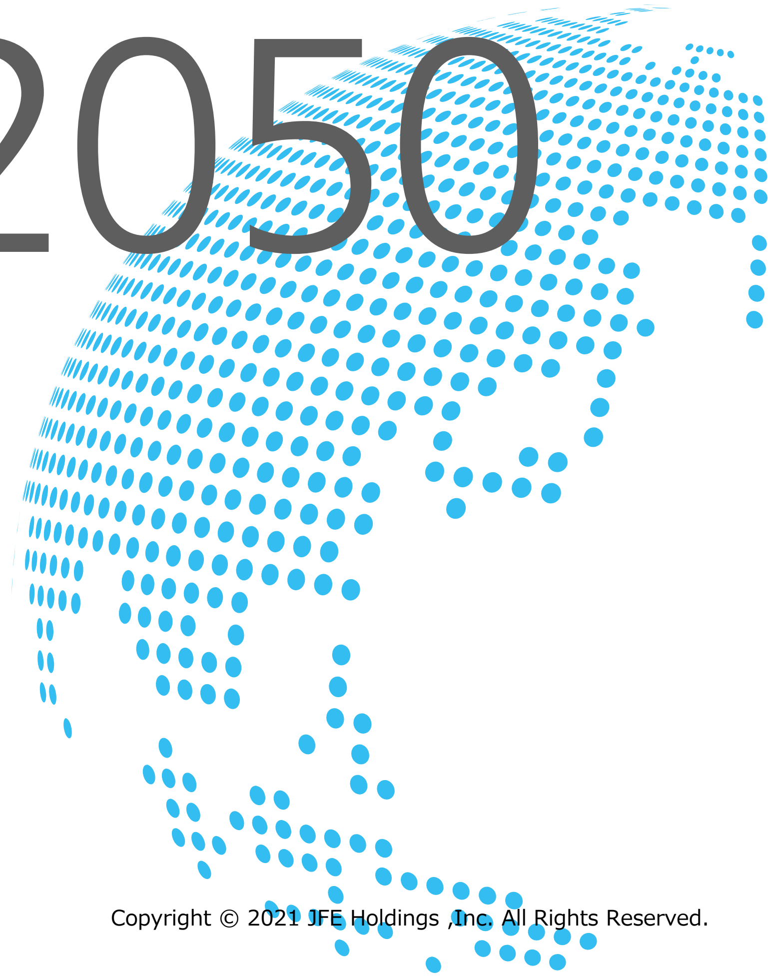
Environmental Vision 2050



May 25, 2021

JFE Holdings, Inc.

01 Outline of JFE Group Environmental Vision for 2050

JFE

SDGs

JFE Group Environmental Vision for 2050

Towards Carbon Neutrality

- **Climate change is an extremely important issue from the perspective of business continuity.**
- **Global climate-change issues**, such as increasingly abnormal weather, **must be addressed urgently.**

2020 was the starting point for responding to climate change through CO_2-reduction activities.

Achieving carbon neutrality in 2050 is the most important issue in JFE's medium-term business plan.

- Based on our corporate philosophy of **contributing to society with the world's most innovative technology**, we will accelerate our research and development of new technologies and **pursue super-innovative technologies** to combat climate change.
- In addition to addressing our **business risks, we will seek business opportunities that allow us to help realize a more sustainable world** and enhance our corporate value by contributing to CO_2 emissions reduction across society.
- **The philosophy of the Task Force on Climate-related Financial Disclosure (TCFD) will be reflected in our business strategies and deployed in a systematic manner**

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SDGs

JFE Group Environmental Vision for 2050

Towards Carbon Neutrality

(Group-wide investment in GX in the 7th Medium-term Business Plan: **340 billion yen**)

R&D, etc. 50 billion yen
ST CAPEX for electrical steel sheet in Kurashiki 49 billion yen
EN monopile approx. 40 billion yen

ST: JFE Steel
EN: JFE Engineering

1. 7th Medium-term Business Plan Initiatives

- **Steel business: Reduce steel-business CO_2 emissions in FY2024 by 18% vs. FY2013**

2. Initiatives for carbon neutrality by 2050

***CCU**: Carbon dioxide Capture and Utilization

a. Reduce CO_2 emissions at JFE Steel

- **Pursue super-innovative technologies mainly for carbon-recycling blast furnaces and CCU***
- Develop hydrogen-based ironmaking (direct-reduction) technology, maximize use of electric arc furnace technology, etc.

b. Expand contributions to CO_2 emissions reduction in society

- Engineering business: Expand and develop renewable-energy power generation and carbon-recycling technologies.
- Steel business: Develop and market eco-products and eco-solutions.
- Trading business: Increase trading in biomass fuels, steel scrap, etc. and strengthen business in supply chain management (SCM) for eco products.

CO_2 emissions reduction contributions:
12 million tons in FY2024
25 million tons in FY2030

c. Accelerate groupwide commercialization of offshore wind-power business

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Initiatives in Carbon Neutrality by 2050

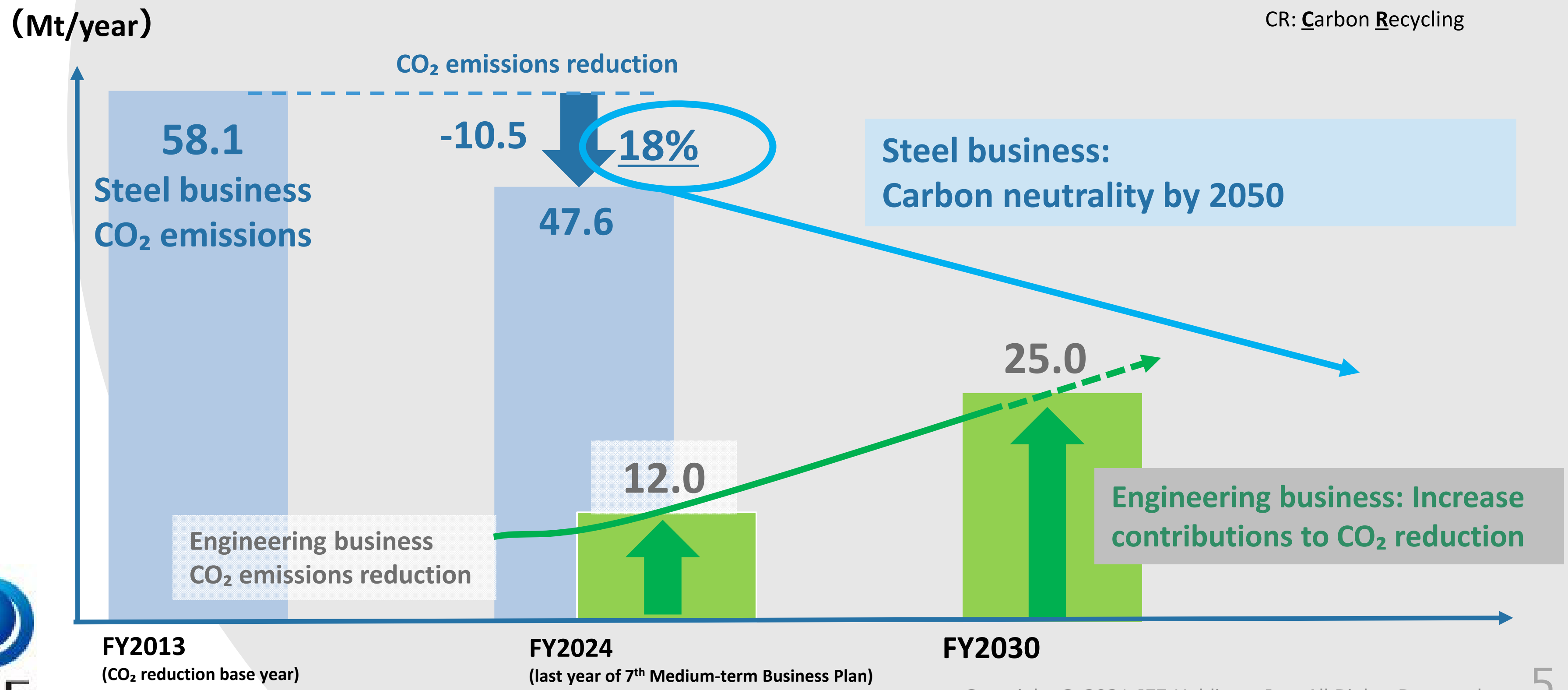
Steel business: Reduce CO_2 emissions in FY2024 by 18% vs. FY2013
Drive JFE's carbon neutrality by decarbonizing steel processes, etc.

GX investment in steel business: 160 billion yen over 4 years

Engineering business: Support carbon neutrality in society through expansion and development of renewable-energy power generation and CR technologies, etc.

GX investment in engineering business: 130 billion yen over 4 years

CR: Carbon Recycling



02 Steel-business Initiatives for Carbon Neutrality

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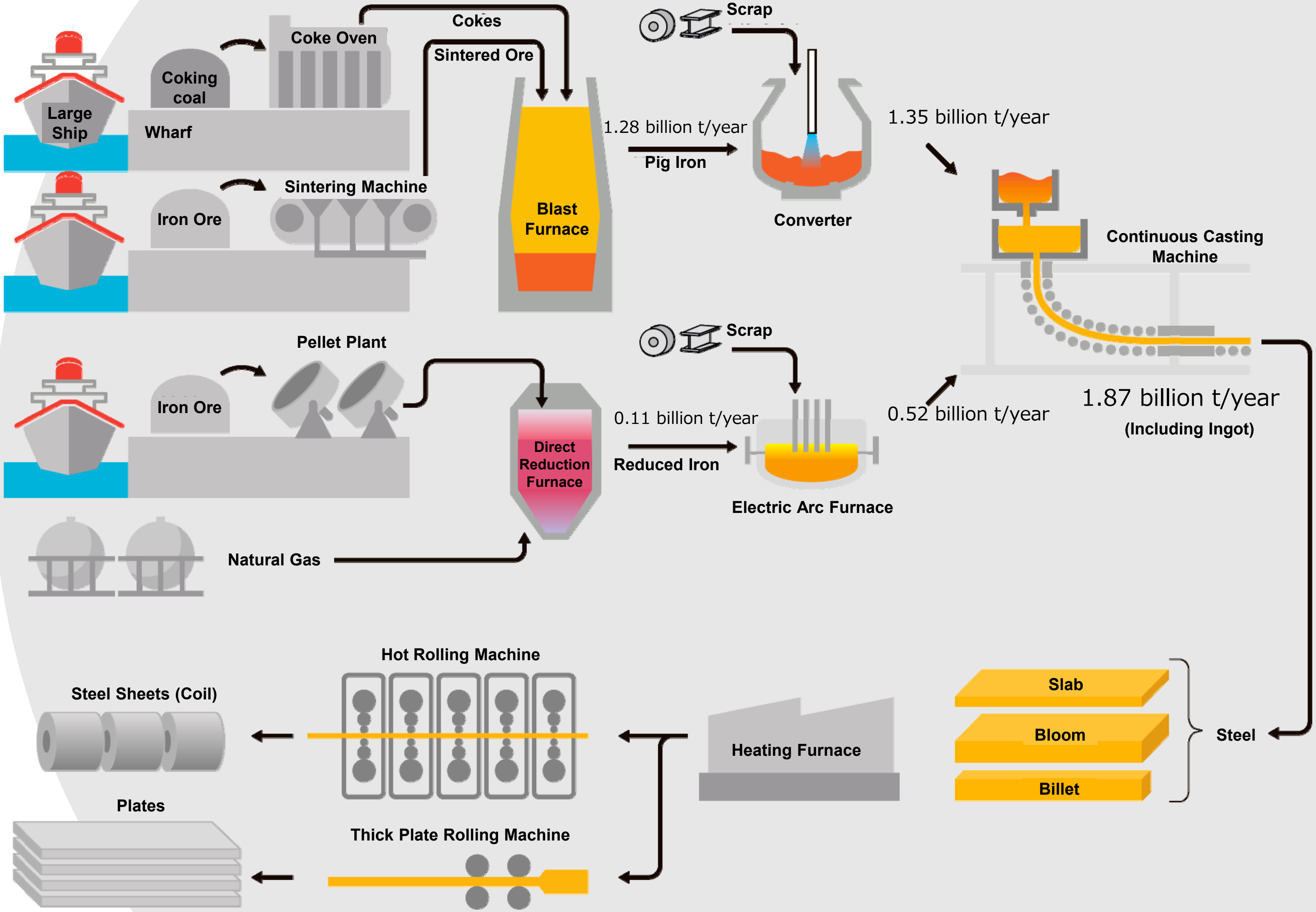
02 Outline of Steelmaking Process

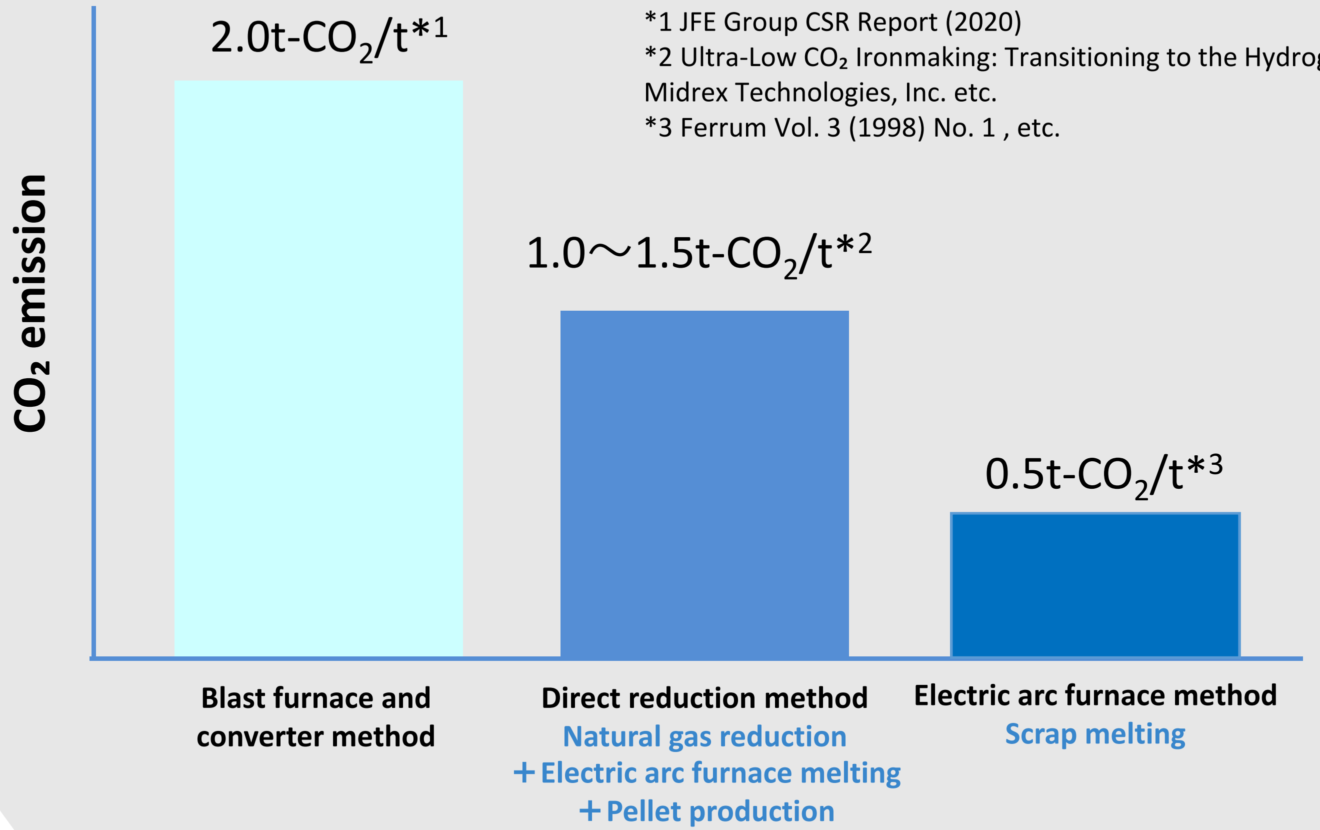
Steel Manufacturing Process



Source: 2019 data on production volumes, World Steel Association (WSA)

CO_2 Emissions in Steelmaking

Blast furnace and converter method:
Carbon (reducing material) used to remove oxygen from iron oxide in iron ore
Combustion of carbon (heat resource) provides heat to melt iron
→More CO_2 generated compared to direct-reduction or electric-arc-furnace methods

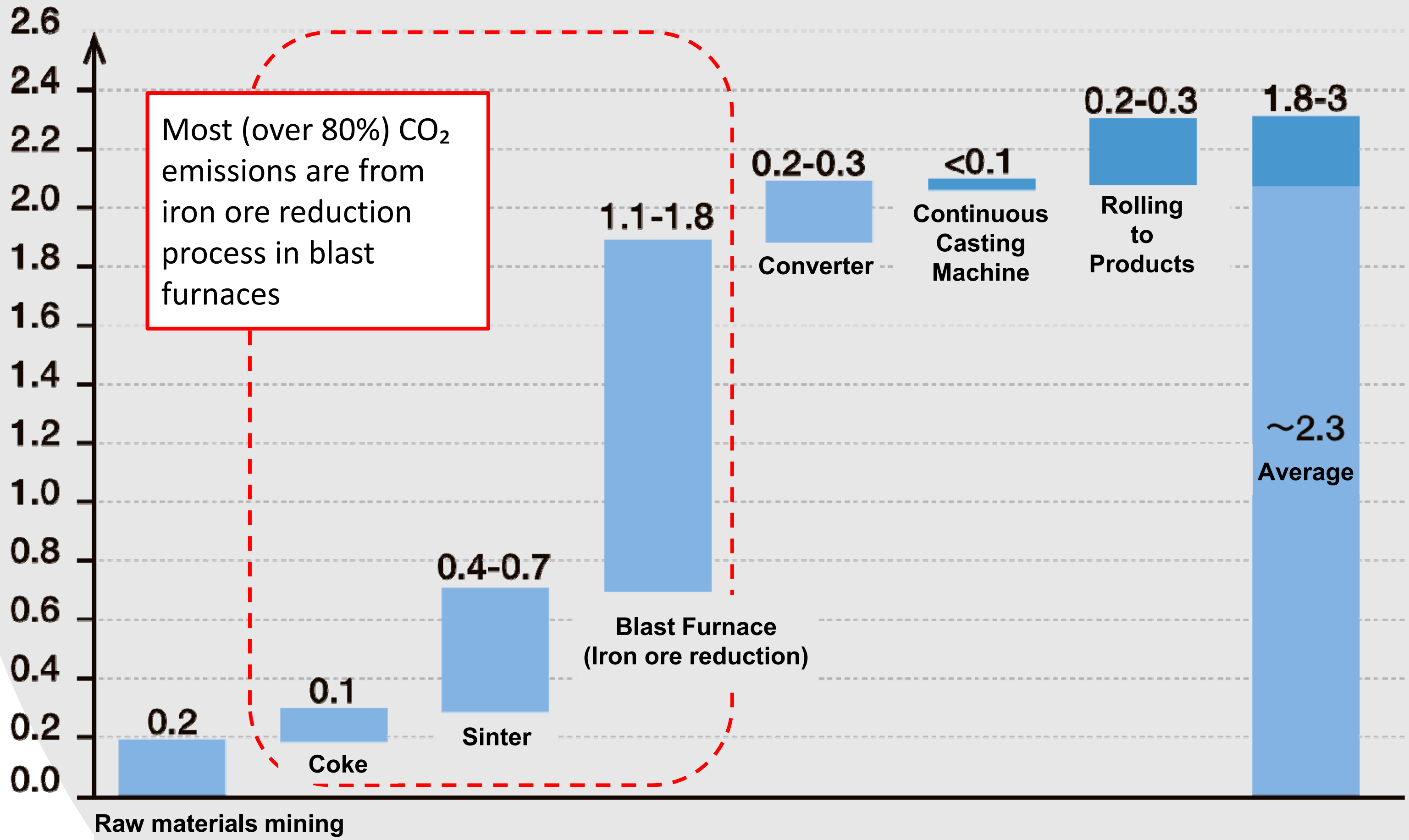


*1 JFE Group CSR Report (2020)
*2 Ultra-Low CO_2 Ironmaking: Transitioning to the Hydrogen Economy, Midrex Technologies, Inc. etc.
*3 Ferrum Vol. 3 (1998) No. 1 , etc.

CO_2 Emissions in Steelmaking (Blast furnace and converter method)

- 14% of domestic CO_2 emissions come from steel manufacturing
- CO_2 reduction in ore reduction process is important to achieve carbon neutrality

Ratio of CO_2 emissions from steel manufacturing processes (t-CO_2/t-crude steel)



Source: "2050 Carbon Neutral Basic Policy," Japan Iron and Steel Federation, February 15, 2021

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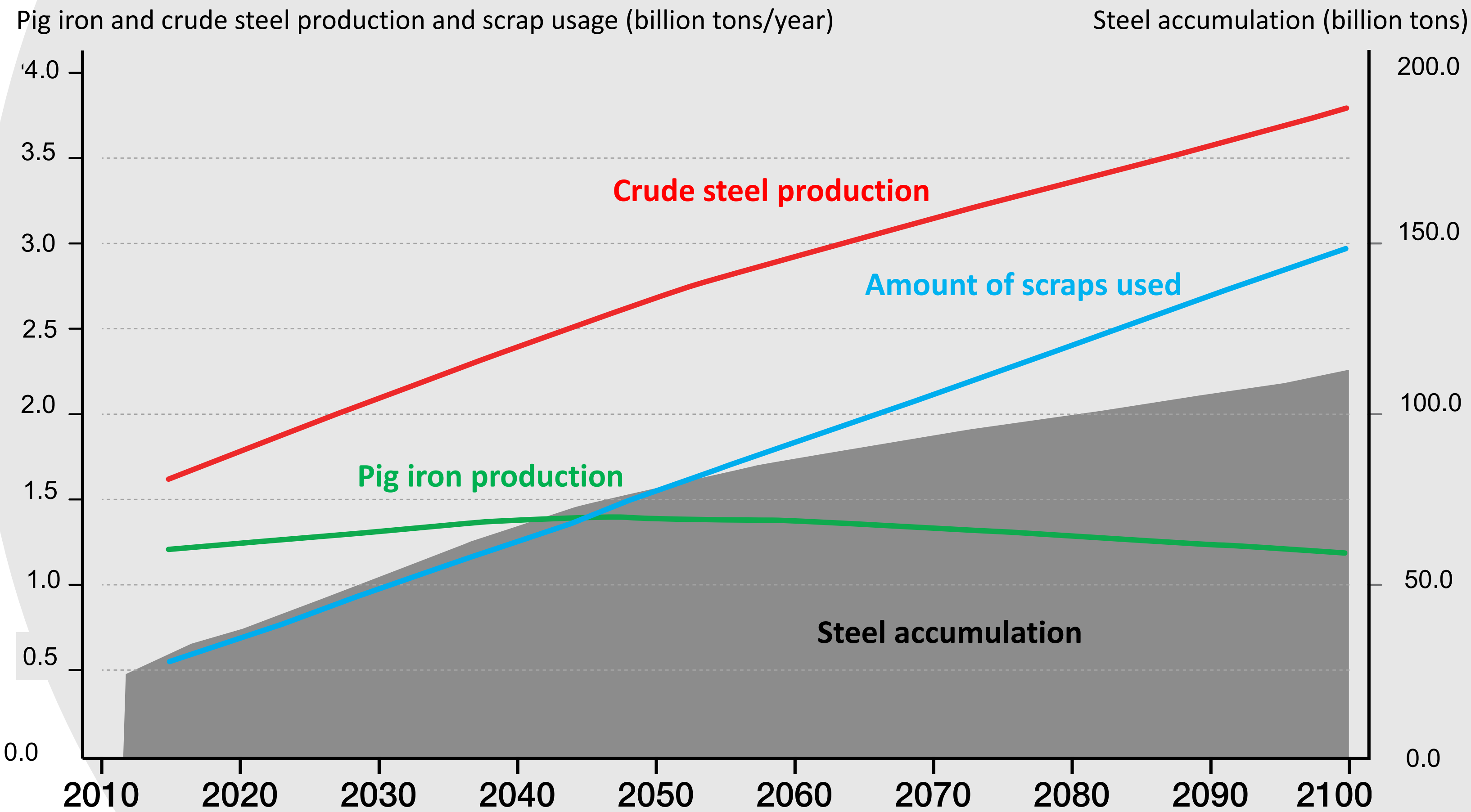
Outlook for Global Steel Production and Accumulation

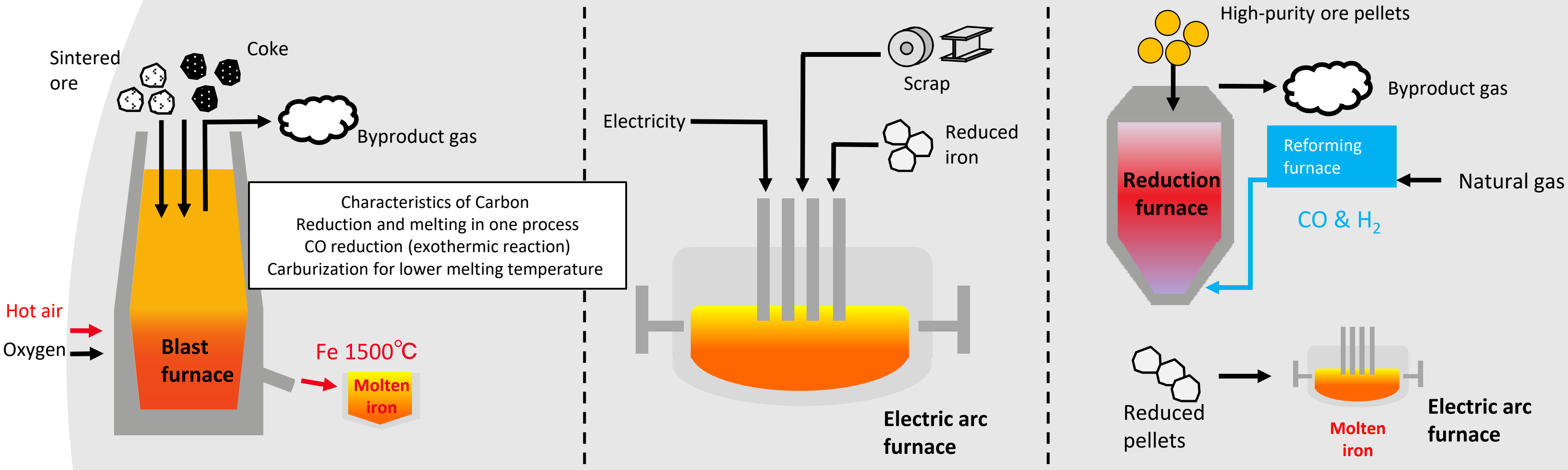
- Demand for crude steel will increase
- Obsolete scrap will also increase, but not enough to meet steel demand
- Constant supply of pig iron is essential for supply of high-performance steel products



Source: "The Challenge of Zero Carbon Steel: Long-term Global Warming Countermeasures," Japan Iron and Steel Federation, November 2018

Advantages and Problems of Current Steelmaking Process

Each method has advantages and disadvantages that require multi-track technological development.



	Blast furnace	Electric arc furnace	Direct reduction
Advantages	● Stable mass production ● Can use existing equipment ● Can use low and medium grade ore ● Can manufacture high-grade steel	● CO_2 emissions are low	● CO_2 emissions are low ● Carbon neutrality once 100% hydrogen reduction is possible
Disadvantages	• Requires replacement of coke and other materials with carbon-neutral reducing materials • Use of CCUS* is essential • Yet-unestablished method needed to prevent temperature drop in furnace during hydrogen reduction • Hydrogen cost is high	• Low productivity • Manufacturing high-grade steel is difficult • Scrap alone is insufficient iron source • Requires a carbon-neutral power source • High cost of electricity (Japan)	• Only high-grade ores can be used • New measures needed to prevent temperature drop in furnace during hydrogen reduction • Hydrogen cost is high • Capital investment cost is high

*CCUS: Carbon Capture, Utilization and Storage

Roadmap to Carbon Neutrality in 2050

- Accelerate research and development for early establishment of new technologies
- Adopt multi-track approach to develop super-innovative technologies, focusing on carbon recycling blast furnace + CCU and hydrogen ironmaking (direct reduction)
- Maximize utilization of industry-leading electric arc furnace technology

CO_2 reduction targets

2020	2024	2030	2040	2050
	18% reduction compared to FY2013 (steel business)	Determine and announce revised targets for FY2030 under 7th medium-term period		Carbon neutrality by 2050

Transformation of steel-making processes

Develop carbon-recycling blast furnace with CCU

(Devise processes and large-scale production in stages)

Implementation

Assumes development of infrastructure for supplying large, inexpensive quantities of hydrogen and a system for sharing the costs throughout society

Utilize transition technologies for existing processes:

- **Ferro-coke, COURSE50, CCU, etc.**
- **Maximize use of industry-leading electric arc furnace technology**
  Manufacture high-grade steel, introduce eco-friendly electric arc furnaces, etc.

Process Integration
Iron sources diversification

Develop hydrogen-based ironmaking (direct reduction)

Implementation

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02 Carbon-recycling Blast Furnace Technology Development

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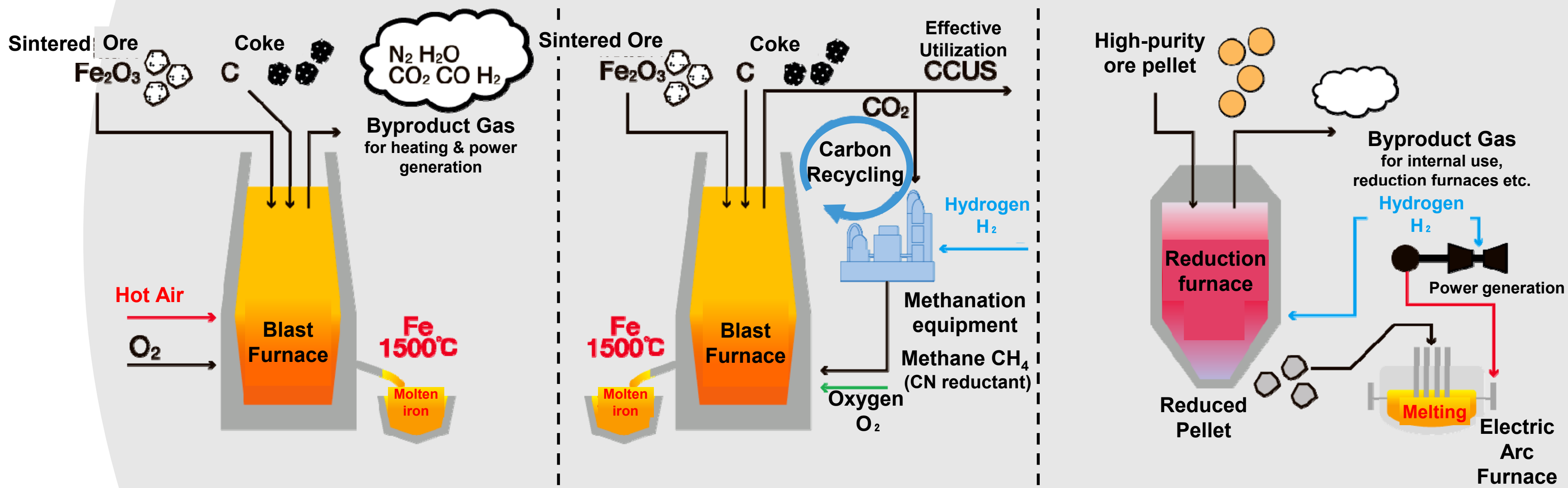
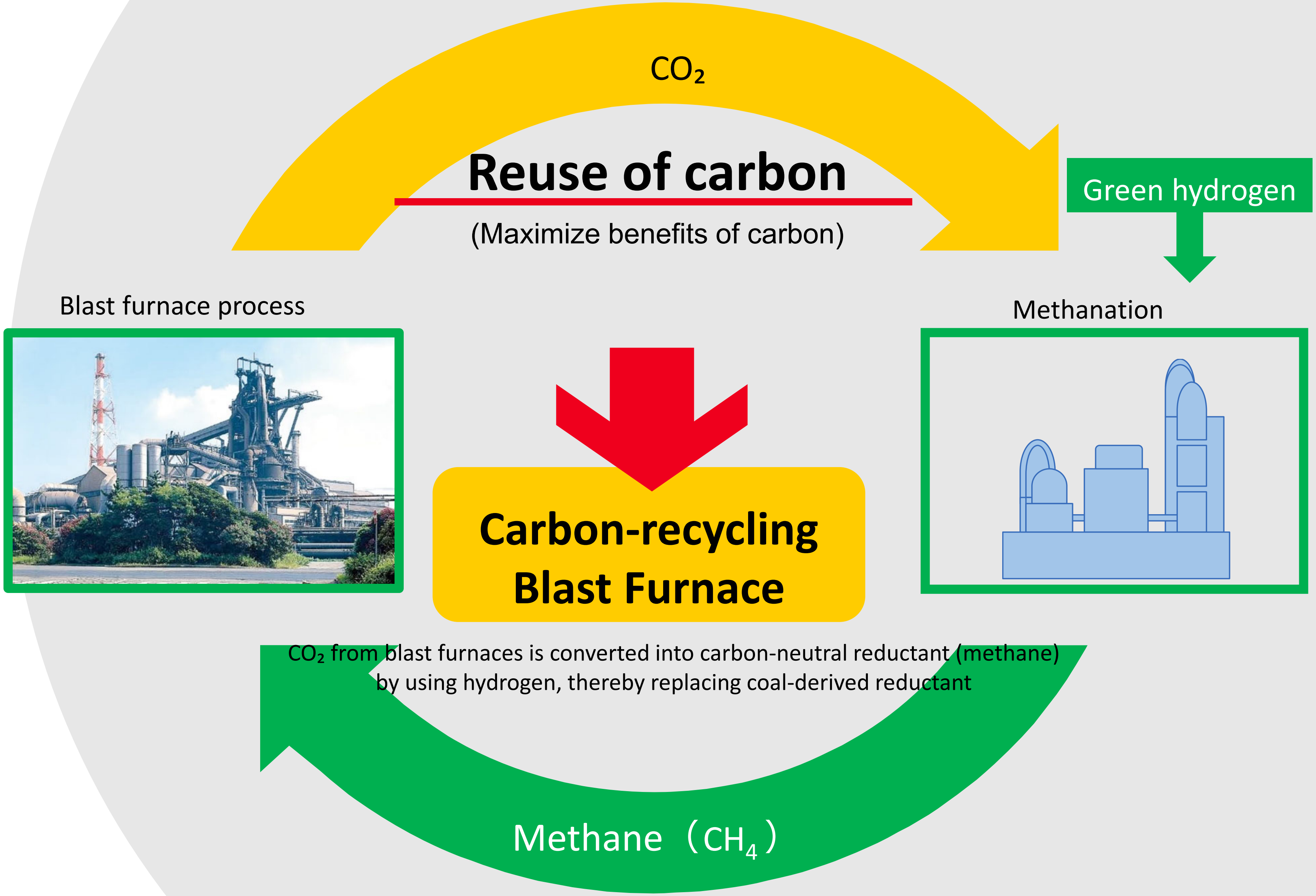
Carbon-recycling Blast Furnaces

- To maximize the blast furnace method for mass, high-efficiency production, including for high-grade steel, technologies for reducing CO_2 emissions from blast furnaces are vital.
- Combining carbon-recycling blast furnaces with carbon dioxide capture, utilization and storage (CCUS) will enable steel works to recycle CO_2 while using raw materials of the same grade as those in conventional blast furnaces, thereby leading to net zero-carbon emissions.



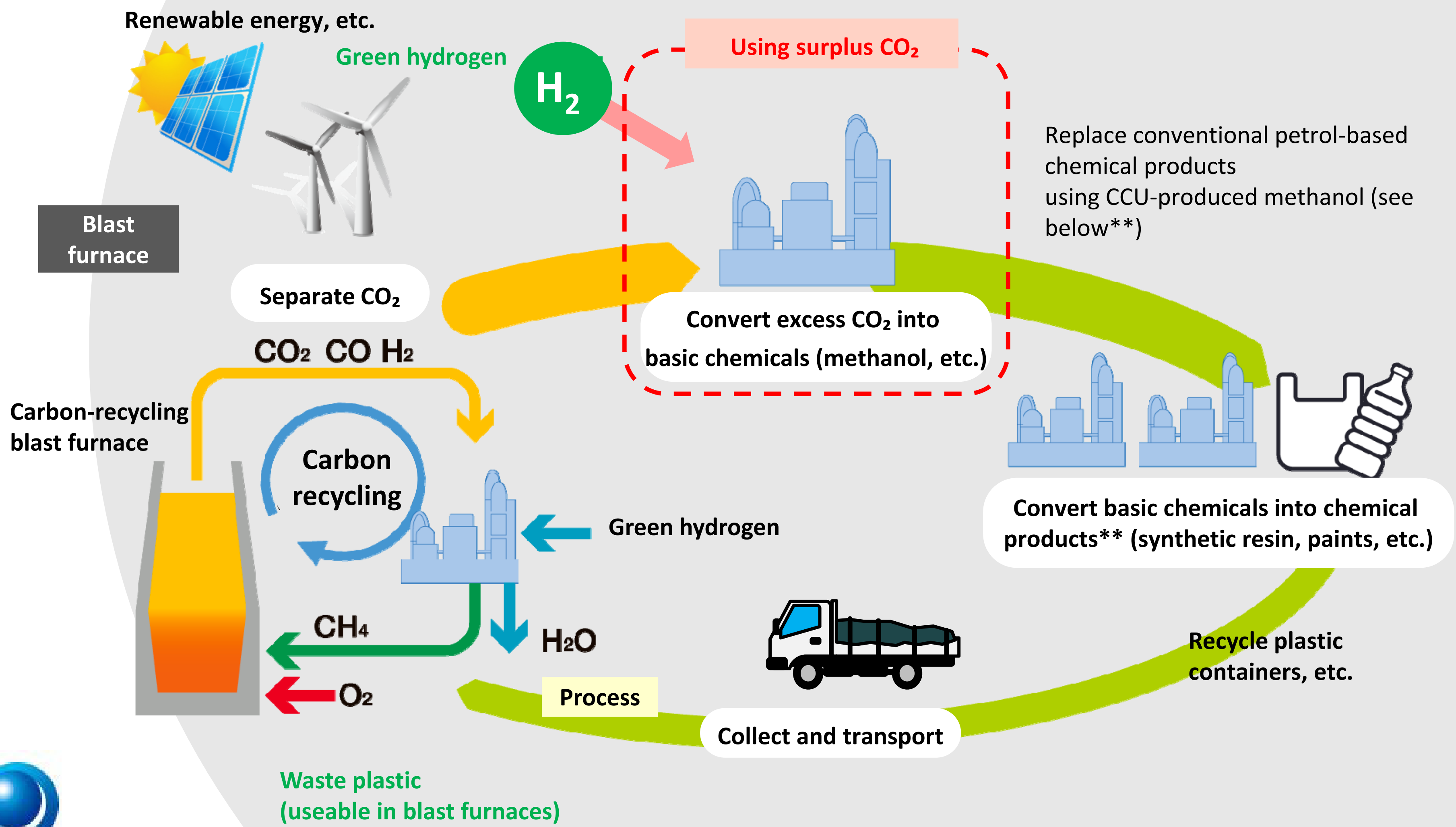
	Normal blast furnace	Carbon-recycling blast furnace	Hydrogen-based ironmaking
Production scale	4 million tons per unit per year	4 million tons per unit per year (similar to normal blast furnace)	2 million tons per unit per year (similar to normal direct-reduction method)
Reductant	Coke and pulverized coal	Coke and recycled methane	Hydrogen
Raw materials	Low-grade raw materials possible	Low-grade raw materials possible	Restricted (high-grade ore)
CO_2 emissions	Two tons of CO_2 per ton of pig iron	Targeting zero (blast furnace reductions and CCUS methods)	Targeting zero (carbon-free method)

Concept of Carbon-recycling Blast Furnace



Carbon-recycling Blast Furnace and Carbon Cycle (CCU*)

- Carbon recycling maximized in blast furnace to reduce CO_2 emissions
- CO_2 emissions minimized through society-wide carbon recycling of excess CO_2



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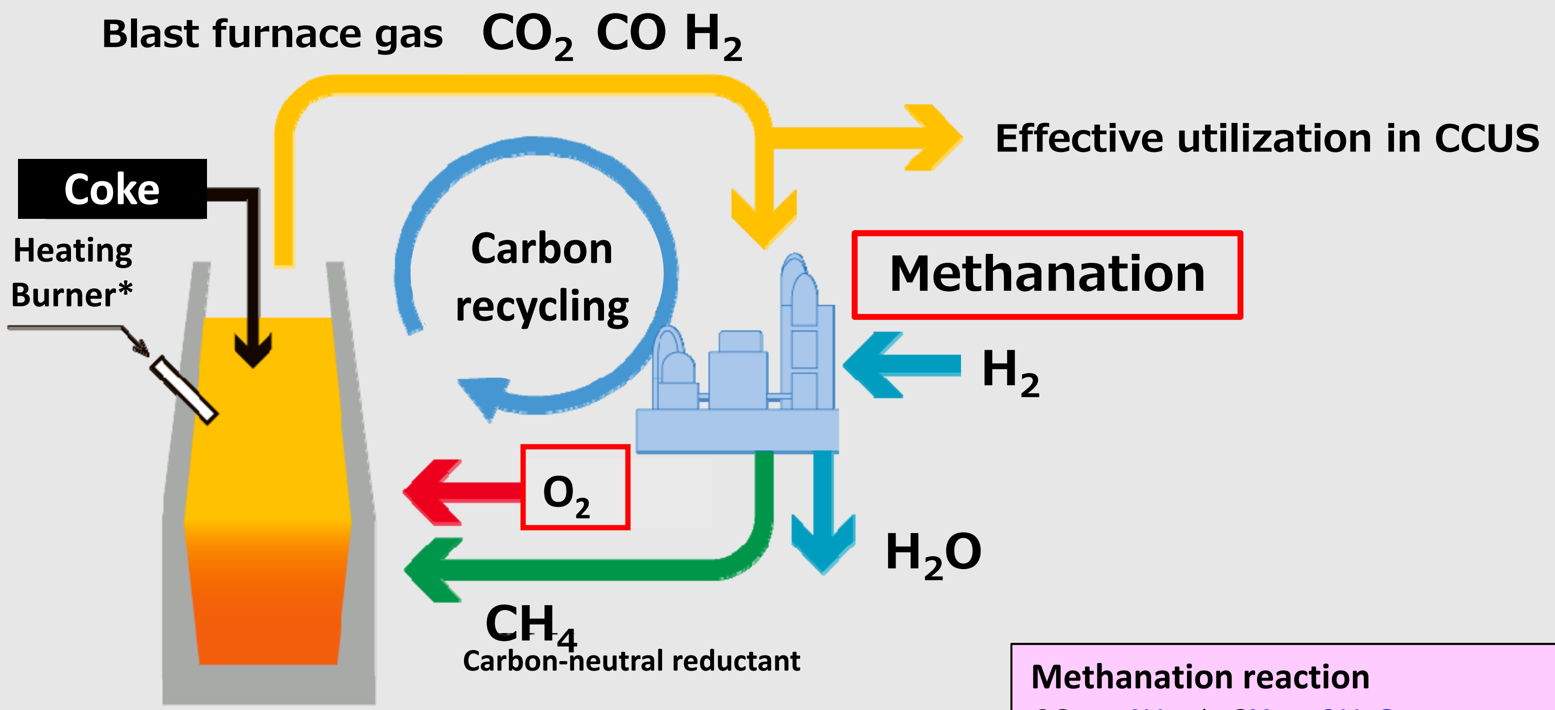
CO_2 Emissions Reduction Using Carbon-recycling Blast Furnace

- CO_2 generated from blast furnace is converted to methane and used repeatedly as reducing material.
- CO_2 emissions are reduced by replacing coke with carbon-neutral methane as the reducing material.



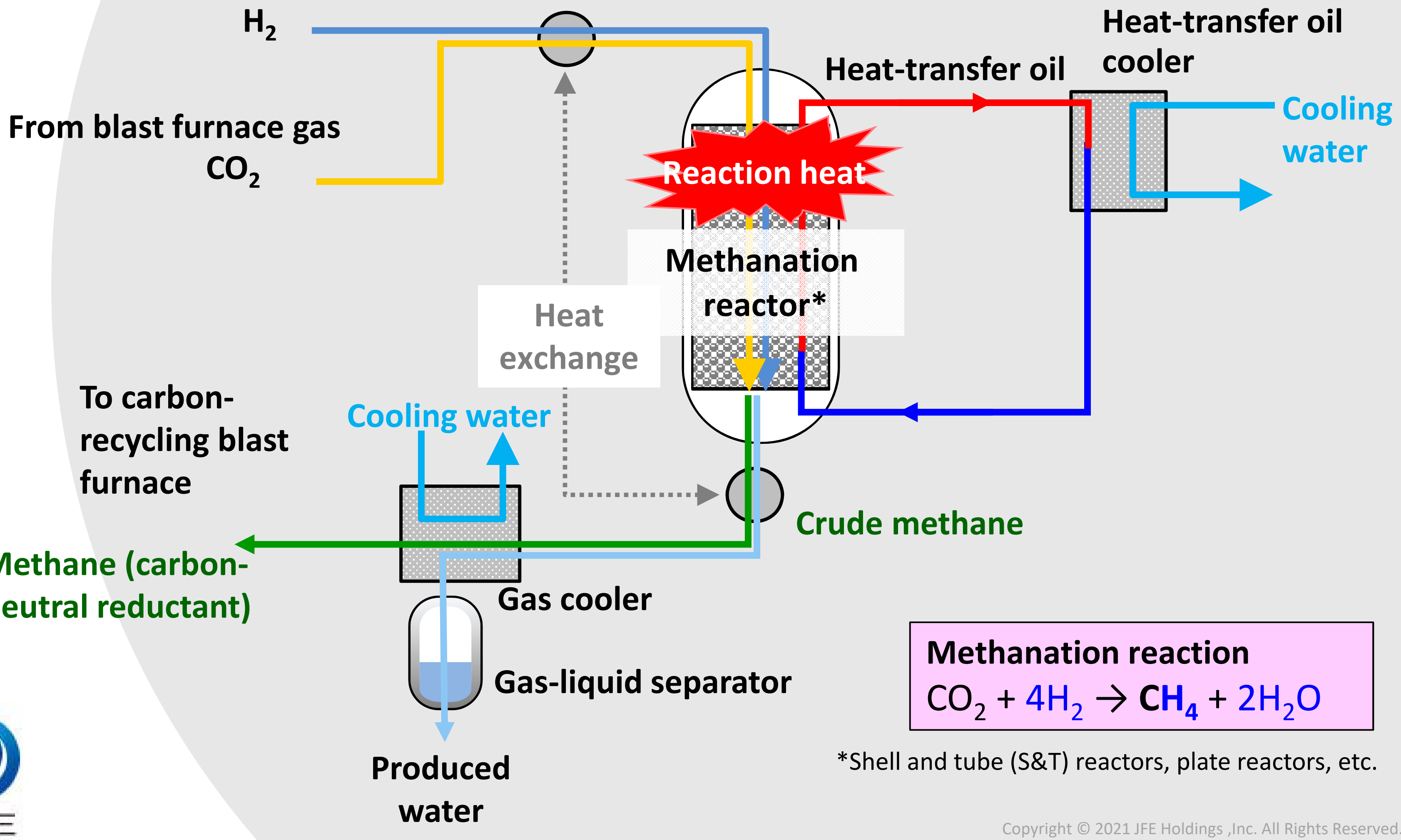
*Use of circulation gas

Methanation reaction
$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$

CO_2 reduction target of 30% in blast furnace, aiming at carbon neutrality through CCUS utilization

Overview of Methanation Technology

- Methanation: Technology for using green hydrogen to convert CO_2 (blast furnace exhaust gas) into methane (carbon-neutral reducing material)
- Key CCU technology expected to help realize carbon-neutral society



Methanation reaction

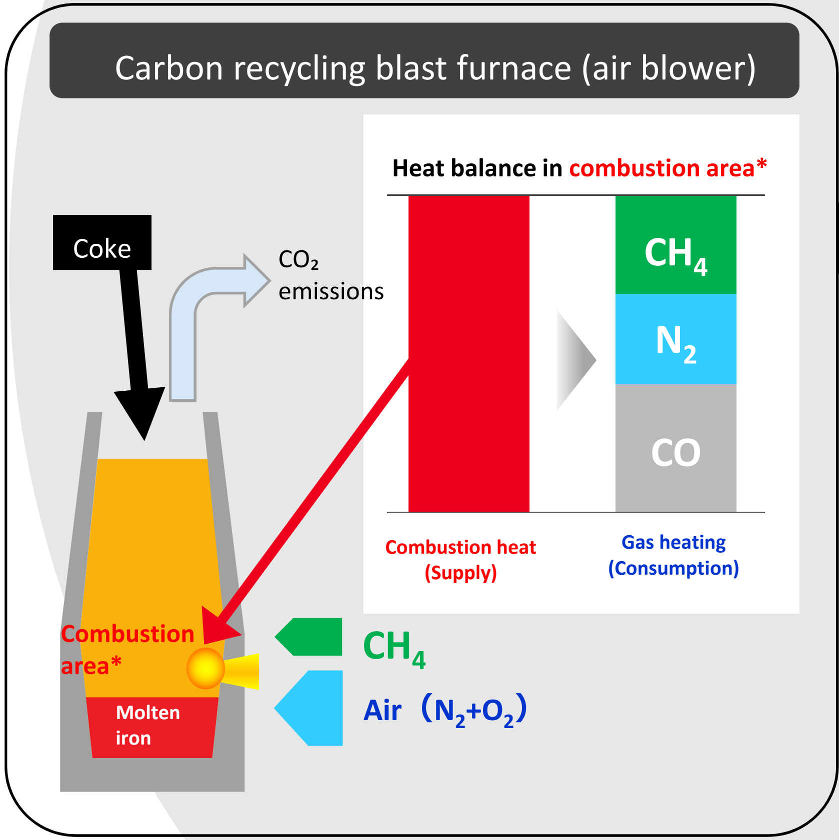
$$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$$

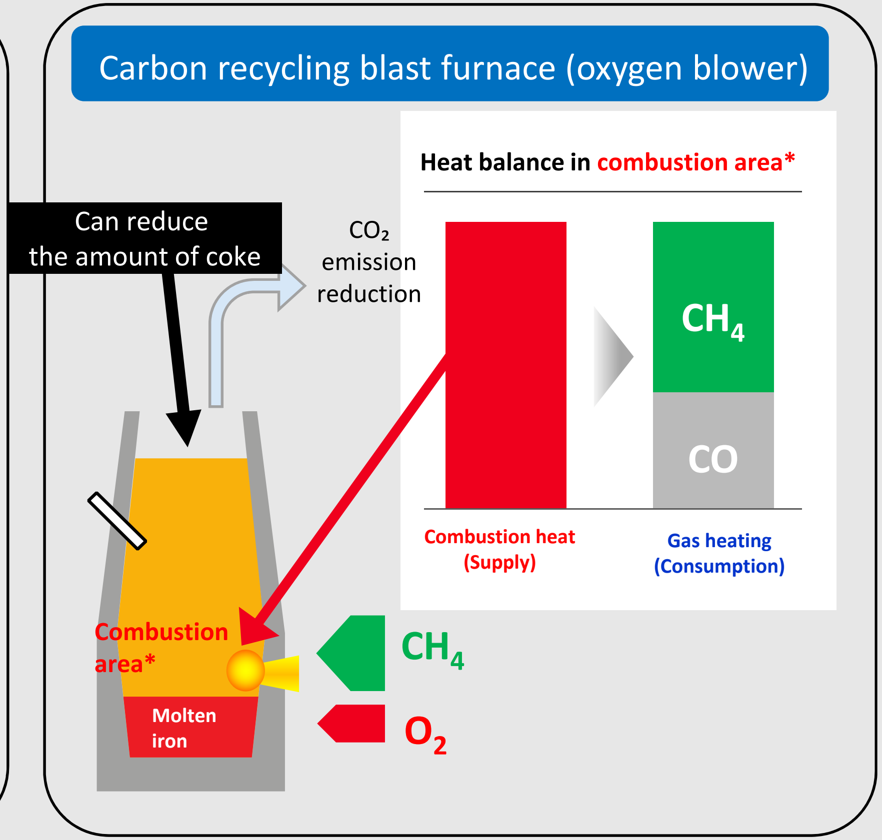
*Shell and tube (S&T) reactors, plate reactors, etc.

Effectiveness of Oxygen Blast Furnace (1)

An oxygen blast furnace can maximize the amount of methane blown in by heating carbon-neutral methane with combustion heat that conventionally is used to heat nitrogen gas.

Challenge **Need to develop an all-new technology to reduce CO_2 emissions by blowing in large amounts of carbon-neutral methane with oxygen. (world's first)**



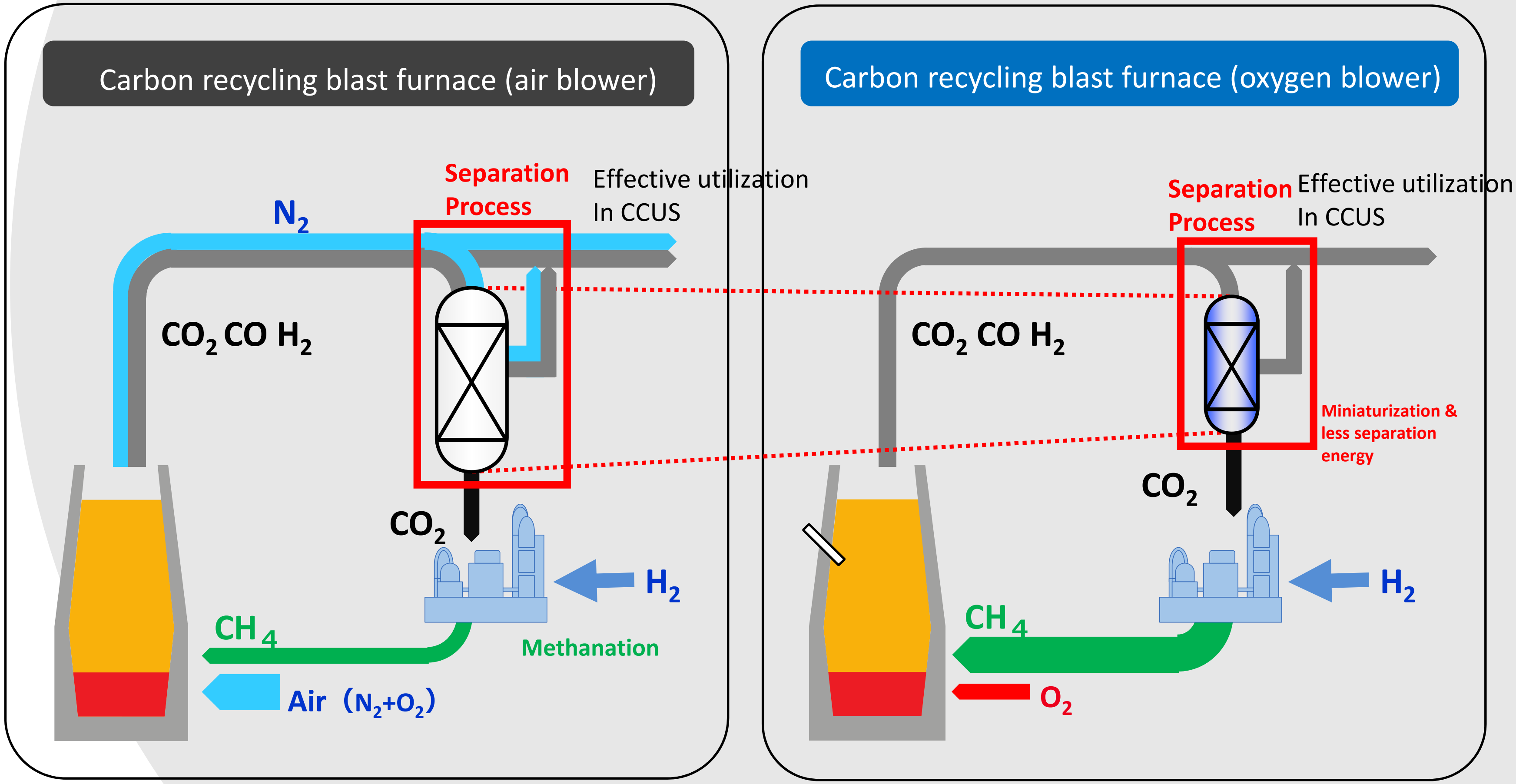


*Combustion heats gas to approx. 2,000°C to melt iron

Effectiveness of Oxygen Blast Furnace (2)

Zeroing out nitrogen in blast furnace gas reduces amount of exhaust gas by about ½, and increasing CO_2 concentration enables CO_2 separation process to be downsized since less energy is required

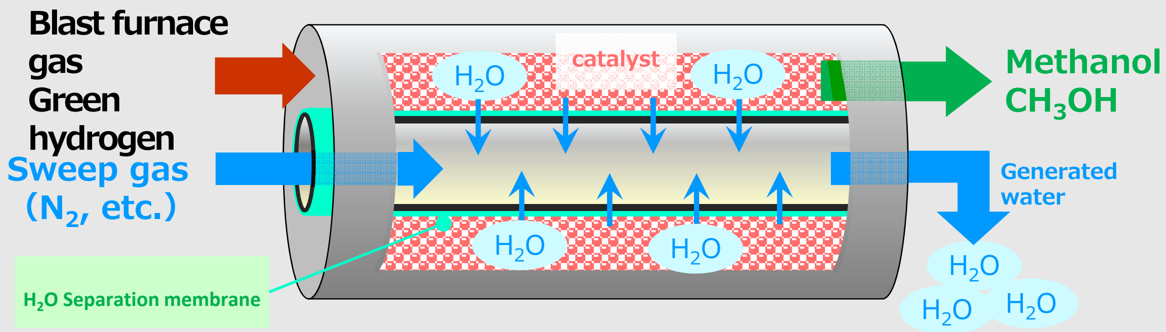
Challenge **Interlock operation with large-scale methanation facilities** (world's first)



High-efficiency CCU Methanol Production Technology

Application in carbon-recycling blast furnaces with CCU for CO_2 emissions reduction currently is jointly being developed by JFE and Research Institute of Innovative Technology for the Earth (RITE).
New type of reactor for CCU methanol synthesis uses steel works exhaust gas to produce methanol significantly cheaper compared to conventional reactors.

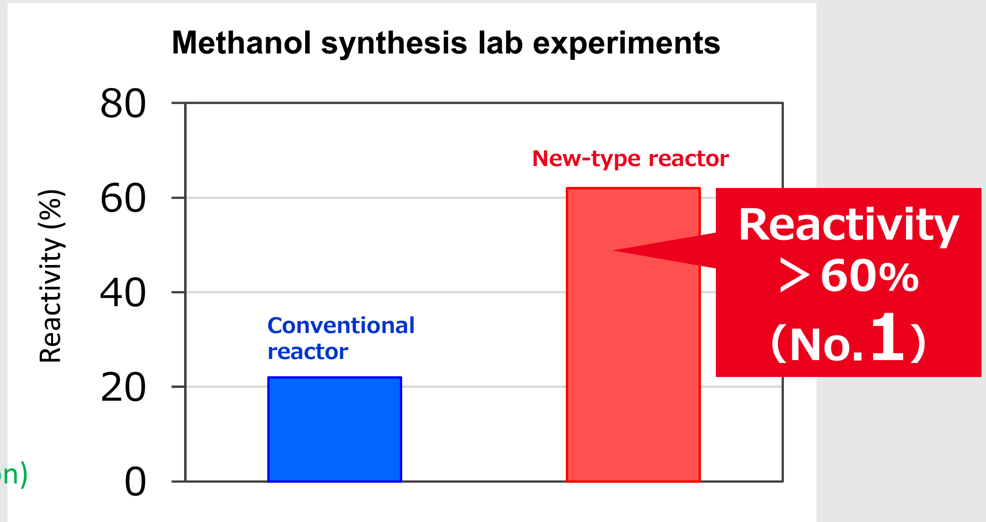
CCU Methanol Synthesis New-type reactor



H_2O selectively permeates separation membrane for greatly increased reaction rate

$$CO_2 + 3H_2 \leftrightarrow CH_3OH + \cancel{H_2O}$$

Chemical equilibrium shifts to right (reaction acceleration)



Roadmap for Developing Carbon-recycling Blast Furnace and Technology

Conduct elemental technology development and small-scale testing for both carbon-recycling blast furnaces and CCU methanol synthesis, targeting completion of proof-of-principle process by 2027

2020 — Proof of principle to be completed by 2027 — 2030

Carbon- recycling blast furnace

Element development
Partial technology test → Small-scale demo (150m³ scale in Chiba area) → Large-scale development → Implementation*

CR blast-furnace elemental technology development: (1) Develop simulation model, (2) Design operations and facility (furnace shape, etc.) based on analysis of in-furnace phenomena (gas flow and temperature distribution), (3) Maximize combustion efficiency through pure oxygen methane burner combustion experiments
Partial demonstration of CR blast furnace: Conduct large-volume city gas injection test at Keihin No.2 blast furnace (before shutdown)
CCU elemental technologies development: (1) Develop low-cost CO_2 separation technology for CCU (2) Develop high-efficiency methanol synthesis reactor

CCU methanol synthesis

Element development
Basic design → Small-scale demo → Large-scale development → Implementation*

Elemental technology development: (1) Develop low-cost CO_2 separation technology for CCU (2) Develop high-efficiency methanol synthesis reactor
Basic design: (1) Conduct CO_2 separation lab tests to evaluate CO_2 separation efficiency and determine operation method (2) Conduct methanol synthesis lab tests to evaluate reaction rate and simulate reaction rate maximization

*Pursuant to development of infrastructure for cheap, high-volume hydrogen supply and system for sharing related costs throughout society

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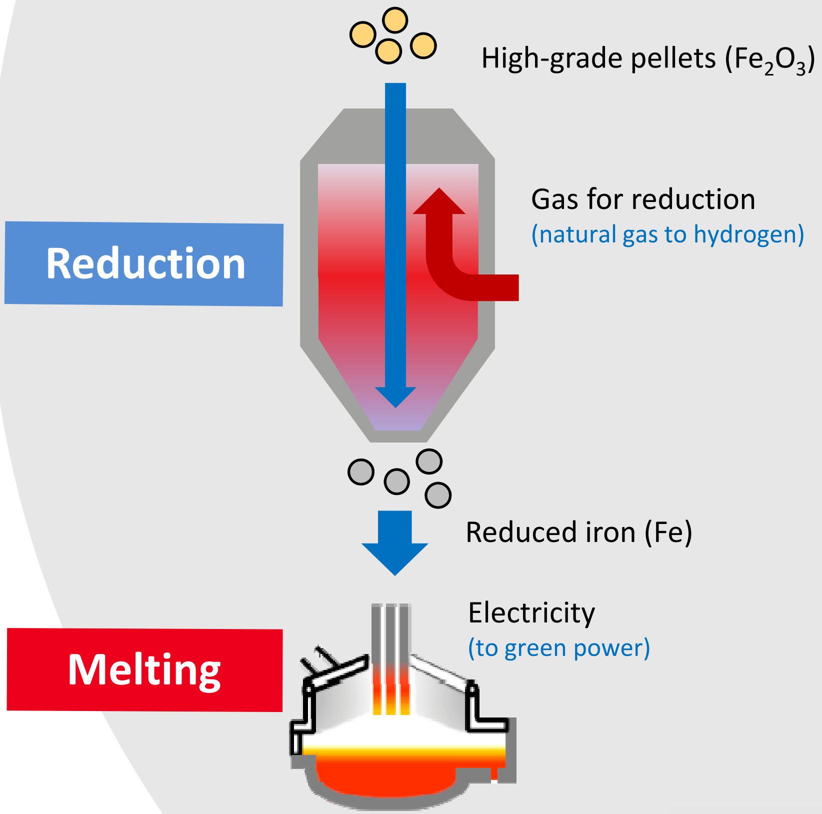
02 Development of Technology for 100% Direct Hydrogen Reduction

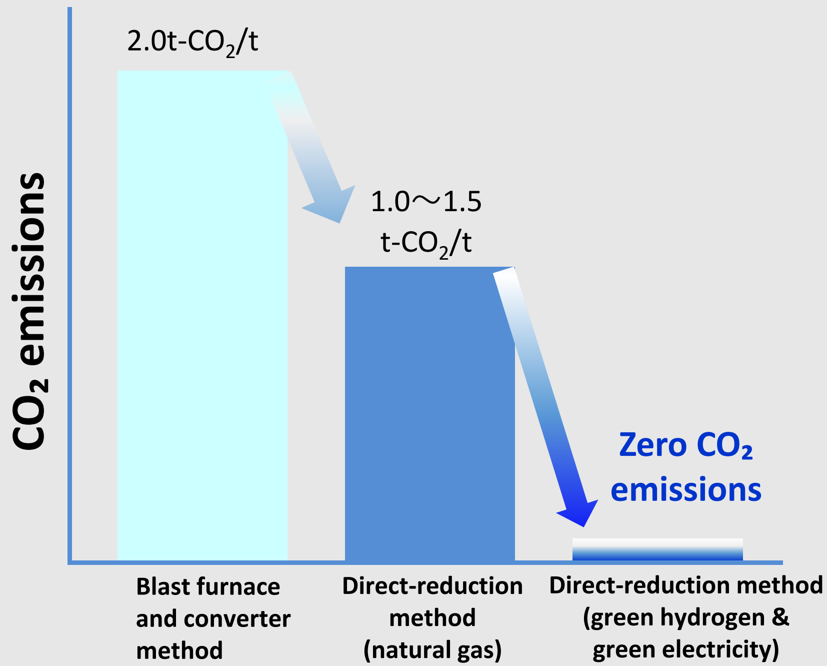
Effectiveness of Hydrogen-reduction Technology

- Oxygen is removed from iron ore in a reduction furnace to produce reduced iron (Fe), which is then melted in an electric arc furnace.
- The amount of CO_2 generated with the current direct-reduction method is about 1/2 that of the blast furnace method.
- Using hydrogen during reduction and green electricity during melting produces zero CO_2 emissions.

Direct-reduction process



CO_2 emissions from various steel processes



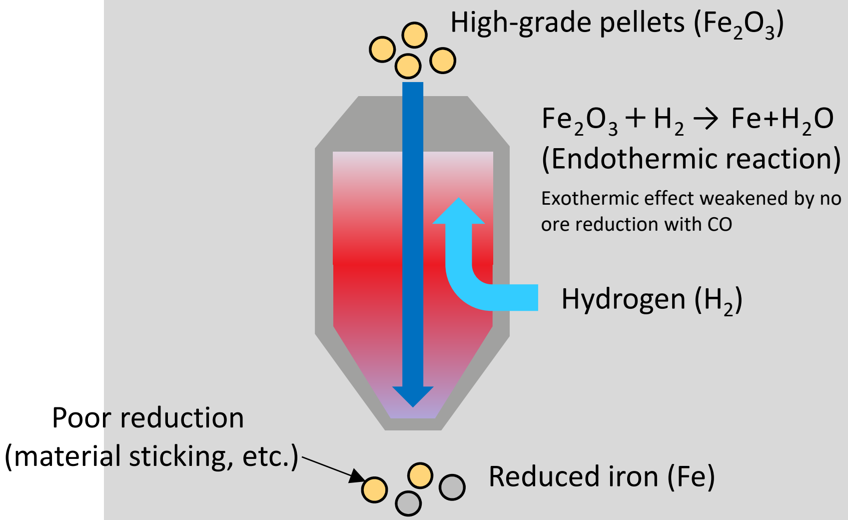
Problems and Solutions for Hydrogen Reduction (1): Endothermic Reaction

Problem Endothermic reaction inhibits reduction
(Hydrogen reduction causes endothermic reaction)

Solution Develop raw material preheating and hydrogen heating technology

Problem

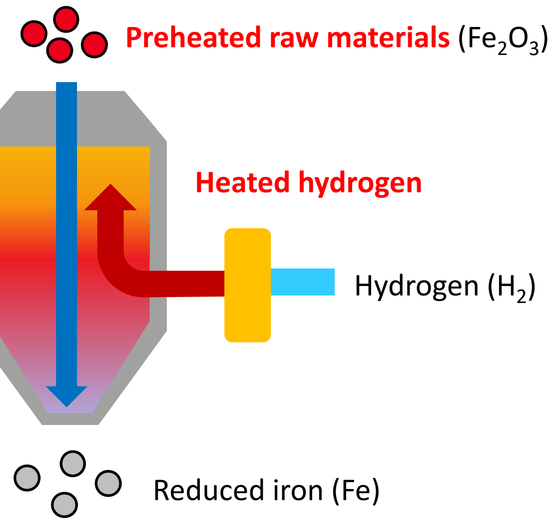
Endothermic reaction inhibit reduction



Reduction failure due to insufficient heat

Solution

- **Develop raw material preheating technology**
- **Develop hydrogen heating technology**



Problems and Solutions for Hydrogen Reduction (2): Limited Raw Materials

Problem High-grade raw materials are produced in limited quantities and difficult to obtain.

Solution Expand sourcing through collaboration with raw material supplier (BHP*)

Problem

Currently, direct reduction can only use scarce high-grade raw materials, of which production is limited.

	Direct reduction	Blast furnace
Quality	High grade	Low to medium grade
Production (billion tons/year)	0.17	2.06

Low- and medium-grade raw materials are not used for direct iron reduction because they are difficult to pelletize and have low Fe content.

Solution

Develop processing technology for low- and mid-grade materials with BHP

Use as raw material for direct reduction

BHP × JFE

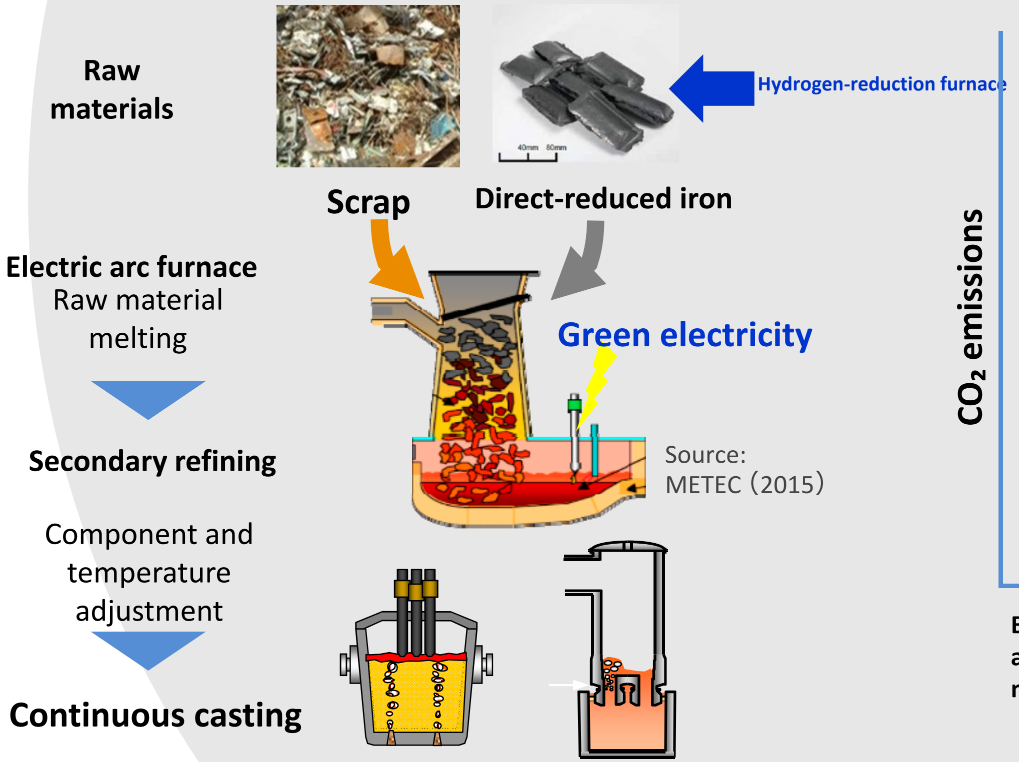
*One of three largest iron ore suppliers, mainly producing in Australia

02 Development of Electric Arc Furnace Process Technology

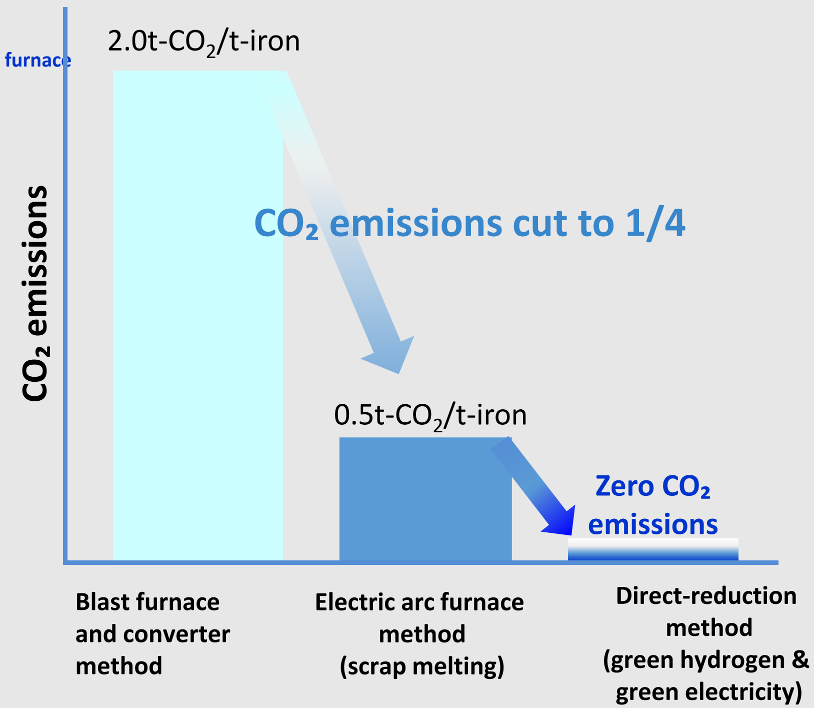
Production of High-grade Steel in Electric Arc Furnace Process

- Steel products are manufactured by melting steel scrap and direct-reduced iron in an electric arc furnace.
- The resulting CO_2 amount is about 1/4 that generated by the blast furnace-converter method.
- CO_2 emissions should be reducible to zero using hydrogen-reduced iron and green electricity.

Electric Arc Furnace process



CO_2 emissions from various steel processes



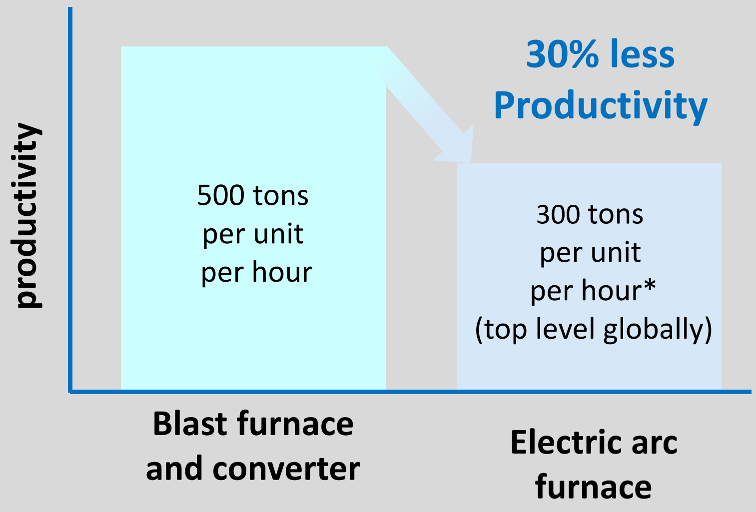
Production of High-grade Steel in Electric Arc Furnace Process: Problem and Solution (1)

Problem Improve productivity of electric arc furnaces, currently 30% less than that of blast furnace-converters
Reduce electric power intensity

Solution High-speed, high-efficiency melting technology for use in electric arc furnaces

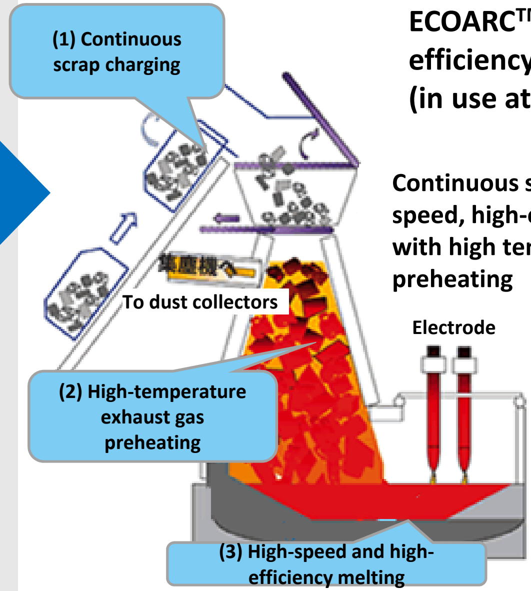
Problem

Productivity improvement



Solution

(1)Technology to melt scrap and reduce iron at high speed
(2)Technology for efficient melting with less electric power



ECOARC™ eco-friendly, high efficiency electric arc furnace (in use at JP Steel Plantech Co.)

Continuous scrap charging in high-speed, high-efficiency melting furnace with high temperature exhaust gas preheating

Need to further improve energy efficiency and productivity

JFE Bars & Shapes Corporation

*Millennium Steel, Jumbo size 420t twin DC FastArc®EAF (2011)

Problem Quality constraints for products with electric arc furnaces
(Many steel types are difficult to manufacture in terms of quality)

Solution Technology to remove impurities and detoxify impurities

Problem

Elimination of quality constraints

Electric arc furnace process (scrap & reduced iron)

Material degradation due to increased impurity concentration

- **Many steel types hard to manufacture in electric arc furnaces**

- **Vehicle steel sheets: Defects & poor processing performance**
- **Electrical steel sheets: Deterioration of properties**

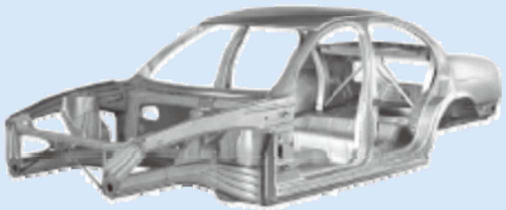
Blast furnace and converter[1]
For ex.: Cu 0.02-0.03%
N ～0.003%

Electric arc furnace steel[2]
For ex: Cu 0.2-0.4%
N 0.004%～

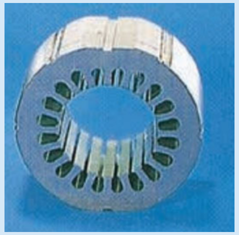
Solution

(1) Technology to remove impurities

(2) Technology to detoxify impurities



Steel plates for cars



Electrical steel sheet (motor cores)

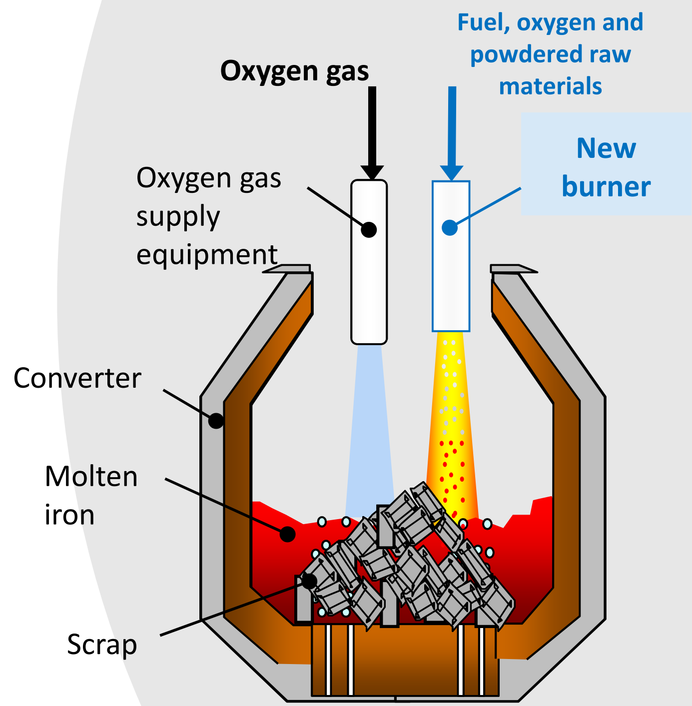
Sources: 1:"Iron and Steel Smelting," The Japan Institute of Metals (2000), 2"Electric Furnace Steelmaking Method," Iron and Steel Academy (2019)

02 Technology for Using Scrap in Converters

Technology for Scrap Use in Converters

Problem Need more robust melting technology to increase use of scrap in converters

Solution (1) Design and engineer larger and more durable burners for use in large converters
(2) Utilize carbon-free fuels (hydrogen or carbon-recycled methane) to reduce CO_2 emissions



Current heat source for converters
Heat from oxidation reaction of carbon and silicon in hot metal

Problem

Increasing volume of scrap usage in a converter reduces heat

↓

New heat technology

Solution

High-efficiency heat-transfer burner for melting scrap in converters

Transferring combustion heat to iron using powdered material* heated with new burner

↓

JFE Steel's "ONLY1" technology
(already commercialized stainless-steel converters)
Develop burner for normal steel converter

↓

Development Goals:
(1)Design and engineer large burners
(2) Use carbon-free fuels such as hydrogen gas

Scrap ratio: 12-15% (current) → 20% or more (target)

*Source: JFE Technical Report No. 38, p. 53 (2016)

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02 Development of Process for Achieving Carbon Neutrality

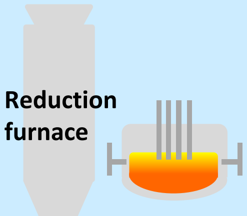
Summary of Process Development

Accelerate R&D for (1) blast furnace technology, (2) direct-reduction technology, (3) electric arc furnace technology and (4) conventional technology
→ Develop innovative technologies multilinearly, aiming to achieve carbon neutrality

Blast furnace technology

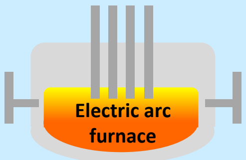
- Carbon-recycling blast furnace with CCU
- COURSE50 and Super-COURSE50
- Ferro coke

Direct-reduction technology



- Hydrogen-based ironmaking(direct reduction)
  Measures for hydrogen endothermic reaction and restriction of raw materials

Electric arc furnace technology



- Electric arc furnace
  Measures to improve productivity and lower electricity costs
  Measures to manufacture high-grade steel
  Measures to expand scrap (hard-to-use scrap, etc.)

Conventional technology

- Expanded use of scarp in converters, etc.
  Development of high-efficiency, heat-transfer burner

Green hydrogen, green electricity, & low-cost mass supply → **Carbon neutrality**

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02 Eco Products (Electrical Steel Sheets Strategy)

Eco-products: JFE's Electrical Steel Sheets Strategy

JFE Steel

Electrical steel sheet manufacturing	**Expand supply system for highly value-added electrical steel sheets**

Japan
Expand non-oriented electrical steel sheet manufacturing facilities

Overseas
Will study electrical steel sheet JV with JSW (India)

JFE Shoji

Electrical core processing and distribution	**World's No. 1 global distribution and processing system for electrical steel sheets**

Expand collaboration with alliance partners

Build SCM in new regions

Deepen processing capabilities of coil centers

Sharing Strategies

synergy effect

Capture growing demand for high-grade electrical steel sheets both in Japan and overseas on group-wide basis

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Eco-products: Strategy for Electrical Steel Sheets in Japan

Japan

Expand manufacturing facilities for non-oriented electrical steel sheet (N/O)*

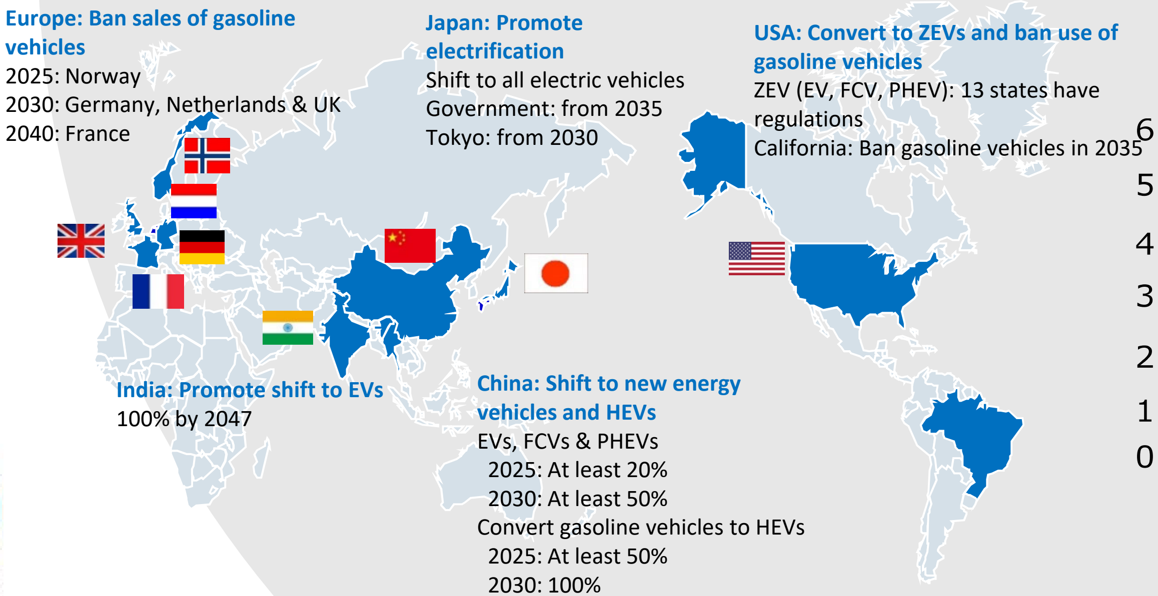
*Announced on April 1, 2021

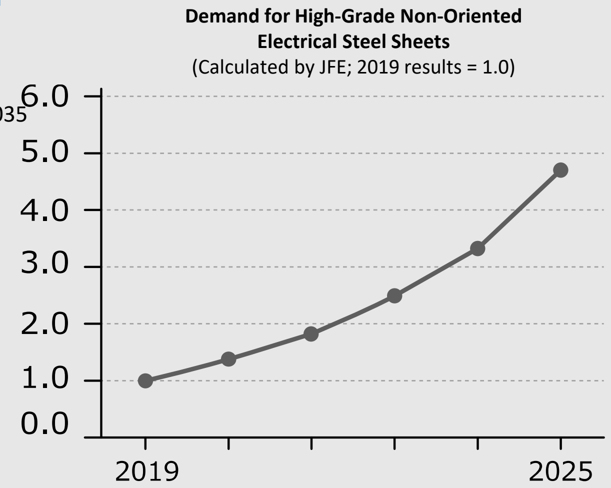
Increase capacity of West Japan Works (Kurashiki district) to meet rising demand for high-grade non-oriented electrical steel sheets used in EV drive motors

Total investment	Approx. 49 billion yen
Operation start	First half of FY2024
Production capacity	Double current production capacity for high-grade non-oriented electrical steel sheets
CO_2 reduction	About 1.5Mt CO_2/year (due to increased adoption of electric vehicles)

Demand Forecast of high-grade non-oriented electrical steel sheets

Demand for high-grade non-oriented electrical steel sheets, indispensable for electric automobiles, is **expected to rapidly increase** as global environmental regulations are accelerated/strengthened





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Eco-Products: Overseas Strategy for Electrical Steel Sheets

Overseas

MOU with JSW of India to study feasibility of electrical steel sheet JV*

*Announced on May 7, 2021

Agreed with strategic-alliance-partner JSW to study establishing grain-oriented steel (G/O) manufacturing and sales company in India

2009 Signed strategic comprehensive agreement

2012 Licensed manufacturing technology for non-oriented electrical steel sheets (N/O)

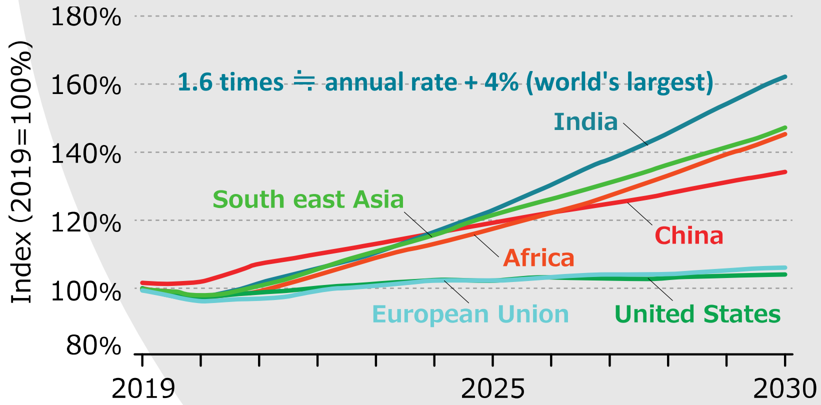
JSW becomes India's largest N/O supplier

2021 Agreed to study feasibility of G/O manufacturing & sales company

Demand Forecast of Grain-oriented Electrical Steel Sheets

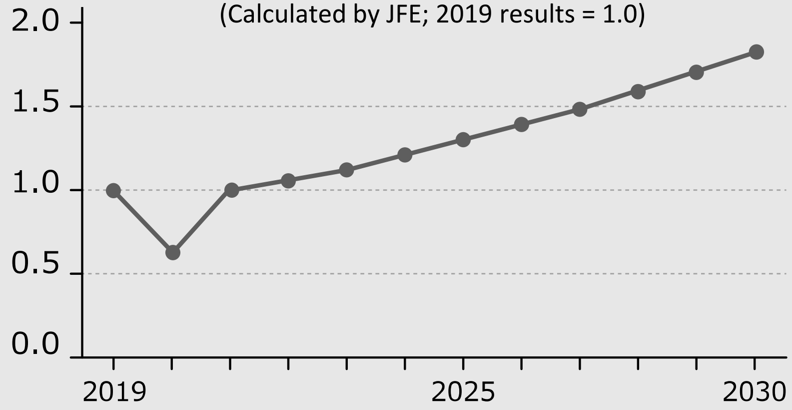
The global demand for grain-oriented electrical steel sheets in transformers is expected to increase due to continuous growth in demand for electric power and the expanding adoption of renewable energy. The demand in India for grain-oriented electrical steel sheets is expected to increase by 1.7 times in 2030 compared to 2019 results.

Electricity demand in India



Source: World Energy Outlook 2020, IEA

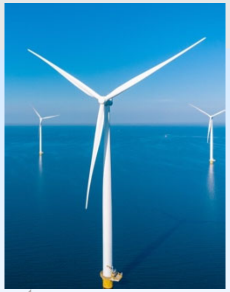
Demand for grain-oriented Electrical Steel Sheets in India
(Calculated by JFE; 2019 results = 1.0)



03 Carbon Neutrality Initiatives in Engineering and Trading Businesses

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]
- **Aim 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.**



JFE Engineering

Feasibility study of **seabed-fixed foundation structure (monopiles)** for an offshore wind power generation

JFE Steel

Increased production capacity and stable mass production of **large and heavy plates** for offshore wind power generation

Utilization of **Kurashiki No. 7 Continuous Casting Machine in Kurashiki district** (scheduled to start operation in FY2021)

Steel supply (JFE Steel → JFE Engineering)

Steel supply (JFE Steel → Each company under the group)

SCM support / Steel supply (JFE Shoji → JFE Engineering)

SCM Support (JFE Shoji → JFE Steel)

JFE Shoji

SCM construction for steel products and processed products for offshore wind power generation contributes to group collaboration

Each company under the group

JMU[2]: fabrication of offshore wind turbine floats and construction of work vessels

Group-wide: **O&M with maximum use of resources**

[1] O&M: Operation & Maintenance. Applied repair and analysis techniques

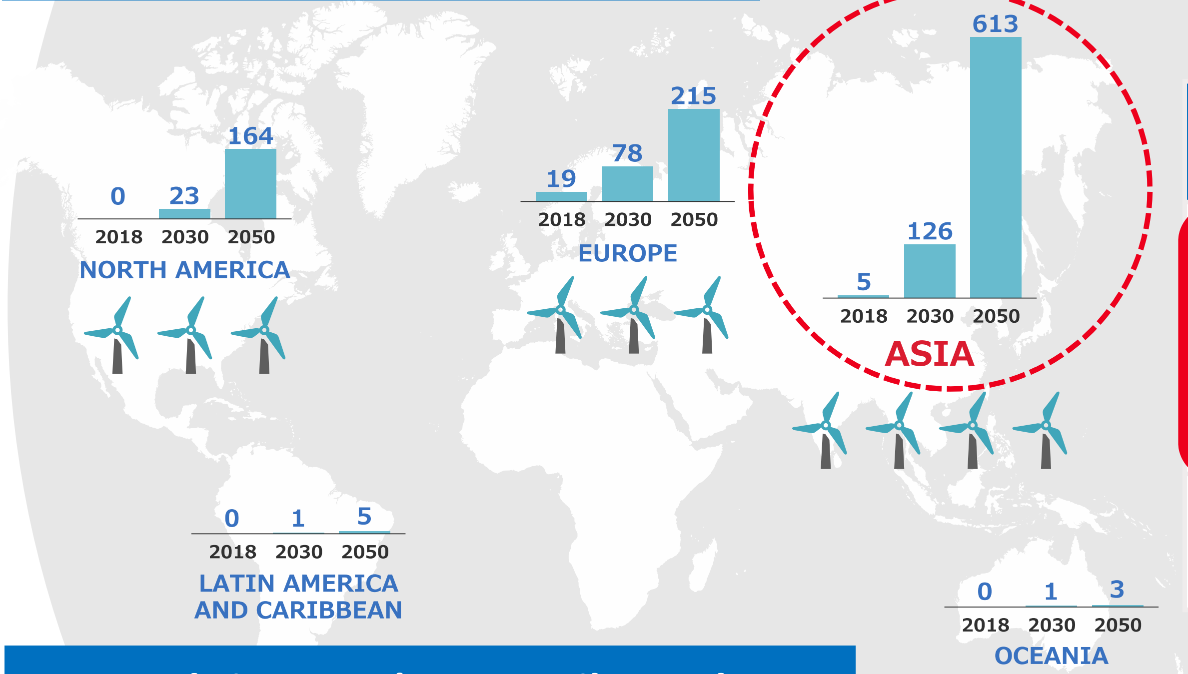
[2] JMU: Equity method affiliate Japan Marine United Corporation

Offshore Wind Demand and Monopile Market Trends

Offshore wind power has been introduced mainly in Europe and China (24 GW as of 2018), but significant growth is expected in Asian countries (including Japan) and North America.

Total installed offshore wind power (GW)

Source: "Future of Wind," IRENA (2019)



Estimated market expansion in Japan

	Expected power generation (GW)	Steel consumption (Mt)
2030	10	1.5
2040	30～45	4.5～6.75
2050	90	13.5

Public and private sector adoption targets (2030–2040)

Source: Japan Wind Power Association

Trends in Japan's monopile market

From around 100,000 tons per year in FY2024, it is forecast to expand to 160,000 tons in the late 2020s and exceed 200,000 tons from the 2030s.

Note: Market size and steel consumption estimates based on ratio of foundation types per target installations

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JFE Engineering's Initiatives: Study Monopile Production

Study of monopile foundation-structure manufacturing

Strategy	Establish monopile plant, first of its kind in Japan, deploying technologies for designing offshore structures, processing and welding large and heavy steel plates, and applying robust marine anticorrosion coatings
Investment scale	About 40 billion yen for plant buildings, machinery and equipment, wharf maintenance, etc.
Production period	Production targeted to start in April 2024 (corresponding to start of construction of Round 1 project)
Market share	50% share (target)

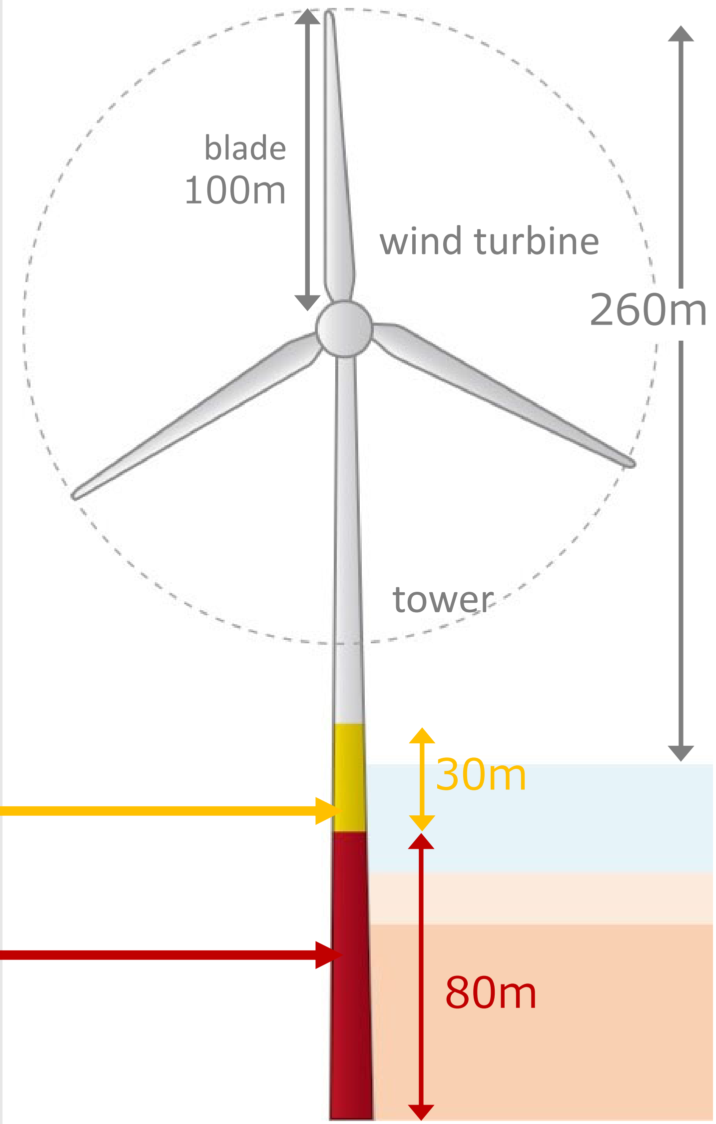
Transition pieces
(pipes connecting to wind turbine tower)

- 9 to 11m in diameter
- About 500t in weight

Monopiles (super heavyweight)
Thick walls, large diameters & long length

- 9 to 11m in diameter
- About 1,400t in weight

Approx. size of main machine (12MW class)

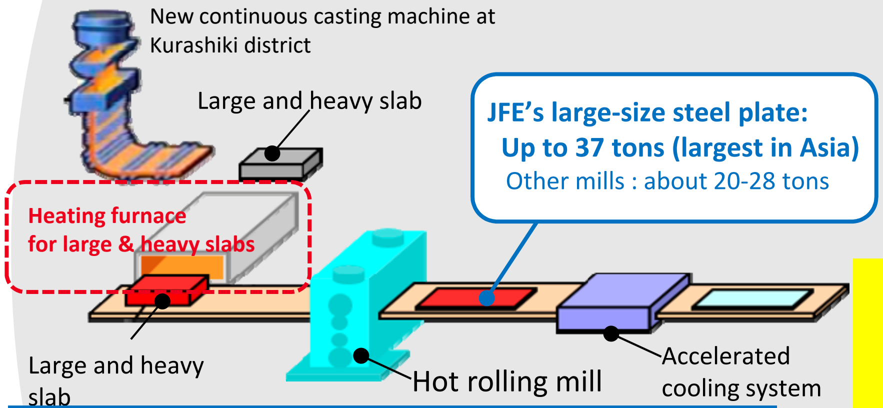


JFE Steel Initiatives: Expand Large-scale Heavy-duty Plate Production Capacity

Larger wind turbines to reduce power costs require larger foundation structures

⇒ Contribute to offshore wind power business with large, thick, high-quality cross-section plates manufactured from world top-class continuous-casting machine with large cross section

Investment in facilities for large and heavy plates for offshore wind



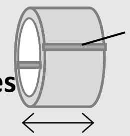
<New continuous casting machine>

- High-efficiency casting of large cross-sectional slabs
- Advanced control technology for greatly improved slab surface and internal quality

Mass production of high-quality, large cross-section, large single-weight thick plates
Large-size plates for offshore wind: over 200k tons/year

Advantages of large-size plates in monopile manufacture

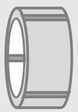
A tube for monopiles made with large-size plates



Less welds

Longer tube length

A tube made with conventional-size steel plates



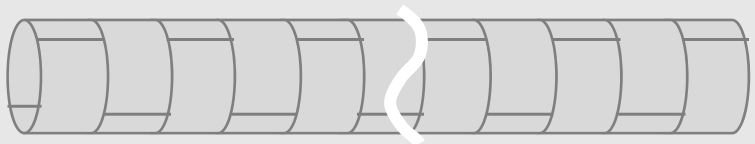
- Multiple welds
- Shorter tube length

- Reduction of welding
- Reduction of assembly man-hours

→ **Lower production cost**

- Shorter production lead time
- Increase in production volume

→ **Promote introduction of offshore wind power**



O&M Using Group Resources

Lifecycle cost structure for seabed-fixed offshore wind turbines (European case: METI-Mitsubishi Research Institute data)

R&D	Manufacture of wind turbines	Manufacture of foundation structure	Electrical system	Installation	O&M	Removal
2.9%	23.8%	6.7%	7.7%	15.5%	36.2%	7.2%

O&M market size: around 2 trillion yen
(Mitsubishi Research Institute data; based on Japan's target of introducing 10 GW by 2030)

JFE aims to support the stable operation of wind turbine generators as a partner of generator manufacturers

Power generation company

Wind turbine generator

cooperation

External corporation ↔ Windmill manufacturer → JFE Group

BOP

BOP = Balance of plant (offshore foundation structure, etc.)

cooperation

JFE Group ↔ External corporation

JFE Group → Partner company


Nacelle repair and failure support


Blade repair


Spare parts supply


Equipment diagnostic forecasts


Structural corrosion evaluation

- **Utilize know-how cultivated in onshore wind O&M and steel structure fabrication**
- **Collaborate with other companies to support the stable operation of domestic offshore wind farms**

JFE

Engineering Business Contributions to Carbon Neutrality

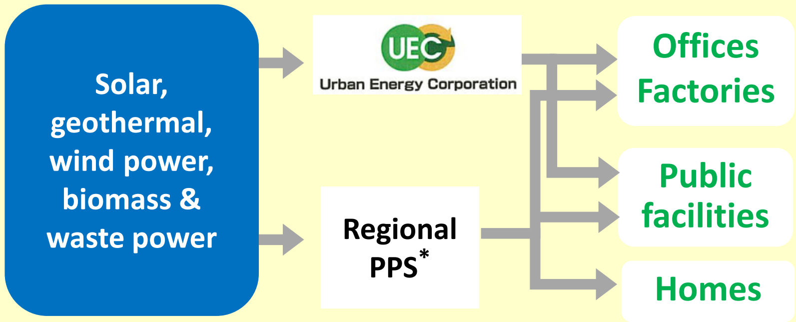
Contributions to CO_2 Reduction through Engineering Business

Renewable Energy

- Biomass, geothermal, solar, offshore wind power (through group synergies), etc.
- Waste power generation

Renewable-energy business (EPC & projects)

- Diversify power sources (offshore wind & hydro)
- Participate widely in EPC and project management
- Provide energy services such as local supply of renewable energy sources and zero-emission plans for clients



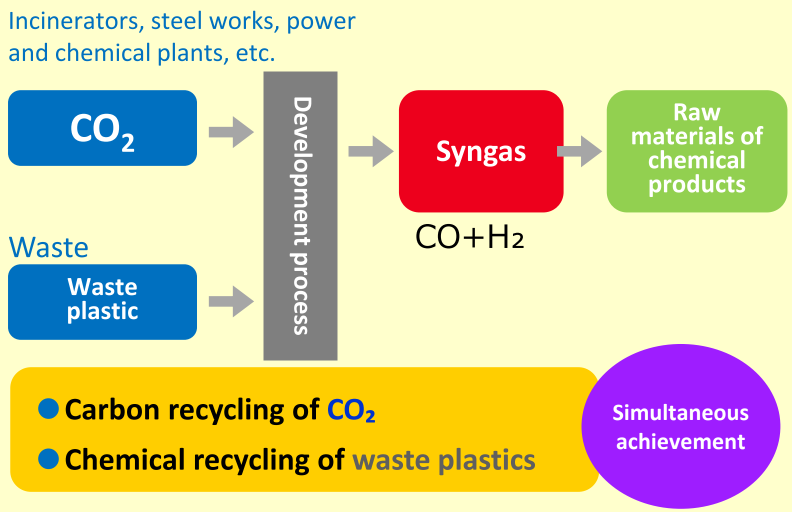
*Power producer and supplier that produces electricity locally for local consumption

Carbon Recycling

- Conversion of CO_2 into synthesis gas and chemical products
- CO_2 separation and recovery

Practical use of carbon recycling

(CO_2-based chemical production technology)



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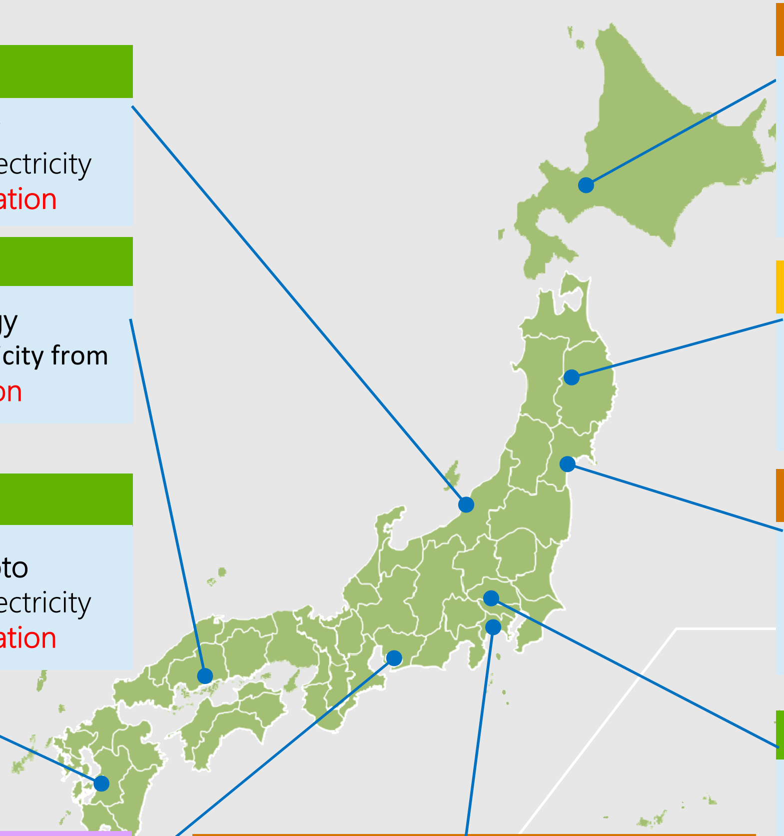
JFE Engineering's Support of Local Production for Local Consumption

Support local energy production for local consumption (independent and decentralized) and regional carbon neutrality through biogas power generation from food waste and expansion of regional power producers and suppliers (PPS)*



Niigata city
Niigata Swan Energy
Sales of locally produced electricity from waste power generation

Fukuyama city
Fukuyama Mirai Energy
Sales of locally produced electricity from waste power generation

Kumamoto city
Smart Energy Kumamoto
Sales of locally produced electricity from waste power generation

Toyohashi city
Honokuni Toyohashi Electric Power
Sales of locally produced electricity from biogas power generation

J Biofood Recycling
Biogas power generation from food waste
Food recycling and sales of locally produced electricity

Sapporo Biofood Recycling
Feed & fertilizer production from food waste and biogas power generation
Food recycling and sales of locally produced electricity

Hachimantai city
Hachimantai Geothermal Plant sales
Local electricity from Matsuo-Hachimantai Geothermal Power Plant

Tohoku Biofood Recycling
Biogas power generation from food waste
Food recycling and sales of locally produced electricity

Tokorozawa city
Tokorozawa Mirai Denryoku
Sales of locally produced electricity from waste power generation

*Produce electricity locally for local consumption

JFE

Trading Business Contributions to Carbon Neutrality

Leverage global network and corporate resources for carbon neutrality within JFE group and society

JFE Shoji

JFE Steel | **JFE Engineering**

Reduce CO_2 emissions in steel business

Collaborate with JFE Steel to expand steel scrap procurement and explore procurements of reduced iron and later hydrogen

- Scrap
- Reduced iron
- Hydrogen

Facilitate wider use of renewable energy

Support the stable supply of fuel for biomass power plants operated by JFE Engineering to help reduce CO_2 emissions

Biomass fuel

Aim to become carbon neutrality

04 Carbon Neutrality Proposals to Society

JFE

Proposals to Society

JFE's key business concern is developing carbon-neutral steelmaking, but many other issues also must be resolved.

Costs of Achieving Carbon-neutral Steel

- **Massive research and development costs**
  - ⇨ Approximately 100 billion yen by 2030 and more by 2050 (will require maximum use of government R&D support, such as Green Innovation Fund)
- **Massive investment in equipment**
  - ⇨ Total capital investment in steel works will exceed R&D costs (approximately 500 billion yen per blast furnace with a capacity of 4 million tons per year)
- **Stable supply of inexpensive, high-volume green hydrogen and electricity, and development of related infrastructure (Ensure the global competitiveness of industrial power price)**
- **Even with cheap hydrogen, production costs will significantly increase***

*Assuming 20 yen per Nm^3 of hydrogen

Significant cost increases are inevitable and there are limits to the efforts of individual companies. Government support and cooperation with society will be essential, including for the creation of a mechanism through which society would bear the increased costs.

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