RITE Symposium on IPCC AR6 WG3

Steel Industry's Vision and Challenge towards Carbon Neutrality

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Hiroyuki Tezuka

Fellow, JFE Steel Corporation

Energy Technology Committee, Chair,

The Japan Iron and Steel Federation

IPCC AR6 WG3　SPM C.5 Industry

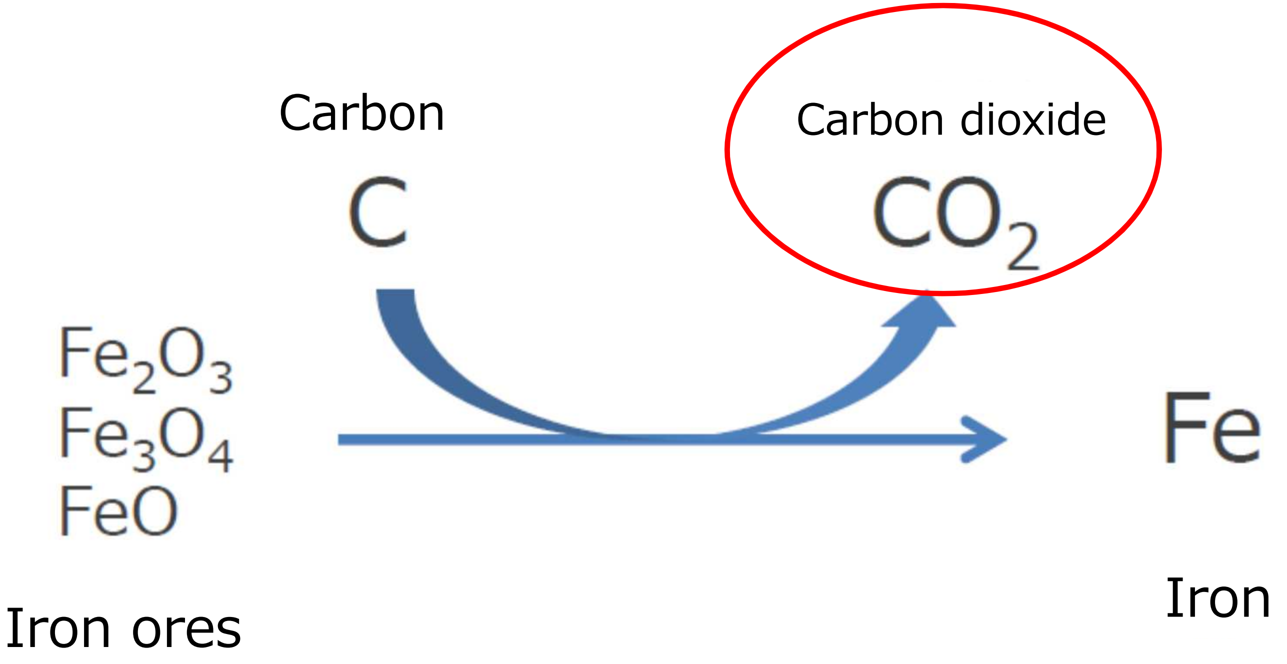
- Net-zero CO_2 emissions from the industrial sector are ***challenging but possible***. ・・・Progressing towards net zero GHG emissions from industry will be enabled by the **adoption of new production processes** using low and **zero GHG electricity, hydrogen, fuels, and carbon management.**
- **The use of steel, cement, plastics, and other materials is increasing globally, and in most regions**. There are many sustainable options for demand management, materials efficiency, and circular material flows that can contribute to reduced emissions
- many low- to zero- GHG intensity production processes are **at the pilot to near-commercial** and in some cases commercial stage but ***not yet established industrial practice***. Introducing new sustainable basic materials production processes could ***increase production costs*** but, given the small fraction of consumer cost based on materials, are expected to **translate into minimal cost increases** for final consumers.
- ***Hydrogen direct reduction for primary steelmaking is near-commercial in some regions***.
- Action to reduce industry sector emissions may **change the location of GHG intensive industries** and the organisation of value chains. **Regions with abundant low GHG energy and feedstocks have the potential to become exporters of hydrogen-based chemicals and materials processed using low-carbon electricity and hydrogen**. Such ***reallocation*** will have global distributional effects on employment and economic structure.

CO2 is inevitably produced in the reduction process

Remove oxygen from iron ore (reduction)

Carbon (C) removes the oxygen (O)(reduction) in the iron ore as carbon is more reactive than iron (Fe)

Iron ore is reduced to iron, and carbon is combined with oxygen to form carbon dioxide.



Challenges toward carbon neutrality in the steel industry

Means	Challenges

1. Iron ore reduced by carbon (current process)

Fe_2O_3 + C + O_2 ➡ Fe + CO_2 + Heating (Exothermic) …CO_2 emission

Measures against generated CO2		challenges
(1)	CO2 emissions are separated and captured for Utilization and geological storage (CCUS).	…Storage and hydrogen
(2)	Biomass use (use of wood and other materials that absorb CO2, resulting in net zero)	…Planting, securing required amount
(3)	Waste plastic use	…Impurities, securing required amount
(4)	Natural gas use (Direct reduction, DRI)	…Productivity, heating

2. Iron ore reduction by hydrogen

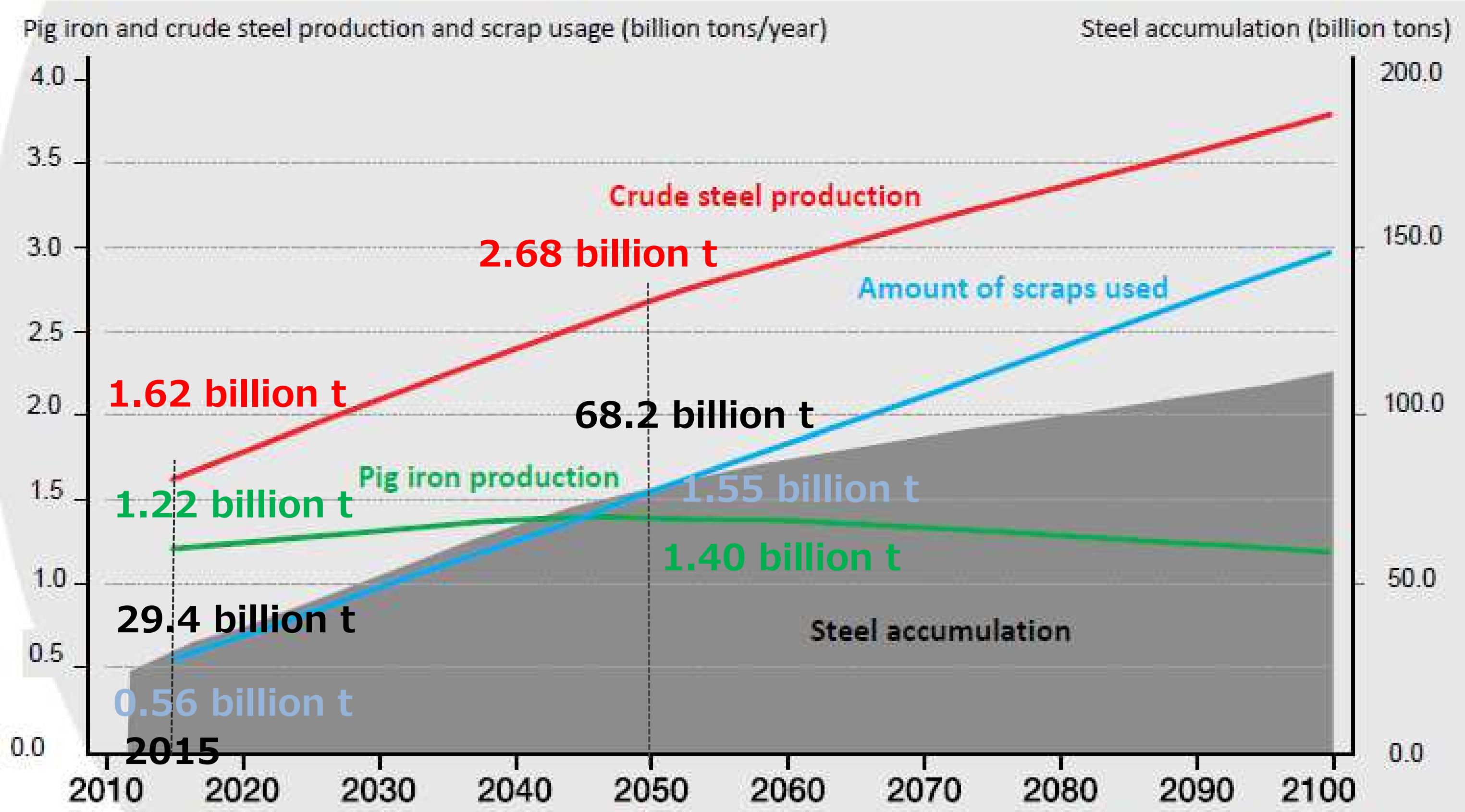
Fe_2O_3 + H_2 + heating ➡ Fe + H_2O (Endothermic) … Large amount of hydrogen preheating

3. Use of scrap (reduced iron)

We need to overcome lots of challenges to achieve carbon neutrality.

Outlook for Global Steel Production and Accumulation

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



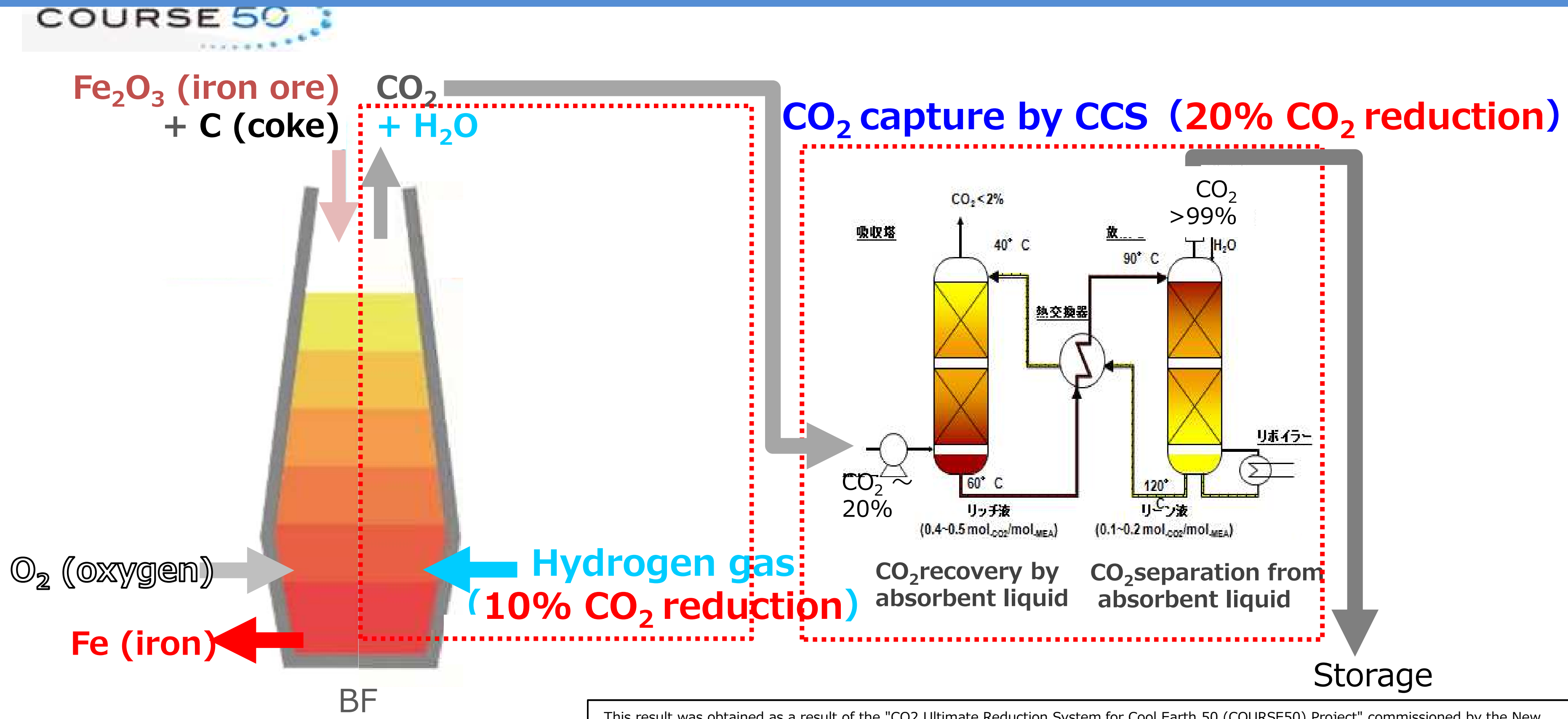
Source: "The Challenge of Zero Carbon Steel: Long-term Global Warming Countermeasures," Japan Iron and Steel Federation, November 2018

COURSE50 : hydrogen reduction ironmaking technology (NEDO, JISF)

On the condition that the existing infrastructure of the integrated steelworks will be utilized to the maximum extent possible,

- Reduction of carbon and increase of hydrogen during iron ore reduction (using coke oven gas with high hydrogen content)
- Separation and recovery of CO2 from blast furnace exhaust gas (using unused waste heat from the steel mill)

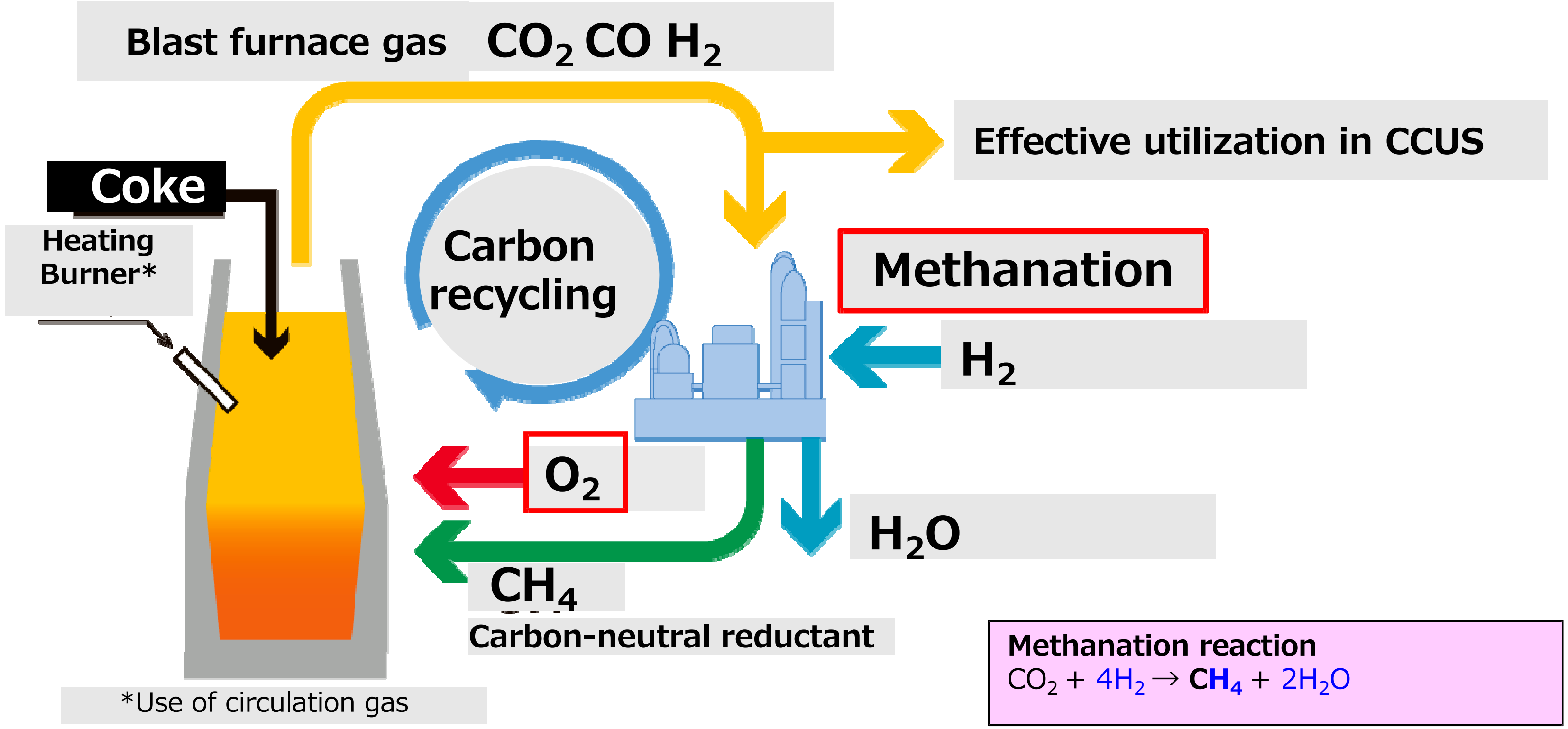
These measures will enable the reduction of CO2 emissions from steel mills by 30%.



This result was obtained as a result of the "CO2 Ultimate Reduction System for Cool Earth 50 (COURSE50) Project" commissioned by the New Energy and Industrial Technology Development Organization (NEDO) (Japan Iron and Steel Federation COURSE50).

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.

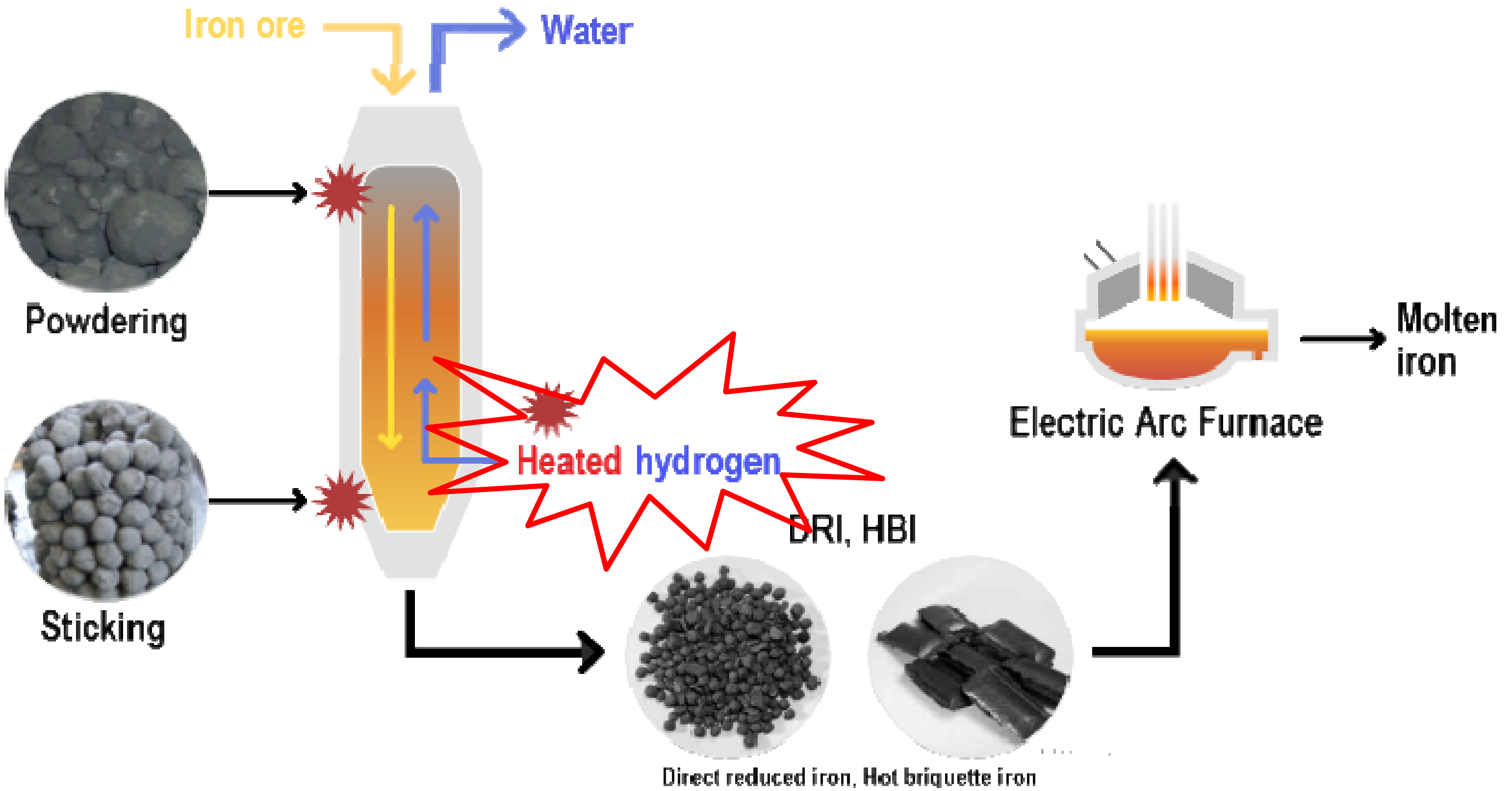


CO_2 reduction target of 30% in blast furnace, aiming at carbon neutrality through CCUS utilization

Source : JFE Group Environmental Vision 2050

100% hydrogen use by the direct reduction

1. Hydrogen reduction is endothermic so hydrogen preheating to be required.
2. Available iron ore is limited (less powdering and less sticking ore)
3. The re-melting and slag separation are required in the EAF



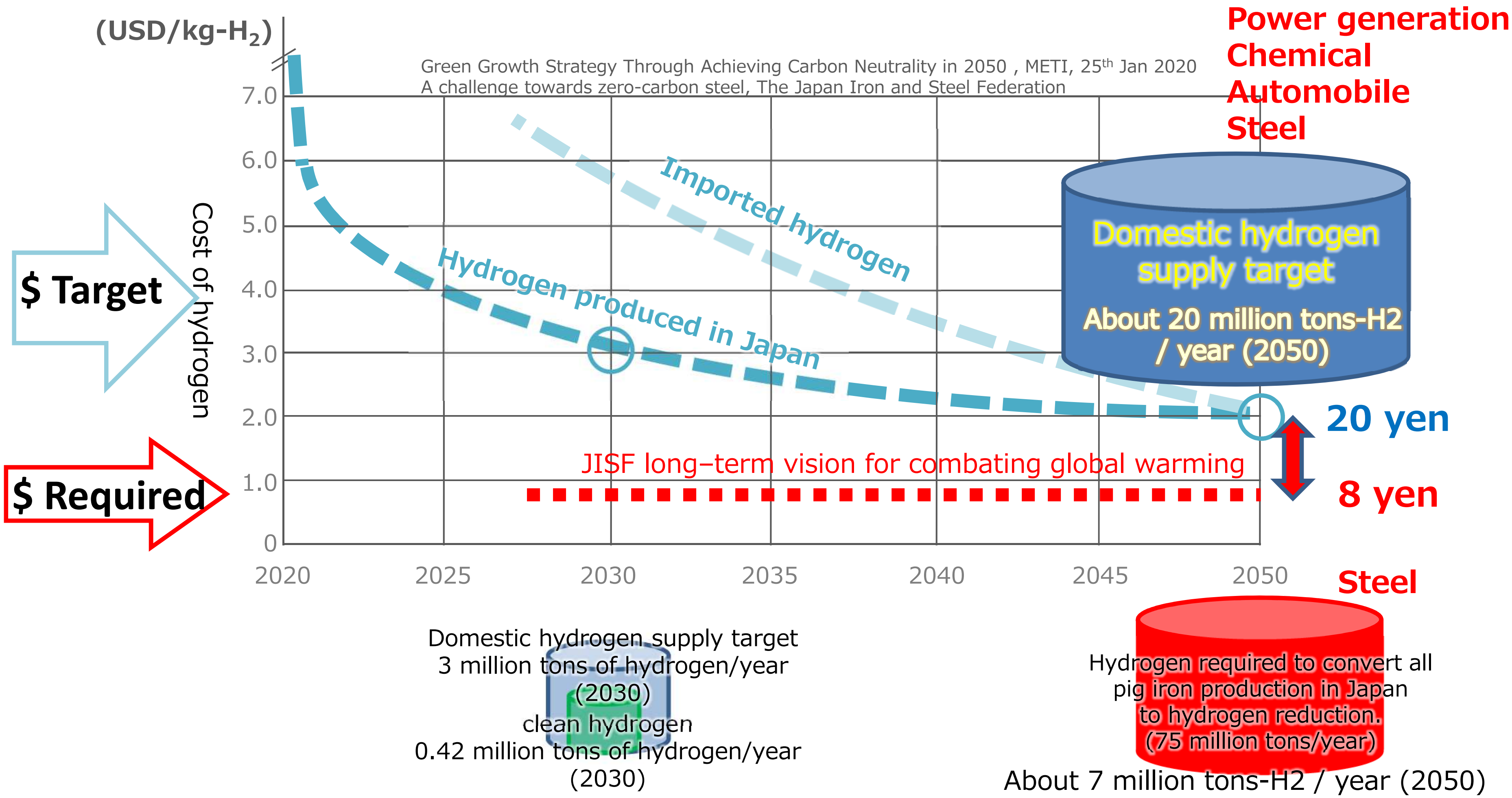
IPCC AR6 WG3 E5. Investment and Finance

- Tracked financial flows fall short of the levels needed to achieve mitigation goals across all sectors and regions.
- Average annual modelled investment requirements for 2020 to 2030 in scenarios that limit warming to 2°C or 1.5°C are a factor of three to six greater than current levels,
- In modelled pathways, regional investments are projected to occur when and where they are most cost-effective to limit global warming. The model quantifications help to identify high-priority areas for cost-effective investments, but do not provide any indication on who would finance the regional investments.
- There is sufficient global capital and liquidity to close global investment gaps, given the size of the global financial system, but there are barriers to redirect capital to climate action both within and outside the global financial sector。

Too rush deployment may cause cost increase/inflation, then may hinder financing for investment.

The current hydrogen strategy does not satisfy the amount and cost requirement.

Hydrogen cost and supply target in Green Growth Strategy Through Achieving Carbon Neutrality in 2050



Current H2 cost target is still too expensive Hydrogen Steelmaking

Prerequisites to achieve carbon-neutral steel

Costs of Achieving Carbon-neutral Steel

- **Massive research and development costs**

→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

- **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.

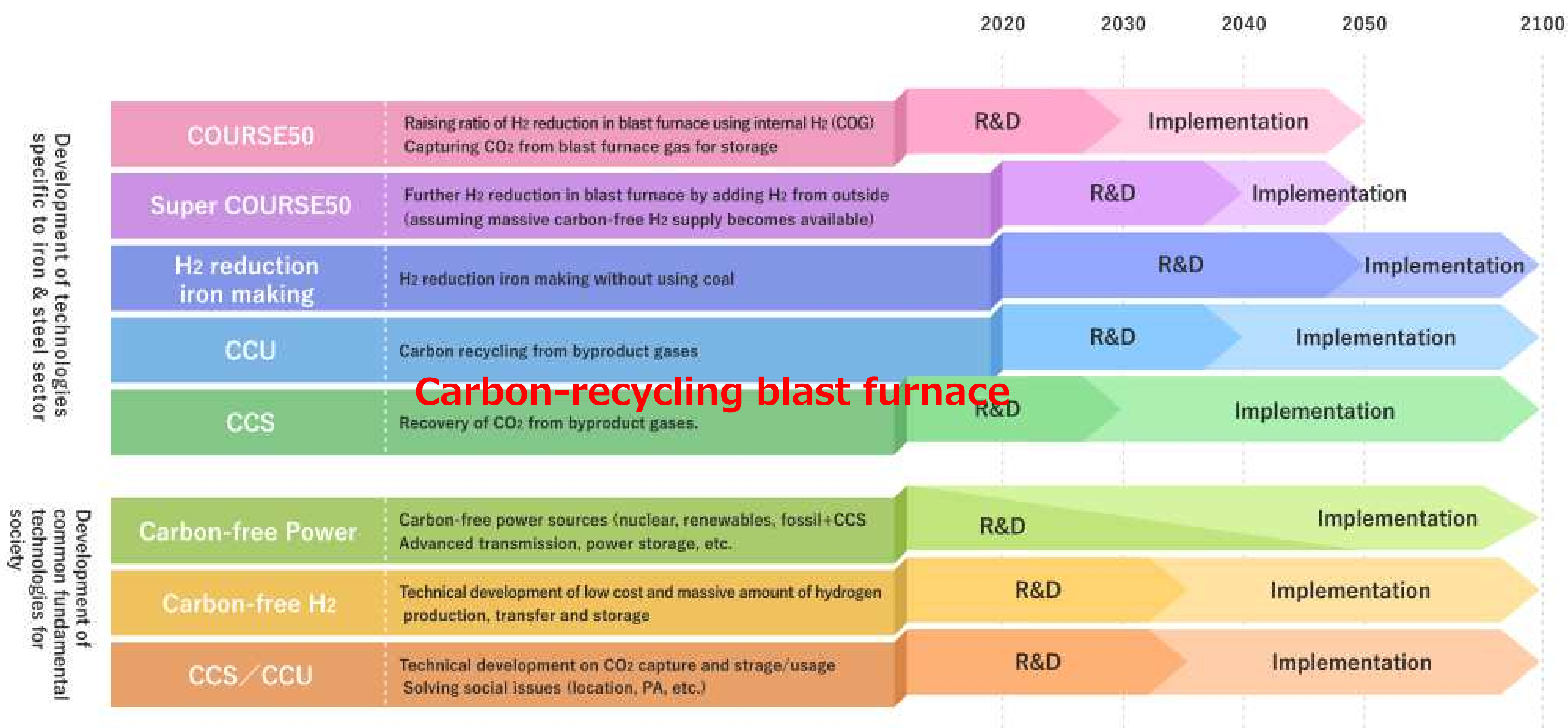
Source : JFE Group Environmental Vision 2050

Needs sufficient Financing & sustained/assured Market Demand

END

Thank you for your attention

JISF's CO_2 reduction scenario



Multiple pathways: all options need to taken.