel strips and silicon tetrachloride (SiCl<sub>4</sub>) gas in a furnace while continuously passing the steel strips through the furnace.

### Super Core Manufacturing Process



### High Tensile Strength Steel Sheets (HITEN) for Automobiles

Higher strength steel sheets are needed for automobile bodies in order to improve fuel efficiency, vehicle safety and, more recently, the cruising range of EVs. Generally, increasing the strength of steel sheets decreases their formability and, in some cases, limits how they can be applied. JFE Steel offers the JEFORMA® series, a lineup of cold-rolled and galvanized steel sheets in strength grades 590, 780, 980, and 1,180 MPa, each with distinct formability characteristics. The series facilitates selection of the optimal steel sheet based on body part shape and forming method. More recently, the Company has also worked on the following development initiatives for high tensile strength steel sheets for automobiles.

### Joint Development with thyssenkrupp Steel Europe

JFE Steel and thyssenkrupp Steel Europe jointly launched new 980-1,180 MPa-class cold-forming, high-tensile steel sheets by designing a new steel composition and microstructure with an emphasis on local ductility and establishing a new heat treatment method. Compared to conventional high-tensile steel sheets, these products achieve higher yield strength and ductility with excellent local ductility, characteristics that will contribute to lighter-weight automobile body frames and better crash safety performance. In addition, they can be formed into parts with complicated shapes, using conventional cold forming rather than hot stamping, and thereby helping to improve productivity, lower manufacturing cost, and save energy during parts manufacturing.

### 1.5 GPa-Grade High Tensile Strength Cold-Rolled Steel Sheets

In 2020, JFE Steel's 1.5 GPa-grade high tensile strength cold-rolled steel sheets were adopted for the first time in the world\* for cold press forming applications in vehicle body structural parts, representing the highest strength vehicle body structural parts obtained through cold press forming. Until then, the adoption of high tensile strength cold-rolled steel sheets for complex-shaped vehicle body structural parts had been limited to 1.3 GPa grade because increasing sheet strength can result in decreased cold press formability and delayed fracture resistance. Consequently, 1.5 GPa-grade high tensile strength steel sheets manufactured through a hot press forming process were more commonly adopted to meet these challenges. JFE Steel achieved both high yield strength and delayed fracture resistance even with the 1.5 GPa-grade high tensile strength steel sheets while maintaining cold press formability equivalent to 1.3 GPa-grade sheets by using a proprietary WQ (water quenching) method-based continuous annealing process to control the steel sheet's microstructure. This enabled the adoption of 1.5 GPa-grade high tensile strength steel sheets for vehicle body structural parts through a cold forming method, thus reducing environmental impact and cost.

In addition, we received the Minister of Economy, Trade and Industry Award in the FY2023 National Invention Awards, for inventing ultra-high tensile strength thin steel sheet that improves fuel efficiency and collision safety of automobiles. This invention relates to cold-rolled steel sheets for automobiles with ultra-high tensile strength of over 1,320 MPa and dramatically improved delayed fracture resistance. It is therefore used in the ultra-high tensile strength cold-rolled steel sheets described above.

\*According to our research

JFE Steel develops and manufactures steel sheet products that are easy to use, with full consideration for environmental impact and contribution to reducing energy and resources. The company will contribute to reducing CO<sub>2</sub> emissions in society in general through the use of its products for automobile parts.

### ■ Related Products and Technologies

Expand contributions to CO <sub>2</sub> emissions reduction in society		
Contribution to CO <sub>2</sub> Reduction through the Engineering Business	Large-scale biomass power generation	<a href="https://www.jfe-eng.co.jp/news/2022/20220601.html">Started Construction Work for the Tahara Biomass Power Plant, One of the Largest Woody Biomass Combustion Power Plants in Japan, with an Output of 112,000 kW (Japanese only)</a> (https://www.jfe-eng.co.jp/news/2022/20220601.html)
	New regional electricity	<a href="https://www.jfe-holdings.co.jp/en/csr/pdf/csr2022e.pdf">Regional Electricity Retail Businesses in Partnership with the Local Municipal Governments Establishing New Regional Electricity Businesses (FY2022 CSR, P. 116)</a> (https://www.jfe-holdings.co.jp/en/csr/pdf/csr2022e.pdf)
	Multisite energy total service	<a href="https://www.jfe-eng.co.jp/news/2022/20220926.html">House Foods Group Has Agreed to Adopt Multisite Energy Total Service at 17 Sites across 8 Group Companies: Driving CO<sub>2</sub> Reduction (Japanese only)</a> (https://www.jfe-eng.co.jp/news/2022/20220926.html)
	Food waste recycling	<a href="https://www.jfe-holdings.co.jp/en/csr/pdf/csr2022e.pdf">Food Waste Recycling Business (FY2022 CSR, P. 115)</a> (https://www.jfe-holdings.co.jp/en/csr/pdf/csr2022e.pdf)
<a href="https://www.jfe-eng.co.jp/news/2022/20220401.html">Construction of a New Food Waste Recycling Biogas Power Generation Plant in Fukuoka, Fukuoka Prefecture: J&amp;T Recycling's First Establishment of Food Recycling Business in Kyushu (Japanese only)</a> (https://www.jfe-eng.co.jp/news/2022/20220401.html)		

Expand contributions to CO<sub>2</sub> emissions reduction in society

Contribution to CO <sub>2</sub> reduction through the engineering business	Carbon-neutral world	<a href="https://www.jfe-holdings.co.jp/en/csr/pdf/csr2022e.pdf">Contribution to Creating a Carbon-Neutral World Through the Transport of Hydrogen and CO<sub>2</sub> (FY2022 CSR, P. 114)</a> (https://www.jfe-holdings.co.jp/en/csr/pdf/csr2022e.pdf)
		<a href="https://www.jfe-eng.co.jp/news/2023/20230111.html">Contract Received for the Construction of CO<sub>2</sub> Liquefaction, Storage and Loading/Unloading Facilities—a Large-Scale, Long-Distance, Lower Cost Transportation System for Liquid CO<sub>2</sub> to Realize a CCUS Society (Japanese only)</a> (https://www.jfe-eng.co.jp/news/2023/20230111.html)
	PET bottle recycling	<a href="https://www.jfe-eng.co.jp/news/2022/20220421.html">Kyoei J&amp;T Recycling Corporation’s West Japan PET Bottle MR Center to Start Full Commercial Operation (Japanese only)</a> (https://www.jfe-eng.co.jp/news/2022/20220421.html)
Electrical steel sheets	JNRF™	<a href="https://www.jfe-steel.co.jp/en/release/2020/201203.html">JFE Steel Develops JNRF™ Silicon-Gradient Steel Sheet for High-Speed Motors—Minimizes High-Frequency Iron Loss And Improves High Magnetic Flux Density</a> (https://www.jfe-steel.co.jp/en/release/2020/201203.html)
	Facility expansion	<a href="https://www.jfe-steel.co.jp/en/release/2021/210401.html">JFE Steel to Expand Electrical Steel Sheet Production Capacity at Kurashiki Facility</a> (https://www.jfe-steel.co.jp/en/release/2021/210401.html)
		<a href="https://www.jfe-steel.co.jp/en/release/2023/230522-1.html">JFE Steel Formally Decides to Further Expand Electrical Steel Sheet Capacity of the Kurashiki facility</a> (https://www.jfe-steel.co.jp/en/release/2023/230522-1.html)
	Supply chain for electrical steel sheets	<a href="https://www.jfe-steel.co.jp/en/release/2021/210507.html">JFE Steel &amp; JSW Steel Proposes Grain-Oriented Steel Sheet Manufacturing JV in India</a> (https://www.jfe-steel.co.jp/en/release/2021/210507.html)
		<a href="https://www.jfe-steel.co.jp/en/release/2023/230522-2.html">About the Basic Agreement to Establish a Joint Venture Company in India to Manufacture Grain-Oriented Electrical Steel with JSW Steel Limited</a> (https://www.jfe-steel.co.jp/en/release/2023/230522-2.html)
		<a href="https://www.jfe-steel.co.jp/en/release/2023/230803-2.html">About the Joint Venture Agreement to Establish a Joint Venture Company in India to Manufacture Grain-Oriented Electrical Steel with JSW Steel Limited</a> (https://www.jfe-steel.co.jp/en/release/2023/230803-2.html)
		<a href="https://www.jfe-holdings.co.jp/en/sustainability/environment/product/#pro_global_supply">Establish a Global Supply Chain in Electrical Steel Sheet Business</a> (https://www.jfe-holdings.co.jp/en/sustainability/environment/product/#pro_global_supply)
	High Tensile Strength Steel Sheets (HITEN) for automobiles	Development of high tensile strength steel sheets for automobiles
<a href="https://www.jfe-steel.co.jp/en/release/2020/201223.html">JFE Steel 1.5 GPa-Grade High-Tensile Strength Cold-Rolled Steel Sheets Adopted for First Time in Vehicle Body Structural Parts</a> (https://www.jfe-steel.co.jp/en/release/2020/201223.html)		

## Accelerate Group-Wide Commercialization of the Offshore Wind-Power Business

Offshore wind power generation is a key initiative of the Japanese government's Green Growth Strategy to achieve carbon neutrality by 2050. We will participate in this effort by leveraging the Group's collective strength with our engineering business acting as the main driver. Specifically, the Group will work on commercializing the manufacturing and O&M\* of foundation structures (monopiles, jackets) in addition to establishing a supply chain encompassing material procurement, manufacturing, and O&M. We anticipate this will significantly contribute to the JFE Group's efforts to achieve carbon neutrality as well as the government's strategy to achieve carbon neutrality.

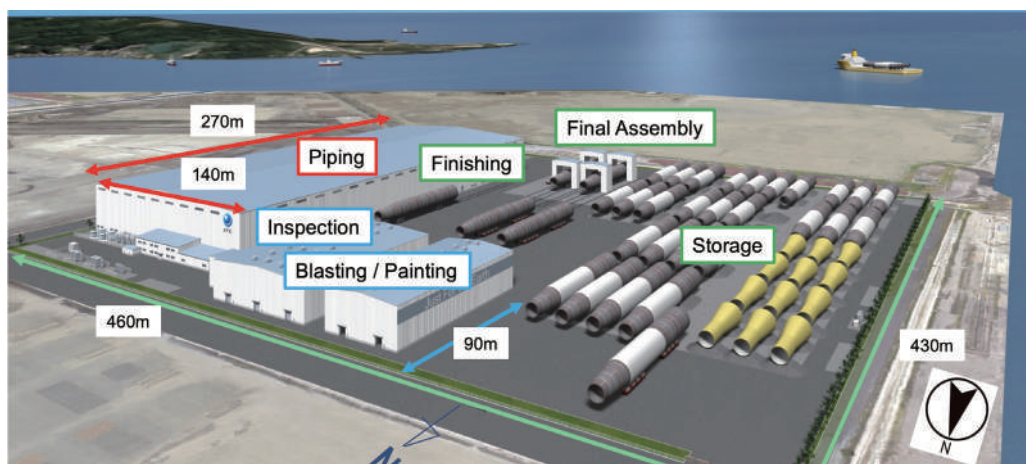
\*Operation and maintenance

### Construction of a Monopile Manufacturing Plant

JFE Engineering is constructing a manufacturing plant for monopiles, which are the foundational structural components for offshore wind power generation, in Kasaoka, Okayama Prefecture. Monopiles are extremely large steel structures, approximately 10 m in diameter, 100 mm thick, and 100 m long. When completed, the plant will be the only one in Japan capable of manufacturing such large structures. It is designed for production efficiency, implementing manufacturing processes based on the experiences gained in the manufacturing of large steel structures at the Tsu Works. The plant site includes extensive grounds and a quay from which manufactured structures can be directly shipped, as well as state-of-the-art equipment such as large-diameter bending machines and welding machines for extra-thick plates. Production is scheduled to start in April 2024, with an annual capacity of up to 100,000 tonnes, and is expected to significantly contribute to the establishment of a domestic supply chain in the offshore wind power generation business and to the realization of carbon neutrality.

### Overview of New Monopile Manufacturing Plant (Kasaoka)

Construction site	Kasaoka City, Okayama Prefecture (JFE Steel West Japan Works Fukuyama area)	Investment amount	Approximately 40 billion yen* (plant building, mechanical equipment, quay reinforcement) *Includes the facility reinforcement cost of the Tsu Works.
Construction start	June 2022	Site area	Approximately 20 ha (includes storage area)
Operation start	April 2024	Production capacity	Approximately 80,000–100,000 tonnes per year (Approx. 50 sets)
Length of shipping quay	200 m (quay total length: 400 m)	Quay depth	–11 m







Construction work of the monopile manufacturing plant, as of May 2023

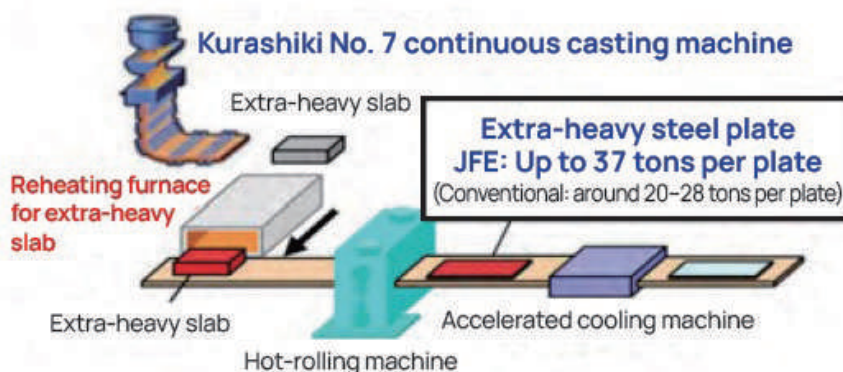
### Large and Heavy Steel Plates for Offshore Wind Power Generation

The large and heavy steel plate J-TerraPlate™, produced with the No. 7 continuous caster of the Kurashiki Plant at the JFE Steel's West Japan Works, has been selected for the first time for the production of monopile foundations for offshore wind power generation.

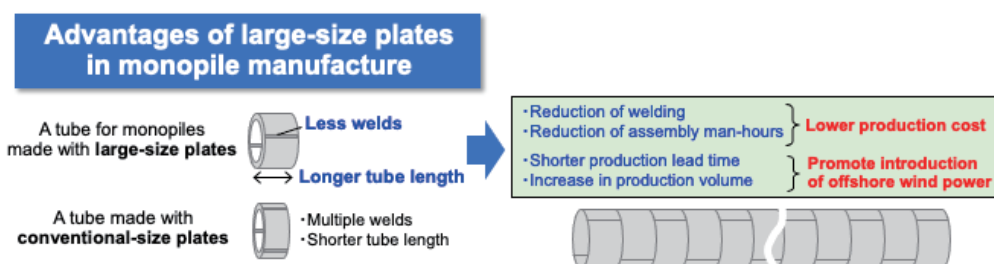
Offshore wind turbines have recently grown in size, requiring larger monopiles and other foundational structures to support them. The monopiles are manufactured by welding ultra-thick steel plates, resulting in increased welding workloads that require monopile manufacturers to improve the efficiency of the operations. Using larger and heavier steel plates makes it possible to reduce the volume of welding operations, compared to conventional small-size plates, and also helps to raise process efficiency while lower manufacturing costs.

We have been investing in equipment at the plate mills and other facilities to manufacture and supply steel plates of up to 37 tonnes (previously limited to around 20 to 28 tonnes per plate in general), the largest in Asia and capable of supporting wind turbines in harsh offshore environments over the long term and in large quantities using the extra-large slabs produced with the state-of-the-art No. 7 continuous casting machine. These investments have resulted in the first-time adoption of this product for the production of monopile foundations.

#### Manufacturing Process of Large and Heavy Steel Plates for Offshore Wind Power Generation

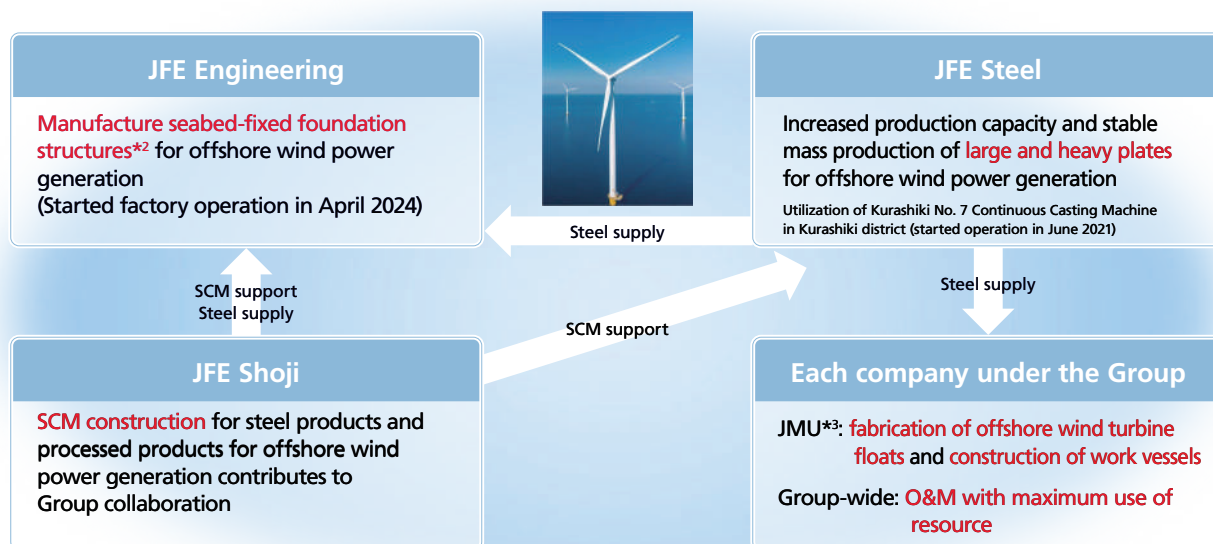


#### Advantages of Using Large and Heavy Steel Plates for Monopiles



## Commercialization of Offshore Wind-Power Business

- By commercializing our manufacturing of foundation structures (monopiles), we will become the forerunner in the business of offshore wind-power generation and establish a supply chain across the entire Group, including foundation manufacturing and O&M.\*1
- We will strive to expand business in the field of renewable energy by leveraging the JFE Group's collective strengths (synergies), with JFE Engineering as the main player.



\*1 Operation and maintenance. Apply expertise of maintenance and analysis technologies.

\*2 Seabed-fixed foundation structures: monopiles, jackets, etc.

\*3 Japan Marin United Corporation (equity method affiliate)

■ Technologies of Group Companies

Category	Company	Details
Foundation structures	JFE Engineering	Seabed foundations (monopiles, jackets, etc.)
	Japan Marine United	Floating foundations (semi-submersible)
	JFE Steel	High-quality, large and heavy steel plates, high-strength steel (reduced using HBL series steel plates)
Construction	Japan Marine United	SEP vessels (self-elevating platform)
	JFE Engineering	JFE-RAPID (cable laying method)
		Battery systems for power storage
	GECOSS	Stands for large steel structures
	JFE Steel	Natural stone substitute materials (use of steel slags)
O&M (operation and maintenance)	JFE Engineering	Technologies for remote monitoring and operation
	JFE Advantech	Vibration measurement equipment and systems, sea monitoring tools (water quality, sea conditions)
	Japan Marine United	Offshore support vessels (work vessels)
	JFE Plant Engineering	Wind turbine maintenance (diagnosis and repair)
	JFE Technos	Technologies and expertise in planning, constructing, and maintaining onshore turbines
	JFE Techno-Research	Equipment evaluation and analysis for corrosion, fatigue, vibration, etc., diagnosis of remaining service life, strength and durability testing and evaluation techniques for large structures
Supply chain	JFE Shoji	Contribution to optimizing offshore wind power generation project execution

## Initiatives for Achieving Carbon Neutrality in the Keihin Waterfront Areas

The JFE Group is partnering with Kawasaki City to devise options for repurposing land in the Keihin district of the Japan East Works after the operation of blast furnaces and other facilities are suspended. One key vision for land use is to play a leading role in achieving carbon neutrality. Public-private partnerships are also underway to accelerate the government's plan to create a carbon-neutral port in the Keihin waterfront area, including the land belonging to the Japan East Works.

Since April 2022, JFE Holdings, ENEOS Corporation, and JERA Co., Inc. are conducting a joint study on establishing a hydrogen and ammonia receiving and supply base. As part of this effort, we are considering utilizing the deep-water wharves and adjacent land areas of Ogishima, an island in the Keihin district. Furthermore, in March 2023, the Kawasaki waterfront area was selected as a candidate site for receiving liquefied hydrogen for the Liquefied Hydrogen Supply Chain Commercialization Demonstration Project, a joint initiative by Japan Suiso Energy Ltd., Iwatani Corporation, and ENEOS Corporation that is part of NEDO's Green Innovation Fund Project: Large-scale Hydrogen Supply Chain Establishment. We are actively exchanging information with these companies.

The JFE Group intends to play a role in building a stable and economical supply chain for hydrogen and other decarbonized fuels, starting with Ogishima, and to contribute to realizing carbon neutrality in the Keihin waterfront area and for society as a whole.



Aerial view of the Keihin waterfront area (courtesy of Kawasaki City)

## Adapting to Climate Change (Contribution to Achieving Societal Resilience)

### Contributions to Disaster Prevention and Mitigation and Increased National Resilience

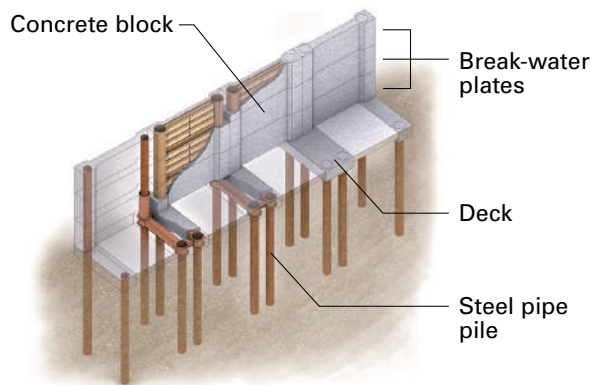
The JFE Group is not only focused on reducing CO<sub>2</sub> emissions (climate change mitigation); we also intend to contribute to the resilience of society in general by adapting to climate change.

With infrastructure such as hybrid tide embankments and permeable steel slit dams, the Group will contribute to preventing and mitigating disaster-related damage to infrastructure critical to daily life and economic activities, and to strengthening their resilience.

#### Hybrid Tide Embankments

Hybrid tide embankments are made of steel and concrete. Because of their hybrid structure, they require shorter construction time and less space.

Concrete blocks for hybrid tide embankments are precast at a JFE Group factory, while steel pipe piles for foundations are installed at the construction site, thereby reducing the time required for on-site construction by about 60%. This arrangement does not require large amounts of materials, equipment, or workers on site, so it does not interfere with other construction work. Furthermore, compared to a conventional embankment structure, the land area occupied by the embankment can be reduced by about 80%, saving considerable space. We will continue to apply and advance our technology to further contribute to disaster prevention in the region.



Cross section



Hybrid tide embankments

► [JFE Engineering Infrastructure Using Steel Structures \(Japanese only\)](https://www.jfe-eng.co.jp/products/bridge/co01.html)

(<https://www.jfe-eng.co.jp/products/bridge/co01.html>)

**Permeable Steel Slit Dams**

A permeable steel slit dam is a steel pipe structure installed in a river to trap debris flows.

Made of strong steel pipes to withstand the impact of driftwood and huge debris, it has large openings to let water and sediment to pass through, which prevents the water level from rising upstream during floods and also ensuring that debris does not flow downstream. Since it does not block the flow of water, unlike a dam, it can be shaped to the slope of a riverbed to protect the ecosystem. The JFE Group is working to expand the use of permeable steel slit dams by reducing installation costs and shortening the construction period through structural innovations.



Permeable steel slit dams

**Terre Armée Method**

The Terre Armée method drove the spread of the reinforced soil technology in Japan. This reinforced soil wall construction method was introduced to Japan about half a century ago, and since then, it has been used in a variety of situations, mainly in domestic infrastructure development, such as highway and other road structures, and the construction of airports, schools, and defense facilities. By applying layers of steel reinforcement in the embankment, friction between the steel strips and the earth results in a vertically strong structure that exhibits excellent earthquake resistance.

JFE Shoji Terre One Corporation, a subsidiary of JFE Shoji, has developed a new Terre Armée method, with an innovative fail-safe system. The feature helps to visually confirm the health of structures after being subject to unforeseen forces, such as massive earthquakes. Being able to easily detect the internal anomalies of reinforced embankments helps to determine the safety of the infrastructure and schedule necessary maintenance work in a timelier manner.

We will contribute to building disaster-resistant roads and towns by promoting the Terre Armée method and by expanding sales of other products that contribute to disaster prevention, disaster mitigation, and national land resilience.



Application in highway walls for National Route No. 3,  
Kumamoto Prefecture)



Fail-Sensor indicator  
(red indicating internal anomalies)

## Risk Management (Climate Change)

JFE Holdings is responsible for comprehensive risk management in accordance with its Basic Policy for Building Internal Control Systems. The JFE Group Sustainability Council, chaired by the president of JFE Holdings, consolidates information and strengthens management across the Group to reduce the frequency and impact of risks.

The executive officer responsible for risk strives to identify potential ESG risks such as those associated with climate change. As necessary, the council confirms and evaluates risks and discusses and determines countermeasures. Key managerial issues are deliberated by the Group Management Strategy Committee.

The Board of Directors supervises initiatives on ESG risks such as those related to climate change and CSR by discussing, making decisions on, and receiving reports about these matters.

Climate-related risks are identified and evaluated based on a scenario analysis conducted under the framework recommended by the TCFD in 2017. Key factors that may affect management are selected for further analysis and incorporated into formulating business strategies, such as the Seventh Medium-term Business Plan.

### Monitoring Method for Climate Change-Related Risks

Issues that may affect management are monitored by the JFE Group Sustainability Council, Group Management Strategy Committee, and Management Committee. Measures are implemented based on a quarterly report on climate change-related risks deliberated by the specialized committees of each Group company (e.g., the Environmental Committee). The JFE Group Environmental Committee consolidates information and strengthens management to reduce the frequency and impact of risks and to maximize opportunities.

#### Countermeasures Based on Monitoring

1. Group-wide deliberations
2. Monitoring penetration of policies within the Group
3. Monitoring deployment of policies throughout the Group

For further details, refer to the following links.

- ▶ [System for Promoting Sustainability](#) (P.24)
- ▶ [Risk Management](#) (P.220)
- ▶ [Environmental Management](#) (P.47)

## Metrics and Targets (Medium- and Long Term Targets and Results in FY2022)

The JFE Group's steel business is led by its operating company, JFE Steel, which is a member of the Japan Iron and Steel Federation (JISF). The JFE Group is promoting the JISF's Commitment to a Low Carbon Society, which focuses on the Three Ecos initiatives and the development of innovative new iron and steelmaking processes. Under the initiative, the JISF's target for FY2030 had originally been to reduce emissions by 9 million t-CO<sub>2</sub>. However, with the end of Phase I of this initiative in 2020, it was rebranded as the JISF's Carbon Neutrality Action Plan, and the Phase II target (FY2030 target) was revised to a 30% reduction in energy-derived CO<sub>2</sub> emissions in FY2030, compared to FY2013. JFE Steel is aggressively pursuing the achievement of this goal.

In addition, JISF has formulated and announced the Long-term Vision for Climate Change Mitigation in 2030 and beyond, which is intended to realize zero-carbon steel. JFE Steel played a key role in formulating this vision. Furthermore, in 2021, the JISF announced the "Basic Policy of the Japan steel industry on 2050 Carbon Neutrality sought by the Japanese government," declaring that the Japanese iron and steel industry will boldly take on the challenge of realizing zero-carbon steel.

The JFE Group intends to increase sustainability through solutions that address global climate change while restructuring to respond to developments in the environment facing our steel business. We considered 2020 to be the landmark year for further reinforcing our efforts to tackle climate change, and we declared our target to reduce CO<sub>2</sub> emissions in the steel business in FY2030 by 20% or more, compared to FY2013, and to achieve carbon neutrality by 2050.

In May 2021, the JFE Group placed top priority on its climate change initiatives and formulated the JFE Group Environmental Vision for 2050 as part of the Seventh Medium-term Business Plan, under which we will strive to achieve carbon neutrality by 2050. The Group also disclosed new CO<sub>2</sub> emissions reduction targets, and in February 2022, the FY2030 target for the steel business was revised upward to 30% or more, compared to FY2013. Major Group companies of JFE Steel have formulated CO<sub>2</sub> reduction targets at the same level as JFE Steel. The Group companies in Japan and overseas work together to incorporate efforts to address climate change issues into their business strategies. The Group will systematically pursue the reduction of CO<sub>2</sub> emissions by incorporating the TCFD's principles in its management strategies.

### JFE Group's Initiatives to Reduce CO<sub>2</sub> (JFE Group Environmental Vision for 2050)

#### Seventh Medium-term Business Plan Initiatives

- Reduce steel-business CO<sub>2</sub> emissions in FY2024 by 18%, compared to FY2013 (JFE Steel).  
Furthermore, JFE Steel's major group companies have also set their own CO<sub>2</sub> reduction targets for FY2024 to ensure that these targets are achieved. With this, more than 99% of the total CO<sub>2</sub> emissions of the entire JFE Steel Group is accounted for.
- The target of reducing CO<sub>2</sub> in FY2030: 30% or more, compared to FY2013 (JFE Steel)

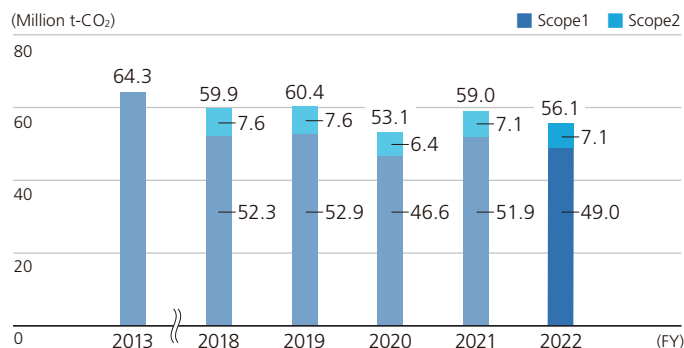
#### Initiatives for Carbon Neutrality by 2050

- Reduce CO<sub>2</sub> emissions at JFE Steel
  - Pursue ultra-innovative technologies mainly for carbon-recycling blast furnaces and CCU
  - Develop hydrogen-based ironmaking (direct-reduction) technology
  - Develop electric arc furnace process technology
- Expand engineering business contributions to CO<sub>2</sub> emissions reduction in society
  - Reduce CO<sub>2</sub> emissions by 12 million tonnes in FY2024 and 25 million tonnes in FY2030
- Offshore wind-power generation business
  - Accelerate commercialization of our offshore wind-power business by applying the strengths of the Group

▶ [JFE Group Environmental Vision for 2050, Presentation Material](https://www.jfe-holdings.co.jp/en/investor/zaimu/g-data/2020/May2021-210525-release01.pdf)  
(<https://www.jfe-holdings.co.jp/en/investor/zaimu/g-data/2020/May2021-210525-release01.pdf>)

## CO<sub>2</sub> Emissions of the JFE Group

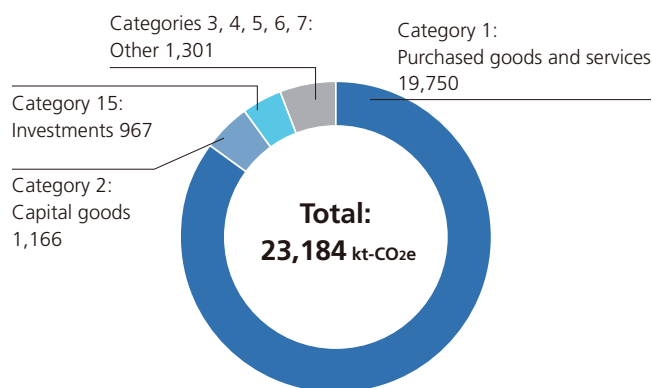
### CO<sub>2</sub> Emissions of the JFE Group



Notes:

- Data cover 76 companies  
 JFE Steel and 26 major domestic and overseas subsidiaries  
 JFE Engineering and 12 major domestic and overseas subsidiaries  
 JFE Shoji and 35 major domestic and overseas subsidiaries
- Data for JFE Steel include CO<sub>2</sub> emissions from non-energy sources.
- Starting with FY2018, data for JFE Steel's subsidiaries and JFE Engineering's subsidiary include CO<sub>2</sub> emissions from non-energy sources.
- FY2013 figure includes data for the Sendai Works of JFE Bars & Shapes Corporation.
- Since FY2021, the figures include data for an expanded list of JFE Steel, JFE Engineering, and JFE Shoji major subsidiaries.

### Scope 3 Emissions of the JFE Group (FY2022)



Coverage:

- (Categories 1, 2, 3, 4, 5) JFE Steel, 21 JFE Steel major domestic subsidiaries, JFE Engineering, 1 JFE Engineering major subsidiary, and JFE Shoji
  - (Category 6, 7) JFE Steel, 21 JFE Steel major domestic subsidiaries, JFE Engineering, 15 JFE Engineering major domestic and overseas subsidiaries, and JFE Shoji
  - (Category 15) Japan Marine United, and 10 JFE Steel equity-method affiliates (7 domestic and 3 overseas)
- Sources: Green Value Chain Platform (Ministry of the Environment) and others

For more on quantitative data related to CO<sub>2</sub> emissions, refer to the following information.

➤ [Environmental Data](#) (P.225)



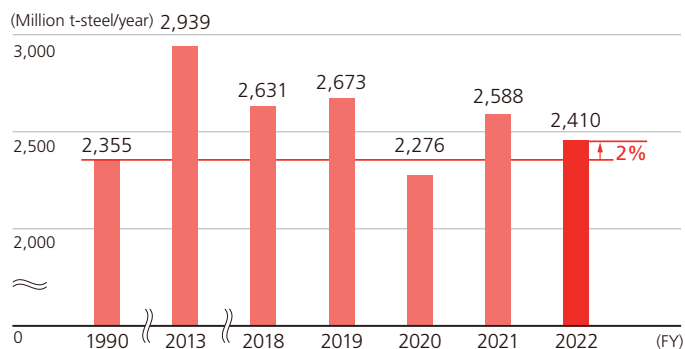


## Initiatives to Save Energy and Reduce CO<sub>2</sub>

JFE Steel has always aggressively pursued CO<sub>2</sub> reduction and energy savings, including the introduction of energy-saving equipment.

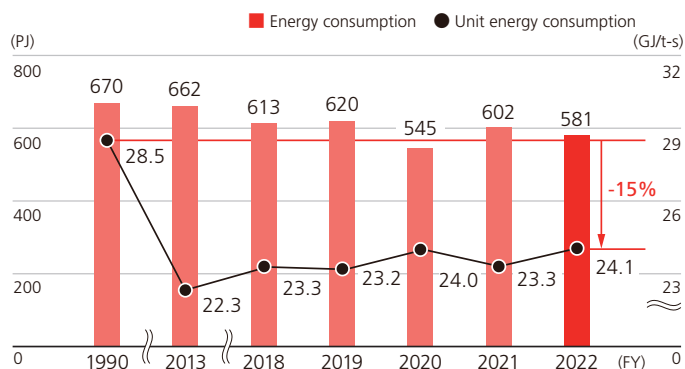
### Energy Consumption and CO<sub>2</sub> Emissions in FY2022

#### ■ Production of Crude Steel of JFE Steel



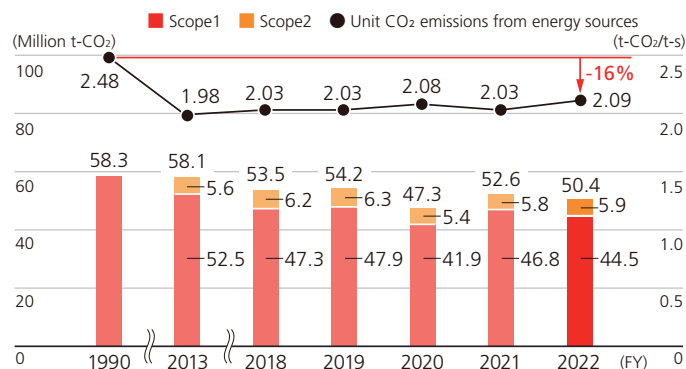
Note: FY2013 figure includes data for the Sendai Works of JFE Bars & Shapes Corporation.

#### ■ Energy Consumption and Unit Energy Consumption of JFE Steel



Note: FY2013 figure includes data for the Sendai Works of JFE Bars & Shapes Corporation.

### CO<sub>2</sub> Emissions from Energy Sources and Unit CO<sub>2</sub> Emissions of JFE Steel



Notes:

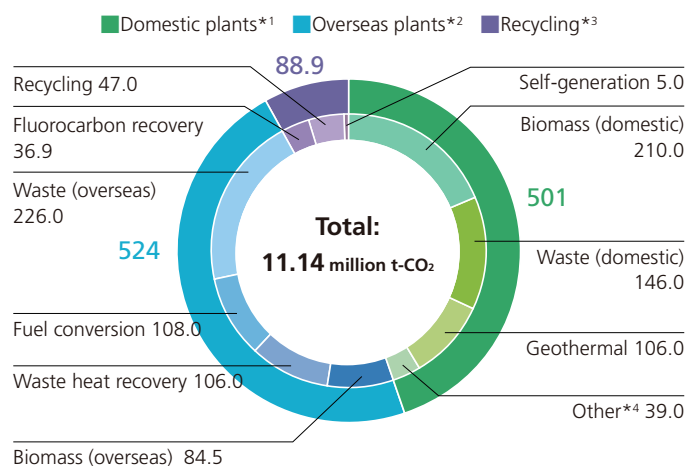
- The CO<sub>2</sub> emissions and emission intensity in FY2022 are calculated using the CO<sub>2</sub> emission factor for electricity purchased in FY2021, adopted by the Japan Iron and Steel Federation’s Commitment to a Low Carbon Society.
- FY2021 data was revised by applying the CO<sub>2</sub> emission factor for electricity purchased in FY2021, as adopted by the Japan Iron and Steel Federation’s Commitment to a Low Carbon Society.
- FY2013 figure includes data for JFE Bars & Shapes Corporation’s Sendai Works.

### JFE Engineering

JFE Engineering contributes to CO<sub>2</sub> emissions reductions in society as a whole through its business operations, such as by expanding renewable energy generation and constructing and operating plastic and food recycling plants. In FY2022, the Company contributed to reducing 11.14 million tonnes of CO<sub>2</sub> emissions (a 5% increase compared to FY2021) across society. JFE Engineering will further expand its business and contribute to CO<sub>2</sub> emissions reductions of 12 million tonnes in FY2024 and 25 million tonnes in FY2030.

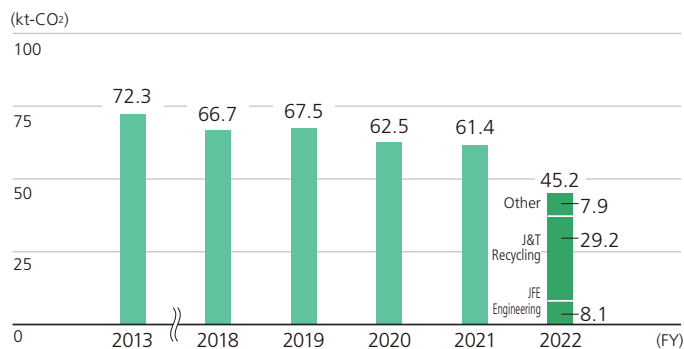
In addition, since FY2021 we have been implementing such initiatives as subscribing to on-site solar power PPA and zero-emission electricity plans at the Yokohama office and a low-emission electricity plan at the Tsu Works. As a result, in FY2022 we have achieved a 50% reduction in CO<sub>2</sub> emissions, compared to FY2013. We have also been working on reducing waste and implementing energy-saving activities at our steelworks and in our offices. The Company will steadfastly conduct business in ways that save resources and are environmentally sound, including expanding the use of renewable energy.

### JFE Engineering’s Contribution to CO<sub>2</sub> Emissions Reductions (FY2022)



- \*1 Data cover JFE Engineering.
- \*2 Data cover JFE Engineering and Standardkessel Baumgarte GmbH (SBG), a German subsidiary of JFE Engineering Corporation.
- \*3 Data cover J&T Recycling Corporation and JFE Urban Recycle Corporation.
- \*4 Other includes solar, wind, digestion gas, sludge incineration, PPA, and energy service

### JFE Engineering Group's CO<sub>2</sub> Emissions from Energy Sources



Notes:

- Data cover JFE Engineering and 13 major domestic and overseas subsidiaries.
- FY2021 figure includes data for an expanded list of JFE Engineering major subsidiaries.

### JFE Shoji

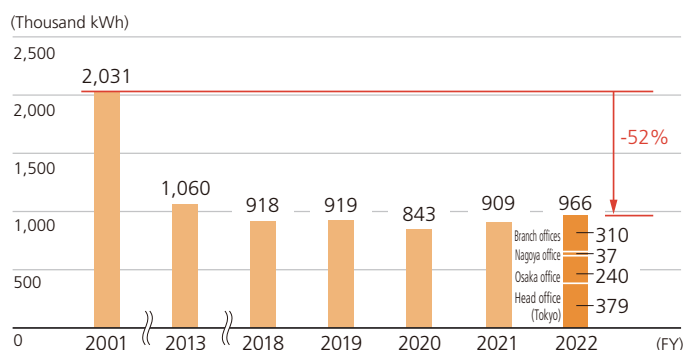
Under the environmental strategies formulated in 2001, JFE Shoji is continuously implementing initiatives to reduce paper and electricity consumption and strictly manage waste separation as part of its energy reduction efforts.

In terms of reducing paper consumption, the company continues to use recycled paper to conserve natural resources, and we also ensure that documents are printed in black and white using both sides of the paper. We are also strongly promoting paperless meetings through the use of large monitors and web conferencing systems. Consequently, the amount of paper used per employee is on a downward trend. As for electricity consumption, JFE Shoji is reducing its environmental impact by introducing motion-sensor lighting and energy-saving equipment through office renovations, implementing leave-on-time days, improving operational efficiencies through robotic process automation (RPA), and other measures.

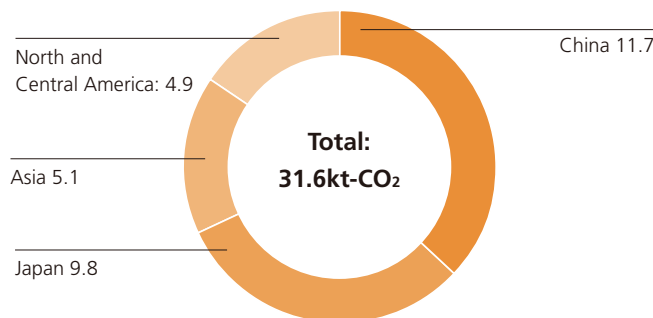
In addition, the company has established a new goal in the domestic operating companies to reduce CO<sub>2</sub> emissions by installing solar panels and purchasing electricity derived from renewable energy sources. In February 2023, we completed a project at JFE Shoji Coil Center Corporation in Shizuoka that achieved virtually zero CO<sub>2</sub> emissions in steel processing, the first time\* this has been achieved in the steel distribution industry. As a result of this and other ongoing efforts to reduce the amount of electricity consumed, CO<sub>2</sub> emissions in FY2022 in the domestic operating companies were reduced by 11.2%, compared to FY2019.

\*According to our research

### Electric Power Consumption by JFE Shoji



■ CO<sub>2</sub> Emissions of the JFE Shoji Group (FY2022)



Notes: Data cover CO<sub>2</sub> emissions from electricity use by JFE Shoji and 35 major domestic and overseas subsidiaries (steel-processing companies).

### Endorsing and Participating in External Initiatives

The JFE Group expresses its views and opinions on various public policies and external initiatives related to climate change and environmental conservation through Keidanren (Japan Business Federation) and the Japan Iron and Steel Federation (JISF), and it proactively participates in these activities.

The Group also endorses the Challenge Zero declaration and will rise to the challenge in pursuit of innovation. Challenge Zero (Innovation Challenges Towards a Net Zero Carbon Society) is a new joint initiative by Keidanren and the Japanese government for proactively publicizing and supporting companies and organizations that pursue innovative actions to realize a decarbonized society, which is the long-term goal of the Paris Agreement.

The Japan Iron and Steel Federation (JISF) is actively working toward achieving its Carbon Neutrality Action Plan (formerly the Commitment to a Low Carbon Society), with the target year of FY2030. In November 2018, the JISF also formulated and published the Long-term Vision for Climate Change Mitigation for 2030 and beyond, which represents the industry's challenge for realizing zero-carbon steel. In February 2021, the JISF announced the "Basic Policy of the Japan steel industry on 2050 Carbon Neutrality aimed by the Japanese government," declaring that the Japanese iron and steel industry will boldly take on the challenge of realizing zero-carbon steel. As a member of the JISF, JFE Steel will be an active participant in these medium- and long-term climate change initiatives. In addition, the Ministry of Economy, Trade, and Industry (METI) has announced its intention to establish the GX League, a forum that invites companies to work on GX; take up the challenge of GX in cooperation with the government, academic, and economic sectors; discuss how to transform the overall economic and social system; and drive the creation of new markets. The Group participates in the GX League because it believes that its goal is aligned with the JFE Group's overall objective for climate change initiatives. JFE Steel is also participating in activities outside of Japan such as the Japan India Public and Private Collaborative Meeting, Japan-ASEAN Steel Initiative, and Japan-China Steel Industries Exchange. Furthermore, it is a member of the World Steel Association (WSA)'s Climate Action data collection program, which uses ISO 14404 as the standard for measurement and calculation.

JFE Engineering is a member of the Japan Climate Leaders' Partnership (JCLP). Established in 2009, the JCLP is a coalition of Japanese corporations that encourage the industrial community to fully recognize the urgency of climate change and take more decisive action to create a sustainable, decarbonized society. Companies fulfill their corporate responsibility by demonstrating leadership in the transition to a decarbonized society. The Company is participating in the Decarbonization Consortium, JCLP's platform for encouraging information sharing and collaboration between companies and is actively engaged in creating opportunities to learn from companies at the frontline of decarbonization efforts, and collaborating with other companies to create new solutions. Furthermore, with the GX League, established and promoted by METI, becoming fully operational in April 2023, JFE Engineering has decided to officially participate in the league starting in FY2023. Through the league, we will promote co-creation with various stakeholders and contribute to the realization of carbon neutrality and the transformation of economic and social systems.

In 2021, JFE Shoji became a signatory to the United Nations Global Compact, affirming its support for these principles. JFE Shoji will comply with the Ten Principles of the Global Compact and endeavor to achieve the SDGs. In addition, we are also

a member of the Global Compact Network Japan, the local network of the Global Compact. In FY2022, we participated in subcommittees on supply chains, human rights due diligence, human rights education, and other topics, learning about global trends and exchanging information between companies for connecting to our own SDG promotion efforts.

For more details, refer to the following.

▶ [Steel Industry Initiatives](#) (P.104)

Initiatives by industry groups

▶ [The Japan Iron and Steel Federation: Climate Change Policy](https://www.jisf.or.jp/en/activity/climate/index.html) (https://www.jisf.or.jp/en/activity/climate/index.html)

▶ [The Japan Iron and Steel Federation: Challenges towards Carbon Neutrality](https://www.carbon-neutral-steel.com/en/)  
(https://www.carbon-neutral-steel.com/en/)

▶ [Keidanren \(Japan Business Federation\): Challenge Zero](https://www.challenge-zero.jp/en/) (https://www.challenge-zero.jp/en/)

▶ [The Ministry of Economy, Trade, and Industry: GX League \(Japanese only\)](https://gx-league.go.jp/) (https://gx-league.go.jp/)

▶ [WSA: Climate Action data collection programme](https://worldsteel.org/climate-action/climate-action-data-collection/data-providers/)  
(https://worldsteel.org/climate-action/climate-action-data-collection/data-providers/)

▶ [Japan Climate Leaders' Partnership \(JCLP\)](https://japan-clp.jp/en) (https://japan-clp.jp/en)

▶ [United Nations Global Compact](https://www.unglobalcompact.org/) (https://www.unglobalcompact.org/)

▶ [Global Compact Network Japan \(Japanese only\)](https://www.ungcjin.org/) (https://www.ungcjin.org/)

## Scenario Analysis in Line with the TCFD Recommendations

### Initiatives

The JFE Group intends to achieve carbon neutrality by 2050, and it leverages the scenario analysis in line with the TCFD recommendations **to identify and assess climate change-related risks and opportunities and to strengthen the resilience of its organizational strategy**. Please refer to the “Climate Change” page for governance, strategy, risk management, metrics, and targets for climate change-related issues in line with the TCFD recommendations.

► [Climate Change](#) (P.53)

### Milestones Related to Climate Change around JFE’s Business and JFE’s Initiatives

1997	Kyoto Protocol adopted at COP3 in Kyoto
2008	JISF’s Voluntary Action Plan launched
2013	JISF’s Commitment to a Low Carbon Society launched
2015	Paris Agreement adopted at COP21
2017	TCFD published the final report of its recommendations
2018	JISF announced the Long-term Vision for Climate Change Mitigation, Zero Carbon Steel
2019	<b><u>JFE Group announced its endorsement for the final report of the TCFD recommendations</u></b> <b><u>JFE Group published a scenario analysis in line with the TCFD recommendations</u></b>
2020	Keidanren launched the Challenge Zero initiative Ministry of Economy, Trade and Industry published a list entitled Companies Taking on the Zero-Emission Challenge <b><u>JFE Group published its targets in its medium- to long-term vision (target for 2030 and achieving carbon neutrality by 2050)</u></b>
	Prime Minister Suga declared Japan will achieve carbon neutrality by 2050
2021	JISF announced the Basic Policy of the Japan Steel Industry on 2050 Carbon Neutrality Aimed by the Japanese Government <b><u>JFE Group published its roadmap for achieving carbon neutrality in 2050 in the JFE Group Environmental Vision for 2050</u></b>
	Japanese government formulated the Green Growth Strategy Through Achieving Carbon Neutrality in 2050
2022	<b><u>JFE Group announced that the CO<sub>2</sub> emissions reduction target for FY2030 for JFE Steel has been revised upward to 30% or more compared to FY2013</u></b> JISF published the “Evaluation of the Phase I Target (FY2020 Target)” and Phase II (FY2030 target) of reducing the total volume of energy-related CO <sub>2</sub> emissions by 30% in its “Activities to Combat Global Warming—Report of JISF’s Carbon Neutrality Action Plan (Commitment to a Low Carbon Society) (March 2022).”
2023	The Act Concerning the Promotion of a Smooth Transition to a Decarbonized Economic Structure (the “GX Promotion Act”) was enacted.

The Challenge Zero (Innovation Challenges Toward a Net Zero Carbon Society) is a new joint initiative by Keidanren (Japan Business Federation) and the Japanese government for proactively publicizing and supporting companies and organizations that pursue innovative actions toward realizing a decarbonized society as the long-term goal of the Paris Agreement. The JFE Group endorses the Challenge Zero declaration and will rise to the challenge of pursuing innovation. The Ministry of Economy, Trade and Industry (METI), in collaboration with Keidanren and the New Energy and Industrial Technology Development Organization (NEDO), has been tackling a project called the Zero-Emission Challenge. The project is preparing a list of companies generating innovation toward realizing a decarbonized society and providing investors and other stakeholders with useful information on them. At the TCFD Summit 2021 on October 5, 2021, approximately 600 companies, both listed and unlisted, were announced as Zero Emissions Challenge Companies. These organizations are boldly accepting the challenge of innovation to realize a decarbonized society, and the JFE Group was selected as one of them.

The JFE Group publishes information on specific initiatives through the following website.

▶ [Challenge Zero](https://www.challenge-zero.jp/en/member/34) (https://www.challenge-zero.jp/en/member/34)

▶ [Zero-Emission Challenge](https://www.meti.go.jp/english/press/2021/1005_002.html) (https://www.meti.go.jp/english/press/2021/1005\_002.html)

## Scenario Analysis

### Tools and Methods

Scenario analysis is used to portray an accurate understanding of climate-related risks and opportunities and assess implications to the current business strategy, thereby enabling an organization to establish strategies that reflect the results of the assessment. As our business could be significantly affected by climate change, we have created both a 2°C scenario and a 4°C scenario. In FY2022, we expanded the scope to also include a 1.5°C scenario.

All three scenarios are based on those developed by the International Energy Agency (IEA). Analysis was conducted under the assumption that uniform carbon pricing is implemented by major emitting countries to increase the feasibility of achieving the 1.5°C target. Under the long-term scenario analysis, our goal is to achieve carbon neutrality by 2050. We conducted risk assessments that take into account the prospect of achieving the 2°C scenario and the necessity of ultra-innovative technology for the 1.5°C scenario (IPCC 1.5°C Special Report) in steelmaking for carbon neutrality by 2050.

Selected Scenario		1.5/2°C Scenario	4°C Scenario
Reference Scenario	Transition Risks	Transition scenarios developed by the IEA · Sustainable Development Scenario (SDS)* <sup>1</sup> · 2°C Scenario (2DS)* <sup>2</sup> · IPCC Special Report on Global Warming of 1.5°C · NZE2050* <sup>3</sup>	Transition scenarios developed by the IEA · New Policies Scenario (NPS)* <sup>1</sup> · Reference Technology Scenario (RTS)* <sup>2</sup>
	Physical Risk	Climate change projection scenario developed by the Intergovernmental Panel on Climate Change (IPCC) · Representative Concentration Pathways (RCP) Scenario* <sup>4</sup>	
How Society will Look		Dynamic policies will be adopted and technical innovations will progress to limit the average temperature rise by the end of this century to 2°C and realize sustainable development. Assume a society in which our business is affected by social changes accompanying transition to a decarbonized society. · Worldwide/industry-wide uniform carbon pricing* <sup>5</sup> · Increase in the ratio of sales of electric vehicles to overall vehicle sales	Despite new policies implemented in each country based on approaches under the Paris Agreement, the average temperature will rise by about 4°C by the end of this century. Assume a society in which our business is affected by temperature rise and other climate change. · Increase in the occurrence of flooding · Sea level rise

\*1 Source: IEA's World Energy Outlook 2018

\*2 Source: IEA's Energy Technology Perspectives 2017

\*3 Source: IEA's Net Zero by 2050—A Roadmap for the Global Energy Sector

\*4 Source: IPCC Fifth Assessment Report

\*5 When carbon pricing differs from country to country, a gap opens in international competitiveness between countries that impose strict CO<sub>2</sub> emissions regulations and those with less strict regulations. This will result in carbon leakage where CO<sub>2</sub> emissions of a strict climate policy country are reduced as production and investment decline while production and investment increase in other countries with laxer emission constraints, thereby increasing their nations' CO<sub>2</sub> emissions. One reference scenario, SDS, assumes the implementation of carbon pricing in developed countries and some developing countries. We took this into account in formulating the 2°C scenario based on the assumption that uniform carbon pricing is introduced to major emitting countries to push toward achieving the 2°C scenario target.

## Scope of Business and Period for Analysis

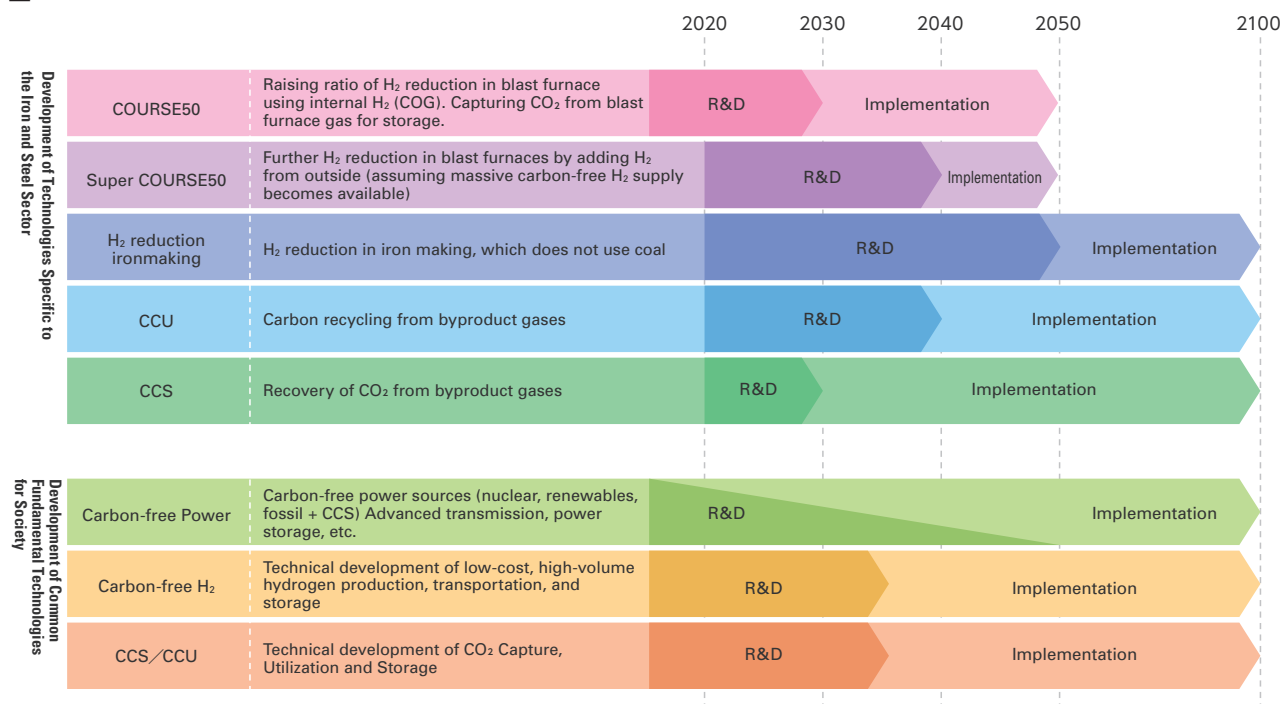
This analysis covers the following businesses: the steel business by JFE Steel, the engineering business by JFE Engineering, the trading business by JFE Shoji, and businesses carried out by some of the other Group companies. The period covered is up to 2050.

## Relevance with the JISF’s Long-term Vision for Climate Change Mitigation

The Japan Iron and Steel Federation (JISF) has been working toward its Commitment to a Low Carbon Society, and Phase I of this initiative ended in FY2020. From FY2021, the effort was rebranded as the Carbon Neutrality Action Plan, and the Phase II target (FY2030 target) was revised. In November 2018, the JISF also formulated and published the Long-term Vision for Climate Change Mitigation for 2030 and beyond. JFE Steel played a central role in the formulation of this long-term vision. The vision represents the industry’s challenge toward realizing zero-carbon steel and lays out the prospect of achieving the 2°C scenario for steelmaking and necessity of ultra-innovative technologies to achieve the 1.5°C scenario. Furthermore, on February 15, 2021, the JISF announced the “Basic Policy of the Japan Steel Industry on 2050 Carbon Neutrality Aimed by the Japanese Government,” which declares that the Japanese iron and steel industry will boldly accept the challenge of realizing zero-carbon steel.

The JFE Group’s scenario analysis is intended to ensure resiliency in our Group’s business strategy during the intermediate stages of these long-term challenges.

### Efforts to Achieve Zero Carbon Steel



► [JIFS: Challenges towards Carbon Neutrality](https://www.carbon-neutral-steel.com/en/) (https://www.carbon-neutral-steel.com/en/)



## Process to Identify Key Factors that Impact the Business

STEP 1: Examine the entire value chain from a holistic perspective and sort out factors that impact the businesses under analysis (for more information on risks and opportunities in the value chain, refer to:

► [JFE Group Value Chain](#) (P. 30)

STEP 2: Examine all factors at an overview level and identify key factors by taking into account the level of impact and stakeholder expectations and concerns

	1.5/2°C Scenario	4°C Scenario
Impact on Procurement		5. Unstable raw materials procurement due to increased occurrence of climatic hazards
Impact on Direct Operation	1. Decarbonization of iron and steelmaking process 2. Increased needs for effective utilization of steel scrap	6. Damage to production bases and offices caused by climatic hazards
Impact on Product and Service Demand	3. Change in demand for automotive steel, etc. 4. Increase in demand for solutions to enhance decarbonization	7. National resilience

Level of Impact



Expectations and concerns of stakeholders



Axis for identifying key factors

Axis for identifying key factors:

- Level of impact (possibility of risks and opportunities arising × Level of impact if manifested)
- Expectations and concerns of stakeholders

## Results of Scenario Analysis

Climate change is a critical concern from the perspective of business continuity for JFE Group management. Our steel business, which emits 99.9% of the Group's total CO<sub>2</sub> emissions, has been developing technologies for saving energy and reducing CO<sub>2</sub> emissions. We have actively addressed the risks by applying these technologies to steel manufacturing. We will continue to develop processes to further reduce environmental impact while at the same time seeking to turn this challenge into an opportunity for addressing climate change by deploying the technologies we have fostered across the globe.

The JFE Group has developed and maintained a variety of eco-friendly products and technologies, including high-performance steel materials that help save energy when customers use them, as well as renewable energy power generation. We view the current challenges as an opportunity and are contributing to addressing climate change. As automobiles in general become lighter in weight along with the broader adoption of electric vehicles, we will support the transition by improving the functions of the JFE Group's high tensile strength steel sheets and electrical steel sheets. In addition, we will help reduce CO<sub>2</sub> emissions in society by further disseminating renewable energies and implementing recycling initiatives as well as energy conservation.

To achieve the long-term goal of the Paris Agreement of keeping the global average temperature increase well below 2°C compared to pre-industrial levels and to strive to limit it more strictly to 1.5°C, the Group will continue to develop and disseminate innovative technologies and contribute to the prevention of global warming. We will also support national resilience by providing steel for social infrastructure and construction to address the emerging risks associated with the growing severity of meteorological disasters.

## Analysis Results

	Changes in Society and Response		Stakeholder Expectations and Concerns for the JFE Group	Results of Assessment
<b>1.5/2°C Scenario</b> <b>Key Factor ①</b> Decarbonization of Iron and Steelmaking Process	Increasing social demand for decarbonized iron and steelmaking process	Implement innovative technology to realize decarbonation at a large scale	<ul style="list-style-type: none"> <li>Significantly contribute through innovative technologies</li> <li>Increase in investment to implement innovative technologies</li> <li>Increase in operating costs due to the introduction of carbon pricing</li> </ul>	<b>Opportunity</b> ↗ Develop and put into practical use innovative technologies in addition to existing ones
		Introduction of carbon pricing		<b>Risk</b> → Investment into implementing innovative technologies is feasible ↘ Need to accelerate R&D and implementation under 1.5°C scenario → The Group's cost competitiveness will remain the same if uniform carbon pricing is implemented across all countries. ↘ Operating cost increases (if carbon pricing is not properly introduced)
<b>1.5/2°C Scenario</b> <b>Key Factor ②</b> Increased Needs for Effective Utilization of Steel Scrap	Increasing interest for electric arc furnace method for its lower CO <sub>2</sub> emissions	Increasing expectations for electric arc furnace steel Increasing volume of scraps generated	<ul style="list-style-type: none"> <li>Electric arc furnace as an alternative to converter furnace</li> <li>Expanding electric arc furnace steelmaking within the JFE Group</li> </ul>	<b>Opportunity</b> ↗ Converter furnace steelmaking is increasing due to constraint on the supply of scrap ↗ Expansion in electric arc furnace steelmaking and electric arc furnace engineering ↗ Expansion in scrap logistics business
<b>1.5/2°C Scenario</b> <b>Key Factor ③</b> Change in Demand for Automotive Steel	Shift in demand for automobiles	Increasing demand for EV motors	<ul style="list-style-type: none"> <li>Increase in demand for electrical steel sheets for EV motors</li> <li>Decrease in demand for special steel due to decreased demand for internal-combustion engines</li> <li>Alternative steel material for automobiles to meet the trend of using multimaterials</li> <li>Demand to improve decarbonization and recyclability of steel</li> </ul>	<b>Opportunity</b> ↗ Increase in demand for electrical steel sheets due to rising popularity of electric vehicles ↗ Increase in demand for special steel due to higher car sales ↗ Increase in demand for high tensile strength automotive steel sheets ↗ Recyclability of steel regains attention ↗ Increase in demand for low-CO <sub>2</sub> steel products
		Decreasing demand for internal-combustion engines Cars are lighter in weight and use multimaterials		Demand for decarbonization and high recyclability
<b>1.5/2°C Scenario</b> <b>Key Factor ④</b> Increase in Demand for Solutions to Enhance Decarbonization	Transition to decarbonized society	Increasing demand for solutions to promote the transition Overseas expansion of energy-saving technologies	<ul style="list-style-type: none"> <li>Renewable energy power generation plant</li> <li>Promote low-carbon business, or eco solutions, in developing countries using best available technologies (BAT) developed and put into practical use in Japan</li> </ul>	<b>Opportunity</b> ↗ Entire construction and operation of renewable energy plants (biomass, geothermal, and solar power generation) ↗ Entire construction and operation of incinerators and plastic recycling plants ↗ Entire construction of CCU/CCS facilities ↗ Overseas expansion of low-carbon business
<b>4°C Scenario</b> <b>Key Factor ⑤</b> Unstable Raw Materials Procurement due to Increased Occurrence of Climatic Hazards	Increasingly devastating climate hazards caused by temperature rise	Raw materials procurement becomes unstable	<ul style="list-style-type: none"> <li>Raw material procurement becomes unstable</li> </ul>	<b>Risk</b> → Ongoing specific measures: Diversify supply sources, strengthen capabilities of facilities
<b>4°C Scenario</b> <b>Key Factor ⑥</b> Damage to Production Bases and Offices Caused by Climatic Hazards	Increasingly devastating climate hazards caused by temperature rise		<ul style="list-style-type: none"> <li>Increase in damage caused by typhoons and heavy rain</li> <li>Increase in damage caused by drought</li> <li>Flooding caused by sea level rise</li> </ul>	<b>Risk</b> → Measures against flood and drought are already in progress → Impact of flooding caused by sea level rise can be addressed with current countermeasures
<b>4°C Scenario</b> <b>Key Factor ⑦</b> National Resilience	Increasingly devastating climate hazards caused by temperature rise	Increasing the importance of enhancing infrastructure Increasing demand for disaster mitigation products	<ul style="list-style-type: none"> <li>Contribute to reinforcing infrastructure with steel and other relevant products</li> </ul>	<b>Opportunity</b> ↗ Reinforce infrastructure with steel and other relevant products

## Overview of a Scenario Analysis Assessment

Timeframe: **short term (2024)** ⇒until 2024, **medium term (2030)** ⇒until 2030, **long term (2050)** ⇒until 2050 (final)

### FOCUS Key Factor (1) Decarbonization of Iron and Steelmaking Process

We are developing innovative technologies to emerge as the pioneer in realizing a decarbonized society. With a strong financial base to meet investments for implementing innovative technologies, we are significantly contributing to the transition to a decarbonized society.

**Short term (2024)**

**Medium term (2030)**

JFE Steel has been committed to developing energy-saving technologies toward increasing the efficiency of the iron and steelmaking process and decarbonization. These initiatives have helped JFE Steel acquire technologies that realize the world's top energy efficiency in iron and steelmaking. To further push ahead with decarbonization, the Company will enhance the development of innovative ironmaking processes such as COURSE50 and ferro-coke, which are expected to reduce the carbon footprint through hydrogen reduction and CCS.

We anticipate that achieving the CO<sub>2</sub> reduction target for FY2030 may require investments and loans of around one trillion yen, and approximately 110 billion yen has been approved by FY2022. We intend to steadily advance toward obtaining the necessary investments and loans to achieve the reduction target.

**Short term (2024)**

**Medium term (2030)**

**Long term (2050)**

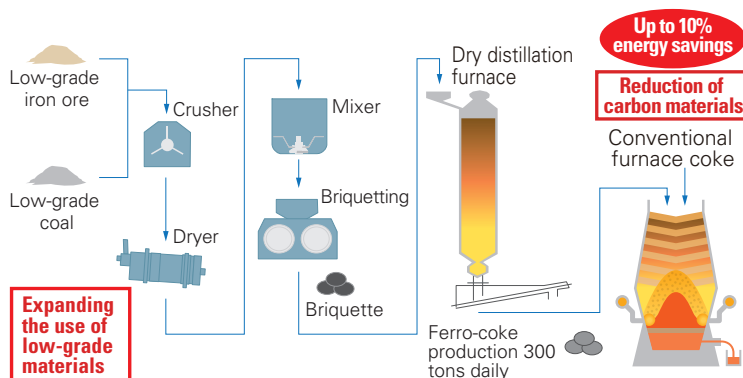
COURSE50 applies hydrogen reduction technology and CCS to reduce CO<sub>2</sub> emissions by about 10% and 20%, respectively, through each technology, for a total reduction of about 30%. The first facility is expected to come online by 2030, followed by the implementation of other plants by 2050, corresponding with the timing for upgrading blast furnace facilities. Ferro-coke is a technology for significantly reducing CO<sub>2</sub> emissions by improving the reduction rate of iron ore put into blast furnaces. In addition to these technologies, we will push forward to establish a hydrogen reduction ironmaking technology which we will aim to put it into practice after 2030 in order to realize the ultimate goal of creating zero-carbon steel.

We consider implementing innovative technologies as critical and will advance with this strategy together with the government. Furthermore, we have a sufficient financial base to meet necessary investments.

For the six-year period from FY2017 to FY2022, JFE Steel worked on the New Energy and Industrial Technology Development Organization (NEDO) project: "Development of Environmental Technology for Steelmaking Process/ Development of Ferro-Coke-Utilization Process Technologies." In the project's final year, we conducted tests to assess the effect of using ferro-coke produced in a medium-scale facility in a blast furnace at the West Japan Works in Fukuyama and confirmed that it lowered the reducing agent rate. The ultimate goal of this technology is to reduce energy consumption in the ironmaking process by approximately 10%. In the future, we will work on identifying issues and researching the operating conditions for achieving this goal by using the mass/energy balance model we have developed for the model steelworks and the general-purpose high-functional blast furnace simulator\* that reflects the above test results.

\*Developed by Nippon Steel Corporation during the project

#### Example of Developing an Innovative Technology: Ferro-Coke Production Process



**Long term (2050)**

In the long term, we will develop carbon-recycling blast furnaces (CR blast furnaces), hydrogen steelmaking, and electric arc furnaces while striving to achieve carbon neutrality by 2050, as stated in the JFE Group Environmental Vision for 2050. In particular, we have been focusing on a technology that combines a CR blast furnace with CCU. This is an ultra-innovative technology that targets net zero CO<sub>2</sub> emissions by drastically reducing CO<sub>2</sub> emissions from the blast furnace process, maximizing its ability to efficiently produce high-grade steel in mass volume, and enabling CO<sub>2</sub> reuse in the blast furnace. The remaining CO<sub>2</sub> that cannot be fully reused in the furnace will be further reduced by manufacturing basic chemicals such as methanol.

**Long term (2050)**

International expectations have been rising for organizations to seek pathways for achieving the 1.5°C scenario. We believe the necessary actions are not significantly different from the 2°C scenario. In the 1.5°C scenario, however, the development and implementation of decarbonizing technologies would need to further accelerate, requiring significantly more R&D costs and capital investment. A public infrastructure capable of supplying cheap and ample green hydrogen and electricity would also need to be in place. We believe that addressing these issues will require more support from the government and collaboration across society, including a mechanism for broadly sharing the financial burden and a long-term government strategy for supplying green hydrogen and electricity. The JFE Group has been actively advancing decarbonization initiatives, including commissioning NEDO's Green Innovation Fund project\*<sup>1</sup>, issuing transition bonds\*<sup>2</sup>, and participating in the GX League\*<sup>3</sup>.

▶ **\*1 NEDO's Green Innovation Fund project (Japanese only)** (<https://www.jfe-steel.co.jp/release/2022/01/220107.html>)

▶ **\*2 Issue Transition Bonds** (<https://www.jfe-holdings.co.jp/en/release/2022/01/220120.html>)

▶ **\*3 GX League (Japanese only)** (<https://gx-league.go.jp/>), **GX League members (Japanese only)** (<https://gx-league.go.jp/member/>)

## The Group's cost competitiveness will remain the same if uniform carbon pricing is implemented across all countries.

**Short term (2024)****Medium term (2030)**

Various approaches to carbon pricing have been introduced around the world, and in Japan, emissions trading and the introduction of growth-oriented carbon pricing are being discussed in line with the GX Promotion Law for achieving carbon neutrality by 2050. In Europe, a border adjustment tax is also being discussed.

If uniform carbon pricing is introduced to major emitting countries, the increase in operating cost will be reflected reasonably on the price of steel products both in Japan and overseas, thus maintaining the Company's cost competitiveness. In addition, since CO<sub>2</sub> emissions per unit of steel production is the lowest of all competing materials, steel retains its superior position in cost competitiveness.

On the other hand, the introduction of carbon pricing in a manner that is biased toward certain regions, industries, or countries such as Japan would have a major impact on the JFE Group and particularly on its steel business, as this would further increase the current price of electricity, which is already higher in Japan than in other countries. It may cause the Company to lose its cost competitiveness and may even inhibit innovation and hinder the realization of carbon neutrality. As carbon pricing is introduced, we will need to closely monitor emerging trends to confirm that it will truly contribute to growth.

## FOCUS Key Factor (2) Increased Need for Effective Utilization of Steel Scrap

To achieve carbon neutrality, we are focusing on high-grade steel manufacturing and raising efficiency by applying our industry-leading electric arc furnace technology. Furthermore, we will open up opportunities for the entire JFE Group by expanding the use of our electric arc furnaces, increasing the use of our electric arc furnace construction technology, and expanding scrap logistics.

Short term (2024)

Medium term (2030)

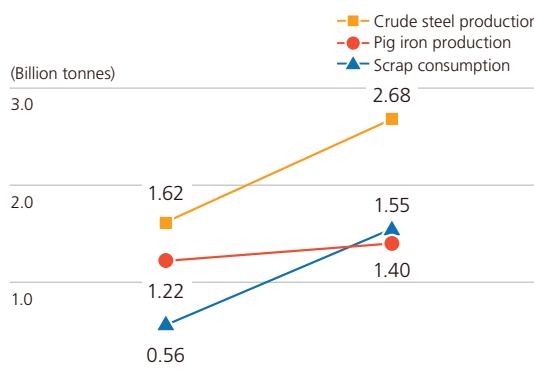
Long term (2050)

The JISF predicts that the demand for crude steel will continue rise along with growth of the global population and economic development and that both the blast furnace and electric arc furnace methods will emerge as major, indispensable steelmaking processes (JISF's Long-term Vision for Climate Change Mitigation). To achieve carbon neutrality, we need to expand the production of steel products using the electric arc furnace method, which emits less CO<sub>2</sub>. For this to happen, we need to explore technologies that improve the productivity of electric arc furnaces and address the constraints in producing high-grade steel products. Additional technologies are required for increasing the volume of scrap used in converter furnaces.

The JFE Group is viewing increased demand for electric arc furnace steel as well as the worldwide increase in the amount of scrap generated as an opportunity, and it will enhance its electric arc furnace steel production while applying its engineering technology for constructing an entirely cutting-edge, energy-saving electric arc furnace facility with the ultimate goal of opening up additional business opportunities. In regard to expanding the use of electric arc furnaces, we have decided to strengthen the electric furnace at the Sendai Works and introduce an electric furnace in the stainless steel manufacturing process in the Chiba district (total investment: approx. 15 billion yen). We are also considering the introduction of a high-efficiency, large-scale electric furnace in the Kurashiki district. Moreover, the Group will advance the development of technologies to utilize scrap and boost industry-wide use of this material.

Meanwhile, securing a stable supply of scrap needed for steel production using electric arc furnaces is another vital issue we must address. Expanding the use of scrap will also generate greater demand for distribution options, which will in turn provide an opportunity for JFE Shoji to expand its logistics business.

### ■ Estimated Supply and Demand for Steel Production and Scrap Use



## FOCUS Key Factor (3) Change in Demand for Automotive Steel

The shift to EVs is accelerating as new and stricter environmental regulations are being introduced globally at a faster pace. Demand for electrical steel sheets for EV motors as well as special steel is increasing as global car sales rise. The increase in the intensity of high tensile strength automotive steel sheets contributes to further weight reductions.

Short term (2024)

Medium term (2030)

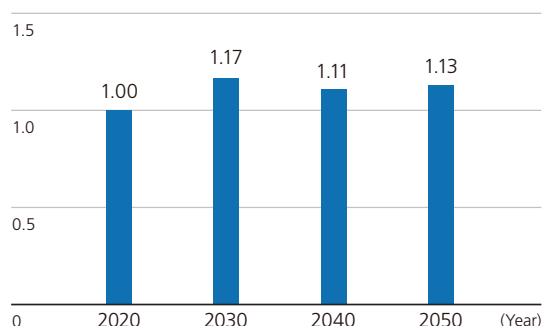
Long term (2050)

The increasing popularity of electric vehicles (EVs) has given rise to rapidly expanding demand for electrical steel sheets used in EV motors. JFE Steel has already commercialized the JNE series of non-oriented electrical steel sheets for automotive applications, as part of its eco-product lineup, and has gained a major market share. In the Kurashiki district, we have decided to triple the production capacity of high-grade, non-oriented electrical steel sheets for EV main motors, compared to the current capacity (total investment: approx. 95 billion yen).

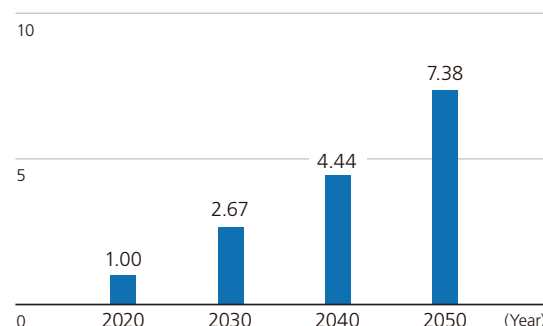
On the other hand, it has been pointed out that an increase in EVs may lead to a decline in the amount of special steel used in engine components. The amount of this type of steel, used in hybrid vehicles and electric vehicles, is 80% and 60% of gasoline cars, respectively. We believe that the risk level for this matter, however, is low since car sales are expected to increase even under the 1.5°C/2°C scenarios and total demand for special steel for cars is increasing.

Nonetheless, the situation for EV remains the same in terms of strong demand for lighter-weight body structures. JFE Steel has developed a cold-rolled steel sheet boasting 1.5 GPa-grade tensile strength as an eco-product and has put it into practical use as an automotive steel sheet. With its high strength, the product can significantly reduce the weight of a car frame. In response to customer demand for more environmentally sound options, we intend to expand its application and further increase its strength, thus dramatically reducing CO2 emissions from cars in motion.

■ Estimated World Demand for Automotive Special Steel



■ Estimated World Demand for Automotive Electrical Steel Sheets



Vertical axis: Steel demand (comparison by year with the year 2020 as 1.00)

Source: Estimated by JFE Holdings based on the reports from METI's Strategic Commission for the New Era of Automobiles

## Steel demand will increase due to renewed interest in its highly recyclable quality, essential for decarbonization.

Short term (2024)

Medium term (2030)

Long term (2050)

Steel is a highly recyclable material that can be reborn as many different products over and over again with no loss in its intrinsic quality. In the future, public resource recycling is expected to increase toward establishing a decarbonized society. We believe that the high recyclability of steel will gain attention once again in light of this transition.

## Managing emissions throughout the supply chain (Scope 3) has attracted increasing attention, and this will increase demand for low-CO<sub>2</sub> emission steel products.

Short term (2024)

Medium term (2030)

Long term (2050)

The rising worldwide support for decarbonization is expected to drive greater demand for low-CO<sub>2</sub> emission steel products, such as in the automobile industry, where CO<sub>2</sub> emissions must be managed throughout the supply chain. In the IEA's Net Zero Emissions by 2050 Scenario (NZE), the share of steel production using electric arc furnaces is expected to increase to 37% by 2030 and 53% by 2050. Since steel production using electric arc furnaces emits less CO<sub>2</sub> than using blast furnaces, customer demand may shift to products manufactured using the former.

The JFE Group considers the growing demand for low-CO<sub>2</sub> emission steel products as an opportunity. We will therefore actively advance the development of ultra-innovative technologies and, during the transition phase, explore other means for supplying products with low environmental impact. In the first half of FY2023, JFE Steel began supplying JGreeX™, a brand of green steel products that significantly reduce CO<sub>2</sub> emissions in the steel manufacturing process compared to conventional products. At present, it is difficult to immediately supply green steel products with significantly lower or zero emissions, so the reductions created by our technologies are allocated to specific steel products by applying the mass balance method and then supplied as green steel products. Reduction of CO<sub>2</sub> throughout the supply chain is rapidly progressing and JFE Steel will contribute to the decarbonization of society by expanding its capacity for supplying JGreeX™ and further reducing CO<sub>2</sub> emissions through the use of advanced low-carbon technologies as well as energy-saving, high-efficiency technologies.

## Effect of trend to use multi-materials is limited.

Short term (2024)

Medium term (2030)

Long term (2050)

Aluminum and carbon fiber reinforced plastic are potential alternative materials for reducing the weight of cars. It has been pointed out, however, that the production cost of these materials and the amount of CO<sub>2</sub> emitted throughout their life cycles is higher than those of steel. Therefore, under the 2°C scenario, which assumes the introduction of a carbon pricing whereby the price differential between steel and alternative materials will be larger. Under this scenario, while the trend of using multi-materials may show some progress for luxury cars, their use would be limited for economy cars. Moreover, considering a situation in which all panels used for doors and other parts of a luxury car were changed to aluminum, the effect on weight reduction could be expected to be 5% of all materials used in luxury and economy cars together.

Multiplied by the number of cars produced, the impact over the total demand for automotive steel can be assumed to be limited.

In the meantime, JFE Steel has developed a multi-material structure that uses a small amount of fiber resin to maximize steel quality. In this new structure, a highly ductile, strong adhesive resin is sandwiched between a body part made of an ultra-high strength steel plate and a part made of a thin steel plate. This structure is capable of further reducing the weight of automobile frame parts and also improving collision safety performance.

We will continue developing and proposing various products and technologies that meet customer needs.

## FOCUS Key Factor (4) Increase in Demand for Solutions to Enhance Decarbonization

### Providing solutions: renewable energy power generation, Multisite Energy Total Service, recycling business, carbon-recycling technologies, and energy-saving steel technologies

#### Renewable Energy Power Generation

Short term (2024)

Medium term (2030)

Long term (2050)

Demand for power generation plants using non-carbon emitting renewable energies is expected to increase. The JFE Group engages in designing, procuring, constructing, and operating biomass power generation\*<sup>1</sup>, geothermal power generation\*<sup>2</sup>, solar power generation\*<sup>3</sup>, and onshore wind power generation plants in its engineering domain.

We will also focus on offshore wind power generation, which the Japanese government has positioned as one pillar of its Green Growth Strategy to achieve carbon neutrality by 2050. Specifically, we plan to manufacture and market monopiles and other seabed-fixed structures with JFE Engineering as the main driver. JFE Engineering has started constructing Japan's first monopile-foundation manufacturing plant, scheduled to start production in April 2024\*<sup>4</sup>. JFE Steel will contribute by increasing the supply of large and heavy steel plates, and JFE Shoji will assist by establishing SCM, which includes information sharing with Taiwan, a leader in offshore wind power generation, and East and Southeast Asian countries, where demand is expected to expand. We will also focus on O&M\*<sup>5</sup> to fully deploy Group resources.

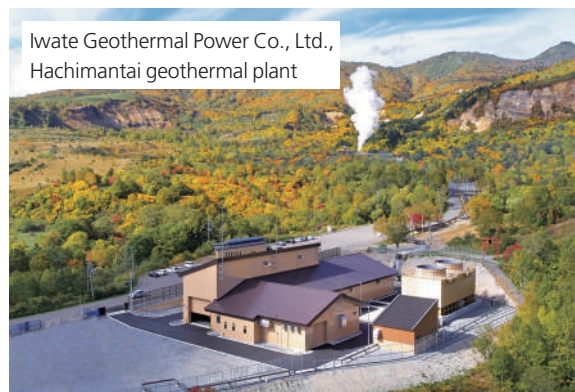
Furthermore, from the perspectives of the effective use and recycling of resources, we are taking action to increase power output at waste processing facilities. JFE Engineering is developing a fully automated operation\*<sup>6</sup> to facilitate higher power output at waste incinerators (introduced to 12 facilities by FY2022, and will be gradually expanded to 16 facilities).

Moreover, we are utilizing renewable energy as the main power source for our retail electricity business\*<sup>7</sup>, and in helping to establish and operate regional electricity retail companies\*<sup>8</sup>, we focus on local production and consumption of electricity based on renewable energy. In FY2020, we helped 8 locations establish and operate their regional electricity companies. In FY2024, we plan to do the same for around 10 locations, and in FY2030, for around 20.

(Contribution to CO<sub>2</sub> reduction resulting from renewable energy power generation: FY2020: 9.65 million tonnes per year → FY2024: 12 million tonnes per year → FY2030: 20 million tonnes per year)



Waste-to-energy power generation plant



Geothermal power generation plant

▶ **\*1 The JFE Engineering Corporation's biomass power generation (Japanese only)** (<https://www.jfe-eng.co.jp/products/power/ele07.html>)

▶ **\*2 The JFE Engineering Corporation's geothermal power generation plant** (<https://www.jfe-eng.co.jp/en/products/power/gene01.html>)

▶ **\*3 The JFE Engineering's solar power generation (Japanese only)** (<https://www.jfe-eng.co.jp/products/power/ele05.html>)

**The JFE Technos Corporation's solar power generation (Japanese only)** (<https://www.jfe-technos.co.jp/products/solar/>)

▶ **\*4 JFE Engineering invests in constructing a new monopile foundation factory** (<https://www.jfe-eng.co.jp/en/news/2021/20210720.html>)

\*5 Operation and maintenance business

▶ **\*6 JFE Engineering's BRA-ING Pre-release (Japanese only)** (<https://www.jfe-eng.co.jp/news/2020/20200727.html>)

▶ **\*7 Urban Energy Corporation's electricity retail business (Japanese only)** (<https://u-energy.jp/service/retail.html>)

▶ **\*8 Urban Energy Corporation's regional electric power support business, targeting local governments (Japanese only)** (<https://u-energy.jp/service/municipality.html>)

**Establishing regional electricity retail companies in partnership with local municipal governments (CSR Report 2022, P. 116)** (<https://www.jfe-holdings.co.jp/en/csr/pdf/csr2022e.pdf>)



### Multisite Energy Total Service

Short term (2024)

Medium term (2030)

Long term (2050)

In addition to the conventional service of optimizing energy use for single sites, JFE Engineering offers the Multisite Energy Total Service (JFE-METS)\*, which optimizes energy use for multiple sites through centralized management. We realize overall energy savings and CO<sub>2</sub> reduction by analyzing energy consumption at multiple sites and achieving total optimization by installing and operating energy-related equipment at each site to circulate energy throughout the network, including remote locations.

▶ [\\*The JFE Engineering Corporation's JFE-METS \(Japanese only\)](https://www.jfe-eng.co.jp/news/2019/PDF/20200130.pdf) (https://www.jfe-eng.co.jp/news/2019/PDF/20200130.pdf)

### Recycling Business

Short term (2024)

Medium term (2030)

Long term (2050)

We are striving to reduce the use of new fossil fuel-derived materials by recycling waste plastic and food waste. In waste plastic recycling, in addition to the conventional recycling of plastic containers and packaging, we are actively engaged in the so-called bottle-to-bottle business, in which used PET bottles are recycled into new ones. We have completed the construction of the PET bottle recycling raw material manufacturing plant (West Japan PET Bottle MR center), and full commercial operation has begun. The plant recycles approximately 10% of the total number of PET bottles shipped nationwide, demonstrating a complete resource recycling model for reducing CO<sub>2</sub> emissions. In food recycling, we generate methane gas from disposed food wastes to create renewable energy (fuel gas and electricity). JFE Engineering manages the engineering, procurement, and construction of recycling plants, while J&T Recycling Corporation manages the operation and business development of the plants\*.

Industry-wide decarbonization cannot be achieved through technical developments in manufacturing alone. We therefore believe that demand for CCU and CCS facilities will increase as they facilitate the efficient use and storage of CO<sub>2</sub>. JFE Engineering is able to undertake the entire process of building CCU and CCS facilities from design and procurement to construction.

▶ [\\*JFE Engineering and J&T Recycling Corporation's Recycling \(Japanese only\)](https://www.jfe-eng.co.jp/products/recycle/) (https://www.jfe-eng.co.jp/products/recycle/)

### Energy-Saving Steel Technologies

Short term (2024)

Medium term (2030)

From the perspective of the steel industry, there is room for disseminating eco solutions (energy-saving steel technologies) in nations such as China, where close to 50% of the world's crude steel is produced, and India and ASEAN countries, where further growth in production is expected. The potential CO<sub>2</sub> reduction achieved by internationally transferring and disseminating advanced energy-saving technologies widely used in Japan will exceed 400 million t-CO<sub>2</sub> worldwide (Japan is estimated to contribute to the reduction of approximately 80 million t-CO<sub>2</sub> in FY2030 through these technologies).

## FOCUS Key Factor (5) Unstable Raw Material Procurement due to Increased Occurrence of Climatic Hazards

**Ongoing initiatives to address the issue, such as alternative procurement and dispersed supplier bases, and increasing plant capacity.**

Short term (2024)

Medium term (2030)

In Australia, our major source country for raw materials, the frequency of typhoons is predicted to double. If production and shipments are disrupted in Australia for too long, we may not be able to continue production and would therefore suffer a loss. To address this, we are promoting alternative procurement and dispersed supplier bases.

#### Alternative procurement and dispersed supplier bases:

Respond to disaster by carrying out spot procurement from China's port stocks, increasing procurement from closer source countries such as Indonesia and front-loading the purchase and/or increasing the purchase contract of different brands from outposts in unaffected regions of Australia. Also, use the stock and external yard of the Group company Philippine Sinter Corporation.

The decarbonization in the steelmaking process is expected to lead to a diversification of the required raw materials. We will take into account the risk of climate change for these materials as well and work to establish diversified procurement sources.

## FOCUS Key Factor (6) Damage to Production Bases and Offices Caused by Climatic Hazards

**Measures against flood and drought in progress; impact of flooding caused by rising sea levels can be addressed with current countermeasures.**

Short term (2024)

Medium term (2030)

We are taking action to minimize damage under the assumption that typhoons and heavy rains will become stronger and that the occurrence of disasters comparable to the torrential rain in western Japan in 2018 will rise. We have currently invested approximately 6.5 billion yen for disaster prevention at steelworks and strengthened drainage facilities and other assets. About 3.5 billion yen of separate investment has already been made to prepare for water shortages at steelworks by installing desalination facilities at some of them. Although no severe drought disaster has struck since 1994, we are preparing to minimize any damage, even if the frequency of occurrence should increase.

All steelworks are exposed to the risk of floods associated with rising sea levels because of their location in coastal areas. The estimated sea level rise by 2050 is 20 to 30 cm (70 cm by 2100 if the impact of climate change manifests itself at the highest level). We believe that current measures against storm surge, which generates more sea level rise, are sufficient to address the risk. However, we will continue analyzing climatic hazards going forward to prepare for the changing circumstances.

## FOCUS Key Factor (7) National Resilience

**Contribute to infrastructure enhancement with products such as high-strength H-shaped steel and steel pipe piles, hybrid tide embankments, and permeable steel slit dams.**

Short term (2024)

Medium term (2030)

The JFE Group takes seriously the increased frequency and severity of recent climatic hazards in Japan. Also, the daily life of the Japanese citizenry is being exposed to a heightened risk of danger. The JFE Group defines its mission as promoting disaster prevention and mitigation as well as national resilience to maintain vital infrastructure that is essential to daily life and economic activities.

The JFE Group will gather its collective energy to protect key structures from earthquakes using structural steel such as high-strength H-shaped steel and steel pipe piles as well as steel sheet piles. It will also help to reinforce embankments that are prone to bursting and provide disaster prevention products such as hybrid tide embankments and permeable steel slit dams, in addition to reconstructing infrastructure.

➤ [Hybrid Tide Embankments](#) (P.81)

➤ [Permeable Steel Slit Dams](#) (P.82)

➤ [Terre Armée Method](#) (P.82)

Links to information about the JFE Group Environmental Vision for 2050 and Climate Change Scenario Analysis

Commitment to a Low Carbon Society: ➤ [Steel Industry Initiatives](#) (P.104)

Targets and Results Related to Climate Change: ➤ [Material Issues of Corporate Management and KPIs](#) (P.20)

Initiatives on Climate Change: ➤ [Climate Change](#) (P.53)

Technologies and Products Related to Reducing ➤ [Development and Provision of Eco-friendly Processes and Products](#) (P.108)

## Steel Industry Initiatives

### Initiatives

#### The Japan Iron and Steel Federation (JISF) Initiatives

##### Long-term Vision for Climate Change Mitigation

The JISF has been focusing on achieving the goals for 2020 under its Commitment to a Low Carbon Society (renamed the Carbon Neutrality Action Plan in FY2021). Furthermore, in November 2018, the JISF formulated and published its Long-term Vision for Climate Change Mitigation for 2030 and beyond, with JFE Steel playing a central role in its development. This document lays out the industry's challenge for realizing zero-carbon steel and explains the pathway for achieving the 2°C scenario for steelmaking and the necessity of ultra-innovative technologies to achieve the 1.5°C scenario. Also, on February 15, 2021, the JISF announced the "Basic Policy of the Japan steel industry on 2050 Carbon Neutrality sought by the Japanese government," declaring that the Japanese iron and steel industry will boldly accept the challenge of realizing zero-carbon steel.

► [Relevance with the JISF's Long-term Vision for Climate Change Mitigation](#) (P. 93)

##### JISF's Carbon Neutrality Action Plan

In February 2021, the JISF declared that the Japanese steel industry will boldly take on the challenge of realizing carbon neutrality. The Plan on Commitment to a Low Carbon Society was amended and renamed as the Carbon Neutrality Action Plan, and the Phase II target (2030 target) was revised.

In the Eco Process of the plan, an ambitious 2030 target was set taking into account new perspectives such as the expansion of scrap use as well as the maximum introduction of best available techniques (BATs) based on energy efficiency already among the highest in the world.

Regarding Eco Product, which is intended to reduce GHG emissions at the product use stage, high-performance steel is expected to play a particularly major role in the promotion of offshore wind power and electrification of automobiles, which are among the 14 fields of the government's Green Growth Strategy. Accordingly, the Japanese initiative will accelerate practical global warming measures from a global perspective by making visible the conventional quantitative evaluation of the five types of high-performance steel.

As for Eco Solutions, the JISF will develop a system for introducing appropriate technology for transferring and spreading the production process for decarbonized steel in the Asian regions, where steel production is expected to expand.

Furthermore, regarding Innovative Technology Development, the JISF will take on the challenges of technologies such as direct hydrogen reduction and high-performance steel production using electric arc furnaces under the Green Innovation Fund, in addition to COURSE 50 and ferro-coke.

##### ■ Overview of the Carbon Neutrality Action Plan

###### Eco Process

Cut energy-related CO<sub>2</sub> emissions (total volume) in FY2030 by 30% compared to the FY2013 level by adopting BATs to promote energy conservation, using waste plastics, adopting innovative technologies that are currently under development and scheduled to be in use around 2030, and using raw fuel with less CO<sub>2</sub> emissions.

###### Eco Product

Contribute to CO<sub>2</sub> emissions reduction by domestically and internationally supplying high-performance steel. This steel will reduce CO<sub>2</sub> emissions when used in the final product. The reduction potential in 2030 is estimated to be approximately 42 million t-CO<sub>2</sub> for the five steel products that have been quantitatively evaluated for their contribution to reducing emissions.

**Eco Solution**

Contribute to reducing CO<sub>2</sub> emissions worldwide by transferring and spreading the Japanese steel industry's advanced energy-saving technologies and facilities to the world's steel industry. Estimated contribution on CO<sub>2</sub> emissions reduction is 80 million t-CO<sub>2</sub> in 2030.

**Innovative Technology Development**

Contribute to carbon neutrality by boldly developing technologies in the following four areas.

- Hydrogen reduction technology using in-house hydrogen
- Low-carbon technology using CO<sub>2</sub> contained in externally sourced hydrogen or blast furnace exhaust gas
- Direct hydrogen reduction technology
- Impurity removal technology for electric furnace using direct reduced iron

**Assessment of the 2021 Carbon Neutrality Action Plan (Phase II) Results (JISF)**

Total volume of energy-related CO<sub>2</sub> emissions in FY2021 was 163.09 million tonnes, 31.34 million tonnes, or a 16.1% decrease from FY2013. The achievement rate of the FY2030 target (to reduce 30% from FY2013) has progressed to 53.7%. Energy-related CO<sub>2</sub> emissions and energy consumption are both declining, given continued energy-saving efforts.

While the energy efficiency of the Japanese steel industry is among the highest in the world, vigorous efforts are made to promote greater energy savings by having businesses engaged in this effort draw upon subsidies to promote investment in saving energy and other actions.

**Revolutionary Iron and Steelmaking Process Development****COURSE50**

About 30% of CO<sub>2</sub> emissions can be reduced through hydrogen reduction along with separation and capture of CO<sub>2</sub> from blast furnace gases. The first facility is expected to come online by 2030, followed by other plants by 2050.

**Ferro-Coke**

Ferro-coke is an innovative raw material for blast furnaces that is made by mixing low-grade coke and iron ore. In this energy-saving technology, metallic iron acts as a catalyst, reducing the amount of coke required in the furnace and thus significantly reducing CO<sub>2</sub> emissions in the iron making process.

**Reduced CO<sub>2</sub> Emissions through High-Performance Steel Materials (Effects of Eco Products)**

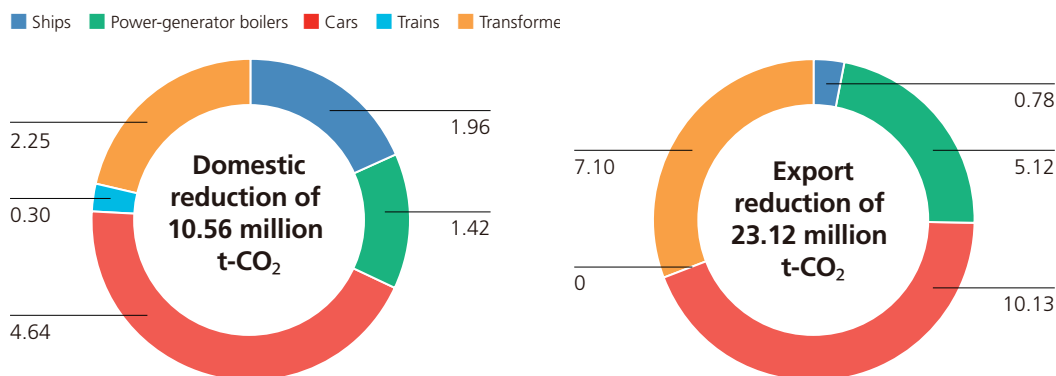
The Japan Iron and Steel Federation (JISF) calculates the CO<sub>2</sub> emissions reduction impact of using high-performance steel materials. It is estimated that the use of five major high-performance steel materials in cars, transformers, ships, power generator boilers, and trains in Japan and overseas\* (FY2021 production: 6.69 million tonnes, 7.3% of crude steel production) helped reduce CO<sub>2</sub> emissions by 33.69 million tonnes (10.56 million tonnes in Japan, 23.12 million tonnes overseas) in FY2021.

\* Estimates made by the Institute of Energy Economics, Japan

\* The five materials are steel sheets for automobiles, directional electrical steel sheets, thick steel sheets for shipbuilding, steel tubes for boilers, and stainless steel sheets.

\* Evaluations for domestic figures are made starting from FY1990. For exports, automobile and ships have been evaluated since FY2003, steel pipes for boilers since FY1998, and electrical steel sheets since FY1996.

■ CO<sub>2</sub> Reduction Resulting from the Use of Five High-Performance Steel Materials in Japan and Abroad (FY2021)



Global Scale Initiatives

Global Actions to Address Global Warming

ISO 14404 is an international standard proposed by The Japan Iron and Steel Federation (JISF) to the International Organization for Standardization (ISO) as a methodology for the globally unified calculation of CO<sub>2</sub> intensity from iron and steel production, ultimately to assess the energy efficiency of steelworks. The Japanese steel industry is addressing global warming through international public-private collaborations, including ISO 14404-based assessment of steelworks in developing countries and recommending specific technologies best suited to India and ASEAN countries. It is continuing this effort together with the Ministry of Economy, Trade and Industry (METI) in order to enhance ISO 14404 so it can be applied to steel manufacturing facilities with more complex structures.

JFE Steel is also addressing global warming by participating in international activities, such as the Japan India Public and Private Collaborative Meeting, the Japan-ASEAN Steel Initiative and the Japan-China Steel Industries Exchange.

In addition, JFE Steel is involved as a member of World Steel Association (WSA)'s Climate Action data collection programme, which uses ISO 14404 as the standard for measurement and calculation.

► [WSA: Climate Action data collection programme](https://worldsteel.org/steel-topics/environment-and-climate-change/climate-action/climate-action-data-collection/data-providers/)

(<https://worldsteel.org/steel-topics/environment-and-climate-change/climate-action/climate-action-data-collection/data-providers/>)

■ WSA Climate Action data collection programme certification





## Contribution to Developing the LCA of Steel Material

Accurately evaluating the environmental impact of products requires assessment and quantification of impact over their entire life cycles, from raw resource mining to material production, product manufacture, use, and final disposal. Life cycle assessment (LCA) is one evaluation method.

After final products such as automobiles and buildings finish their mission in society, all of their steel components can be recycled and reused. This closed loop recycling ability is an excellent characteristic of steel materials. Taking this into account through LCA reveals that steel can be viewed as having extremely low environmental impact compared to other materials.

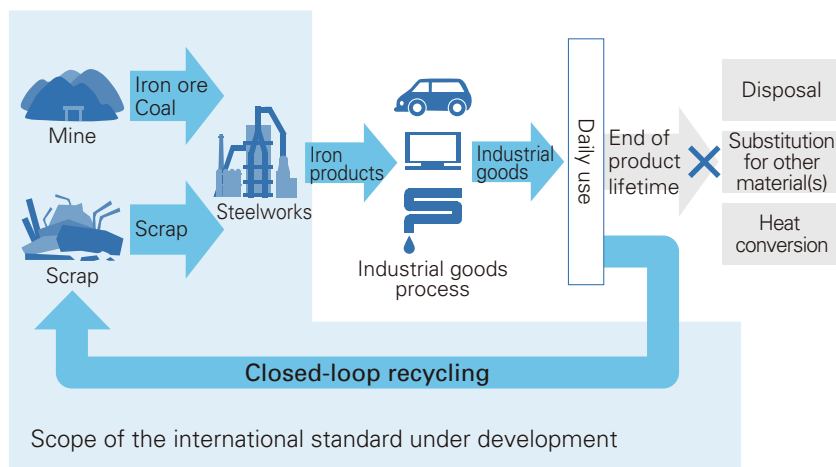
JFE Steel played a major role in the development of ISO 20915 (Life Cycle Inventory Calculation Methodology for Steel Products) and JIS Q 20915 (Life Cycle Inventory Calculation Methodology for Steel Products), initiatives led by The Japan Iron and Steel Federation (JISF), which takes into account the impact of recycling and provides life cycle inventory (LCI) calculation methods specific to steel products.

In addition, 15 Japanese manufacturers of blast furnaces and electric arc furnaces joined forces to calculate the Japanese average for LCI of different steel products. Calculations based on their FY2018 operational data were also published.

JFE Steel acquired EcoLeaf labels, the Japan Environmental Product Declaration program run by the Sustainable Management Promotion Organization (SuMPO), for three steel sheet products for cans (tinplate, laminated steel sheet JFE Universal Brite, and tin-free steel), five building material products (H-beams, JFE Super HISLEND-H beams, extra-thick H beams, construction steel plates, and construction steel columns) and three steel plate products (for offshore structures and wind power equipment, ship building, and UOE steel pipes). We will continue to leverage EcoLeaf labels to help customers promote environmental protection and to strengthen communications with them.

### ► Value of Steel (P.06)

#### Life Cycle of Steel Materials



### Related Links

- [The Japan Iron and Steel Federation \(JISF\): Climate Change Policy page](https://www.jisf.or.jp/en/activity/climate/index.html) (https://www.jisf.or.jp/en/activity/climate/index.html)
- [Japan Iron and Steel Federation \(JISF\): LCA of Steel Products page](https://www.jisf.or.jp/en/activity/lca/index.html) (https://www.jisf.or.jp/en/activity/lca/index.html)
- [Japan Iron and Steel Federation \(JISF\): Publication of ISO 20915](https://www.jisf.or.jp/en/activity/lca/iso/index.html) (https://www.jisf.or.jp/en/activity/lca/iso/index.html)
- [Japan Iron and Steel Federation \(JISF\): Publication of JIS Q 20915](https://www.jisf.or.jp/en/activity/lca/iso/index.html) (https://www.jisf.or.jp/en/activity/lca/iso/index.html)
- [Japan EPD Program by SuMPO](https://ecoleaf-label.jp/english/) (https://ecoleaf-label.jp/english/)

## Development and Provision of Eco-Friendly Processes and Products

### Basic Policy

In accordance with its corporate philosophy of contributing to society with the world's most innovative technology, the JFE Group develops and provides processes and products for addressing climate change and reducing environmental impact. In the JFE Group Environmental Vision for 2050, we announced our initiatives for reducing the CO<sub>2</sub> emissions of the Group and expanding our contribution to reducing CO<sub>2</sub> emissions in society as a whole. Apart from these initiatives, we also strive to enhance our corporate value and play our part in realizing a sustainable society through **the development and provision of various processes and products related to preserving the global environment.**

In the steel business, the Steel Research Laboratory is engaged in research and development under the Environmental Management System (environmental strategies) to create a recycling-oriented society capable of sustainable development by providing the world's best technologies and sparking innovation. In the engineering business, the Research Center of Engineering Innovation conducts research and development of new technologies to support the society of the future, including the creation of next-generation energy and solutions to environmental problems.

- ▶ [JFE Steel: Research and Technological Development](https://www.jfe-steel.co.jp/en/research/index.html) (https://www.jfe-steel.co.jp/en/research/index.html)
- ▶ [JFE Engineering: Technological Development](https://www.jfe-eng.co.jp/en/rtd/) (https://www.jfe-eng.co.jp/en/rtd/)

### Initiatives

#### Primary Eco-Friendly Products and Technologies by Business Segments

Each operating company of the JFE Group leverages its respective strengths to develop and provide a variety of eco-friendly products and technologies.

#### Primary Eco-Friendly Products and Technologies by Business Segments

Product/Technology	Environmental Benefit	Operating Company	Status
▶ <a href="#">Technology for optimized combustion of coke furnace</a> (P.110)	Save energy and reduce CO <sub>2</sub> emissions	JFE Steel	Operation in production process
▶ <a href="#">Ferro-coke</a> (P.111)	Save energy and reduce CO <sub>2</sub> emissions		Experimental operation
▶ <a href="#">Fuel/power operation guidance system</a> (P.111)	Save energy and reduce CO <sub>2</sub> emissions		Under development
▶ <a href="#">Resource saving silicon gradient steel sheet</a> (P.112)	Save resources and reduce CO <sub>2</sub> emissions		Commercialized
▶ <a href="#">Thin, fatigue-resistant steel for steel structures (AFD® steel)</a> (P.114)	Recycle resources and reduce CO <sub>2</sub> emissions		Under development
▶ <a href="#">Denjiro® insulation-coated pure-iron powder for soft magnetic composites</a> (P.115)	Recycle resources and reduce CO <sub>2</sub> emissions		Commercialized
▶ <a href="#">Ultra-thick, high-strength steel plate</a> (P.116)	Recycle resources and reduce CO <sub>2</sub> emissions		Commercialized
▶ <a href="#">Materials used in line pipe for transporting high-pressure hydrogen gas</a> (P.116)	Recycle resources and reduce CO <sub>2</sub> emissions		Under development

Product/Technology	Environmental Benefit	Operating Company	Status
▶ <a href="#">Calcia Improvement Material</a> (P.117)	Recycle resources and preserve biodiversity	JFE Steel	Commercialized
▶ <a href="#">Steel slag hydrated matrix</a> (P.117)	Recycle resources and reduce CO <sub>2</sub> emissions		Commercialized
▶ <a href="#">Precast concrete products mixed with finely ground blast furnace slag</a> (P.118)	Recycle resources and reduce CO <sub>2</sub> emissions		Commercialized
▶ <a href="#">Granulated blast furnace slag</a> (P.118)	Recycle resources, preserve biodiversity, and reduce CO <sub>2</sub> emissions		Commercialized
▶ <a href="#">Marine Stone®</a> (P.119)	Recycle resources, preserve biodiversity, and absorb and secure CO <sub>2</sub>		Commercialized
▶ <a href="#">Frontier Rock®</a> (P.119)	Recycle resources, preserve biodiversity, and absorb and secure CO <sub>2</sub>		Commercialized
▶ <a href="#">Marine Block®</a> (P.119)	Recycle resources, preserve biodiversity, and absorb and secure CO <sub>2</sub>		Commercialized
▶ <a href="#">Woody biomass combustion power plant</a> (P.121)	Renewable energy and reduce CO <sub>2</sub> emissions	JFE Engineering	Construction
▶ <a href="#">PPA solar power generation model</a> (P.121)	Renewable energy and reduce CO <sub>2</sub> emissions		Business expansion
▶ <a href="#">Digital transformation service for boiler power plant</a> (P.122)	Save energy and reduce CO <sub>2</sub> emissions		Business expansion
▶ <a href="#">Dam optimal operation system</a> (P.123)	Renewable energy, reduce CO <sub>2</sub> emissions, and responses to climate change (reduce flooding)		Under development and verification test
▶ <a href="#">Recycle PET bottles</a> (P.125)	Recycle resources, reduce CO <sub>2</sub> emissions, and preserve biodiversity (marine environment conservation)	J&T Recycling	Business expansion
▶ <a href="#">Overseas water treatment</a> (P.126)	Environmental conservation (sewage treatment)	JFE Engineering	Business expansion
▶ <a href="#">Overseas bridge business</a> (P.127)	Environmental conservation (reduce traffic)		Business expansion
▶ <a href="#">Contract molding business using metal 3D printer</a> (P.128)	Save energy and resources		Business expansion
▶ <a href="#">Further expansion of global supply chain for the Steel Sheets Business</a> (P.129)	Save energy and reduce CO <sub>2</sub> emissions	JFE Shoji	Sales expansion
▶ <a href="#">Building a supply chain for offshore wind power generation industry</a> (P.129)	Renewable energy		Sales expansion
▶ <a href="#">Expanding business in biomass fuels</a> (P.130)	Renewable energy and reduce CO <sub>2</sub> emissions		Sales expansion
▶ <a href="#">Expansion of scrap trading to help develop a recycling-oriented society</a> (P.130)	Recycle resources and reduce CO <sub>2</sub> emissions		Sales expansion

For further details on the JFE Group Environmental Vision for 2050, refer to the following resources.

- ▶ [The JFE Group Environmental Vision for 2050](#) (P.53)
- ▶ [The JFE Group Environmental Vision for 2050, presentation material on May 25, 2021](#) (<https://www.jfe-holdings.co.jp/en/investor/climate/presentation/index.html>)





## Certification by SuMPO's EcoLeaf Environmental Labeling Program

JFE Steel has acquired certification for EcoLeaf, a Japanese environmental product declaration (EPD) program managed by the Sustainable Management Promotion Organization (SuMPO) in Japan for three types of steel sheets for cans: tinsplate, JFE Universal Brite (laminated steel sheet), and tin-free steel; five types of building materials: H-beams, JFE Super HISLEND-H beams, extra-thick H beams, construction steel plates, and construction steel columns; and three types of steel plate products: for offshore structures and wind power generating equipment, ship building, and UOE steel pipes.

EcoLeaf is a Type III EPD program managed by SuMPO for quantitatively disclosing the environmental impact of products and services throughout their life cycle, from raw material procurement to disposal and recycling in accordance with ISO 14025:2006 (environmental labels and declarations, Type III Environmental Declarations, Principles and Procedures). The environmental impact of our products is presented as graphic representations of data to increase transparency. The disclosure of environmental impact data with fairness and reliability assured by third-party review and verification enables customers to quantitatively and objectively evaluate the environmental impact of the products they use.



JFE Steel will continue to actively obtain and disclose EcoLeaf certifications for its products.

► [SuMPO Environmental Labeling Program](https://ecoleaf-label.jp/english/) (https://ecoleaf-label.jp/english/)

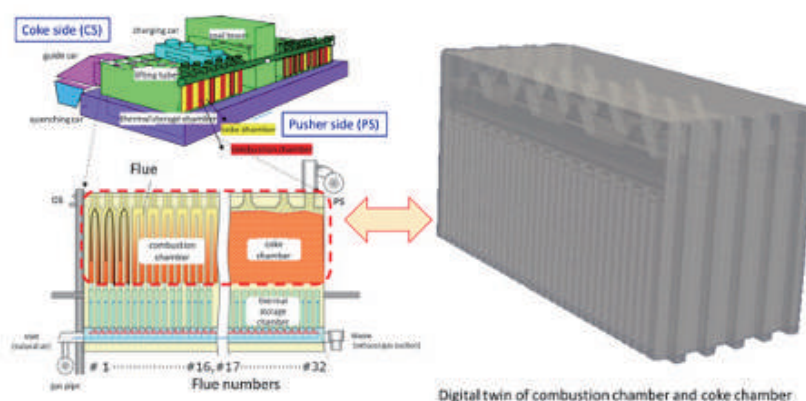
## Technology for Optimized Combustion of a Coke Furnace

JFE Steel has completed technological development of a new facility at the coke furnace in the West Japan Works (Fukuyama District), which is capable of saving energy and cutting CO<sub>2</sub> emissions, by using digital-twin technology, and has started the operation of the process.

We intend to transform into an intelligent steel works through the deployment of cyber physical systems (CPSs) as part of our digital transformation (DX) strategy. Digital twins are a core CPS technology in which physical systems and processes in the real world are replicated with equivalent properties in a digital model ("twin") in a virtual space, allowing for an accurate simulation of the real world. These digital models make it possible to visualize highly inaccessible internal areas of facilities to optimize the design and operation of manufacturing processes for which internal conditions have conventionally been difficult to confirm via sensors or direct observation. The use of the digital twin also makes it possible to predict the effects of major changes to facilities or operations.

The technology was applied to process improvements for the operation of the Number 5, D Group coke furnace in the Fukuyama District of the West Japan Works. The information obtained from the digital twin of coke furnace constructed in virtual space confirmed that a mechanism for partially controlling air supply will achieve greater operational efficiency, information that the company can use for calculating the amount of supplemental air needed to optimize combustion. JFE Steel then applied these learnings in developing the new facility, which is now in commercial operation. The company has achieved an approximately 5% reduction in the amount of fuel used and has reduced its CO<sub>2</sub> emissions by 6,600 tonnes a year, compared to the level with the furnace's previous design. This project was chosen for the Japanese government's Sustainable Open Innovation Initiative funding.

### Architecture of the coke furnace and the digital twin model



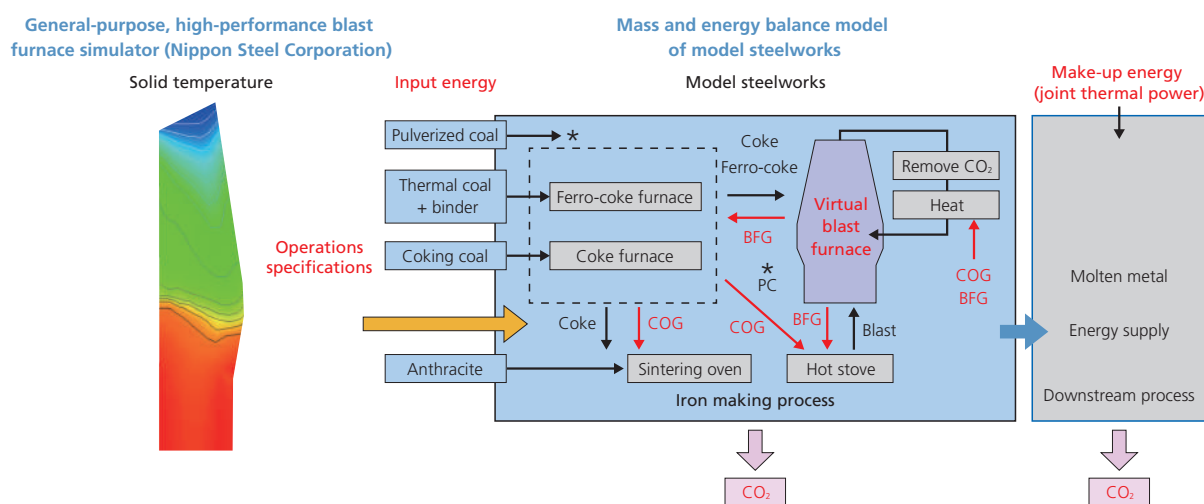
## Ferro-coke

Ferro-coke is an innovative raw material for blast furnaces made by mixing low-grade coke and iron ore. In this energy-saving technology, metallic iron contained acts as a catalyst, reducing the amount of coke required in the furnace and thus significantly reducing CO<sub>2</sub> emissions in the iron making process.

In the six years from FY2017 to FY2022, JFE Steel engaged in a project to develop environmental technology for the steelmaking process, and technological development of the iron making process using ferro-coke, a project by the New Energy and Industrial Technology Development Organization. In the project's final year, the company performed tests at a blast furnace in the West Japan Works (Fukuyama District) using ferro-coke produced in a medium-scale facility and confirmed that the coke ratio was reduced. Going forward, to achieve the final goal of the technology development to establish a technology for reducing the energy consumption in the iron making process by approximately 10%, JFE Steel will use a general-purpose, high-performance blast furnace simulator\* that reflects the mass and energy balance model applicable to the model steelworks that the company developed, along with the above results, to identify issues and examine the operating conditions needed to achieve the final target.

\*The simulator was developed by the Nippon Steel Corporation during the project term.

### How energy saving and CO<sub>2</sub> reduction are assessed at model steelworks



How energy saving and CO<sub>2</sub> reduction are assessed at model steelworks

## Fuel and Power Operation Guidance System for Steelworks

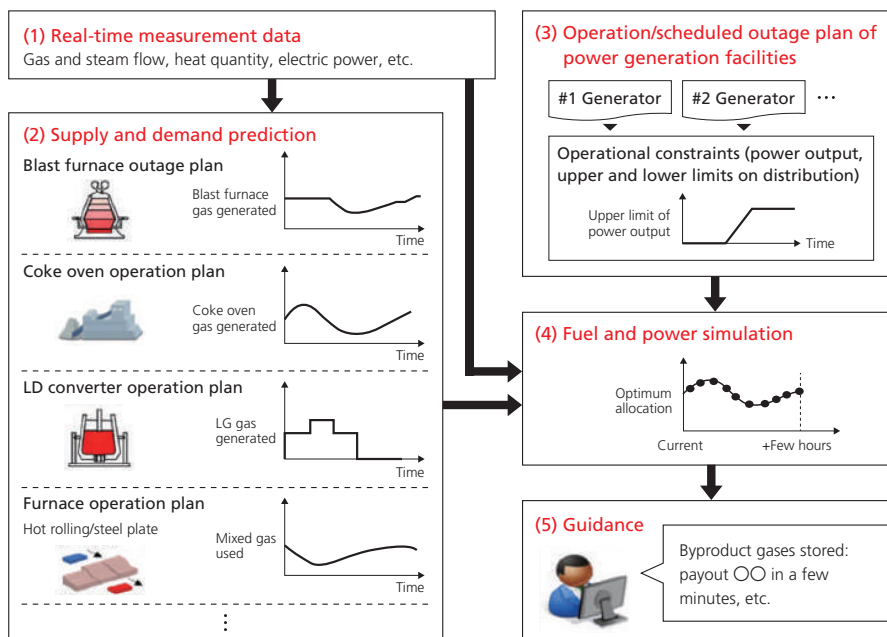
JFE Steel developed a fuel and power operation guidance system for steelworks and succeeded in saving energy and reducing CO<sub>2</sub> as well as fuel and power by optimizing the fuel, steam, and electric power used in the steelmaking process.

Previously, operators determined various factors such as the distribution of byproduct gas to each process, amount of fuel (heavy oil, city gas, etc.) and electricity to purchase, and the amount of byproduct gas stored, taking into account energy demand and supply (amount generated and used) as well as the operating conditions of power generation facilities, to minimize cost and energy loss. However, it was difficult to use this method to accurately estimate the change in energy demand and supply. The guidance system (diagram 1) developed by JFE Steel uses voluminous real-time measurement data (1) obtained through a cyber physical system (CPS)\* and the precise production plans of each factory to predict future demand and supply with high accuracy (2), and by taking into account information such as in-house power generation capacity (3), fuel and power simulation allows for the calculation of the optimal operating conditions with the lowest possible purchase from external sources (4), and the results are fed back to guide the operator (5).

The system's development was awarded the Academic Award (Technical Division) of the 2022 Japan Institute of Energy Award. JFE Steel established the JFE Digital Transformation Center (JDXC®) to promote CPS within the manufacturing process and other digital transformation initiatives to achieve innovative production improvements as well as stable operations. We remain committed to realizing a sustainable society by adopting digital transformation to address the various issues identified at production sites.

\* A system that brings together a vast amount of sensor information about physical space as big data in cyberspace and generates value by feeding back in real time the results analyzed by various measures for application in the physical space.

### ■ Guidance System Overview



▶ **JFE Steel receives Academic Award (Technical Division) of the 2022 Japan Institute of Energy Award (Japanese only)**  
 (<https://www.jfe-steel.co.jp/release/2023/03/230301.html>)

## Resource Saving Silicon-Gradient Steel Sheet

The recent trend toward increasing driving frequency due to the downsizing of electrical equipment has intensified the need to reduce iron loss\*1 in the high-frequency range for electrical steel sheets\*2, widely used as iron core material for electrical equipment such as motors and transformers. Meeting this demand depends upon increasing the concentration of silicon (Si), an element that strengthens electrical resistance. However, increasing concentration also causes magnetic flux density to decrease at the same time.

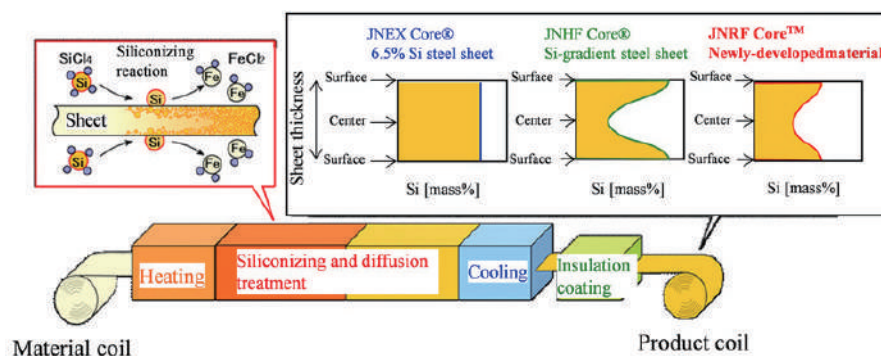
To overcome this, JFE Steel developed JNHF®, JNSF®, and JNRF® using its proprietary chemical vapor deposition (CVD) continuous siliconizing process technology for controlling Si concentration distribution. These products exhibit low iron loss at high frequencies and high magnetic flux density, significantly contributing to greater efficiency while downsizing electrical equipment, and they are used as an iron core material for reactors for solar power generation and high-speed motors.

In recognition of the positive social impact of this development, we received the 2022 Award for Science and Technology from the Minister of Education, Culture, Sports, Science and Technology under the development category of the science and technology field. JFE Steel will continue to contribute to improving electrical equipment by raising efficiency, reducing size, and saving energy by providing high-performance, high-grade electrical steel sheets.

\*1 The loss of energy, primarily as heat, that occurs when the iron core is excited by an alternating current. The less iron lost, the higher the efficiency of electrical equipment.

\*2 Electrical steel sheets are obtained by adding silicon to iron and are widely used as iron core materials in equipment such as motors and transformers.

### ■ CVD Continuous Siliconizing Process and Si Concentration Distribution Control



➤ [Received the 2022 Award for Science and Technology from the Minister of Education, Culture, Sports, Science and Technology under the science and technology field \(development category\). \(Japanese only\)](https://www.jfe-steel.co.jp/release/2022/04/220408.html)  
 (https://www.jfe-steel.co.jp/release/2022/04/220408.html)

➤ [External Awards](#) (P.259)

### Further Expanding Electrical Steel Sheet Production Capacity at the West Japan Works (Kurashiki District)

JFE Steel aims to expand the electrical steel sheet capacity of its West Japan Works (Kurashiki District) in the first half of FY2024 and is also considering a plan to expand the capacity even further in the future.

The electrification of automobiles is accelerating amid the global push toward carbon neutrality. The demand for high-grade, non-oriented electrical steel sheet products used in the drive motors of electric vehicles is expected to continue expanding in parallel with the further tightening of global environmental regulations. In response, JFE Steel has decided to further expand production capacity to accommodate the rising demand.

The company expects to continue investing in expanding its supply capacity for a high-grade, non-oriented, and grain-oriented electrical steel sheet in anticipation of further increases in worldwide demand as more automobiles become electric, energy use becomes more efficient, and renewable energy is more widely adopted.

The company will steadily strengthen its overall manufacturing operations in Japan with world-class technologies for manufacturing advanced products that reduce CO<sub>2</sub> emissions and thereby contribute to a more sustainable world.

#### About Electrical Steel Sheets

Electrical steel sheets contain additives such as silicon and aluminum and offer excellent magnetic properties, including high magnetic flux density and low iron loss. Two types of sheet are available. The non-oriented electrical steel sheet offers excellent magnetic properties that are nearly uniform in all directions and is used in the iron cores of motors. The grain-oriented electrical steel sheet exhibits superior magnetic properties in a single (rolling) direction and is used in the iron cores of power and distribution transformers.

#### Overview of the Expansion

Total expected investment: approximately 46.0 billion yen

Target startup year: FY2026

Expected production capacity: triple the plant's original production capacity for the top-grade, non-oriented electrical steel sheet for electric vehicle primary motors

## Anti-Fatigue Damage Steel for Increased Bridge Safety (AFD<sup>®</sup> Steel)

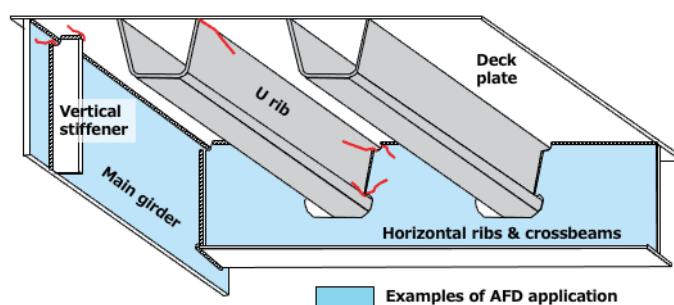
JFE Steel has developed a thin version of its anti-fatigue-damage steel (AFD<sup>®</sup> steel) with improved fatigue resistance. The steel plate, produced by a plate mill at the East Japan Works (Keihin District) using the Super-RQ system with advanced cooling control, has a minimum thickness of 9 mm and retains the mechanical properties of conventional plates while offering improved fatigue resistance. Compared to AFD<sup>®</sup> steel, the thin-walled version is expected to be deployed in a wider range of applications, including bridge structural members that are prone to cracking over time.

Ensuring low maintenance and renewal costs associated with aging is crucial for steel structures purposed for long-duration use. Thin-walled members of bridges are susceptible to fatigue cracking over time, and the cracks may increase in size between inspections and maintenance. The newly developed AFD<sup>®</sup> steel increases the durability of steel structures because it can be used in places prone to fatigue cracking. Compared to ordinary steel, AFD<sup>®</sup> steel reduces the fatigue-crack growth rate\*<sup>1</sup> to half or less of the upper limit of ordinary steel and roughly doubles product life, thereby reducing life cycle costs associated with long service life.

Looking ahead, JFE Steel will continue to improve the performance and quality of steel to achieve superior durability, safety, and economy in steel structures, including bridges, ships, construction machinery, and industrial machinery, thereby contributing to a more sustainable world.

\*1 Fatigue damage is caused by small, repeated forces that create cracks that gradually grow until the material fails. Since these cracks propagate incrementally with the repeated application of force, the length over which the cracks propagate per repetition is called the fatigue crack growth rate.

### ■ Examples of Thin AFD Steel Application



► [Developed thin, fatigue-resistant steel for steel structures](https://www.jfe-steel.co.jp/en/release/2023/230330.html) (https://www.jfe-steel.co.jp/en/release/2023/230330.html)

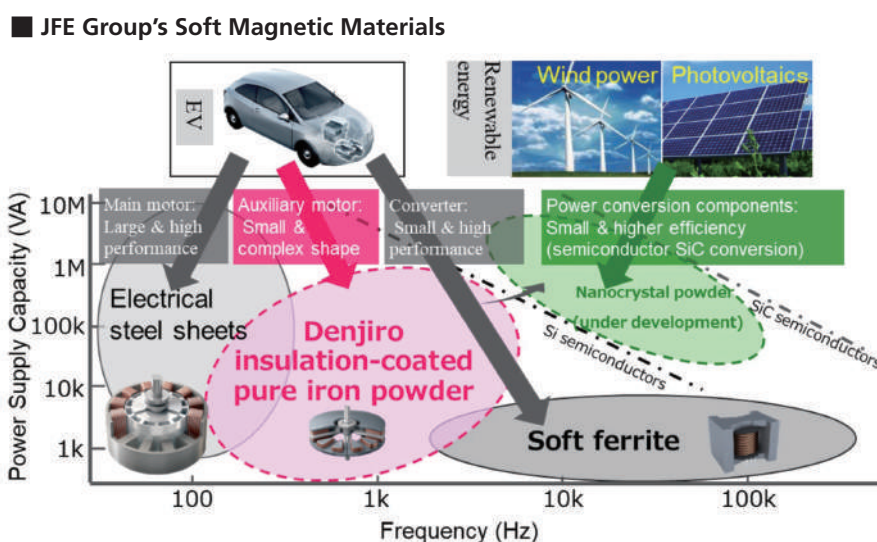
## Denjiro® Insulation-Coated Pure-Iron Powder for Soft Magnetic Composites

The dual demand for extra-compact and high-torque features in motors is growing in parallel with the advance of electric vehicles and other initiatives for a carbon-neutral society. JFE Steel developed Denjiro®, an insulation-coated pure iron powder for soft magnetic composite to meet this demand.

A soft magnetic composite is an iron core made by applying an insulation coating to a soft magnetic\* iron powder and then compression-molding the powder. Compared to electrical steel sheets, which are widely used for iron cores, soft magnetic composites exhibit low loss at high operating frequencies and possess magnetic characteristics well suited for complex-shaped iron cores. The manufacturing yield of soft magnetic composites is favorable, allowing high-rpm motors to be produced at reduced cost. Furthermore, copper wire can be easily recovered when these motors are disposed, making it a highly recyclable product.

A soft magnetic composite developed with Denjiro® is one of the best materials for high-rpm and axial gap motors that favor high torque. With the commercialization of Denjiro™, the JFE Group has established a system for providing a broad lineup of soft magnetic materials for nearly all currently applicable frequency ranges, from electrical steel sheets to soft ferrite cores, and has emerged as the world's only comprehensive supplier that can provide optimal one-stop solutions for all power supply equipment, including motors.

\* Soft magnetism is a property in which the magnetic force flexibly changes in response to changes in electric current. These materials are suitable for use in the iron cores of motors and transformers.



### Development of the Denjiro™ Insulation-coated Pure-iron Powder for Soft Magnetic Composites

(<https://www.jfe-steel.co.jp/en/release/2022/220127.html>)

## Extra-Thick, High-Strength Steel Plate for the Materialization of Large Container Ships

The world's thickest crack arrest steel plate\*<sup>1</sup>, developed by JFE Steel, is applicable to large container ships, with its 460 MPa class yield strength and a thickness of 100 mm. The technology is the first in the world to satisfy two different properties in the thick steel plate: weldability and crack arrestability. Container ships are designed with wide open areas at the top of the deck. Since the hull is exposed to heavy wave force throughout the voyage, the top of the deck and the side of the hull (hatch side coaming) must be built with steel that is thick with high strength. In response to the recent trend of upsizing container ships for more efficient transportation, the thickness of steel plates has increased from 50 mm to 100 mm, with an expected yield strength of 460 MPa. At the same time, an excellent crack-arrest property is required to prevent the propagation of brittle crack. To ensure the safety of hulls that are rapidly becoming larger, the International Association of Classification Societies mandated that all 80 mm to 100 mm class thickness steel used in hatch side coaming must have at least 8,000 N/mm<sup>3</sup>\*<sup>2</sup> arrest toughness (Kca). Using TMCP technology\*<sup>2</sup>, JFE Steel precisely controlled the heating and rolling temperatures and established a proprietary technology that increases the crystallization ratio in the central part of the steel plate's thickness, helping ensure high brittle crack arrestability in the world's thickest, 100 mm, high-strength steel plate.

The development of this technology received the 2023 Award for Science and Technology from the Minister of Education, Culture, Sports, Science and Technology under the development category of the science and technology field for significantly contributing to the materialization of ultra-large container ships. It has been awarded many other prizes including the 2018 Invention Prize of National Commendation for Invention and the 2019 Okochi Memorial Prize. We will continue to improve the economic efficiency, safety, and reliability of vessels by providing high-performance, high-quality steel material while meeting the diversified needs of customers and also addressing global environmental concerns, and contributing to the realization of a sustainable society.

\*1 A steel plate with excellent performance in minimizing vessel damage by stopping brittle crack propagation in the event of weld cracking.

\*2 A thermo-mechanical control process technology that improves the strength and toughness of steel material in an online process using controlled rolling and accelerated cooling systems.

► [Received the Award for Science and Technology from the Minister of Education, Culture, Sports, Science and Technology under the science and technology field \(development category\)\(Japanese only\)](https://www.jfe-steel.co.jp/release/2023/04/230407.html)

(<https://www.jfe-steel.co.jp/release/2023/04/230407.html>)

## R&D into Line Pipe for Transporting High-Pressure Hydrogen Gas

JFE Steel's research and development into the property evaluation of line pipe for transporting high-pressure hydrogen gas has been selected for inclusion in a hydrogen-related technical development under The Nippon Foundation\*<sup>1</sup>—DeepStar\*<sup>2</sup> Joint Research & Development Program on Offshore Oil and Natural Gas\*<sup>3</sup> ("the Project"), which is being conducted in cooperation with major oil companies. JFE Steel will work with DeepStar consortium members ExxonMobil of the U.S.A. and TotalEnergies of France to establish evaluation criteria and methods using the company's Mighty Seam<sup>®</sup> electric-resistance-welded steel pipe\*<sup>4</sup> to transport high-pressure hydrogen for realizing the world's first commercial high-pressure hydrogen pipeline.

The large-scale use of hydrogen for various purposes, such as fuel for power generation, is being widely considered for achieving carbon neutrality by 2050. The use of a pipeline similar to the current supply chain for natural gas is being explored for transporting hydrogen in bulk from the receiving terminal to where it is needed.

Meanwhile, hydrogen causes steel materials to become brittle (reducing ductility). Consequently, methods for evaluating the performance of materials are being established in countries other than Japan to support safety standards and quality inspections. In the Project, JFE Steel's Steel Research Laboratory in Chiba, Japan, will research properties required for high-pressure hydrogen pipelines, particularly through the application of the Engineering Critical Assessment\*<sup>5</sup>. The company will also evaluate performance under high-pressure hydrogen environments using a steel pipe specimen. Technological developments that meet the needs of oil companies will be pursued through strengthened cooperation under the shared goal of contributing to decarbonization.

\*1 A public interest incorporated association designated as a ship promotion organization by the Ministry of Land, Infrastructure, Transport and Tourism of Japan. Funding for its activities is drawn from the proceeds of motorboat racing held by local governments throughout Japan, to primarily support maritime shipping-related business, engage in public services/welfare business, and international cooperation.

\*2 An offshore technology development consortium consisting of businesses that engage in globally exploring, developing, and producing offshore oil and natural gas, such as Chevron (U.S.), Shell (U.K.), and Equinor (Norway), as companies that carry out offshore oil field development and production, and other businesses, universities, and research institutions that offer products and services to those businesses.

- ▶ [\\*3 A joint grant program of the Nippon Foundation and DeepStar for research and development projects for advancing decarbonization in offshore oil and natural gas areas.\(Japanese only\)](https://www.nippon-foundation.or.jp/who/news/information/2023/20230113-83742.html)
- ▶ [\\*4 An electric-resistance-welded steel pipe for line pipe, with excellent weld quality.](https://www.jfe-steel.co.jp/en/products/pipes/linepipe.php)
- \*5 A technology for evaluating safety from a mechanical standpoint, by comparing the forces acting on a structure with material toughness obtained from material testing.

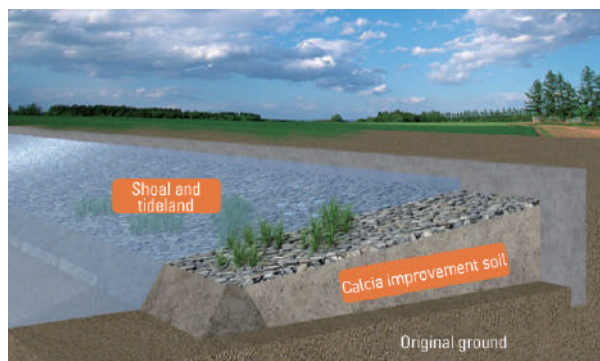
## Calcia Improvement Material

Calcia improvement material is a slag product that uses converter-type steelmaking slag as raw material and is manufactured by controlling the composition and adjusting particle size. Dredged soil mixed with calcia improvement material is called calcia improvement soil, which is stronger than the original weak dredged soil and is therefore able to prevent dredged soil from dissipating into the surrounding area and having a negative environmental impact placed in water.

This enables the effective use of weak dredged soil in land reclamation, shoal and tideland construction, and refilling former dredging sites. Calcia improvement soil has been used to construct a mid-section submerged breakwater\* (Shin Honmoku Pier, Port of Yokohama), the main embankment material for creating a shallow area (incidental facilities at the sediment disposal site, Tokuyama-Kudamatsu Port) and backfilling material for an earthquake-resistant quay wall in the Mino offshore area, Fukuyama Port.

\*An embankment built under the water surface on the inside of a perimeter wall to divide the land into sections for reclamation.

### Calcia Improvement Material and Calcia Improvement Soil



Example of calcia improvement soil application (shoal and tideland construction material)

## Steel Slag Hydrated Matrix

Steel slag hydrated matrix is a steel slag product that can be used as a substitute for concrete but uses ground granulated blast furnace slag instead of cement, and steel slag instead of natural gravel and sand aggregate, as its ingredients. It effectively uses steel slag and does not rely on natural aggregate, thereby reducing environmental impact, and uses less cement, in turn reducing CO<sub>2</sub> emissions.

There are many examples of blocks and artificial stones made from steel slag hydrated matrix being used as a substitute for concrete blocks and natural stones in harbor works, including the Runway D construction project at Haneda Airport by the Ministry of Land, Infrastructure, Transport, and the coastal reconstruction project after the Great East Japan Earthquake. In addition, we are conducting on-site monitoring in the Katsunan Central Zone of Chiba Port with the help of a local fishing association to assess the impact of these blocks on marine biodiversity.



Wave-dissipating and foot protection block



Artificial stones made from steel slag hydrated matrix



## Precast Concrete Products Mixed with Finely Ground Blast Furnace Slag

Finely ground blast furnace slag can be used as a cementing material in concrete. This type of concrete exhibits significantly higher durability under harsh conditions such as applications in sewers and exposure to anti-freeze agents. Its effectiveness in reducing environmental impact is widely understood, although there has recently been growing interest in its practical applications for concrete constructions that require higher durability.

As one of the deliverables for the Japanese government’s Strategic Innovation Promotion Program, the Japan Society of Civil Engineers published a draft guideline in March 2019 on the application of finely ground blast furnace slag to precast concrete product, and its application now includes precast concrete slabs installed in highways and piers. With the application of finely ground blast furnace slag in concrete, the durability of precast products is expected to be greater and more consistent, allowing them to contribute to building national resilience.



Precast concrete slabs mixed with finely ground blast furnace slag installed in piers

## Use of Granulated Blast Furnace Slag to Reduce CO<sub>2</sub> Emissions

Granulated blast furnace slag in crushed and powdered form can be mixed with cement and used as a substitute for cement for making concrete. This leads to reducing the production of cement, thus lowering CO<sub>2</sub> emissions. For example, producing 1 tonne of blast furnace slag cement with 45% of its content substituted with granulated blast furnace slag emits 42% less CO<sub>2</sub> than conventional cement. In FY2021, JFE Steel supplied approximately 6.6 million tonnes of granulated blast furnace slag to cement production, equivalent to a reduction of approximately 4.74 million tonnes of CO<sub>2</sub> emissions.

### ■ CO<sub>2</sub> Emissions for Producing 1 Tonne of Cement (Unit: kg-CO<sub>2</sub>/ton)

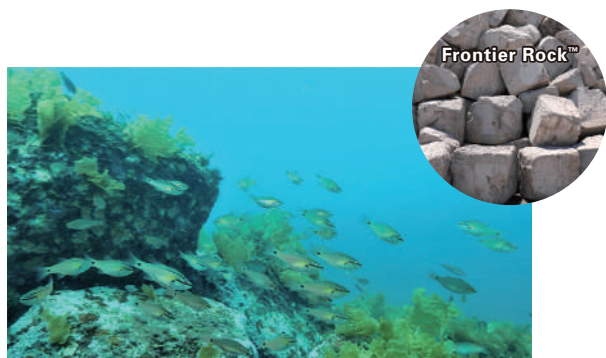
CO <sub>2</sub> Emissions Source	Regular Cement	Blast Furnace Slag Cement
Limestone	476	270
Electricity/energy	283	170
Total	759	440

Source: Data published by the Japan Cement Association

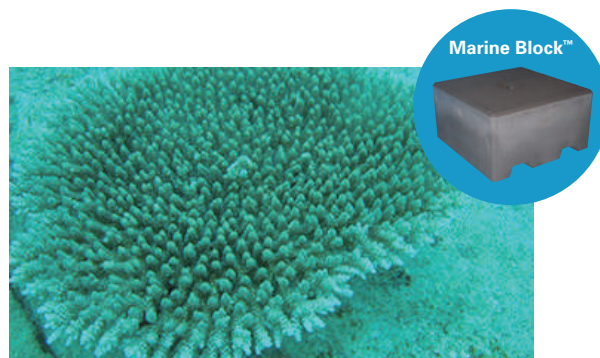
## Restoring Marine Ecosystems Using Steel Slag Products

Marine Stone<sup>®</sup> is a grain-size-adjusted steel slag that controls the generation of hydrogen sulfide from the silty sediment in enclosed coastal seas and improves the environment in which organisms can live. Its effectiveness in improving marine environments is widely recognized, and the joint project with Hiroshima University has received external commendations.

Frontier Rock<sup>®</sup> is another steel slag product that consists of artificial stones made from steel slag hydrated matrix and provides an excellent base for seaweed beds and fishing reefs. A submerged bank built on the seabed off the coast of Minamizu Town, Shizuoka Prefecture, has become a gathering place for large perennial seaweeds as well as useful fishery resources such as lobsters, turban shells, and a wide variety of fish. We are also testing the effects of Marine Block<sup>®</sup> as beds for corals.



School of fish attracted to the submerged bank made of Frontier Rock<sup>®</sup>



Coral growing on Marine Block<sup>®</sup>

## Initiatives for Blue Carbon Using Steel Slag Products and Acquisition of J Blue Credit<sup>®</sup>

In recent years, research on blue carbon (carbon absorbed and stored by living organisms in the ocean) has been advancing. JFE Steel has been participating in the research by creating a seaweed bed using steel slag products and measuring the amount of carbon captured by the entire bed.

The company has been collaborating with Koujiro Fisheries Cooperative (Iwakuni City, Yamaguchi) and the National Institute of Technology, Ube College (Ube City, Yamaguchi) on a project to create a seaweed bed and ecosystem using recycled materials at areas around Shinto, Iwakuni City, since FY2012. The initiative involves creating a seaweed bed with rich biodiversity using Marine Stone<sup>®</sup>, a grain-size-adjusted steel slag, and other steel slag products, and measuring CO<sub>2</sub> absorption of the created beds. The cumulative amount of CO<sub>2</sub> absorbed and stored from 2018 to 2021, which totaled 79.6 tonnes, received J Blue Credit<sup>®</sup> certification by the Japan Blue Economy Association. This was the first certification ever given to a three-party joint project by the Fisheries Cooperative, academia, and private business. The seaweed bed created through the project had the co-benefits of offering a gathering place for diverse fish. The sea area is also useful for education and research.



School of rockfish gathered around the steel slag seaweed bed



Excellent place for education and research (photo from the National Institute of Technology, Ube College)

## JFE Steel and Tohoku University's Collaborative Research Laboratory for Green Steel

In February 2022, JFE Steel and Tohoku University jointly established the Collaborative Research Laboratory for Green Steel within the university's Graduate School of Engineering to research eco-friendly steel materials and production methods for the carbon-neutral era.

The Collaborative Research Laboratory is managed under a cross-divisional system and develops collaborations across a wide range of fields, including the development of steelmaking processes and materials. This will facilitate a multifaceted approach to resolving issues related to low-carbon steelmaking processes and to discover innovative development themes from new perspectives. Furthermore, we will dispatch young researchers to nurture highly specialized human resources who will lead the next generation of the steelmaking industry.



Collaborative Research Wing, Materials Development,  
Graduate School of Engineering, Tohoku University

► [JFE Steel and Tohoku Univ. Establish Collaborative Research Lab for Green Steel](https://www.jfe-steel.co.jp/en/release/2022/220203.html) (https://www.jfe-steel.co.jp/en/release/2022/220203.html)



### JFE Engineering

## JFE Engineering's Commitment through Its Business

With the corporate purpose "Foundation of Life—Just For the Earth" in mind, JFE Engineering is committed to achieving the SDGs in five areas: waste to resources, carbon neutrality, combined utility services, infrastructure, and digital transformation (DX).

Waste to resources businesses include food recycling, plastic recycling, and waste incineration/power generation. Businesses related to carbon neutrality focus on renewable energies, such as offshore wind, solar, biomass, and geothermal power generation. Combined utility services offered by the company include utility services (e.g., water, electricity, gas) that address regional concerns by launching new local electric power companies and offering heat supply services. The company's infrastructure business constructs bridges, gas plants, waterworks plants, pipelines, and other infrastructure by identifying needs such as robustness and longer service life. The DX project involves improving the efficiency of daily work as well as providing products and services that leverage digital technologies such as AI and IoT.

► [JFE GROUP REPORT 2021 \(PP. 43–44\)](https://www.jfe-holdings.co.jp/en/investor/library/group-report/2021/pdf/all.pdf) (https://www.jfe-holdings.co.jp/en/investor/library/group-report/2021/pdf/all.pdf)

## Commercialization of One of Japan’s Largest Woody Biomass Combustion Power Plants

The construction of Tahara Biomass Power LLC, a 112 MW woody biomass combustion power plant, one of the largest of its kind in Japan, with jointly investment by JFE Engineering, Chubu Electric Power Co., Inc., Toho Gas Co., Ltd., and Tokyo Century Corporation, began in 2022, with startup targeted for September 2025. In biomass power generation, wood pellets and other biofuel are combusted to generate electricity. This renewable energy source features easily adjusted output and can stably produce power, thereby contributing to the realization of a carbon-neutral, sustainable society.



Rendering of the completed woody biomass combustion power plant, one of the largest of its kind in Japan (Tahara Biomass Power Plant)

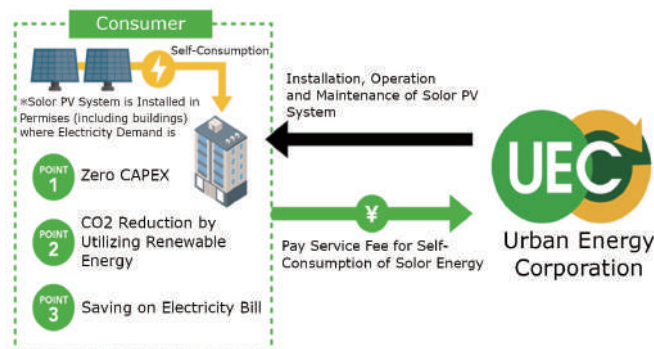
▶ [Construction Begins for Tahara Biomass Power Plant, a 112 MW Woody Biomass Combustion Power Plant, One of Japan’s Largest \(Japanese only\)](https://www.jfe-eng.co.jp/news/2022/20220601.html) (<https://www.jfe-eng.co.jp/news/2022/20220601.html>)

▶ [Construction Begins for One of Japan’s Largest Biomass Power Plants \(Japanese only\)](https://www.jfe-holdings.co.jp/investor/zaimu/g-data/jfe/2022/2022cyu-jigyuu.pdf) (<https://www.jfe-holdings.co.jp/investor/zaimu/g-data/jfe/2022/2022cyu-jigyuu.pdf>)

## Expanding PPA Model Solar Power Generation, Zero-Emi Plan® On-site Service throughout Japan

Urban Energy Corporation, a subsidiary of JFE Engineering, has been offering a solar power generation service, Zero-Emi Plan® On-site Service. The service is based on a solar power PPA model\*, in which the company installs a solar power generation system on a host customer’s property on the roof or the ground, and sells the generated power to the host customer on a long-term basis. The customer can use electricity from renewable sources with no initial investment and can also expect reduced electricity costs.

\* A power purchase agreement (PPA) model in which a third-party installs a solar power system on a host customer’s property on the roof or the ground, and sells the generated power to the host customer on a long-term basis. There are two types depending on where the system is installed. For on-site service, installation is done where the energy will be consumed, while off-site service is installed in a different location.



▶ [Zero-Emi Plan® On-site Service, a Solar Power PPA Service by Urban Energy Achieved a Total of 50 MW Worth of Contracts—2.5 Times the Previous Year, Positioned as a Plan to Add High-value to the Existing Service \(Japanese only\)](https://www.jfe-eng.co.jp/news/2023/20230420.html) (<https://www.jfe-eng.co.jp/news/2023/20230420.html>)

## Digital Transformation Service for Boiler Power Plants (RODAS®)

RODAS® is JFE Engineering’s brand for providing digital transformation (DX) service for boiler power plants. As shown in the following diagram, the service consists of a Global Remote Center for gathering real-time plant operation data under the company’s cloud environment, and Pla’cello®, a data analysis platform for analyzing data. Various services can be developed and provided by combining the two technologies with expertise in boiler plant operations. Examples of tools and services that help improve the efficiency of plant operations include a downloadable tool that offers access to the latest operational and weather data anytime, anywhere; a visualization analysis tool that can be intuitively operated to run time-series data analysis; and a remote maintenance service for distributed control system. The new combustion control system is a plant operation optimization service that saves energy in fans used in power plants and reduces CO<sub>2</sub> emissions, leveraging the system development capabilities provided by AI in Pla’cello® to analyze big data.

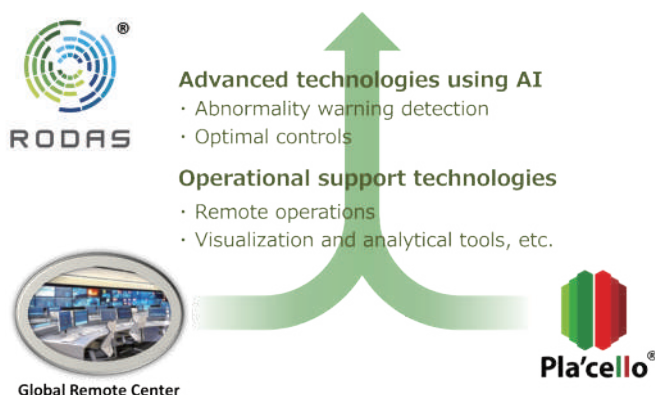
RODAS® was highly regarded as a DX service that contributes to saving energy and won the Minister of Economy, Trade and Industry Grand Prize, the highest award under the Energy Conservation Business Models category of the Energy Conservation Grand Prize 2022. It has already been made available for some users of JFE Engineering boilers by being introduced to four plant sites under paid service agreement, as of March 2023. In addition to services already implemented, AI-based anomaly detection service, EPC, and other new services for improving the efficiency of work that requires expertise in plant operations are being developed in response to user feedback.

\* An abbreviation for Realize Operation by Digitalizing, Analyzing, and Synthesizing, and it also means “a wheel” in Portuguese. It represents our vision to bring together integrated know-how and analysis of all data to realize advanced plant operation, as well as our approach to connect with users to move forward into a better future.

### ■ Won Energy Conservation Grand Prize 2022



### ■ Diagram of RODAS®



▶ [RODAS® Wins the Minister of Economy, Trade and Industry Grand Prize, Energy Conservation Grand Prize 2022—Realizing More Efficient Boiler Power Plant Operation with Digital Transformation Service Package\(Japanese only\)](https://www.jfe-eng.co.jp/news/2023/20230202.html)

(<https://www.jfe-eng.co.jp/news/2023/20230202.html>)

▶ [JFE Engineering’s Digital Transformation Strategy \(RODAS®\)](https://www.jfe-eng.co.jp/dx/en/solution-3.html)

(<https://www.jfe-eng.co.jp/dx/en/solution-3.html>)

## Launch Dam Optimal Operation System that Employs AI

The Hokuriku Electric Power Company (Hokuriku Electric) and JFE Engineering have been conducting since FY2017 a verification test of the Inflow Prediction AI\*<sup>1</sup>, which predicts water inflow into Asaida Dam. In FY2020, the two companies began jointly developing the Dam Optimal Operation System, which also incorporates Dam Optimal Operation AI for planning optimal dam and power plant operations based on the Inflow Prediction AI.

The Dam Optimal Operation System suggests when to open the discharge gates of a dam or a power plant based on dam inflow information obtained from the Inflow Prediction AI as well as the respective dam operation rules for each dam. This will eliminate wasteful discharge and facilitate the generation of more power.

Following the verification test conducted at Asaida Dam, the two companies expanded the application to five dams in the Jinzu River system owned by Hokuriku Electric (Asaida Dam, Shininotani Dam, and Jinzu River No. 1, No. 2, and No. 3 Dams) in FY2021 and began verifying the comprehensive optimization of the operation of all five dams. The results confirmed that if operators followed the AI's suggestions regarding operations, the amount of power generated by the hydropower plants in the Jinzu River system could be expected to increase by around 1% in total. Accordingly, the companies have begun to operate the Dam Optimal Operation System. Furthermore, since the Inflow Prediction AI and Dam Optimal Operation AI have been used to reduce floods\*<sup>2</sup> caused by the early release of water from dams (under safe operation), a positive impact can be expected in flood control. We believe that the system will support local governments and dam managers while also helping to resolve regional issues. Going forward, we will incorporate cutting-edge AI technologies to keep the system advanced and evolving, and continue increasing hydropower generation as a source free of CO<sub>2</sub> emissions.

\*1 A system that can make highly precise forecasts of inflows into a dam in the next 33 hours based on past rainfall and inflow data as well as rainfall predictions by the Japan Meteorological Agency.

\*2 Strong river currents caused by a rapid rise in water levels resulting from heavy rain.



ASAIDA dam

- ▶ [Launch Dam Optimal Operation System that Employs AI \(Japanese only\)](https://www.jfe-eng.co.jp/news/2022/20221019.html) (https://www.jfe-eng.co.jp/news/2022/20221019.html)
- ▶ [Appendix to Launch Dam Optimal Operation System that Employs AI: Overview of Dam Optimal Operation System \(Japanese only\)](https://www.jfe-eng.co.jp/news/images/uploads/888bf12647816e2243755008371a0e1f7968f5af.pdf) (https://www.jfe-eng.co.jp/news/images/uploads/888bf12647816e2243755008371a0e1f7968f5af.pdf)
- ▶ [JFE Engineering's Digital Transformation Strategy \(WinmuSe®\)](https://www.jfe-eng.co.jp/dx/en/solution-4.html) (https://www.jfe-eng.co.jp/dx/en/solution-4.html)

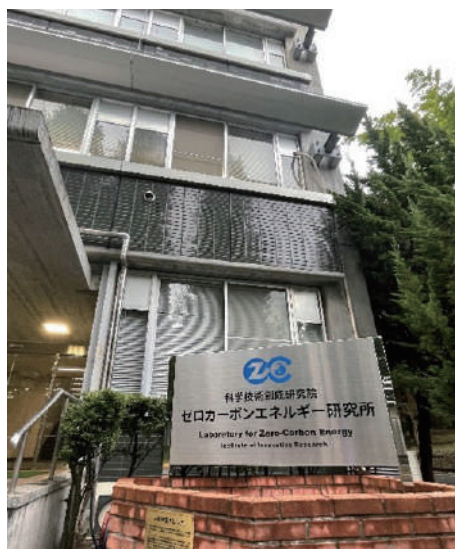
## Established the JFE Engineering Carbon Neutrality Collaborative Research Center with the Tokyo Institute of Technology

JFE Engineering and the Tokyo Institute of Technology opened the JFE Engineering Carbon Neutrality Collaborative Research Center (CRC) at the Institute's Laboratory for Zero-Carbon Energy under the Institute of Innovative Research on July 1, 2022. The purpose of the CRC is to promote new technologies for realizing a carbon-neutral society. The two parties are comprehensively and jointly working on technical developments in carbon neutrality, transcending the boundaries of a typical individual joint research framework to pursue a multilayered approach and generate innovation across the wide range of fields required for realizing a carbon-neutral society.

The CRC will promote the development of new technologies to help realize a carbon-neutral society by combining JFE Engineering's engineering technologies related to plant and infrastructure construction in the fields of energy and the environment with the Tokyo Institute of Technology's advanced academic knowledge in a wide range of areas.



CRC agreement signing ceremony on June 29, 2022



Laboratory for Zero-Carbon Energy, Institute of Innovative Research (Ookayama North No. 1 Campus)

► [JFE Engineering and Tokyo Institute of Technology establishes JFE Engineering Carbon Neutrality Collaborative Research Center \(Japanese only\)](https://www.jfe-eng.co.jp/news/2022/20220629.html) (<https://www.jfe-eng.co.jp/news/2022/20220629.html>)

## Realizing a Recycling-Oriented Society and Protecting the Marine Environment by Horizontally Recycling PET Bottles

Following the launch of the PET flakes plant in October 2021, Kyoei J&T Recycling Corporation\*<sup>1</sup>, a subsidiary of J&T Recycling Corporation\*<sup>2</sup>, began the full-scale commercial operation of a pellet production line after its completion in April 2022. Through bottle-to-bottle recycling technology that facilitates the repeated recycling of bottles (horizontal recycling), CO<sub>2</sub> can be reduced by 63% compared to manufacturing the bottles from crude oil (based on a calculation by Mitsubishi UFJ Research and Consulting). The concept was introduced in White Paper on Manufacturing Industries (Monodzukuri) 2010, issued by the Ministry of Economy, Trade and Industry, as a case for responding to resource environment restrictions\*<sup>3</sup>.

J&T Recycling endorses the activities of Japan Clean Ocean Material Alliance (CLOMA), an alliance for promoting initiatives to address the marine plastic waste problem, and engages in PET bottle and plastic recycling business as a member of CLOMA.

\*1 Joint venture between J&T Recycling Corporation and Kyoei Industries Co., Ltd.

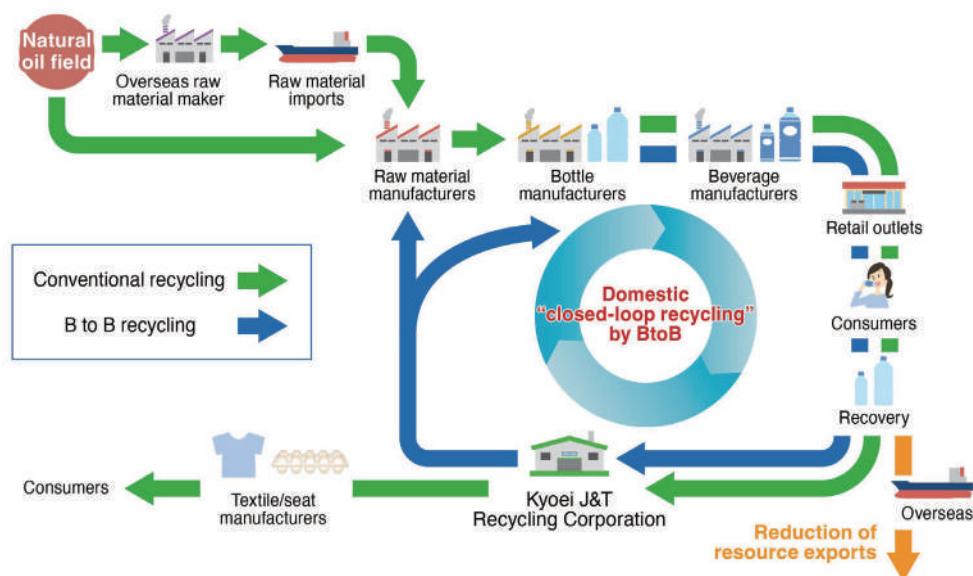
\*2 Group company of JFE Engineering

\*3 By Kyoei Industries Co., Ltd.



Photo of the whole plant

### Horizontal Recycling of PET Bottles





- ▶ [Kyoei J&T Recycling Corporation Begins Full-scale Commercial Operation of West Japan PET Bottle MR Center \(Japanese only\)](https://www.jfe-eng.co.jp/news/2022/20220421.html) (https://www.jfe-eng.co.jp/news/2022/20220421.html)
- ▶ [Establishment of Joint Venture Between J&T Recycling Corporation and Kyoei Industries Corporation—The Largest PET Bottle Recycled Resin Production Plant in Japan Contributing to the Shift to B to B \(Japanese only\)](https://www.jfe-eng.co.jp/news/2020/20200507.html) (https://www.jfe-eng.co.jp/news/2020/20200507.html)

## Overseas Infrastructure Businesses (Water Treatment Business in Southeast Asia)

JFE Engineering has formed a joint venture with Obayashi Corporation and other companies and was awarded the construction for a sewage treatment plant under the Jakarta Sewerage Development Project (Zone 1), which is supported by Japanese ODA loan, from the Directorate General of Human Settlements, Ministry of Public Works and Housing of the Republic of Indonesia.

In Indonesia's capital, DKI Jakarta, the population exceeds 10 million and sewerage coverage remains at 12%. Consequently, the installation of sewer pipelines and development of a sewage treatment plant are urgent priorities. The purpose of this project is to construct a sewage treatment plant in Zone 1, a particularly densely populated area consisting of many commercial facilities among the 15 sewerage zones under Wastewater Management Master Plan.

Given tight land restrictions, a drainage treatment technology using special film to filter (separate) drainage has been adopted to save space and enable high performance in water treatment, for constructing a sewage plant with a capacity of treating wastewater of 240,000 m<sup>3</sup>/day. The project also became the first in Indonesia to adopt a cutting-edge construction method that has been used in Japan. By comprehensively undertaking the process from design to construction, we intend to export high-quality infrastructure.



Rendering of the completed project of Jakarta Sewerage Treatment Plant (Zone 1)

## Overseas Infrastructure Businesses (Expanding Overseas Bridge Business into West Africa)

JFE Engineering is strengthening its overseas business as part of its growth strategy up to 2030. Developing social infrastructure such as bridges in countries and areas experience population growth is essential for contributing to achieving the SDGs across the world. JFE Engineering has been engaging in many overseas bridge construction projects with a focus on Southeast Asia and South Asia. Looking ahead, areas further west, Africa, and North America, are under consideration as prospective markets. Various projects for national economic growth are underway, and JFE Engineering was awarded an improvement project for Tema Intersection, Phase II in Ghana and another improvement project for intersections in Abidjan, the Republic of Cote d'Ivoire. By developing proposals that reflect an understanding of the needs and fully applying its technical capabilities, JFE Engineering will successfully complete these projects and contribute to building a foundation for daily life and the industry in these countries and West Africa.

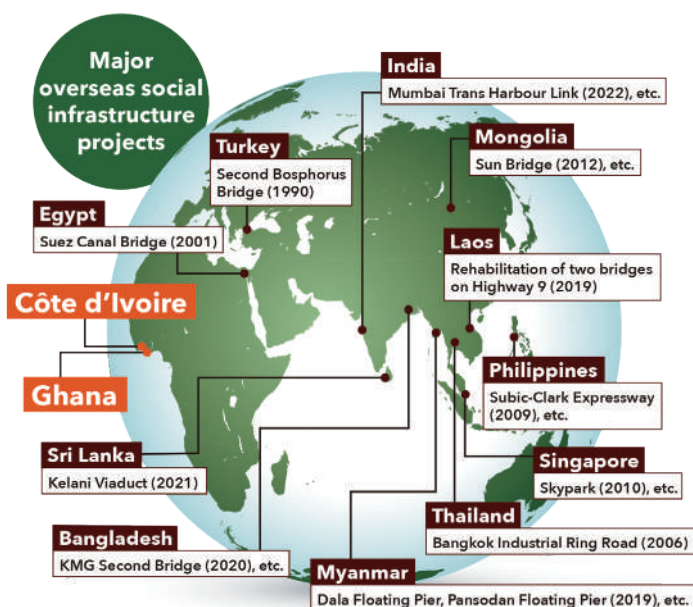
### Order Received for the Phase II of Improvement Project of Tema Intersection in Ghana

Traffic has been increasing in Ghana along with the country's economic development, and severe congestion is occurring in major arterial roads in Accra, the capital. Since this project takes place in narrow urban sites, the construction period must be kept short to minimize the impact on existing traffic already suffering from congestion. Furthermore, many of Japan's excellent sustainable technologies, such as highly durable steel/concrete composite deck slab and steel with extended painted life for improved maintenance, were adopted, helping to mitigate the burden of maintenance and management going forward.

### Order Received for an Intersection Improvement Project in Abidjan, Cote d'Ivoire

In Cote d'Ivoire's largest economic city, Abidjan, traffic congestion associated with aged and underdeveloped road infrastructure has become chronic. This project is intended to realize smooth traffic by constructing flyovers at the three intersections along the arterial road crossing the city and creating multilevel intersections. JFE Engineering proposed value engineering after reviewing the design within the scope of the project specifications, which will significantly cut construction cost and reduce CO<sub>2</sub> emissions associated with the project by adopting local standards and allowing flexibility in design.

### Major bridge projects outside Japan



### Rendering of the completed phase II project for the Tema intersection in Ghana



Source: Japan International Cooperation Agency

### Rendering of the completed improvement project for the Palmeraie intersection, Abidjan, Cote d'Ivoire



Source: Japan International Cooperation Agency

## Contract Molding Business Using One of Japan’s Largest Metal 3D Printers

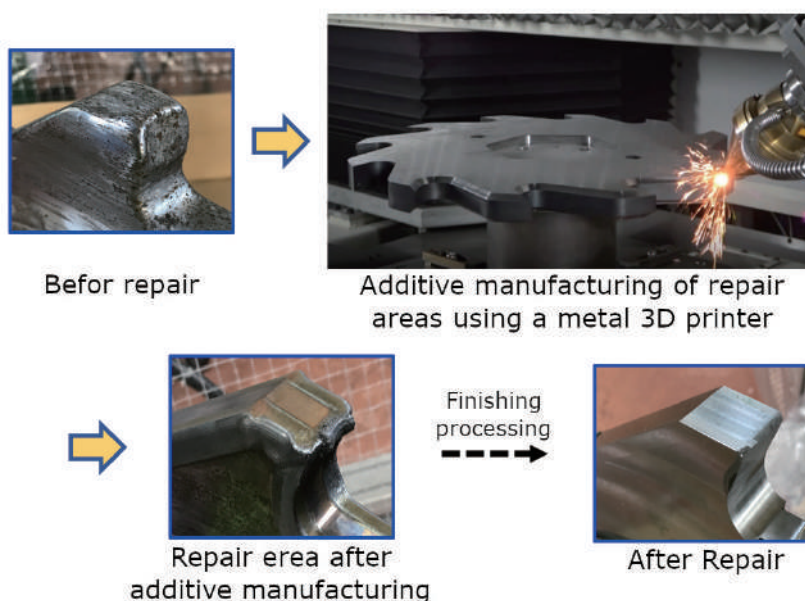
In 2022, JFE Engineering Tsurumi works started a contract molding business using one of Japan’s largest directed energy deposition (DED)\* metal 3D printers. The application of metal 3D printers has been rapidly rising, centering on aerospace and automotive fields. And demand for applications are broadly increasing in Japan as well for plants in key industries such as power, oil, gas, and chemicals, as well as in industrial machinery.

For example, while the casting process requires large amounts of power and time to create a mold and melt material, both power and time can be significantly reduced by forming a shape with layers of thin metal materials based on a 3D model using a 3D printer. The final shape can be formed in a single process using this method (near net shape manufacturing). Near net shaping manufacturing will also significantly boost yield, thereby reducing rare metal material loss.

The Tsurumi works has been manufacturing industrial machinery such as shield machines and steam turbines. We will combine the mechanical processing technology cultivated over the years with new manufacturing methodologies employing 3D printers to develop and promote the foundation of a new industry and drive technical innovation, in addition to developing manufacturing systems for new fields, including aerospace and automobiles. Furthermore, we are committed to preserving limited resources while realizing a sustainable society and supporting daily life, with due consideration for responsible production and consumption patterns.

\* A type of 3D printing method; short for directed energy deposition. Under this method, 3D figures are made by irradiating a laser beam on metal powder and laminating by repeating the padding process of melting and solidifying.

### ■ Usage example (repairing abrasion of a double axel shearing cutter. Base material: SKD61, repair material: SKH51)



▶ [Collaboration between JFE Engineering and Toray Precision Co., Ltd.—Establishing a Complementary Relationship in Molding Business Using Metal 3D Printer \(Japanese only\)](https://www.jfe-eng.co.jp/news/2022/20220523.html) (https://www.jfe-eng.co.jp/news/2022/20220523.html)

▶ [Metal 3D Printer Contract Molding Service \(Leaflet\) \(Japanese only\)](https://jfe-tsurumi.jp/wp-content/uploads/2022/09/20220802_リーフレット_金属3Dプリンター受託造形サービス.pdf) (https://jfe-tsurumi.jp/wp-content/uploads/2022/09/20220802\_リーフレット\_金属3Dプリンター受託造形サービス.pdf)



## Further Expanding the Global Supply Chain for the Steel Sheets Business

The key factor in initiatives for countering climate change, including those for reducing CO2 emissions, is minimizing electricity loss and using generated electricity without loss. Motors found in places such as power plants, factories and homes are responsible for 40–50% of all electricity consumed globally. In Japan, the ratio is approximately 60%. Improving the efficiency of motors by 1% in Japan would contribute to the equivalent of a 500,000 kW-class power generation plant in energy savings. Technological advances are expected in EV engine motors, for which demand is expected to rise during the transition to a decarbonized society, and as many as 50 to 100 other types of motors are installed per vehicle. We expect improvements in efficiency and further reductions in size and weight. In addition, in order to minimize energy loss while distributing electricity from source to factories and homes, continuous improvement in efficiency is required in transformers, where the most loss of electricity occurs.

JFE Shoji has established a stable global supply chain that includes sourcing high-quality electrical steel sheets which are essential for improving the efficiency of motors and transformers from JFE Steel and other manufacturers and processing the products for meeting customer needs. Customers who require high-quality electrical steel sheets, such as manufacturers of motors and transformers, typically operate manufacturing facilities across the globe. To align with this trend, the company has been expanding its electrical steel sheets supply chain based in a global quad-polar organization that includes Japan, America, China, and ASEAN. JFE Shoji is steadily taking action to capture demand, such as by reinforcing its stamping facilities at locations in and outside Japan to establish the world's number one global distribution and processing system for high-quality electrical steel sheets. By further expanding its supply chain and processing capabilities and collaborations with alliance companies, JFE Shoji is striving to significantly improve the distribution and processing of electrical steel sheets.

## Building a Supply Chain for the Offshore Wind Power Generation Industry

Initiatives toward carbon neutrality are expanding around the world to tackle the shared issue of climate change. Japan has set its goal to achieve carbon neutrality by 2050 and formulated the Sixth Strategic Energy Plan in 2021 to lay out strategies to that end. These ambitious strategies include reducing greenhouse gas emissions by 46% in FY2030, boosting renewable energy in its electricity mix to 36–38%, and increasing the ratio of wind in the renewable energy mix to 5% (generating capacity of 23.6 GW) compared to the 0.9% (generating capacity of 4.5 GW) in FY2019.

As for offshore wind power generation, the industry is expected to expand, as targets were set to accept proposals to build 10 GW capacity by 2030 and 30–45 GW by 2040.

JFE Shoji is collaborating with a local enterprise that manufactures the windmill foundations in Taiwan, which is leading in the offshore wind power generation market, and have been achieving progress regarding supply chain of steel materials for foundation structures. Looking ahead, the company will capitalize on the knowledge acquired and contribute to the realization of carbon neutrality by establishing a supply chain that supports the domestic production of goods and the local economy while also meeting customer demand in the offshore wind power generation industry in Japan.

## Expanding Business in Biomass Fuels

JFE Shoji imports palm kernel shells (PKS) to Japan from Malaysia and Indonesia and wood pellets from Southeast Asian countries as fuel supplies for domestic biomass power plants.

Not only are the PKS and pellets considered as carbon neutral fuel because they absorb CO<sub>2</sub> as they grow, but they are also part of a sustainable business model by replanting trees after harvest. Additionally, the company launched alternative fuel initiatives for exiting the use of coal as it strives to become an environmentally sound company.



PKS



Wood pellets

## Expansion of Scrap Trading to Support the Development of a Recycling-Oriented Society

JFE Shoji engages in a recycling business for steel and aluminum scrap. Demand for steel scrap is particularly expected to grow in Japan and overseas as the global community advances toward carbon neutrality. JFE Shoji will contribute to building a recycling-oriented society by increasing scrap recycling across the globe.

## Efficient Use of Resources

### Basic Policy

Economic growth in emerging countries is intensifying the need to conserve non-renewable resources and prevent pollution. Iron can easily be separated and is thus highly recyclable. It can be recycled and reused to make other steel products infinite times (closed-loop recycling). The JFE Group is leveraging each Group company's strengths to enhance resource recycling through recycling co-products from iron and steelmaking, reducing waste at construction sites, and promoting the global recycling of steel scrap.

We continue to pursue efficient uses of resources in both the production and product/service phases of its businesses, through steel scrap recycling, biomass fuel production and waste-to-energy power generation.

### Targets and Results

As we acknowledge that the efficient use of resources is a key environmental issue for manufacturers, we set high-level targets corresponding to the business of our Group companies and monitor the results. The Group companies have consistently fulfilled KPIs for material CSR issues every year up to FY2020 and established environmental practices. We continue to work on efficiently using resources toward the following high-level targets.

#### ■ Targets and Results for FY2022 and Targets for FY2023

Operating Company	FY2022 Targets	FY2022 Results and Initiatives	FY2023 Targets
JFE Steel	Recycling rate of co-products: 99% or higher	Recycling rate of co-products: 99.5%	Recycling rate of co-products: 99% or higher
JFE Engineering	Recycling rate at construction sites <ul style="list-style-type: none"> <li>Recycling rate of rubble: 99.5% or higher</li> <li>Recycling rate of sludge: 95.0% or higher</li> <li>Recycling rate of industrial waste: 85.0% or higher</li> </ul>	Recycling rate <ul style="list-style-type: none"> <li>Recycling rate of rubble: higher than 99.9%</li> <li>Recycling rate of sludge: higher than 99.0%</li> <li>Recycling rate of industrial waste: higher than 84.4%</li> </ul>	Recycling rate at construction sites <ul style="list-style-type: none"> <li>Recycling rate of rubble: 99.5% or higher</li> <li>Recycling rate of sludge: 95.0% or higher</li> <li>Recycling rate of industrial waste: 85.0% or higher</li> </ul>
	Recycling rate of office recyclable waste (Yokohama head office): 98.0% or higher	98.7%	Recycling rate of office recyclable waste (Yokohama head office): 98.0% or higher
JFE Shoji	Global recycling of steel scrap <ul style="list-style-type: none"> <li>Exceed FY2020 scrap trade volume (FY2024 target: +5% from FY2020)</li> </ul>	Scrap trade volume: -14% from FY2020	Global recycling of steel scrap <ul style="list-style-type: none"> <li>Exceed FY2020 scrap trade volume (FY2024 target: +5% from FY2020)</li> </ul>

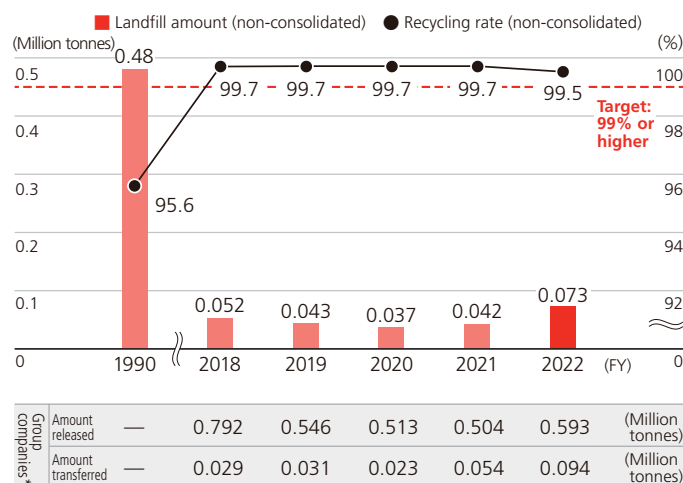
## Initiatives

### Reducing Generation and Emission of Co-products and Reusing Co-products

#### JFE Steel

JFE Steel carefully controls the generation and emission of iron and steelmaking slag (a co-product), iron dust from blast furnaces and converters, sludge from water treatment facilities, and other co-products by setting targets to improve recycling rates. Dust and sludge with high iron content are recycled as raw materials for steelmaking. Iron and steelmaking slag is effectively recycled for reuse in cement and other construction materials. The company is also promoting its use as environment recovery material such as Marine Stone™, which works effectively as a base for the adhesion of organisms and for improving the marine environment. As a result of these efforts, the company accomplished a 99.5% recycling rate for slag, dust, and sludge in FY2022, fulfilling the target of 99% or higher, and it is committed to consistently achieving the target.

#### Landfill of Co-products and Recycling Rates



\*22 JFE Steel consolidated subsidiaries in Japan.

For more quantitative data related to co-products, please refer to the following information.

► [Environmental Data](#) (P.225)

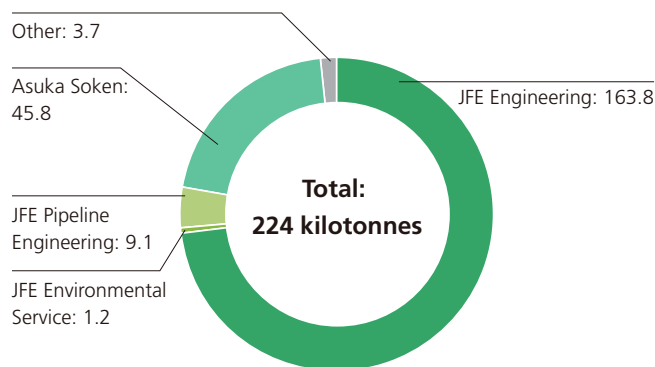
## Promoting Recycling

### JFE Engineering

Most of JFE Engineering's waste is either rubble and sludge discharged from construction sites or industrial waste discharged by the Tsurumi and Tsu works. The company is seeking to reduce industrial waste while also resource recycling through various measures, such as setting environmental goals for recycling rates and properly separating waste on-site before sending it to disposal companies known for achieving high recycling rates. It also complies with the Plastics Resource Circulation Act, enforced in Japan in April 2022, by including initiatives for plastics recycling in its environmental target.

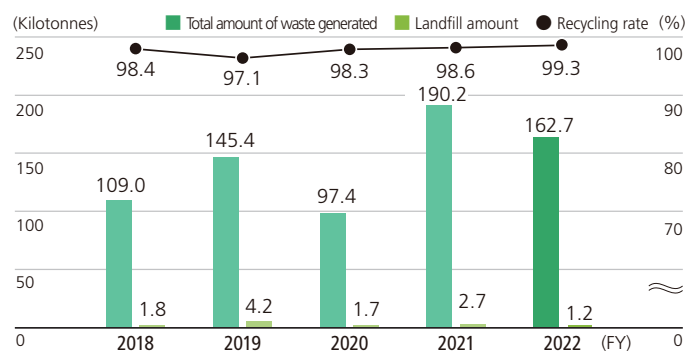
The Yokohama head office sets target recycling rates for office recyclable waste and maintains its efforts to reduce waste (encouraging double-sided copying), reuse (setting up collection boxes for plastic folders and plastic business card cases and recovering label printer cartridges), and recycle (thoroughly separating waste). The JFE Engineering Group is also helping to realize a recycling-oriented society through its PET bottle and food waste recycling initiatives.

#### JFE Engineering Group Waste Disposal for FY2022



\*Data cover JFE Engineering and 11 consolidated subsidiaries in Japan.

#### Waste Generated at Construction Sites



For more on waste generated at the steelworks, please refer to the following information.

▶ [Environmental Data](#) (P.225)



## Resource Recycling Solutions

The JFE Group is involved in establishing a recycling-oriented society through a variety of initiatives. Steelworks promotes the efficient use of raw materials, water, and other resources in the process of iron and steelmaking in addition to encouraging the application of recycled resources such as used plastics for blast furnaces. Moreover, we are striving to more efficiently use co-products generated in the iron and steelmaking process through initiatives such as the international recycling of steel scrap. By leveraging the highly recyclable quality of steel, we are also developing products that contribute to addressing the issue of plastic waste.

In the engineering field, we produce biomass fuel from food waste and sewage sludge, constructing plants, and other infrastructures for waste power generation and offer resource recycling solutions by operating these facilities directly or under contract. In addition, we are pursuing a circular economy by developing PET bottles and a plastics recycling business as well as an energy supplying business.

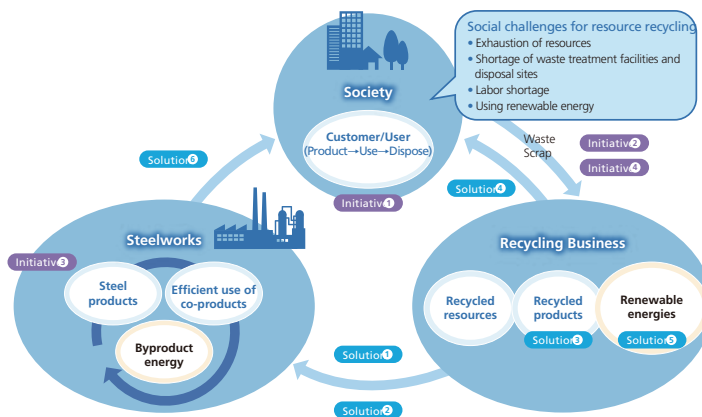
For JFE Steel and JFE Engineering's recycling businesses, please refer to the following information.

► **List of JFE Group's recycling businesses** (<https://www.jfe-holdings.co.jp/en/csr/environment/resource/pdf/resource01.pdf>)

For more on this, please refer to the following information.

► **Development and Provision of Eco-friendly Processes and Products** (P.108)

► **Environmental Communication** (P.152)



### Initiatives for Resource Recycling Solutions

**Solution 1**

**Promoting the use of recycled resources**

- Technology to inject plastic in blast furnaces

Plastic used in iron and steelmaking: 50 thousand tonnes!

**Solution 2**

**Recycling resources**

- Recycling used batteries through an electric arc furnace to separate metals such as iron, manganese, and zinc

Accumulated amount recovered at JFE Bars & Shapes: 100 thousand tonnes!

**Solution 3**

**Offering recycled products**

- Recycled plastic products such as pallets and NF boards

Recycling fluorescent lights (4 million tubes)

Recycling home electronic appliances (0.8 million units)

**Solution 4**

**Recycling**

- Recycling fluorescent lights, batteries, home electronic appliances, etc. (treating hazardous materials for recycling)
- Recycling PET bottles to produce resins

**Solution 5**

**Using renewable energy sources**

- Waste power generation, biomass power generation
- Recycling food waste, biogas generation from sludge

**Solution 6**

**Efficient use of co-products**

- For cement material, etc.

### Initiatives for Realizing a Recycling-oriented Society

**Initiative 1**

**Improving the iron and steelmaking process**

In the iron and steelmaking process, promote the efficient use of raw materials and water resources, reduced generation and emission of co-products and reuse of co-products, and use of recycled resources and recycling of resources.

On-site recycling rate of industrial waste: 99.3%!

**Initiative 2**

**Recycling/power generation business**

Engaging in a power generation business using heat and gas produced when treating wastes.

**Initiative 3**

**Improving the iron and steelmaking process**

In the iron and steelmaking process, promote the efficient use of raw materials and water resources, reduced generation and emission of co-products and reuse of co-products, and use of recycled resources and recycling of resources.

Water recycling rate: 93.2%!

Rate of efficient use of co-products: 99.5%!

**Initiative 4**

**Global circulation of scrap**

Contributing to the expansion of a recycling-oriented society at a global scale by efficiently recovering and transporting iron scrap.

**Shared Initiatives**

**Develop resource recycling technologies and products**

Develop technologies and products that efficiently use co-products generated in the Group's production process as well as wastes generated during social activities.

**Collaboration with administrative entities**

Established a new local-based power company in collaboration with an administration to promote local generation and local consumption of electricity through waste power generation, etc.

## Reducing Plastic Waste Reduction by Manufacturing Cups from Highly Recyclable Steel

Under the logo Steelish™, a combination of “steel” and “stylish,” JFE Steel is engaged in an initiative to expand the use of stylish, recyclable steel products that would introduce a change in daily lifestyles and help propel the global effort to tackle plastic pollution. For instance, JFE Steel proposes single-use steel cups as an alternative to disposable plastic cups. Steel cups are light and sturdy, with a thin rim that feels smooth against the lips, and they are able to keep drinks hot or cold for a long time, as well as being infinitely recyclable into other steel items and easier to recycle than plastic.

To this end, JFE Steel launched the project “BETTER RECYCLE Shonan” in 2021 and has since been involving customers in the development of disposable steel cups, the first time the company has adopted this approach. The project team, made up of members from IBLC Co., Ltd. and “Shonan Style” (a magazine published by EDITORS, Inc.) as well as JFE Steel, sought advice and cooperation from local governments and plastic disposable suppliers in the Shonan area and created a prototype for an eco-friendly disposable steel cup. The prototype and the Steelish™ initiative were presented at “Carnival Shonan 2022,” an event held at the Kanagawa Municipal Tsujido Kaihin Park in November 2022 to explore turning the Shonan beaches into the first zero-waste beaches in Japan.

In March 2023, steel cups were used at “Nakame Challenge Cup 2023 ,” an event hosted by Asahi YOU. US, Ltd. and the Nakame Area Management Association to eliminate disposable plastic bottles discarded by people viewing cherry blossoms in Nakameguro and raise awareness of plastic pollution, food loss, and other sustainability issues.

JFE Steel is committed to playing its part in fostering public awareness about climate change and plastic pollution issues and to achieving the SDGs by developing steel solutions that meet the needs of customers and society as a whole.



The logo for Steelish, featuring the word "Steelish" in a bold, sans-serif font. The letter "i" is stylized with a blue arrow pointing to the right, and the letter "l" is stylized with a blue arrow pointing to the left.

The Steelish® logo



The recyclable steel cup

▶ [Website on recyclable steel cups \(Japanese Only\)](https://www.jfe-steel.co.jp/products/can/use/scene09.html) (https://www.jfe-steel.co.jp/products/can/use/scene09.html)

▶ [BETTER RECYCLE Shonan \(Japanese Only\)](https://www.jfe-steel.co.jp/pr/better_recycle_shonan.html) (https://www.jfe-steel.co.jp/pr/better\_recycle\_shonan.html)

## Water Security

### Basic Policy

The JFE Group uses large quantities of fresh water for cooling and cleansing products and facilities in its core business of steel manufacturing. For this reason, the efficient use of water resources with due consideration to the source of the water and stakeholders in the area is a key challenge. In response, we have established a system for reducing water intake by maximizing the use of recycled water at our steelworks. We will continue our efforts to reduce environmental impact by reducing water consumption through more efficient use.

And while we have always taken measures against meteorological disasters such as droughts and floods at our manufacturing sites in Japan, we are further reinforcing them in anticipation of the increased frequency and severity of weather events associated with climate change by securing alternative means and raising the height of embankments. We also seek to identify water-related risks throughout our business sites and supply chain in Japan and overseas, such as the risk of drought at the source of water intake and pollution at the point of discharge. In areas under water stress, we will respond appropriately through dialogue with stakeholders.

### System

The JFE Group recognizes the issue of water resources as a risk that may significantly impact operations, and we have taken action against meteorological disasters such as droughts and floods. In recent years, we have been seeking to adequately identify and manage water risks based on the assumption that disasters due to climate change will increase in frequency and severity.

With regard to Group risk management, the Group Sustainability Committee, under the leadership of the CEO, who heads the JFE Group CSR Council, discusses, supervises, and guides Group-wide environmental initiatives, including the proper use of water resources.

There were no violations of environmental laws or regulations related to water quality in FY2022, and no fines or penalties were imposed.

### Targets and Results

We acknowledge the use of water resources as a key environmental issue for manufacturers. Because the JFE Group uses large quantities of water in its core business of steel manufacturing, the Group sets high goals for water resource recycling. We defined KPIs for material CSR issues and consistently met them every year up to FY2020. This effort helped us to establish environmental practices. We will maintain our efforts to reduce water consumption toward the following high-level targets.

#### ■ Target and Result for FY2022 and Target for FY2023

Operating Company	FY2022 Target	FY2022 Result and Initiative	FY2023 Target
JFE Steel	Maintain efficient use of water Recirculated water usage rate: 90% or higher	Recirculated water usage rate: 93.2%	Maintain efficient use of water Recirculated water usage rate: 90% or higher

## Initiatives

### Analyzing and Responding to Water Risks

As part of overall risk management, we identify, analyze and evaluate water risks based on past incidents of droughts and floods in the JFE Group's businesses, forecast data from the Meteorological Agency and results of our scenario analysis. In particular, we consider as key risks the damages to business sites and disruption of the supply chain caused by restrictions on water intake due to droughts or increasing severity of meteorological disasters. In response, we are further reinforcing measures such as using recycled water, securing alternative means, and strengthening drainage facilities.

Furthermore, to ensure the stability of our steel business's procurement throughout its supply chain, we are taking initiatives to reduce risks by evaluating them based on past data concerning water-related disasters and results of scenario analysis for materials such as coal and iron ore, securing alternative routes of procurement and diversifying suppliers.



#### JFE Steel

JFE Steel identifies and evaluates water-related risks based on past incidents of damage caused by droughts and floods, forecast data from the Meteorological Agency and results of scenario analysis. We conduct a further evaluation of water risks around each manufacturing site from different perspectives by also using the World Resource Institute (WRI)'s Aqueduct, a mapping tool for evaluating overall water risks from droughts and floods in each region around the world.

According to the WRI's assessment in May 2023, water risks for all of Japan are not designated at a high level or above, but there will be risks of water shortages and flooding due to weather conditions in the future (2030s and 2040s). JFE Steel identifies steelworks under such weather risks and takes measures such as business continuity planning.

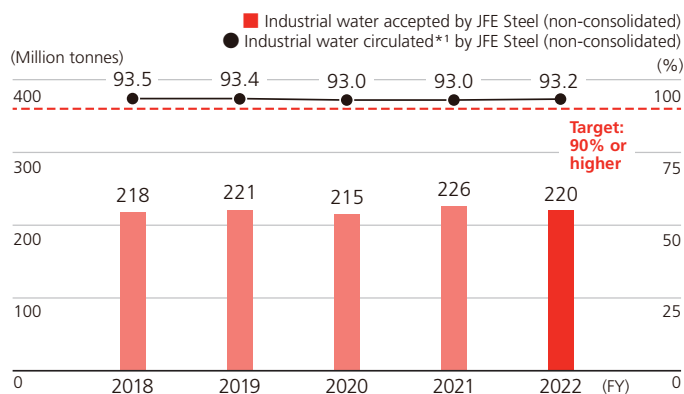
### Efficient Use of Water Resources



#### JFE Steel

A large amount of water is used in the iron and steelmaking process to cool facilities and process products. The target water recycling rate at JFE Steel is 90% or more, which is extremely high considering the amount evaporated when water is used. We are striving to improve the recycling rate by adopting purification processes such as biological and chemical wastewater treatments, and we have been successfully achieving the target. Our recycling rate of industrial water in FY2022 maintained a high level of 93.2%.

### Industrial Water Accepted/Circulated



#### JFE Steel

	2018	2019	2020	2021	2022	(Million tonnes)
Total amount	3,376	3,323	3,066	3,207	3,242	(Million tonnes)
Industrial water accepted	218	221	215	226	220	(Million tonnes)

#### Group companies\*2

	2018	2019	2020	2021	2022	(Million tonnes)
Total amount	289	293	265	235	233	(Million tonnes)
Industrial water accepted	20	20	21	19	18	(Million tonnes)

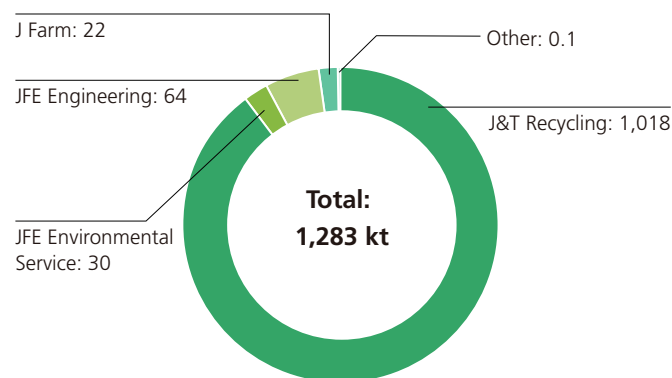
\*1 Industrial water circulated (%) = (Total amount used – industrial water accepted)/total amount used ×100

\*2 22 JFE Steel consolidated subsidiaries in Japan.

## JFE Engineering

JFE Engineering and each Group company strive to use water efficiently at their business sites.

### JFE Engineering Group's Water Consumption for FY2022



Data cover JFE Engineering and 7 consolidated subsidiaries in Japan.

For more on quantitative data related to water, please refer to the following information.

▶ [Environmental Data](#) (P.225)

## Prevention of Pollution

### Basic Policy

The JFE Group regards co-existence and mutual prosperity with local communities, the global environment, and society at large as a critical managerial challenge in terms of business continuity. It strives to control air and water pollutant emissions and aggressively invests in environmental protection. Related internal controls and education are steadily being strengthened as well. Also, the transfer and widespread application of proprietary technologies, mainly in developing countries, contribute to pollution prevention on a global scale.

### Management System

The JFE Group works to reduce environmentally hazardous substances generated from its business activities, takes actions to keep air, water, and other resources clean, and manages these matters Group-wide. In addition to management and supervision carried out by specialized committees set up at each operating company, operating companies' environmental management activities, including compliance with pollution prevention regulations, risk management, and implementing measures are reported to the Group Sustainable Committee, formed under the JFE Group CSR Council and chaired by the CEO of JFE Holdings, for Group-wide discussion, supervision, and guidance.

### Targets and Results

Acknowledging the prevention of pollution as a key environmental concern for manufacturers, the JFE Group has set high-level targets to achieve and maintain the low emission of air pollutants generated from the steelmaking and other processes based on the action plan formulated by the Japan Iron and Steel Federation. Those targets were defined as KPIs for material CSR issues until FY2020 and were consistently met every year, while our efforts to achieve them enabled us to establish environmental practices. We continue to maintain the emission of pollutants at low levels and prevent environmental pollution toward achieving the following high-level targets.

#### ■ Targets and Results for FY2022 and Targets for FY2023

Operating Company	FY2022 Targets	FY2022 Targets and Initiatives	FY2023 Targets
JFE Steel	Continue efforts to keep NOx and SOx emissions at low levels	Continuously maintained NOx and SOx emissions at low levels	Continue efforts to keep NOx and SOx emissions at low levels
	VOC emissions: –30% from FY2000 (1,078 t or less)	VOC emissions: –67% from FY2000 (513 t)	VOC emissions: –30% from FY2000 (1,078 t or less)
	Benzene emissions: –80% from	Benzene emissions: –93% from FY1999 (17 t)	Benzene emissions: –80% from FY1999 (46 t or less)
	Dichloromethane emissions: –40% from FY1999 (46 t or less)	Dichloromethane emissions: –68% from FY1999 (25 t)	Dichloromethane emissions: –40% from FY1999 (46 t or less)
JFE Engineering	Continue efforts to keep NOx and SOx emissions at low levels	Maintained low emissions as results were significantly less than the amount equivalent to the total annual volume restriction • NOx : 126.6 Nm <sup>3</sup> (18,000 Nm <sup>3</sup> ) • SOx : 41.6 Nm <sup>3</sup> (100 Nm <sup>3</sup> )	Continue efforts to keep NOx and SOx emissions at low levels

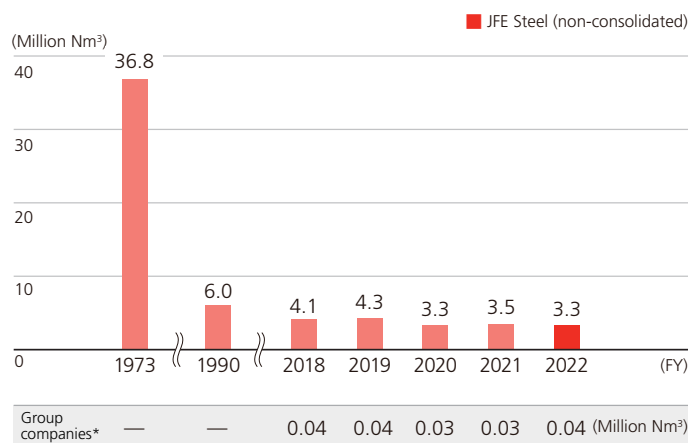
# Initiatives

## Controlling Air Emissions

### JFE Steel

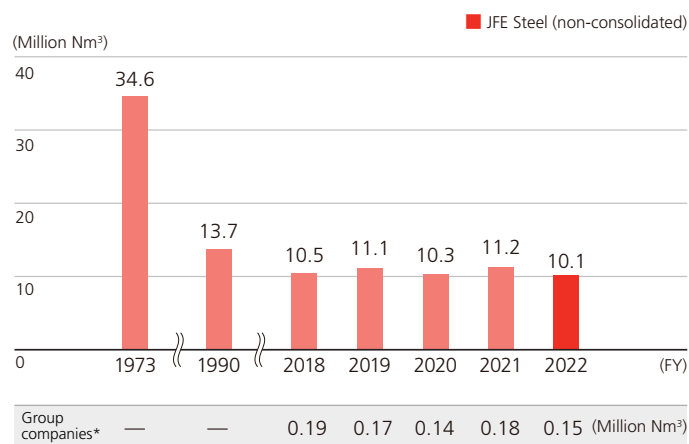
JFE Steel is installing low-nitrogen oxides (NOx) burners in reheat furnaces, switching to low-sulfur fuels and deploying desulfurization and denitration devices in sintering plants, all major sources of sulfur oxides (SOx) and NOx emissions. It has concluded agreements with local administrations that stipulate conditions that are stricter than the total volume restrictions required by the Air Pollution Control Law. The company is continuing to further control emissions at a level that is less than the amount set forth in the agreement. In addition, the company suppresses dust dispersion through measures that include enhancing on-site cleaning, installing sprinklers and windbreak fences in raw material yards, and improving the performance of dust collectors.

#### SOx Emissions



\* 10 JFE Steel consolidated subsidiaries in Japan.

#### NOx Emissions



\* 11 JFE Steel consolidated subsidiaries in Japan.

## JFE Engineering

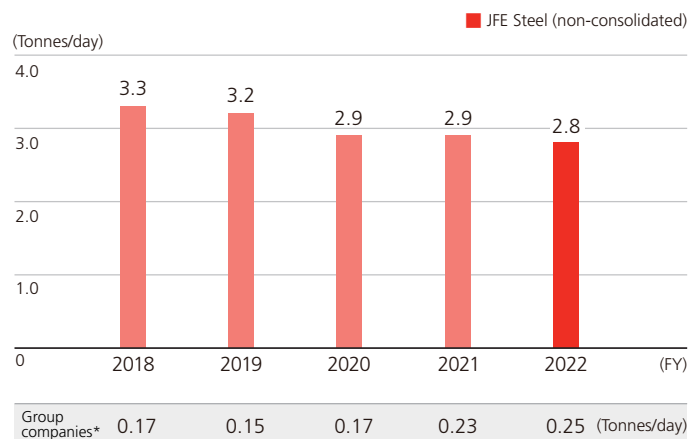
To ensure compliance with the Air Pollution Control Law and relevant local regulations, JFE Engineering properly manages facilities that emit soot and smoke at its Yokohama head office, Tsurumi works, and Tsu works, so NOx and Sox emissions from those facilities are maintained at a level sufficiently lower than the total annual volume restriction (NOx: 18,000 Nm<sup>3</sup>, Sox: 100 Nm<sup>3</sup>). In addition, efforts are being made at construction sites to protect the environment through the use of construction machinery and on-site vehicles in compliance with the Automotive NOx and PM Law and Act on Regulation, Etc. of Emissions From Non-road Special Motor Vehicles (Off-Road Vehicle Law).

## Preventing Water Pollution

### JFE Steel

JFE Steel strives to reduce its environmental impact on waterways by thoroughly purifying water used in iron and steelmaking processes before releasing it into public waterways or sewers. The company has concluded agreements with the administrative entity in each area that set out more rigorous effluent standards, compared to those stipulated under the Water Pollution Prevention Act. It also established a strict voluntary control standard to improve water quality. For FY2022, chemical oxygen demand (COD), the water-quality index for wastewater, was 2.8 tonnes per day.

#### Chemical Oxygen Demand (COD)



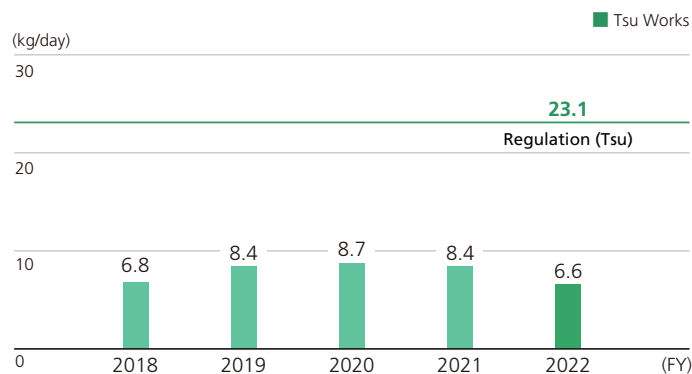
\*10 JFE Steel consolidated subsidiaries in Japan.



## JFE Engineering

Wastewater from the JFE Engineering Yokohama head office, Tsurumi works, and Tsu works, is released into public waterways or sewer systems. Nitric oxide, phosphorus, and COD in the wastewater are measured on a regular basis and effectively managed in accordance with the Water Pollution Prevention Act and Sewerage Act.

### Chemical Oxygen Demand (COD) in Wastewater Released Publicly



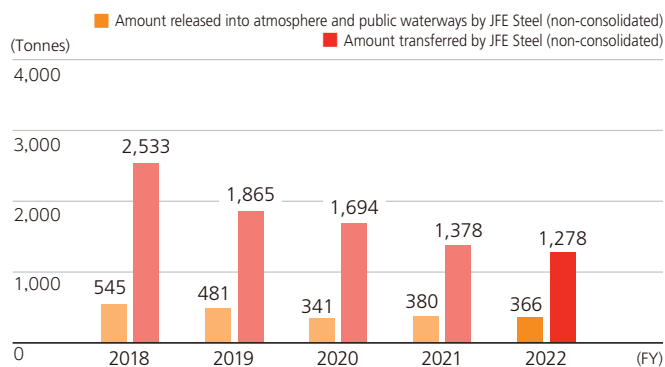
This report uses the maximum value of each year.

## Management of Chemical Substances and Emission Control

### JFE Steel

JFE Steel lowers its environmental impact by voluntarily reducing the chemical substances it releases. Release and transfer amounts of substances subject to Japan's Law concerning Pollutant Release and Transfer Register (PRTR Law) are reported in accordance with the law. In FY2022, chemical substances released into the atmosphere and public waterways totaled 366 tonnes.

### Release and Transfer Amounts of PRTR-registered Substances at JFE Steel



Group Companies*	Amount released (tonnes)	Amount transferred (tonnes)
2018	269	6,643
2019	285	5,967
2020	255	4,216
2021	292	8,433
2022	243	11,501

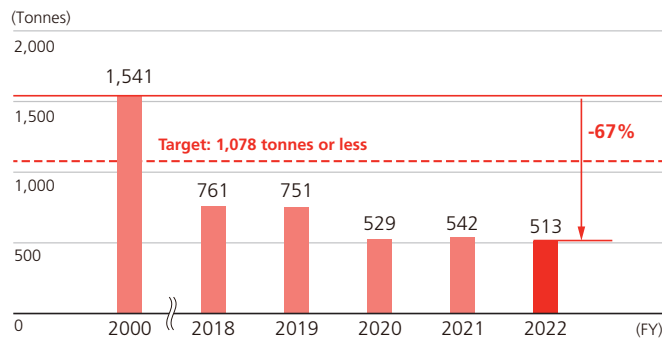
\* 15 JFE Steel consolidated subsidiaries in Japan.

The Japan Iron and Steel Federation formulated a voluntary action plan to reduce VOC emissions by 30% from FY2000 levels by FY2010. As part of this action plan, JFE Steel set a target for reducing emissions to 1,078 tonnes or less. As a result of our initiatives, we achieved a significant reduction that exceeded the 30% reduction target in FY2010 and have been consistently cutting VOC emissions, by more than 50%. Going forward, we will continue to maintain the emissions below 1,078 tonnes

and take the necessary steps to prevent any increase.

Emissions of benzene and dichloromethane are kept at low levels. We will continue to set targets for the two substances and maintain low emissions levels.

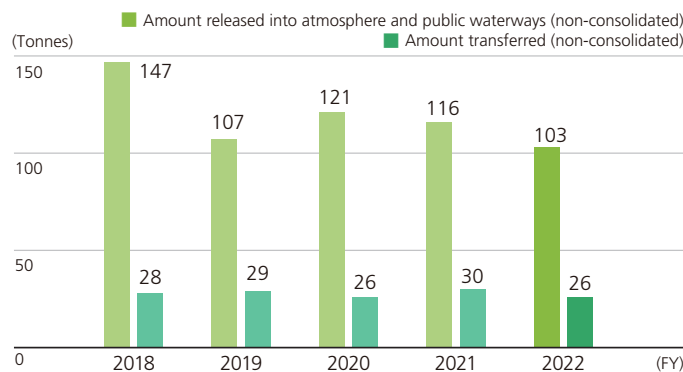
### VOC Emissions



### JFE Engineering

Major chemical substances subject to the PRTR Law for the JFE Engineering works in Tsurumi and Tsu include organic solvents such as xylene used for painting products, manganese and its compounds generated during welding. We report the release and transfer amounts of these substances in accordance with the law.

### Release and Transfer Amounts of PRTR-registered Substances at JFE Engineering



Group companies*	Amount released	45.4	36.7	39.3	37.8	(tonnes)
	Amount transferred	5.4	12.5	4.4	4.4	(tonnes)

\*4 JFE Engineering consolidated subsidiaries in Japan.

For more on quantitative data related to PRTR, please refer to the following information.

➤ [Environmental Data](#) (P.225)

### PCB Waste Management at JFE

Polychlorinated biphenyl (PCB) waste is properly stored and managed at the JFE Group's facilities. High concentration PCB waste is treated in accordance with guidelines set by the Japan Environmental Storage & Safety Corporation (JESCO). The Yokohama Eco Clean Plant of J&T Recycling Corporation treats insulating oil contaminated with slight amounts of PCB, helping to reduce pollutants both in and outside the JFE Group.

# Biodiversity

## Basic Policy

Recognizing that natural capital and biodiversity are foundational for realizing a sustainable society, the JFE Group has endorsed the Declaration of Biodiversity by Keidanren and Action Policy and conducts business in harmony with nature across the world. We particularly recognize the preservation of biodiversity as a key challenge and conduct assessments to minimize the ecological impact associated with our business activities. Our initiatives include cooperating with the community to monitor biodiversity and carry out preservation activities around the steelworks, the key facilities for our business, and in surrounding areas. We are also involved in developing iron and steelmaking slag products that can help restore the marine environment. Furthermore, beyond our business operations, we launched a joint research program with a local government and conduct environmental education for local communities.

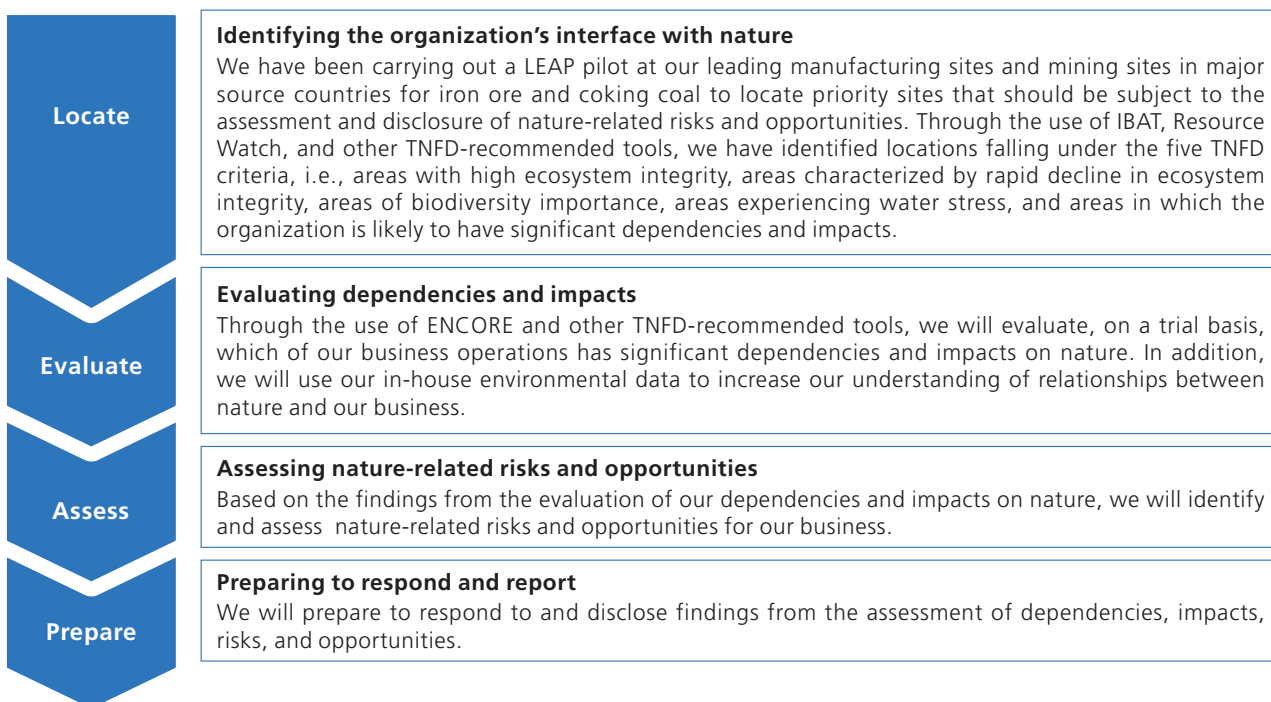
► [Declaration of Biodiversity by Keidanren and Action Policy \(Revised Edition\)](https://www.keidanren.or.jp/en/policy/2018/084.html) (https://www.keidanren.or.jp/en/policy/2018/084.html)

## Initiatives

### Risk and Opportunity Assessment in Line with the LEAP Approach

The JFE Group began pilot testing the LEAP approach in line with the recommendations of the Taskforce on Nature-related Financial Decisions (TNFD), starting with JFE Steel’s leading manufacturing sites and its upstream operations at external mining sites in major source countries for iron ore and coking coal. We will increase our understanding of relationships between nature and the Group toward the disclosure of material risks and opportunities in accordance with the TNFD framework.

#### ■ Progress in pilot LEAP assessment



## Initiatives to Preserve Biodiversity



### Environmental Impact Assessment

To minimize the ecological impact of our business activities on surrounding areas, we are monitoring biodiversity around all of our business sites and planting trees while also preserving rare species in the compound. An environmental impact assessment is conducted in accordance with laws and regulations before launching construction of a new manufacturing site or business. We assess the biodiversity of the surrounding areas as well as our premises to fully understand the situation and to implement the necessary measures for preserving the ecosystem.

### Replanted a Rare Species of Orchid Found at a Planned Construction Site

Plant No. 1 in the JFE Ohgishima Thermal Power Plant, an aging facility, was renovated and resumed operations in 2019. Before this construction, we conducted an environmental prediction and evaluation for the renovation, in accordance with the Environmental Impact Assessment Act and Electricity Business Act. As a result, the Kugenuma orchid, a plant listed in Japan's Ministry of Environment's fourth version of the Red List as an endangered species (Threatened II- Vulnerable, VU), was discovered at the planned construction site for power generation facilities. To preserve the orchids, we replanted them in a different location of the site that had a similar environment.



A Kugenuma orchid discovered at the planned construction site for the JFE Ohgishima Thermal Power Plant

## Contributing to Biodiversity and the Creation of an Attractive Seaside Town by Utilizing Steel Slag Products (Partnership Agreement with Yokohama City)

Silty sediment (sludge containing large amounts of organic matter) piles up at the ocean bed along the seaside frontage of Yamashita Park in Yokohama City, Kanagawa Prefecture, and significantly deteriorates water quality in summer. As a result, the ocean's ability to function as a spawning ground or environment for nurturing organisms has been lost. In a joint research project with Yokohama City, JFE Steel is restoring the intrinsic ability of the waters to purify seawater with the help of marine organisms by using carbonated steel slag products such as Marine Block™ to form shorelines as a base for the adhesion of organisms and assist in improving the marine environment. Immediately after an experiment, we observed an increase in the presence of marine organisms such as starfish and sea cucumbers around the area, and the populations continuing to grow. Moreover, we estimated that 8,400 kl of seawater (equivalent to seventeen 25-meter swimming pools) is filtered per day by filter-feeding marine creatures such as bivalves and sea squirt. We also estimated their impact on the removal of COD\*<sup>1</sup> and the reduction of CO<sub>2</sub> in comparison to results obtained through water purification at sewage treatment plants.

The findings from the research project were presented at many exhibits and other events, helping to raise local awareness of environmental protection. This public-private research project for improving the marine environment has earned public recognition, with Yokohama City and JFE Steel jointly receiving the FY2021 Environmental Award (Group-2) of the Japan Society of Civil Engineering\*<sup>2</sup>. In September 2022, JFE Steel won the Minister of Land, Infrastructure, Transport and Tourism Award of the 5th Eco Pro Awards\*<sup>3</sup>, sponsored by the Sustainable Management Promotion Organization, a general incorporated association.

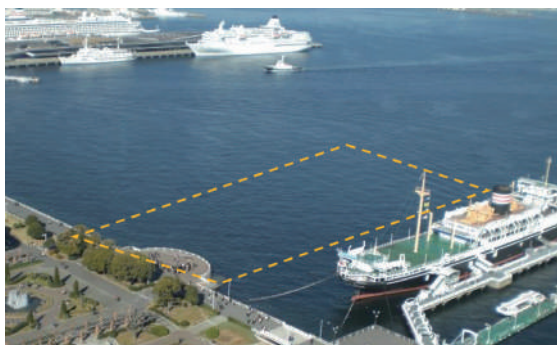
\*1 COD stands for chemical oxygen demand, an indicator for water pollution in seas, oceans, lakes, and ponds. It represents the amount of oxygen (mg/l) consumed when pollutants present in water, such as organic matter, are oxidized.

\*2 The Japan Society of Civil Engineering Award is a prestigious award with a history of over 90 years. The Environmental Award (Group-2) is given to an innovative project that has contributed to any combination of environmental preservation, improvement, and creation activities by developing or operating civil engineering technology or systems.

\*3 The award is given to goods, services, technology, solutions, or business models with specific and outstanding eco-friendly attributes that are widely recognized by businesses, consumers, investors, and market players in the Japanese market.

▶ **FY2021 Environmental Award of the Japan Society of Civil Engineering** (<https://www.jsce-int.org/node/780>)

▶ **The 5th Eco Pro Award (Japanese only)** ([https://sumpo.or.jp/seminar/awards/5th\\_eco-pro\\_award\\_results.html](https://sumpo.or.jp/seminar/awards/5th_eco-pro_award_results.html))



The dotted line indicates the area in which slag products are being used at Yokohama Bay (photo taken by Yokohama City)



Colony of sea squirts on Frontier Rock™



Marine Block™ covered by marine bivalves (Yokohama Bay area)

## Advancing Biodiversity Verification of Steel Slag Products in Collaboration with Venture Businesses

JFE Steel keeps a water tank containing the coral-covered steel slag product Marine Block™ at the exhibition area at the reception of the head office, offering visitors the opportunity to enjoy watching coral and tropical fish while learning about our initiative to preserve the ecosystem using steel slag products. We also intend to conduct experiments inside the tank. Innoqua Inc.\* is providing technical support for the exhibition, which has been featured by several newspapers and TV programs as an example of business collaboration in the field of the environment.

\*A venture company engaged in the development of systems for managing and nurturing corals and fish by combining its aquarist know-how with IoT and AI.



Healthy coral growth on Marine Block™ inside the water tank

## Firefly Festival

JFE Steel has opened its Environment Pond at the Chita Works to the community for a firefly viewing festival every year since 2014. Children at the event have the opportunity to release fireflies. The Company is nurturing an environment that preserves the ecosystem together with the local community by maintaining the watering holes and surrounding environment within the steelworks site and these firefly viewing events.



Releasing firefly larvae



Stream within the Chita Works site where fireflies are released



Firefly viewing party

## The Chita Works Certified as an Aichi Biodiversity Company

In November 2022, our Chita Works was recognized as a certified enterprise under the Aichi Biodiversity Company Certification Program in its first term launched by Aichi Prefecture based on the Aichi Biodiversity Strategy 2030. The program is intended to encourage more businesses in the prefecture to play a pivotal role in preserving local biodiversity by certifying those that have implemented outstanding initiatives to do so.

The Chita Works is working with academia and the public sector, including the local community and nursery schools and kindergartens, to release firefly larvae in the stream running through the site and help them gain a foothold, apart from holding firefly viewing festivals for local residents. Since FY2022, the Chita Works has also exchanged information about the migration of the chestnut tiger butterfly, a species that travels more than 2,000 kilometers across Japan, with municipalities on the Chita Peninsula in Aichi Prefecture. The compound of the Chita Works is filled with thoroughwort and other plants to make it green for the butterflies. The works will continue to take on more initiatives for biodiversity preservation while strengthening its cooperation with the local community.



**EN JFE Engineering**

## Initiatives in Relation to Construction Works

For large-scale construction or construction work carried out near watersheds or mountainsides, customers and/or the relevant authorities may conduct preliminary investigations depending on the importance of preserving the surrounding environment. Various preservation conditions may then be required, including the protection of living creatures.

JFE Engineering respects the proposed conditions and thoughtfully considers biodiversity preservation by keeping the impact of construction works at a minimum. For example, the company may propose a construction method that minimizes the impact of noise or drainage pollution. For its steelworks, the status of biodiversity on its premises and in surrounding areas is checked, and necessary measures are taken to ensure preservation.

## Biotope for Children's Learning Experience

JFE Engineering has conducted some renovation work at the JFE Dragonfly Path in the Tsurumi Works, and since 2009 it has been inviting children in the community to learn about the ecosystem at a biotope, Dragonfly Pond, located along this path. In 2022, the JFE Dragonfly Path Fan Club, a group mainly composed of neighborhood residents, organized a research event that involved capturing dragonflies in order to learn about their ecology and the local environment.

Furthermore, JFE Engineering has been a co-sponsor of the How Far Do Dragonflies Fly since FY2020, with the aim of improving the quality of green spaces in the Keihin coastal areas and contributing to biodiversity. The forum brings together companies, residents, governments, and experts and conducts research activities such as capturing dragonflies that fly in 15 green spaces and biotopes scattered throughout the Keihin Coastal Area and inland areas, tagging them, releasing them, and tracking their movements. The JFE Dragonfly Path also serves as one of the research sites. This forum celebrated its 20th anniversary in 2022, and JFE participated in a panel discussion at the commemorative event at Yokohama City Hall and exchanged opinions with other companies.



Dragonfly Pond serving as biotope



The event celebrating the 20th anniversary of the How Far Do Dragonflies Fly Forum



## Participation in Kanagawa Prefecture's Reforestation Partner Program

In March 2023, the JFE Engineering Group's J&T Recycling Corporation expressed its support for the Kanagawa Reforestation 50 Year Plan and signed a memorandum of understanding with Kanagawa Prefecture on the Reforestation Partner Program\*, an initiative launched by the prefecture.

The company's intent is to use the program as part of its environmental protection and harmony activities while supporting the prefecture's vision. Under the partnership, the company's employees volunteer to help thin trees and take part in other efforts for conserving forests, a valuable source of water for future generations. In May 2023, 18 employees who joined the company in April helped prune trees at the Municipal Forest for the 21st Century located in Ashigara, Kanagawa Prefecture, and learned firsthand the importance of environmental preservation and volunteering.

The Reforestation Partner Program grants naming rights to participants for parts of the prefecture-owned forests, one of which is now called the J&T Kankyo Miracle Forest (with the word "miracle" expressed in kanji, meaning the "future is coming"). J&T Recycling Corporation is constantly enhancing its ESG initiatives to improve the environment.



New employees pruned trees in a volunteer activity



J&T Kankyo Miracle Forest



Valuation report on CO<sub>2</sub> absorption by the forest

\*For details about the Reforestation Partner Program, please refer to:

▶ [Website for Kanagawa Prefecture \(Japanese Only\)](https://www.pref.kanagawa.jp/docs/pb5/partner.html) (https://www.pref.kanagawa.jp/docs/pb5/partner.html)

## Endorsing and Participating in External Initiatives

As a member of the Keidanren Committee on Nature Conservation, the JFE Group endorses the Declaration of Biodiversity by Keidanren and Action Policy and actively engages in the conservation of nature and biodiversity. In addition, the Group took part in the Business for GBF Project, launched by the Ministry of the Environment and Keidanren Committee on Nature Conservation. JFE Steel's steel slag product was selected by the Ministry and Keidanren and introduced as an example of an initiative that contributes to the conservation of biodiversity. Going forward, we will deepen our understanding of and contribute to the Post-2020 Global Biodiversity Framework and other global initiatives committed to preserving nature and biodiversity.

For further details on external initiatives, please refer to:

▶ [Business for GBF Project, Ministry of the Environment](https://www.biodic.go.jp/biodiversity/private_participation/business/en/) (https://www.biodic.go.jp/biodiversity/private\_participation/business/en/)

## Products and Technologies (Preserving Biodiversity)

The JFE Group endorses and participates in the Challenge Zero initiative that is being jointly sponsored by Keidanren and the Japanese government. And we are collaborating with Yokohama City on a project that uses steel slag to improve the marine environment while also developing various products aimed at conserving biodiversity.

For more on products and technologies related to environmental protection, please refer to the following information.

▶ [Development and Provision of Eco-friendly Processes and Products](#) (P.108)

▶ [Challenge Zero](https://www.challenge-zero.jp/en/member/34) (https://www.challenge-zero.jp/en/member/34)

## Environmental Communication

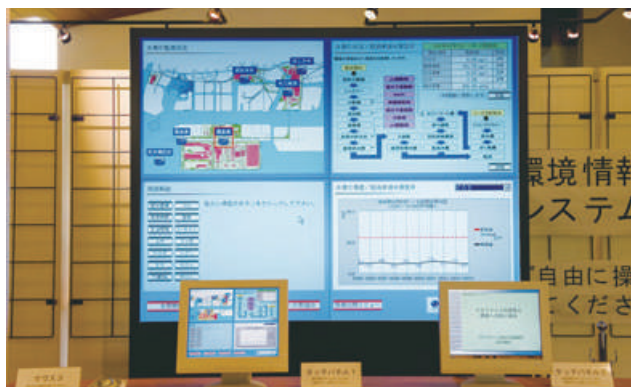
### Basic Policy

The JFE Group gives utmost priority to communicating with all stakeholders, including in matters relating to the environment. In addition to disclosing environmental information, the Group carries out extensive two-way communication between the public and the business community by supporting and participating in environment-related activities outside the Group.

### Initiatives

#### Disclosing Environmental Data

The East Japan Works of JFE Steel discloses real time environmental data on local air and water quality. Visitors can review this information in the first-floor lobby of the Visitor Center in the Chiba District and in the Amenity Hall and the first-floor lobby of the Keihin Building in the Keihin District.



Environmental data display in the Keihin District

#### Environmental data display in the Keihin District

#### Commercial Video and Special Website about JFE

We created a commercial video and special website featuring the JFE Group's initiatives for a sustainable future to bring the Group closer to stakeholders. The video and website are titled "Sus-tetsu-nable!" with the word "tetsu" meaning iron inserted into the word "sustainable." We hope that the video and website will help the public better understand iron as an essential element for social infrastructure and recognize the Group's efforts as an indispensable member of society.

▶ [Special website "Sus-tetsu-nable!" \(Japanese Only\)](https://www.jfe-holdings.co.jp/sus-tetsu-nable/) (<https://www.jfe-holdings.co.jp/sus-tetsu-nable/>)

## ecobeing Environmental Website

The JFE Group provides support to ecobeing, a web magazine operated by KLEE INC., which disseminates information on the environment under the slogan, "Let's talk more with the Earth!" The website series, ecopeople, has featured people from a variety of fields and also introduced JFE Group employees and initiatives. In 2022, the magazine covered JFE Steel's BETTER RECYCLE Shonan, featuring the project for addressing plastic pollution by increasing the application of steel sheets for can-making along with those involved in the project in and outside the company, among other environmental initiatives beyond the JFE Group. By supporting this website magazine from an objective standpoint, the JFE Group seeks to help stimulate public discussion and awareness about ESG and the SDGs.

Please see the following for further details.

► [ecobeing \(Japanese only\)](https://www.ecobeing.net/) (https://www.ecobeing.net/)

► [BETTER RECYCLE Shonan \(Japanese only\)](https://www.ecobeing.net/ecopeople/2022_summer/04.html) (https://www.ecobeing.net/ecopeople/2022\_summer/04.html)

## Sponsoring Midori no Komichi Environmental Diary

The JFE Group sponsors the Midori no Komichi (Green Trail) environmental diary project hosted by Green Cross Japan with the hope that children will become more aware of environmental issues by keeping diaries of their activities and thoughts about ecology.

Please see the following for further details.

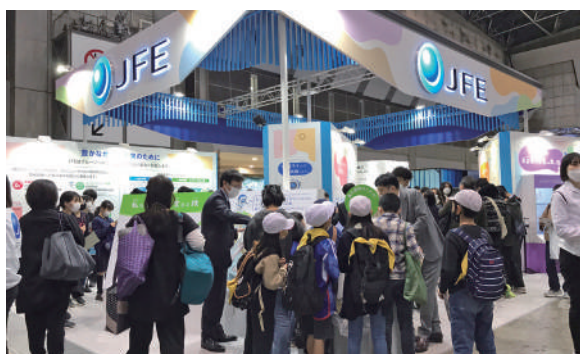
► [Midori no Komichi Environmental Diary \(Japanese only\)](https://www.midorinokomichi.net/) (https://www.midorinokomichi.net/)

## Participation in Environmental Exhibitions Such as EcoPro2022 and Tokyo Bay Festival 2022

The JFE Group's business activities for protecting the environment have been presented at various environmental exhibitions.

In December 2021, the JFE Group participated in one of the largest environmental exhibitions in Japan, EcoPro2022, held at Tokyo Big Sight. Under the theme, "For a Prosperous Global Future—the JFE Group Collective Efforts to Address Climate Change," we displayed our initiatives for reducing CO2 emissions in the steel business as well as technologies, mainly in engineering, that help reduce emissions across all of society. Many people, predominantly elementary and junior high school students, visited our booth to observe the Group's climate change initiatives by watching videos and using models to gain hands-on experience.

In 2022, JFE Steel received the Minister of Land, Infrastructure, Transport and Tourism Award of the 5th Eco Pro Awards, sponsored by the Sustainable Management Promotion Organization (a general incorporated association) for "Creating a Rich Sea through Public-Private Partnership: Improved Quality of Waters with a Steel Slag Product and an Initiatives for Environmental Education," a joint project with Yokohama City, and the award ceremony was held at EcoPro2022.

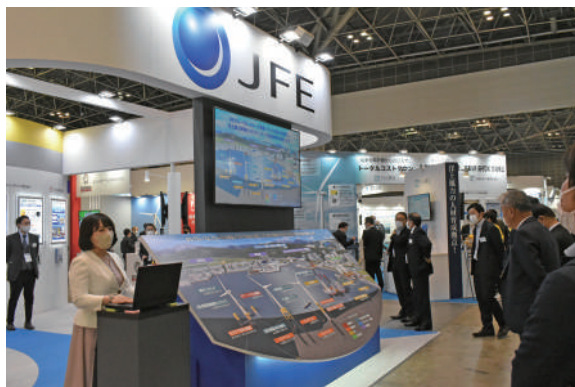


The JFE Group's booth at EcoPro2022



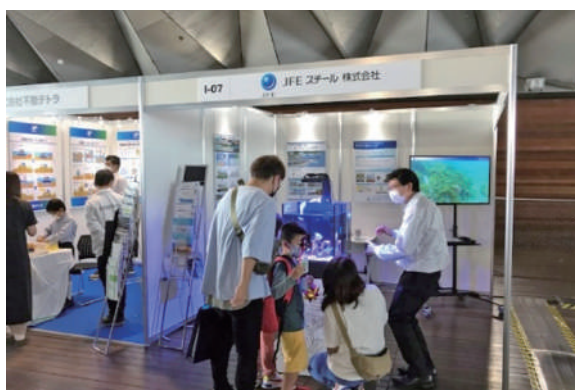
The event drew many children as well as adults.

The JFE Group's eight companies jointly participated in the 11th WIND EXPO at Tokyo Big Sight in March 2023. The WIND EXPO is one of the Smart Energy Week expos, a set of simultaneous expositions about seven new energy fields, and Japan's largest wind energy exposition. Our involvement in the WIND EXPO provided an opportunity to display the Group's expertise in various categories in relation to offshore wind power generation from foundation structures, construction, and O&M (operation and maintenance) to supply chains while deepening relationships with a wide range of visitors. We will continue to encourage efforts in the offshore wind power generation business and win more orders.



JFE Group's booth at WIND EXPO

In October 2022, JFE Steel took part in Tokyo Bay Festival 2022: SDGs and Tokyo Bay, an event held in Yokohama City to appreciate the bounty of Tokyo Bay, and presented the company's involvement in the regeneration of the marine environment and contribution to biodiversity through its steel slag products. The event was held in person for the first time in three years and offered a great opportunity for the company to showcase to the many visitors how its products contribute to the SDGs.



JFE Steel's booth at Tokyo Bay Festival 2022