Upheaval in Slow Motion

Steel industry's radical gradual transformation

GLOBAL STEEL DYNAMICS FORUM

26–28 June 2023

New York Marriott Marquis / New York, N.Y., USA

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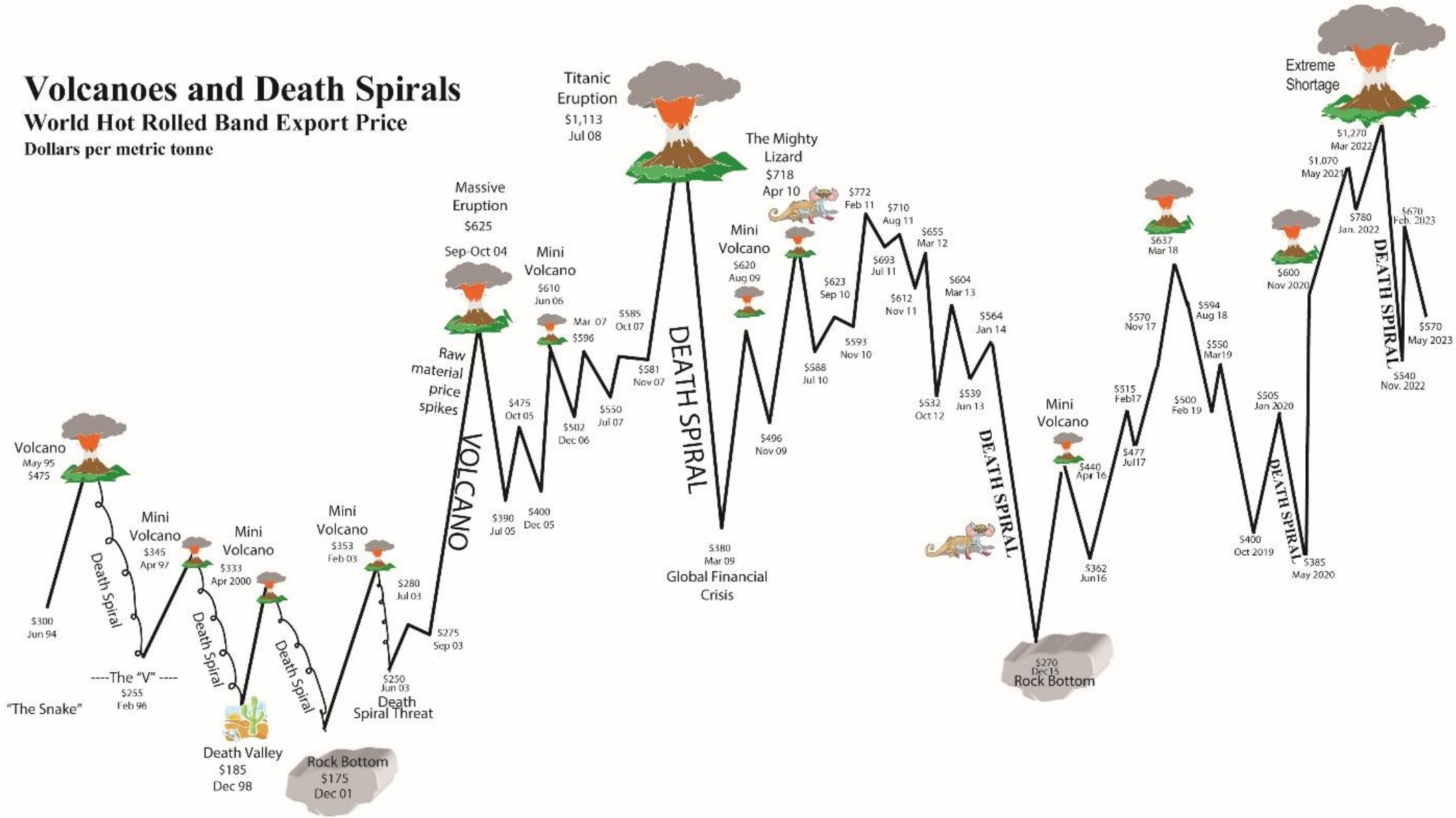
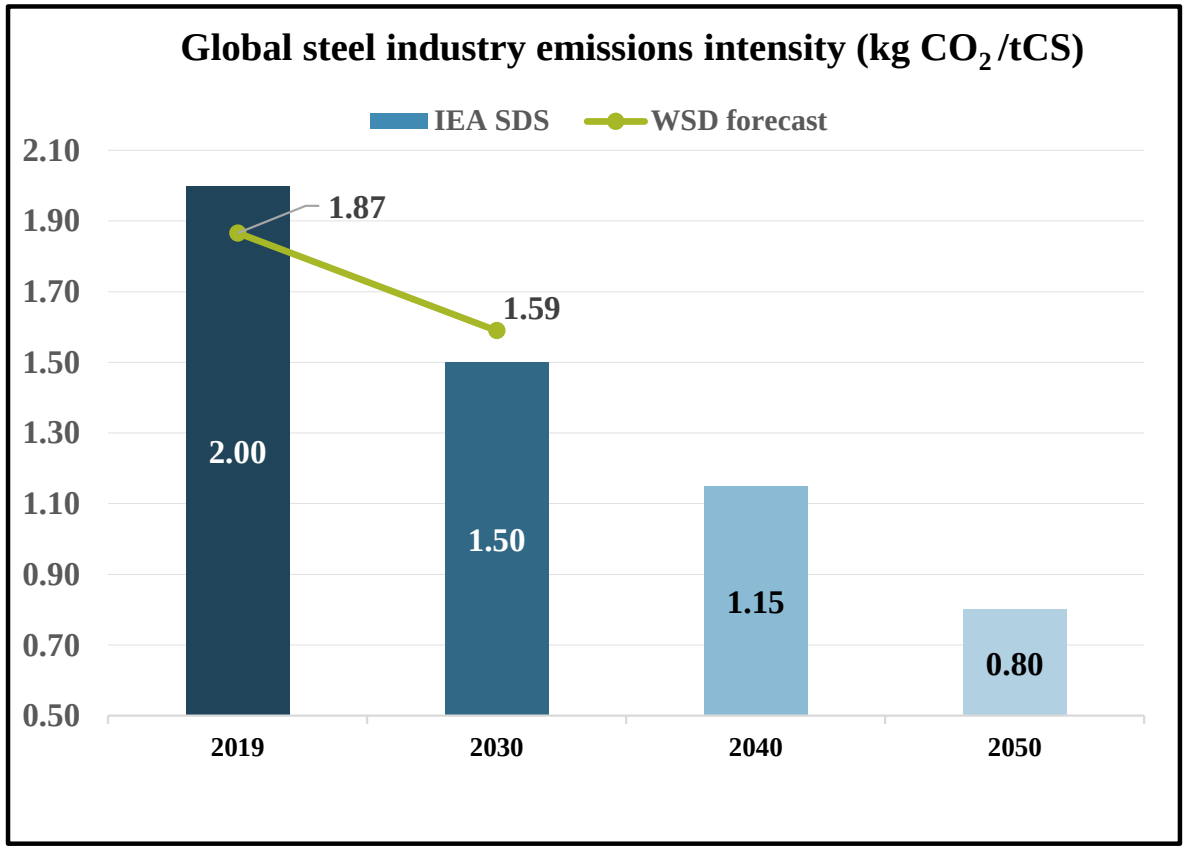
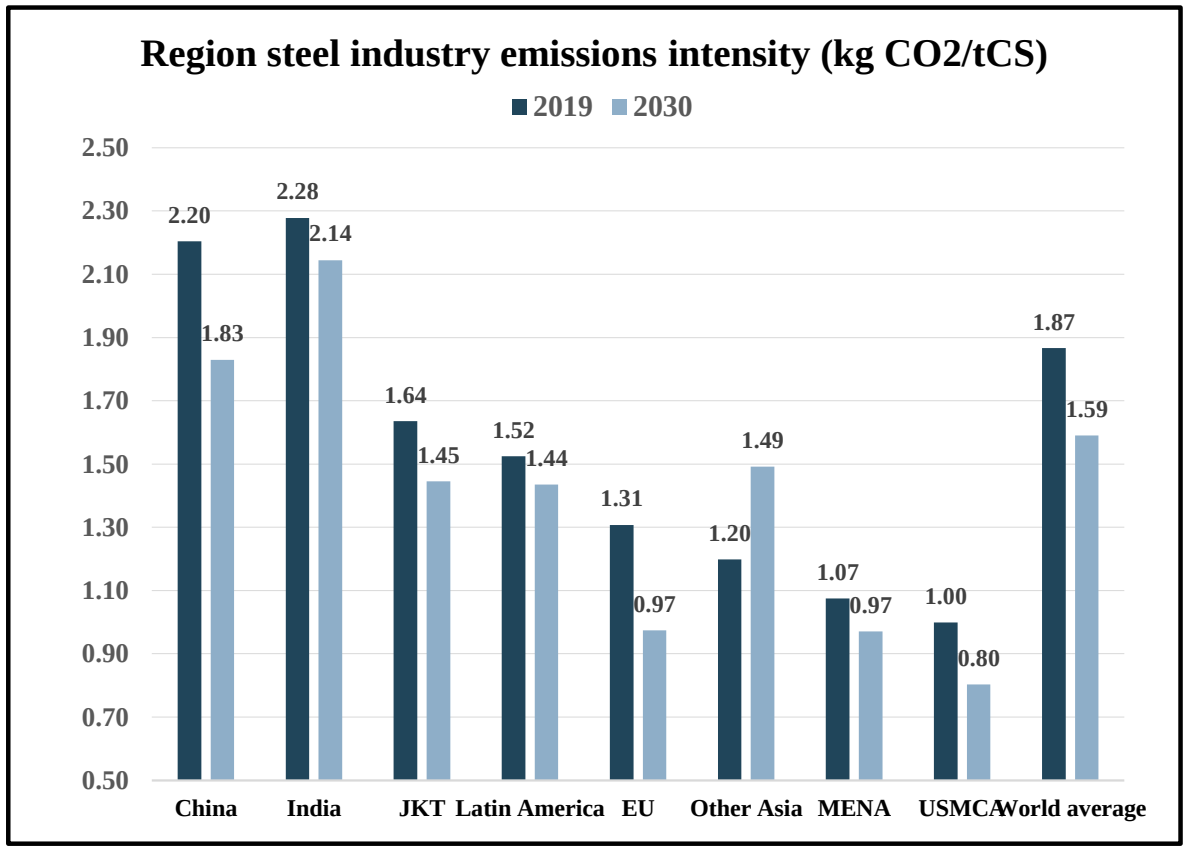
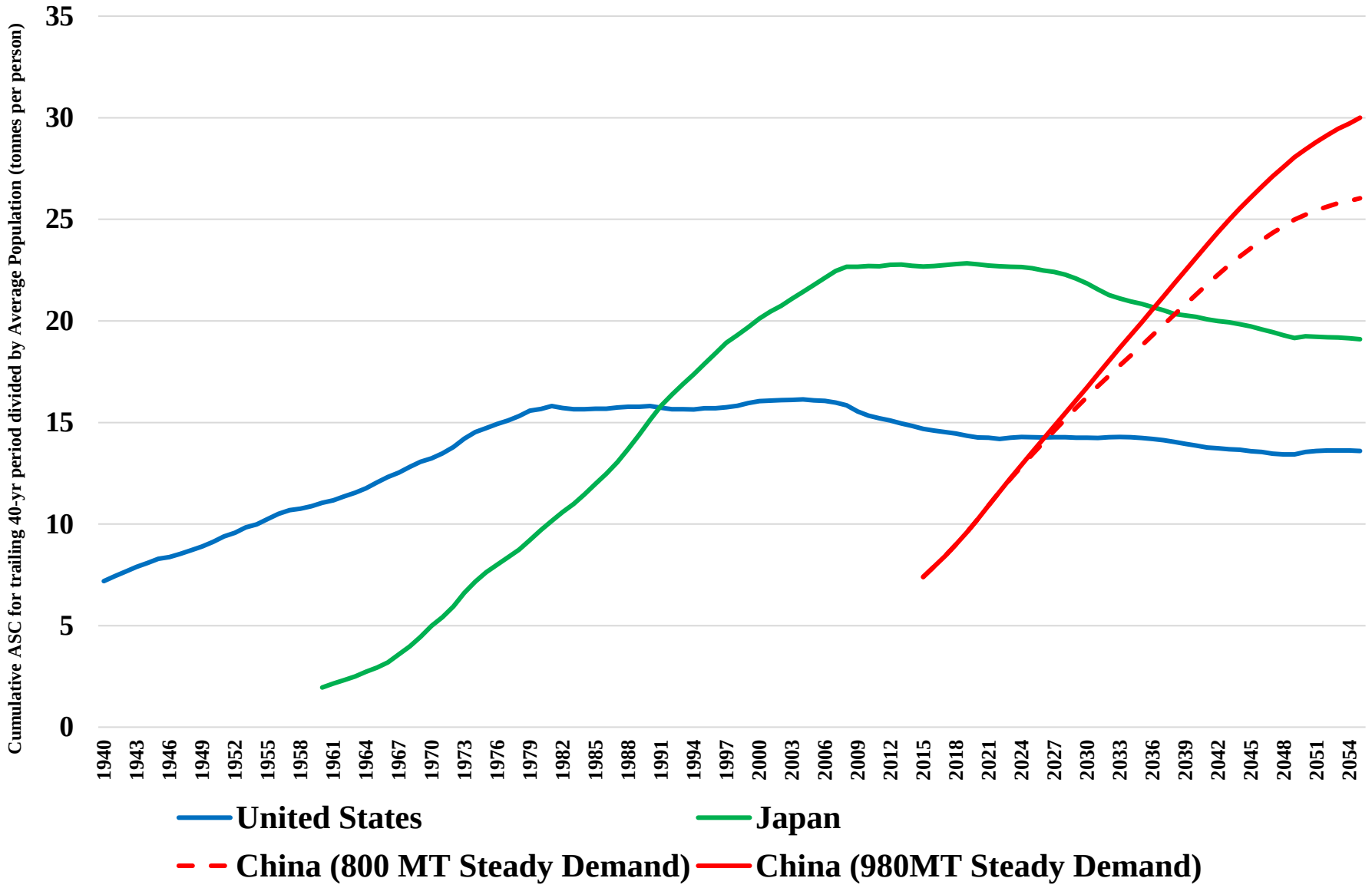



Global steel industry emissions intensity (kg CO_2/tCS)
IEA SDS
WSD forecast
2.10
1.90
1.70
1.50
1.30
1.10
0.90
0.70
0.50
1.87
1.59
2.00
1.50
1.15
0.80
2019
2030
2040
2050


Region steel industry emissions intensity (kg CO2/tCS)
2019
2030
2.50
2.30
2.10
1.90
1.70
1.50
1.30
1.10
0.90
0.70
0.50
2.20
1.83
2.28
2.14
1.64
1.45
1.52
1.44
1.31
0.97
1.20
1.49
1.07
0.97
1.00
0.80
1.87
1.59
China
India
JKT
Latin America
EU
Other Asia
MENA
USMCA
World average

What is "Peak Steel?"

(40 Year Cumulative Steel Consumption to 40 Year Average Population)



WSD WORLD STEEL DYNAMICS

China's Crude Steel Production & Apparent Consumption

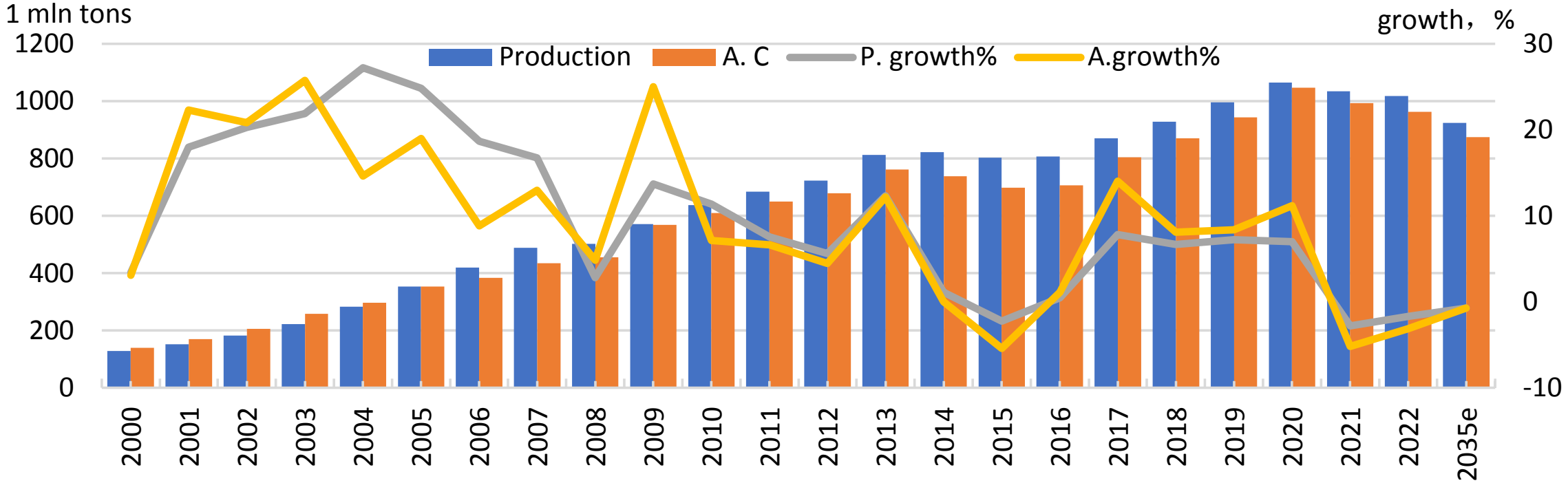


Table. China's Crude Steel Production, Apparent Consumption for 2000-2022, and 2035 Forecast (MT)

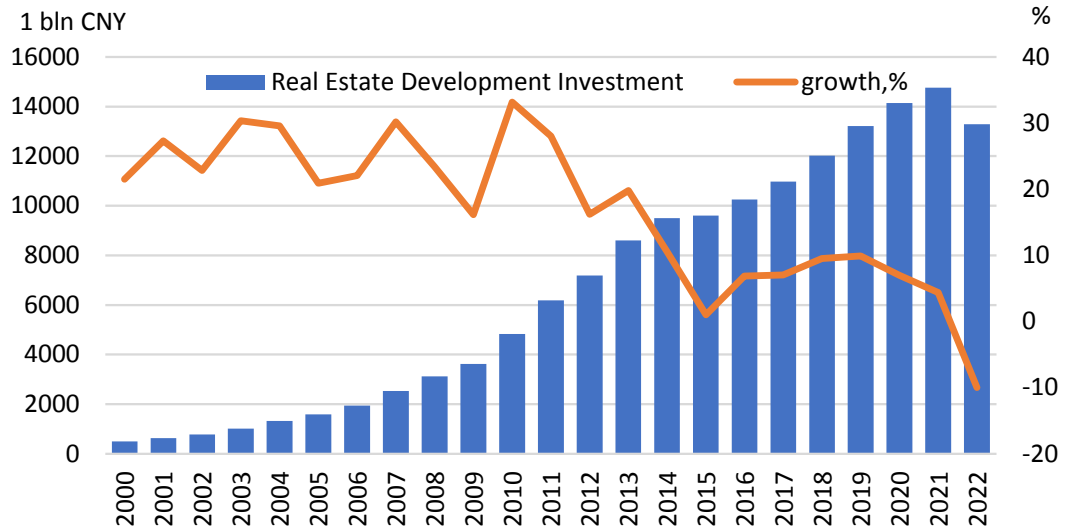
Year	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2035e
Production	129	353	637	685	724	813	822	804	808	871	929	996	1065	1035	1018	900-950
Apparent Consumption	139	353	610	650	680	762	738	698	706	805	870	943	1048	993	963	850-900
P. Growth, %	3.4	24.9	11.4	7.5	5.6	12.3	1.1	-2.3	0.5	7.8	6.7	7.2	7.0	-2.8	-1.7	-0.7*
A. Growth, %	3.1	19.0	7.2	6.6	4.5	12.2	0.0	-5.4	1.1	14.0	8.1	8.4	11.2	-5.2	-3.1	-0.7*

It is estimated that China's apparent steel consumption will decrease to the range of 850-900 million tons, and production will decline to 900-950 million tons by 2035.

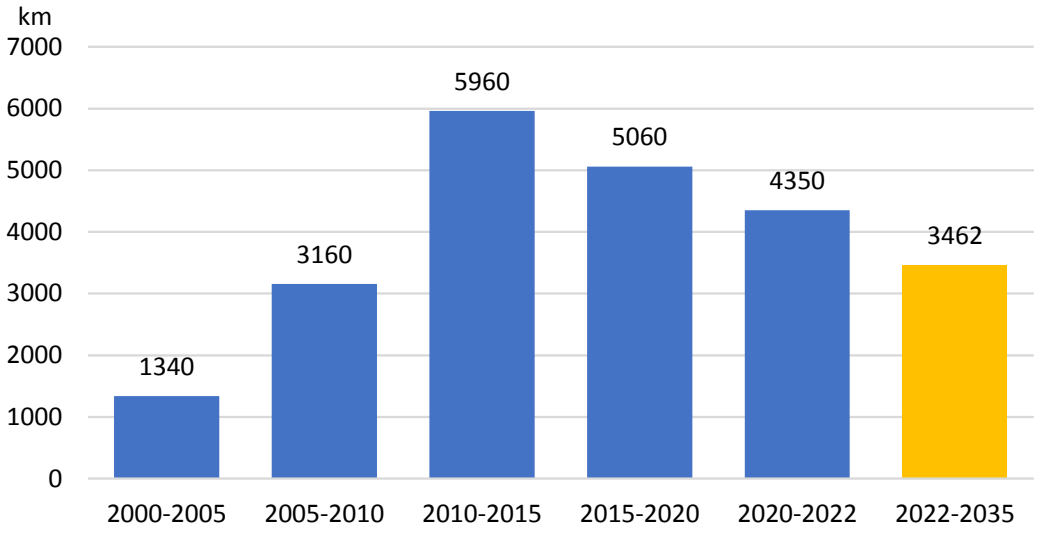
Note: The figures marked with * represent the average growth rate from 2022 to 2035.

Source: SteelHome Database

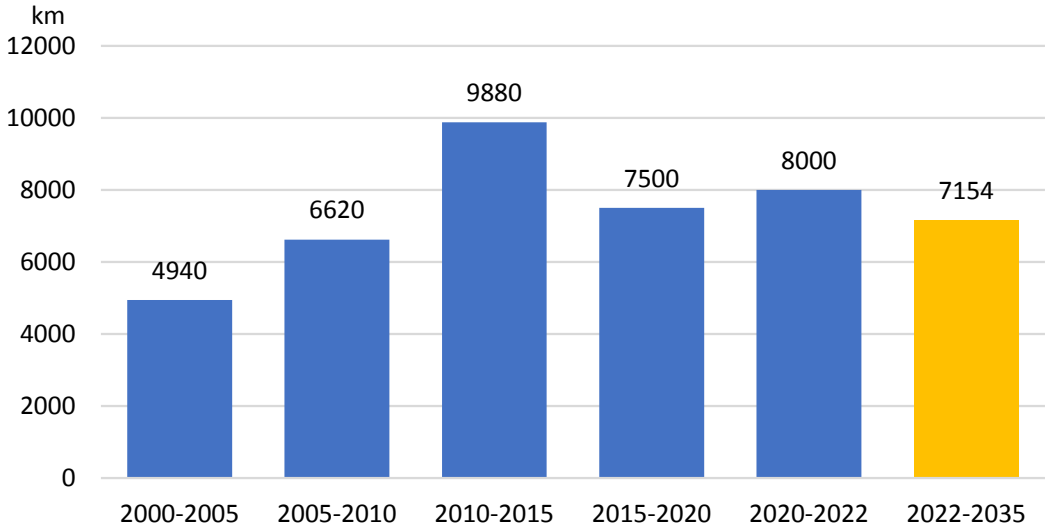
China s'Real Estate Development Investment



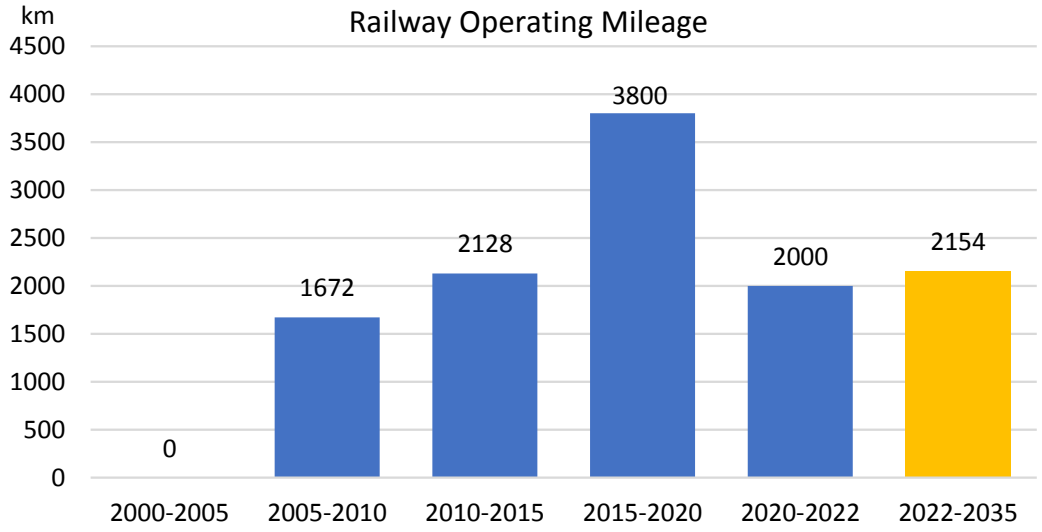
Annual Average Increase in Railway Operating Mileage



Annual Average Increase in Expressway Mileage



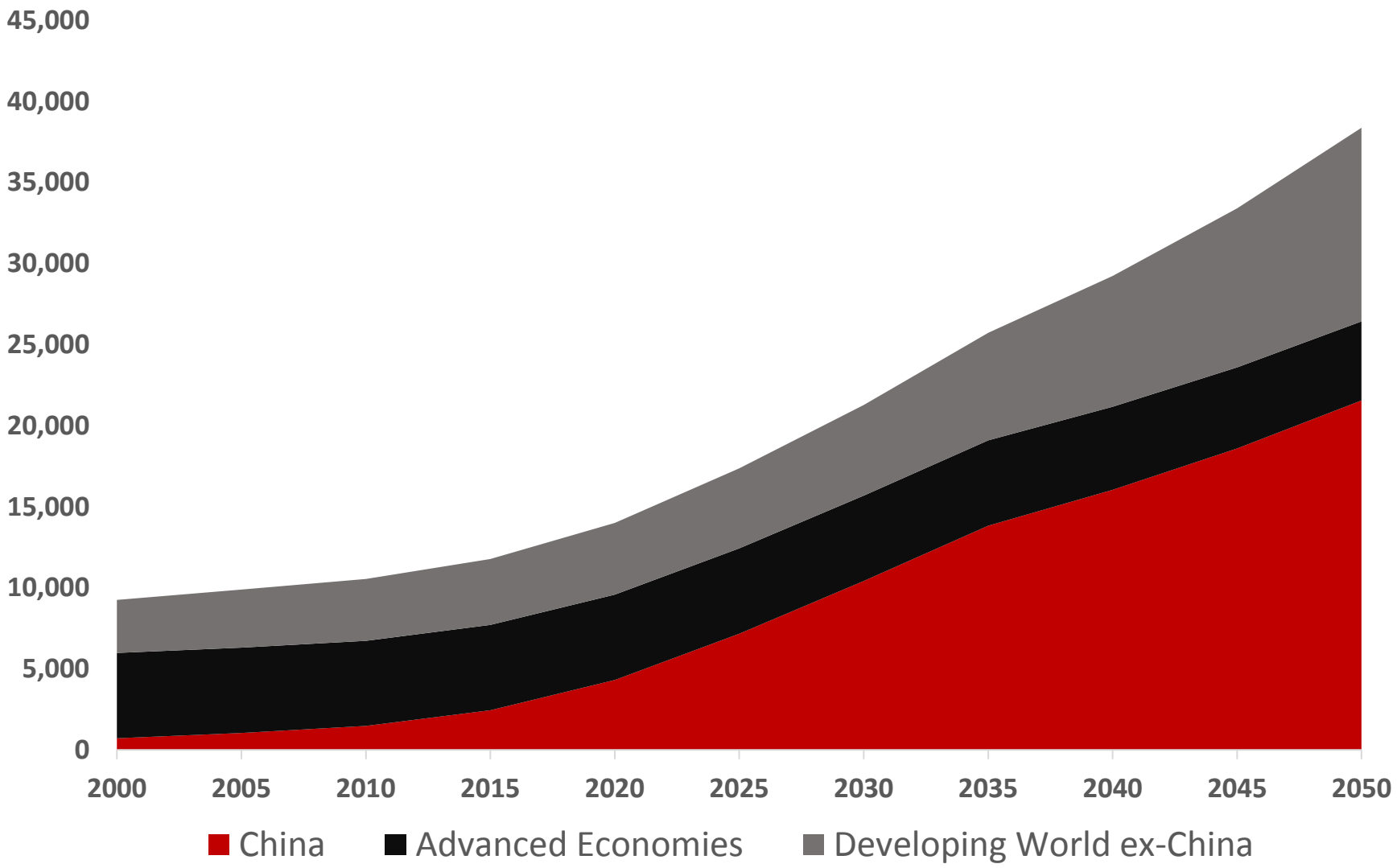
Annual Average Increase in High-Speed Railway Operating Mileage



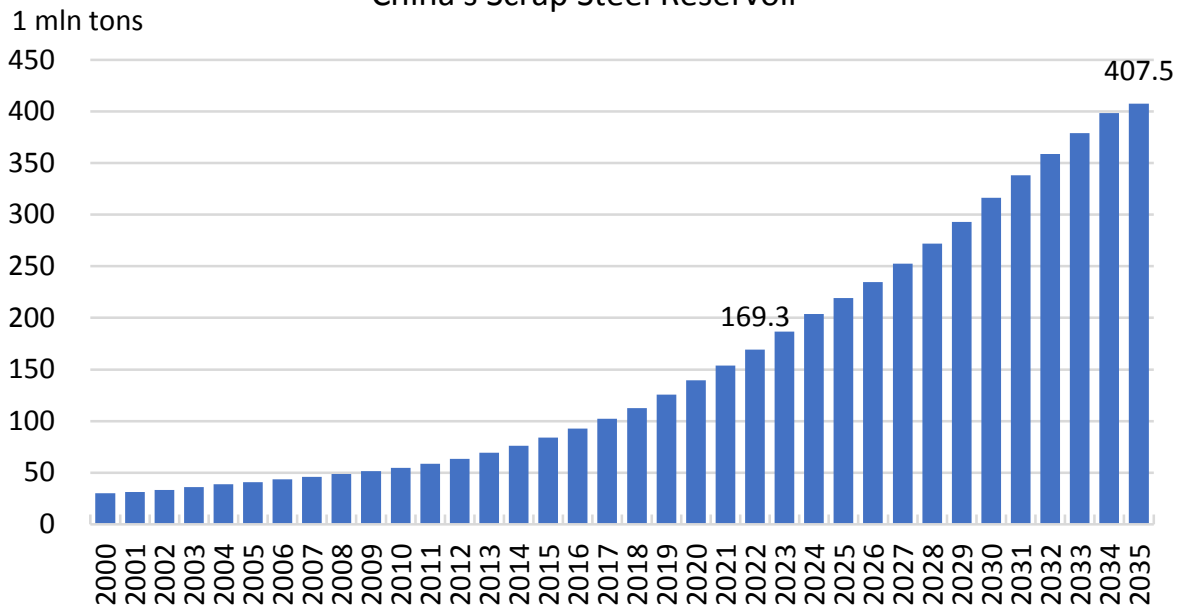
Source: SteelHome Database

Regional Aggregate Obsolete Scrap Reservoir

million metric tonnes



China's Scrap Steel Reservoir



China EAF Crude Steel Production

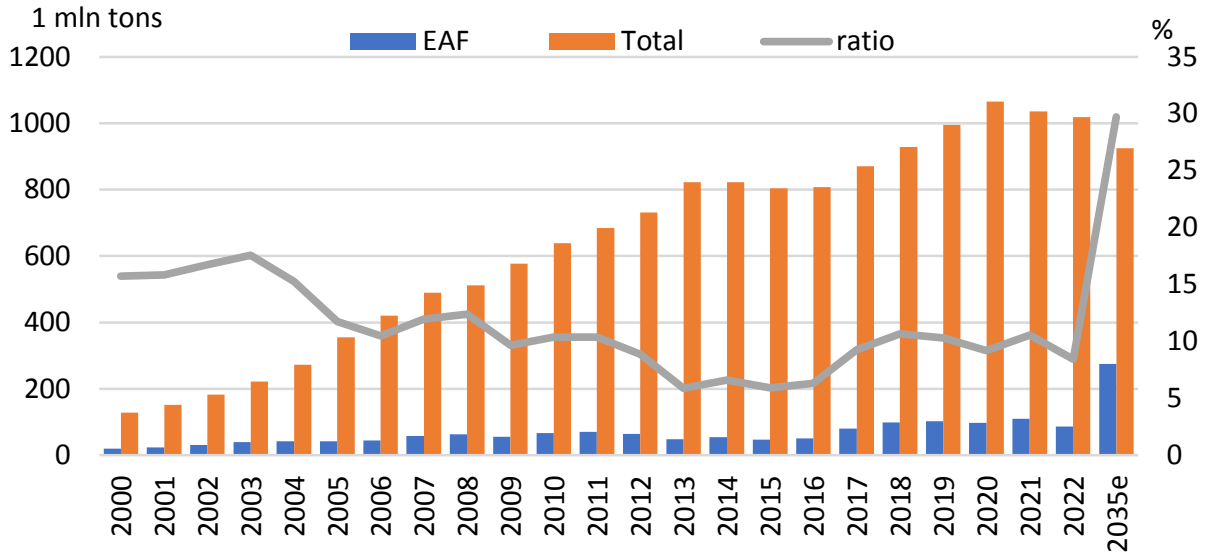


Table. China Scrap Steel Reservoir, EAF Crude Steel Output and Ratio (MT)

Year	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2035e
Total Crude Steel Output	128.5	355.8	638.7	683.9	731.0	822.0	822.3	803.8	807.6	870.7	929.0	995.4	1064.7	1035.2	1018.0	925
EAF	20.2	41.8	66.3	70.9	64.8	48.4	54.3	47.5	50.9	80.7	99.0	102.5	98.0	109.3	86.0	275
EAF Ratio, %	15.7	11.7	10.4	10.4	8.9	5.9	6.6	5.9	6.3	9.3	10.7	10.3	9.2	10.6	8.4	30.0
Depreciation Scrap Steel Reservoir	30.0	102.4	169.3	186.8	203.6	219.1	234.6	252.4	271.9	292.9	316.4	338.1	358.9	379.2	398.5	407.5

Source: SteelHome Database

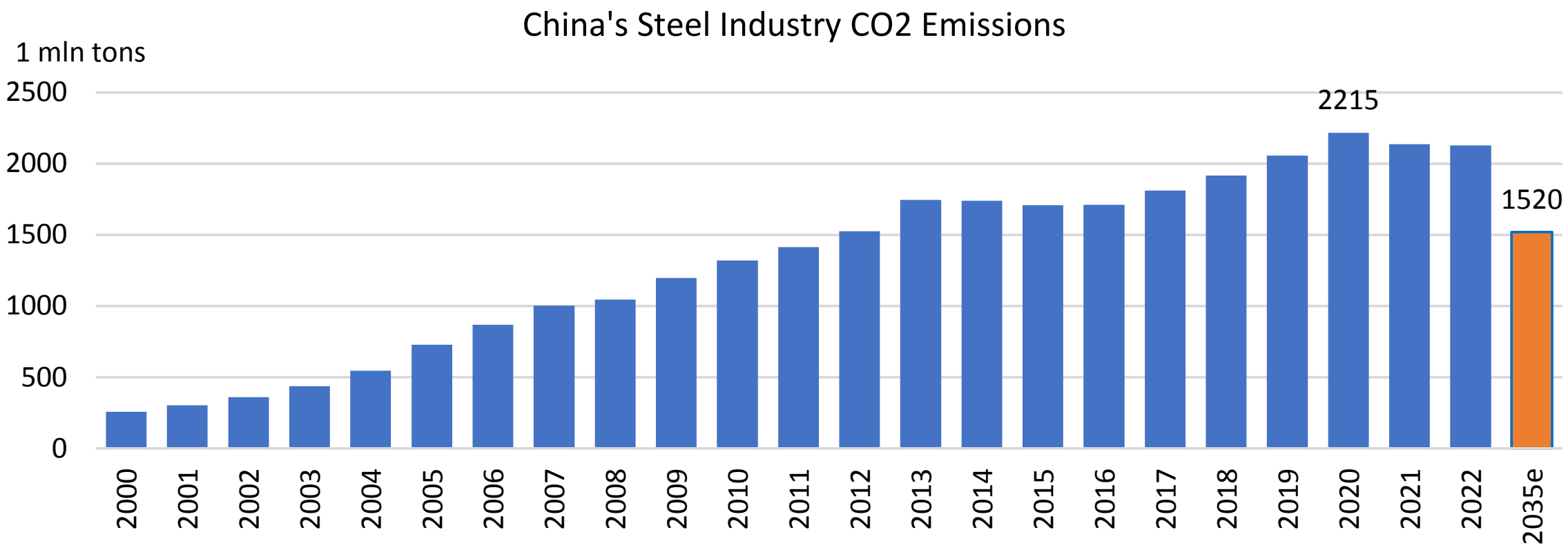


Table. Chinese Steel Industry CO2 Emissions (MT)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2035e
CO2 Emissions	256	302	361	438	546	728	869	1001	1045	1197	1319	1412	1524	1745	1738	1707	1711	1811	1915	2057	2215	2135	2128	1520

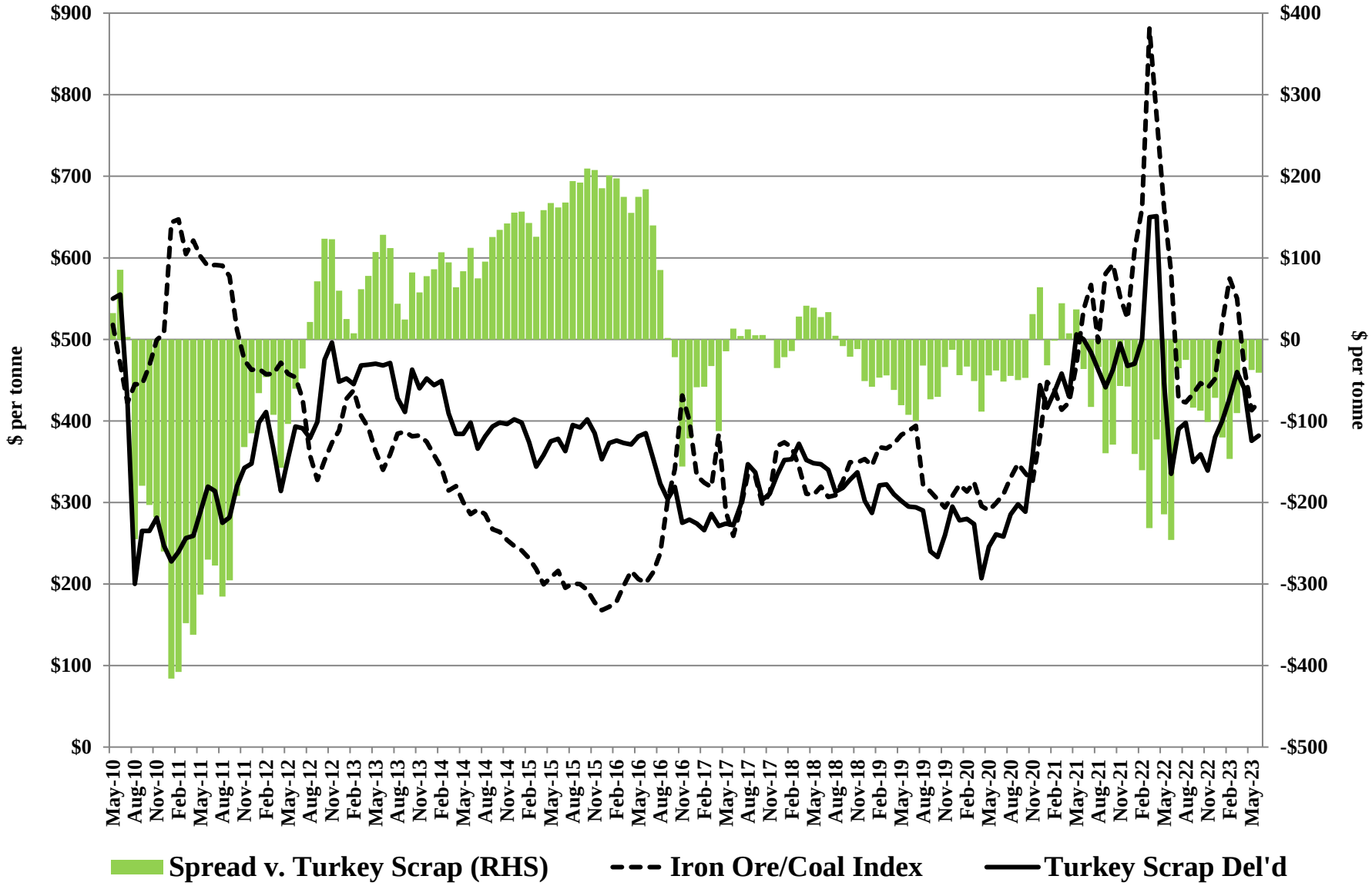
Source: SteelHome Database

Chinese Metallics Demand Scenarios

	Scenario 1			Scenario 2			Scenario 3		
	2022	2030f	Δ 2030 v. 2021	2022	2030f	Δ 2030 v. 2021	2022	2030f	Δ 2030 v. 2021
Production									
Crude Steel	1,031	900	-131	1,031	1,000	-31	1,031	950	-81
BOF	906	653	-254	906	762	-144	906	707	-199
EAF	125	248	123	125	238	113	125	243	118
Metallics Supply/Demand									
Hot Metal	841	618	-223	841	711	-130	841	665	-176
DRI/HBI	1	17	16	1	16	15	1	16	15
Total Scrap Demand	389	462	73	389	484	95	389	473	84
Obsolete Scrap Demand	158	260	**103**	158	260	**102**	158	260	**102**
Obsolete Scrap Supply	157	321	164	157	321	164	157	321	164
Iron Ore Requirement	1,340	1,009	-331	1,340	1,156	-183	1,340	1,083	-257
Iron Ore Supply/Demand									
Iron Ore Domestic	210	200	-10	210	210		210	205	
Iron Ore Imports	1,130	809	***-321***	1,130	947	***-183***	1,130	878	***-252***

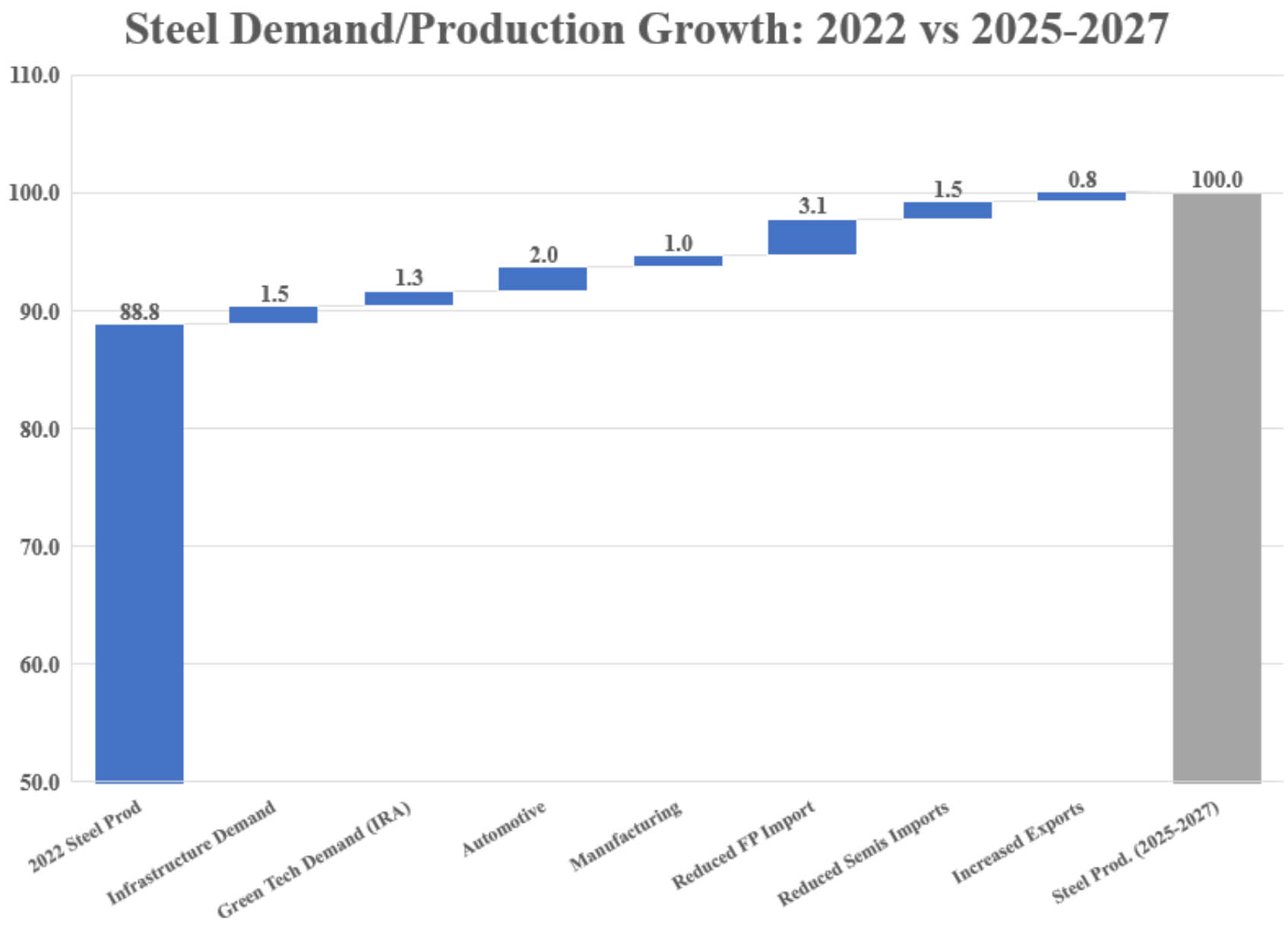
Source: WSD Estimates, WSA, NBS, TexReport

Turkey scrap HM 80/20 versus Weighted Iron Ore/Coking Coal Price Index



Source: WSD Estimates, Platts, Steelbenchmarker

Not so “Full of Sheet!”



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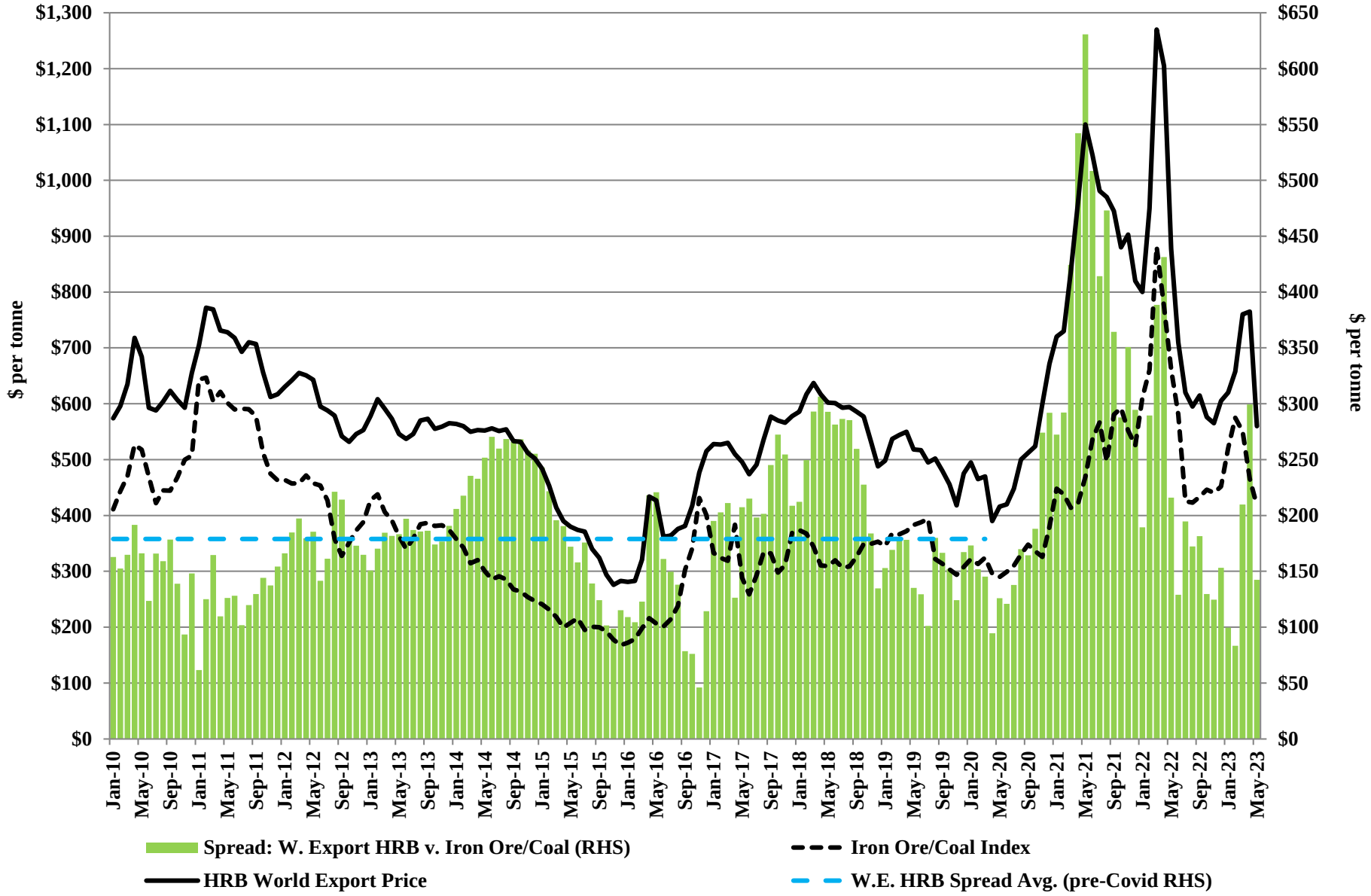
HRB World Export Price versus Iron Ore/Coal Index and Spread



Source: WSD Estimates, Steelbenchmarker, SBB

WSD WORLD STEEL DYNAMICS

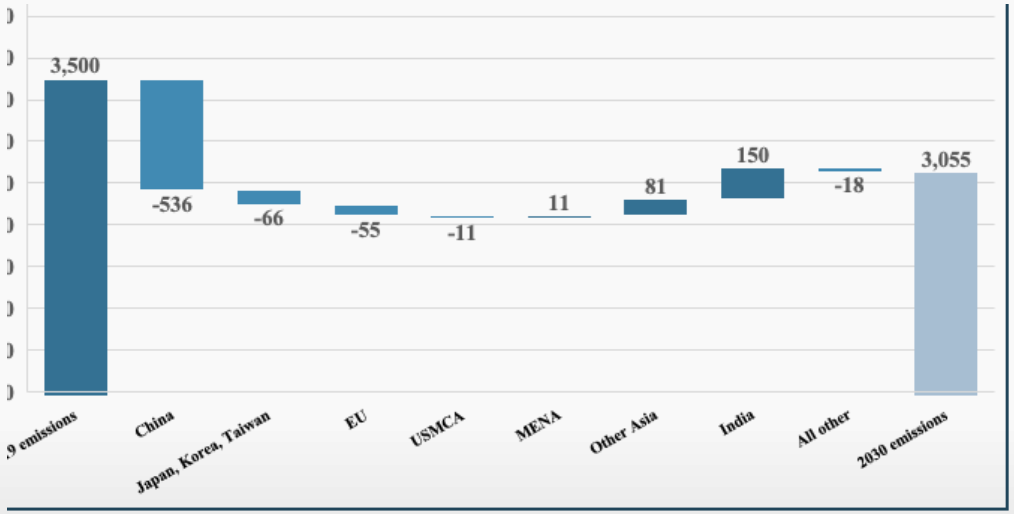
Global steel industry decarbonization

Report #1: the race to the 2030 starting line

WSD WORLD STEEL DYNAMICS

2030 global steel industry CO_2 emissions

WSD expects global steel industry CO_2 emissions to decrease 13% from ~3,500mt in 2019 to 3,055mt in the 2030 base case forecast, led by a massive reduction in China.[7]



Base case

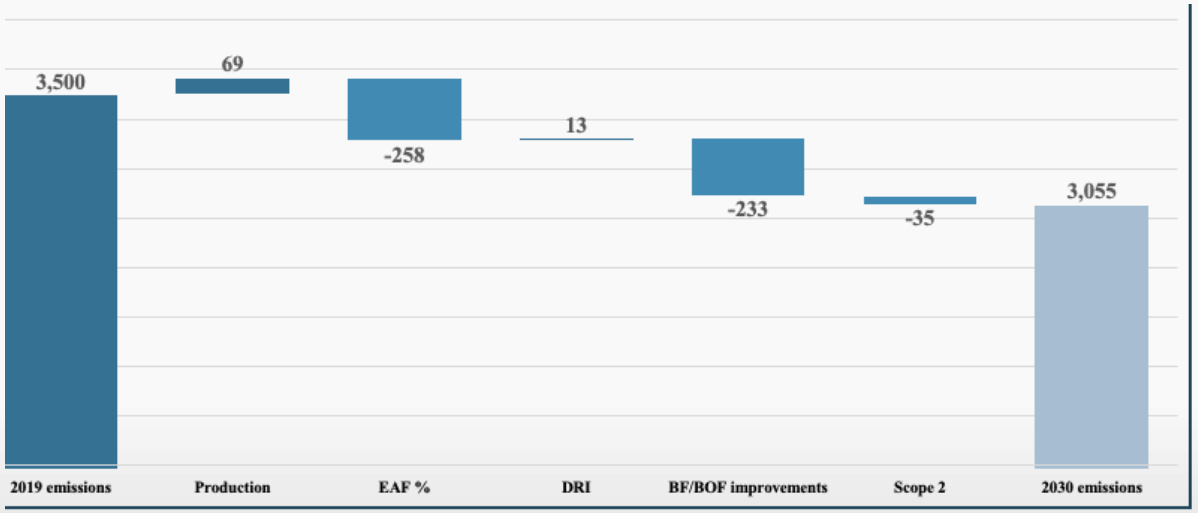
	Change	% change
China	-536mt	-24%
Developed countries	-138mt	-22%
Developing countries	+230mt	+34%
World	- 445mt	-13%

7. Data in all subsequent slides is for the base case unless otherwise indicated.

Source: WSD analysis

Decarbonization drivers: global

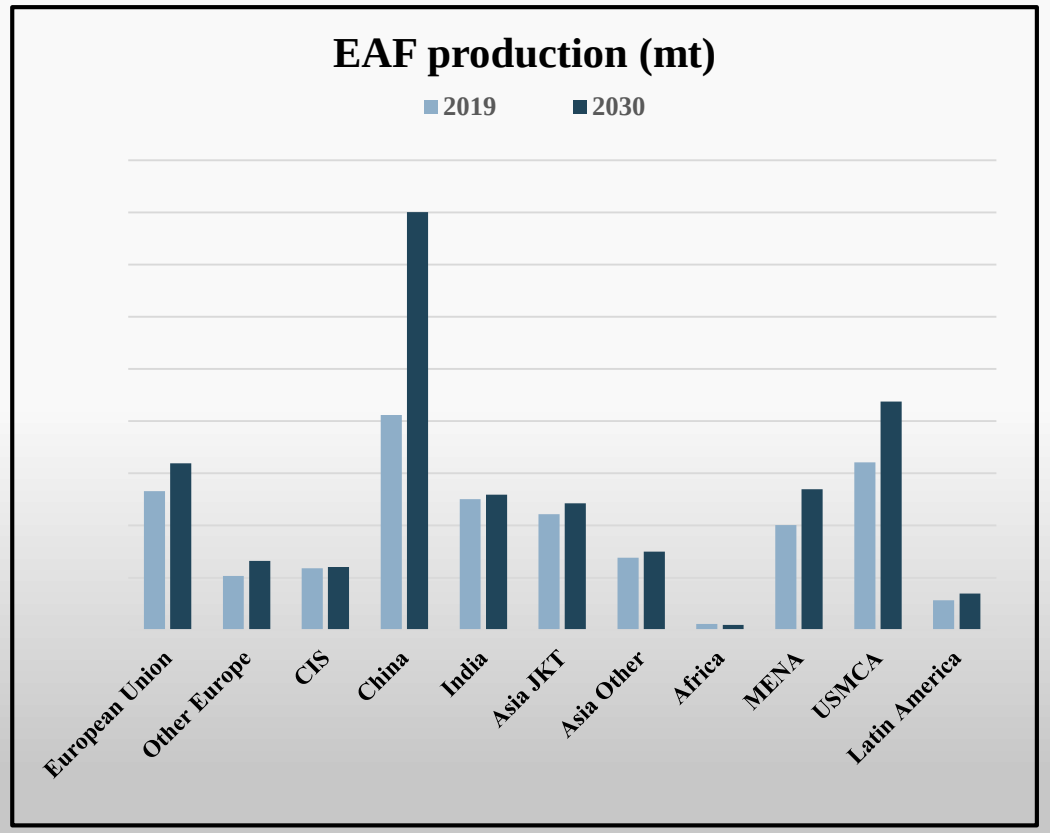
WSD has quantified five main categories of decarbonization drivers which generate the expected 445mt reduction in emissions between 2019 and 2030.

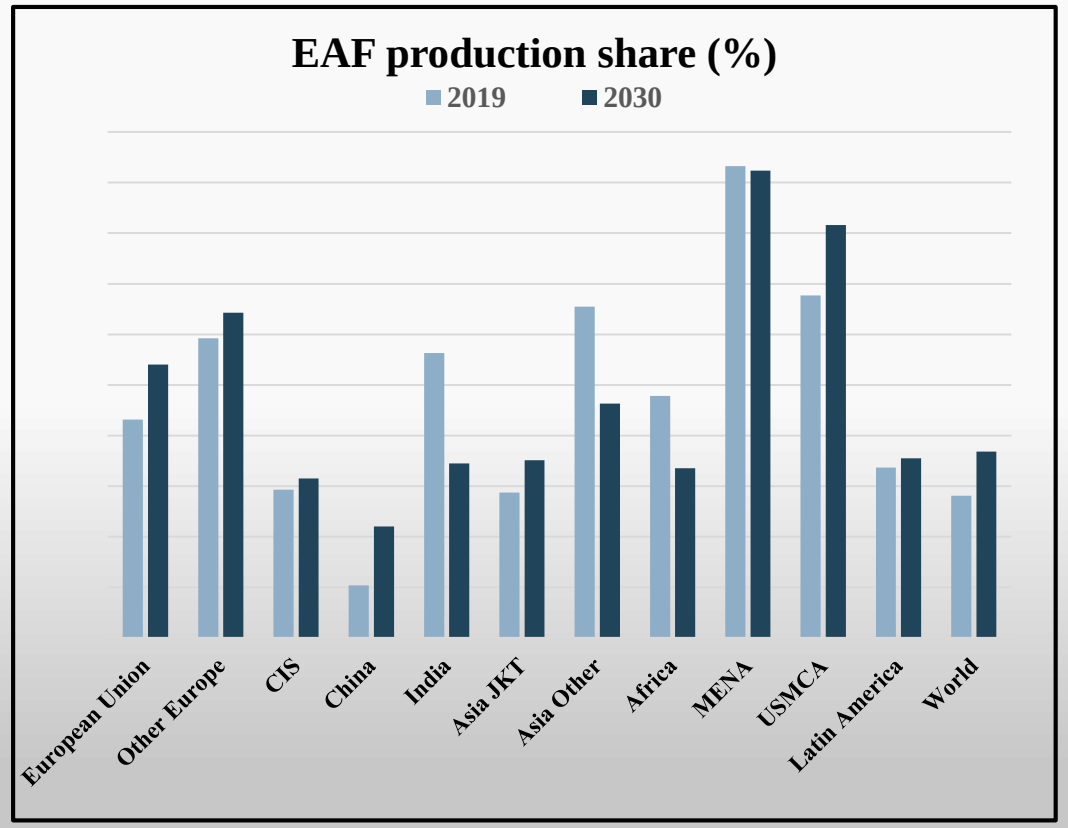


9. In WSD's base case, low emissions hydrogen for steelmaking accounts for <10% of global DRI reduction, 18%% in the EU,. (Section V).
10. WSD does not expect BF/BOF CCUS to make a measurable contribution to BF/BOF decarbonization this decade. (Section IV).
Source: WSD analysis

Decarbonatization drivers: EAF production

WSD expects global EAF production to grow from 530mt to 710mt and from 28% to 37% of total steel output; the EAF share in developed regions increases from 41% to 55% but decreases from 56% to 47% in developing regions.





Source: WSD analysis

Decarbonization drivers: summary BF/BOF operating metrics

The global average BF/BOF emissions intensity is expected to decline from 2.24 to 2.05 kg CO_2/tCS as steel producers in all regions reduce coke rates by deploying various improvement levers.[13]

Global	2019	2030
BF fuel rate (kg/tHM)	529	507
BF coke rate (kg/tHM)	410	358
BOF hot metal ratio (charge %)	86.3%	83.4%
BF/BOF emissions intensity (kg/tCS)	2.24	2.05

China	2019	2030
BF fuel rate (kg/tHM)		
BF coke rate (kg/tHM)		
BOF hot metal ratio (charge %)		
BF/BOF emissions intensity (kg/tCS)		

Developed regions	2019	2030
BF fuel rate (kg/tHM)		
BF coke rate (kg/tHM)		
BOF hot metal ratio (charge %)		
BF/BOF emissions intensity (kg/tCS)		

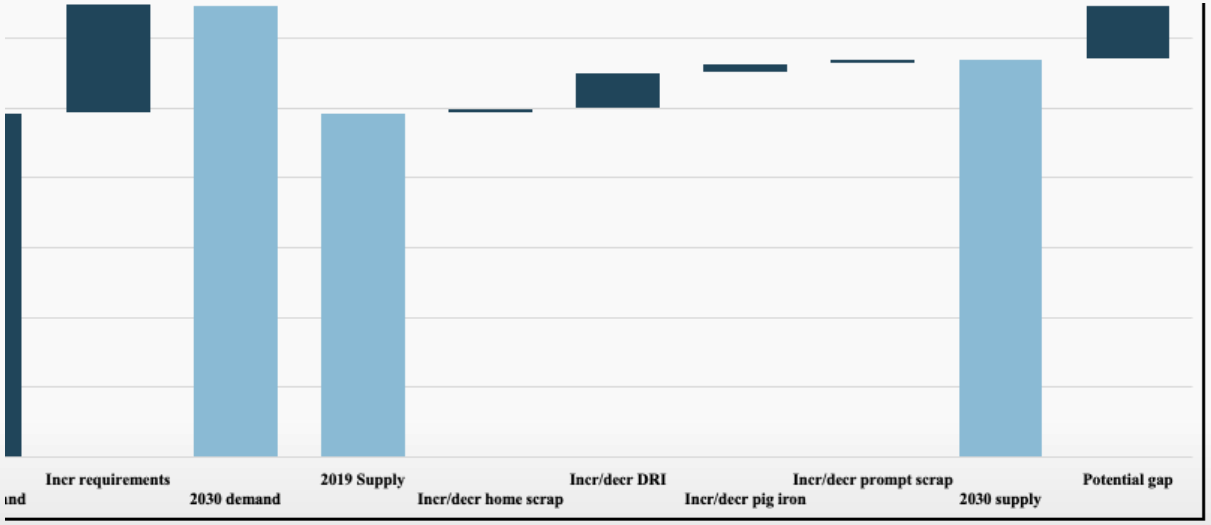
Developing regions	2019	2030
BF fuel rate (kg/tHM)		
BF coke rate (kg/tHM)		
BOF hot metal ratio (charge %)		
BF/BOF emissions intensity (kg/tCS)		

13. Section IV provides details behind this summaries

Source: WSD analysis

2030 USMCA scrap and OBM balance

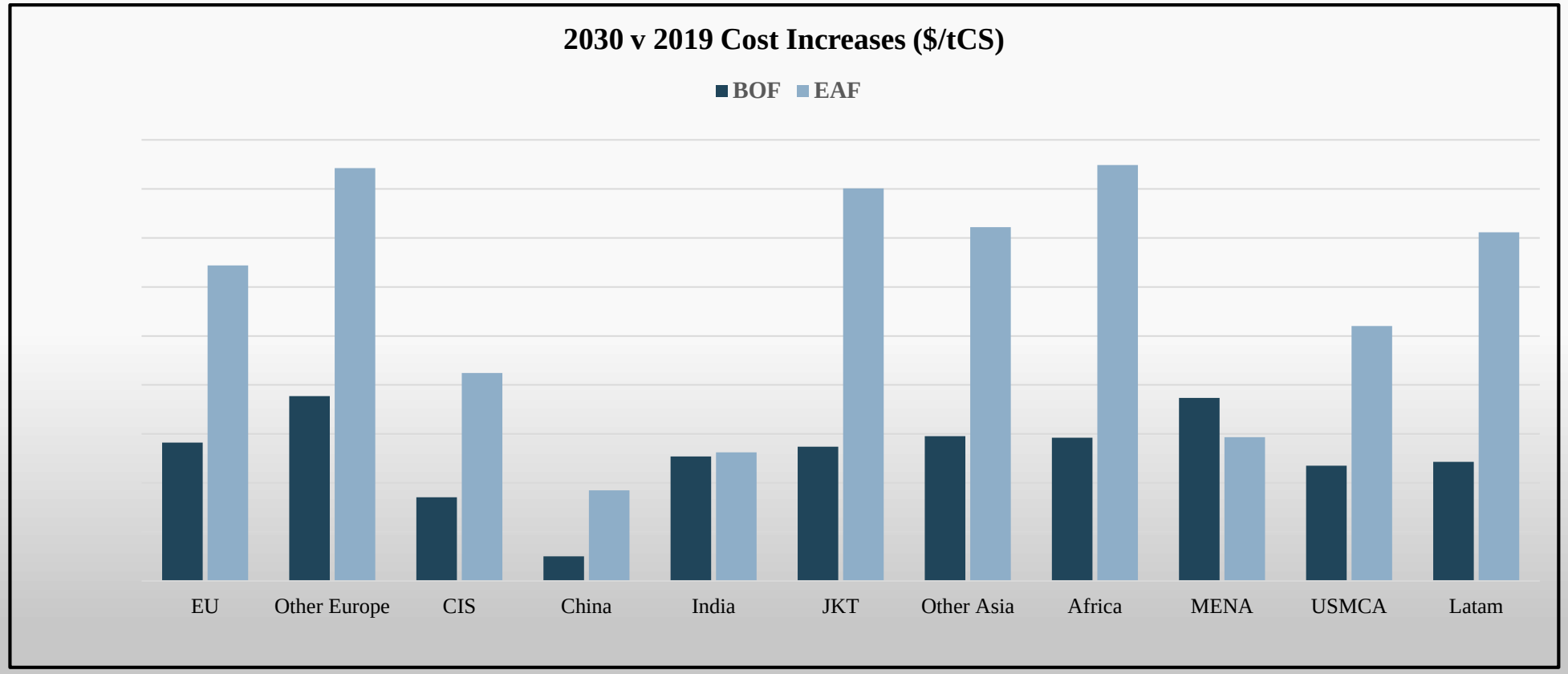
The USMCA's scrap requirements are expected to increase dramatically, creating a potential shortfall relative to 2019 supply, necessitating increased recovery rates, reduced exports and/or additional DRI capacity.



Source: WSD analysis

Shifts in EAF and BF/BOF cost structures

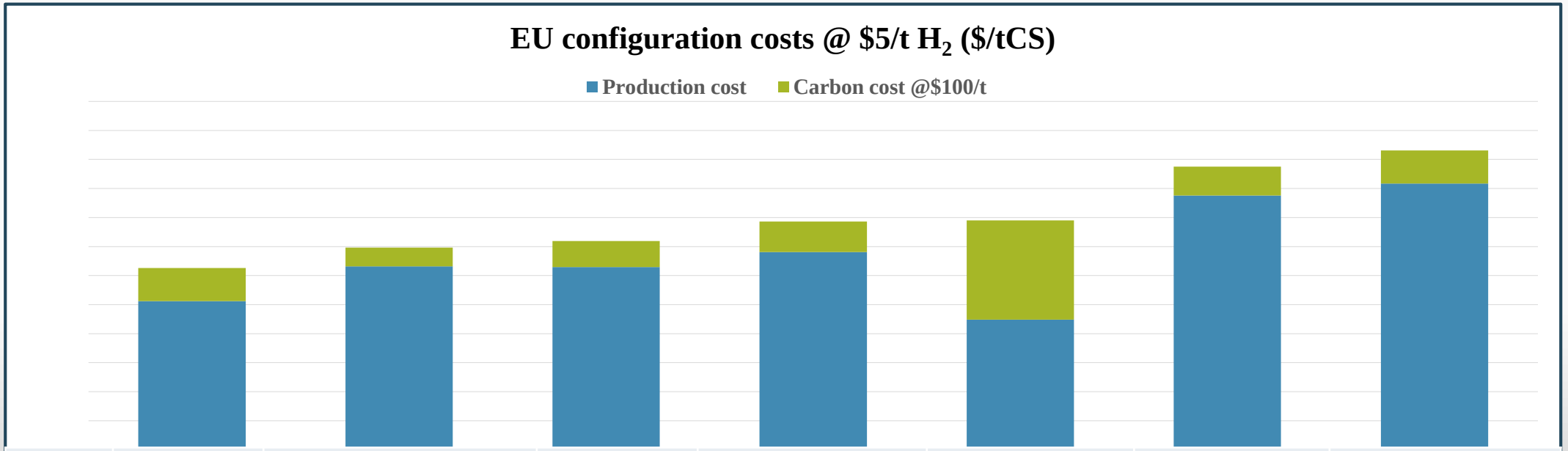
Higher prices for scrap, pellets and natural gas will drive EAF production cost increases to outpace cost increases for BF/BOF production, in some regions by more than $100/tCS.



Prices adjusted for regional differences due to market conditions, transportation costs and other
EU BOF cost exclude the cost of green hydrogen injection (5kg H2/tHM) which adds around $25/tCS
Source: WSD analysis

EU pro forma configuration costs

At $5/kg for low emissions hydrogen (base case) and a $100/t carbon tax, the BF/EAF configuration is the low-cost configuration by a wide margin.



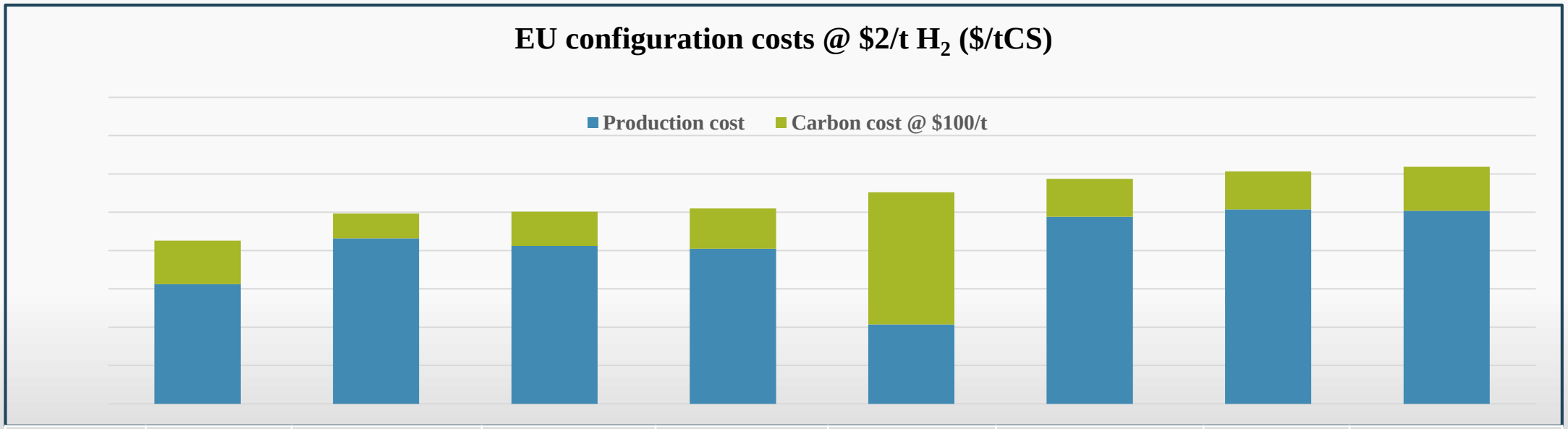
Configuration	O	D	Base case	F	A	J	H
Ironmaking	BF	DRI	DRI	DRI	BF	DRI	DRI
Pellets	BF	DRI	DRI	DRI	BF	DRI	DRI
Steel making	EAF @ 40% HM	EAF	EAF	EAF	BOF	Smelter/BOF	EAF
% DRI	n/a	0%	20%	40%	n/a	n/a	80%
% Green H	n/a	0%	15%	40%	n/a	40%	80%

The hydrogen price is assumed to be either a fully-loaded (with capital return) production cost or a purchased price based on a supply contract; assumes 0 free allowances although they will not be fully phased out until 2034; configuration D will with 100% scrap will not be able to produce the same high quality flat roll steels as the others; included for illustrative purposes only.

Source: WSD analysis

EU pro forma configuration costs

At $2/ton for low emissions hydrogen and a $100/t carbon tax, the BF/EAF route remains the low-cost configuration while the spread to the other configuration narrows.



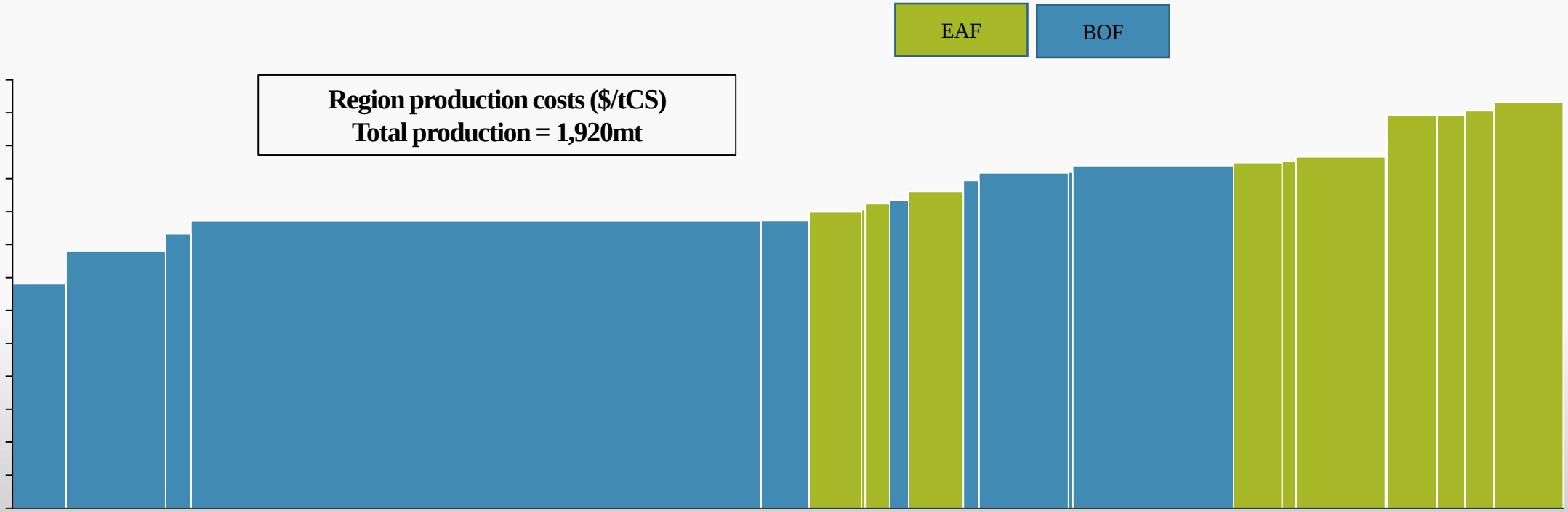
Configuration	O	D	Base case	G	A	M	K	I
Ironmaking	BF	DRI	DRI	DRI	BF	DRI	DRI	DRI
Pellets	BF	DRI	DRI	DRI	BF	BF	DRI	DRI
Steel making	EAF	EAF	EAF	EAF	BOF	Smelter/BOF	Smelter/BOF	EAF
% DRI	40% HM	0%	20%	40%	n/a	n/a	n/a	80%
% Green H	n/a	0%	15%	40%	n/a	40%	40%	80%

The hydrogen price is assumed to be either a fully-loaded (with capital return) production cost or a purchased price based on a supply contract; assumes 0 free allowances although they will not be fully phased until 2034; configuration D will with 100% scrap will not be able to produce the same flat roll steels as the others; included for illustrative purposes

Source: WSD analysis

2030 pro forma industry cost curve

BOF configurations in 2030 are expected to have significantly lower production costs than EAF configurations based on expected raw material and energy cost shifts.

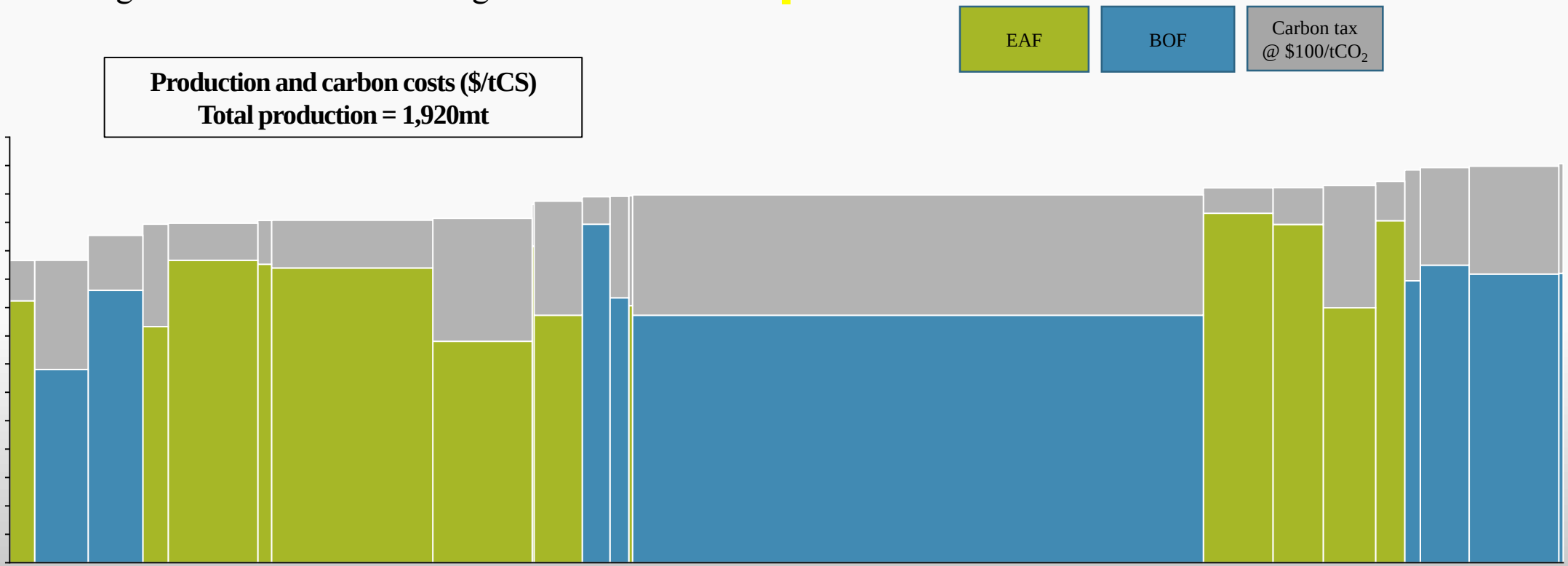


Costs are pro forma 2030 crude steel cash costs/ton reflecting each region's average metallics mix and input prices for each configuration. Carbon tax calculated on country/region specific emissions intensity estimates weighted by long/flat mix.

Source: WSD analysis

2030 pro forma industry cost curve

A $100/t carbon tax applied universally would result in a flatter industry cost curve, but with EAF configurations in some regions still "stuck" at the higher end of the curve.

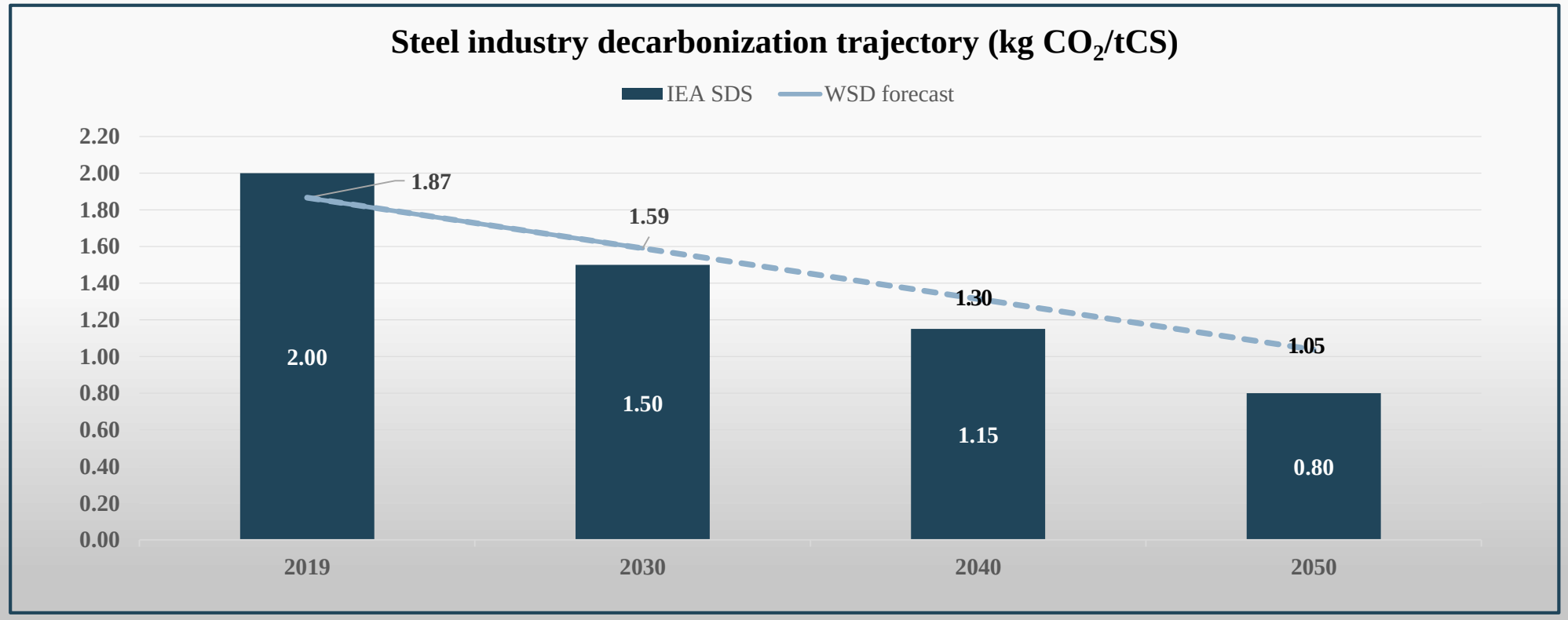


Costs are pro forma 2030 crude steel cash costs/ton reflecting each region's average metallics mix and input prices for each configuration. Carbon tax calculated on country/region specific emissions intensity estimates, weighted by long/flat mix.

Source: WSD analysis

After 2030: the challenge ahead

Based on the trajectory of the decarbonization progress forecast for 2030, global steel intensity will decrease to around 1.3 kg/tCS by 2040 and to 1.05 by 2050, above the IEA's Sustainable Development Scenario (SDS) target.



Source: IEA *Iron and Steel Technology Roadmap* 2020 and updates; WSD analysis

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Please join over 200 industry leaders and global experts in the space of the economy, energy markets, and steelmakers raw materials, as we discuss the current state and outlook for the European Steel Industry.

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