



KOBELCO Group's CO₂ Reduction Solution for Blast Furnace Ironmaking

February 16, 2021

Kobe Steel, Ltd.

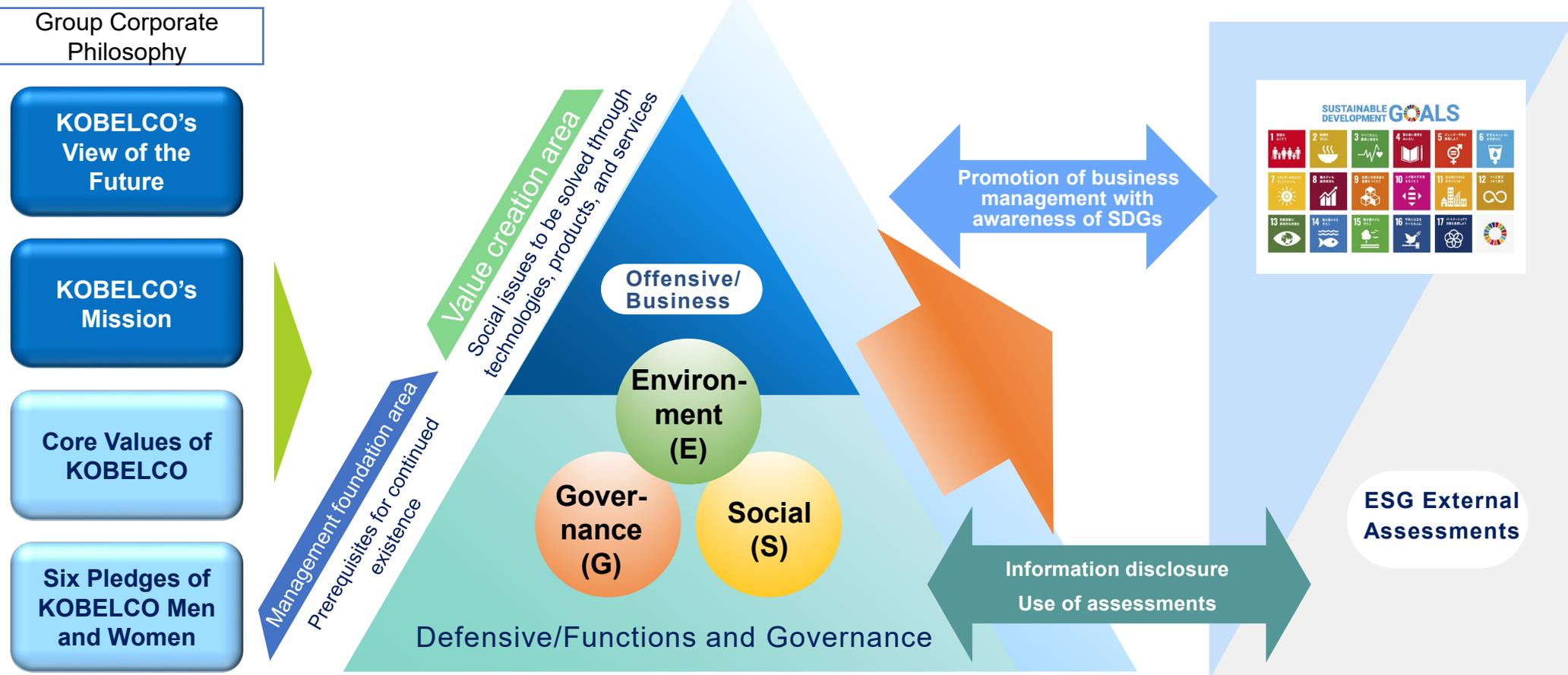
1. Introduction

2. KOBELCO Group's CO₂ Reduction Solution for Blast Furnace Ironmaking

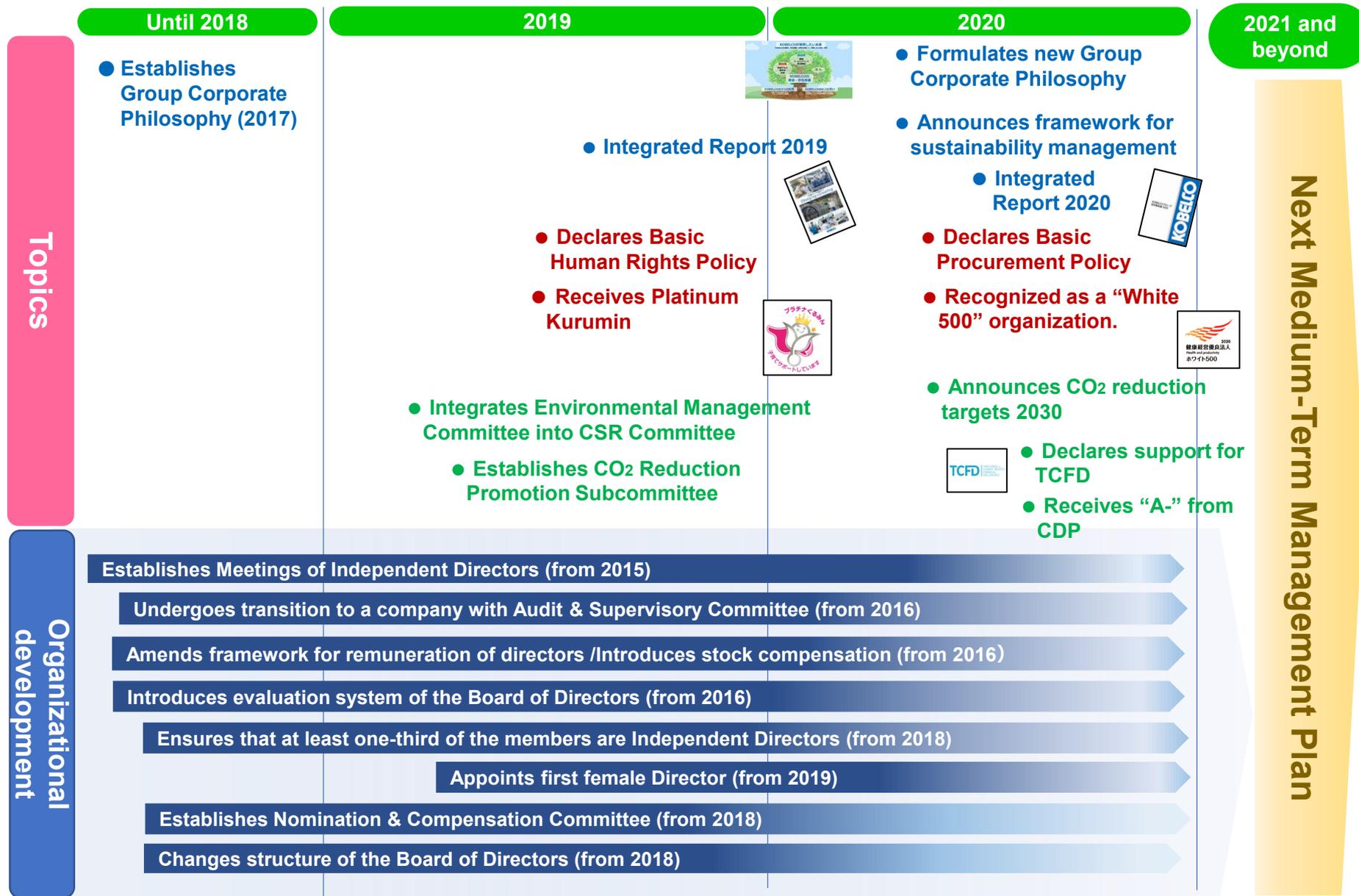
01

Introduction

Framework for KOBELCO Group's Sustainability Management



Addressing social issues both aggressively (in value creation area) and defensively (in management foundation area)



Initiatives & Topics in Value Creation Area – Contribution to Creating a Green Society –

CO₂ Reduction
through Utilization
of DRI

MIDREX® Process



Solutions for
automotive weight
reduction & Electrification



Promoting ICT
Technology in
Construction Machinery

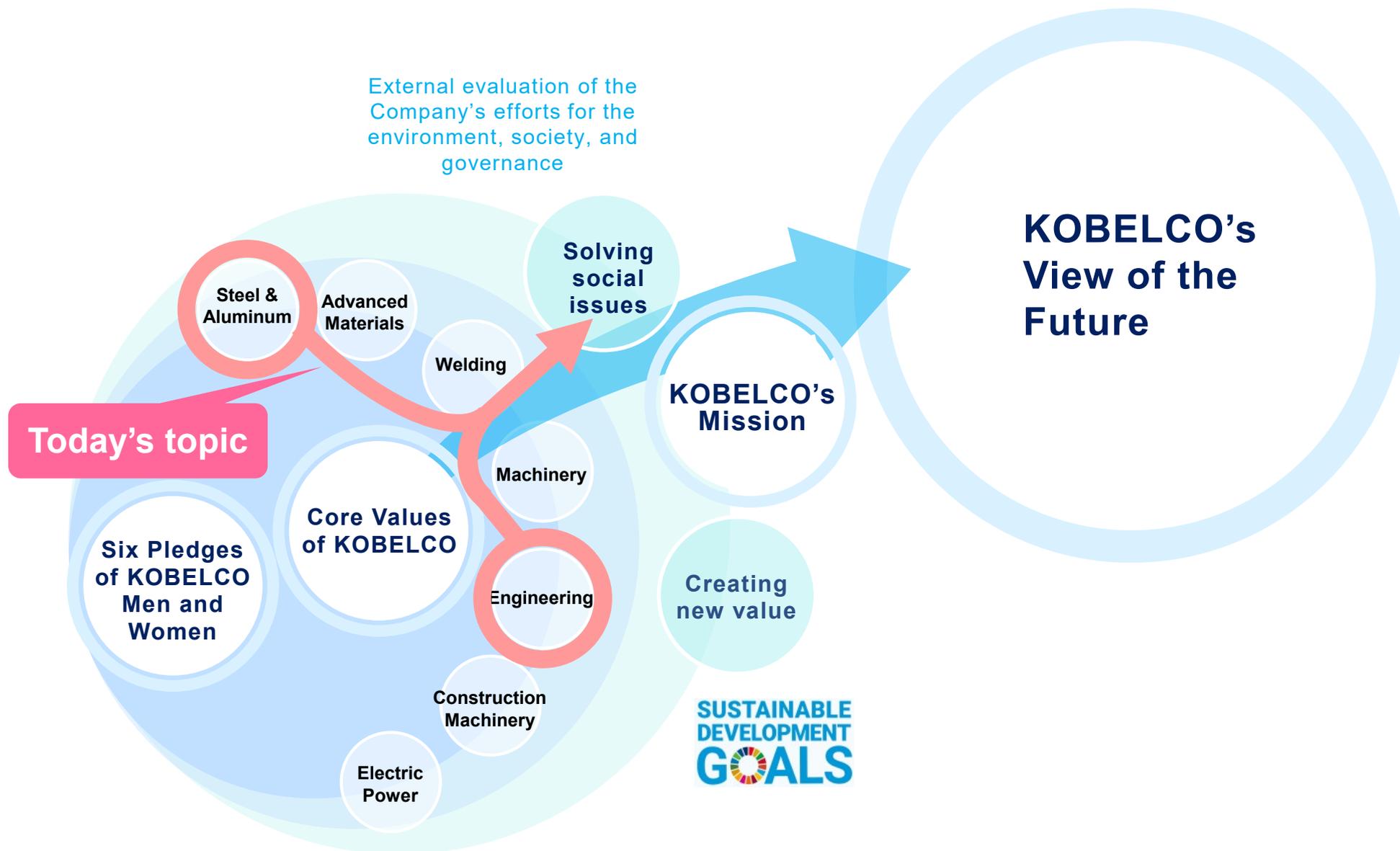


Water Treatment & Waste
Processing Technologies



Energy Conservation
at Production Sites
(Industrial Machinery)





Achieving new development and providing solutions for social issues through the combination of our diverse products and technologies

02

KOBELCO Group's CO₂ Reduction Solution for Blast Furnace Ironmaking

— Innovative technology to reduce CO₂ emissions from blast furnace operations successfully verified —

Kobe Steel, Ltd. has successfully demonstrated the technology* that can significantly reduce CO₂ emissions from blast furnace (BF) operations, combining the technologies in the engineering business and in the iron and steel business.

This achievement is a result of the integrated efforts of the Kobe Steel Group (also known as the KOBELCO Group) leveraging its diverse businesses.

* Verified at the No. 3 blast furnace (4,844m³) of the Kakogawa Works in Hyogo Prefecture, Japan in October 2020

1 . CO₂ emissions significantly reduced from BF operations (Verified: CO₂ emissions reduced by approx. 20% compared to FY2013)

☆ Successfully reduced CO₂ emissions from BFs
by charging a large amount of HBI^{*1)} produced by
Midrex[®] Process^{*2)} with a significant decrease in RAR^{*3)}.

* 1) HBI (hot briquetted iron): direct reduced iron (DRI) in a briquetted form

* 2) MIDREX[®] Process: the leading direct reduced iron (DRI) making process developed
by Midrex Technologies, Inc., a Kobe Steel's wholly owned subsidiary in the U.S.

* 3) RAR (reducing agent rate): the amount of carbon fuels used as the reductant such as
coke and pulverized coal

2. A low-cost CO₂ reduction solution

(Lower additional costs for reducing CO₂ emissions)

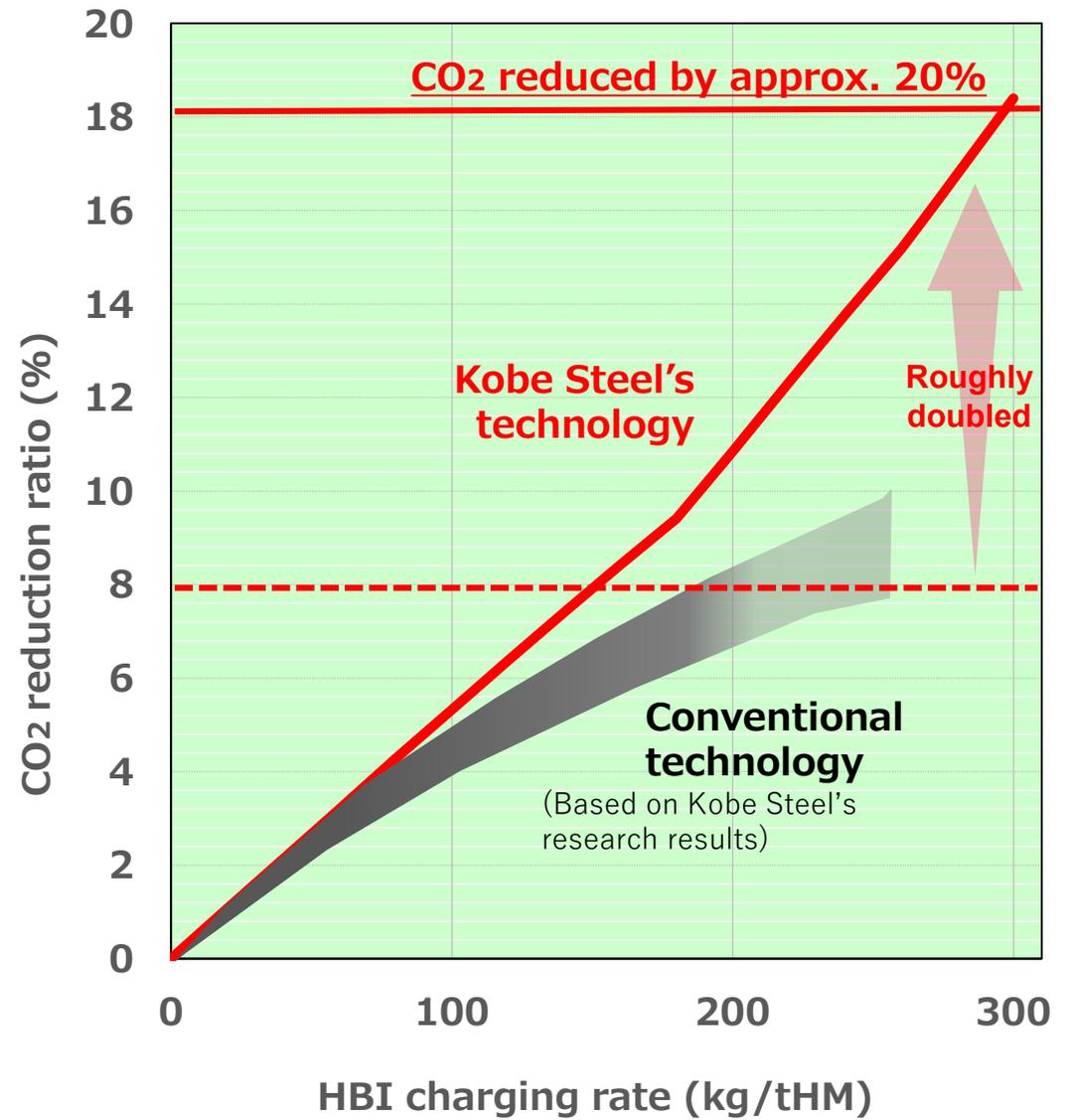
☆ Successfully reduced the use of expensive coke^{*4)} to the world's lowest level by KOBELCO's BF operation technologies.

* 4) Coke: a carbon fuel made from coal
(Coal processing requires a lot of equipment and costs)

— CO₂ Reduction Ratio in BF Operations —

1. Reduced CO₂ emissions from BFs significantly by charging a large amount of HBI produced by Midrex[®] Process
2. Successfully reduced CO₂ emissions by approx. 20% with a stable decrease in RAR from 518 to 415 kg/tHM* by charging 305 kg/tHM of HBI
3. Achieved roughly twice the CO₂ reduction effect of previous attempts to reduce CO₂ emissions from BFs with HBI

* tHM: ton hot metal



CO₂ Reduction Cost

$$\frac{\left(\begin{array}{l} \text{The quantity of HBI used} \\ \times \text{ HBI unit price} \end{array} - \begin{array}{l} \text{The quantity of iron ore reduced} \\ \times \text{ iron ore unit price} \end{array} - \begin{array}{l} \text{The quantity of reductant} \\ \text{reduced} \times \text{ reductant unit price}^* \end{array} \right)}{\begin{array}{l} \text{The quantity of CO}_2 \text{ reduced} \\ (= \text{The quantity of reductant reduced} \times \text{CO}_2 \text{ emission factor}) \end{array}} + \text{Equipment cost} + \text{Other costs}$$

① The quantity of reductant reduced \times reductant unit price
= the quantity of coke reduced \times coke unit price + the quantity of
pulverized coal reduced \times pulverized coal unit price

(Typical raw material unit prices are: **HBI** > **Coke** > **Iron ore** > **Pulverized coal**)

CO₂ reduction costs can be minimized by:

- Increasing the quantity of HBI charged in BF operations, and
- Reducing the use of reductant (expensive coke) in large quantity.

About the Technology Demonstrated

— CO₂ Reduction Cost (2) —

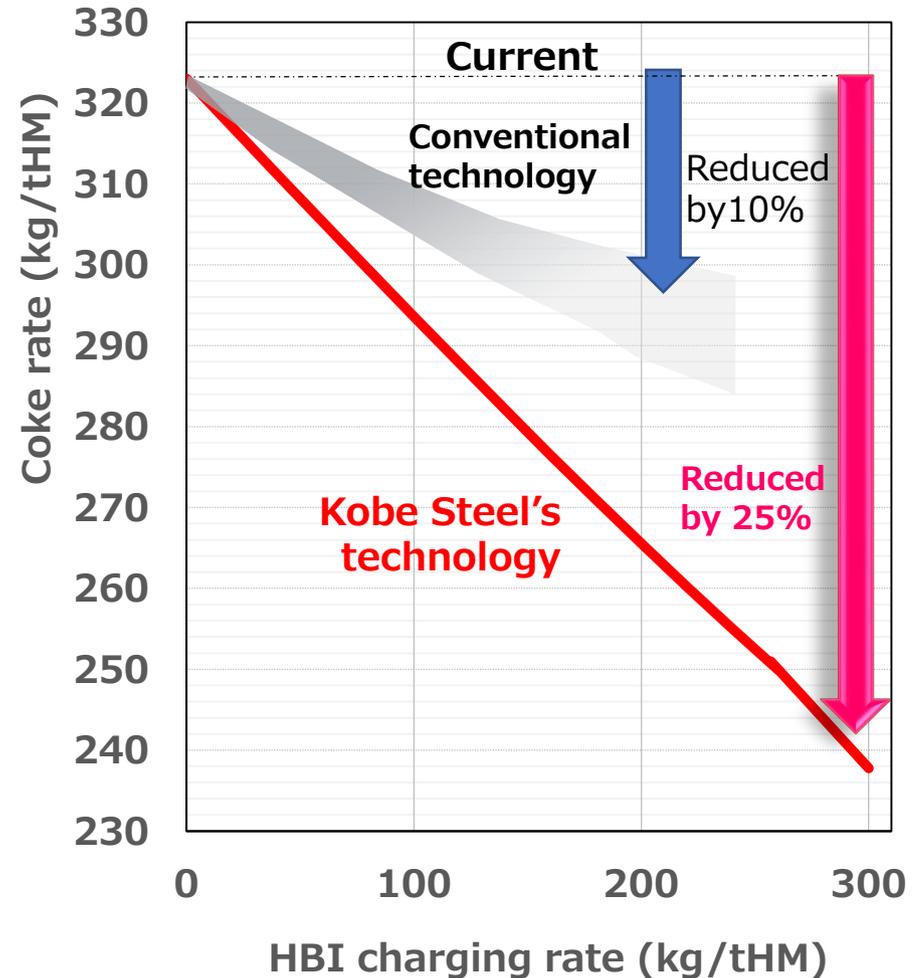
The key to lowering the CO₂ reduction cost is how much expensive coke can be reduced by HBI charging

Results of the demonstration test

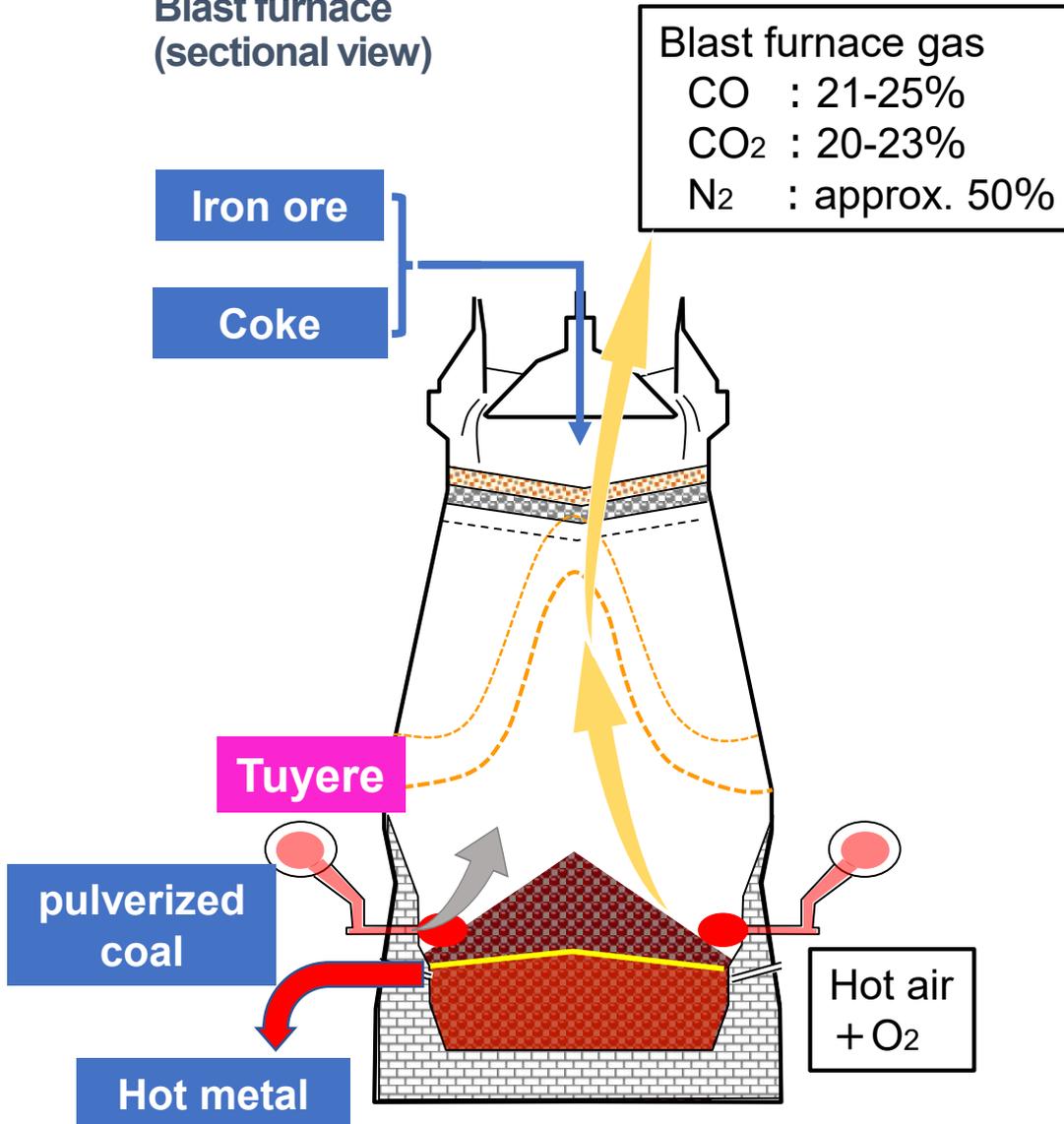
	Quantity of HBI charged (kg/tHM)	Coke rate (kg/tHM)	Coke rate reduced (kg/tHM)
Kobe Steel	305	239 World's lowest level	85
Previous	250	290	34

Note: The figures above are based on Kobe Steel's research results

The coke rate reduced by 2.5 times compared with the conventional method



Blast furnace
(sectional view)



Functions of the Blast Furnace

(1) Reduction of iron ore

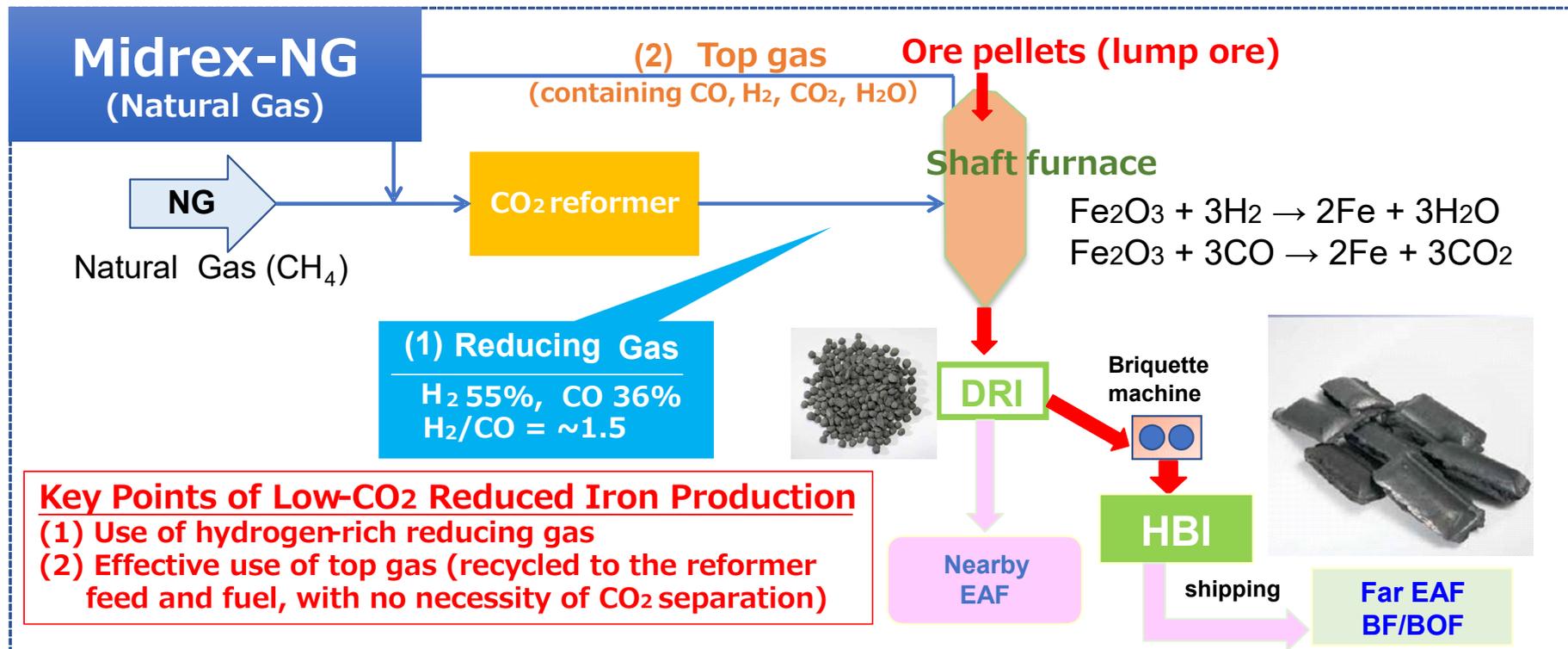


(2) Melting of iron (solid → liquid)

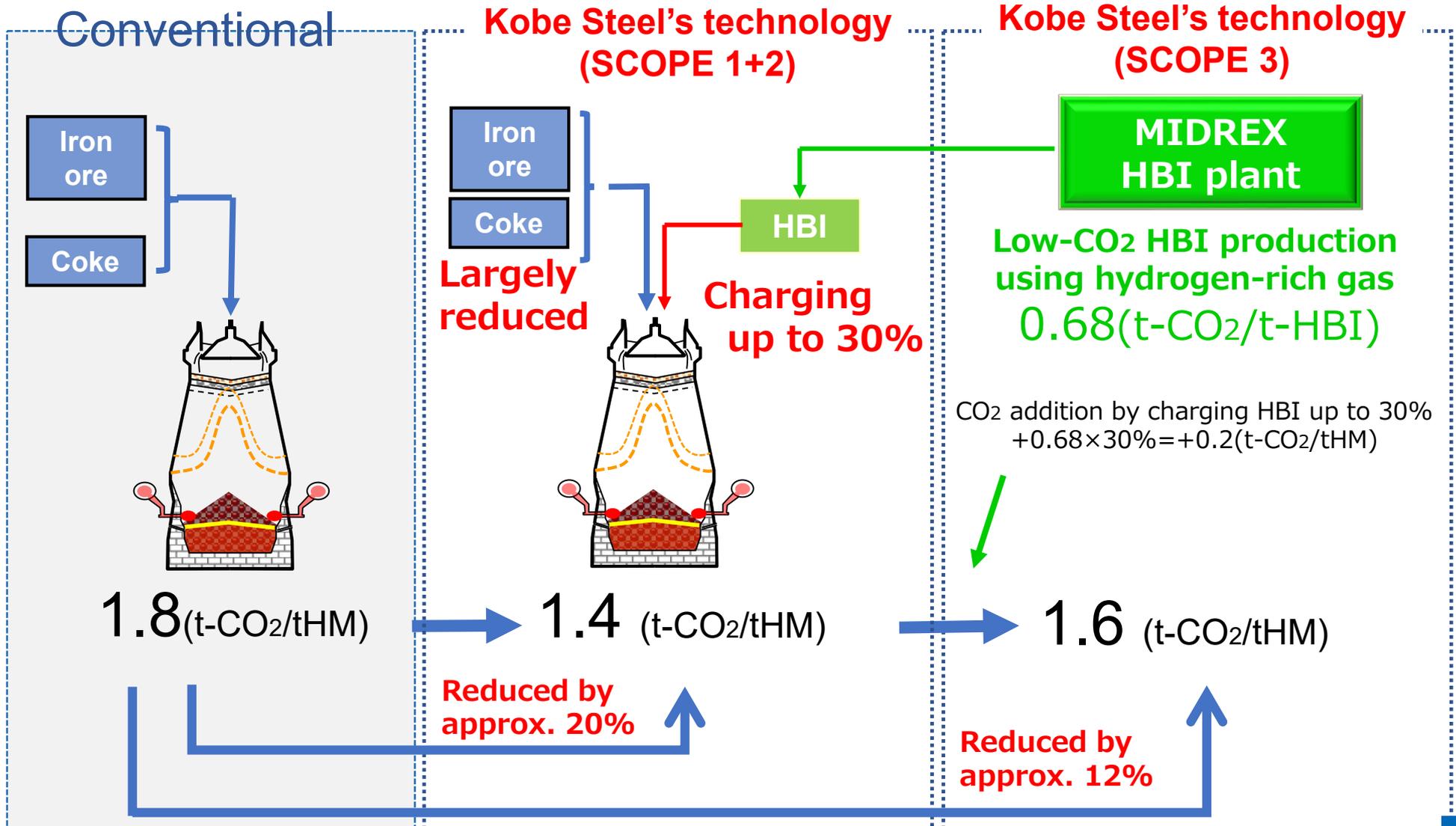
Using combustion heat generated from $\text{C} + \text{O}_2 = \text{CO}$

Note: Approx. 80 to 90% of CO₂ emissions from steel production is generated in BF operations.

- **MIDREX[®] Process:** Direct reduction of ore pellets (lump ore) to produce reduced iron (DRI, HBI) with reducing gas (H₂ ~55% CO ~36%), obtained from reforming natural gas
 - **DRI (Direct Reduced Iron):** Clean iron source (Fe ~90%, low impurities), widely used and substituting high-grade scrap and pig iron in EAF, BF and BOF
 - **HBI (Hot Briquetted Iron):** Compacted & Briquetted DRI for long distance transport such as shipping
- **MIDREX/EAF route with 20–40% less CO₂ emissions than BF/BOF route.**
- **More than 90 MIDREX modules worldwide, producing about 80% of the world's natural gas-based DRI/HBI**



Conventional reduction method in BF route is partly replaced by MIDREX[®] Process utilizing hydrogen rich gas



Technological Challenge: Essential to eliminate instability of BF conditions with the HBI charging in large quantity and the reduction of coke used.

KOBELCO Group's technologies

HBI manufacturing technology



MIDREX®

HBI charging technology



BF operation technology utilizing AI



Advanced pellet production technology



Low-CO₂ BF Operation Technology



About 20% lower CO₂ emissions

+

Low CO₂ reduction costs

+

Technology readily available

KOBELCO Group's CO₂ Reduction Solution will:

- (1) Reduce CO₂ emissions from BF operations in large quantity and at low additional cost
- (2) Provide a new option that could become readily available for a wide range of applications as a promising addition to other advanced technologies being developed by steelmakers around the world

KOBELCO Group's Low-CO₂ BF Operation Technology

Further reduction of CO₂ emissions

Lower CO₂ reduction cost

Further improvement of low-CO₂ BF operation technology

Contributing to the reduction of CO₂ emissions from BFs worldwide based on this technology

Establishing and promoting production and sales systems for low-CO₂ steel products (with new added value and differentiated features) and setting the terms and condition for sales

KOBELCO Group's mission

Reduce CO₂ emissions from the steel industry as quickly as possible and at the lowest possible cost

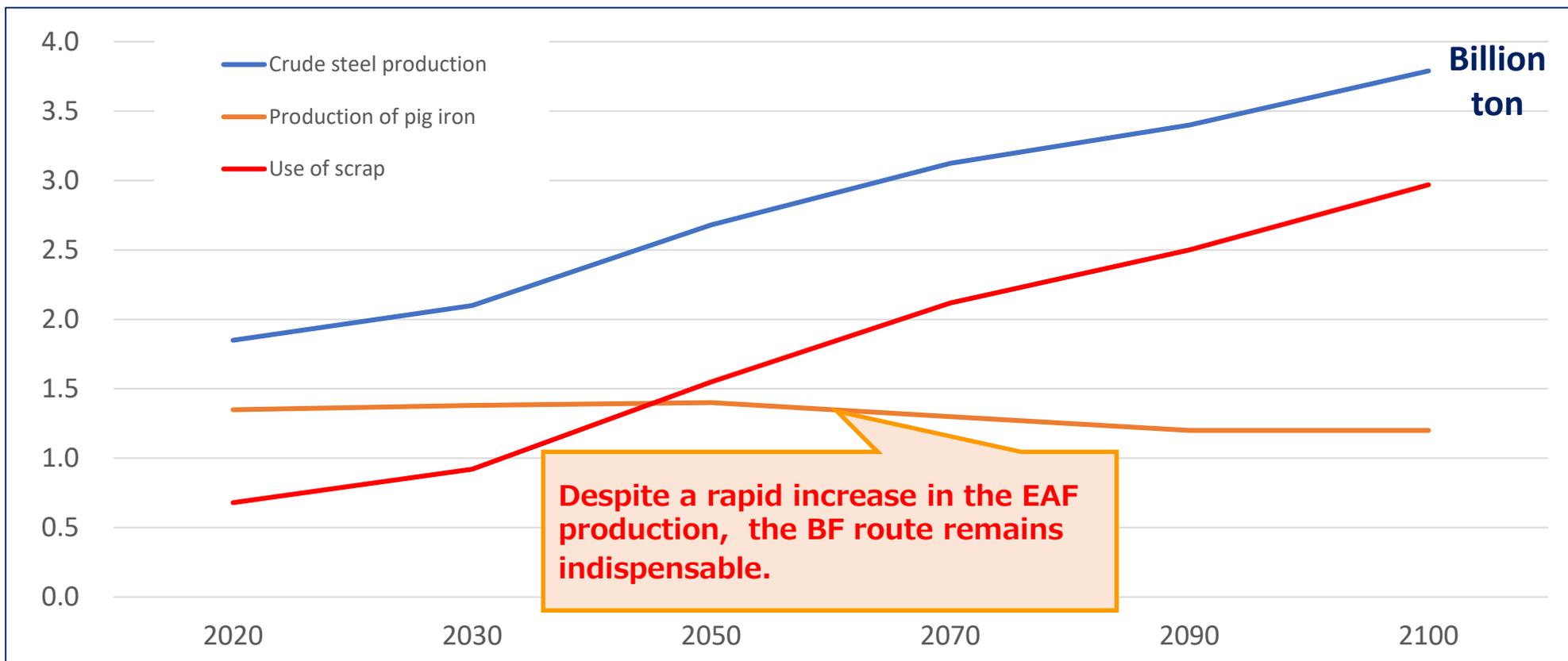
KOBELCO Group's Corporate Philosophy

KOBELCO's View of the Future	<p>Our view of a society and future to be attained as we carry out KOBELCO's mission</p> <p>We envision a world in which people, now and in the future, can fulfill their hopes and dreams while enjoying safe, secure, and prosperous lives.</p>
KOBELCO's Mission	<p>Our mission and the social significance of the KOBELCO Group that we must fulfill</p> <p>Our mission is to provide solutions to the needs of society, by making the best use of the talents of our employees and our technologies.</p>
Core Values of KOBELCO	<p>The commitments of the KOBELCO Group to society and the values shared by the entire KOBELCO Group</p> <ol style="list-style-type: none"> 1. We provide technologies, products and services that win the trust and confidence of our customers we serve and the society in which we live. 2. We value each employee and support his and her growth on an individual basis, while creating a cooperative and harmonious environment. 3. Through continuous and innovative changes, we create new values for the society of which we are a member.
Six Pledges of KOBELCO Men and Women	<p>Code of Conduct for all Group employees to follow to fulfill the Core Values of KOBELCO and the Quality Charter</p> <ol style="list-style-type: none"> 1. Heightened Sense of Ethics and Professionalism 2. Contribution to the Society by Providing Superior Products and Services Quality Charter 3. Establishing a Comfortable but Challenging Work Environment 4. Living in Harmony with Local Community 5. Contribution to a Sustainable Environment 6. Respect for Each Stakeholder



For details, please see the Next 100 Project page on the Kobe Steel's website.
https://www.kobelco.co.jp/english/about_kobelco/outline/next100/

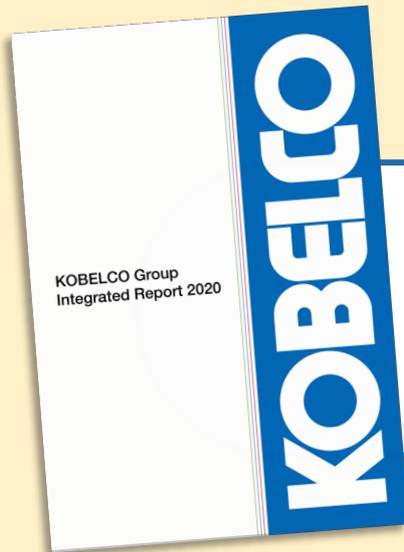
References



Credit : JISF long-term vision for climate change mitigation A challenge towards zero-carbon steel

- ◆ World crude steel production (= demand for steel) continues to increase with population growth.
- ◆ Scrap is mainly used in EAFs. With the increase in steel production, BFs will remain indispensable to cover the entire demand.
- ◆ Efforts toward achieving carbon neutrality by 2050 are essential in the steelmaking business.

Kobe Steel has been contributing to the reduction of CO₂ emissions around the world through MIDREX[®] process technologies mainly for EAFs. Going forward, we will also work on to provide CO₂ reduction solutions for BFs.



» Related link

KOBELCO Group's Integrated Report 2020 is available on our website.
Please use the QR code for easy access to the URL below.

URL: https://www.kobelco.co.jp/english/about_kobelco/outline/integrated-reports/



Note: QR code is a registered trademark of Denso Wave Incorporated.



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 - Strategy changes of alliance partners