Steel making technology using hydrogen: COURSE50

- A challenge towards Zero-carbon STEEL -

February 18th, 2021

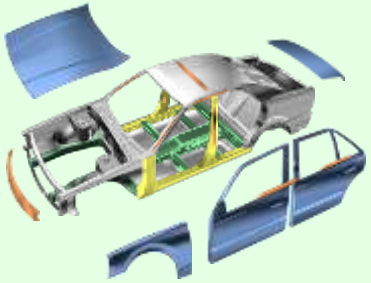
Seiji Nomura

NIPPON STEEL CORPORATION

Steel supports our lives

Cans

Home appliances



Cars

Railroads

Ships

Bridges

Steel products

Steel making process

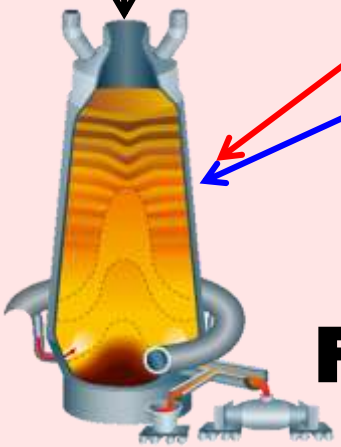
Iron Ore

Fe_2O_3

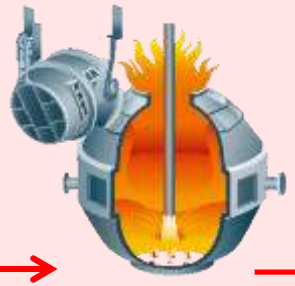
Coal

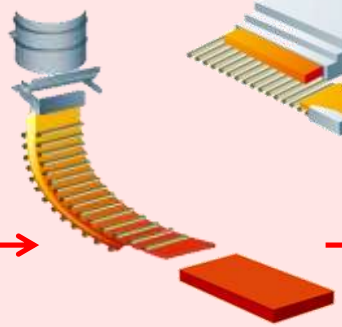
C

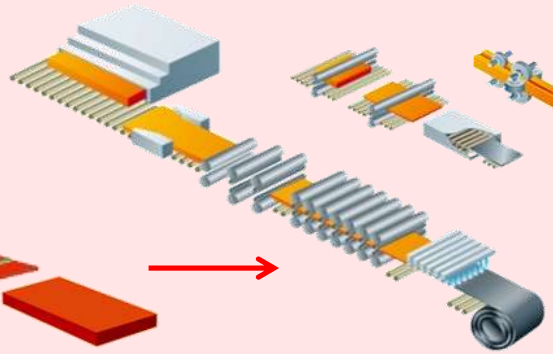
H_2



Fe







Blast furnace

Pathways towards Zero-carbon STEEL

1. Carbon capture, sequestration and utilization

$Fe_2O_3 + C \rightarrow Fe + CO_2 + Heat$

- CO_2 → CCS (Carbon Capture and Sequestration)
- CO_2 → CCU (Carbon Capture and Utilization)

2. Using hydrogen as a reductant

$Fe_2O_3 + H_2 \rightarrow Fe + H_2O - Heat$

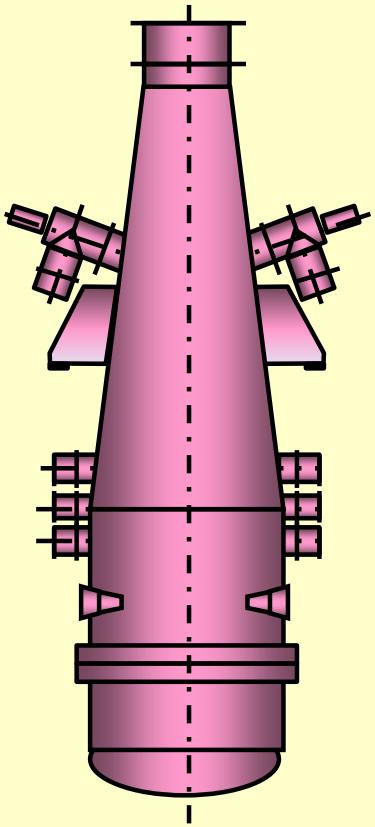
- H_2 → A huge amount of carbon-free H_2 supply with rational cost
- $- Heat$ → An innovative technology for heat compensation

COURSE50:The First Step to the Future

COURSE50: CO_2 Ultimate Reduction System for Cool Earth 50

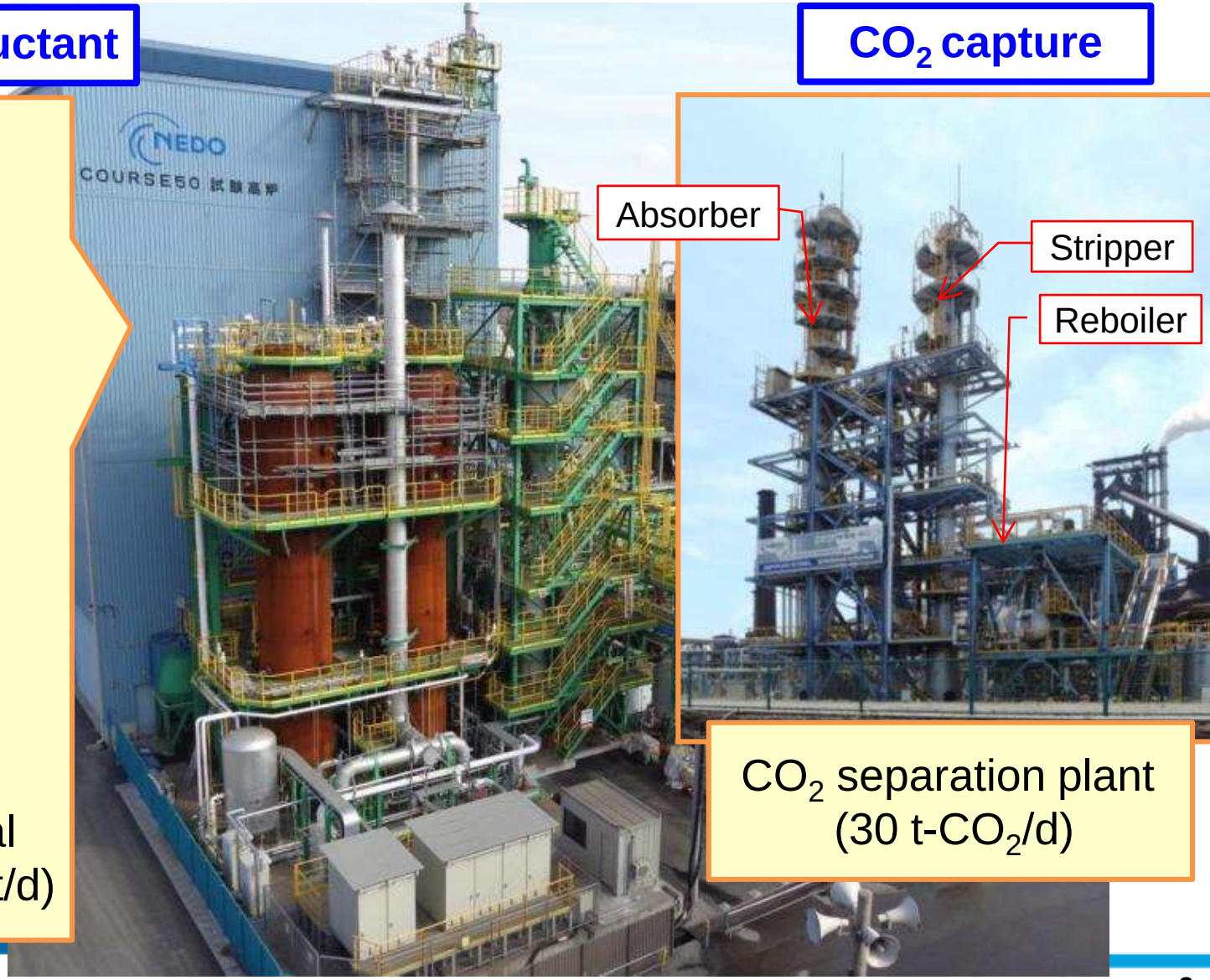
100%-sponsored research project by NEDO (New Energy and Industrial Technology Development Organization)

Using H_2 as a reductant



12m³ Experimental Blast Furnace (34 t/d)

CO_2 capture



CO_2 separation plant (30 t-CO_2/d)

COURSE50: CO_2 reduction by H_2

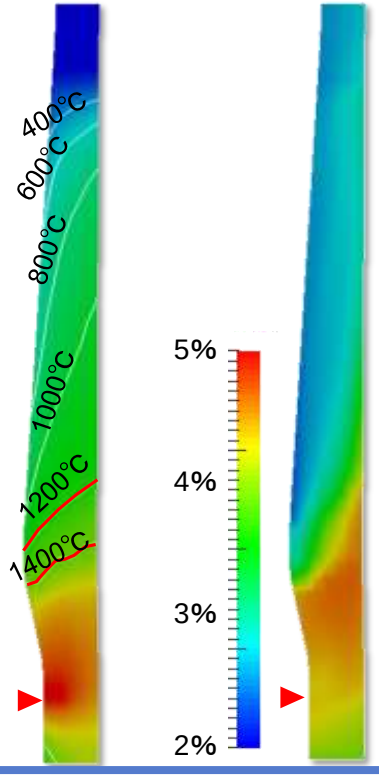
COURSE50: CO_2 Ultimate Reduction System for Cool Earth 50

100%-sponsored research project by NEDO (New Energy and Industrial Technology Development Organization)

Experimental blast furnace

Calculation by mathematical model

Solid temp. H_2 concentration



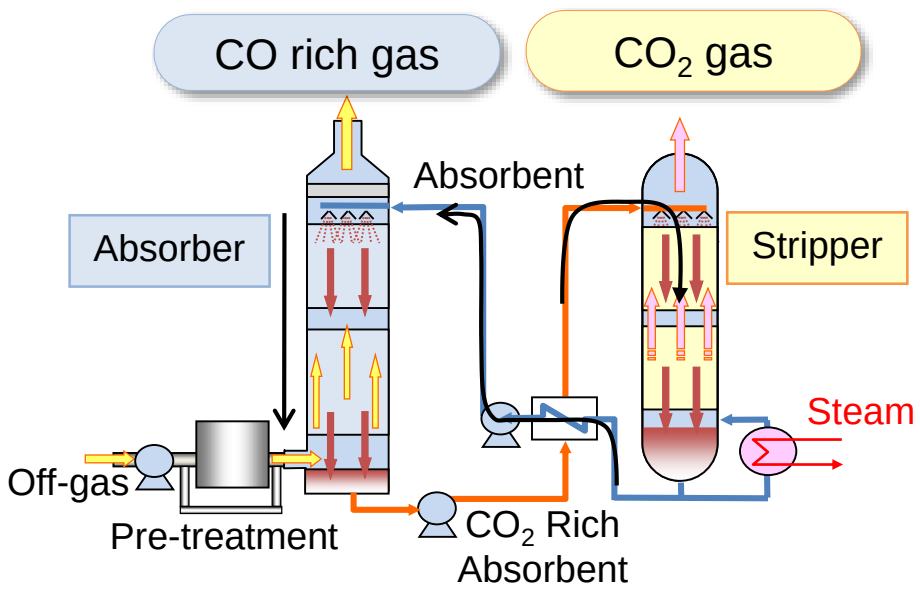
Combination of experiment and calculation helped to achieve
10% reduction in CO_2 by H_2-rich gas in the experimental blast furnace.

COURSE50: CO_2 capture

COURSE50: CO2 Ultimate Reduction System for Cool Earth 50

100%-sponsored research project by NEDO (New Energy and Industrial Technology Development Organization)

- Basic technology: COURSE50 project
- Chemical absorbent: Nippon Steel & RITE
- Reaction process: Nippon Steel Engineering



ESCAP Process flow

2 commercial plants in operation (120 and 143 t-CO_2/day)

120 tons of CO_2/day, CO_2 Purity:>99.9 vol%

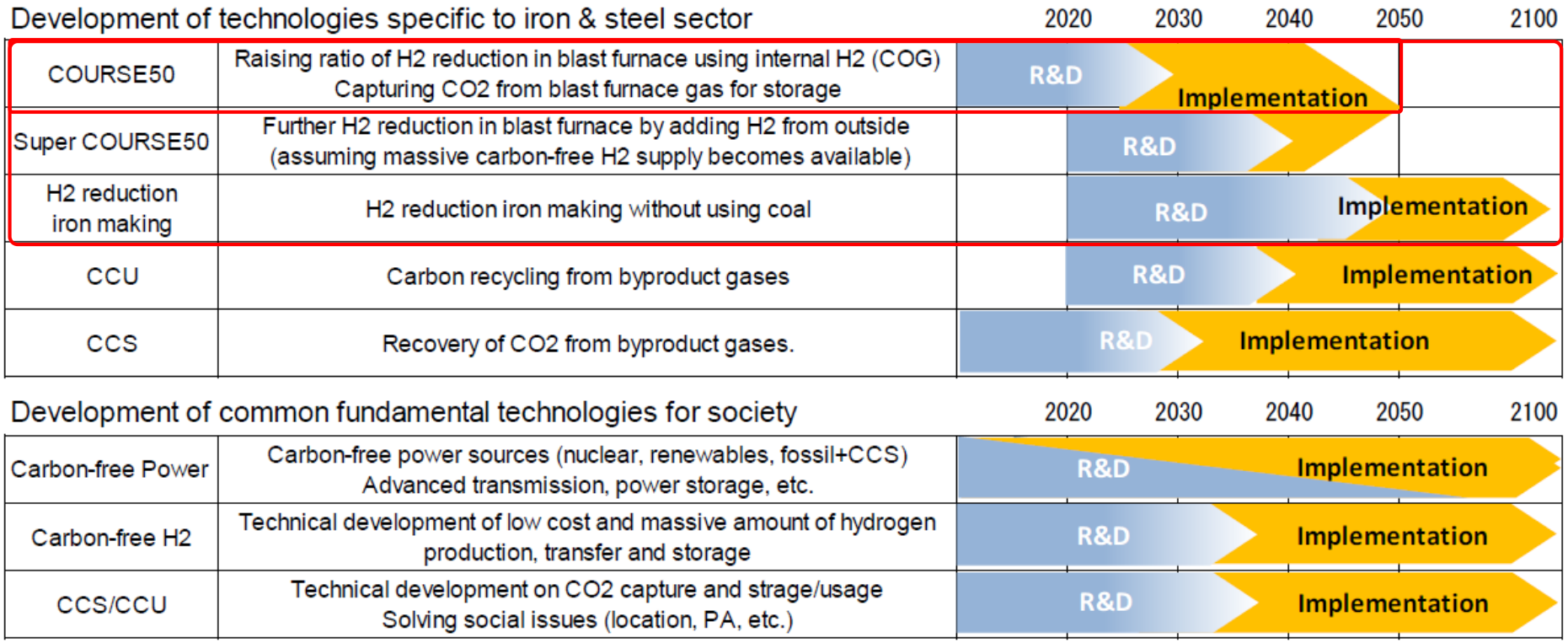
ESCAP commercial facility
(Liquid CO_2 Plant for Air Water Carbonic Inc.)

ESCAP™ (**E**nergy **S**aving **C**O_2 **A**bsorption **P**rocess) : A trademark of NIPPON STEEL ENGINEERING CO., LTD.

CO_2 separation from blast furnace gas was confirmed.

Roadmap for Zero-carbon STEEL

Roadmap for the development of super innovation technologies



JISF Long-term vision for climate change mitigation, Japan Iron and Steel Federation, 2019

- ✓ Very tough technical issues to overcome in hydrogen-reduction ironmaking.
- ✓ Huge and stable supply of carbon-free hydrogen with rational cost.
- ✓ JISF challenges to develop super innovative technologies to realize Zero-carbon STEEL.