Keidanren’s Commitment to a Low Carbon Society
~ Ex. Long-term Vision for Steel Industry ~

March 6, 2019

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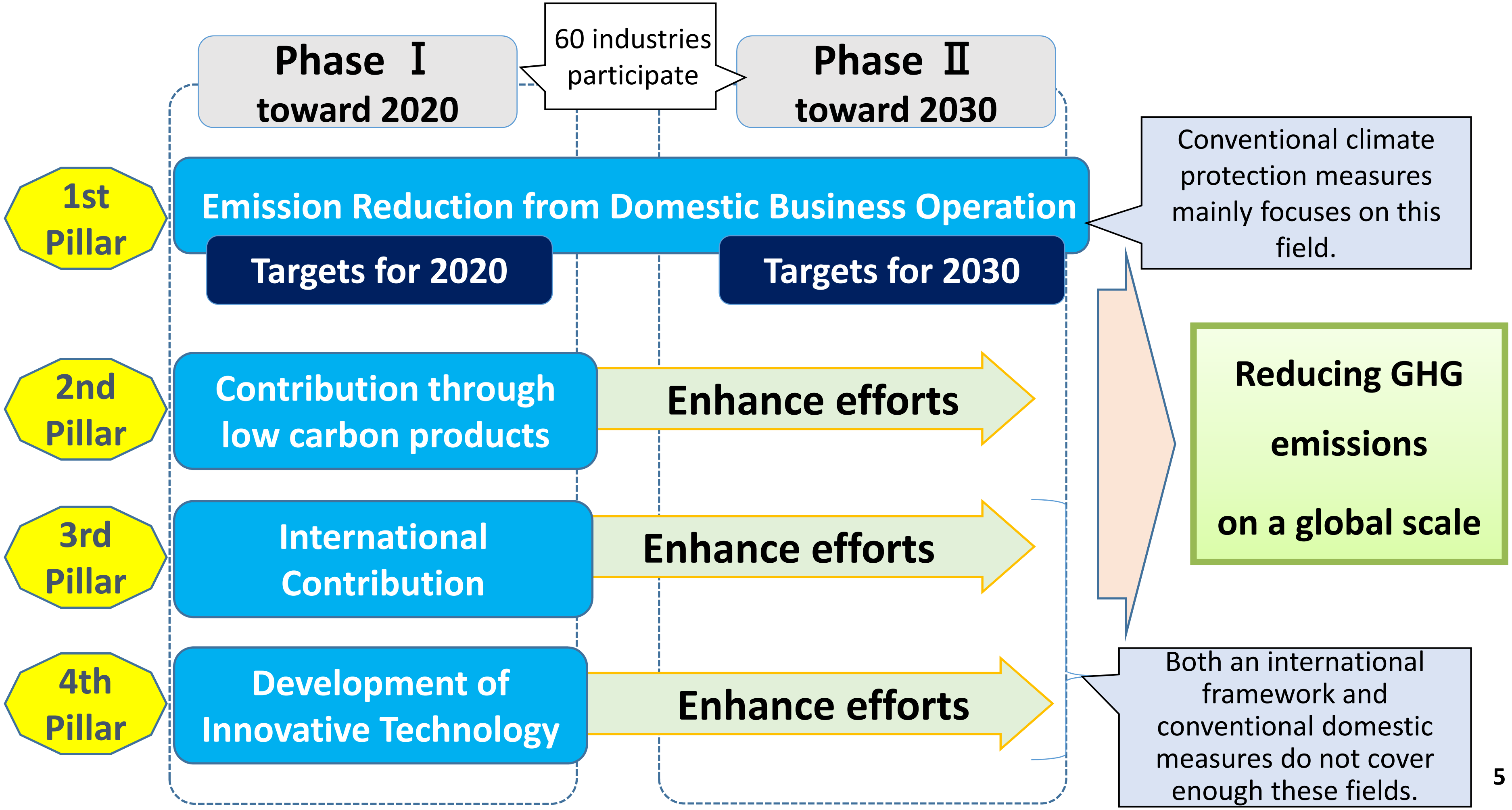
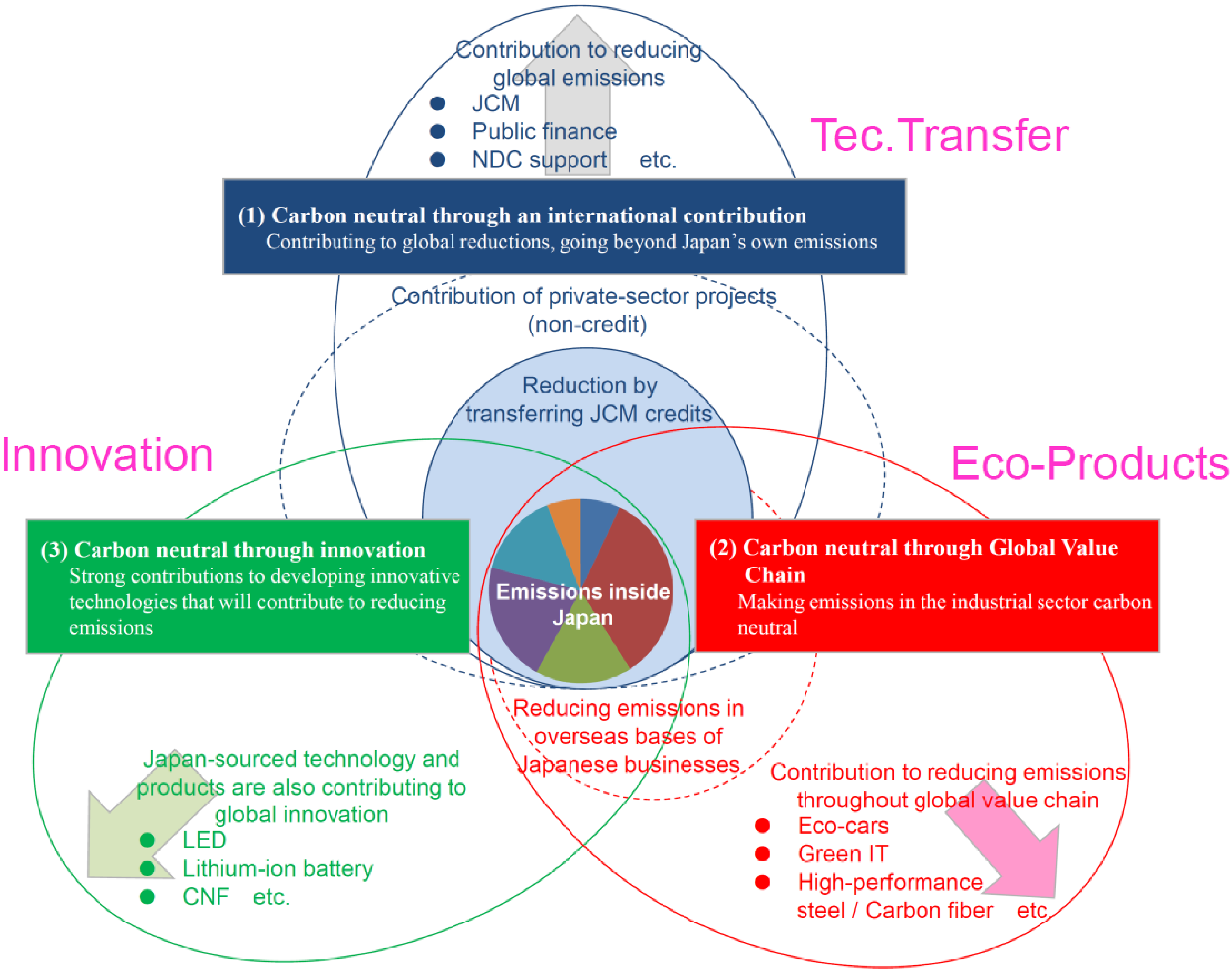
Keidanren's Commitment to a Low Carbon Society

1. Participating industries and companies set their own targets.
2. The plan consists of 4 pillars (shown bellow).
3. 60 industries made their plans for the Phase I (toward 2020) and for the Phase II (toward 2030).



Long-term Climate Change Policy Platform, METI Japan



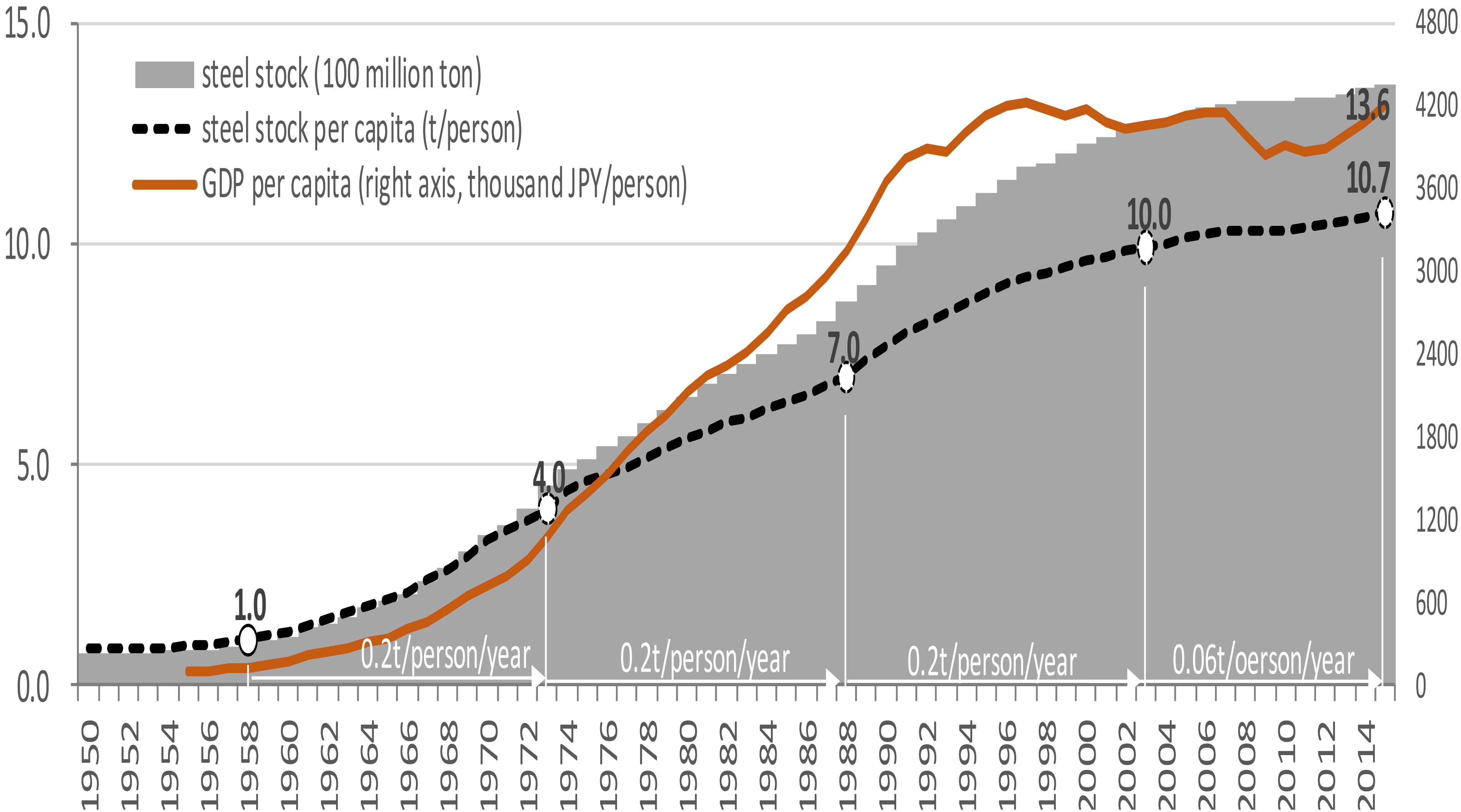
JISF Long-term vision for climate change mitigation

A challenge towards Zero-carbon STEEL

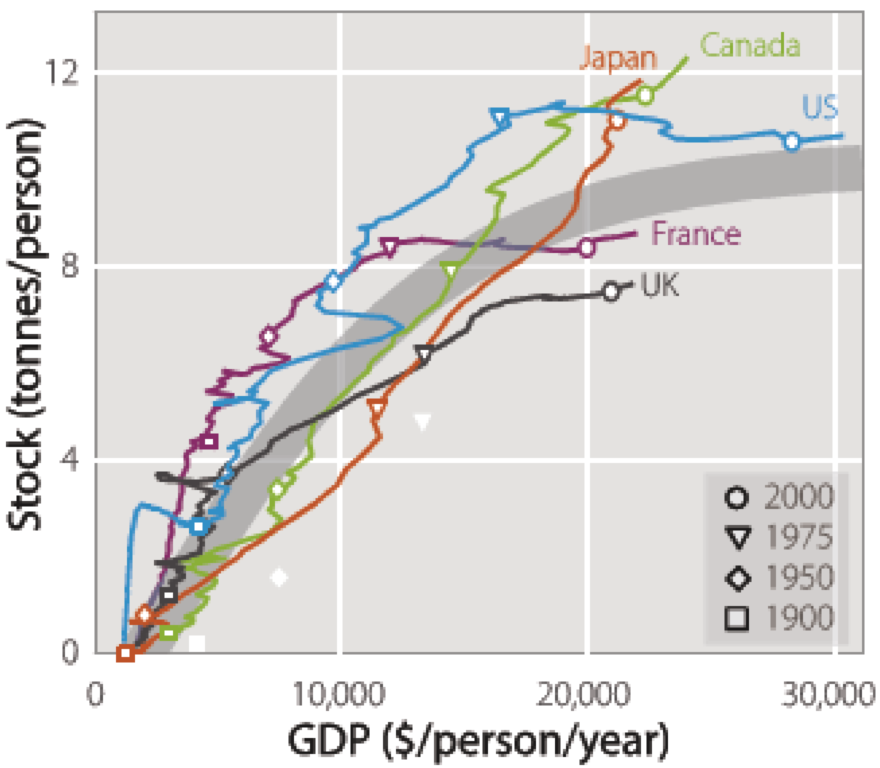
November 19, 2018

Japan Iron and Steel Federation

Estimating the future steel demand and supply: performance trend of Japan

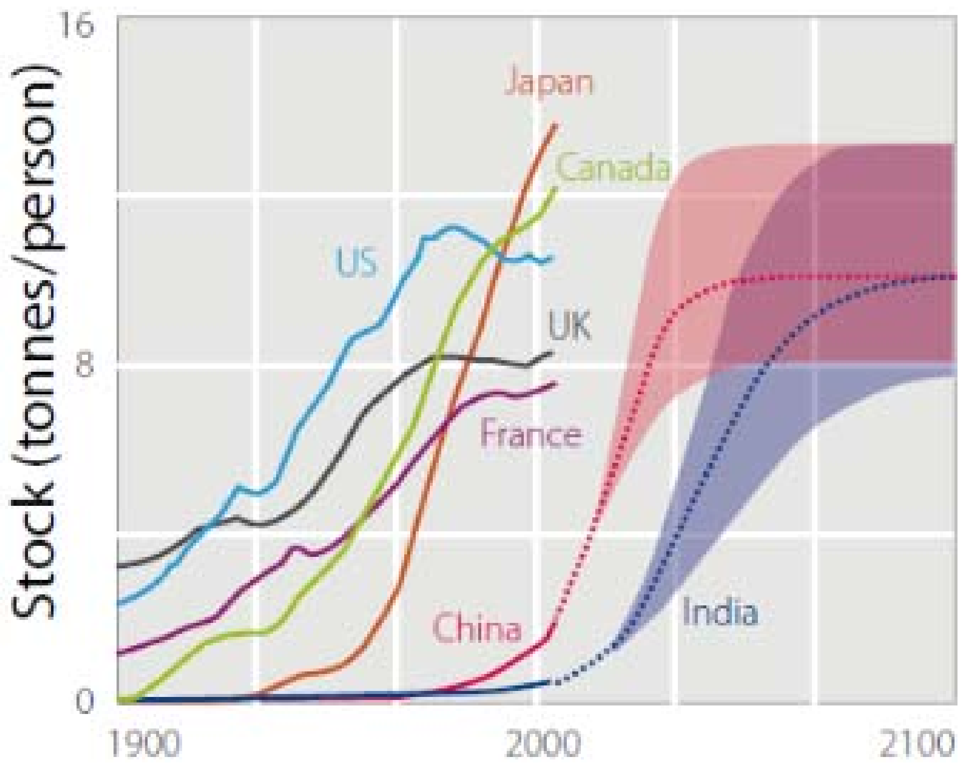


Estimating the future steel demand and supply: performance trend of the world



Relationship between GDP per capita and steel stock

Muller, et.al, “Patterns of Iron Use in Societal Evolution”, Environ. Sci. Technol. 2011, 45



Transition of steel stock per capita

“Sustainable steel: at the core of a green economy”, World Steel Association, 2012

Estimating the future steel demand and supply: calculation assumptions

[Calculation assumptions]

a) Steel stock per capita
2015：4.0t/person (actual data)
2050：7.0t/person (assumed)
2100：10.0t/person (assumed)

b) Population
World Population Prospects2017, UN

		2015	2050	2100
World Population (billion) *		7.38	9.77	11.18
Steel Stock	Per Capita (t/person)	4.0	7.0	10.0
	total (billion ton)	29.4	68.2	111.8

c) Diffusion and loss
0.1% of the total steel stock was assumed to be diffused or lost.

d) The rate of scrap generation
- d-1) internal scrap: 12.5% of total crude steel production (2015 actual data)
- d-2) manufacturing scrap: 9.3% of total steel products shipped out (2015 actual data)
- d-3) end-of-life scrap: assumed to increase gradually from 0.8% of total steel stock in 2015 (actual data) → 1.5% in 2050→ 2.0% in 2100.

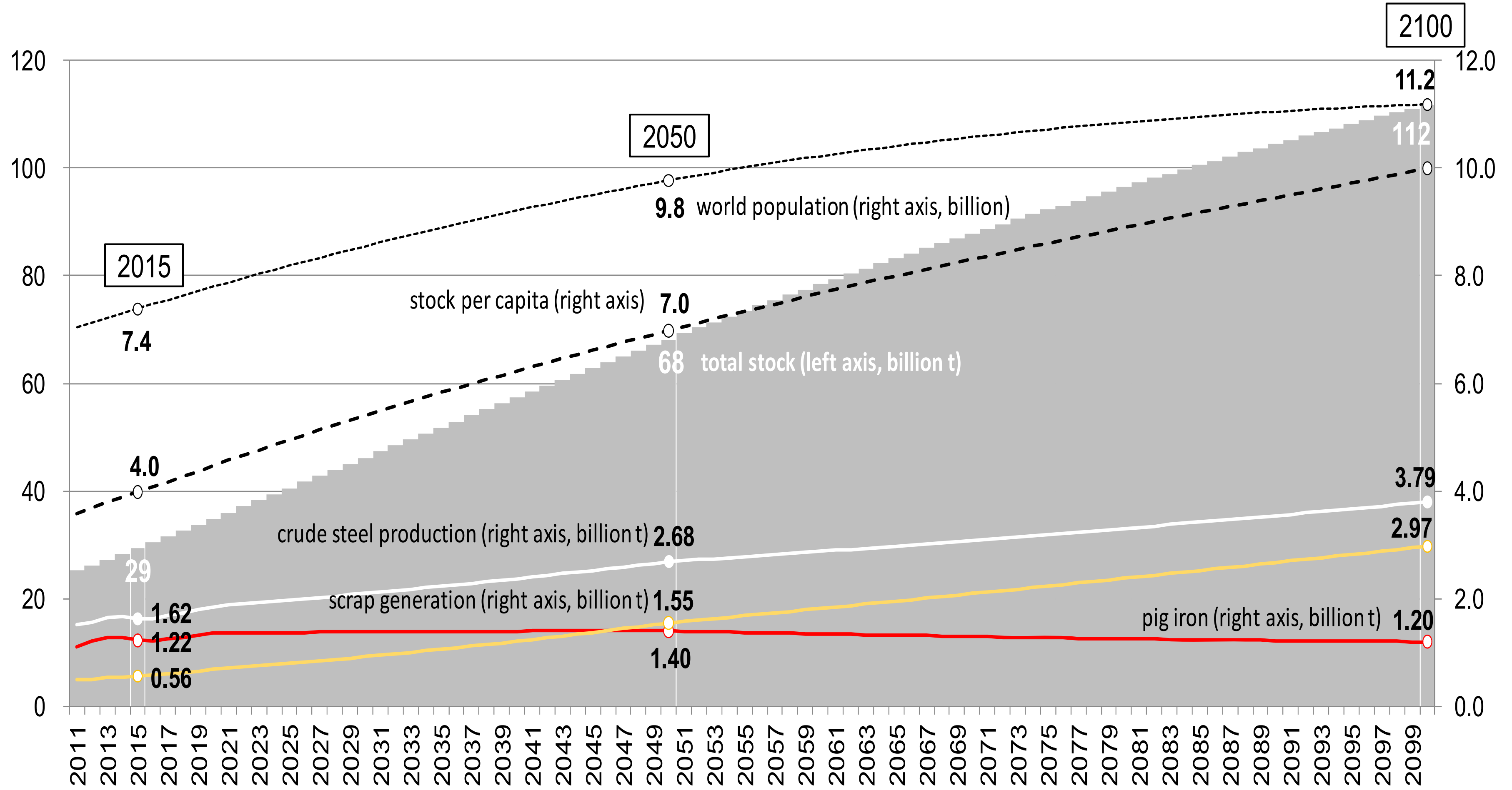
e) Yield ratio of crude steel to iron source
Yield ratio of crude steel to iron source was set as 91% (2015 actual data) for both pig iron and scrap

	production (billion ton)		scrap generation (billion ton)				scrap generation rate （%）			steel stock		loss rate	world pop.
	crude steel	pig iron DRI	total	internal	prompt	end-of-life	internal/ crude steel	prompt/ products	EoL/ steel stock	total (billion ton)	per capita (t/person)	（%）	(billion)
2015	1.62	1.22	0.56	0.2	0.13	0.22	12.5	9.3	0.8	29.4	4	0.1	7.38
2020	1.85	1.35	0.68	0.23	0.15	0.3	12.5	9.3	0.9	34.8	4.5	0.1	7.8
2030	2.1	1.38	0.92	0.26	0.17	0.49	12.5	9.3	1.1	46.2	5.4	0.1	8.55
2050	2.68	1.4	1.55	0.34	0.22	0.99	12.5	9.3	1.5	68.2	7	0.1	9.77
2100	3.79	1.2	2.97	0.47	0.31	2.19	12.5	9.3	2	111.8	10	0.1	11.18

Estimating the future steel demand and supply: calculation results

(billion ton

	2015	2050	2100
Amount of steel in final products	1.29	2.13	3.01
Crude steel production	1.62	2.68	3.79
Pig iron production	1.22	1.4	1.2
Scrap consumption	0.56	1.55	2.97



Long-term climate change mitigation scenarios of steel industry

BAU (Business as Usual) Scenario

The amount of crude steel production changes, while the CO_2 intensity stays at the current level for both natural resource route and the recycling route. The amount of scrap recovered (= used) will increase, leading to a rise of the scrap ratio in the iron source which lowers CO_2 intensity. However, the total amount of CO_2 emissions will increase due to the increase in the amount of crude steel production.

Maximum Introduction of BAT (Best Available Technologies) Scenario Scenario①

Maximize the diffusion of existing advanced energy saving technologies (CDQ,TRT etc.) to the world. IEA ETP 2014 assumes that the reduction potential by international diffusion of BAT is 21%, and that this will be achieved by 2050. Although the CO_2 intensity will be improved compared to the BAU scenario, the total amount of CO_2 emission will increase due to the increase in the amount of crude steel production.

Maximum Introduction of Innovative Technologies Scenario Scenario②

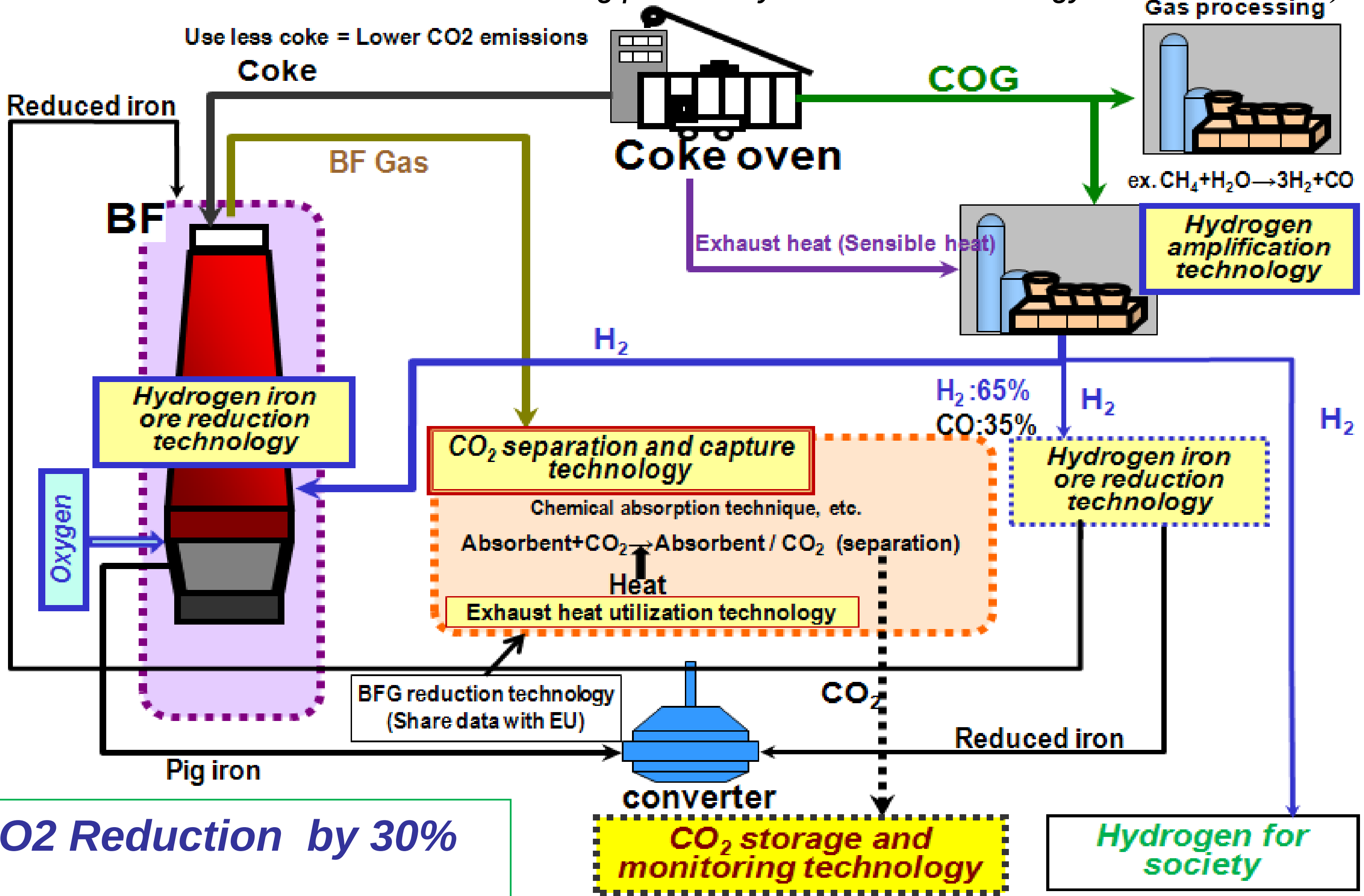
The innovative technologies currently being developed (COURSE50: hydrogen reduction portion, ferro coke, etc) will be introduced at the maximum level from 2030 to 2050, and the CO_2 intensity in the natural resource route will be improved by 10%.

Super Innovative Technologies Development Scenario Scenario③、④

With the introduction of super innovation technologies (hydrogen reduction steel, CCS, CCU etc.) that are not yet in place and the achievement of zero emission of the grid power supply, it is assumed that "zero-carbon steel" will be realized in 2100. Based on the level of achievement in 2050, low level case (20% reduction in CO_2 intensity from the Maximum Introduction of Innovative Technologies Scenario), middle level case (50% reduction) and high level case (80% reduction) were estimated.

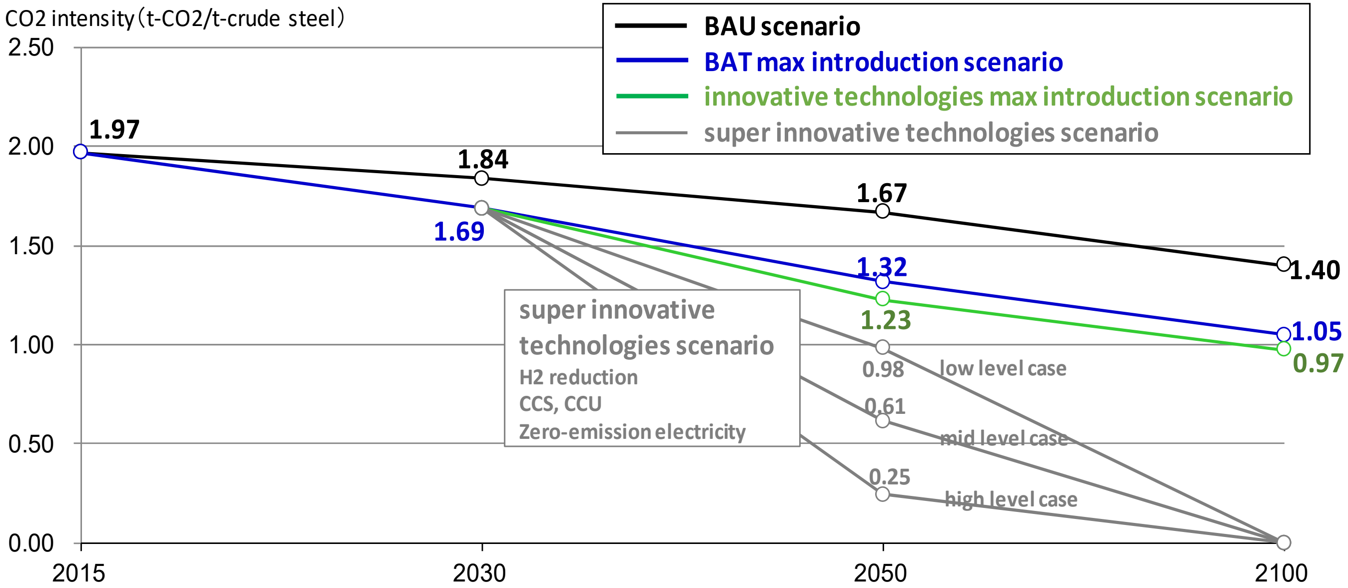
COURSE50 ~ Breakthrough Technology

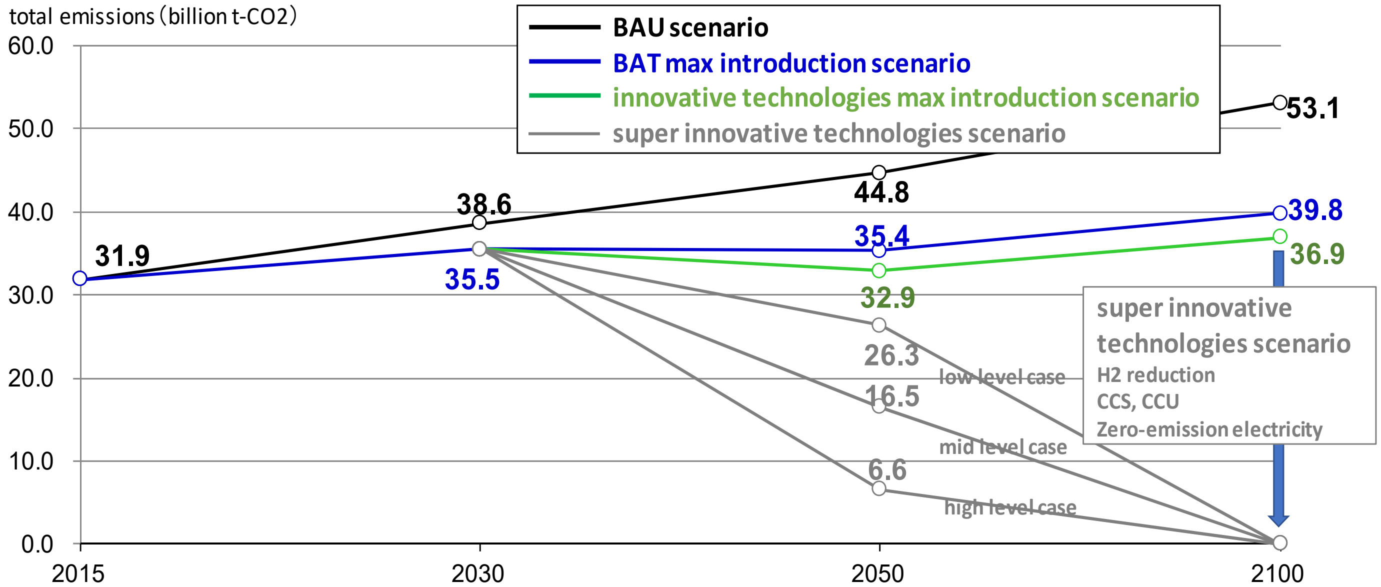
(COURSE50 : *CO2 Ultimate Reduction in Steelmaking process by Innovative technology for cool Earth 50*)



- ***CO2 Reduction by 30%***
- ***Develop by 2030***

Long-term climate change mitigation scenarios for steel industry: CO_2 emissions





The total storage volume in 2030-2100 when the Super Innovation Technology Scenario is executed only with CCS:

Low level case: 91.1 Bt-CO_2

Middle level case: 101.2Bt-CO_2

High level case: 111.2Bt-CO_2

→ also necessary to solve issues beyond technical aspects, such as securing CO_2 storage sites, acceptance from society, implementing entities, and distribution of the economic burdens.

The amount of hydrogen required for producing pig iron in hydrogen reduction in 2100: 1.2 trillion Nm^3

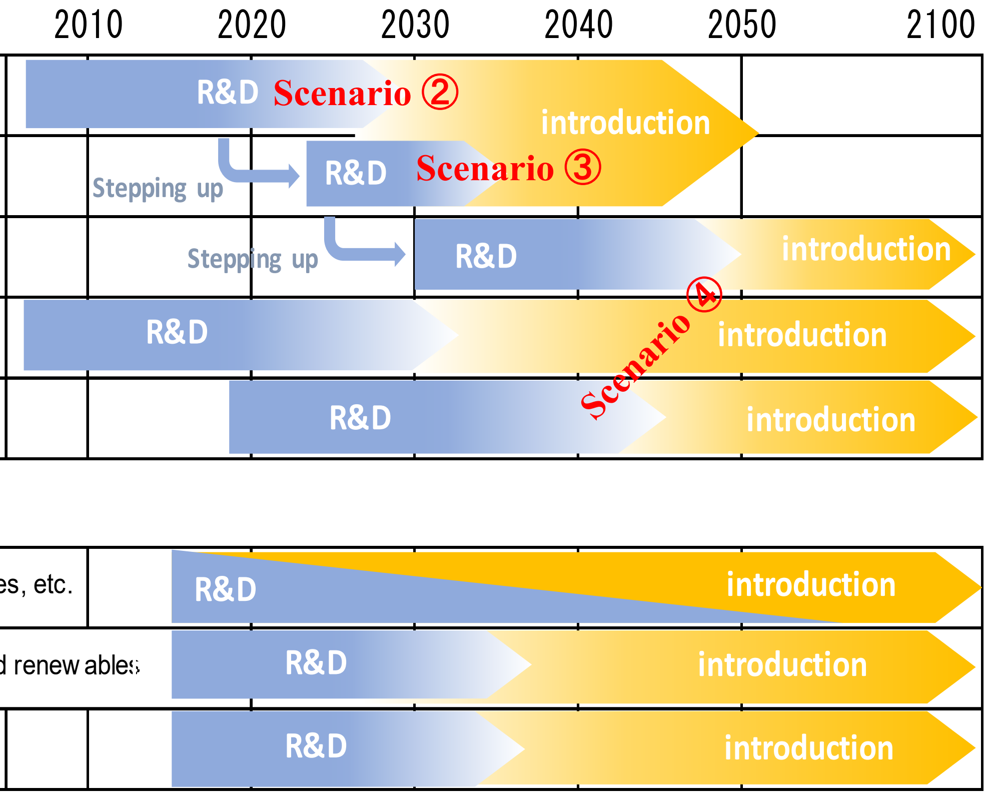
→ low cost and stable supply of large amounts of carbon-free hydrogen is a requirement for practical application

Requirement for the implementation of the super innovative technologies scenario

Long-term climate change mitigation strategy by JISF: super innovative technologies development

Development of technologies specific to iron & steel sector	
COURSE50	H2 reduction in BF (internal H2)
Super COURSE50	H2 reduction in BF (external H2)
H2 reduction iron making	H2 reduction without using BF
CCS	Recovery of CO2 from BF gas, etc.
CCU	Adding value to CO2 from steel plant

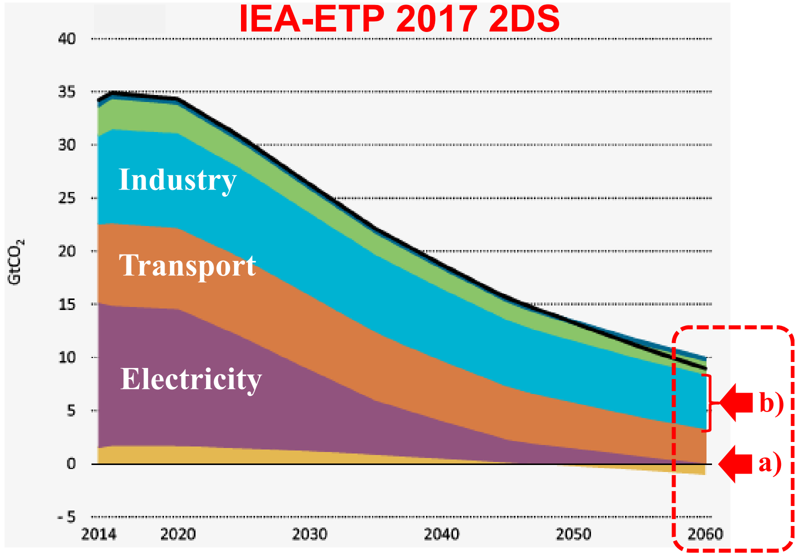
Development of common fundamental technologies for society	
Zero-emission electricity	Zero-emission electricity through nuclear, renew ables, etc.
Carbon-free H2	Low cost, large quantity production w ith nuclear and renew ables
CCS/CCU	cheap storage, location, adding value, etc.



Long-term climate change mitigation strategy by JISF: Consistency with IEA-ETP2017 2DS

IEA-ETP 2017 2DS assumes:

By 2060,
a) zero emission from the electricity sector
b) 30% emission reduction from the industry sector



Calculation Assumptions

- Emission factor from gird electricity: combined average from IGES GRID EF v10.2
- Grid electricity intensity in BF-BOF route: 140kWH/t-s (2016 average of Japan)
- Grid electricity intensity in EAF route: 872kWH/t-s (2016 average of Japan)
- CO_2 emission factor in BF-BOF route: 2.4t- CO_2 /t-s
- CO_2 emission factor in EAF route: 1.0t- CO_2 /t-s
- Yield of crude steel against iron source: 0.91 (both natural resource route and scrap route)