NIPPON STEEL

Steel, a sustainable material

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Nippon Steel Corporation

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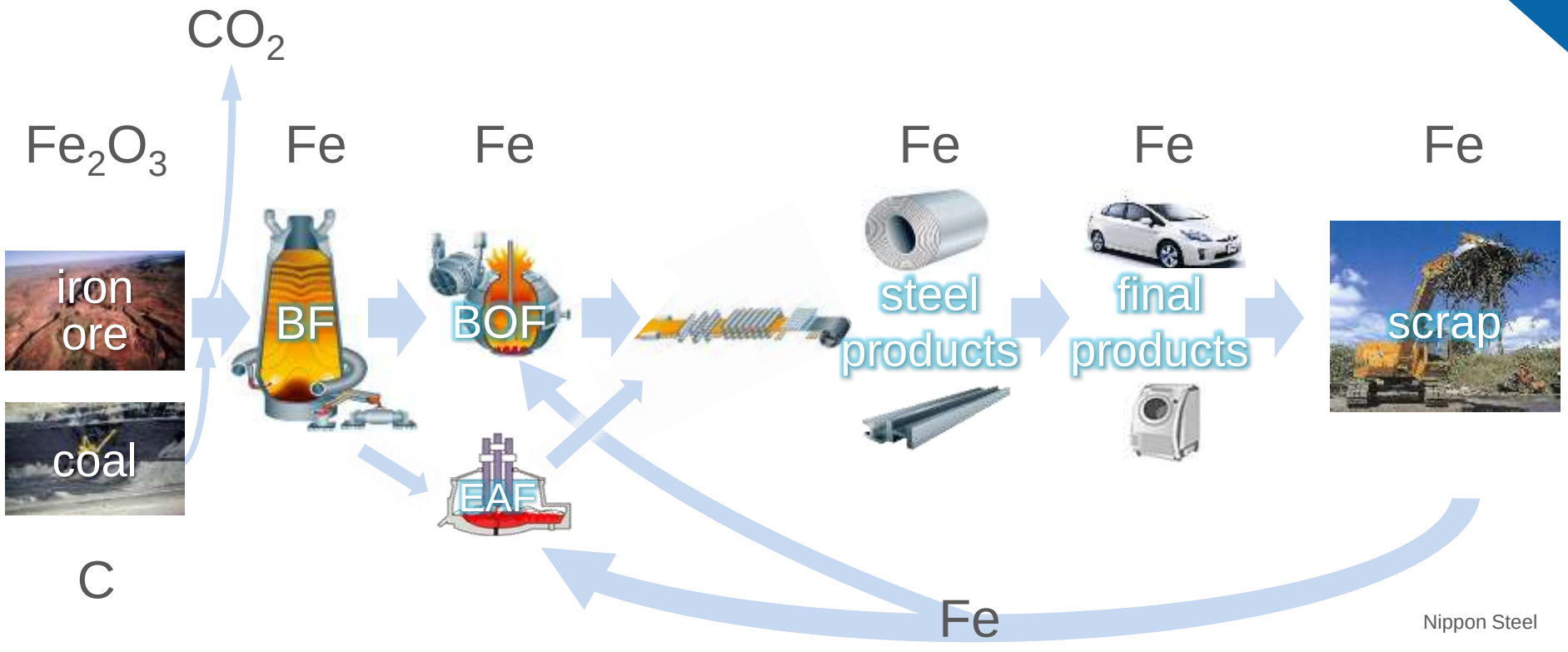
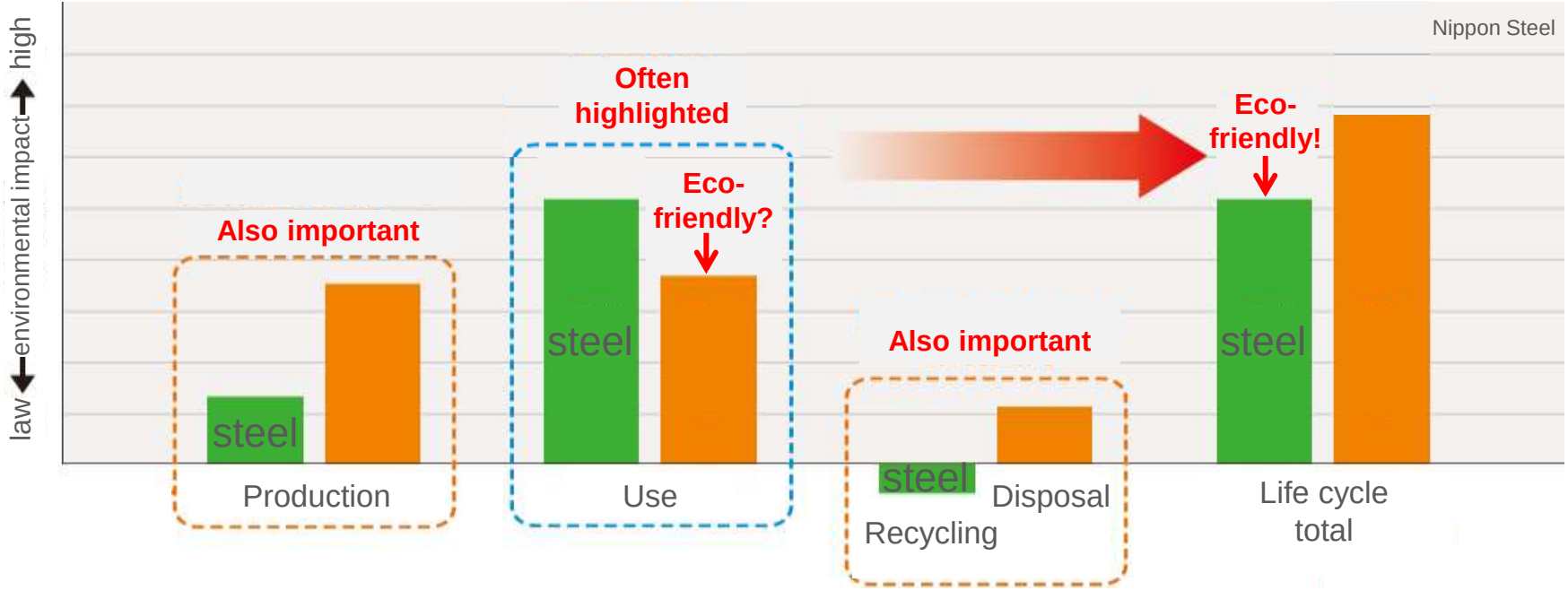
NIPPON STEEL CORPORATION

Circulation of steel: production and recycling



Iron is reduced from iron ore with coal to produce steel and CO_2.
Once reduced, steel maintains its property even after recycling.

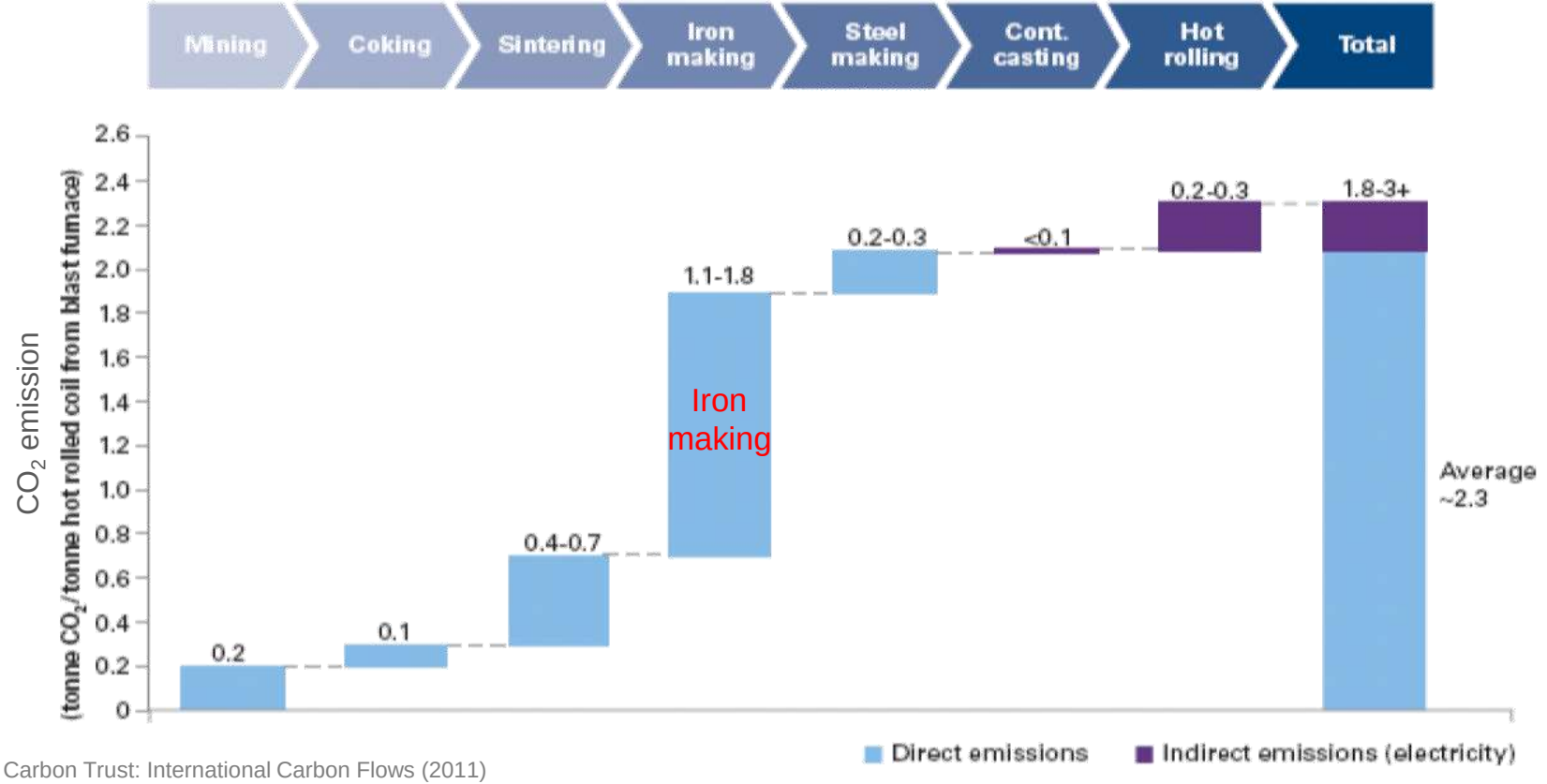
Life Cycle Thinking



Life cycle thinking is very important.
Steel is often the best choice thinking of the whole life cycle.

Environmental impact in production

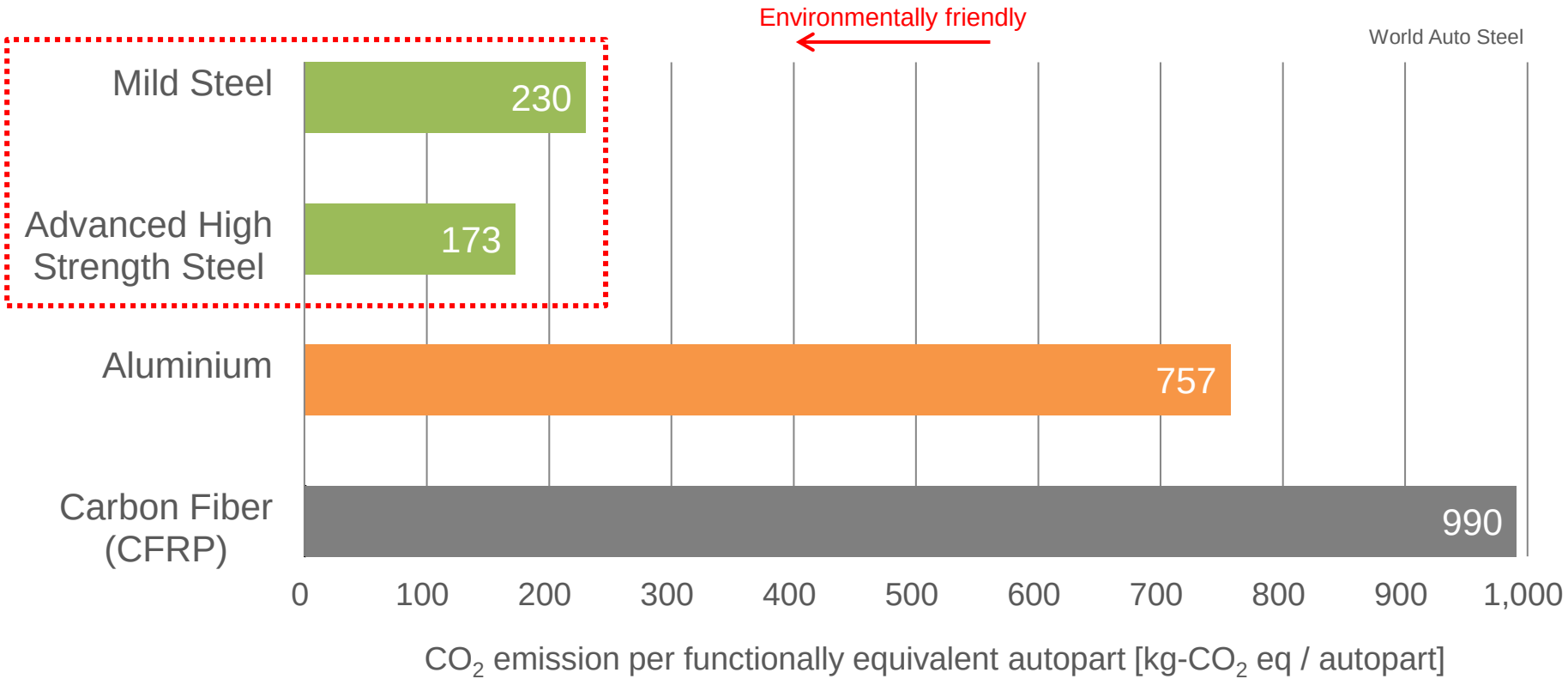
CO_2 emission of steel in production



Carbon Trust: International Carbon Flows (2011)

In the production phase of steel, iron making process is the most significant step in green house gas emission.

CO_2 emission in production



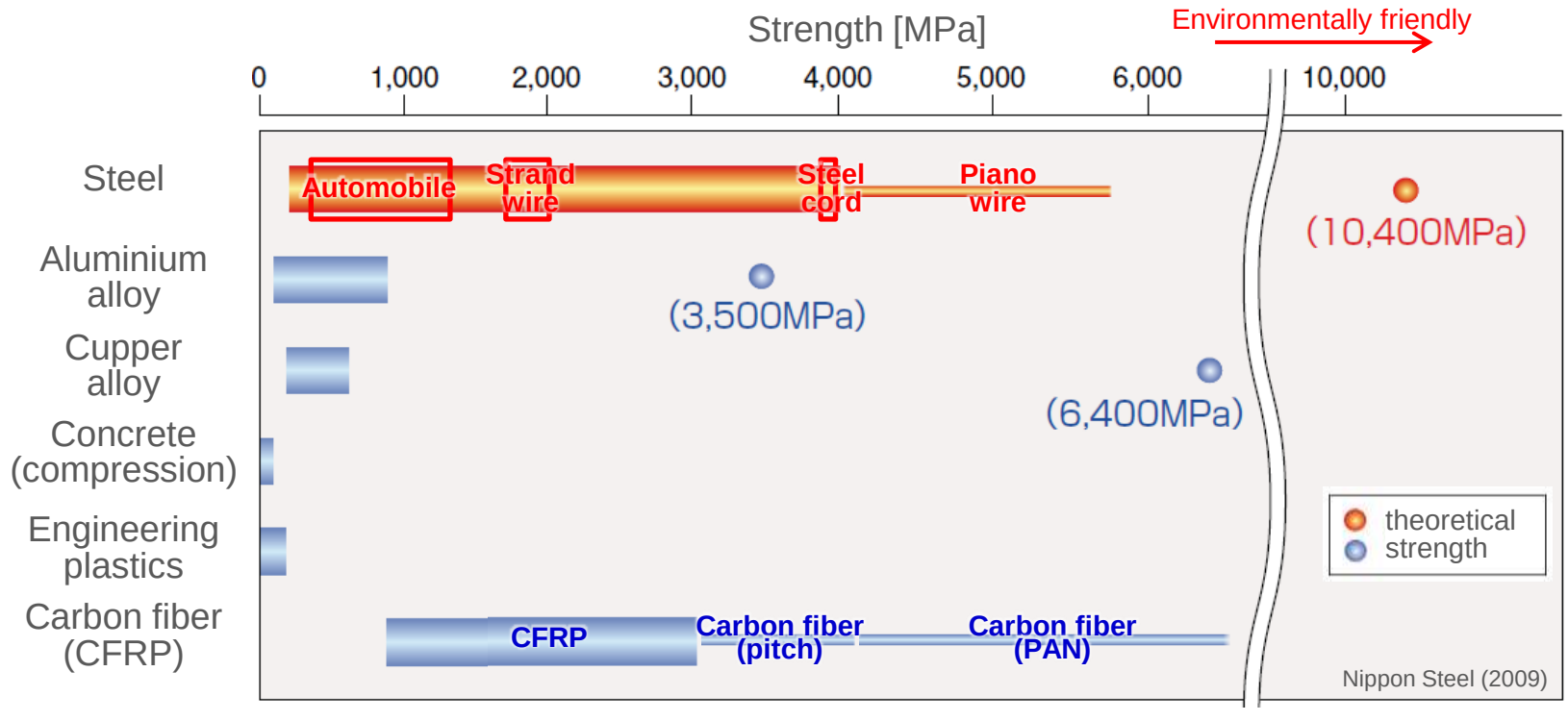
CO_2 emission in production per same performance component is low in steel compared to other light-weight materials.

Environmental impact in use

Weight per strength (vehicle)

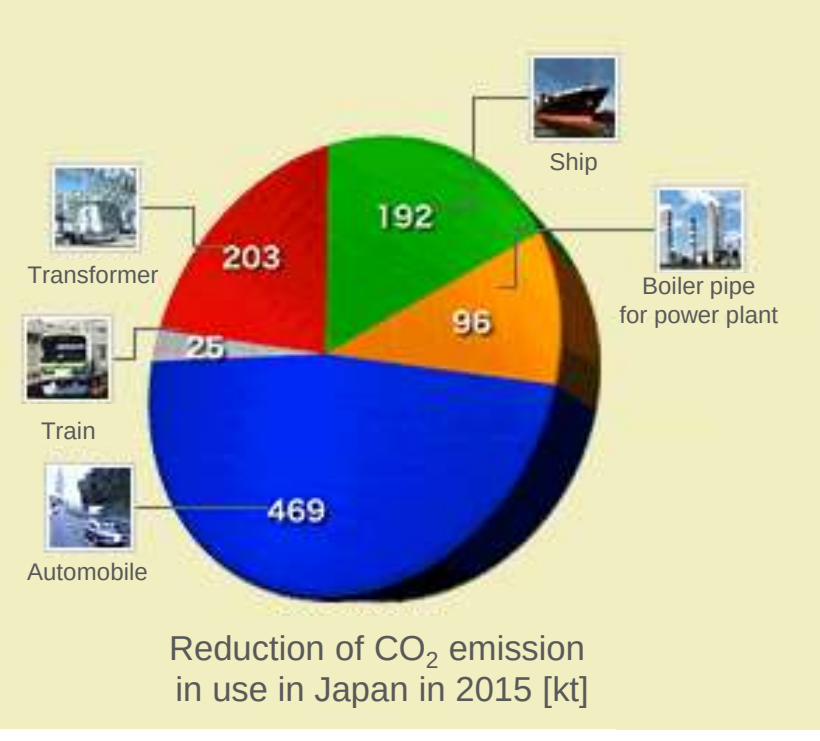
Steel is becoming lighter and lighter.
Now, steel is lighter than aluminium per strength.

Strength of materials

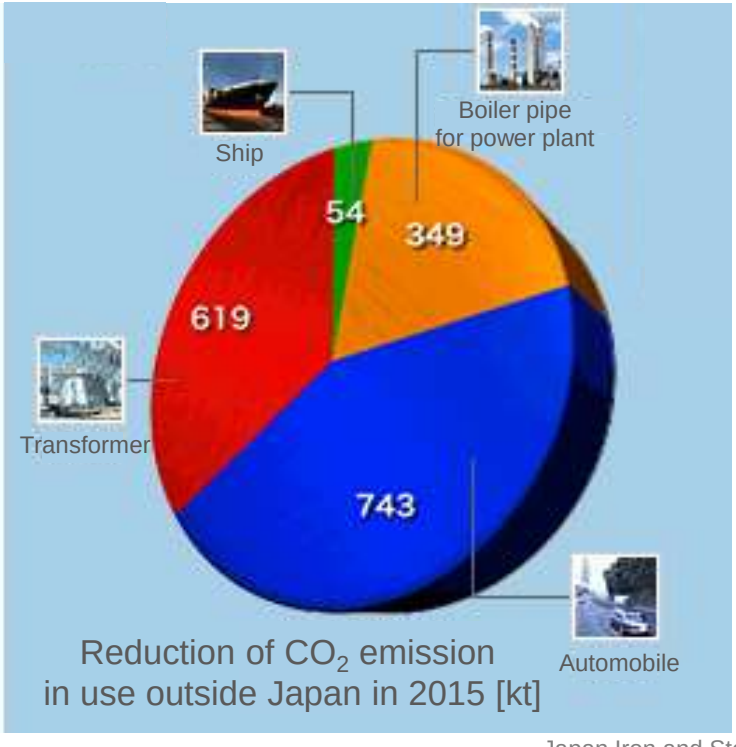


Theoretical strength of steel is very high.
Future steel might be far more stronger than now.

High performance steel products reduce CO_2 emission in use phases



Reduction of CO_2 emission in use in Japan in 2015 [kt]

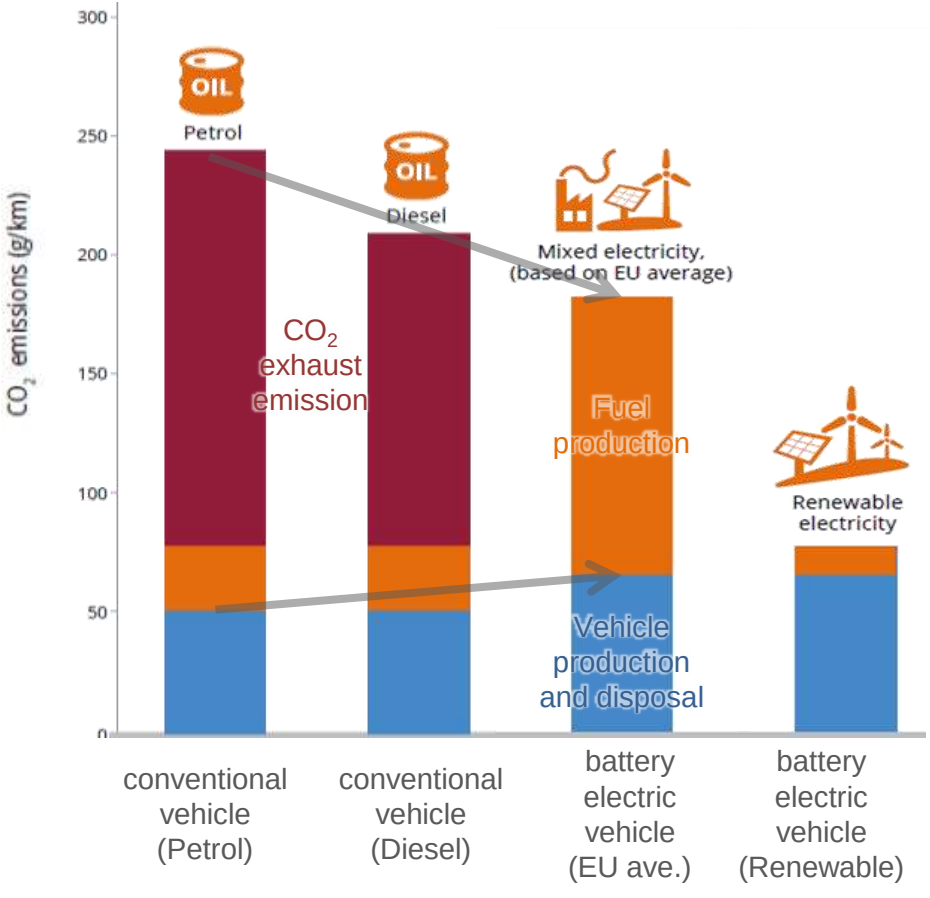


Reduction of CO_2 emission in use outside Japan in 2015 [kt]

Japan Iron and Steel Federation

Some of high performance steel products contributed to the reduction of CO_2 emission in the world.

CO_2 emission in life cycle (vehicle)

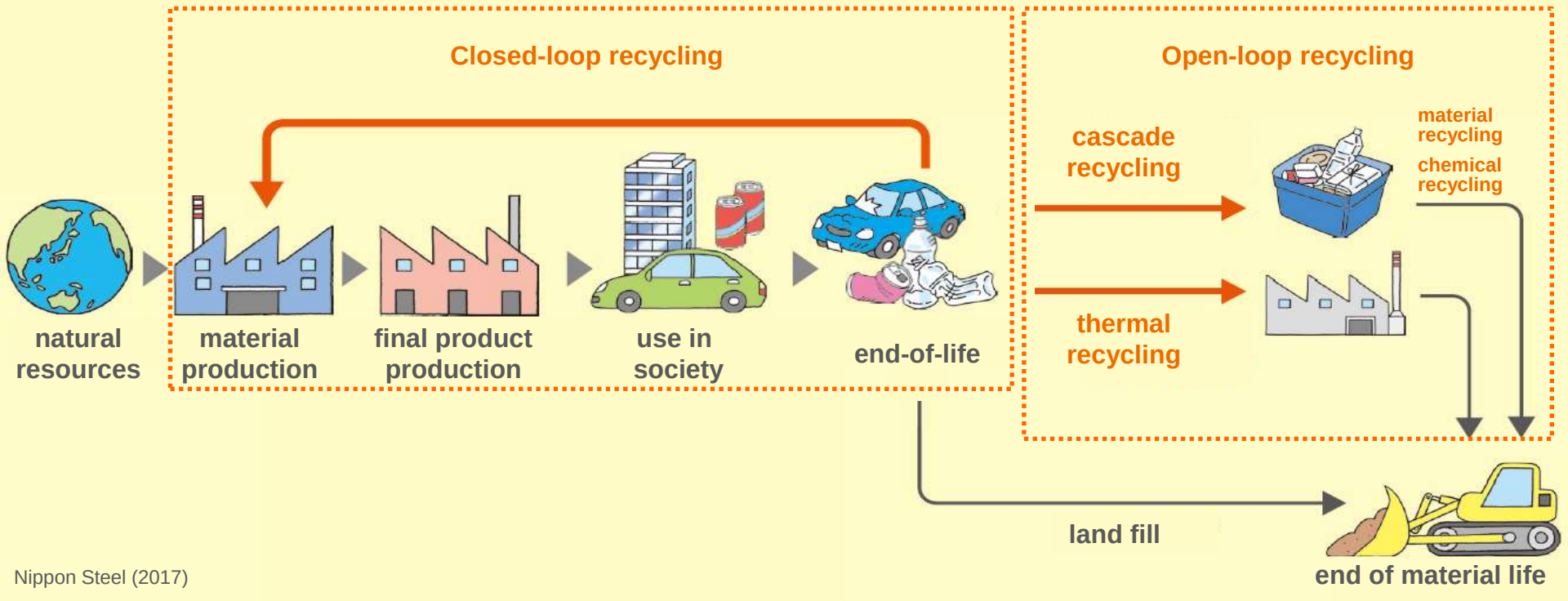


EEA Signals 2017

CO_2 emission in production becomes significant in low emission vehicles.

Recycling of materials

Open-loop and closed-loop in recycling



Nippon Steel (2017)

Most of the recycling is open-loop, degrading its property.
Steel is recycled “closed-loop”, fully substitutional to the primary steel.

Requirements for sustainable recycling

1. Easy sorting

Steel sticks to magnet, most other materials do not.

2. Low environmental impact in recycling process

Steel scrap is easily recycled by re-melting.

3. Existence of economical recycling system

Steel scrap is traded as a steel material worldwide.

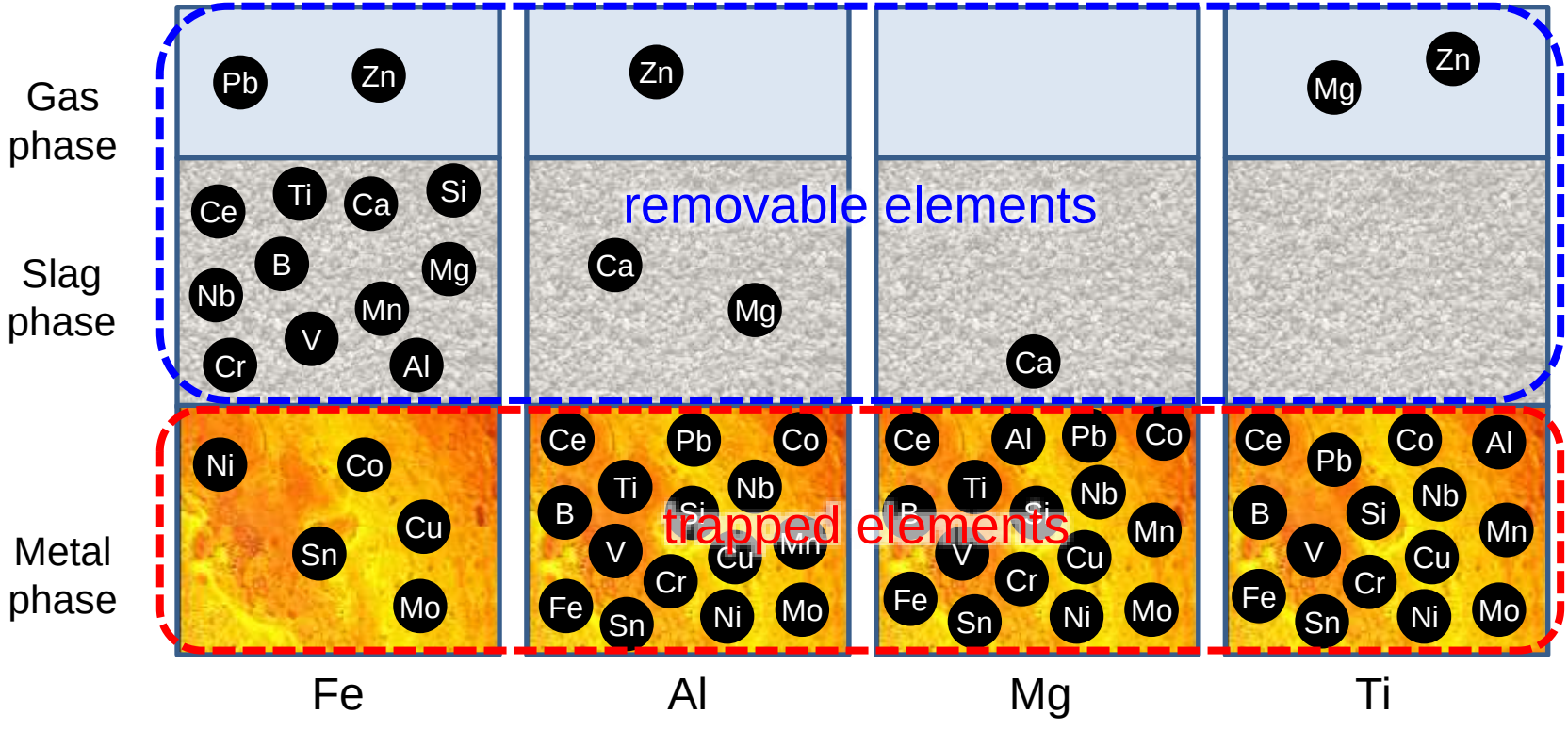
4. Refinable in recycling

Most impurities in steel scrap can easily be removed.

Steel meets all these requirements for closed-loop recycling.

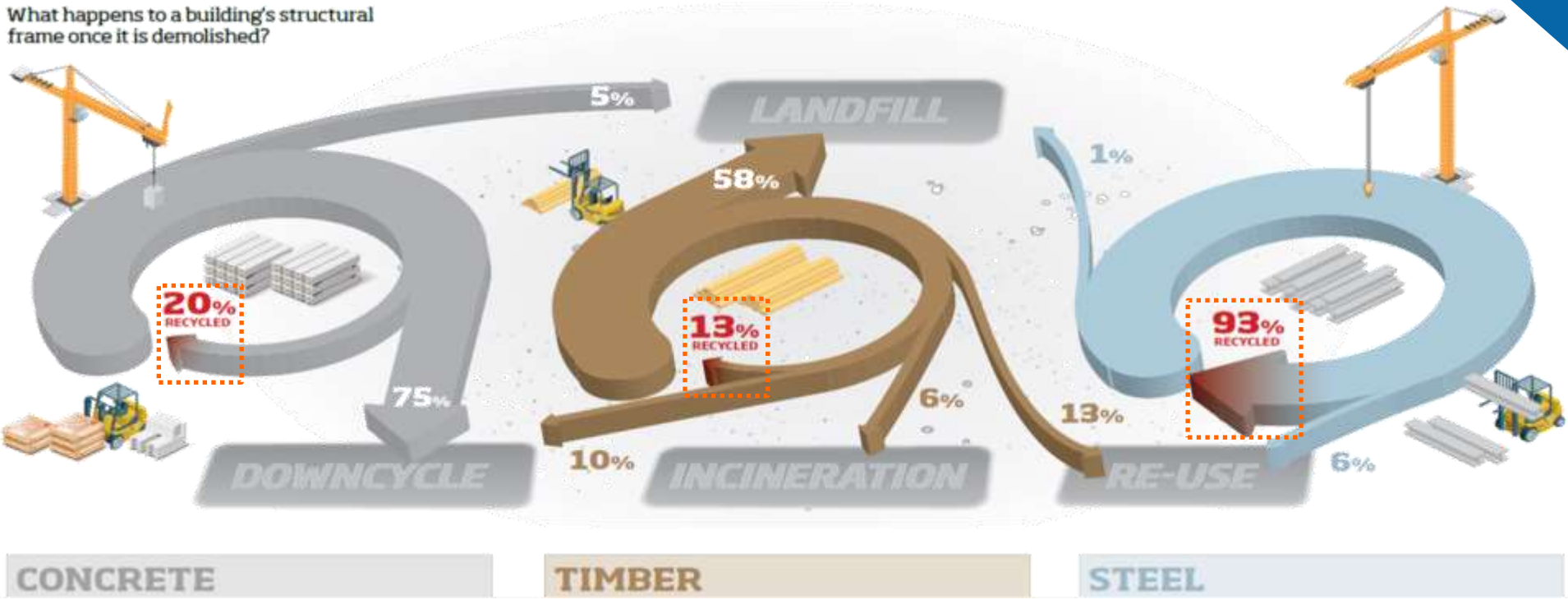
Metal Refining

Hiraki, Xin, Nakajima, Matsubae, Nakamura and Nagasaka (2012)



Most impurities in steel are removed by oxidization since iron is NOT easily oxidized.
Other metals can to a large extent be removed by magnetic separation.

Recycling in construction (UK)

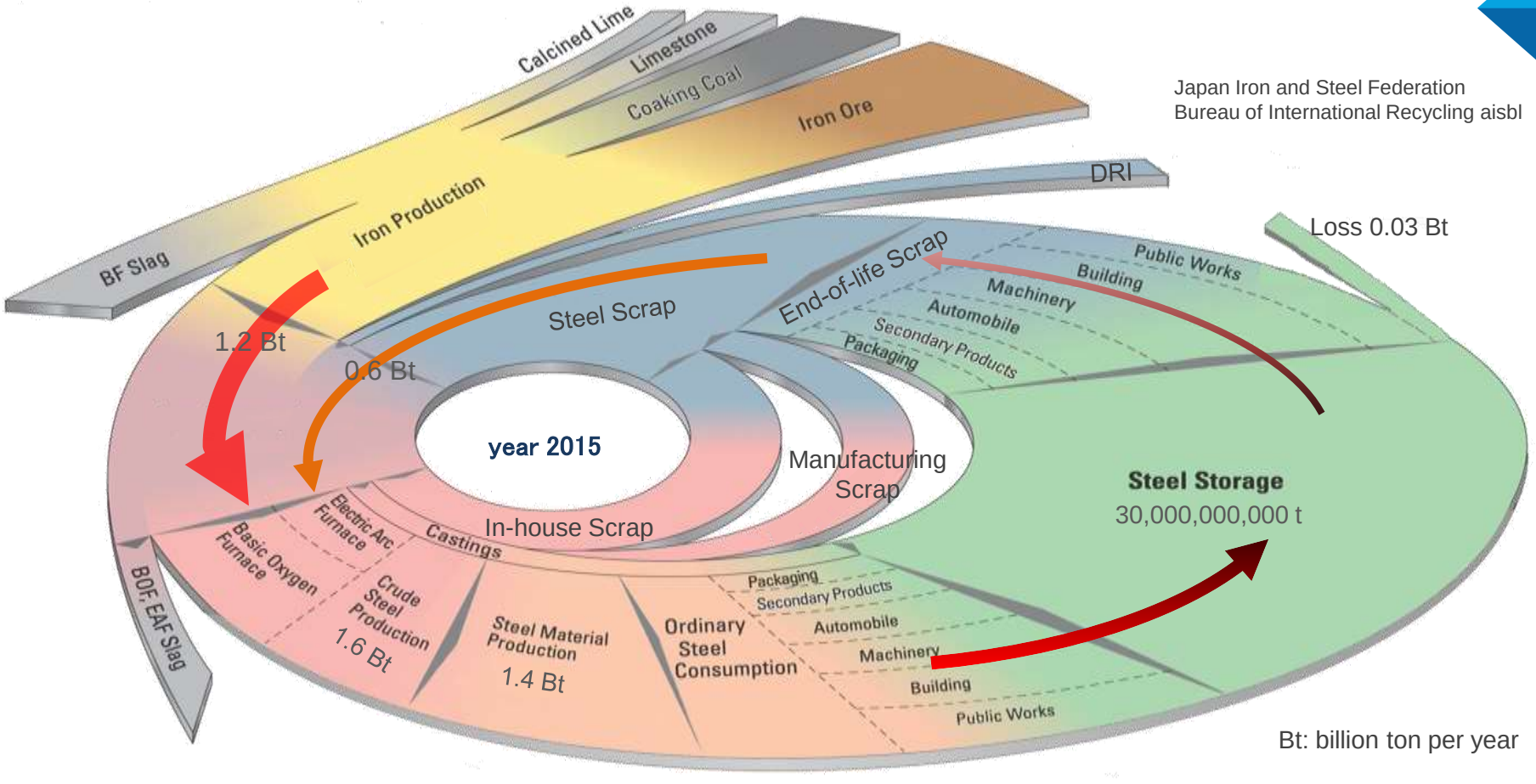


SteelConstruction.info, https://www.steelconstruction.info/File:B_Fig10_2013.png#filelinks

Most of the steel is recycled in construction. Others, not.

Circulation of steel in the world

Japan Iron and Steel Federation
Bureau of International Recycling aisbl

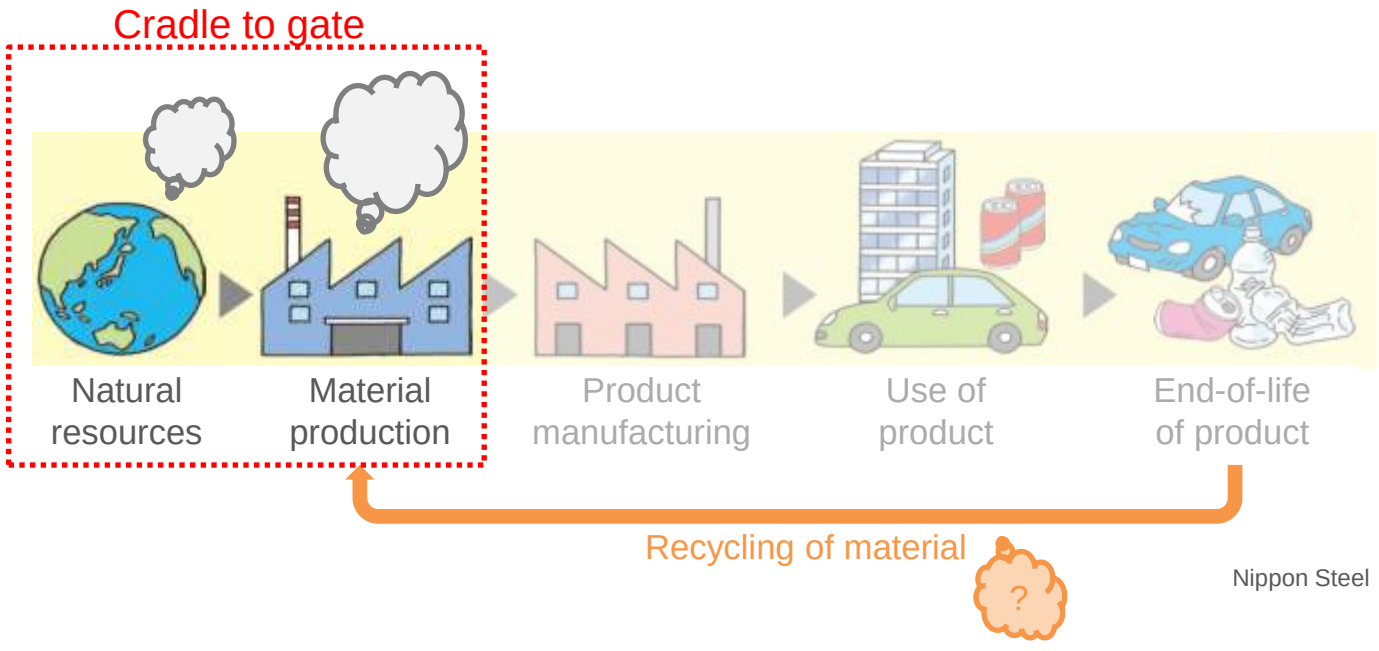


Bt: billion ton per year

Steel is accumulated year by year, without loss, and circulated.

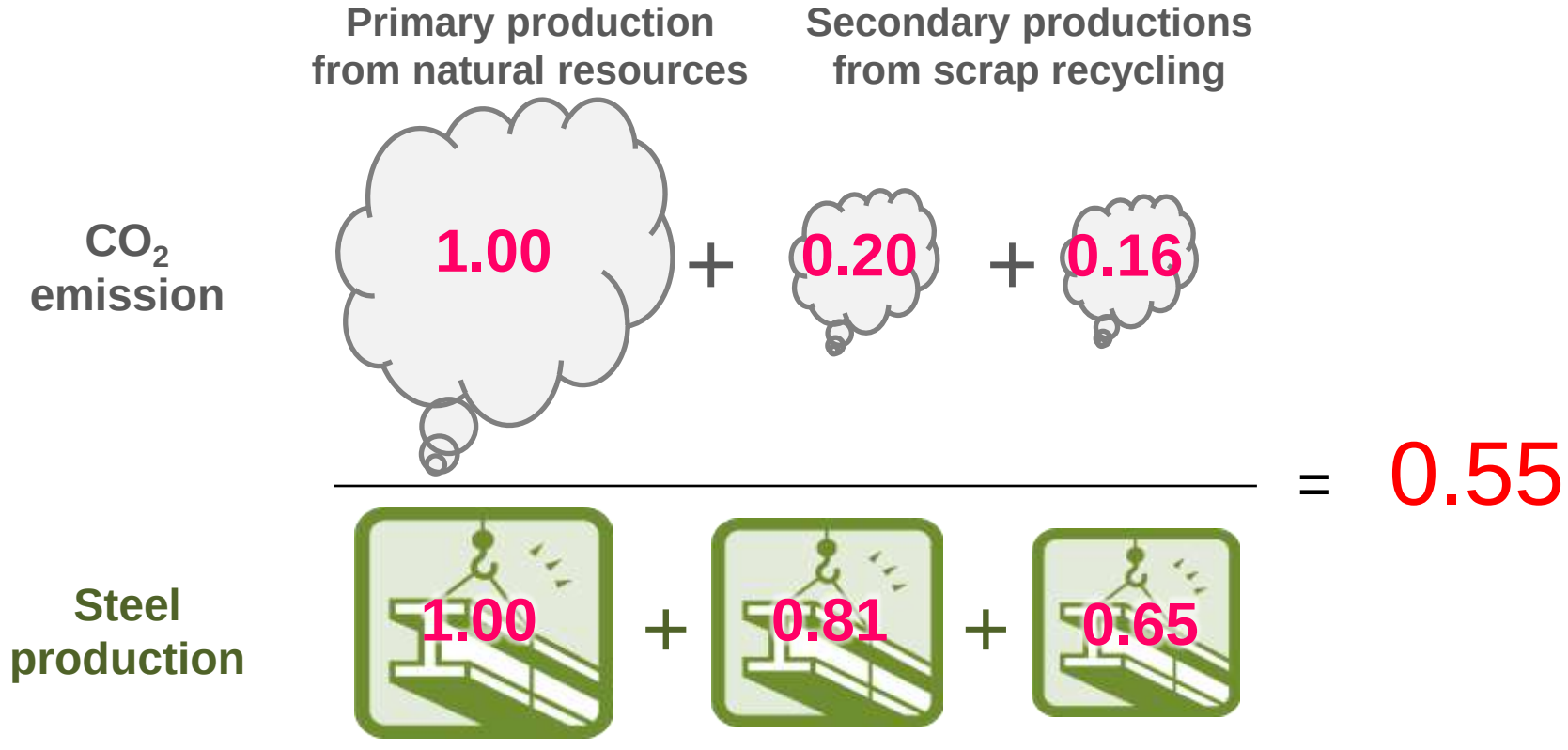
How should we calculate the effect of recycling?

Recycling effect of material



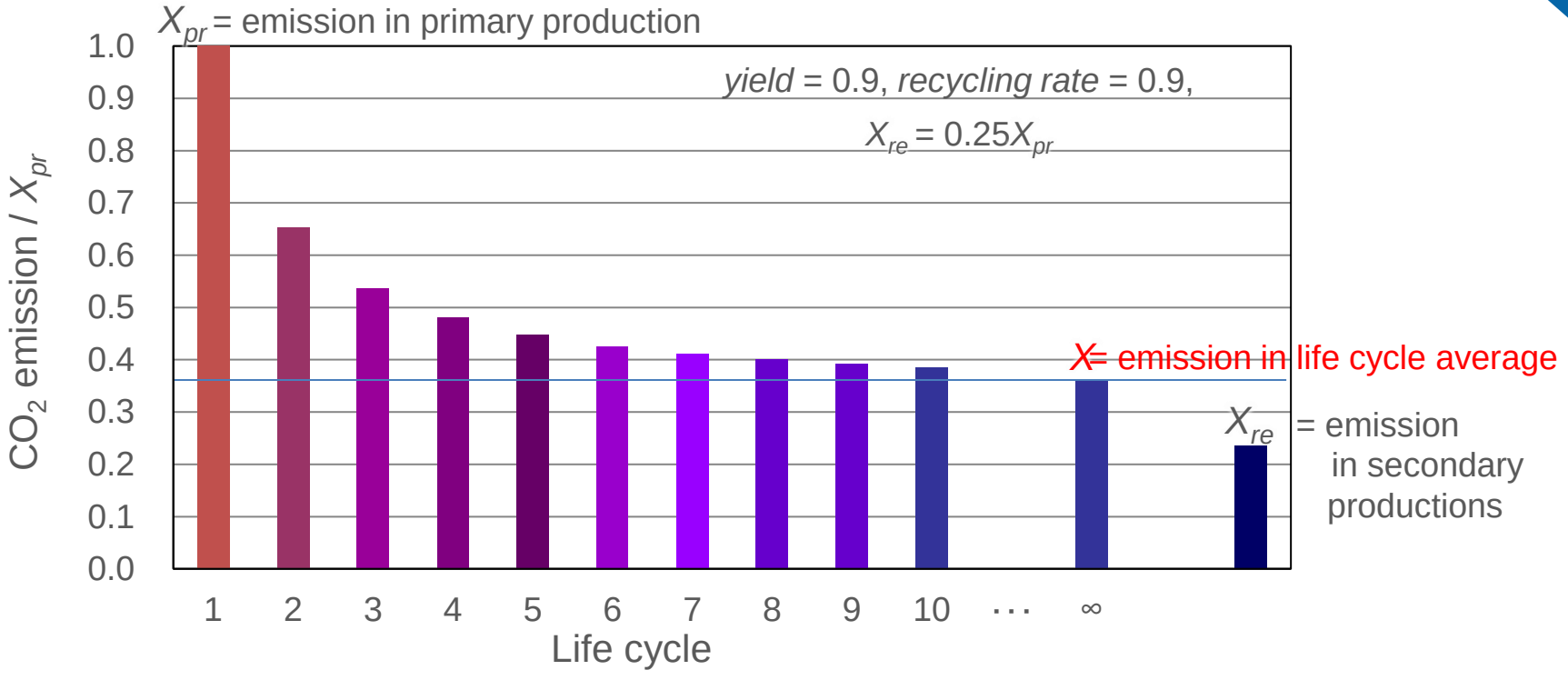
CO_2 emission is calculated from cradle to gate in most materials.
How about in steel, where scrap is recycled again and again?

Multiple recycling (e.g. 3rd cycle)



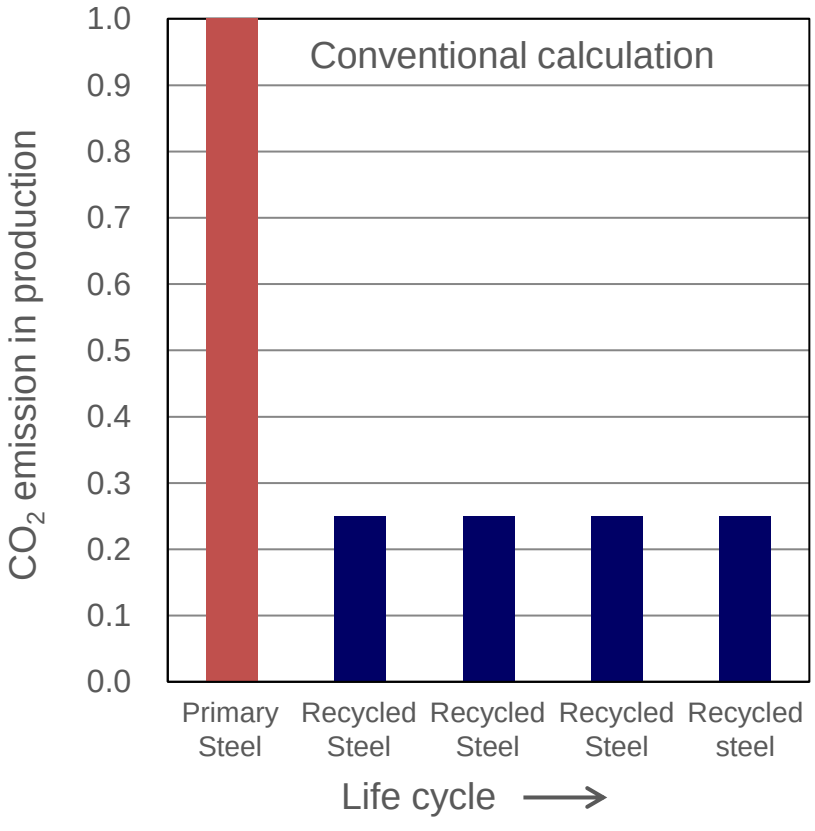
CO_2 emission =1.0 (primary production), 0.25 (secondary production)
R (scrap recovery rate) = 0.9, Y (recycling yield) = 0.9

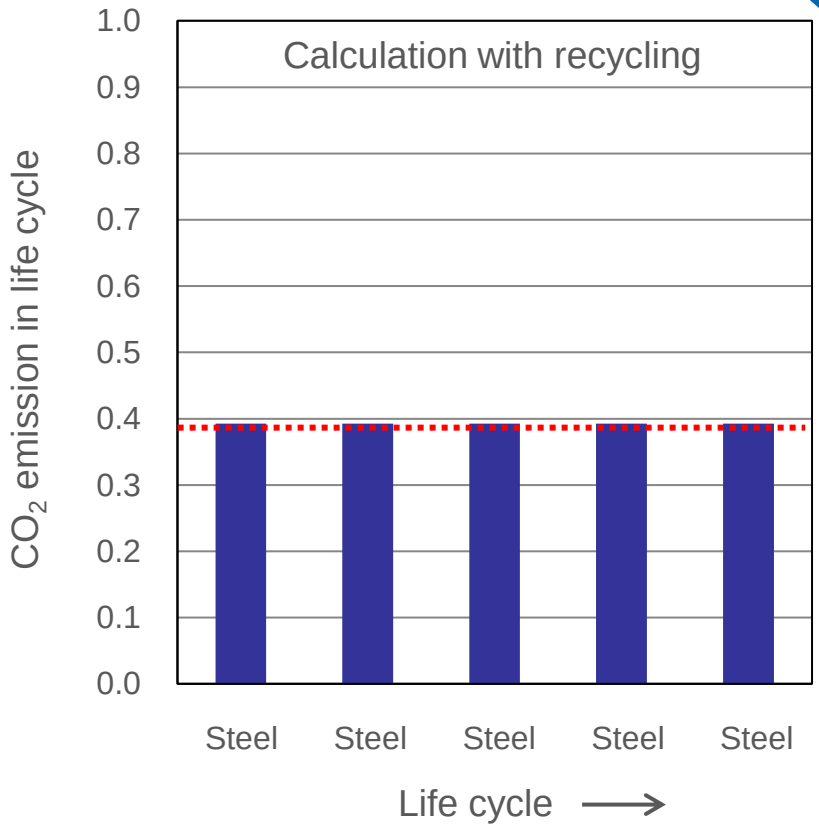
CO_2 emission in multiple recycling



CO_2 emission in life cycle average converges to a value in multiple recycling.

CO_2 emission in multiple recycling

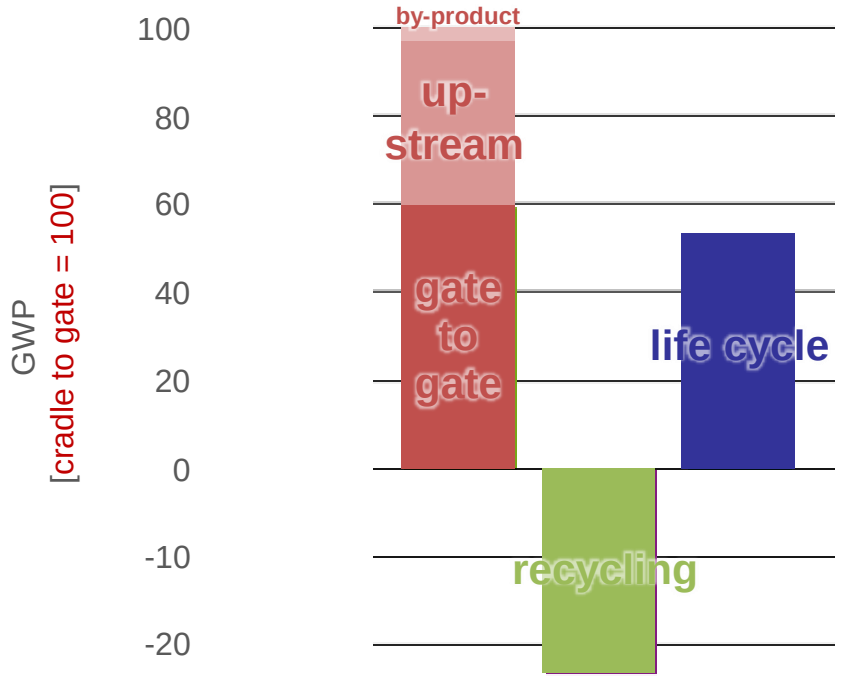




In closed-loop recycling, there is no difference in primary and recycled steels.

CO_2 emission of steel including recycling

Global warming potential of
hot-dip galvanized steel sheet (world average)



worldsteel, Life cycle inventory study, May 2018, P23

Recycling effect is big.
CO_2 emission of recycled product is far less than those without recycling.

Long-term vision for climate change mitigation

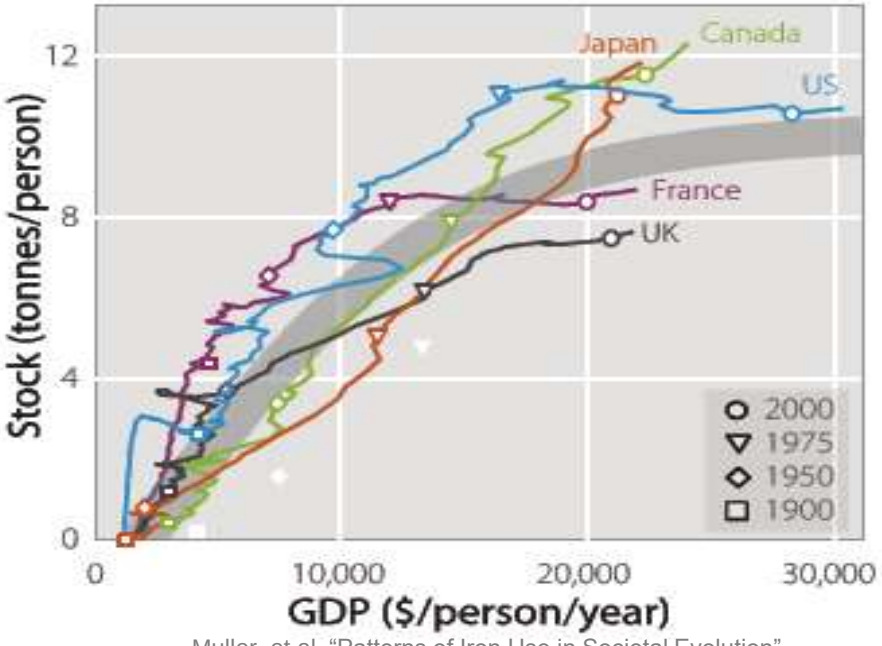
A challenge towards Zero-carbon Seel

November 19, 2018

Japan Iron and Steel Federation

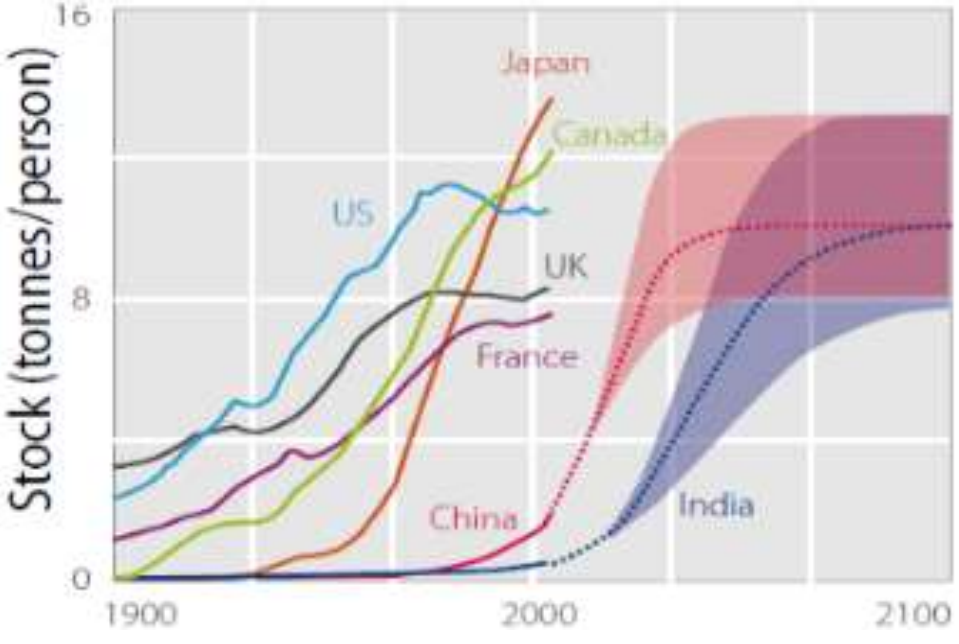
Steel stock in the future

Relationship between GDP per capita and steel stock per capita



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

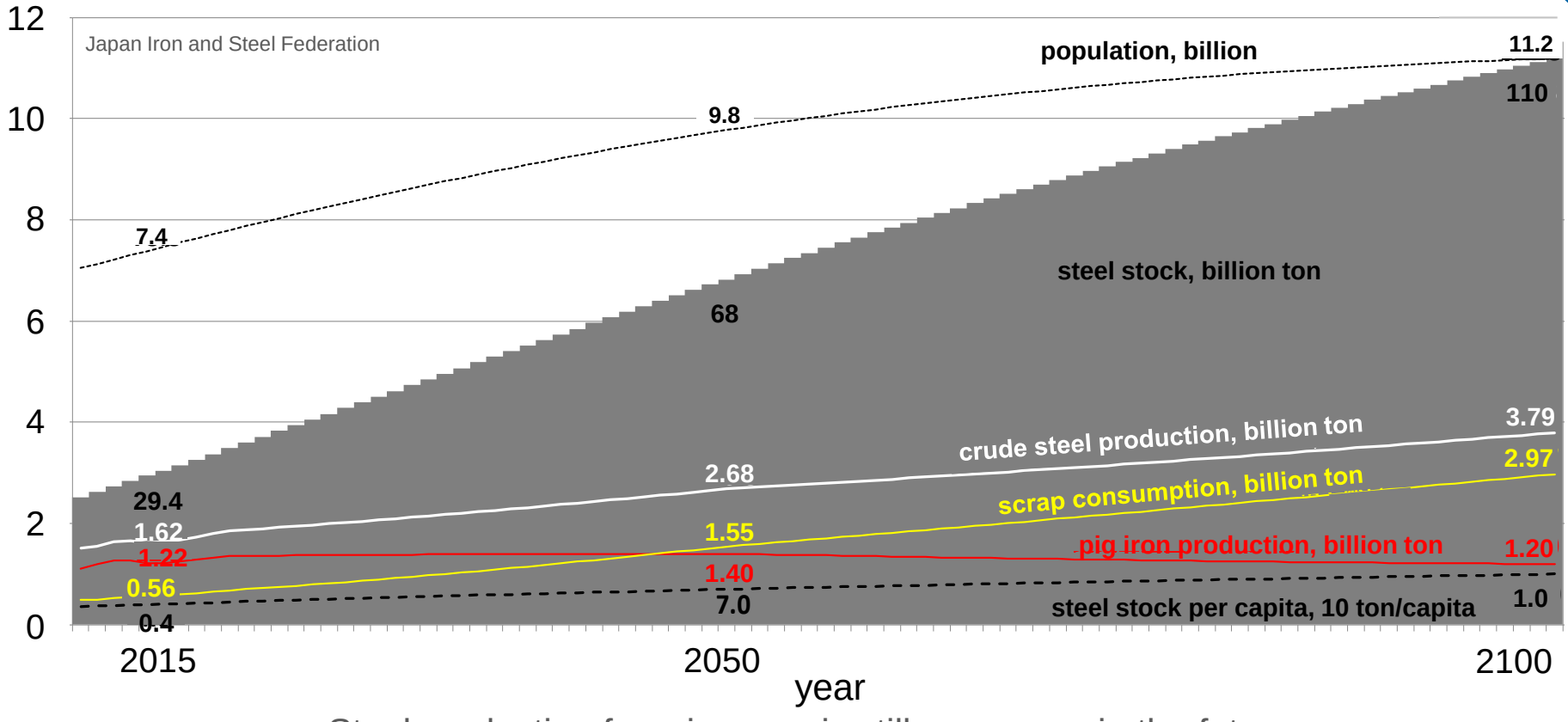
Transition of steel stock per capita



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

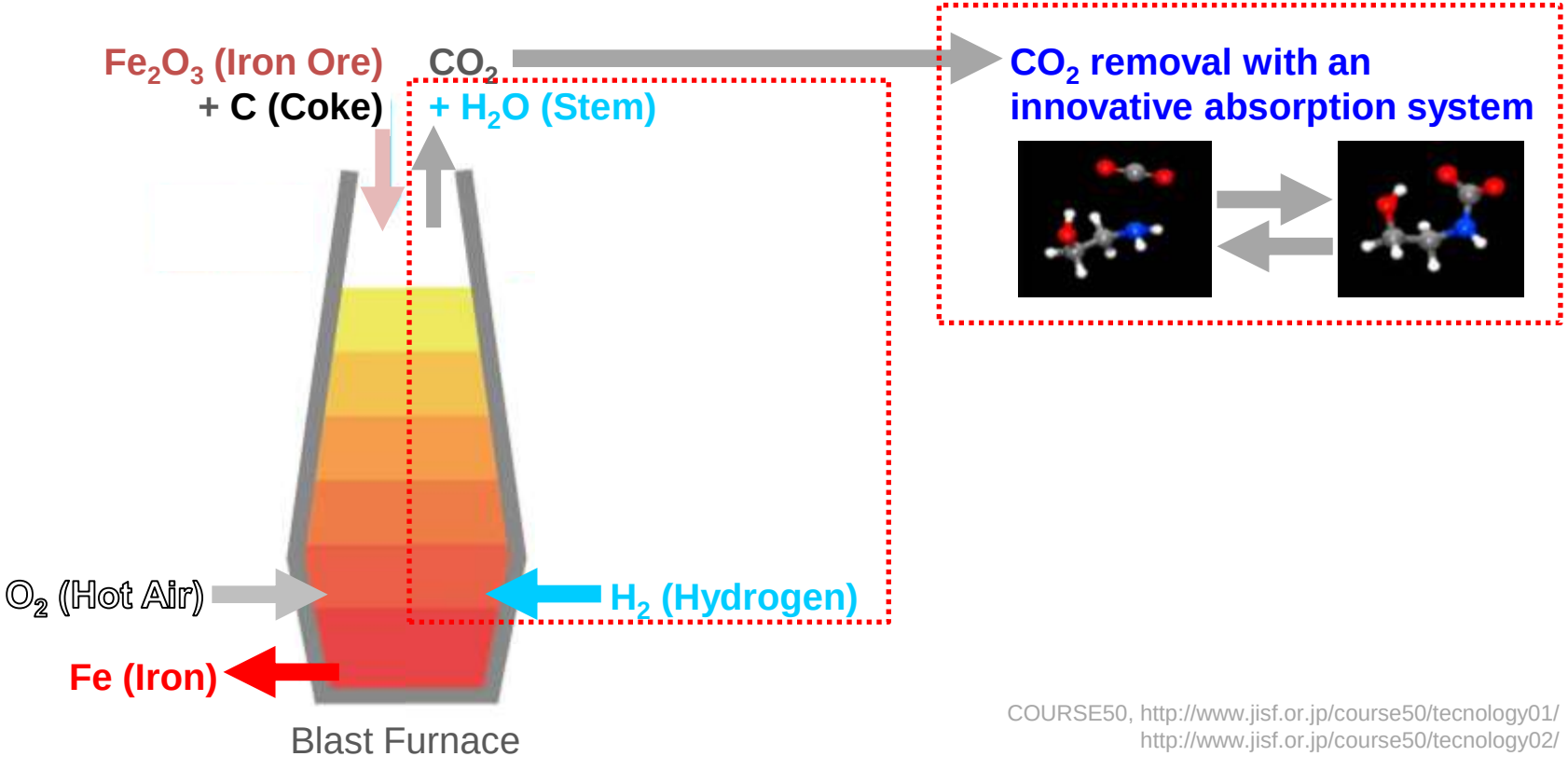
Steel stock saturates at about 10 t/capita in developed countries.

Steel demand and production



Steel production from iron ore is still necessary in the future.
How should we make it?

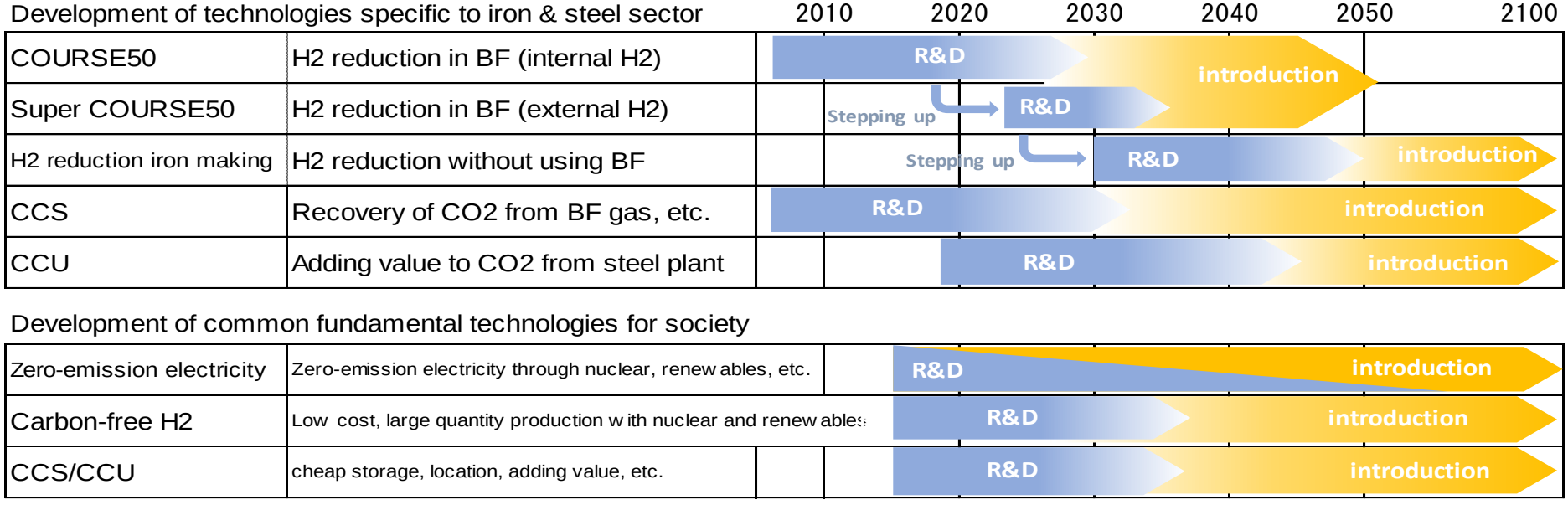
Innovative Technologies - COURSE50



COURSE50, http://www.jisf.or.jp/course50/tecnology01/
http://www.jisf.or.jp/course50/tecnology02/

In COURSE50, iron ore is also reduced with hydrogen and CO_2 is removed by an innovative absorption system.

Time course for the zero-carbon steel



Japan Iron and Steel Federation (2018)

COURSE50 is the first step to the zero-carbon steel.

Activities for promotion of the sustainability of steel by JISF

Activities by JISF

1. Development of Standards: JIS 20915 and JIS Q 20915
2. Development of PCRs for EPD referring ISO 20915, including recycling effect
3. Life cycle inventory data collection and disclosure of the average data.
4. Promotions in video, conferences, seminars, etc.

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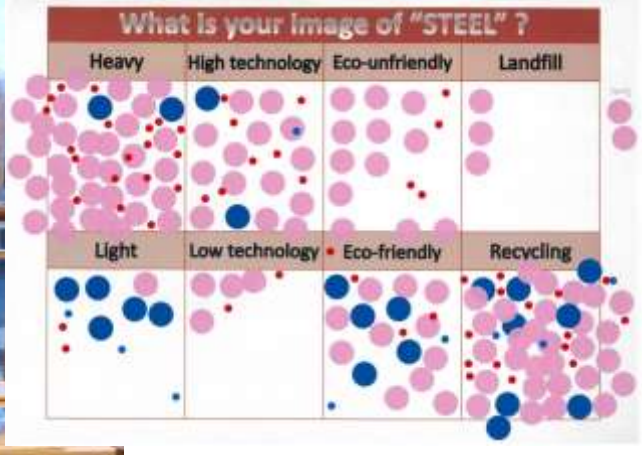

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Actually, Steel is Light

And steel is becoming even "lighter"

Technology is making steel lighter and lighter by increasing its strength. A series of technological innovations reduced the amount of steel required to achieve the same strength by two-thirds. With many future innovations lined up, steel is a material with a high potential to become even "lighter".

Steel can be recycled "lightly"

Steel has another life after the product is no longer used. Almost all steel is recycled worldwide, because steel can be sorted easily using magnets and has the flexibility to be recycled into a variety of steel products. Because of these properties, steel can be recycled "lightly" into all kinds of steel products.

Steel has a "light" burden on the environment

Steel production generates less CO_2 than the production of many materials. Additionally, because of its recyclability, steel has very small environmental burden at the time of disposing. Steel is a material with a "light" impact on the environment through its entire life cycle.

http://www.jisf.or.jp/en/

Japan Iron and Steel Federation

Thank you for your attention !