Forging a Low-Carbon Future: Strategies for the Steel Industry

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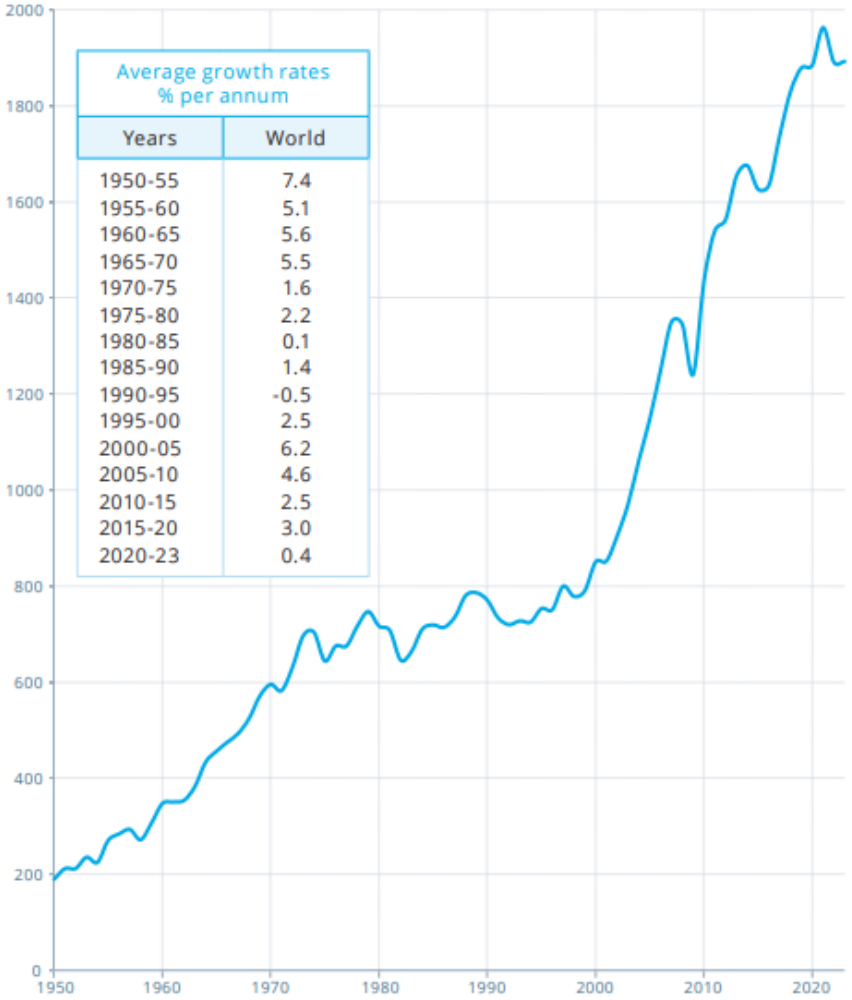
Disclaimer

Where we've been

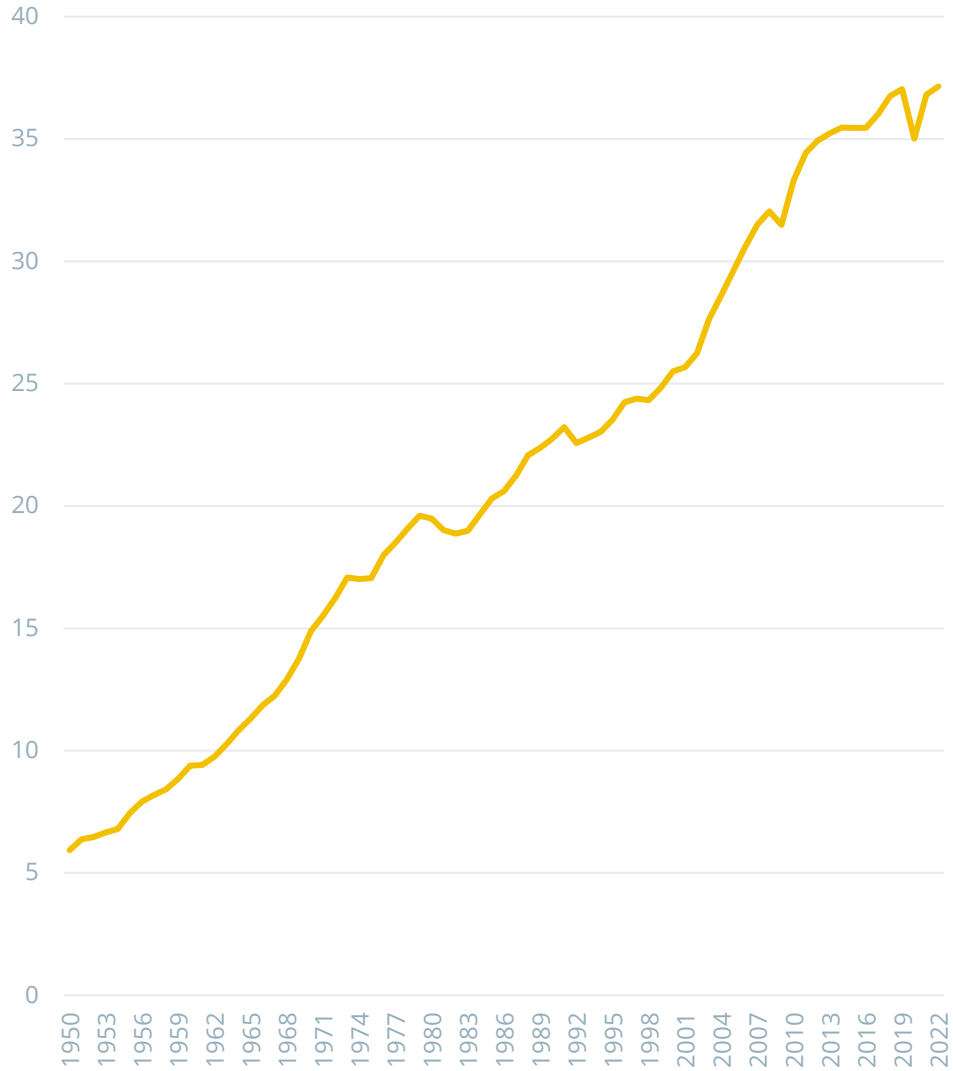
million tonnes, crude steel production



Average growth rates
% per annum

Years	World
1950-55	7.4
1955-60	5.1
1960-65	5.6
1965-70	5.5
1970-75	1.6
1975-80	2.2
1980-85	0.1
1985-90	1.4
1990-95	-0.5
1995-00	2.5
2000-05	6.2
2005-10	4.6
2010-15	2.5
2015-20	3.0
2020-23	0.4

Global Emissions from fossil fuel use



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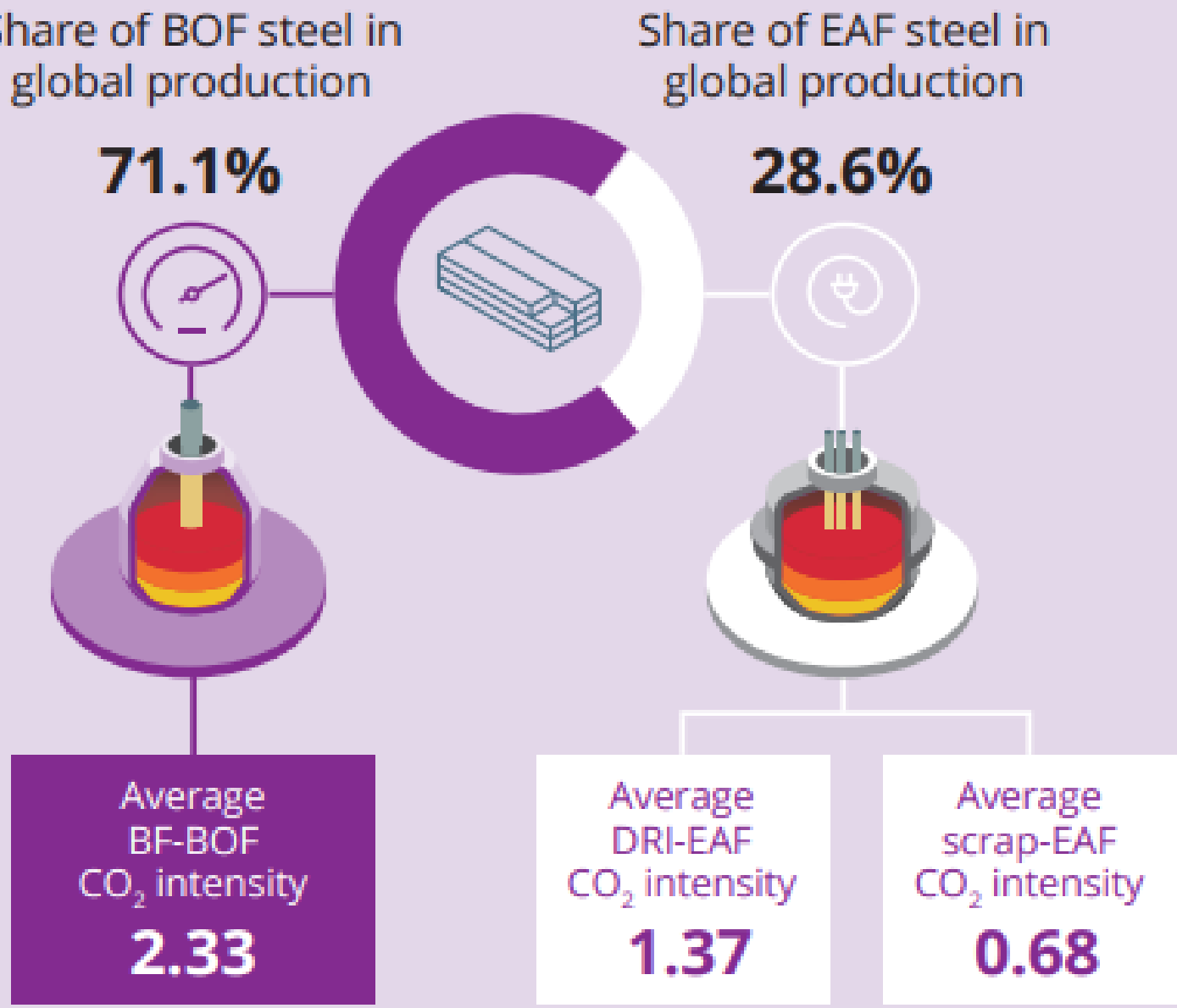
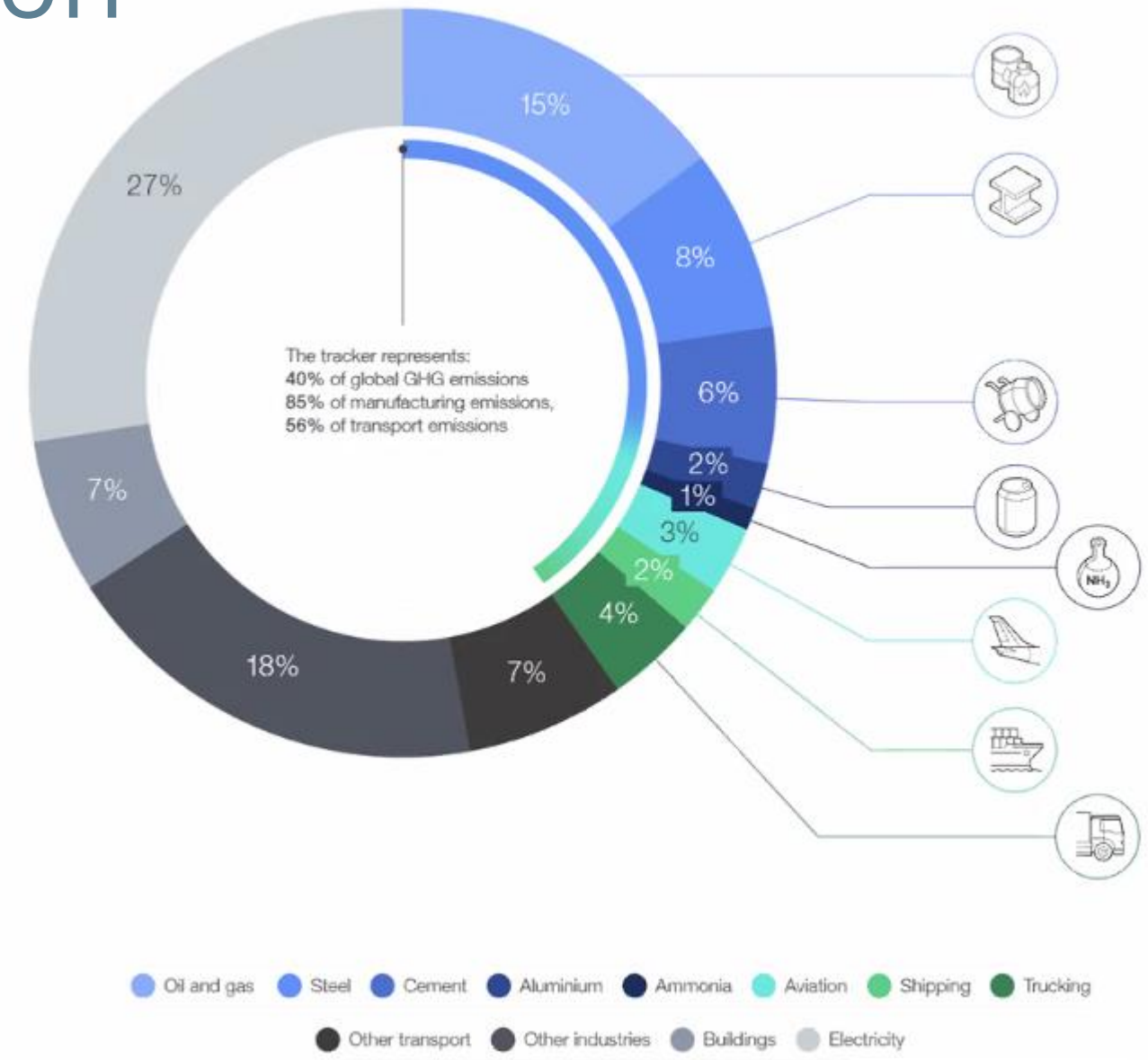
Crude steel production by process



In tonnes CO_2 per tonnes of crude steel cast, based on 2022 calculation.

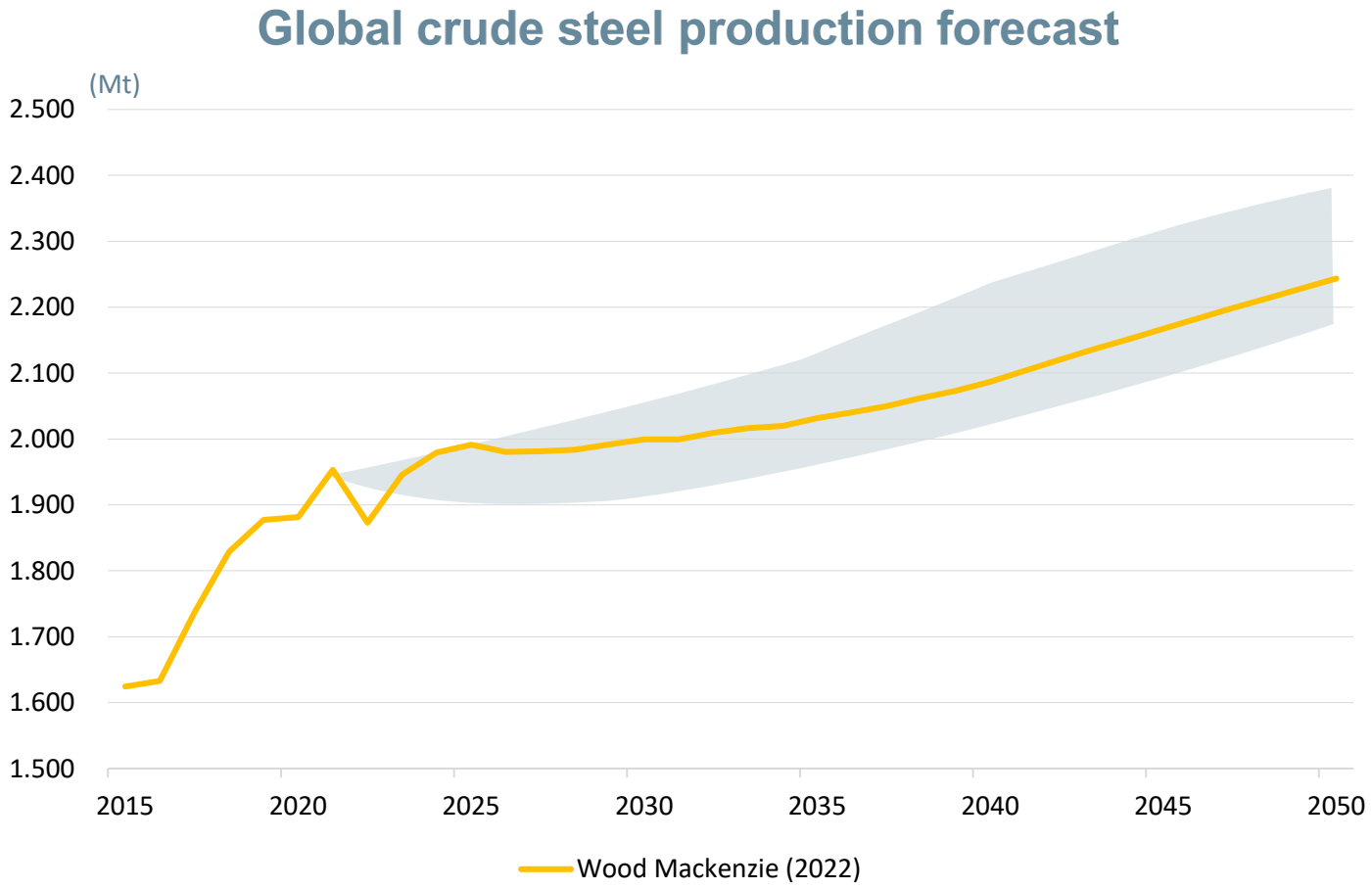
Steel’s contribution

Steel represents around 8% of global emissions



Long-term global steel production required to meet both market needs and carbon reduction

- Crude steel production to reach 2.2-2.4 bil. tonnes by ‘50 with modest growth of steel demand
- Liable to reduce carbon emissions required by a society despite production increase



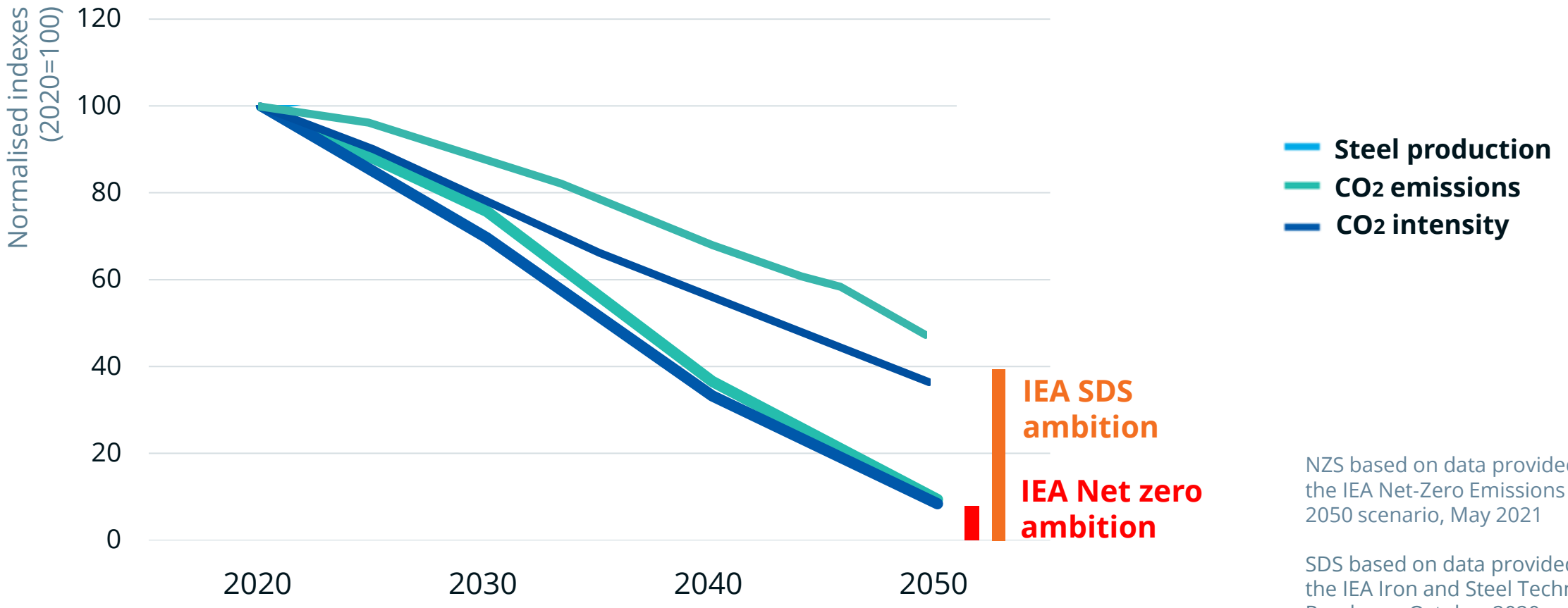
Global crude steel production (’20-’50)

- **Various institutions :** Project modest growth of about 1% annually next 30 years to 2.2-2.4 billion tonnes in ‘50. China’s crude steel production to peak between ’20~ ’30
- **Wood Mackenzie** : Forecasts China’s crude steel production peaking in ‘20 to reach 804 Mt in ’50 under zero carbon initiative (‘70), and India and SEA’s production replacing China’s after ’40

Source : Wood Mackenzie(‘22.6.)

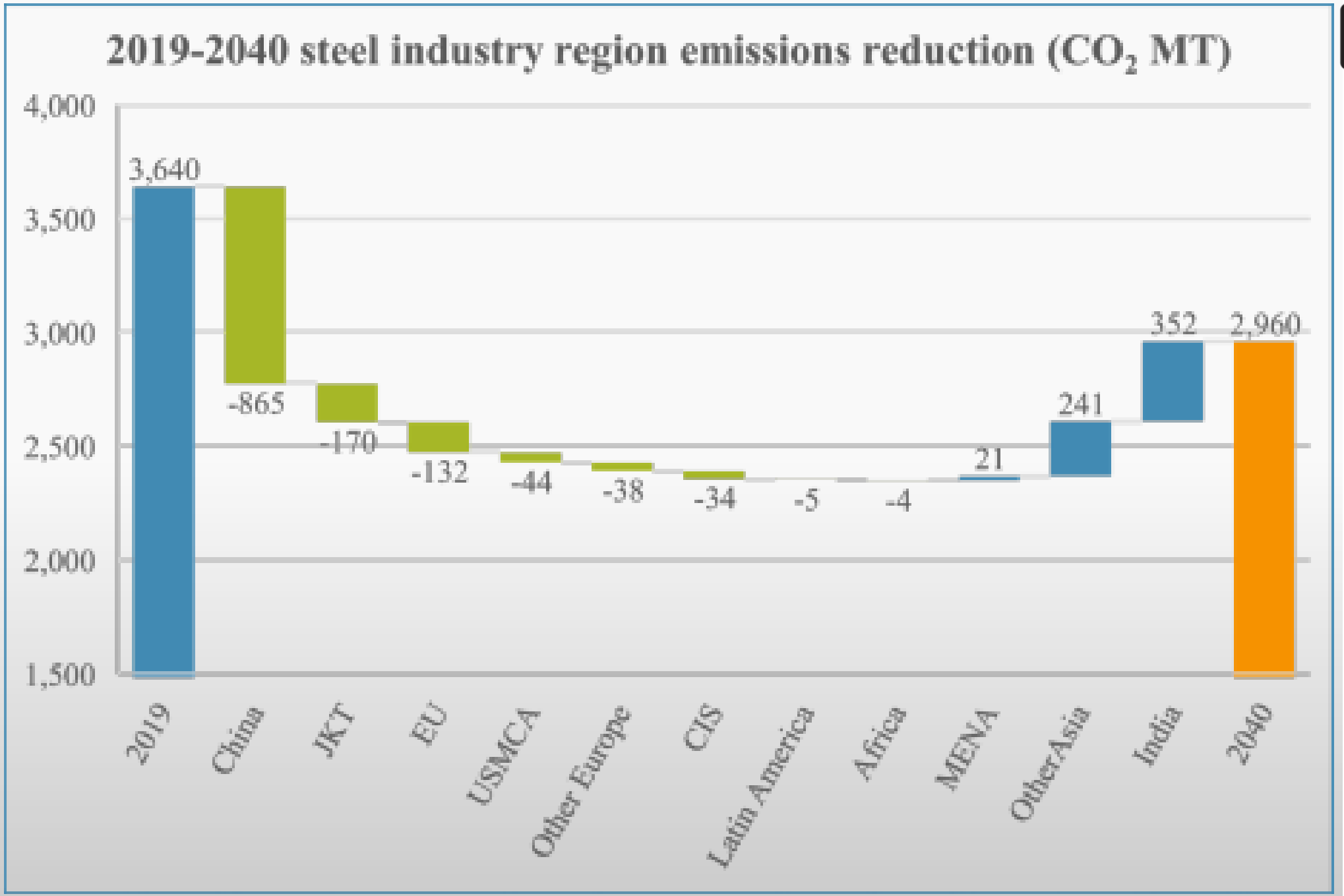
IEA scenarios

Steel production, total CO2 emissions and CO2 intensity 2020-2050 under the International Energy Agency (IEA) Scenarios



NZS based on data provided in the IEA Net-Zero Emissions by 2050 scenario, May 2021

SDS based on data provided in the IEA Iron and Steel Technology Roadmap, October 2020


2019-2040 steel industry region emissions reduction (CO_2 MT)
4,000
3,500
3,000
2,500
2,000
1,500
3,640
-865
-170
-132
-44
-38
-34
-5
-4
21
241
352
2,960
2019
China
JKT
EU
USMCA
Other Europe
CIS
Latin America
Africa
MENA
OtherAsia
India
2040

The answer?

Radical change to our industry....

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The answer?

Radical change to our industry....

... and the way we reduce iron.

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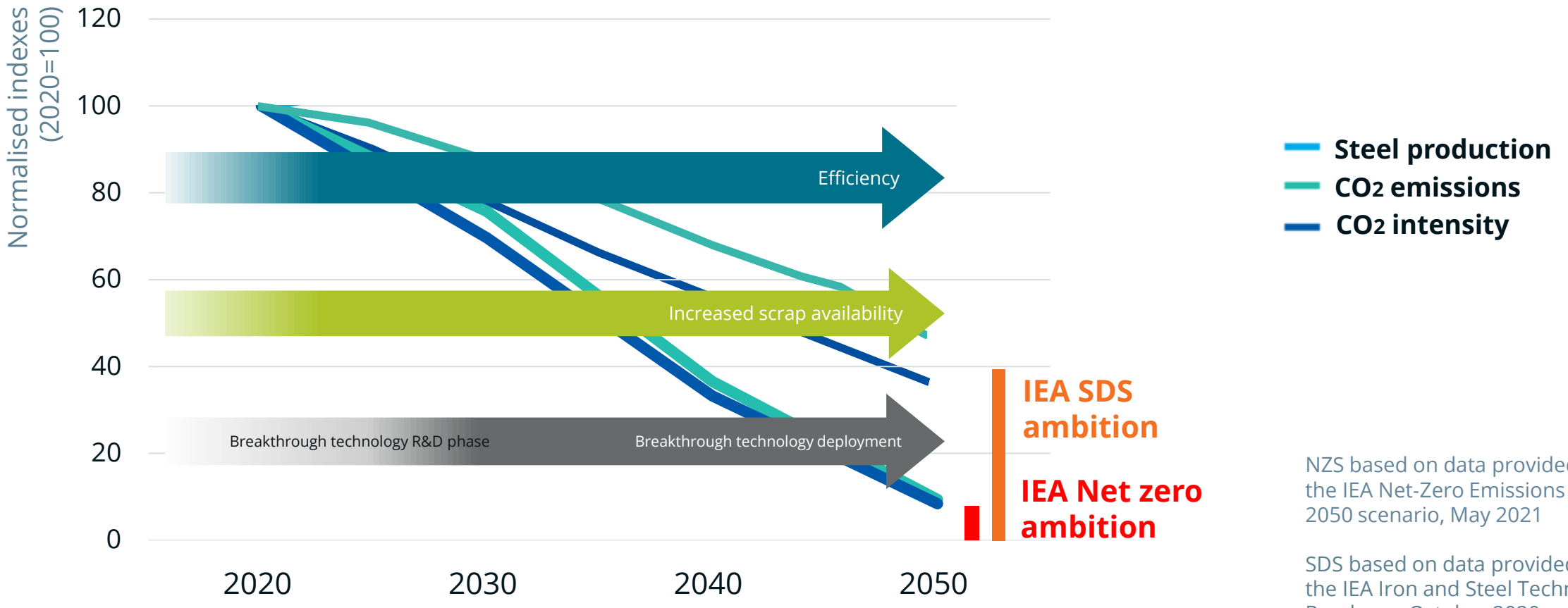
IEA scenarios and our approach

Steel production, total CO2 emissions and CO2 intensity 2020-2050 under the International Energy Agency (IEA) Net-Zero Emissions scenario (NZS)



NZS based on data provided in the IEA Net-Zero Emissions by 2050 scenario, May 2021

SDS based on data provided in the IEA Iron and Steel Technology Roadmap, October 2020

1. Efficiency

Climate Action
STEP UP
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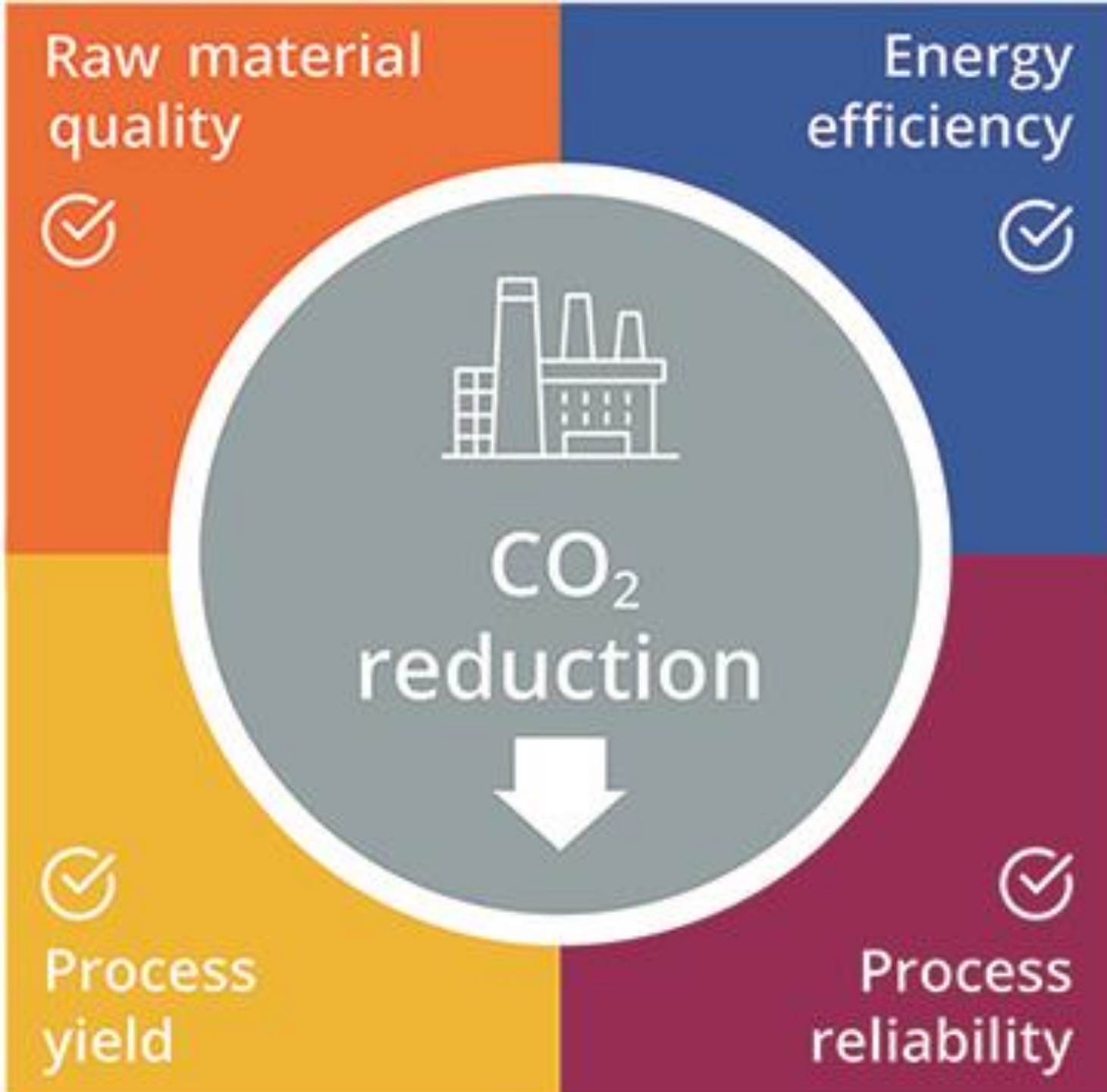
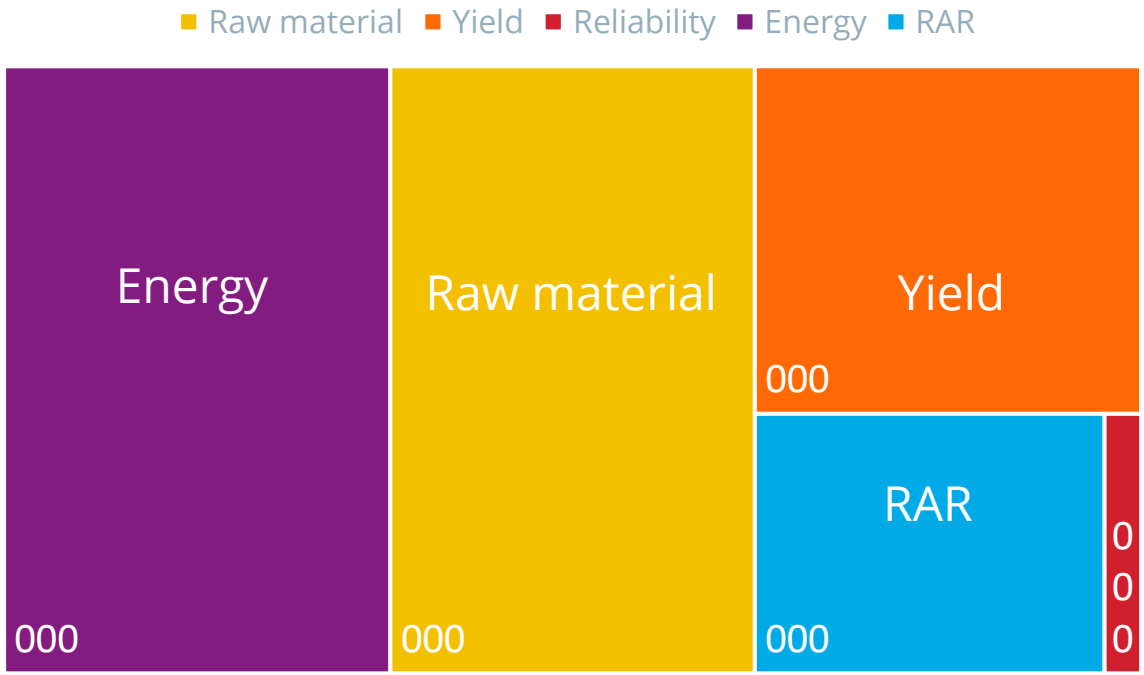


step up programme potential CO_2 intensity savings

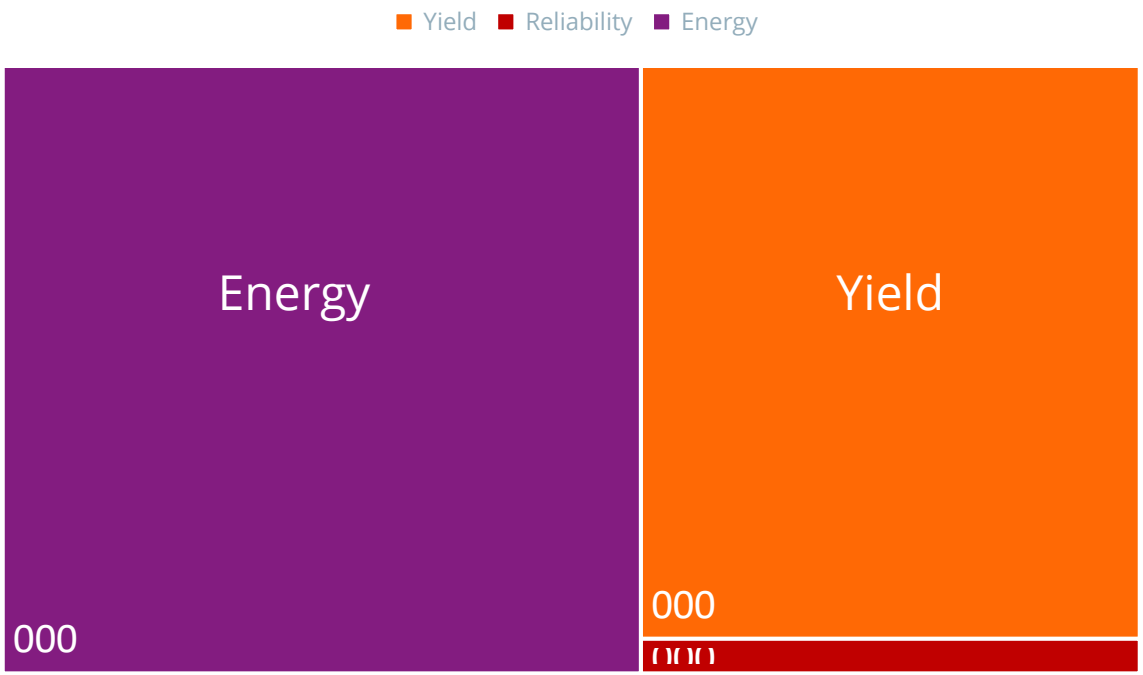
step up CO_2 reduction potential for ore route

(t CO_2/t Crude Steel)



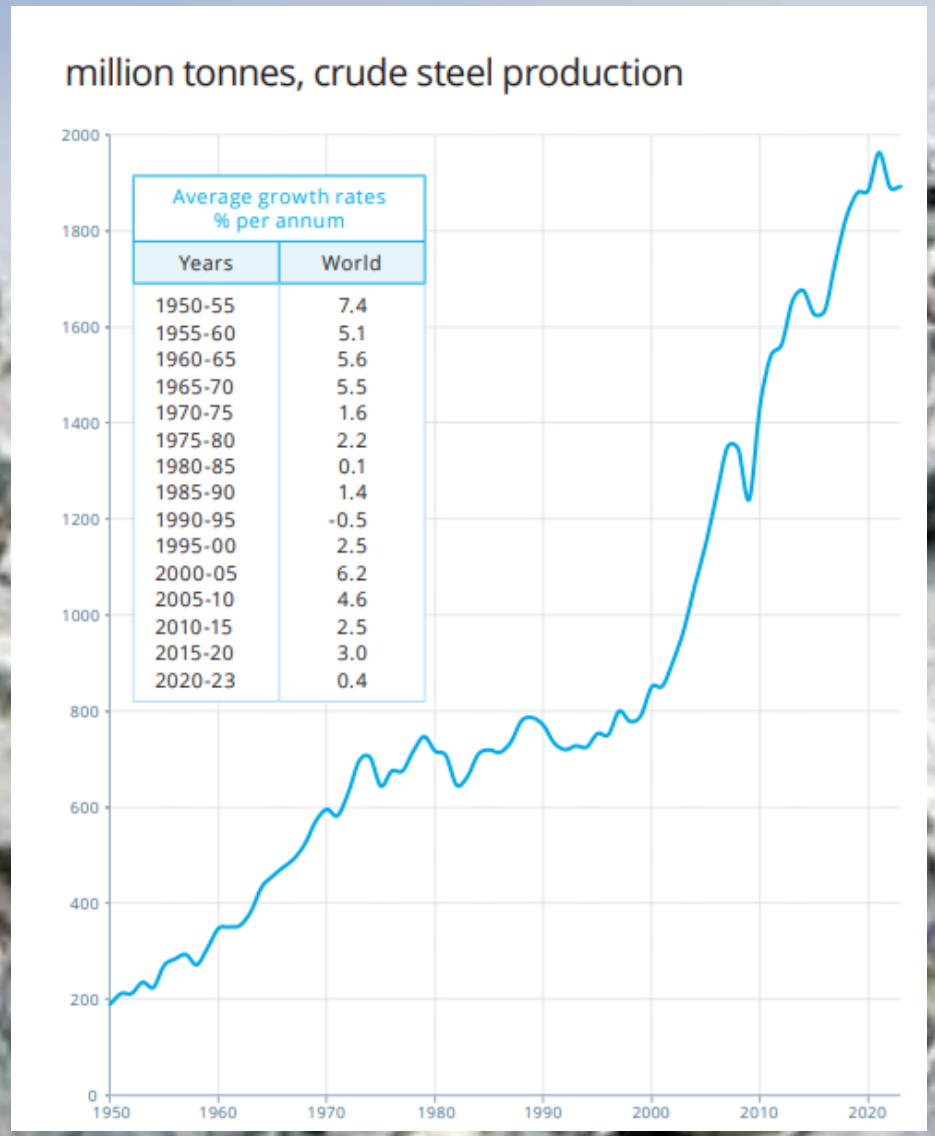
step up CO_2 reduction potential for scrap route

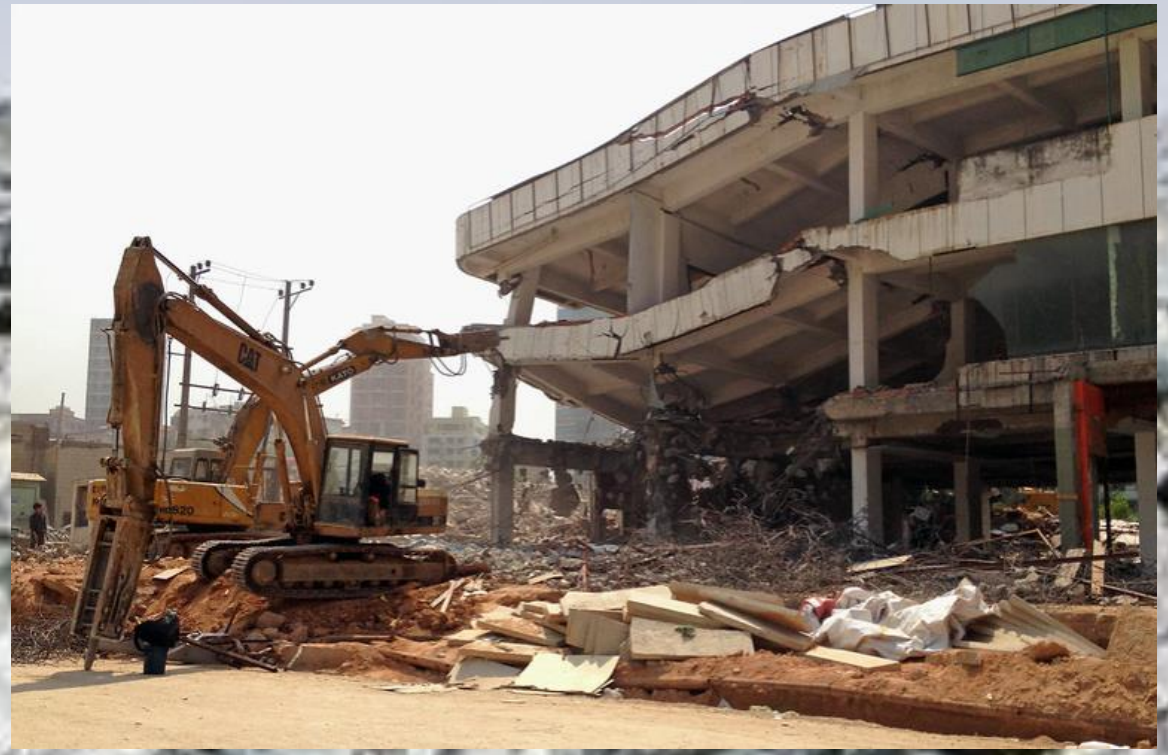
(t CO_2/t Crude Steel)



Source: worldsteel step up programme data, CO_2, Energy, Reliability and Process yield assessment systems for 2017 / 2018 data.

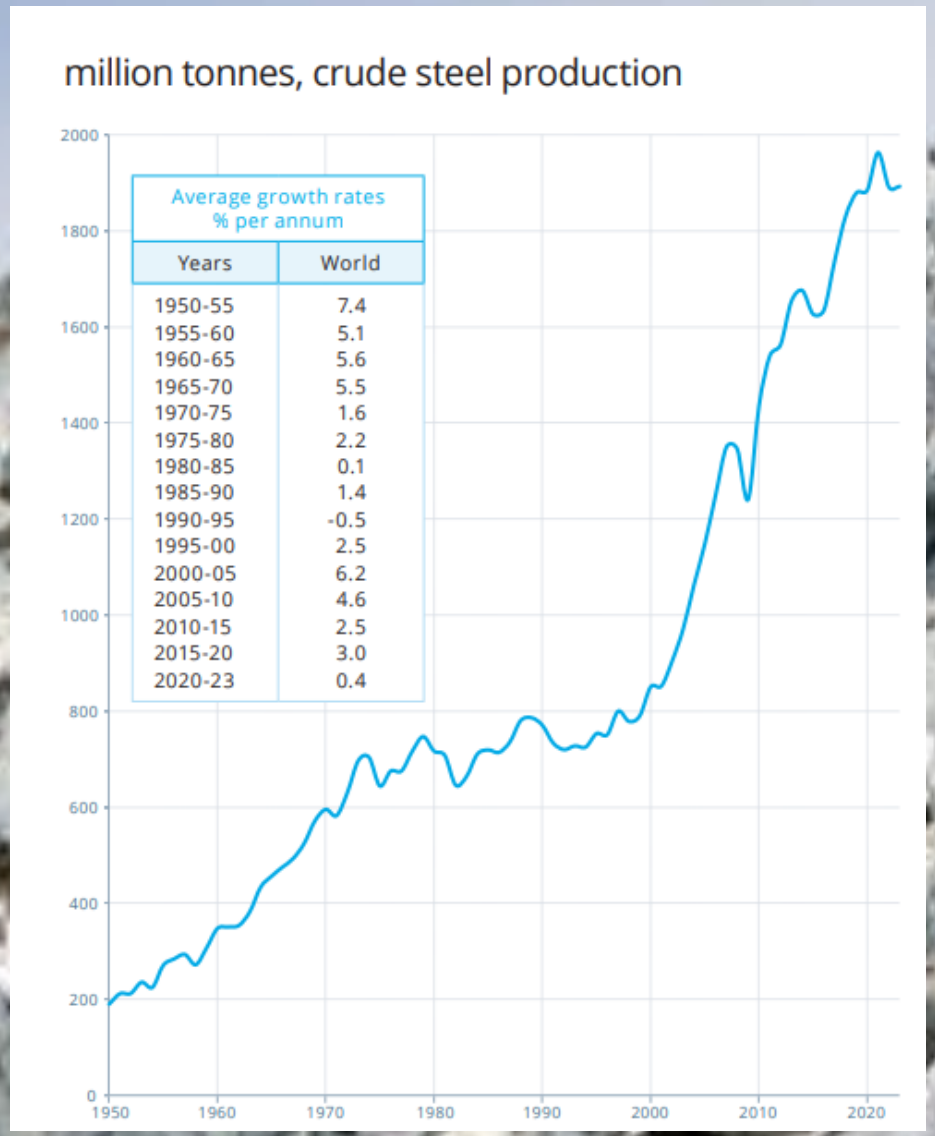
2. Increased Scrap Usage

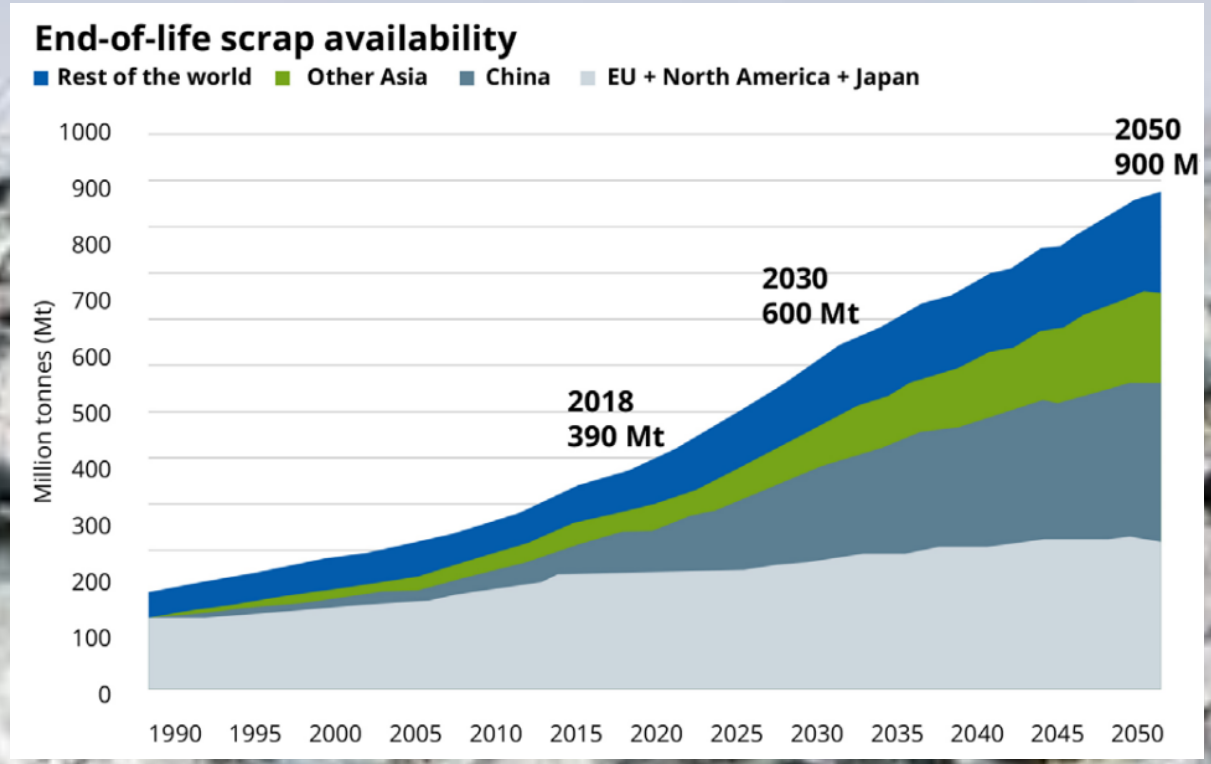


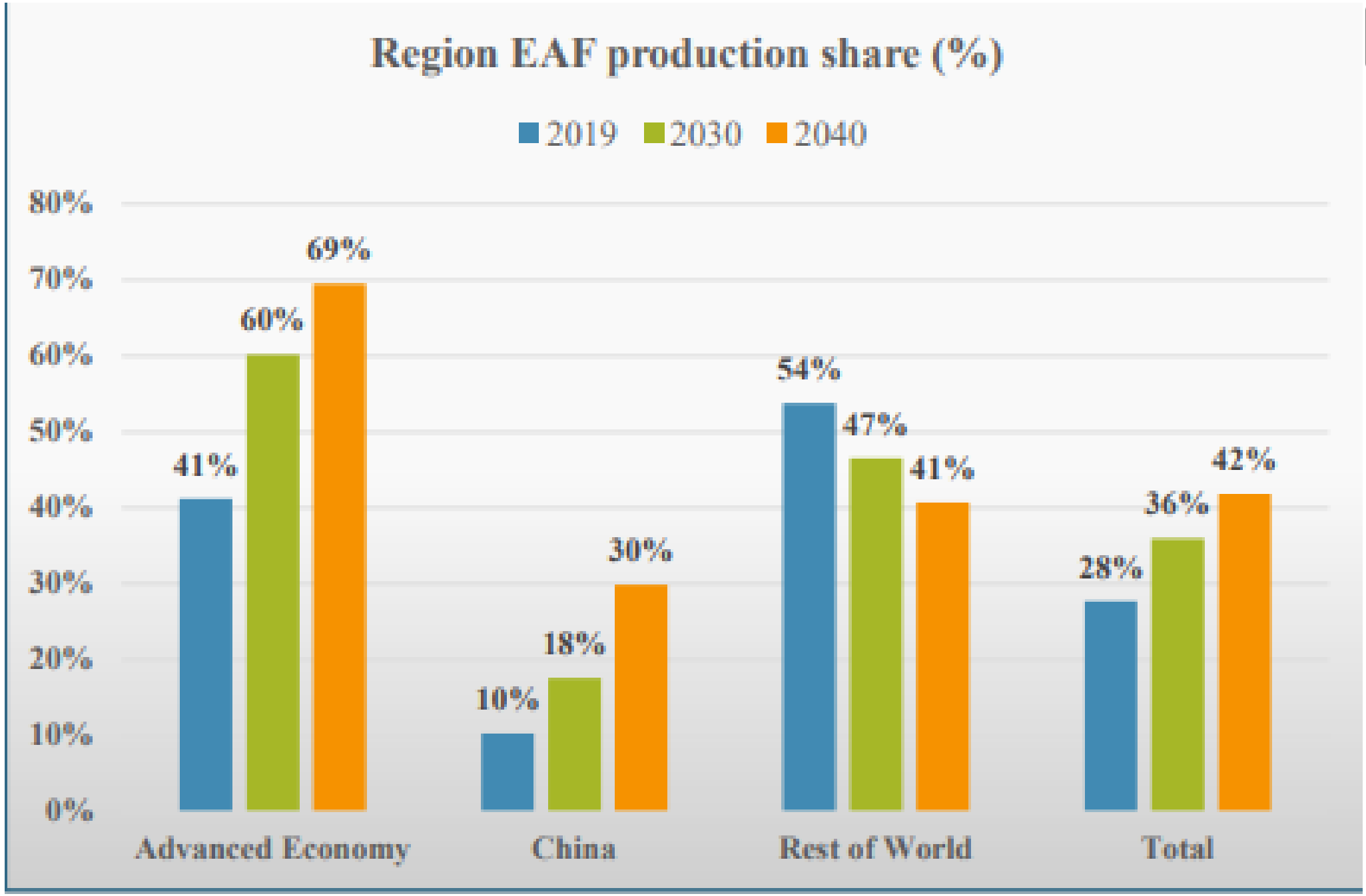


Average lifespan of a steel product is around 40 years

2. Increased Scrap Usage






Region EAF production share (%)
2019
2030
2040
80%
70%
60%
50%
40%
30%
20%
10%
0%
41%
60%
69%
10%
18%
30%
54%
47%
41%
28%
36%
42%
Advanced Economy
China
Rest of World
Total

3. Breakthrough Technology

Radical change to our industry....

... and the way we reduce iron.

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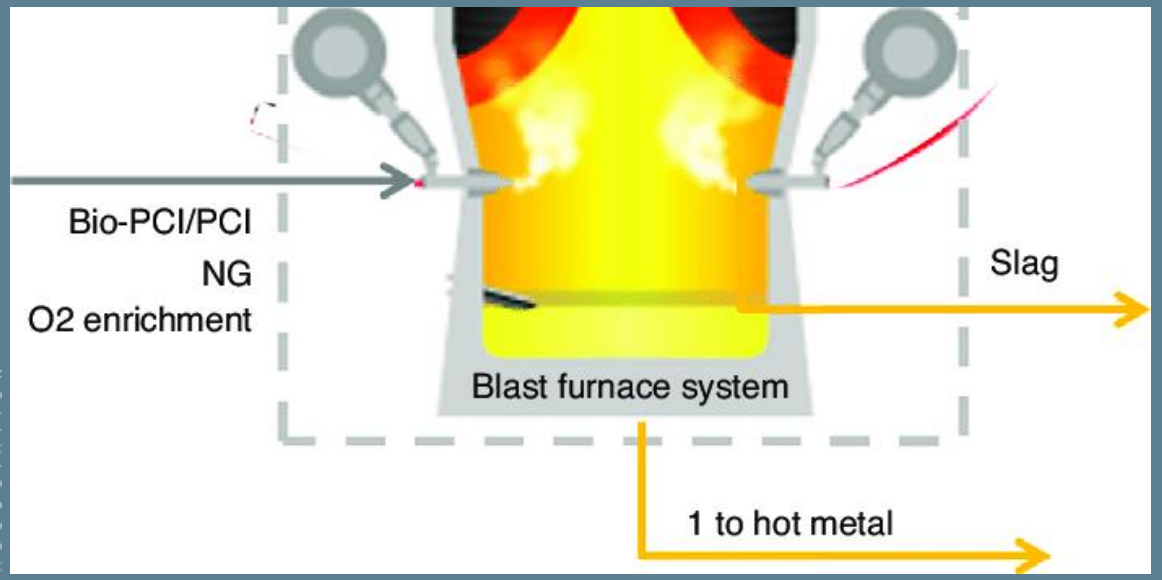
3. Breakthrough Technology

Hybrid Technology

Hydrometallurgy

CCS

Electrolysis+



Hybrid Technology

- A number of steelmakers and OEMs are looking at transitional solutions using H2 and biomass in traditional blast furnaces.
- Reductions of 33% from the blast furnace have been verified using heated hydrogen injection.
- Substituting PCI with biochar can lead to significant emission reductions.

HBIS

In 2023 the world's first 1.2 million tonne Hydrogen steelmaking pilot plant successfully delivered its first green DRI products.

Hebei Iron & Steel Group – HBIS, is the first worldwide steelmaker producing DRI using more than 60% Hydrogen in the feed gas mix, on industrial basis.

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حديد الإمارات أركان
emirates steel arkan

Emirate Steel/ADNOCs CCS plant has been operating since 2016.

The project captures, compresses and dehydrates up to 90% of CO2 from a Steel production facility and transports and injects CO2 through a 43 km buried pipeline for onshore EOR.

Capture capacity is 0.8MtCO2/yr

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包钢集团
BAOGANG GROUP

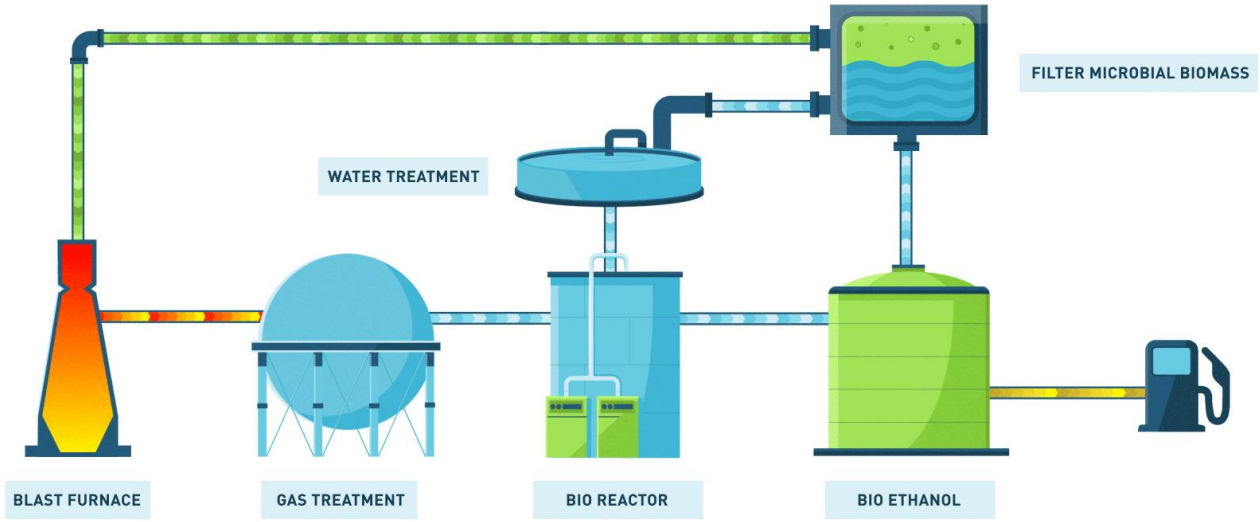
Baotou CCS project in China

Baotou Steel's 2 million-ton CCUS project Baotou Steel is pioneering China's first full-chain CCUS project, and the worlds first BF CCS project.

The captured CO2 will be used in two ways: reacting with steel slag for carbon sequestration, and transporting the remaining CO2 via pipeline to an adjacent oilfield for enhanced oil recovery.

Phase I, includes building a 500,000-ton carbon capture and purification facility fed by the stoves and lime kiln is expected to come on stream in 2024.

ArcelorMittal



The first of its kind in Europe, the Steelanol plant converts blast furnace gas (BFG) into ethanol using a biocatalyst. It captures carbon from steel mill gases, turning it into ethanol, reducing CO2 emissions by 85% per ton of ethanol.

The project's impact is 125,000 tons of CO2 reduction per year

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AVB
AÇO VERDE DO BRASIL

Zero Carbon Steel from Sustainable Biomass

Aco Verde do Brasil (Brazilian Green Steel) operate a 800Mt BF based steel plant, fed by sustainably grown wood charcoal.

Carbon inventories for 2019 amounted to 0.06 tonne of carbon dioxide per tonne of steel produced.

Other steel companies working to or already biomass in their operations include Arcelor Mittal and Ternium.

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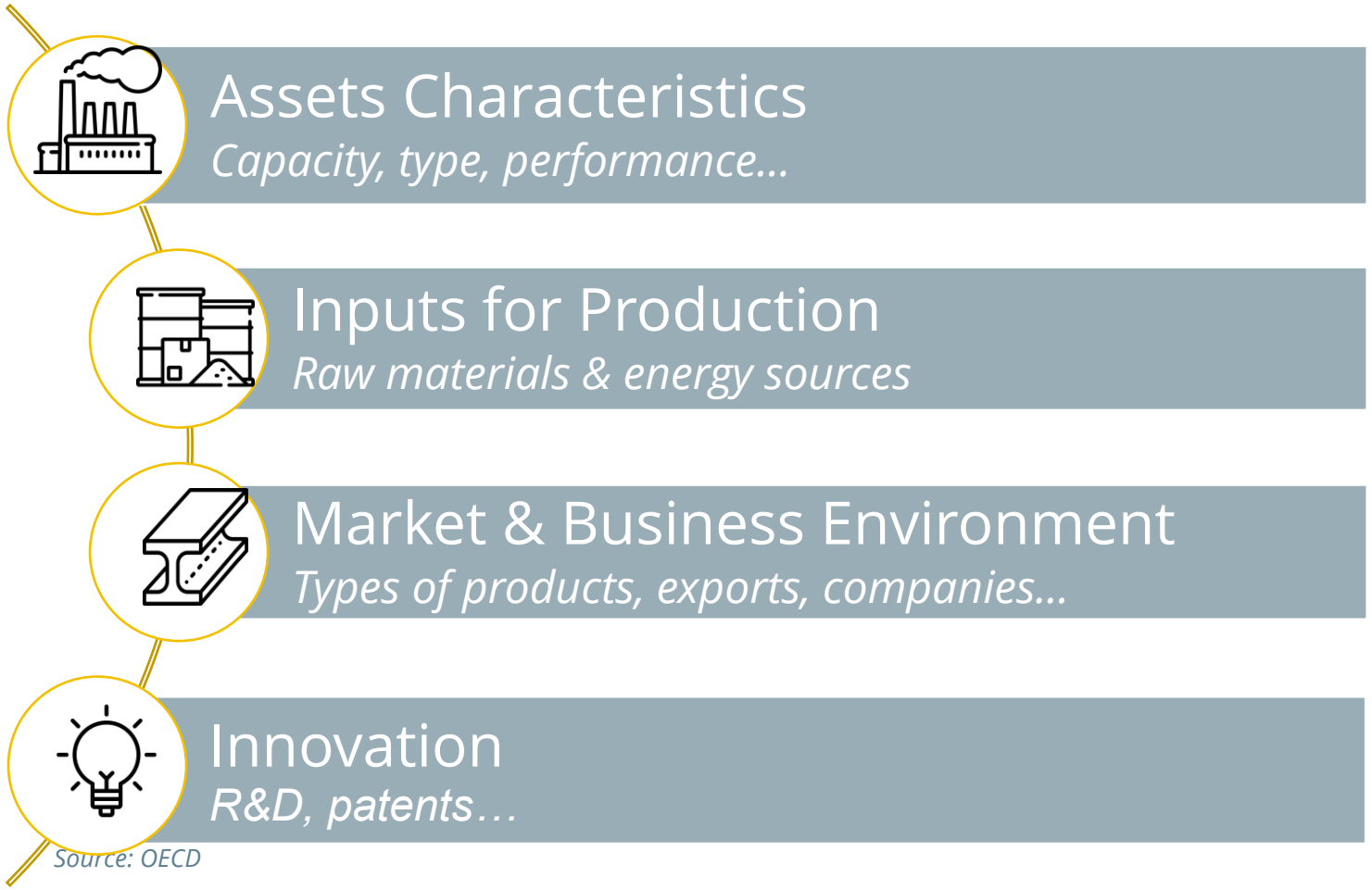
Current Project Status

Project Type	Europe		China		Americas	
	Projects	Production (MT)	Projects	Production (MT)	Projects	Production (MT)
Hydrogen-based	11	20.1	5	7.6	2	2.8
Electrolysis	3	9.4	0	0.0	0	0.0
CCUS-based	2	2.5	2	3.0	1	2.6
Other	1	0.1	1	0.6	1	0.3
Total	17		8		4	

Project Type	Africa		Australia		Middle East	
	Projects	Production (MT)	Projects	Production (MT)	Projects	Production (MT)
Hydrogen-based	1	0.0	2	0.0	1	5.0
Electrolysis	1	5.0	1	0.0	0	0.0
CCUS-based	0	0.0	0	0.0	0	0.0
Other	0	0.0	1	0.1	0	0.0
Total	2		4		1	

Green Steel Tracker LeadIt

Realities: There is not one decarbonisation pathway



Source: OECD

- Different starting points
- Different circumstances

→ Collaboration needs to bring benefits to all parties

… and government policy and regulation!

Source: OECD

Challenges to the transition

Regulatory and Policy Challenges

Technological and Economic Challenges

Social, Organisational, and Environmental Considerations

Conclusion

- Over the coming decades the manufacture of iron and steel will be transformed.
- Efficiency, optimal scrap usage and ultimately breakthrough technology will be required
- Hybrid technologies may easy the transition.
- First movers are achieving demonstration at industrial scale.
- A successful transition requires collaboration across technology, economics, policy, and social dimensions.

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