NIPPON STEEL

Nippon Steel's CCS implementation efforts and challenges to achieve carbon neutrality

Nippon Steel Corporation

February 8, 2024

Carbon Neutral Vision 2050

Released in March 2021

<Aim to reduce CO_2 emissions by 30% by 2030 and achieve carbon neutrality by 2050>

Our 2030 target is ambitious compared to those of our global peers, and is feasibly aligned with the Japanese government's plan

Provision of high-performance steel products and solutions that contribute to reducing CO_2 emissions in society

- Reduce CO_2 emissions at the time of production and processing by customers
- Reduce CO_2 emissions at the time of use of our products by end customers

Decarbonization of steelmaking process for providing carbon neutral steel

- Reduce CO_2 emissions in customers' supply chains

By providing high-performance steel products and solutions, and by decarbonizing steelmaking process ahead of other countries, we are determined to provide carbon neutral steel to our customers (including approximately 6,000 companies in Japan) and support their international competitiveness. From September 2023, we will launch sales of NSCarbolex® Neutral, a steel product that is certified as reducing CO_2 emissions by a third-party organization.

NET ZERO

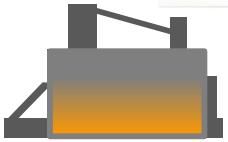
NIPPON STEEL Green Transformation initiative

Steel making process using the blast furnace method

The blast furnace method is currently the only steel production process that mass-produces high-grade steel from iron ore.

The production of 1 ton of steel produces approximately 2 ton of CO_2.

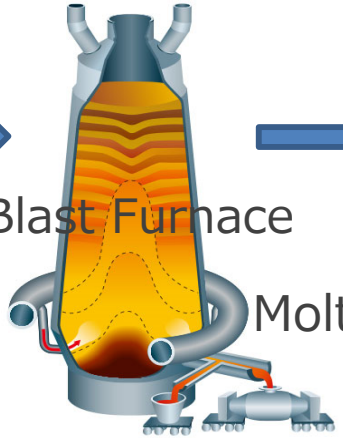
Iron Ore(Oxide)
(Fe+O)



Sintering Plant

Coke Plant

Coal
(C)

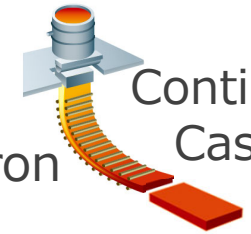


Blast Furnace

Molten iron
(Fe)

Reducing iron ore
(Separate Oxygen)

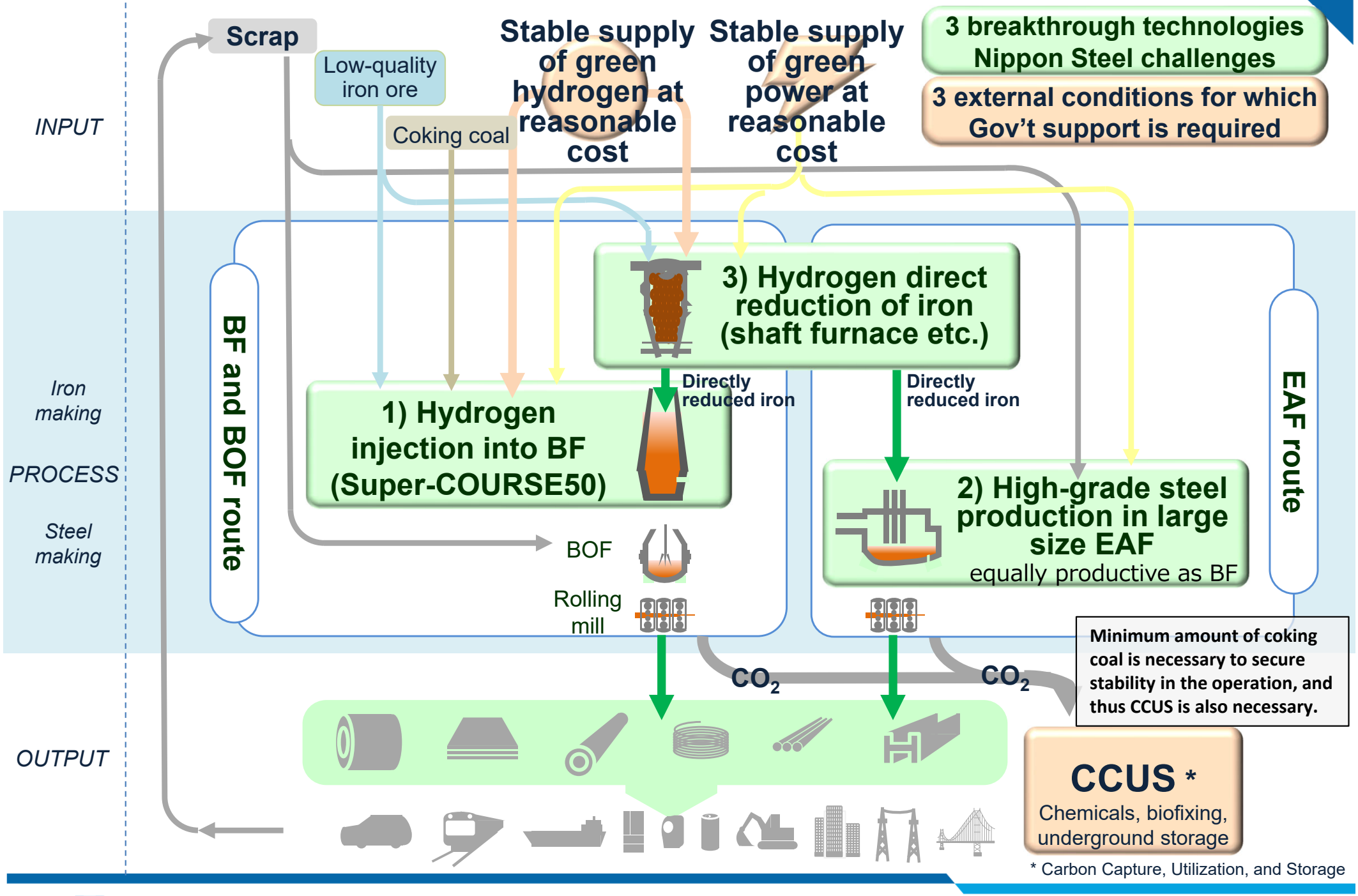
Basic Oxygen Furnace



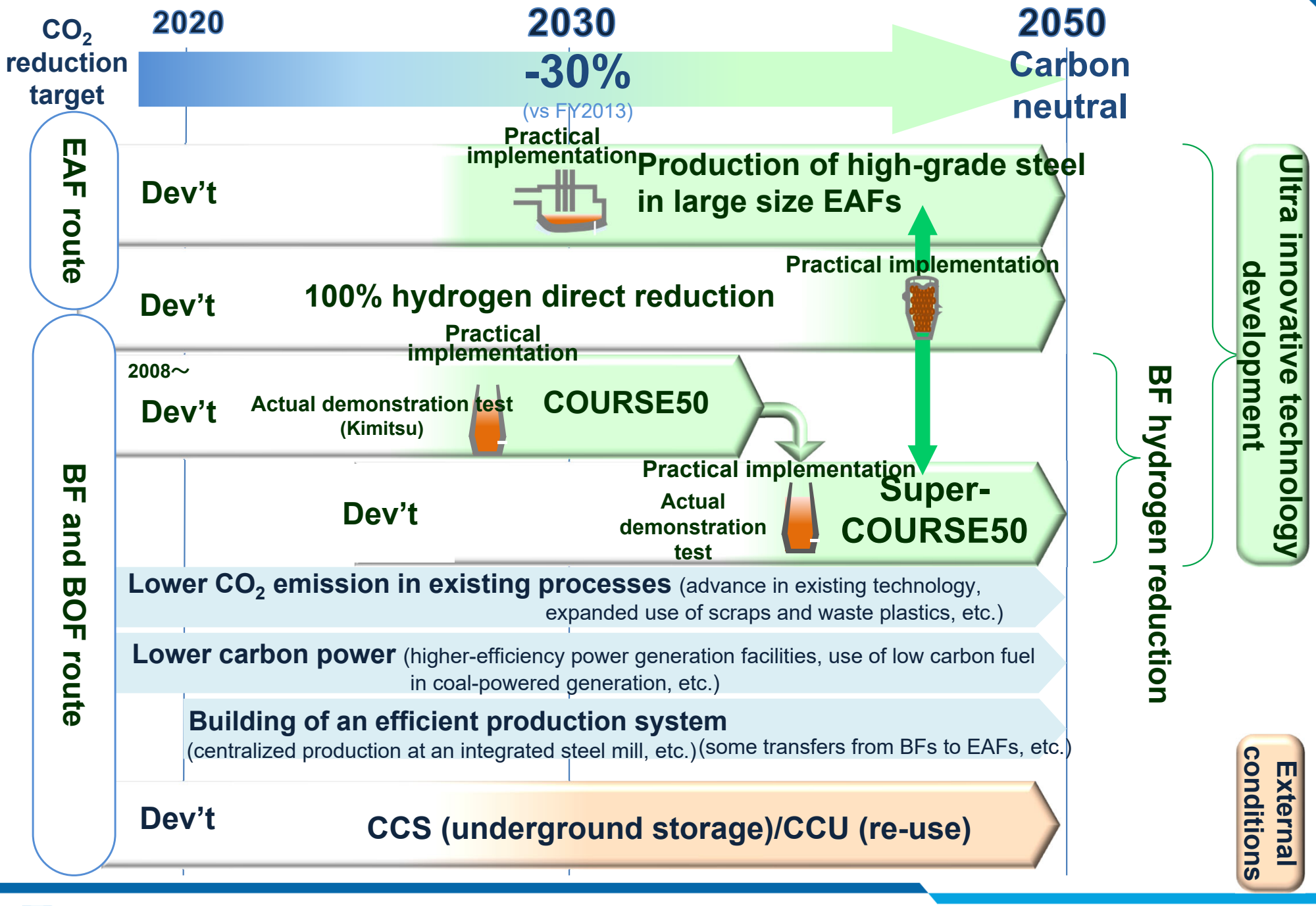
Continuous
Casting

High grade steel making
(Consistent control of production conditions)

Carbon Neutral Process

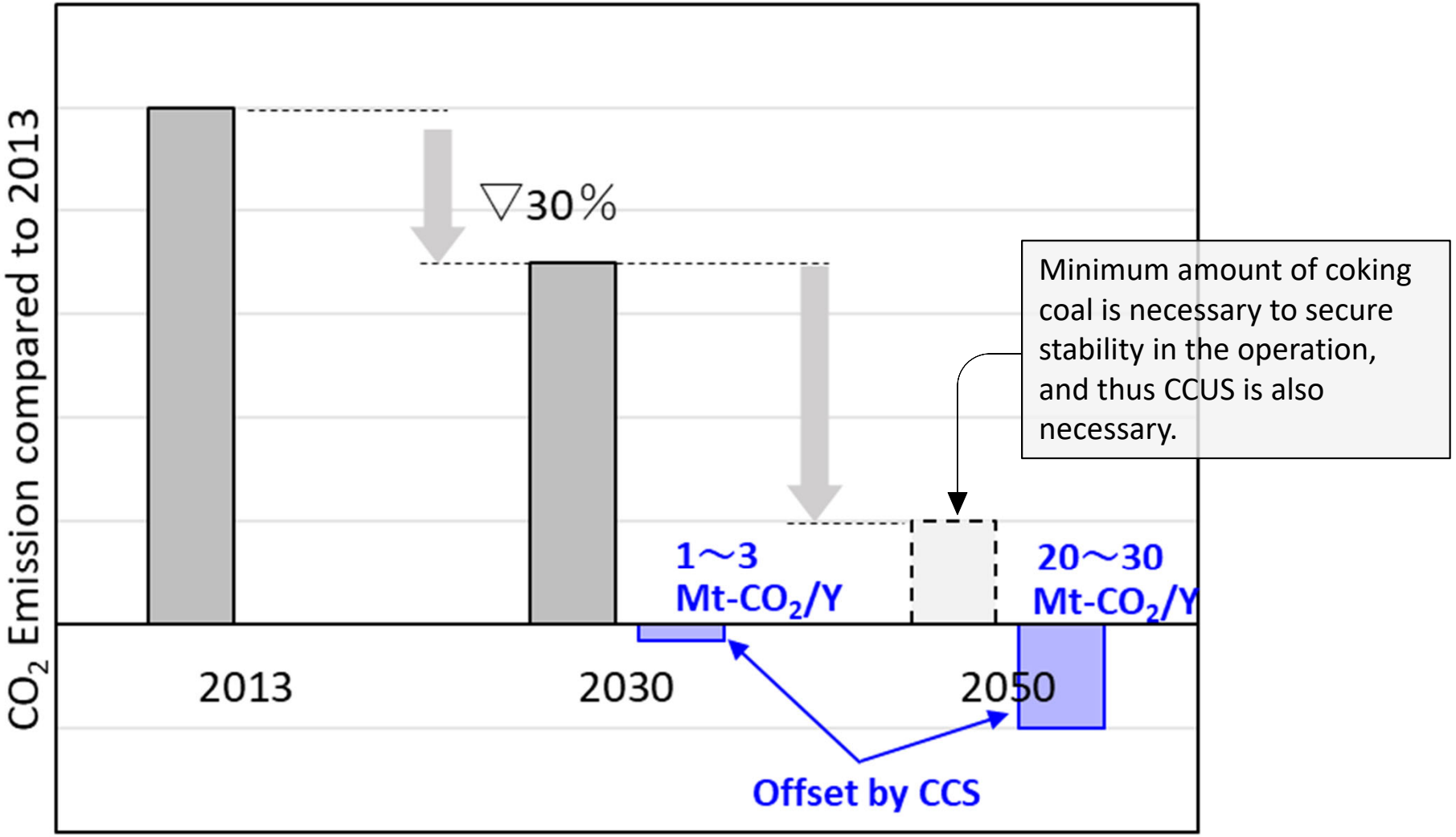


Our roadmap of CO_2 emissions reduction measures



Our CO_2 decarbonization scenario by CCS

- Aiming to implement 1-3 million t-CO_2/year of CCS in 2030 through advanced CCS projects.
- Furthermore, in order to achieve carbon neutrality in 2050, we aim to expand CCS by 20 to 30 million t-CO_2/year.



CCS Implementation Approach

Target

- 1 ～ 3 Mt-CO_2/year（by 2030）
- 20～30Mt-CO_2/year（by 2050）

Implementation Concept

- Actively participate in national projects under government policy
- Storage at several sites abroad in addition to domestic sites

Approach

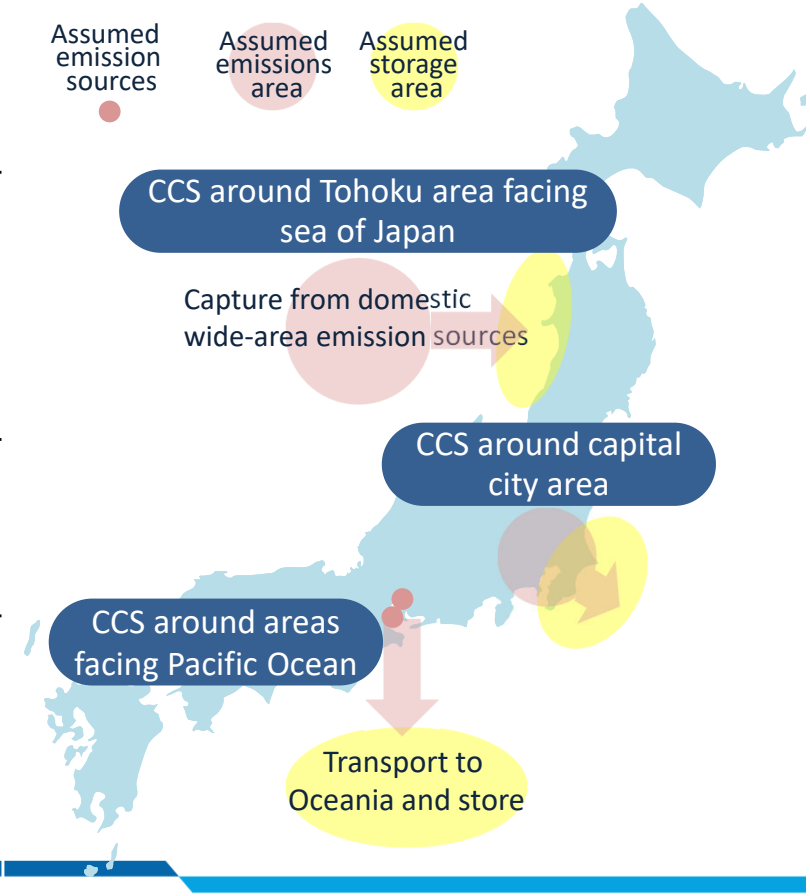
- Through the "Advanced CCS Project" by METI/JOGMEC, the first implementation in 2030 and expanded implementation thereafter

Participated in advanced CCS projects

Participated in three leading joint projects coordinated by JOGMEC, “Survey on the Implementation of Advanced CCS Projects” (released Aug. 2nd and 3rd ,2023)

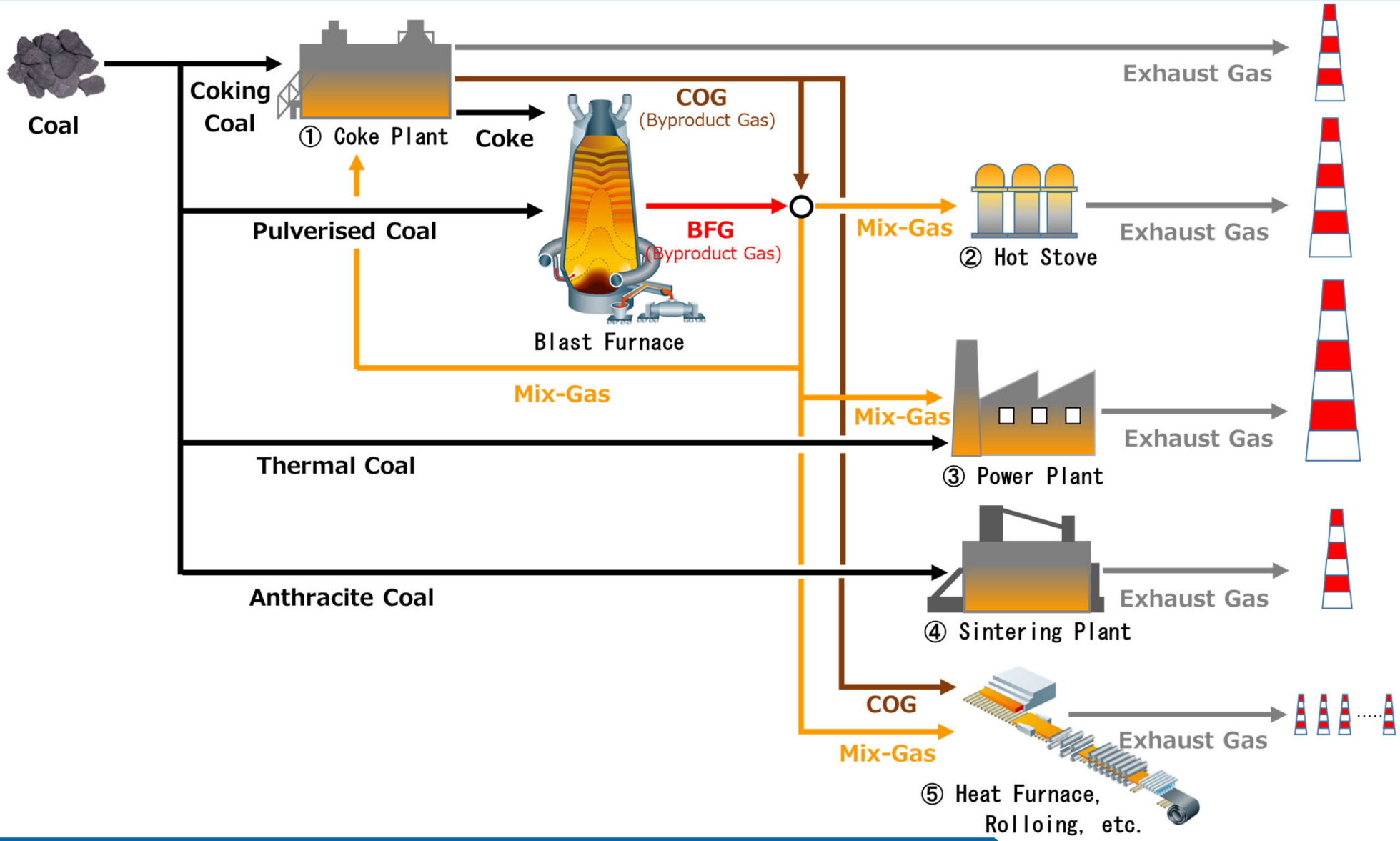
- Nippon Steel and other companies have been commissioned with other companies to conduct a feasibility study on the three advanced CCs project in 2023 coordinated by JOGMEC, Japan Organization for Metals and Energy Security
- Promote with each company the development of external conditions such as securing storage sites, development of storage infrastructure, and development of laws and regulations.
- Nippon Steel is proactively involved in studies related to CO_2 separation and capture, liquefaction, and shipping terminals, based on location restrictions of each steelworks.

		Storage Kt-CO_2/Y	Company	Characteristics
CCS around Tohoku area facing sea of Japan	Domestic	2,000	ITOCHU Corporation Nippon Steel Taiheiyo Cement Corporation Mitsubishi Heavy Industries, Ltd. ITOCHU Oil Exploration Co., Ltd. INPEX Corporation Taisei Corporation	➢ Ship transportation of liquefied CO_2 ➢ Storage in the aquifer in the Tohoku region off the Sea of Japan
CCS around capital city area	Domestic	1,000	INPEX Corporation Nippon Steel Kanto Natural Gas Development Co., Ltd.	➢ Transporting CO_2 through pipelines ➢ Storing the CO_2 in offshore coastal zones of the Tokyo metropolitan area
CCS around areas facing Pacific Ocean	Overseas	2,000	Mitsubishi Corp. Nippon Steel ExxonMobil Asia Pacific Pte.Ltd.	➢ Collect and liquefy CO2 emissions from multiple industries in the Ise Bay/Chubu region ➢ Transport and storage to offshore depleted oil and gas field oversea



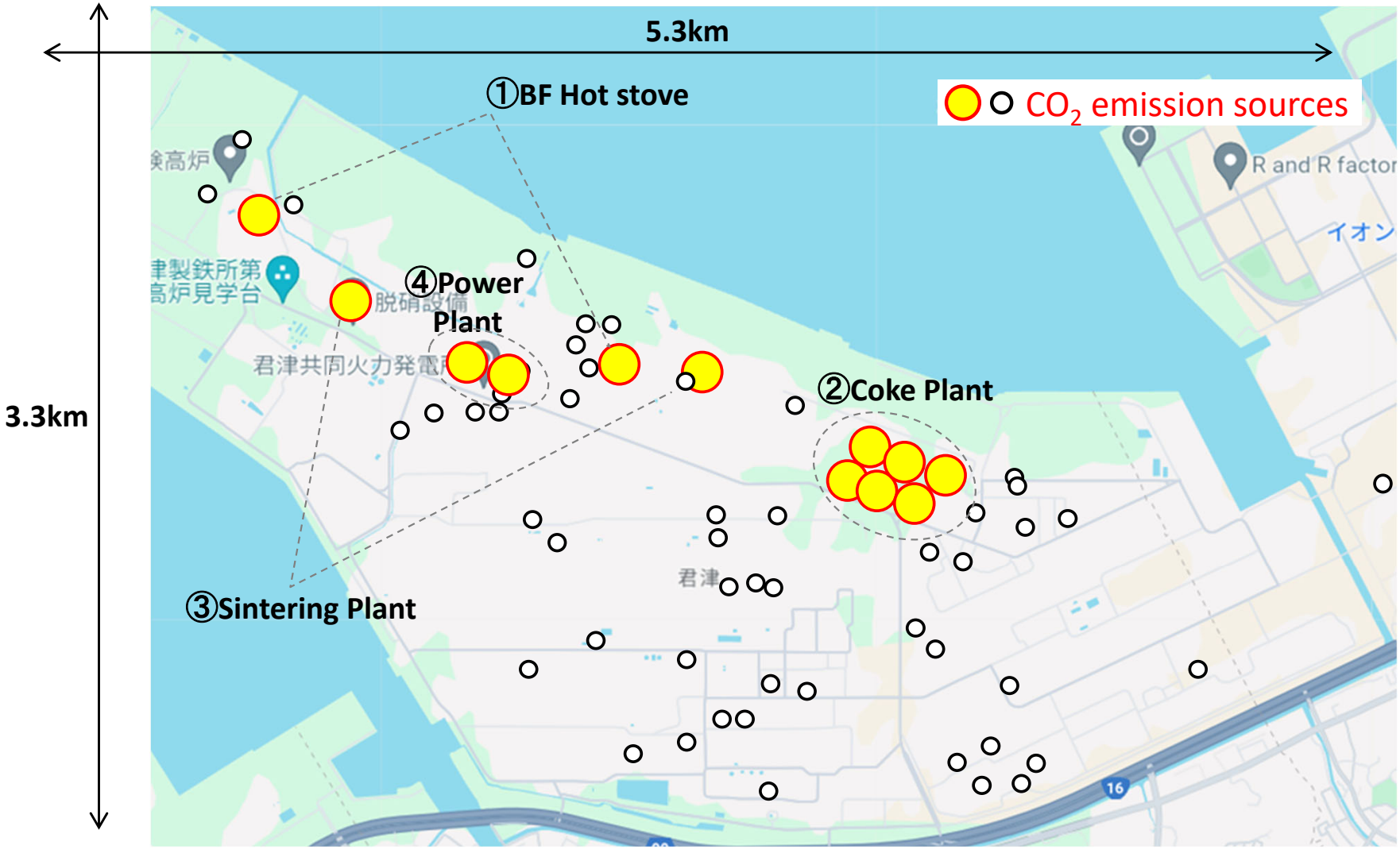
C-flow in the integrated steelmaking process

- CO_2 emissions from integrated steel works come from coal.
- The main sources of CO_2 emissions from steel works are
  ① Coke plants, ②Blast furnace hot stoves, ③ Power plants and ④Sintering plants.



CO_2 emission sources in the integrated Steel Works

- There are more than 100 exhaust gas sources in the integrated steel works.
- It is difficult to install CO_2 capture and liquefaction facilities at each emission sources because existing facilities exist around the CO_2 emission sources.



Major Sources of CO_2 Emissions at Model Steel Works (※1)

※1：Integrated steel works with a pig iron output of 8 Mton/Y assuming major steel works in Japan

- **Blast furnace hot stoves have the highest CO_2 concentration and considered the most efficient source of CO_2 capture.**
- **To achieve carbon neutrality in the future, it will also be necessary to capture CO_2 from small-scale, low-concentration emission sources such as Rolling and other furnaces.**

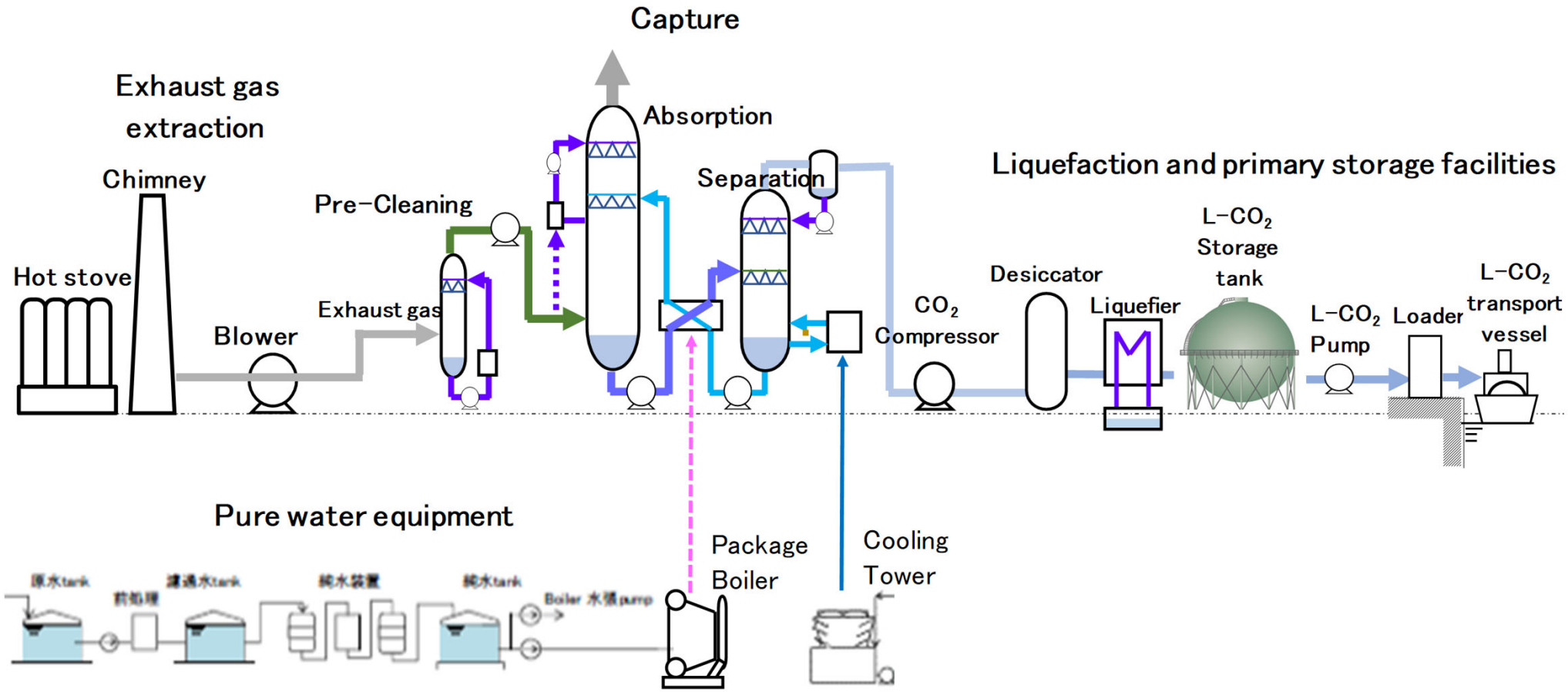
Emission source	Production (kt-s/year)	**CO_2 Emissions (kt-CO_2/year)**	Exhaust Gas Amount (kNm^3/h)	Exhaust Gas Components					Nubmer of exhaust gas souce
				CO_2	H_2O	N_2	O_2	Others	
①Coke Plant	3,800	**1,900**	460	**24%**	5%	69%	2%	SOx, NOx, dust	10
②BF Hot Stove	8,000	**3,200**	720	**26%**	4%	69%	2%	SOx, NOx, dust	2
③Power Plant	–	**8,100**	4,580	**12%**	4%	74%	9%	SOx, NOx, dust	～4
④Sintering Plant	11,700	**1,800**	2,420	**4%**	1%	78%	16%	SOx, NOx, dust	3
⑤Heat furnace,Rolling, etc	–	900	600	**8%**	18%	71%	3%	SOx, NOx, dust	～90
Total		**15,900**	8,780						

These figures are part of the results of a project commissioned by NEDO, New Energy and Industrial Technology Development Organization, and conducted by Nippon Steel Corporation.

CO_2 capture and liquefaction in steel works

～currently being designed～

- CO_2 capture by chemical absorption and deep-cooling separation, will be employed.
- Nippon Steel is studying to introduce these technologies to steel works through the JOGMEC Advanced CCS Projects.



Ⅰ)Challenges in implementing CO_2 capture and liquefaction

1. **Securing the installation Space**
   - How to secure sufficient space for CO_2 capture and liquefaction in the presence of existing production equipment, piping, and other interferences

2. **Improve energy efficiency/Reduce CO_2 emissions/Ensure economic rationality**
   - CO_2 capture and liquefaction process consume large amounts of energy (especially the heating of the absorbent solution for CO_2 desorption).
   - Developments are needed to increase efficiency and economy of the process.

3. **Development for low concentration and small CO_2 emission sources.**
   - Achieving carbon neutrality requires the capture of CO_2 not only from large emission sources but also from small emission sources.

Ⅱ) Issues regarding overseas CCS

1. Arrangement on CO_2 offset credit attribution

- In implementing overseas CCS, international arrangements are needed to ensure that the attribution of CO_2 offset credits is clearly defined.

2. Regulatory arrangements in CCS

- Arrangement on the responsibility of operators for the security and monitoring of stored CO_2
- Setting of storage standards in terms of CO_2 concentration and the amount of impurities in CO_2 that are reasonable from a technical, environmental and economic point of view.