Ore Based Metallics for steelmaking via DRI Smelting furnace

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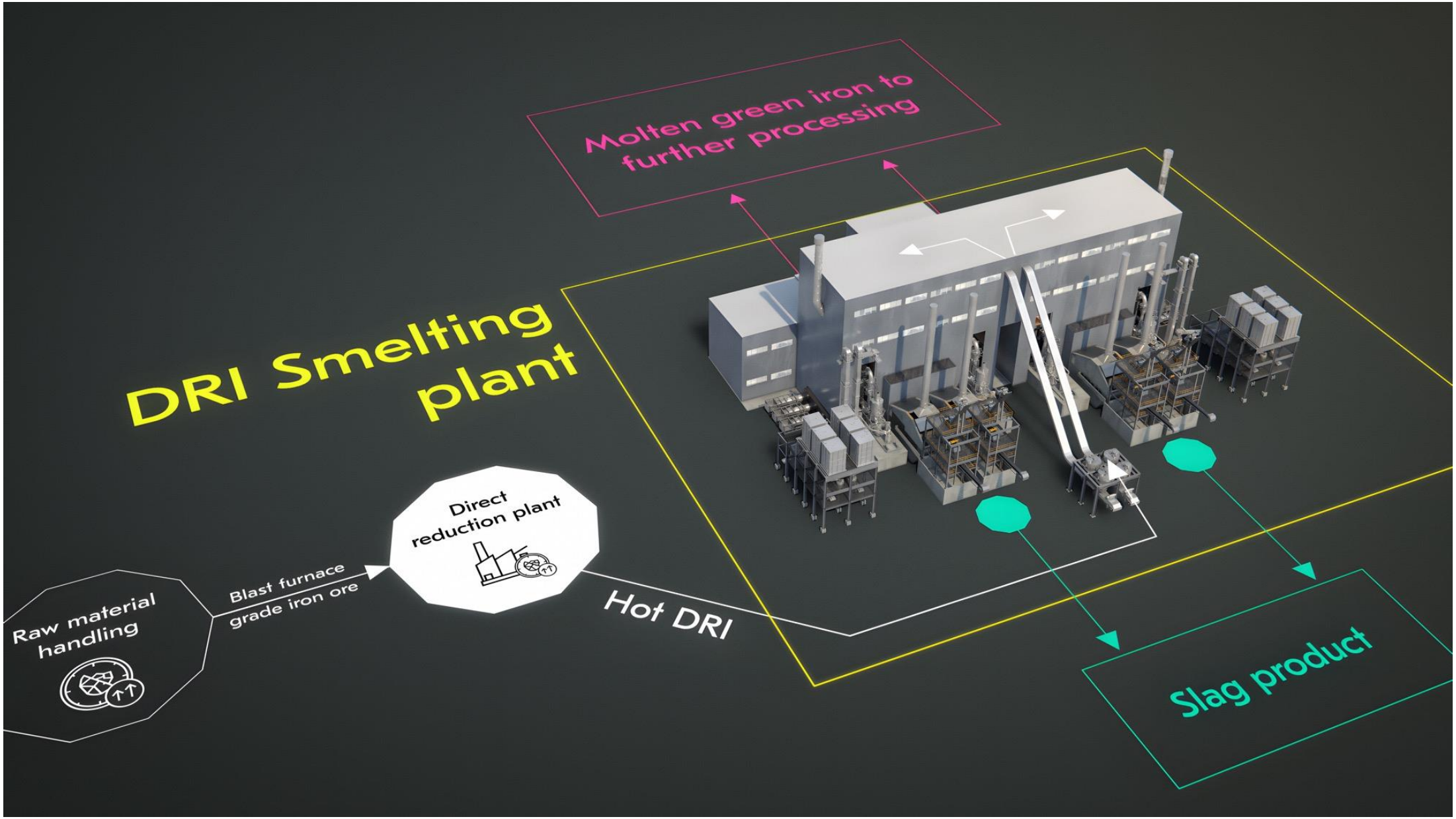
Introduction

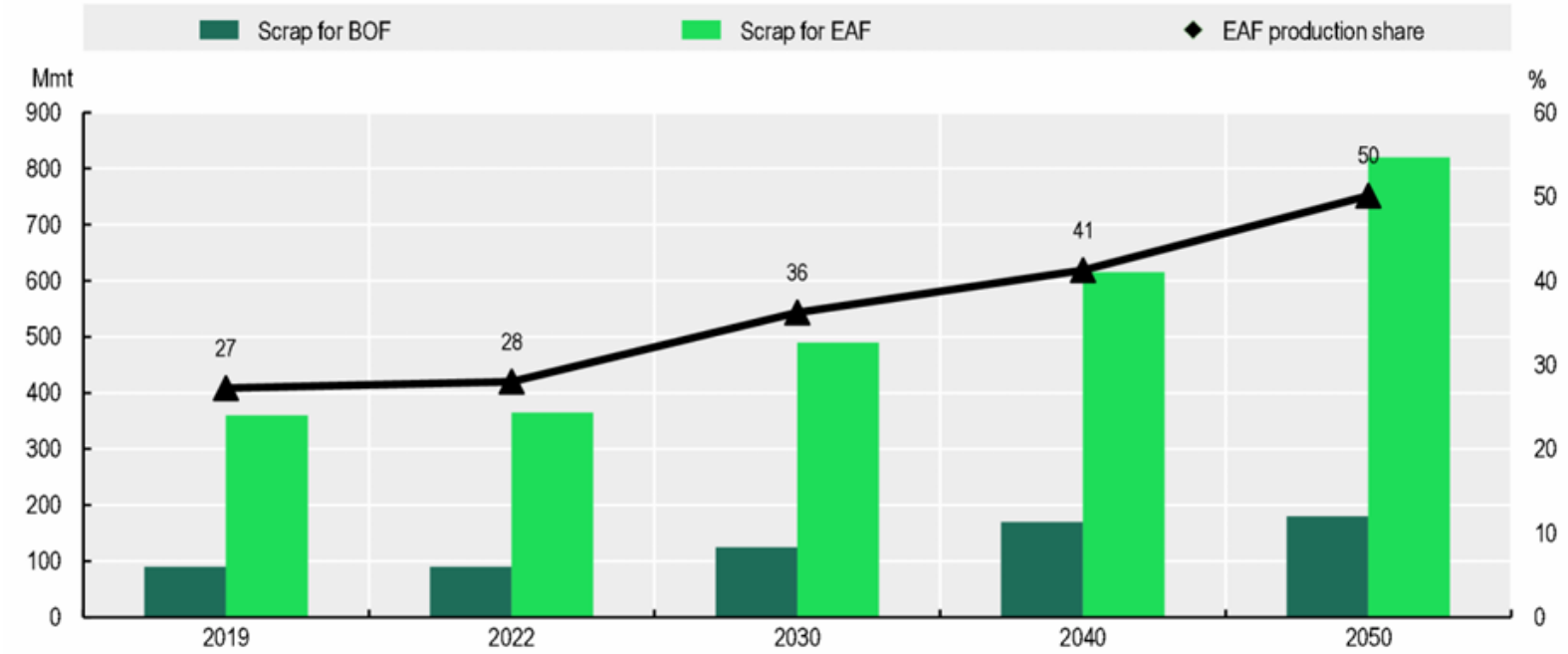
- The share of electric steelmaking via EAF has been increasing recently and this looks like the new normal
- A new process route DRP + ESF (=Direct Reduction Plant + Electric Smelting Furnace) has been proposed as an alternative for Blast Furnace (BF)
- The metal produced with an Electric DRI Smelting Furnace is originating from virgin iron units and is therefore a great OBM feed for steelmaking processes (EAF or BOF)
- This would be helping with scrap challenges (availability and quality)


Molten green iron to further processing
DRI Smelting plant
Direct reduction plant
Raw material handling
Blast furnace grade iron ore
Hot DRI
Slag product

Global scrap and EAF outlook

- EAF share is increasing
- Scrap consumption is increasing

Figure 3.4. Global consumption of scrap and share of EAF production, 2019-50

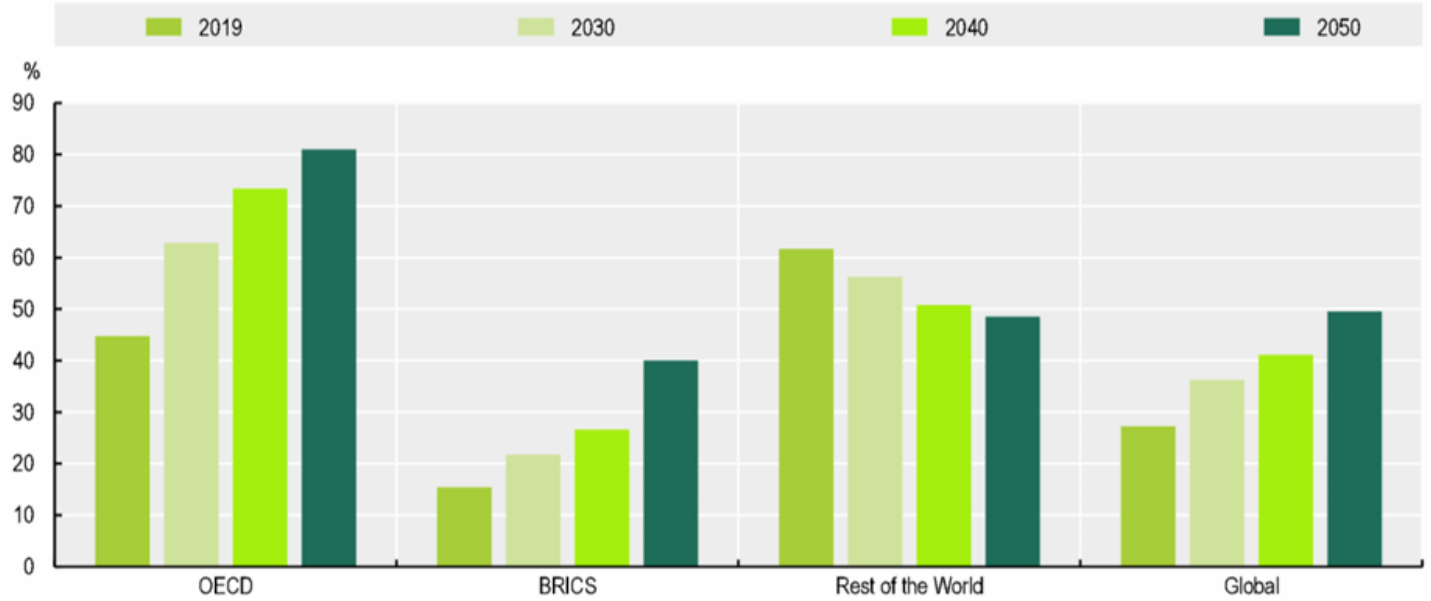


Note: Assumptions for EAF production shares, DRI charge rates for EAFs, and BOF hot metal ratios are given in Annex B.
Source: World Steel Dynamics (WSD) model.

EAF share in different regions

- Especially in the OECD countries the share of EAF is increasing
  - Scrap demand is increasing

Figure 3.5. Share of EAF production for aggregate regions

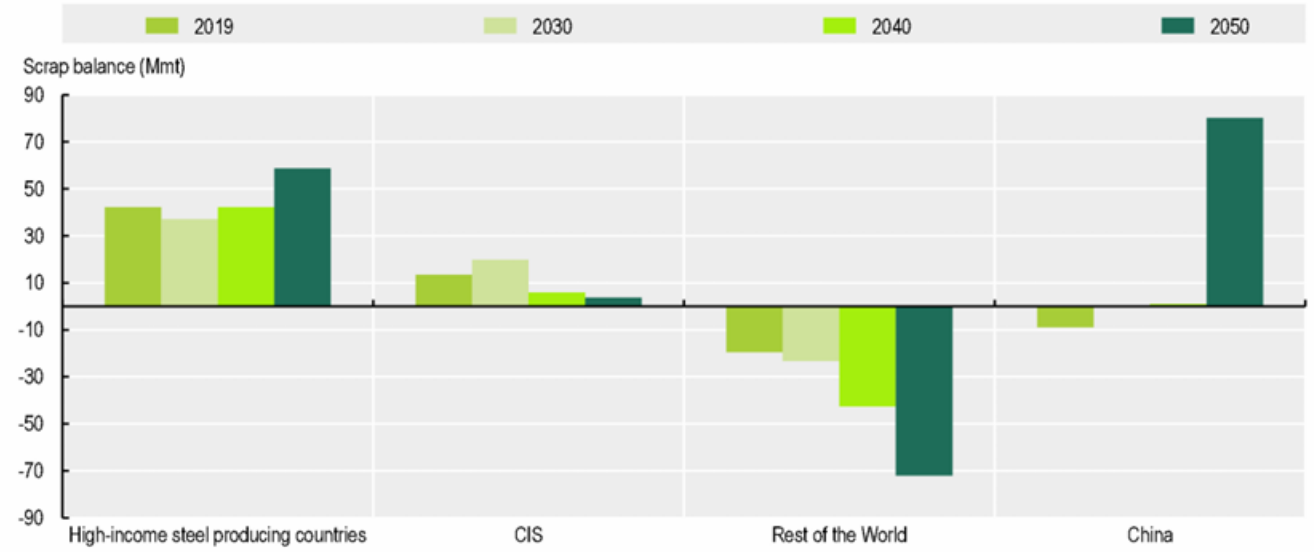


Source: World Steel Dynamics (WSD) model.

Scrap balance in regions

- Scrap balance outlook looks promising in the high income countries

Figure 3.7. Key trends of scrap balance in selected steel-producing countries, 2019-50

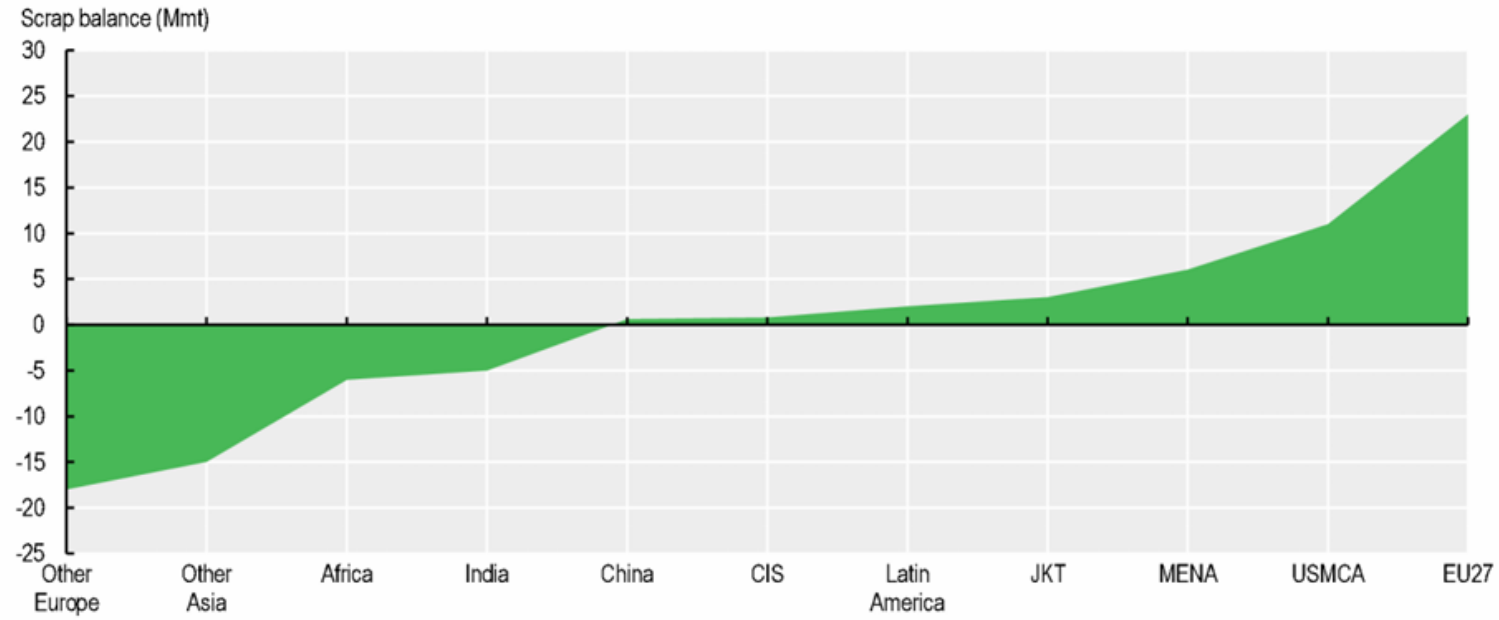


Note: See Annex B for more details on the country coverage by aggregate region. The CIS is separated as it is expected to show a sizeable recoverable surplus, at least through 2030, due to its historical steel consumption levels and low-cost iron ore and coal.
Source: World Steel Dynamics (WSD) model.

North-America scrap balance

- And for the North-America the balance looks good

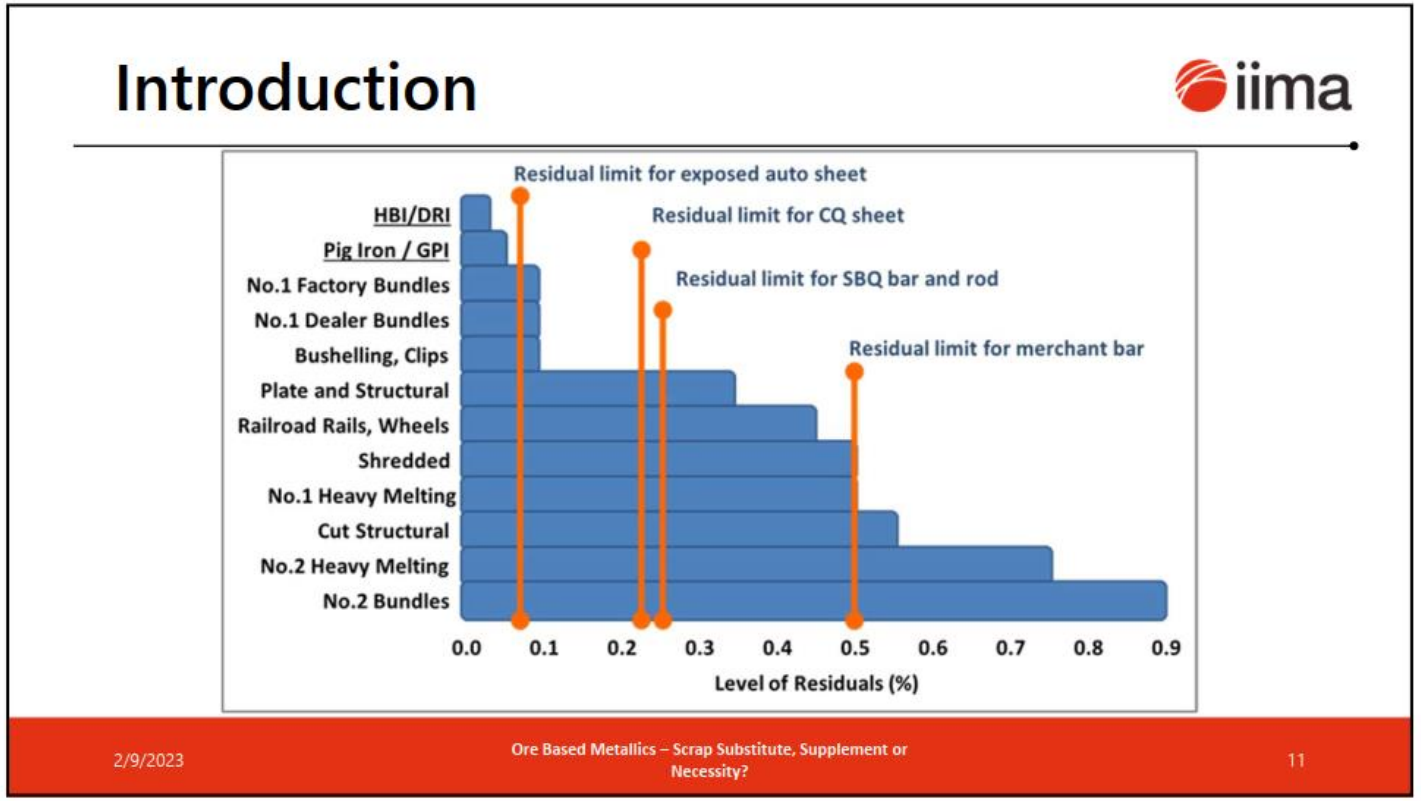
Figure 3.8. Regional dynamics for scrap balance by 2040



Note: Annex B provides more details on the country coverage by region. India like other countries is actively pursuing CCUS to reduce CO2 emissions from its BF/BOF production. An assessment of the prospects for CCUS adoption is outside the scope of this paper. The importance of scrap for India's steel decarbonisation remains under any CCUS adoption scenario at least through 2050.
Source: World Steel Dynamics (WSD) model.

Quality of scrap and limits for steel qualities

- But how about the quality of the scrap?
- How to make the same BF route steel qualities via EAF by adding more scrap?



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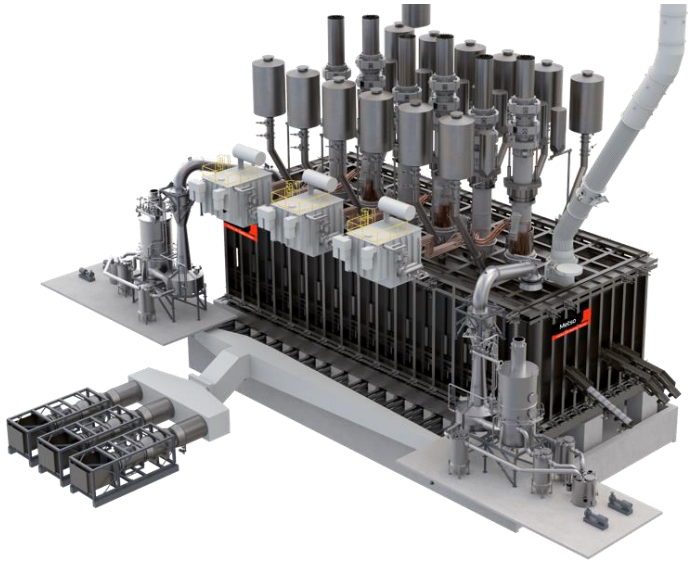
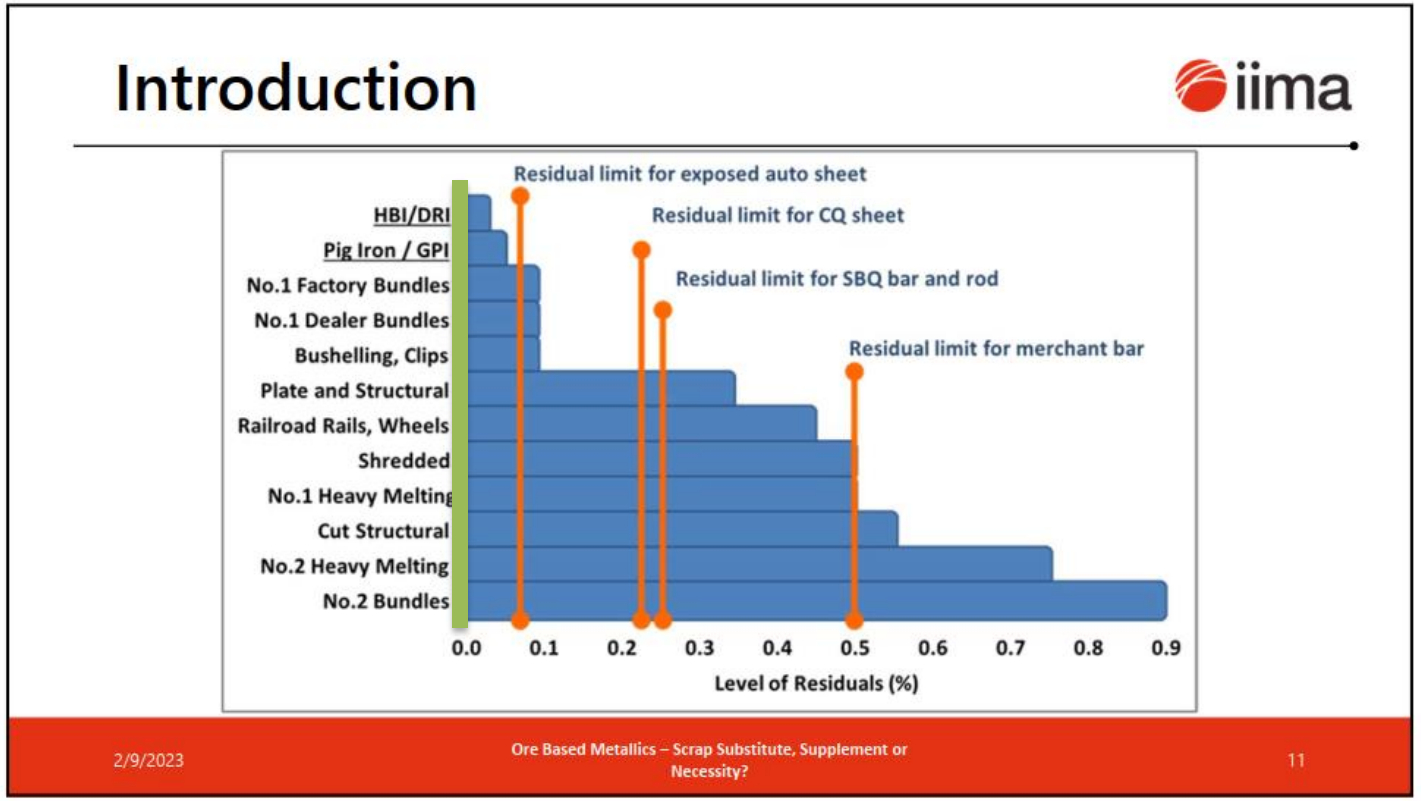
Quality of scrap and limits for steel qualities

- Producing DRI from iron ore and smelting it into metal produces clean metal without residuals
- Cu < 0.01% typically





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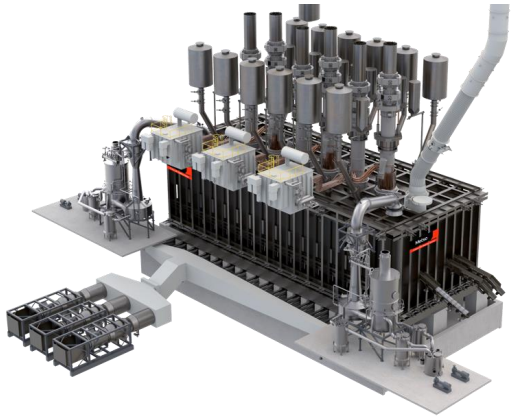
Typical DRI Smelting metal qualities

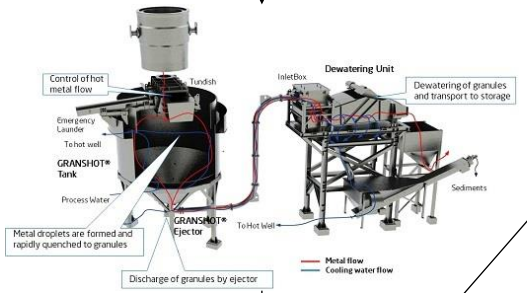
	Low carbon metal	Medium carbon metal
Fe	More than 98%	More than 96%
C	1% or less	1% – 3%
Si	0.1%	0.2 – 0.6%
P	0.1%	0.1%
S	0.01%	0.03%
Mn	0.3 – 1.0%	0.3 – 1.0%
Cu	0.01%	0.01%
Ni	0.01%	0.01%
Cr	0.01%	0.01%
Ti	0.01%	0.01%
Usage	EAF	EAF or BOF

- Carbon
  - BOF needs at least 2.5% carbon
  - EAF could use 1% carbon or less, but likes to have more, to ensure better foaming
- Silicon
  - Not too much, not a problem
- Phosphorous
  - Needs to be oxidized (EAF or LF)
- Sulphur
  - Not too much, not a problem
- Manganese
  - Depends… sometimes to be oxidized
- Metallic residuals
  - Not too much, not a problem

”Molten green iron for further processing”

De-coupling iron and steel production

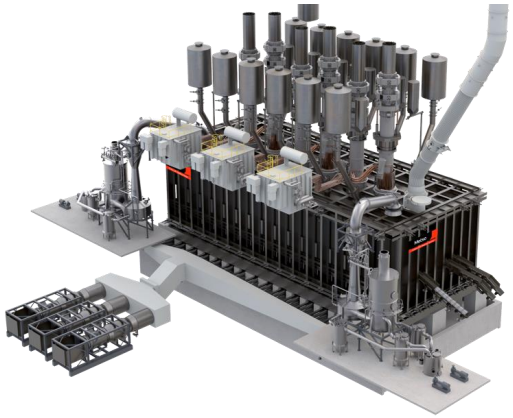




”Molten green iron for further processing”

Integrated to steel plant

DRI Smelting Furnace



BOF

LF

CCM

EAF

Feasibility of DRI Smelting route to metallics / steel

NG +50$/t

H2… +150…250 $/t

l and utili

m

DRI smelting Metal 440$/t (1,15 t DRI/t metal)

For comparison:
- Steel scrap 400…500 $/t
- Brazil BF pig iron 420/t $ with no penalties on carbon (0.5 t/t metal), +20$/t logistics

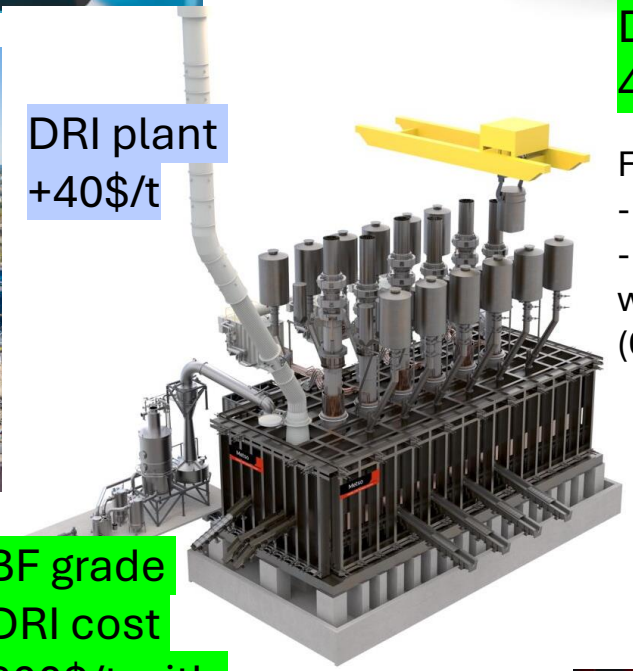
Steel price in USA 700…900$/t

BF Ore 100$/t

- Pellets +10 $/t

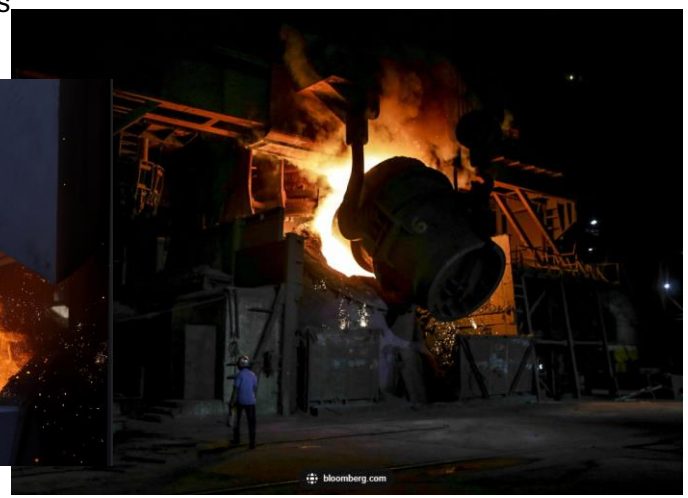
- DR ore pellets +50$/t)

DRI plant +40$/t



BF grade DRI cost 300$/t with natural gas (1,5 t pellets for 1 t DRI)

DRI smelting +80$/t



Conclusions

- Globally the scrap demand is tightening
- Meanwhile the scrap quality would need to be increased, to enable producing the blast furnace route steel grades
- An electric DRI smelting furnace could be one possibility to produce clean ore based metallics for the steel production processes
- Need to evaluate case by case the overall process route and it technical and economical feasibility, but in generally speaking it is looking promising
- EAF customers typically a bit conservative in using lower carbon containing OBMs in their scrap mix → let's try and demonstrate this?!

Thank You!

Metso