



The future of scrap supply

Global and regional perspectives

Ville-Valtteri Visuri

Associate Professor, Deputy Head
Process Metallurgy Research Unit
University of Oulu

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The Role of Scrap in Steel Sector Decarbonization



Stig-Göran Nilsson (2002)
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Steel production and consumption

Production

- China is by far the largest steel producer and is followed by the EU, USA and Russia.
- The apparent steel use by capita varies greatly by region (2021).^[1]
 - World 233 kg/capita
 - USA 291 kg/capita
 - EU 344 kg/capita
 - China 667 kg/capita
 - S. Korea 1076 kg/capita
- Most of the recent growth of steel use is attributable to China.

References

[1] World Steel Association, "World Steel in Figures 2022", 2022.

[2] Eurofer 2021

www.eurofer.eu

Crude steel production per region: World

PRODUCTION

All qualities • in '000,000 metric tonnes

REGIONS IN DESCENDING ORDER OF CRUDE STEEL PRODUCTION TABLE • 2020

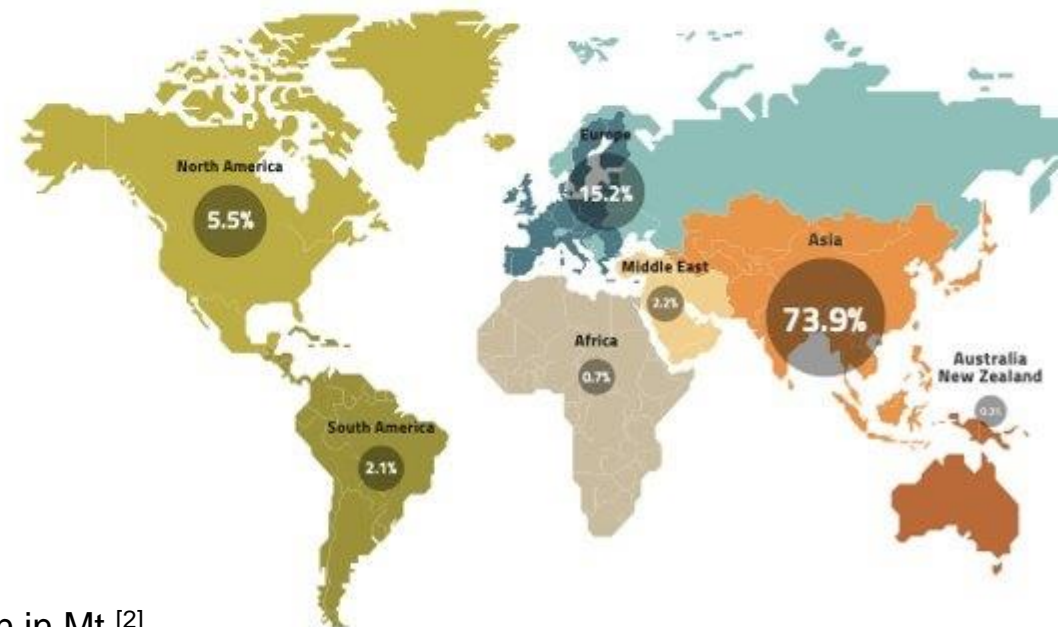
SOURCE: EUROFER

		% shares
	2020	2020
Asia	1,351.3	73.9%
▶ of which China	1,054.7	57.7%
▶ of which India	100.3	5.5%
▶ of which Japan	83.2	4.6%
Europe	278.1	15.2%
▶ of which European Union	139.3	7.6%
▶ of which CIS	100	5.5%
North America	101	5.5%
of which United States	72.7	4.0%
South America	38.2	2.1%
Middle East	40.7	2.2%
Africa	12.6	0.7%
Australia/New Zealand	6.1	0.3%
WORLD	1,828.2	100%

MAP OF STEEL PRODUCTION BY REGION

MAP • 2020

SOURCE: EUROFER



Crude steel production per region in Mt.^[2]



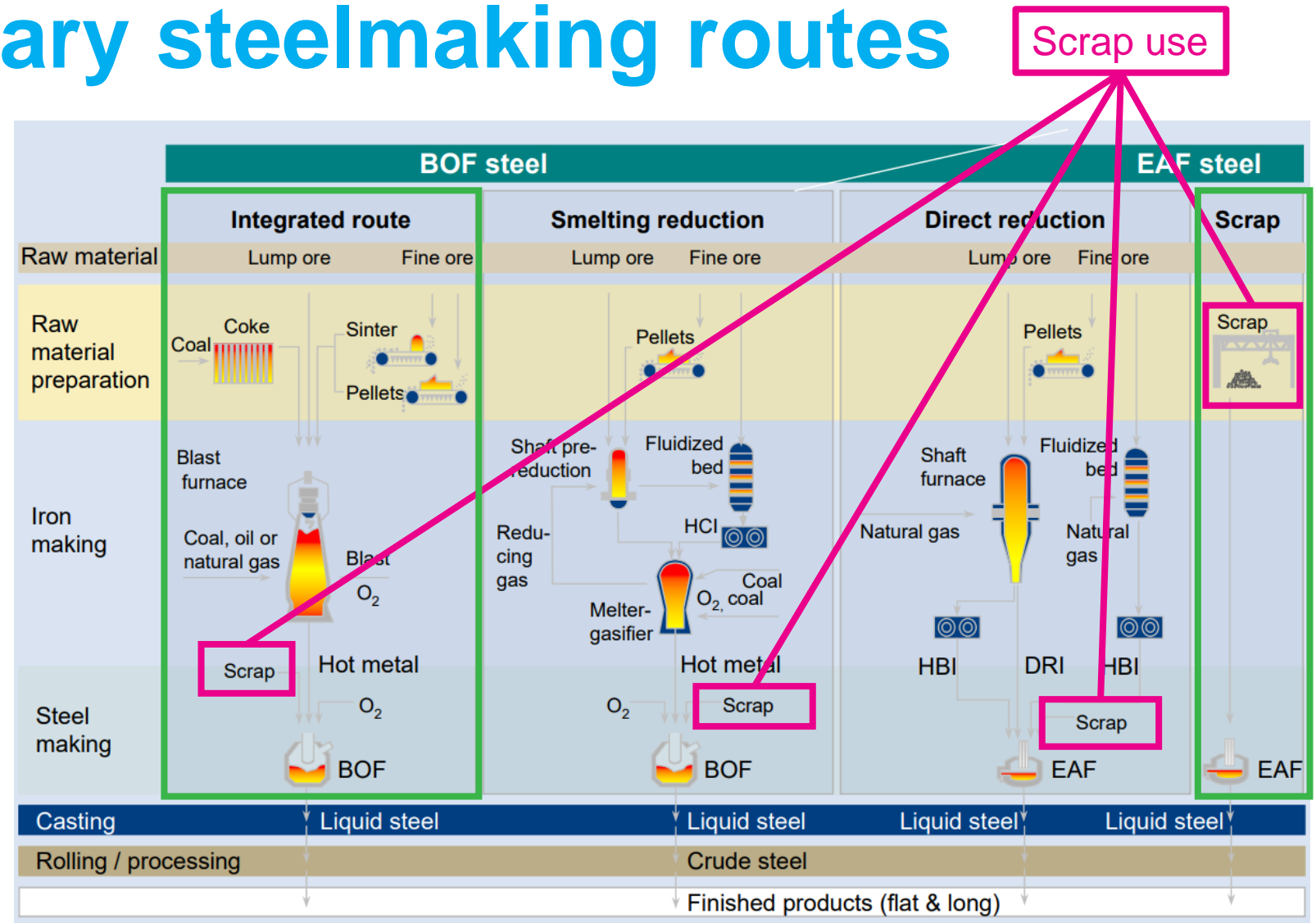
Contemporary steelmaking routes

Ore-based steelmaking

- Roughly 70% of crude steel production is iron ore –based.
- The most common route is the integrated route:
 - blast furnace (BF)
 - + basic oxygen furnace (BOF)
- The hot metal produced contains ~4.5 wt-% carbon that is removed in the BOF.
 - release of CO₂

Scrap-based steelmaking

- Roughly 30% of crude steel is produced from scrap using electric arc furnaces (EAF).



Steel production routes.^[1]

Reference

[1] J.T. Ghenda, "A Steel Roadmap for a Low Carbon Europe 2050", 2013.



Scrap use in steelmaking

EAF route vs the BF–BOF route

- EAFs can be operated using up to 100% scrap.
 - EAF-based steel plants (0.5–2 Mt/pa) are the main users of scrap in the steel industry.
 - Scrap can be supplemented flexibly with *direct reduced iron* (DRI) or *hot briquetted iron* (HBI).
- BOFs are also charged with scrap for cooling.
 - On average, 12.5% of scrap is used, but scrap shares up to 30% are technically possible.^[1]
 - Integrated steel plants (2–10 Mt/pa) are also significant scrap recyclers.
 - Increasing the scrap use in BOFs offers a possibility to reduce the direct CO₂ emissions.

EAF route	BF–BOF route
Raw materials per ton of steel ^[2]	Raw materials per ton of steel ^[2]
710 kg <u>steel scrap</u>	1370 kg iron ore
586 kg iron ore	780 kg coal
150 kg coal	270 kg limestone
88 kg limestone	<u>125 kg steel scrap</u>
2.3 GJ electricity	
Share of production in the EU in 2022. ^[3]	Share of production in the EU in 2022. ^[3]
44%	56%

References

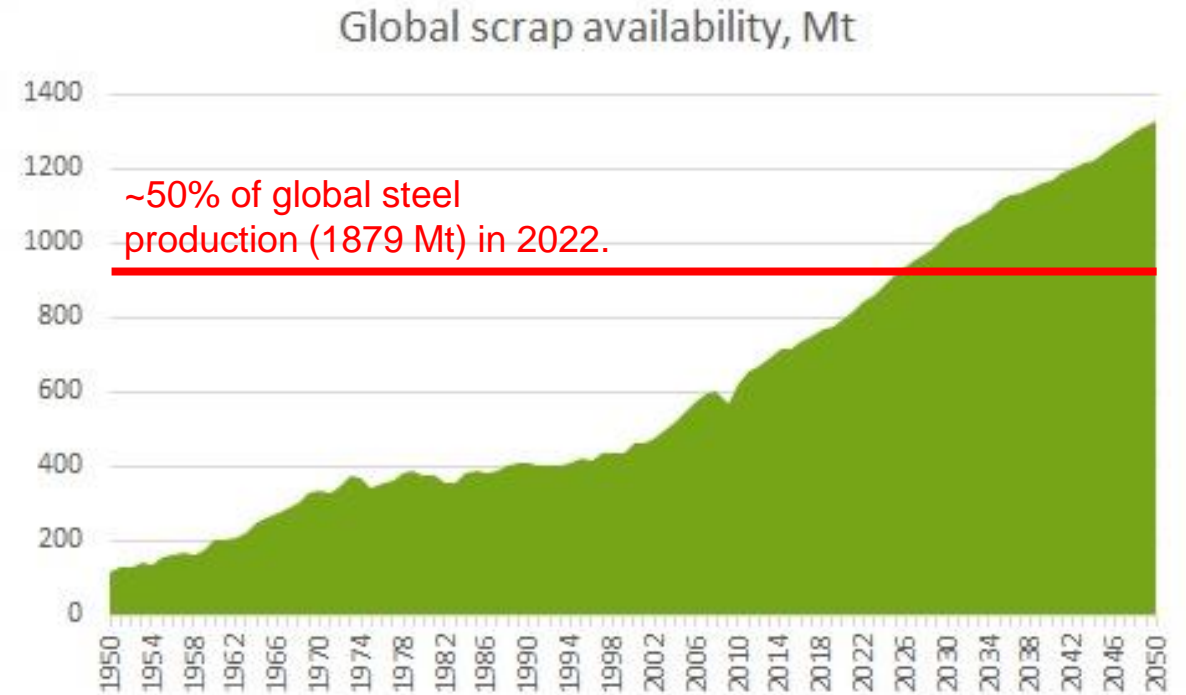
- [1] World Steel Association, "Fact sheet – steel and raw materials", 2023.
- [2] World Steel Association.
- [3] World Steel Association, "World Steel in Figures 2022", 2022.



Scrap availability

Global availability

- The availability of scrap has increased substantially during the last decade.
- Due to the long lifetime of steel products, the availability of scrap follows the global steel production with a delay.
- Substantial iron ore –based production will still be needed in the foreseeable future.
 - Hydrogen-reduction of iron ore has been envisioned as a solution.
 - The DRI produced using hydrogen would be melted in an EAF, which would allow the use of scrap to supplement DRI.



Projections for global scrap availability.^[1]

Reference

[1] B.B. Çiftçi, "Blog: The future of global scrap availability", World Steel Association, 2.5.2018.



Scrap availability

Availability by region

- The greatest growth in the availability of scrap is expected in China and developing countries.
 - China's scrap availability is estimated to increase from about 200 Mt today to roughly 300 Mt by 2030 and 400 Mt by 2050.
 - The share of EAF steelmaking in China is relatively low, being 11% in 2021.^[1]
 - New EAF-based steel plants are expected to be commissioned in China.
- The availability of scrap in developed countries (NAFTA+EU+Japan) is projected to increase slightly to about 350 Mt by 2030.

References

[1] World Steel Association, "World Steel in Figures 2022", 2022.

[1] B.B. Çiftçi, "Blog: The future of global scrap availability", World Steel Association, 2.5.2018.

Global scrap availability, Mt



Projections for global scrap availability by region.^[2]

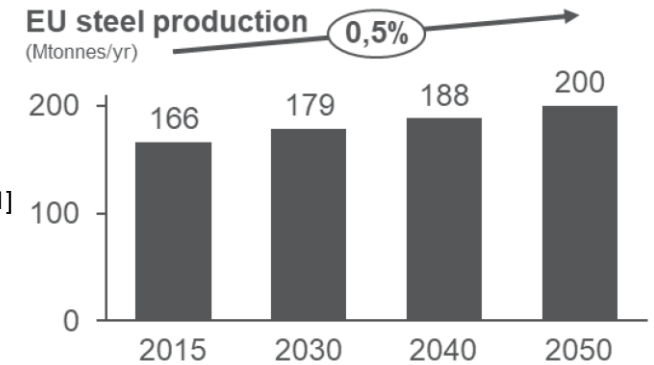


Scrap availability

Availability in the EU

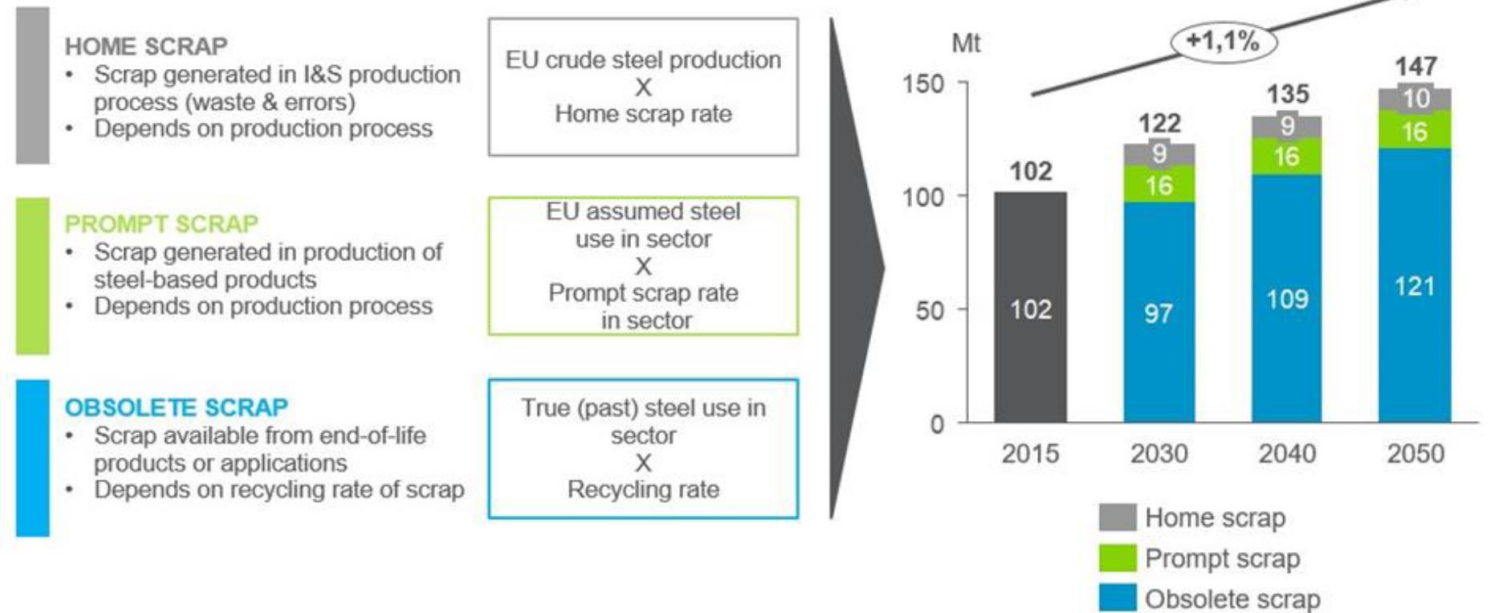
- Scrap is very important for EU's aims to reduce the CO₂ emissions.
- The availability of scrap is projected to increase at an annual rate of 1.1%, reaching 147 Mt by 2050.
- Meanwhile, the steel production is projected to increase at a slower rate of 0.5% to around 200 Mt by 2050.

There is a significant potential to reduce the direct CO₂ emissions by increasing the scrap use.



Forecast for steel production in the EU.^[1]

Scrap availability in EU28



Forecast for scrap availability in the EU28.^[1]

Steel production is assumed to grow annually by 0.5% until 2050.

Reference

[1] EUROFER, "Low Carbon Roadmap, Pathways to a CO₂-neutral European steel industry", European Steel Association, 2019.



Trade in ferrous scrap

World trade in ferrous scrap by area in 2021.^[1]

Destination	Exporting region										Total imports
	EU	Other Europe	Russia, other CIS, and Ukraine	USMCA	Other America	Africa and Middle East	China	Japan	Other Asia	Oceania	
EU	28.6	3.3	0.6	0.7	0.5	-	0.0	0.0	0.0	0.0	34.0
Other Europe	14.3	2.6	2.5	3.8	0.9	1.4	-	0.0	0.0	0.0	25.6
Russia, other CIS, and Ukraine	0.4	0.0	1.1	0.0	0.0	0.0	0.0	-	0.0	0.0	1.5
USMCA	0.6	0.3	0.0	8.4	0.0	0.0	0.0	-	-	-	8.7
Other America	0.0	0.0	-	0.8	0.3	0.0	-	-	0.0	0.0	1.1
Africa	2.2	1.6	0.1	0.5	0.0	0.2	-	-	0.0	0.0	4.5
Middle East	0.1	0.2	0.0	0.2	0.0	0.2	-	0.0	0.0	0.0	0.8
China	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.1	0.0	0.6
Japan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.1	0.0	0.1
Other Asia	1.8	2.7	0.9	8.8	2.0	3.5	0.0	6.9	2.9	2.7	32.1
Oceania	0.0	0.0	-	0.0	0.0	-	-	-	0.0	0.1	0.2
Total exports	47.9	10.9	5.1	23.3	3.8	5.5	0.0	7.3	3.2	2.8	109.8
Net exports	13.9	-14.7	3.7	14.0	2.6	0.2	-0.6	7.2	-28.9	2.6	

The EU, USA and Japan are the largest net exporters

Turkey, India and South Korea are the largest net importers

Reference
 [1] World Steel Association, "World Steel in Figures 2022", 2022.



Challenges

Economic challenges

- Price and availability of scrap.
- Price and availability of CO₂-lean electricity.
- Possible export restrictions for scrap.

Technical challenges

- Physical shape and size.
- Impurities can be detrimental for steel properties.
 - Copper and tin have a detrimental effect on hot rolling properties, but their content can be decreased only by dilution.
 - Radioactive substances.
- Variance of scrap properties → process variance.
- The reliability/transfer capacity of the electricity grid can limit construction of new EAF capacity.



Pia & Hans Nordlander (2015)
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Conclusions

1. Scrap plays a vital role for the decarbonisation of the steel industry.
2. The availability of scrap is projected to increase to especially in China and developing countries.
3. However, the availability of scrap will not match the rise global steel production in the foreseeable future.
4. The share of scrap-based steelmaking could rise to around 50% of the global total production by 2050.
5. In the EU, the importance of the EAF process will rise as it can be used to melt both scrap and DRI that can be produced CO₂-free using hydrogen reduction.



EASES

*European Academic Symposium on
EAF Steelmaking*

COMING UP NEXT WEEK

**5th European Academic
Symposium on EAF Steelmaking**

University of Oulu
05–07 June 2023

Chaired by
Ville-Valtteri Visuri
Thomas Echterhof



Thank you for your attention!

Contact

Ville-Valtteri Visuri

Associate Professor, Deputy Head

Process Metallurgy Research Unit

University of Oulu

PO Box 4300

90014 University of Oulu

+358 50 412 5642

ville-valtteri.visuri@oulu.fi



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