Hydrogen Energy Ministerial Meeting
H_2EM 2019

A challenge towards Zero-carbon STEEL

September 25th, 2019
Kosei Shindo
NIPPON STEEL CORPORATION

Introduction

- Over 1.8 billion tons of worldwide steel production
  population/economic growth … steel demand increase
- Carbon-reduction … large amount of CO2 emission
- Steel production from iron ore is still needed in 2100
- Nov. 2014 : JISF
  Commitment to a Low Carbon Society Phase II
  2030 target … JPN's NDC (medium-term target)
- Nov. 2018 : JISF
  Long-term vision for climate change mitigation
  "A challenge towards Zero-carbon STEEL"
  beyond 2030 … JPN's long-term strategy
  Hydrogen … a vital measure

Pathways towards Zero-carbon STEEL

Pathway 1: Carbon usage and treatment

$1/2Fe_2O_3 + 3/4C \rightarrow Fe + 3/4CO_2$ ・・・ GHG

CCS/CCU is needed

- Proven
- Existing
- Experienced
- Exothermic reaction

Pathway 2: Carbon avoidance by hydrogen

$1/2Fe_2O_3 + 3/2H_2 \rightarrow Fe + 3/2H_2O$ ・・・ water

- Unproven
- Unexisting
- Inexperienced
- Endothermic reaction

A huge amount of carbon-free hydrogen supply with rational cost is needed

Roadmap for Zero-carbon STEEL

- ✓ JISF has decided to develop super innovative technologies to realize zero-carbon STEEL.
- ✓ Hydrogen replacing carbon and CO_2 capture are main measures.
- ✓ COURSE50 is the first step to the future.
- ✓ For hydrogen-reduction, massive and stable supply of carbon-free hydrogen with rational cost is essential.

Challenges specific in iron & steel sector

		2020 2030 2040 2050 2100
COURSE50	Raising ratio of H2-reduction in blast furnace using internal H2 (COG) Capturing CO2 from blast furnace gas for storage	R&D → Implementation
Super COURSE50	Further H2-reduction in blast furnace by adding H2 from outside (assuming massive carbon-free H2 supply becomes available)	Stepping up → R&D
H2-reduction ironmaking	H2-reduction ironmaking without using coal	Stepping up → R&D → Implementation

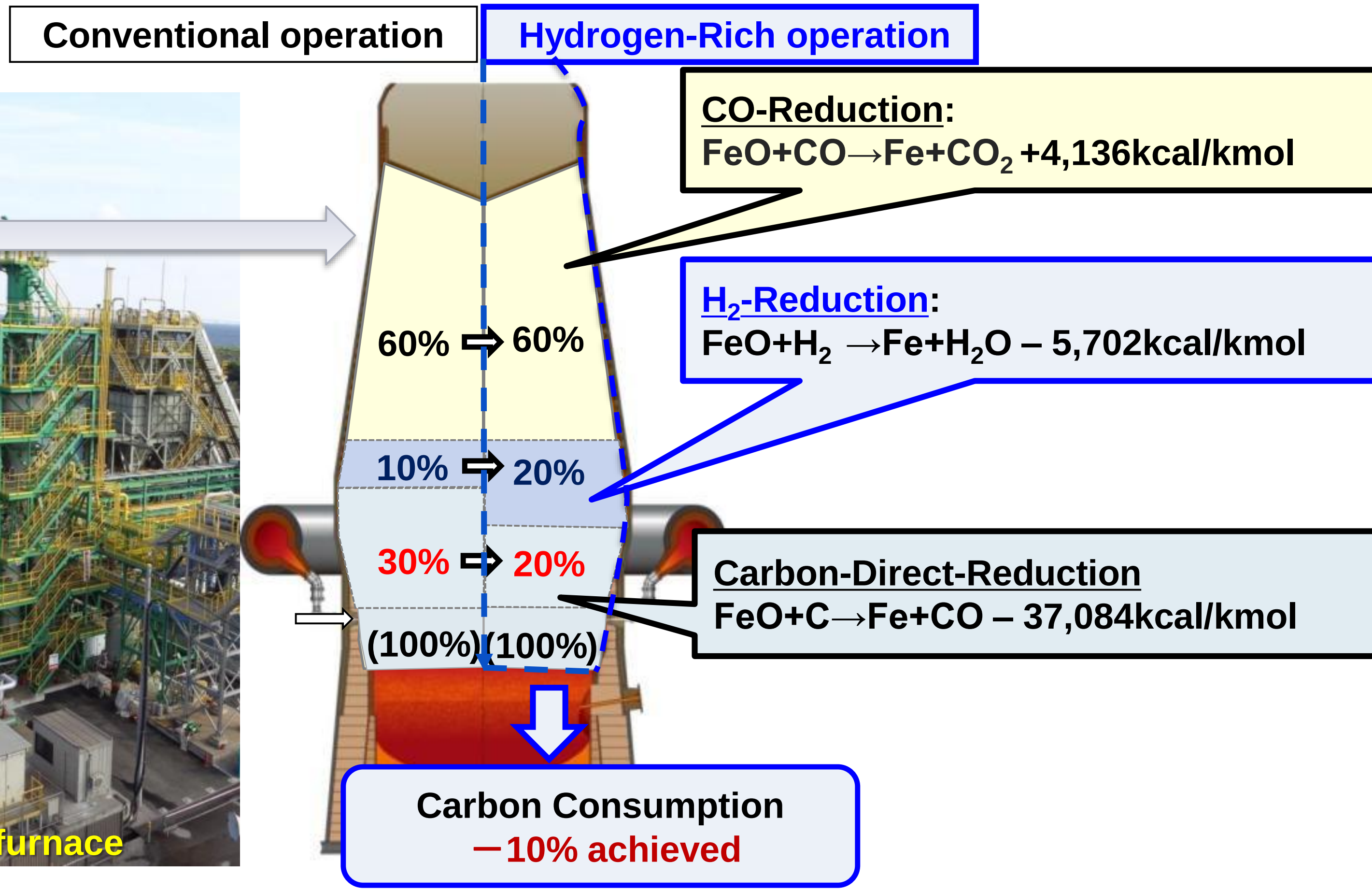
Challenges common in social fundamental

		2020 2030 2040 2050 2100
Carbon-free H2	Technical development of low cost and massive amount of hydrogen production, transfer and storage	R&D → Implementati
CCS/CCU	Technical development on CO2 capture and strage/usage Solving social issues (location, PA, etc.)	R&D → Implementatio

COURSE50:The First Step to the Future

CO2 Ultimate Reduction in Steelmaking process by innovative technology for cool Earth 50

Ratio of reducing reaction in the experimental blast furnace



In the experimental blast furnace, 10% reduction in carbon consumption has been achieved by hydrogen-rich operation.

Requirements for Hydrogen Supply

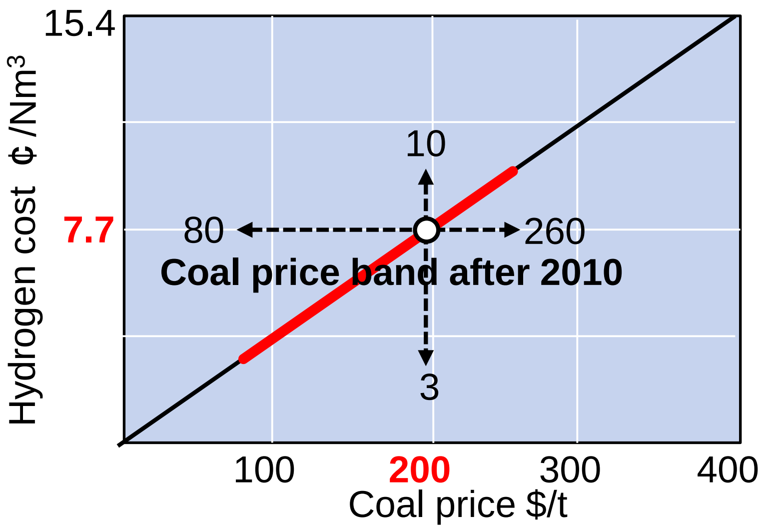
<u>Volume</u> for $1/2Fe_2O_3 + 3/2H_2 + 48kJ \rightarrow Fe + 3/2H_2O$

reduction + compensation of endothermic reaction…

<u>1000 Nm^3-H_2/t-hot metal = 1.3 trillion Nm^3-H_2/year</u>

for worldwide iron production

<u>Cost</u> equivalent for carbon reduction ironmaking:



A trial calculation : Assuming **$200/t-coal** and **700kg-coal/t-hot metal**, coal cost is **140$/t-hot metal**.

55% of thermic value of coal is consumed for reduction (another 45% changes to byproduct gases), and then the cost of reducing agent is **$77/t-hot metal**.

The equivalent cost of hydrogen **($77/t-hot metal / 1000$Nm^3$-$H_2$/t-hot metal)** becomes **¢ 7.7/Nm^3-H_2**

Conclusions

- ✓ **"A challenge towards Zero-carbon STEEL"**
  - Direction towards achieving the long-term goal of the Paris Agreement
- ✓ **Clear but very tough technical challenges**
  - Technical issues to overcome in hydrogen-reduction ironmaking
  - Huge and stable supply of carbon-free hydrogen with rational cost
- ✓ **COURSE50 : the first step to realize Zero-carbon STEEL**
  - Challenge super innovative technologies for realizing Zero-carbon STEEL using the technologies gained from COURSE50