Medium- to Long-Term Global Outlook on Steel and Ferrous Raw Materials Demand

2025 ITA Annual Conference

JIANG, Li

27 October 2025

Personal Viewpoint Disclaimer:

- This presentation is the result of independent research conducted by the author and expresses solely the author's personal views and conclusions.
- It is explicitly stated that these views and opinions are the author's own and do not reflect or represent the views or positions of any company, organization, or institution with which the author may be associated.
- The author takes full responsibility for the accuracy and completeness of the information presented and acknowledges any errors or omissions as their own.
- This document is intended for informational purposes only and does not purport to represent the official stance or endorsements of any entity other than the author themselves.

Conclusions

1. Steel Demand Outlook:

- China's crude steel demand is forecasted to decline to 861 mmt by 2035, and further decline to 839 mmt by 2050.
- In contrast, global steel demand is expected to grow steadily, reaching 2.23 bt by 2035 and further expanding to 2.63 bt by 2050.

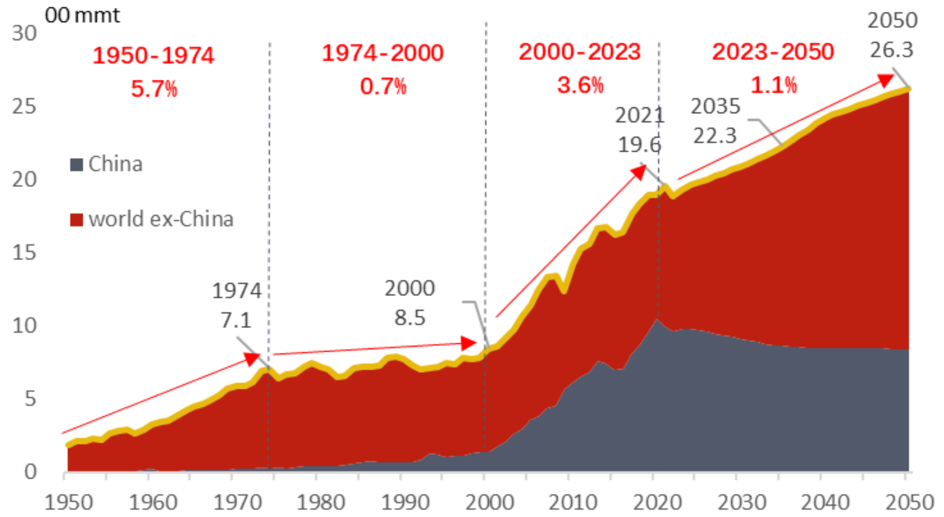
2. In-Use Steel Stock and Scrap Generation Forecast:

- Global in-use steel stock is projected to nearly double, surging from 38.9 bt in 2023 to 71.1 bt by 2050. Correspondingly, global scrap generation is expected to reach 1.42 bt by 2050, with scrap contributing 49% of the iron content in global steelmaking.
- China's in-use steel stock will follow a similar trajectory, increasing from 12.5 bt in 2023 to 22.9 bt by 2050, while its scrap generation is projected to reach 450 mmt by 2050.

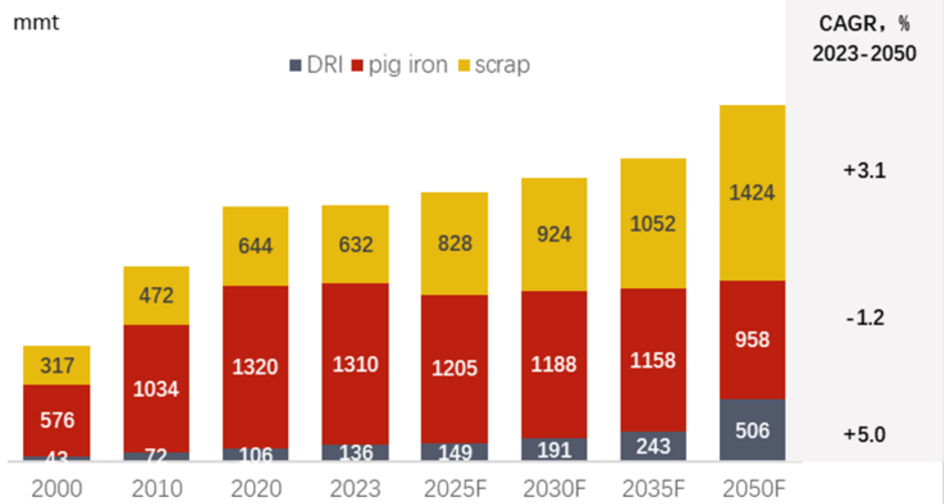
3. Iron Ore and DRI Demand projection:

- By 2050, global pig iron and DRI output is anticipated to reach 1.47 bt, iron ore demand is expected to stabilize at 2.34 bt, comparable to 2023 levels.
- Driven by decarbonization efforts and limited high-quality scrap availability, DRI demand is forecasted to surge to 506 mmt by 2050, constituting 18% of iron content in steelmaking.

Global crude steel demand forecast



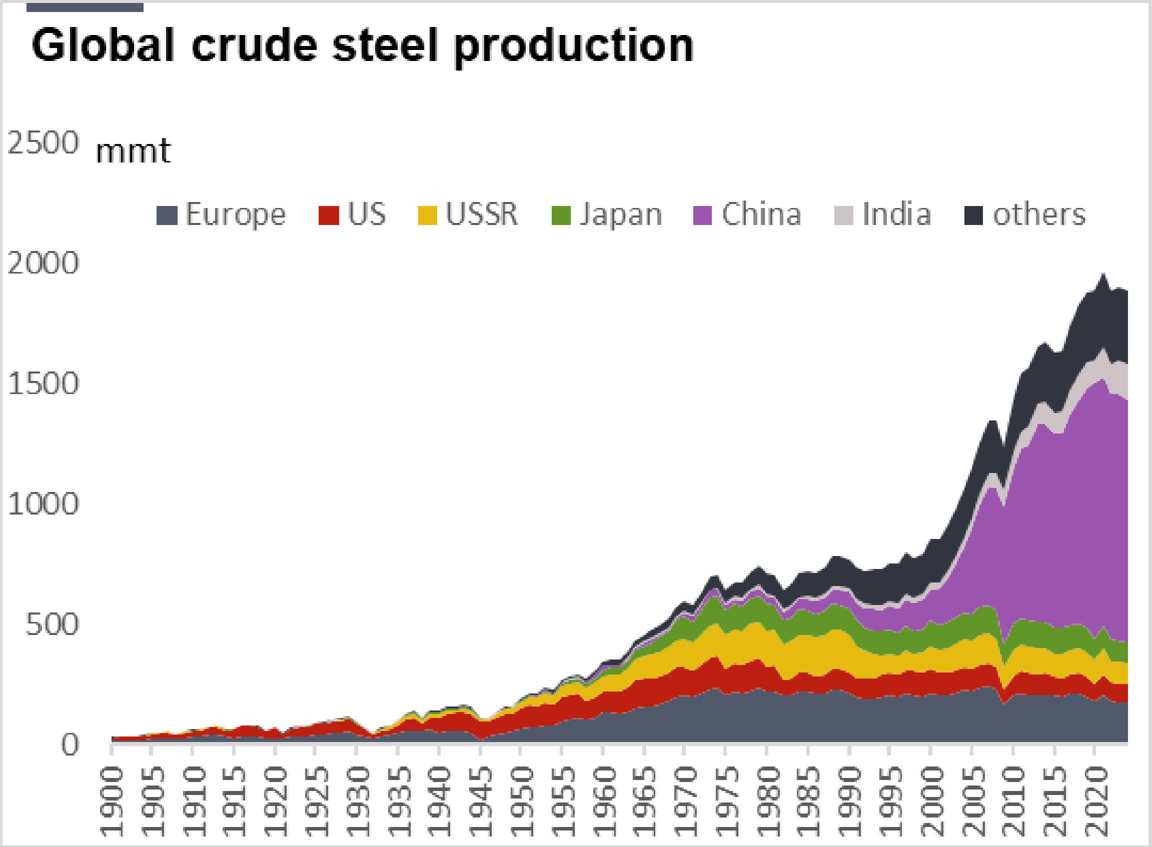
Global ferrous raw materials demand forecast



Agenda

- **Review of Steel Demand Forecasting Methods, Methodology Improvements, and Key Research Findings**
  - **Review of Steel Demand Forecasting Models**
  - **Four Improvements to the Traditional S-Curve for Steel Demand Forecasting**
  - **Four Key Findings about Steel Demand**
- **Global and Chinese Steel Demand Forecast**
- **Global and Chinese Ferrous Raw Materials Demand Forecast**

Global Steel Supply and Demand Review



Years of Negative Growth in Global Crude Steel Production

Time period	Event	Overall Decline	Duration (years)	CAGR	Ex. China	China
1907-1908	Panic of 1907	-21%	1	-21%		
1913-1914	World War I	-21%	1	-21%		
1917-1919	Spanish Flu	-30%	2	-15%		
1920-1921	American Economic Crisis	-38%	1	-38%		
1929-1932	Global Economic Crisis	-48%	3	-16%		
1937-1938	Roosevelt Recession	-18%	1	-18%		
1943-1946	World War II	-31%	3	-10%		
1953-1954	Korean War/US Recession	-5%	1	-5%		
1957-1958	Global Recession/Asian Flu	-7%	1	-7%		
1970-1971	The Nixon Shock	-2%	1	-2%		
1974-1975	Oil Crisis	-8%	1	-8%		
1979-1982	Second Oil Shock/Iran-Iraq War	-14%	3	-5%	-15%	8%
1989-1992	Gulf War/USSR Dissolution/Japanese Real Estate Bubble Burst	-8%	3	-3%	-12%	31%
1997-1998	Asian Financial Crisis	-3%	1	-3%	-4%	5%
2008-2009	Global Financial Crisis	-8%	1	-8%	-20%	13%
2014-2015	Oil Price Crash/Chinese Economic Recession	-3%	1	-3%	-4%	-2%
2020-2021	COVID-19 Pandemic	0%	1	0%	-7%	7%
2021-2022	Russo-Ukrainian War/Global Inflation/Supply Chain Crisis	-4%	1	-4%	-6%	-2%
2023-2024	Chinese Real Estate Market De-bubbling	-1%	1	-1%	1%	-2%
2025-	Trump Tariffs 2.0	?	?			

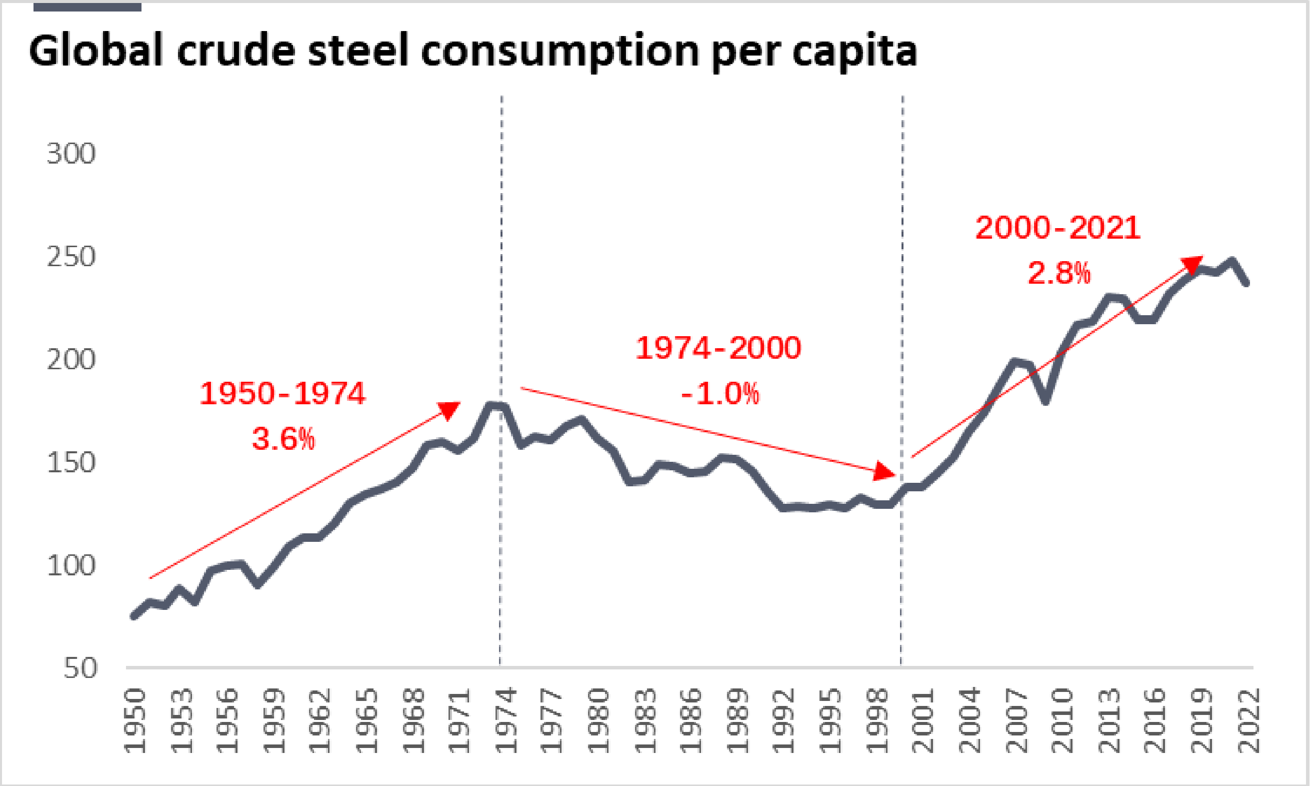
Source: worldsteel, Author Summary

Review of Steel Demand Forecasting Models

Forecasting Model	Period	Representative Authors & Years	Characteristics
Econometric Methods	1995-2010	Labson (1995), Pei & Tilton (1999), Abbott (1999), Mckay (2010)	- Build mathematical models based on historical data and economic indicators (GDP, industrial output, prices, etc.) to predict demand by fitting historical curves.
			- Diverse methods: dynamic equilibrium models, partial adjustment models, cointegration regression, simultaneous equations, etc.
			- Advantages: Consider multiple influencing factors, data-driven.
			- Disadvantages: Reliant on accurate variable selection, susceptible to multicollinearity, long-term predictions may not reflect technological substitution effects.
Vector Autoregression Model	1991-2003	Chen (1991), Crompton & Wu (1999, 2003)	- All variables are endogenous, no need for exogenous variables for prediction (e.g., BVAR model).
			- Includes linkage analysis between economic indicators (GDP, investment, money supply, etc.) and steel consumption.
			- Advantages: Avoids prediction errors from exogenous variables.
			- Disadvantages: Low stability of results, not widely adopted.
Intensity of Use (IU) Method	1970s-2014	Malenbaum (1973,1975), Tilton (1990), Roberts (1996), Crompton (2000), Rebiasz (2006), Ausubel & Waggoner (2008), McKay (2010)	- Core theory: Steel consumption per unit GDP follows an inverted U-shaped curve with economic development (increases initially, then declines).
			- Analyzes industrial structure transformation (from construction/manufacturing to services) with per capita GDP.
			- Advantages: Intuitively reflects the relationship between economic stages and demand.
			- Disadvantages: Requires precise matching of national industrialization paths, limited applicability to emerging economies.
Sectoral Analysis (SWIP) Method	2000-2007	Crompton (2000), Rebiasz (2006), worldsteel (2007)	- Decomposes demand by downstream industries (machinery, construction, etc.), calculates weighted industry production index (SWIP).
			- Advantages: Reflects industrial structure differences, accurate for short-term predictions.
			- Disadvantages: Strong subjectivity in weighting, errors can amplify, weak in long-term trend prediction.
Steel Stock Method	1950s-2020	Harrison Brown (circa 1950), Van Vuuren (1999), Müller (2006,2011), Tanikawa (2002), Pauliuk (2013), Ryan (2020)	- Based on Logistic/Gompertz functions, analyzes the saturation pattern of per capita steel stock with economic development.
			- Advantages: Suitable for long-term stock predictions.
			- Disadvantages: Reliant on saturation value assumptions, significantly affected by technological changes or recycling rate variations.
S-Curve Law	Post-2010	Wang Anjian, Chen Qishen, Gao Xinrui, Zhang Yanfei (2010-2016)	- Pioneered the S-shaped relationship between per capita resource consumption and GDP.
			- Defines three demand stages: take-off point, turning point, zero-growth point.
			- Limitations: Actual demand continues to grow (e.g., China 2017-2020), challenging the model's peak prediction accuracy.
Inverted U-Curve Law	2010	Cheng Jinhua (2010), Yu Wenjia (2010)	- Resource consumption intensity (resource amount per unit GDP) follows an inverted U-shaped curve with per capita GDP.
			- Combined with the S-curve, analyzes the peak of steel consumption intensity (per capita GDP $6000-7000, 1990 prices).
			- Reveals changes in resource efficiency during industrialization stages, but peak position is significantly influenced by technology and policy.

Source: Author Summary

Traditional S-Curve in Steel Demand Forecasting



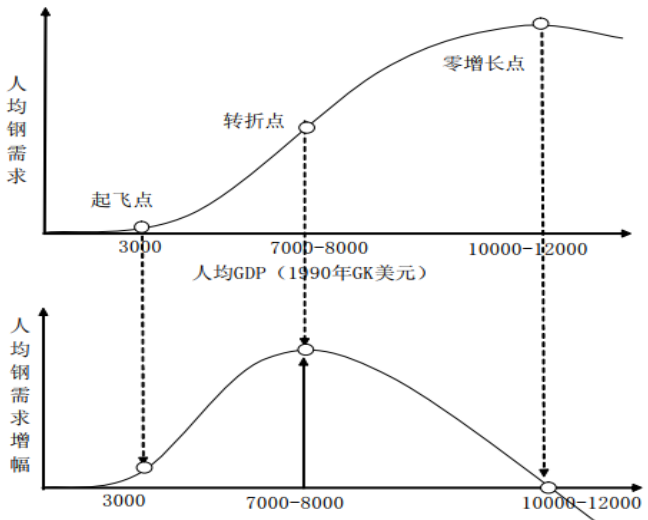


图 2　人均钢、水泥消费增幅的三个转变点

Fig. 2　Threeturning points of per capita steel and cement consumption

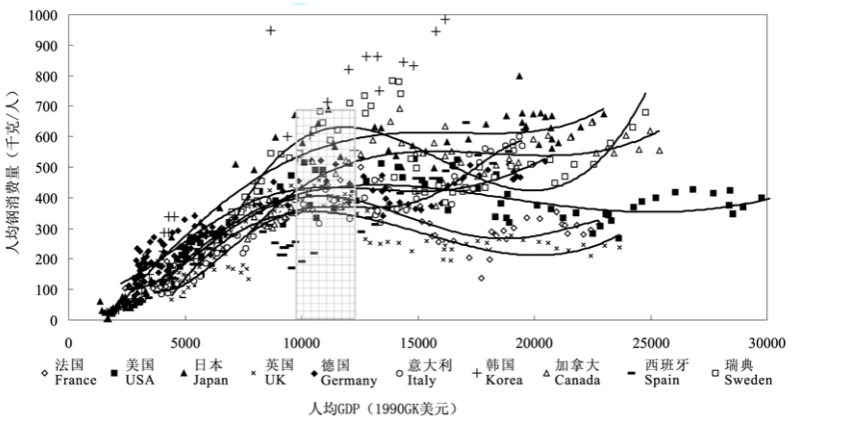


图 1　典型发达国家人均钢消费量与人均 GDP "S" 形规律

(来源：世界钢铁协会, 2009; 美国经济咨询商局(The Conference Board), 2009)

Fig. 1　S-shaped rule between per capita crude steel consumption and per capita GDP of typical developed countries

(Source: Worldsteel Association, 2009; The Conference Board, 2009)

Source: worldsteel, CHEN Qi-shen *An Analysis of the Three Turning Points in the "S-Shape" Rule of Steel and Cement Demand*

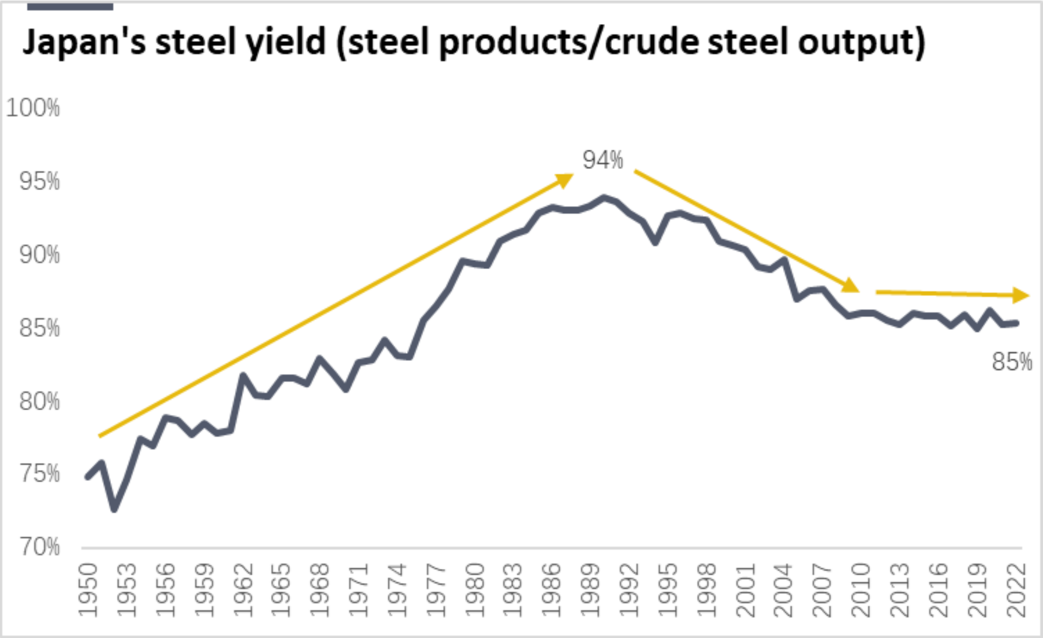
4 Improvements to Traditional S-Curve for Steel Demand Forecasting

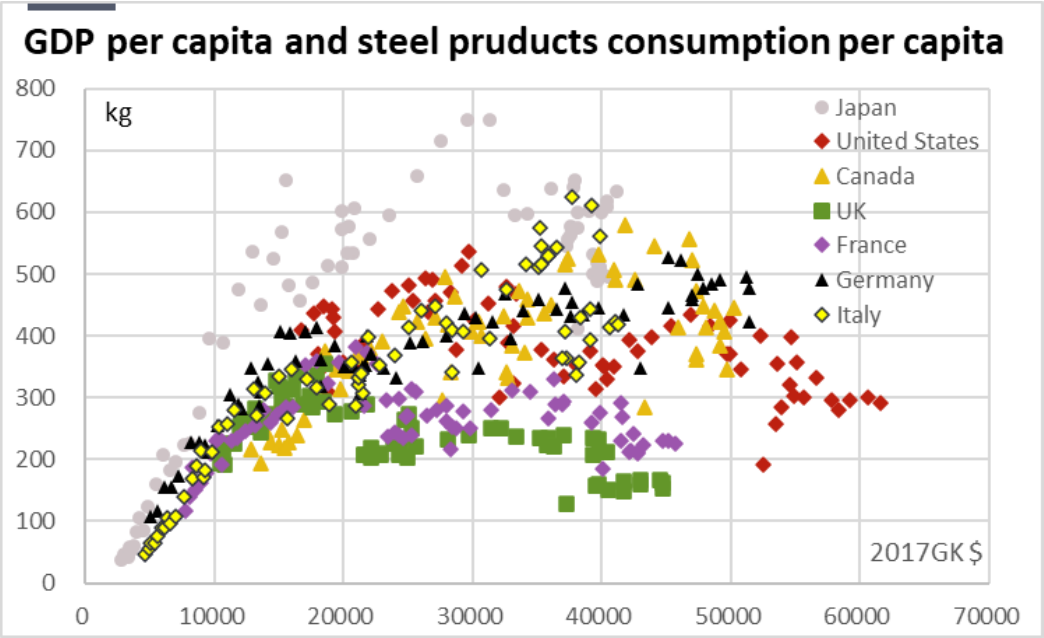
Improvement 1: Replacing crude steel consumption with steel product consumption, reflecting advancements in steel production technology and improved yield rates, providing a more precise standard for measuring long-term steel demand.

Improvement 2: Using GDP measured in 2017 GK$ instead of 1990 GK$ to more accurately measure economic development levels.

Improvement 3: Using continuous data from consistent sources to ensure the consistency and reliability of analytical data.

Improvement 4: Incorporating indirect import and export analysis to reflect the comprehensive impact of international trade on steel demand.





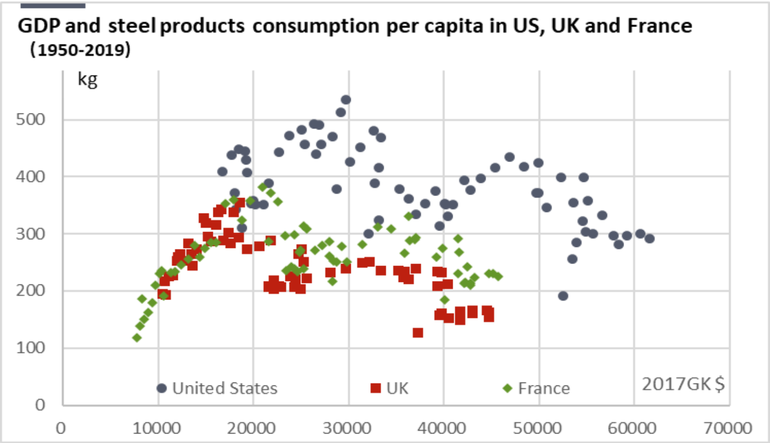
Source: JISF, GDDC, worldsteel, UN, Author's Estimation

4 Key Findings #1: Not all countries follow the traditional S-curve in their steel demand development

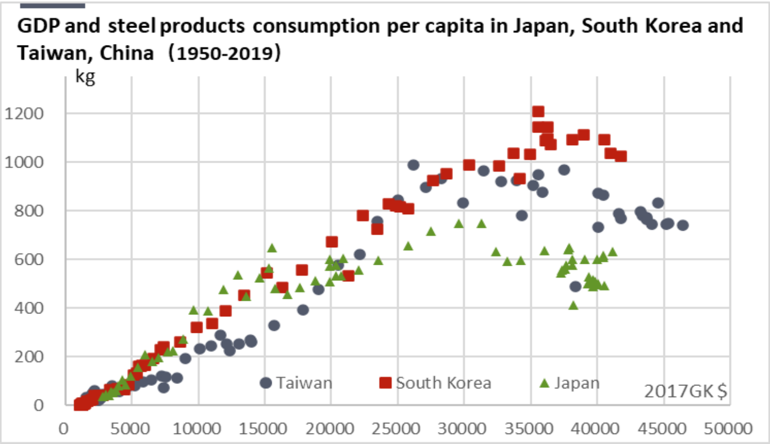
Updated and optimized different types of S-curves: 4 different curves

Which Model Will China's Future Steel Demand Follow? — The German Model

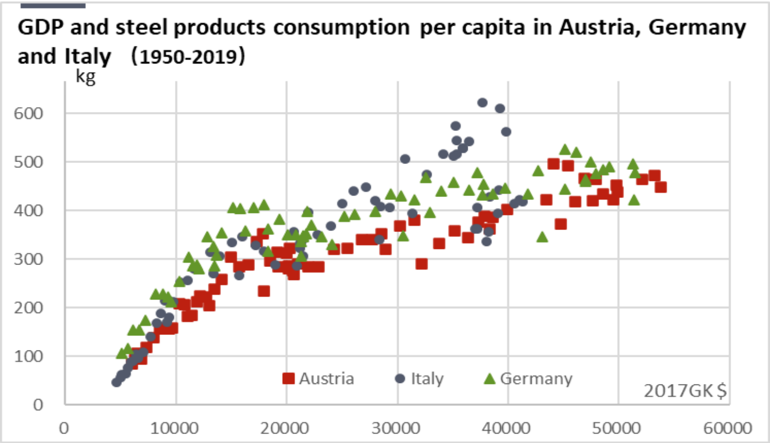
■ Traditional S-curve with subdued peaks



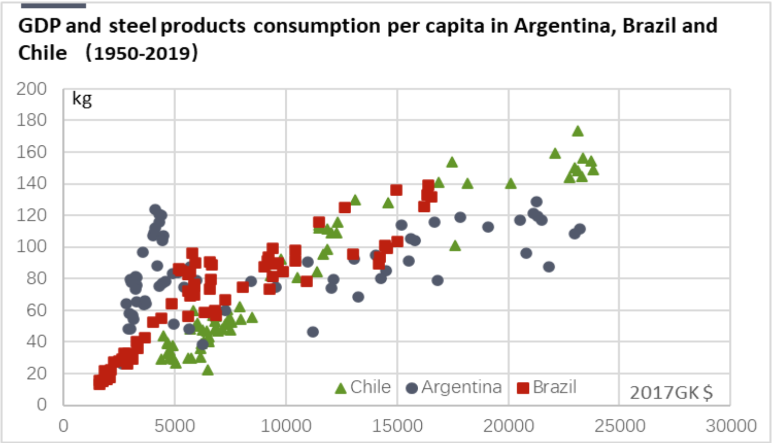
■ S-curve with elevated peaks



■ Rises steadily to a sustained high plateau



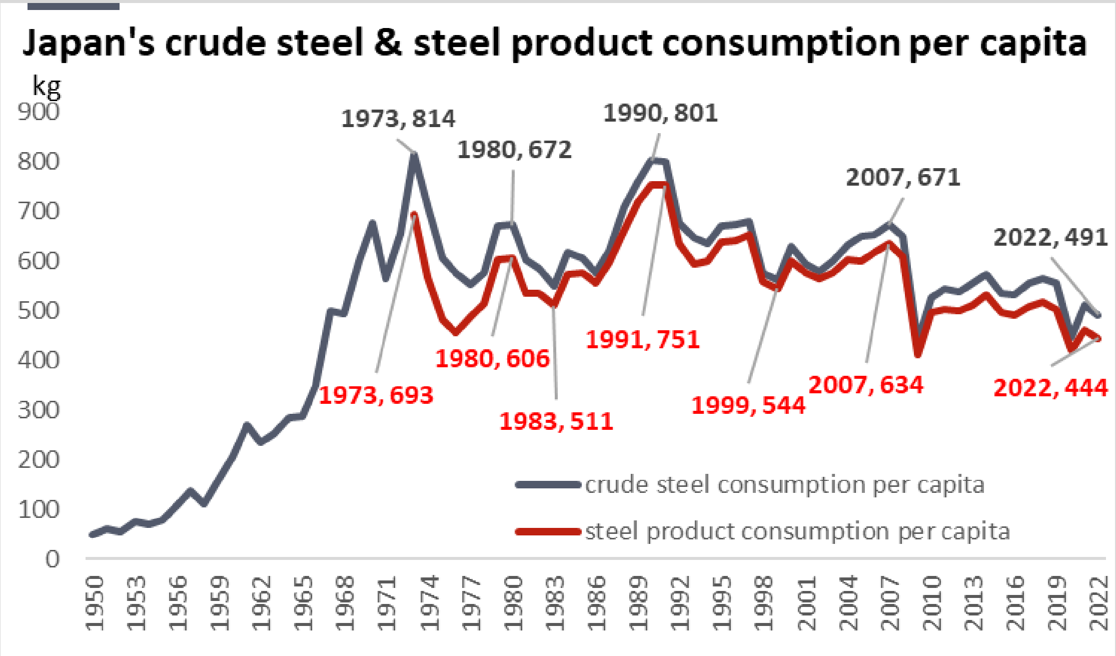
■ Remains consistently at a low plateau

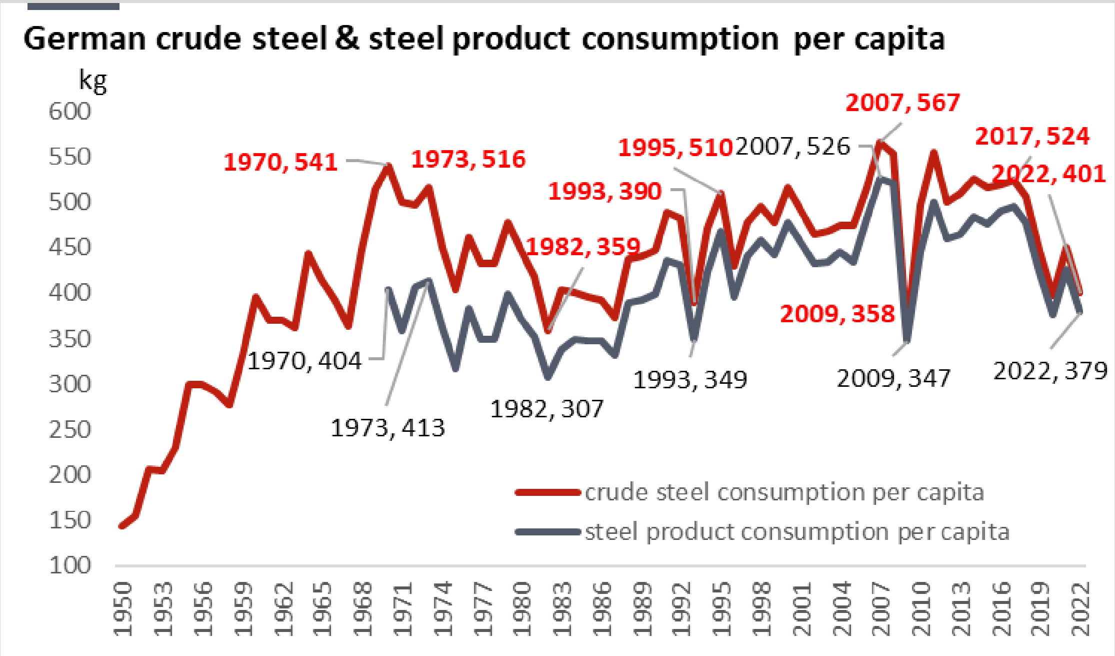


Source: worldsteel, JISF, AISI, UN, GDDC, Author's Estimation

4 Key Findings #2：Steel demand does not continuously decline after peaking

Post-peak steel demand: non-linear decline



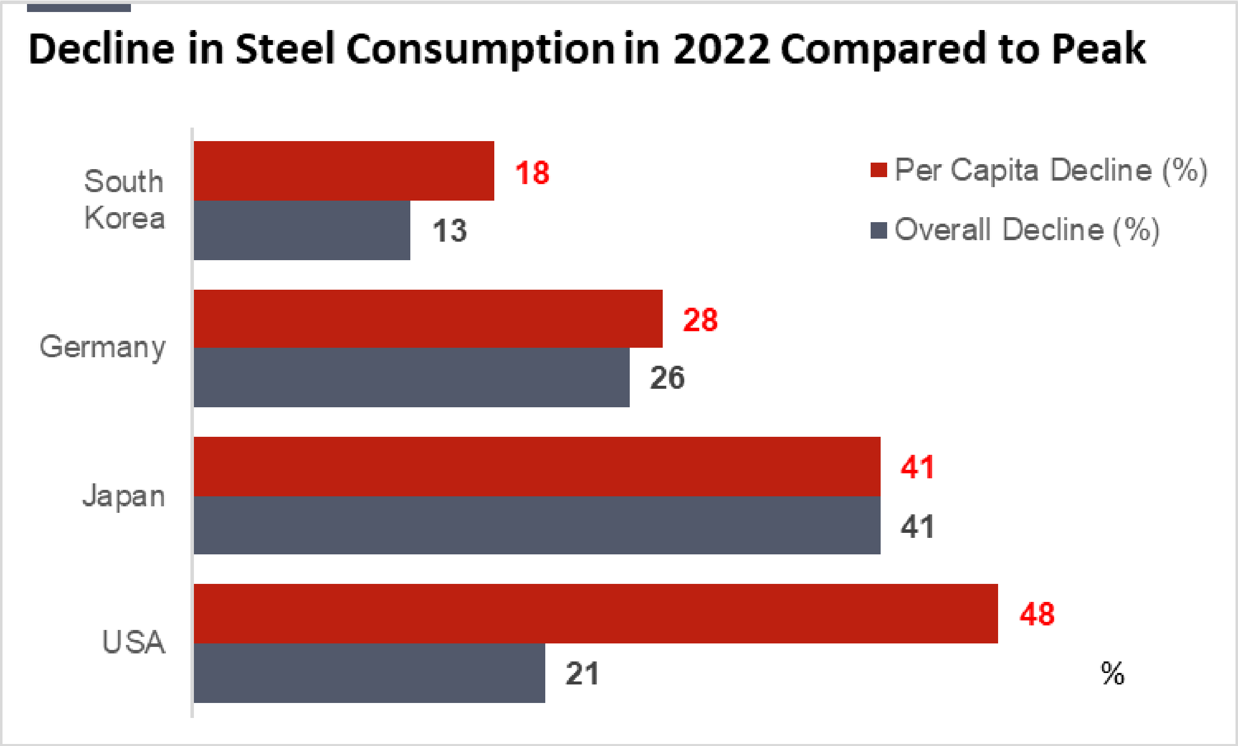


Source: worldsteel, JISF, Author's Estimation

4 Key Findings #3：Magnitude of post-peak decline in steel demand depends on changes in a country’s economic structure and population

Post-peak steel demand: magnitude of the decline varies significantly

- The U.S. sees a sharper fall in per capita steel use due to manufacturing outsourcing and a dominant service sector, mitigated by immigration-driven population growth, softening the total consumption drop.
- Japan's demand plunges due to a small domestic market and high reliance on external economies, compounded by industrial shifts.
- Germany's steel consumption dips less, supported by the stable manufacturing sector within the vast EU market.



Source: worldsteel

4 Key Findings #4：Steel demand rebounds by more than 40% after 8-9 years of decline

Post-peak steel demand: duration of decline and height of rebound

- **Duration of Decline after Peak:**
  - **After hitting their peak, countries typically see steel consumption decline for about 8-9 years.**
- **Height of Rebound for the second Peak**
  - **Factors like economic cycles and structural shifts can trigger a rebound in steel consumption, sometimes by more than 40% from the lowest point.**

US	9 years	1973-1982	Steel consumption	Steel consumption per capita
		Decline	-38%	-44%
	18 years	1982-2000	Steel consumption	Steel consumption per capita
		Increase	75%	41%
	9 years	2000-2009	Steel consumption	Steel consumption per capita
		Decline	-51%	-55%
	5 years	2009-2014	Steel consumption	Steel consumption per capita
		Increase	81%	73%
	8 years	2014-2022	Steel consumption	Steel consumption per capita
		Decline	-12%	-16%
Germany	9 years	1973-1982	Steel consumption	Steel consumption per capita
		Decline	-27%	-26%
	25 years	1982-2007	Steel consumption	Steel consumption per capita
		Increase	79%	72%
	15 years	2007-2022	Steel consumption	Steel consumption per capita
		Decline	-26%	-28%
Japan	9 years	1973-1982	Steel consumption	Steel consumption per capita
		Decline	-20%	-26%
	8 years	1982-1990	Steel consumption	Steel consumption per capita
		Increase	52%	47%
	8 years	1990-1998	Steel consumption	Steel consumption per capita
		Decline	-25%	-26%
	8 years	1998-2007	Steel consumption	Steel consumption per capita
		Increase	15%	14%
	15 years	2007-2022	Steel consumption	Steel consumption per capita
		Decline	-32%	-30%

Source: worldsteel

Agenda

- Review of Steel Demand Forecasting Methods, Methodology Improvements, and Key Research Findings
- **Global and Chinese Steel Demand Forecast**
- Global and Chinese Ferrous Raw Materials Demand Forecast

Megatrends facing the global and Chinese steel industry’s demand over the next 25 years

Socioeconomic Changes

Population growth
Aging population
Urbanization
Mega cities
Rising living stardards
...

Geopolitical Risks

De-globalization
Restructuring of global supply chain
Restrictions of trade on critical materials
Restock of industrial strategic reserves
Re-arm
...

Climate Change

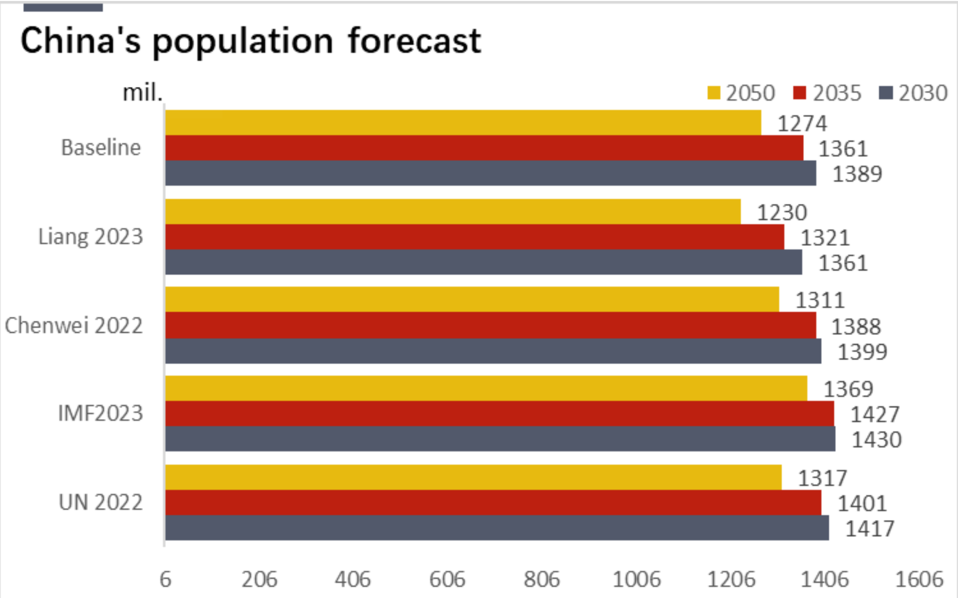
Environmental policies
Carbon pricing
Energy transition policies
Decarbonisation investment
...

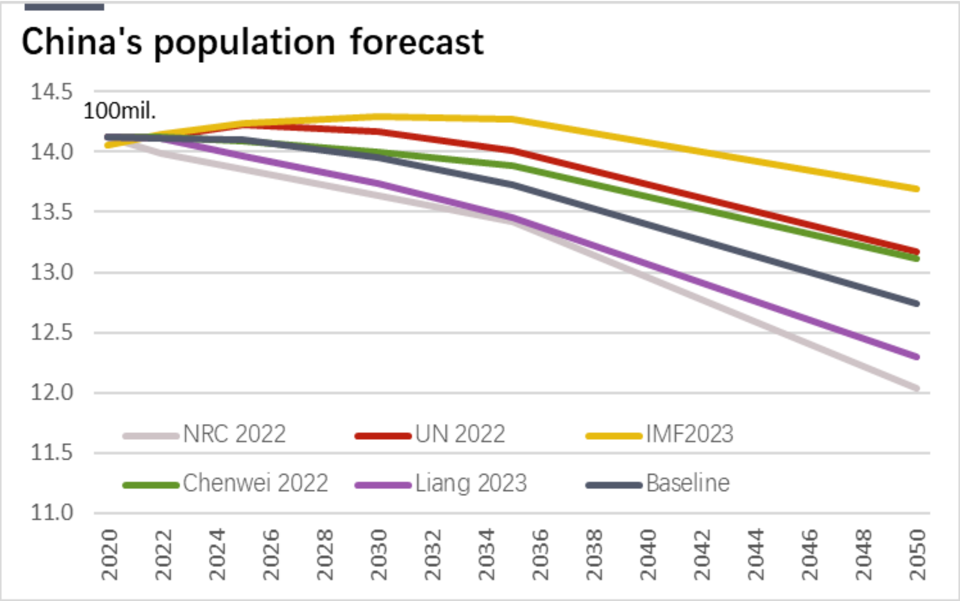
Innovative technologies

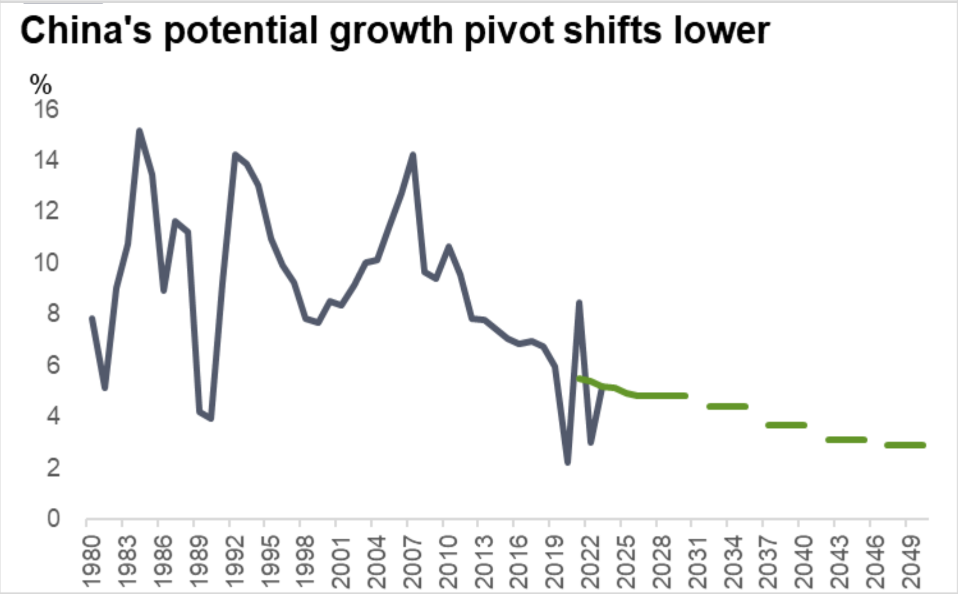
AI
Digital Transformation
Diversifying Autonomous mobility
......

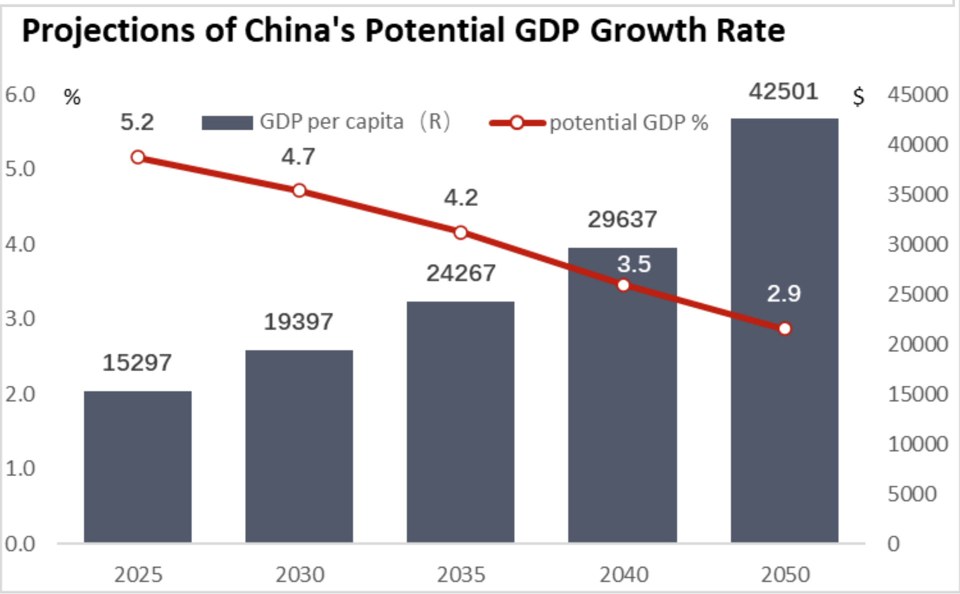
Source: Author's Estimation

China’s population and economic projections



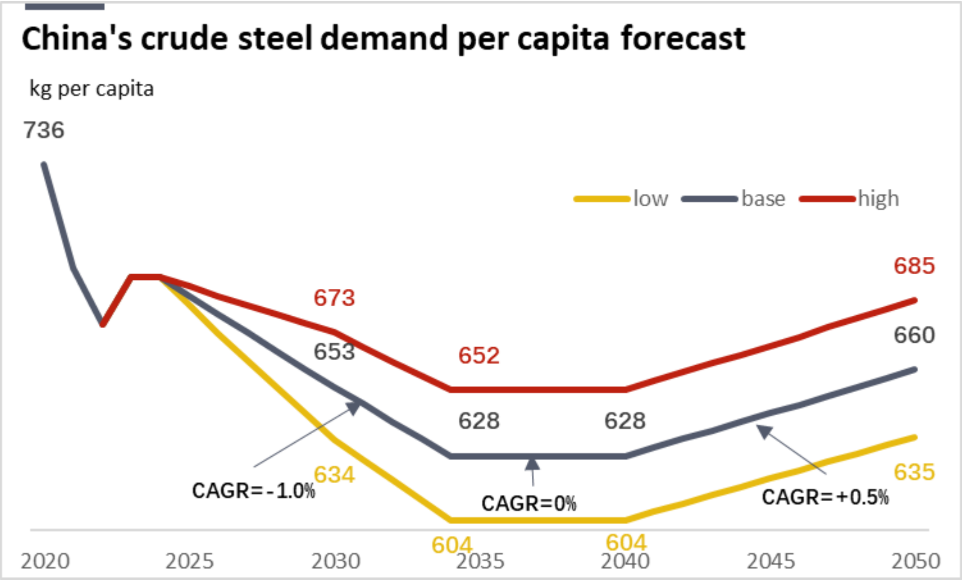


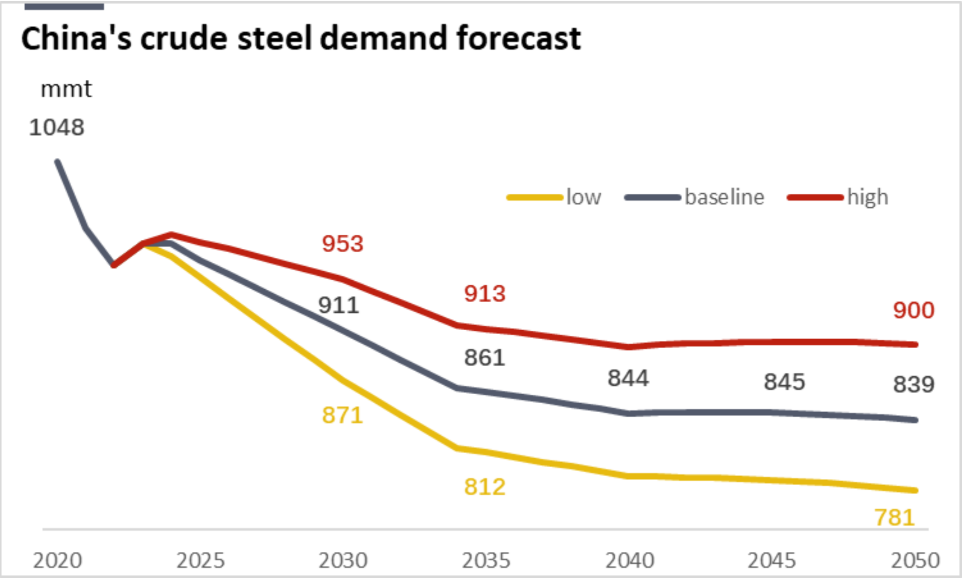


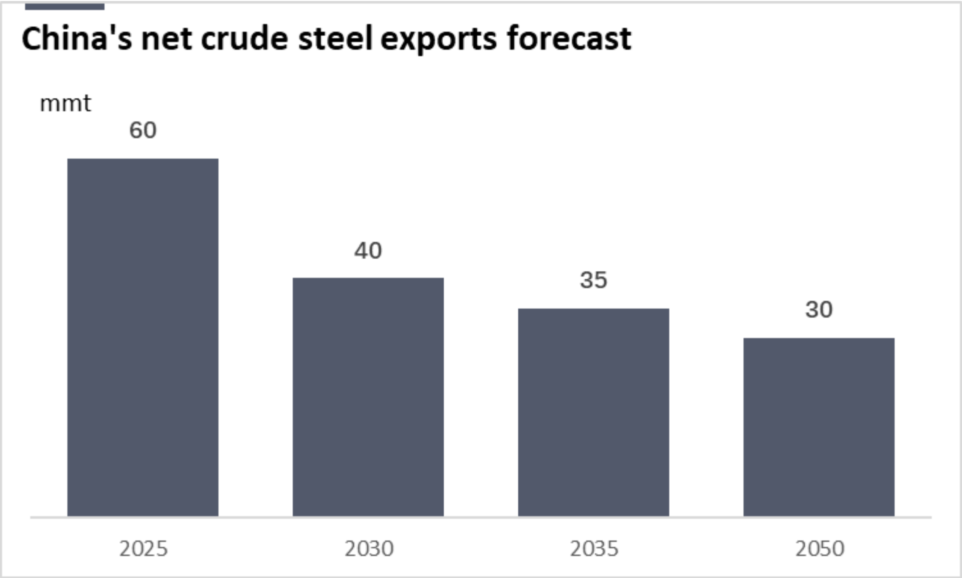


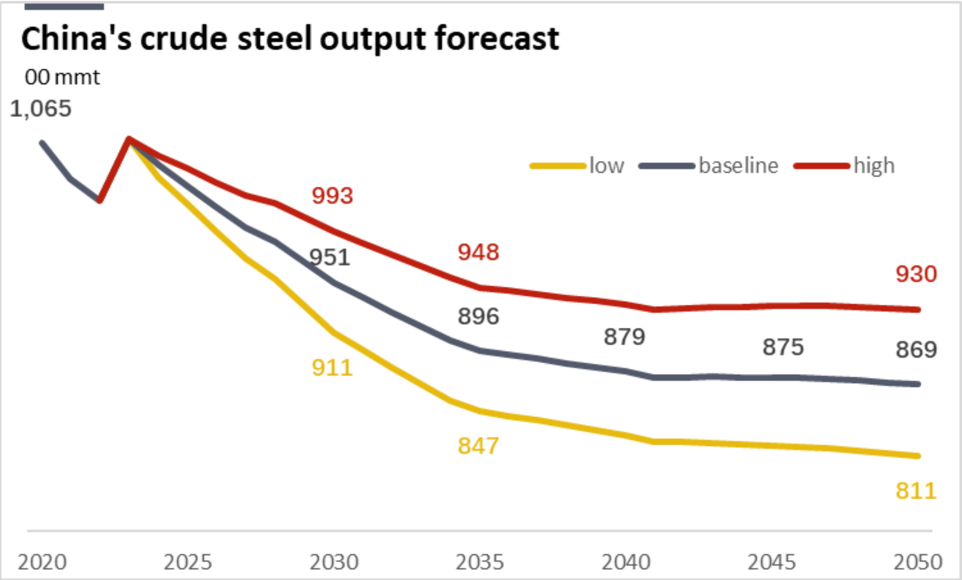
Source: worldsteel, Zhang XiaoJing *Prospects for economic growth in the context of the vision of socialist modernization*

China's steel demand to decline CAGR 0.5% in '21-'50 to 839 mmt by '50





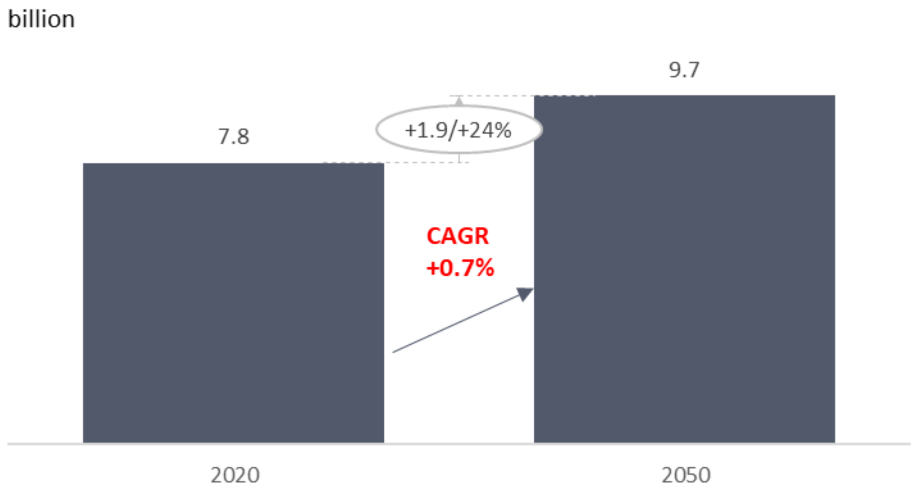




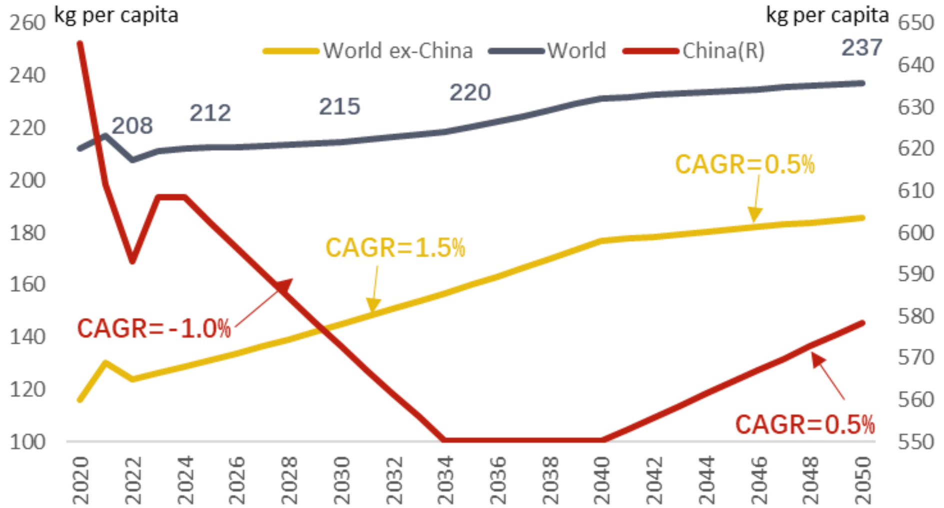
Source: Author's Estimation

Global steel demand to grow CAGR 1.1% in '23-'50 to reach 2.63 billion tons by '50

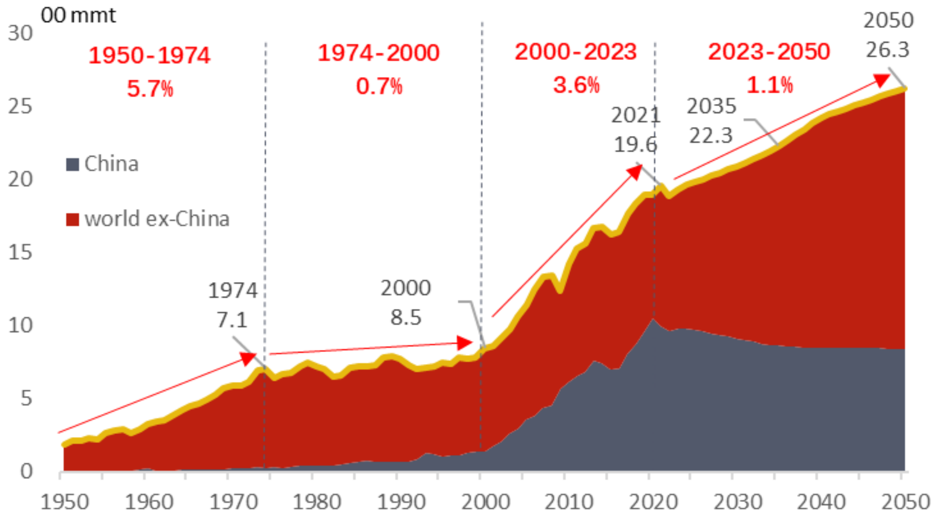
Global population projection



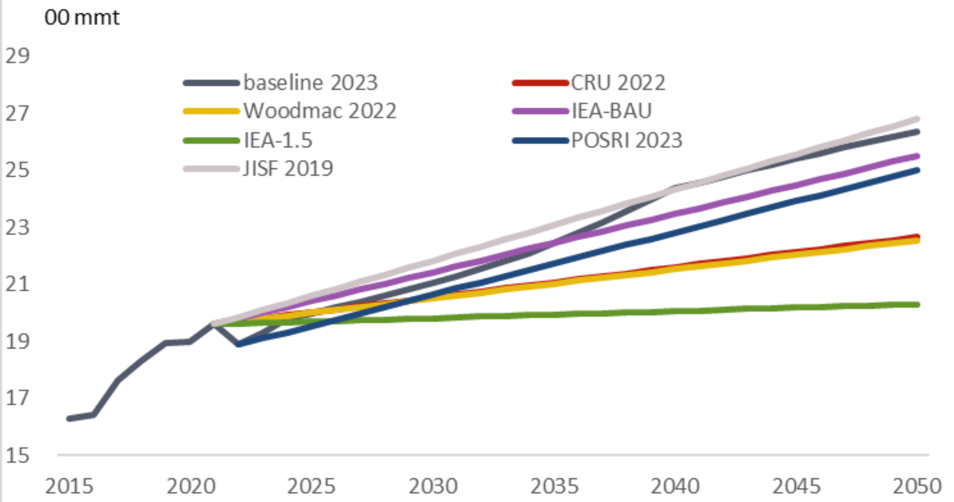
Forecast of global crude steel demand per capita



Global crude steel demand forecast



Comparison of global crude steel demand forecasts by organizations



Source: UN, worldsteel, Author's Estimation

Conclusions

Global steel demand forecast

- Traditional drivers of steel demand, including population changes and economic growth, along with urbanization and higher living standards, will sustain steel resource demand for decades. Global population is expected to increase to 9.7 billion by 2050, growing at a 0.7% CAGR. Assuming that the growth in global steel demand keeps pace with population growth at a CAGR of 0.7%, global steel demand will reach 2.4 billion tons by 2050.
- Rising geopolitical risks and the trend towards deglobalization have prompted a focus on supply chain security, leading to a restructured global supply chain, production capacity fragmentation, and increased supply constraints. These changes, alongside trade restrictions on critical materials, are driving commodity demand higher, with nations enhancing their strategic reserves.
- Climate change introduces both challenges and opportunities for steel in the green energy sector, with demand for steel in wind, hydro, and solar energy significantly outpacing traditional energy sources due to its role in low-carbon technologies. Furthermore, the development of low-carbon technologies also rely heavily on steel support.
- While technological advances have a mixed impact on steel demand, with automotive lightweighting reducing it and high-strength steel expanding its applications, the overall effect is deemed neutral.
- Considering these dynamics, global steel demand is expected to grow at a 1.1% CAGR from 2023 to 2050, achieving a 35% increase to reach 2.63 billion tons by 2050.

China’s steel demand forecast

- In the context of deglobalization, China's scale advantage is poised to drive economic growth, overtaking demographic dividends and globalization. With China's economy evolving, demand for higher quality and specialized steel in sectors like steel structures, new energy, and electric vehicles is expected to rise. Investments will be spurred by the emphasis on secure supply chains, green growth, and energy transition.
- The manufacturing sector remains a key growth driver, with robust steel consumption expected to continue. China's steel demand may emulate the patterns seen in countries like Germany and Italy, maintaining high per capita consumption over time.
- With China‘s population projected to decrease to 1.27 billion by 2050, showing a -0.4% CAGR, and assuming a -0.1% CAGR in per capita steel consumption, the country’s steel demand is anticipated to fall at a -0.5% CAGR, totaling 839 million tons by 2050.

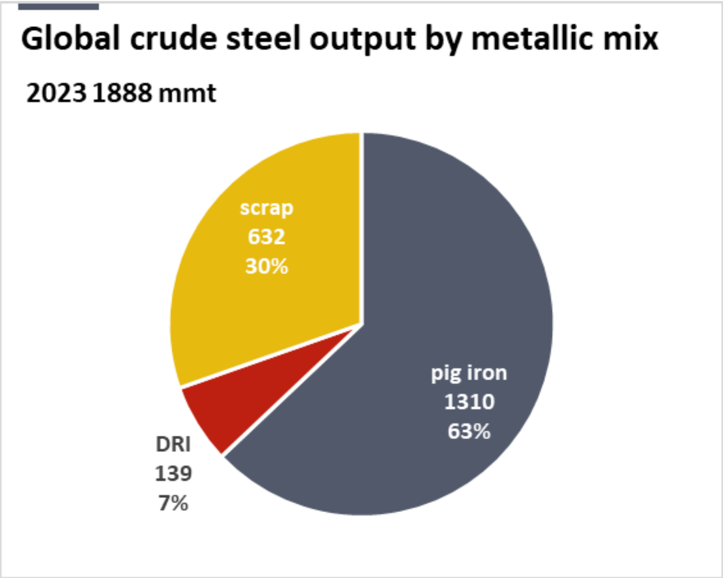
Agenda

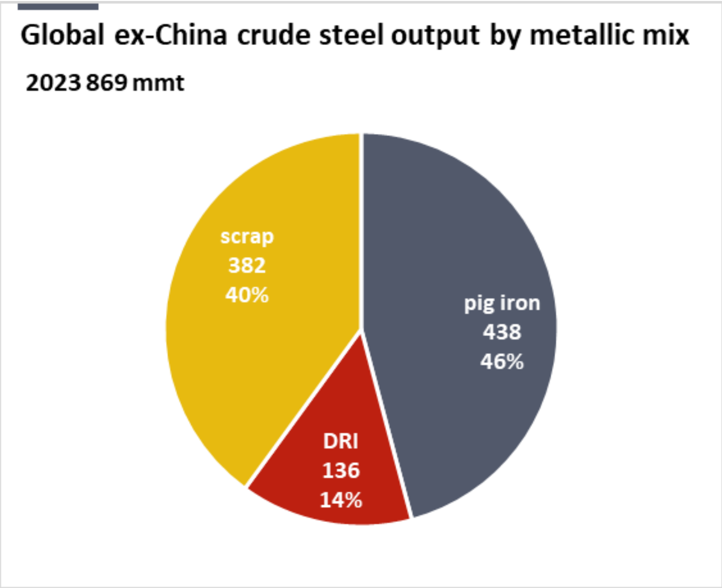
- Review of Steel Demand Forecasting Methods, Methodology Improvements, and Key Research Findings

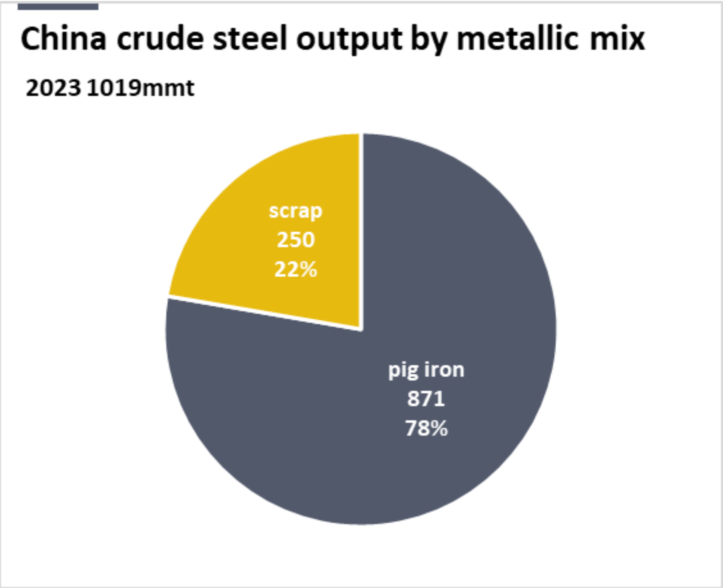
- Global and Chinese Steel Demand Forecast

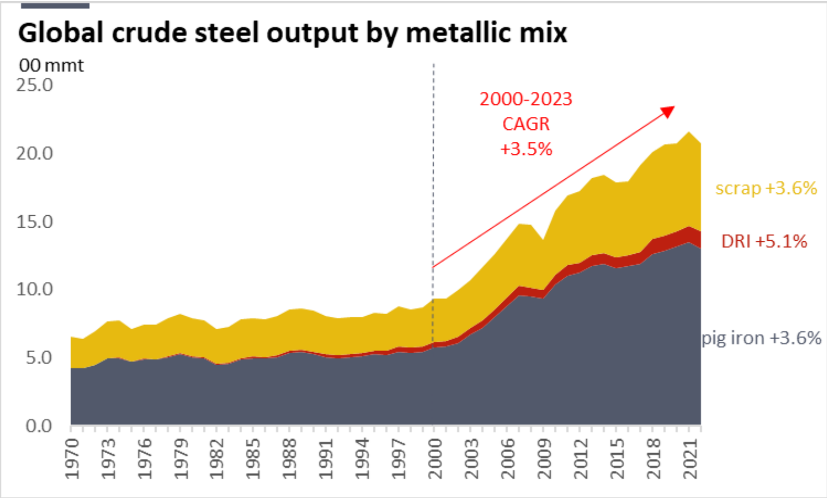
- **Global and Chinese Ferrous Raw Materials Demand Forecast**

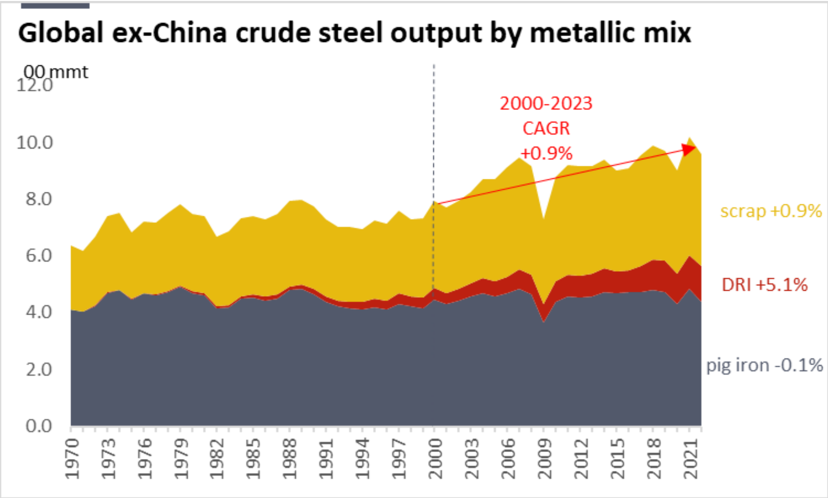
Global crude steel output growth mainly driven by iron ore & scrap in China and DRI ex. China

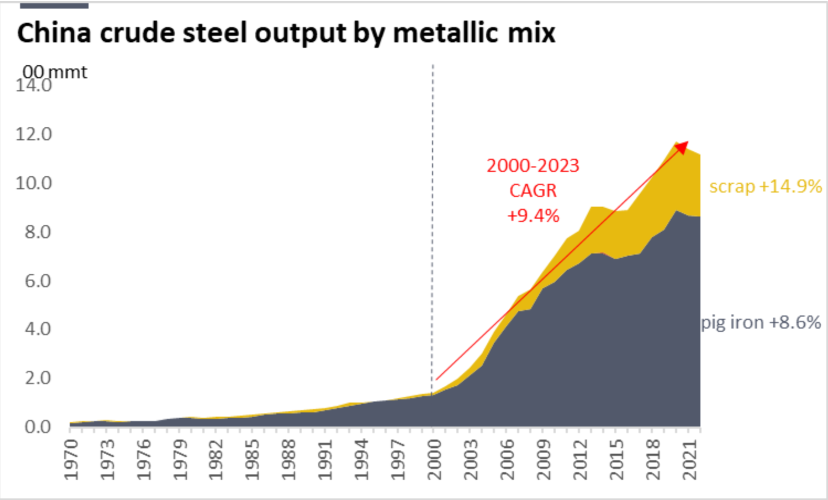






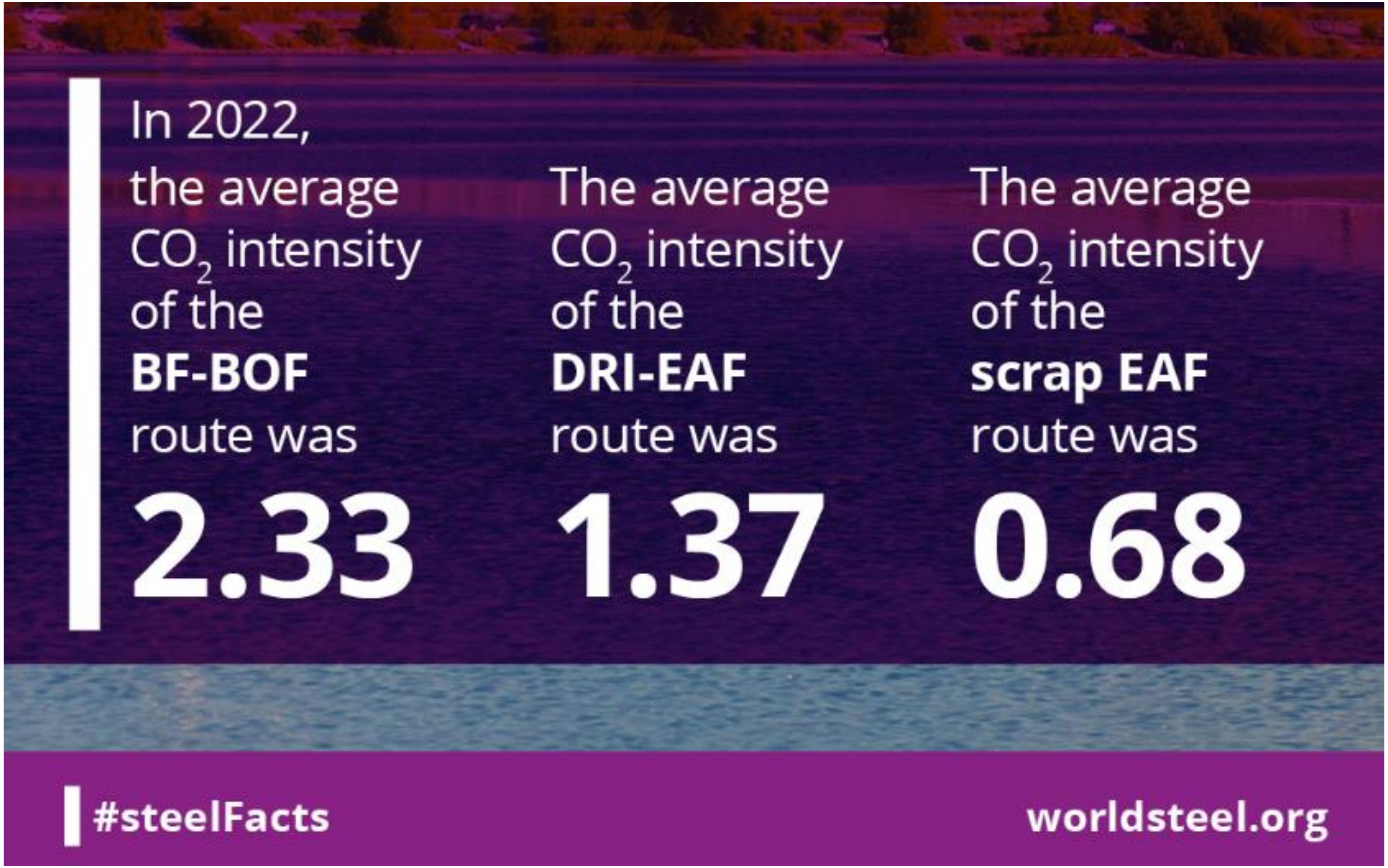






Source: worldsteel, Author's Estimation

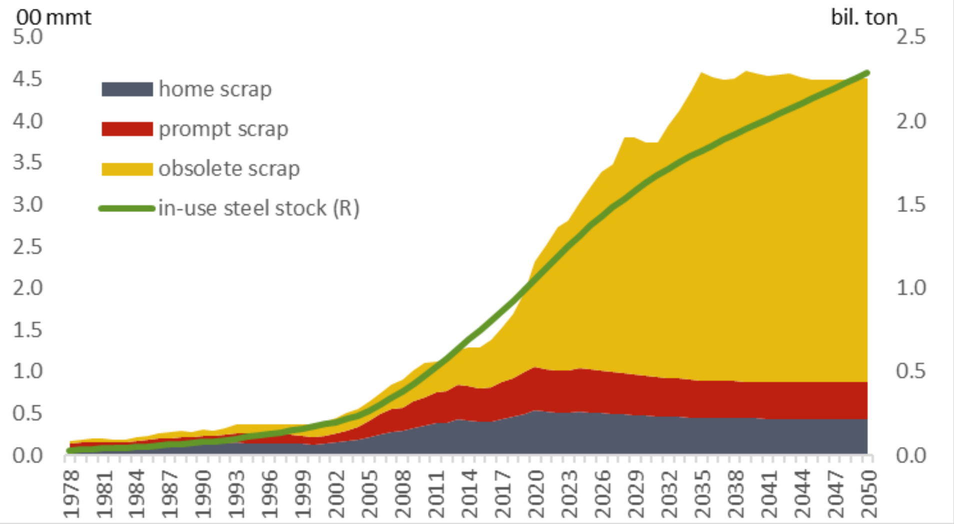
Decarbonization of global steel industry requires maximizing the use of scrap and DRI



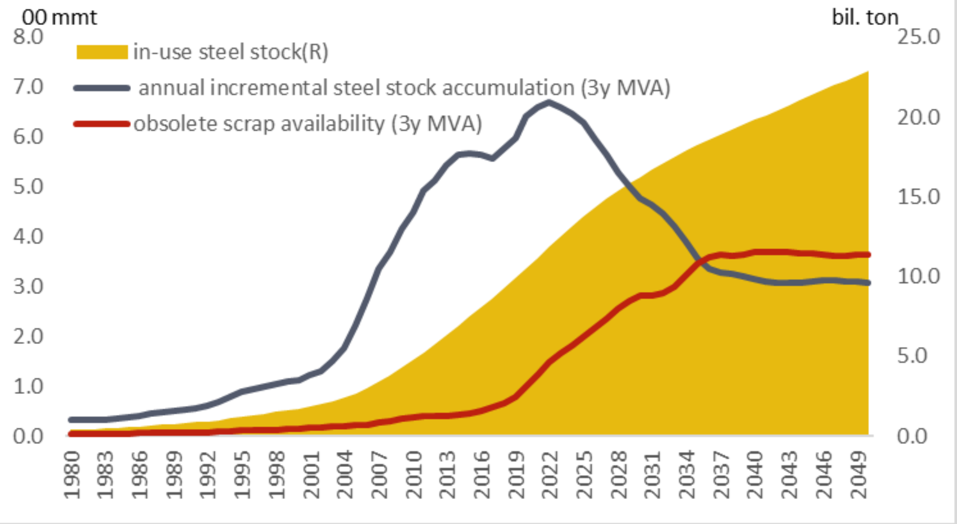
Source: worldsteel

China's in-use steel stock to double to 22.9 bil. tons, doubling scrap supply to 0.45 bil. tons by '50

China in-use steel stock and scrap resource forecast



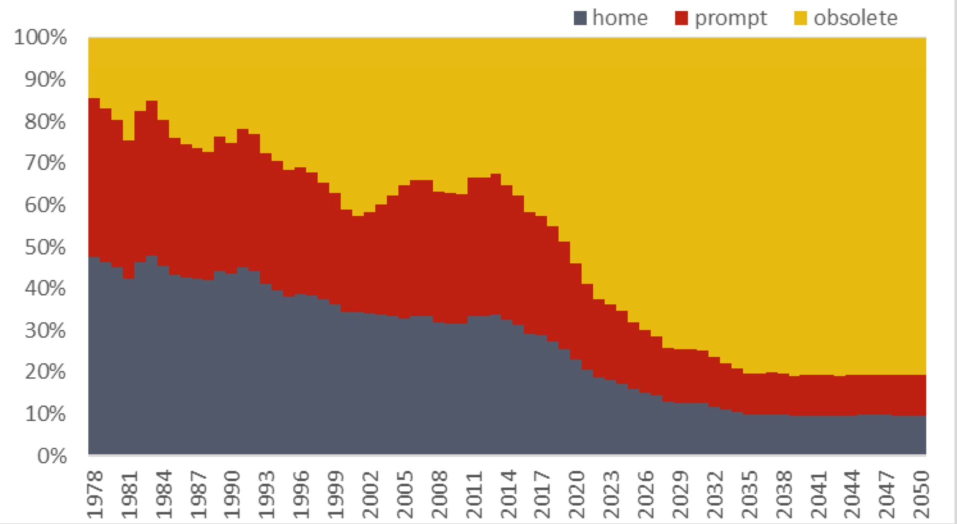
China in-use steel stock and obselete scrap availabilty forecast



China's Steel Stock and Scrap Generation/Resources Forecast

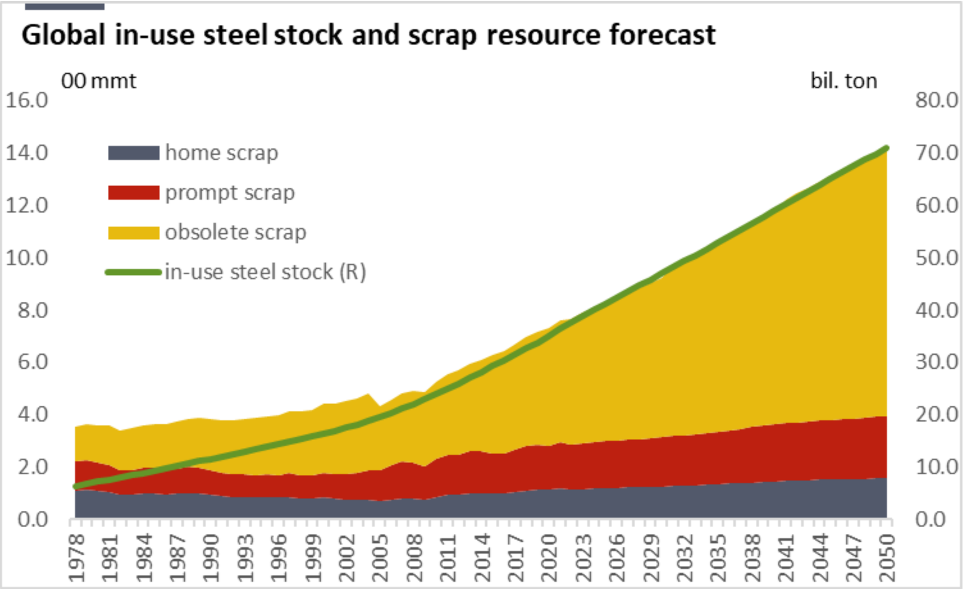
Year	Scrap Generation/Resources (mmt)				Share			Crude steel production	In-use Steel Stock	Per Capita In-use Steel Stock	Population
	home	prompt	obselete	total	home	prompt	obselete	mmt	bil. Ton	ton	billion
2000	13	9	15	37	34%	24%	41%	129	1.7	1.4	1.26
2010	38	37	38	113	34%	33%	33%	702	5.2	3.9	1.35
2020	53	53	125	231	23%	23%	54%	1065	10.5	7.4	1.42
2023	51	51	179	281	18%	18%	64%	1019	12.5	8.8	1.43
2030	48	48	279	375	13%	13%	75%	951	16.3	11.5	1.42
2035	45	45	369	458	10%	10%	80%	896	18.2	13.0	1.40
2040	44	44	369	457	10%	10%	81%	879	19.8	14.4	1.38
2050	43	43	364	451	10%	10%	81%	869	22.9	17.4	1.31
2023-2035	-6	-6	190	177				-123	5.7	4.2	-0.03
2035-2050	-1	-1	-5	-8				-27	4.7	4.4	-0.09
2023-2050	-8	-8	185	170				-150	10.4	8.7	-0.11
2023-2035CAGR	-1.1%	-1.1%	6.2%	4.2%				-1.1%	3.2%	3.3%	-0.2%
2035-2050CAGR	-0.2%	-0.2%	-0.1%	-0.1%				-0.2%	1.5%	2.0%	-0.4%
2023-2050CAGR	-0.6%	-0.6%	2.7%	1.8%				-0.6%	2.3%	2.6%	-0.3%

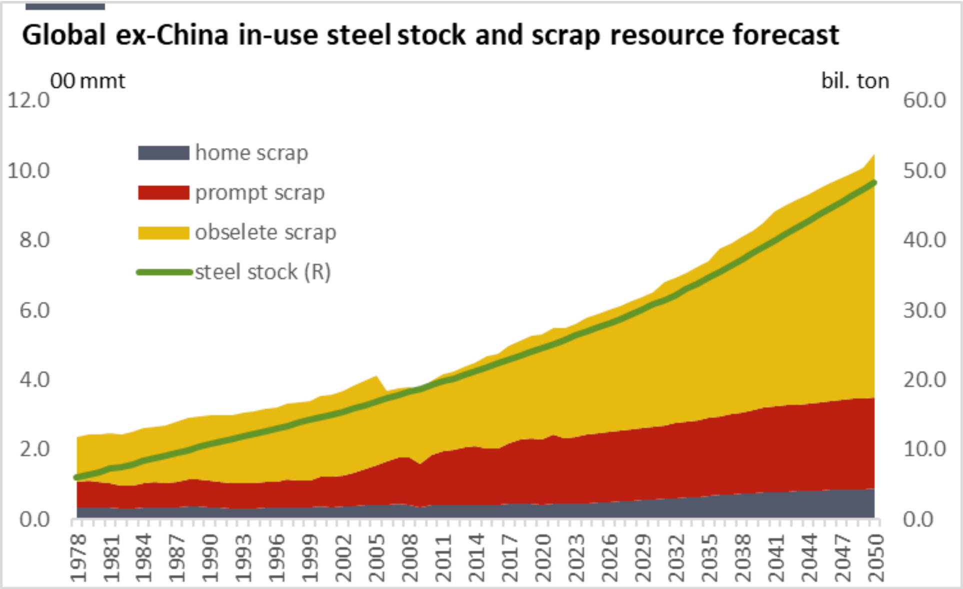
China scrap composition forecast



Source: Author's Estimation

Global in-use steel stock to double to 71.1bil. tons, scrap supply to increase CAGR 3.1% to 1.42 bil. tons by ’50

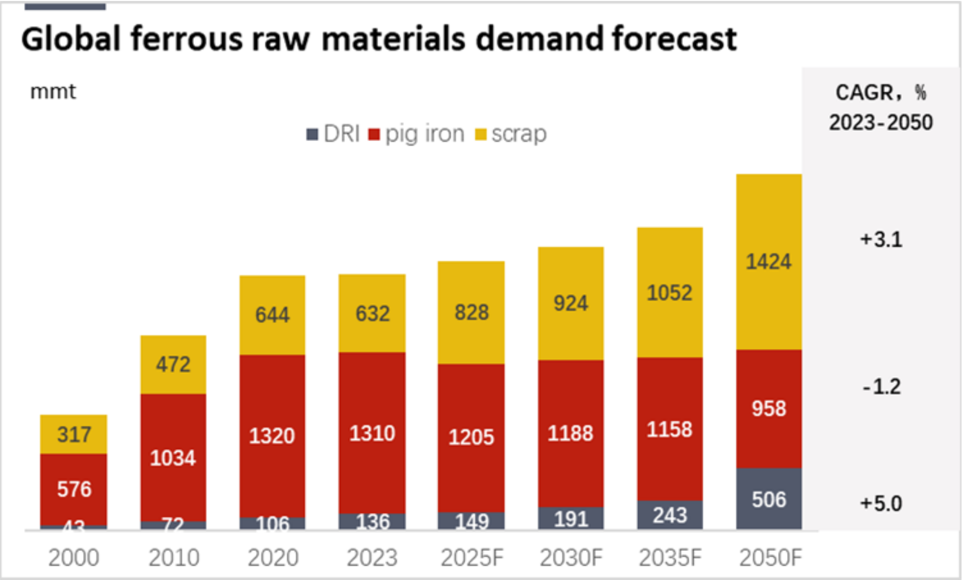


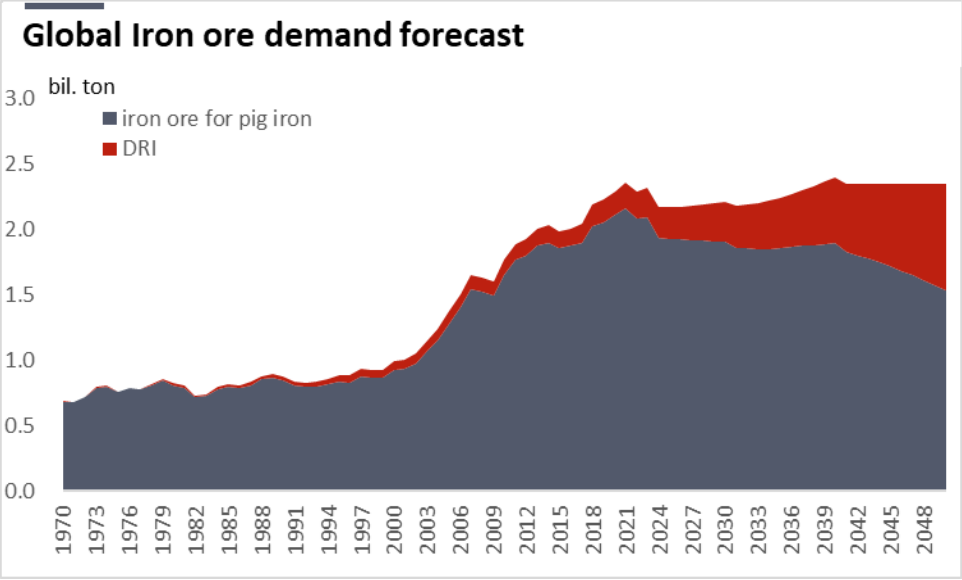


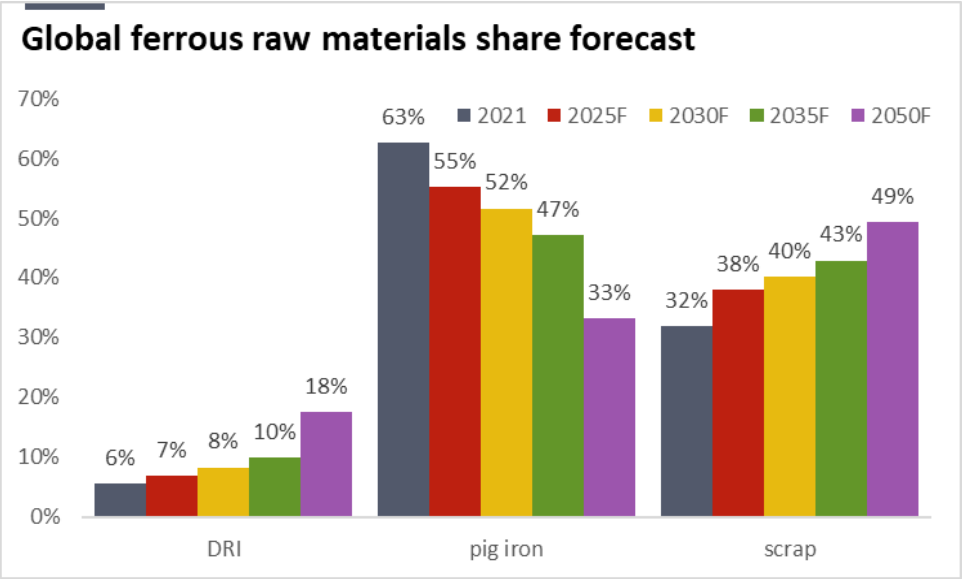
Year	Crude steel production (mmt)			Scrap Generation/Resources (mmt)			In-use Steel Stock (bil. ton)			Per Capita In-use Steel Stock (ton)			Population (billion)		
	Global	China	Global ex-China	Global	China	Global ex-China	Global	China	Global ex-China	Global	China	Global ex-China	Global	China	Global ex-China
2000	850	129	722	317	10	306	16.4	1.7	14.6	2.7	1.4	3.0	6.15	1.26	4.88
2010	1435	639	796	472	107	365	23.9	4.7	19.2	3.4	3.5	3.4	6.99	1.35	5.64
2020	1882	1065	817	644	282	361	35.1	10.5	24.5	4.5	7.4	3.8	7.84	1.42	6.42
2023	1888	1019	869	632	250	382	38.9	12.5	26.4	4.8	8.8	4.0	8.05	1.43	6.62
2025	1984	1029	955	828	322	506	41.2	13.7	27.5	5.0	9.6	4.1	8.19	1.42	6.77
2030	2093	951	1142	924	375	549	47.0	16.3	30.8	5.5	11.5	4.3	8.55	1.42	7.13
2035	2231	896	1335	1052	458	594	52.8	18.2	34.6	6.0	13.0	4.6	8.88	1.40	7.48
2040	2424	879	1545	1170	457	713	58.9	19.8	39.1	6.4	14.4	5.0	9.19	1.38	7.81
2050	**2625**	**869**	**1757**	**1424**	**451**	**973**	**71.1**	**22.9**	**48.2**	**7.3**	**17.4**	**5.7**	**9.71**	**1.31**	**8.40**
2020-2035	349	-169	517	409	176	233	17.7	7.7	10.1	1.5	5.6	0.8	1.0	0.0	1.1
2035-2050	395	-27	422	371	-8	379	18.3	4.7	13.6	1.4	4.4	1.1	0.8	-0.1	0.9
2020-2050	743	-196	939	780	168	612	36.0	12.4	23.6	2.8	10.0	1.9	1.9	-0.1	2.0
2020-2035CAGR	1.1%	-1.1%	3.3%	3.3%	3.3%	3.4%	2.8%	3.7%	2.3%	1.9%	3.8%	1.3%	0.8%	-0.1%	1.0%
2035-2050CAGR	1.1%	-0.2%	1.8%	2.0%	-0.1%	3.3%	2.0%	1.5%	2.2%	1.4%	2.0%	1.4%	0.6%	-0.4%	0.8%
2023-2050CAGR	1.2%	-0.6%	2.6%	3.1%	2.2%	3.5%	2.3%	2.3%	2.3%	1.5%	2.6%	1.4%	0.7%	-0.3%	0.9%

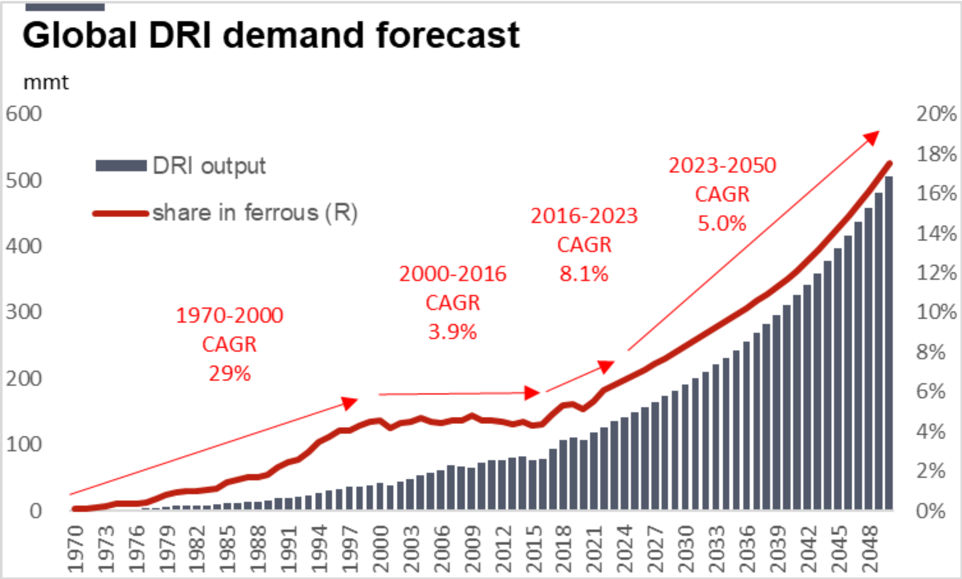
Source: Author's Estimation

Iron ore demand to mirror 2023's level at 2.34 bil. tons, DRI demand to triple, reaching 506 mmt by '50









Source: Author's Estimation

Conclusions

Past, Present, and Future of Global Metallic Mix

- From 2000 to 2023, annual growth rates for global crude steel, pig iron, DRI, and scrap steel were 3.5%, 3.6%, 5.0%, and 3.1%.
- In 2023, global crude steel output hit 1.888 billion tons, with pig iron, DRI, and scrap at 1.31 billion, 136 million, and 630 million tons, taking up 63%, 7%, and 30% of iron content, respectively.
- By 2050, global crude steel output is expected reach 2.63 billion tons, with pig iron, DRI, and scrap at 960 million, 506 million, and 1.42 billion tons, representing 33%, 18%, and 49% of iron content, with growth rates of -1.2%, +5.0%, and +3.1%.

In-use Steel Stock forecast

- From 1870-2022, global in-use steel stock reached 37.6 bt, with a per capita of 4.7 tons.
- In 2000-2022, an additional 21.2 bt were added, 56% of the total, which will be converted into scrap in 20-40 years.
- Global in-use steel stock was 38.9 bt in 2023, projected to double to 71.2 billion by 2050, with a per capita of 7.3 tons.
- China’s in-use steel stock was 12.5 bt in 2020, expected to hit 22.9 bt by 2050.

Iron Ore and DRI Demand Forecast

- By 2050, global pig iron and DRI output is expected to reach 1.47 billion tons; iron ore demand to stay at 2.34 billion tons, matching 2023 levels. Iron ore's iron content contribution to drop to 51%, down 19% from 2023.
- With decarbonization and limited high-quality scrap, DRI demand estimated to grow at 5% CAGR, reaching 506 million tons by 2050, making up 18% of iron content.

Scrap Availability Forecast

- Global scrap availability is projected to grow at a CAGR of 3.1% to 1.42 bt, accounting for 49% of the iron content in the global crude steel output of 2.63 bt by 2050.
- China's scrap availability is expected to grow at a CAGR of 2.0% to 450 million tons, representing 51% of the iron content in China's crude steel output of 869 million tons by 2050.

Appendix: Source Report

The methodology and long-term forecasts in this presentation are adapted from my paper:

“China and Global Steel Demand Forecast Through 2050”

Published in *Iron & Steel Technology* (AIST), June 2025.

📄 Full report available at: 🔗 [AIST Website]

(Scan QR code to download full report)

END