THE IRREPLACEABLE NEED FOR CARBON OF A TRANSFORMED STEEL INDUSTRY

Christoph Feilmayr
voestalpine Stahl GmbH

Johannes Gabl
K1-MET GmbH

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K1 MET
metallurgical competence center

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Steel production in Linz: 5 Mt/y
Employees, worldwide: 50.000

TRANSFORMATION of steel industry

- AIM: Replace CARBON by HYDROGEN & ELECTRICITY!

- **HYDROGEN**: chemical reduction from ore to iron
- **ELECTRICITY**: energy for heating & smelting

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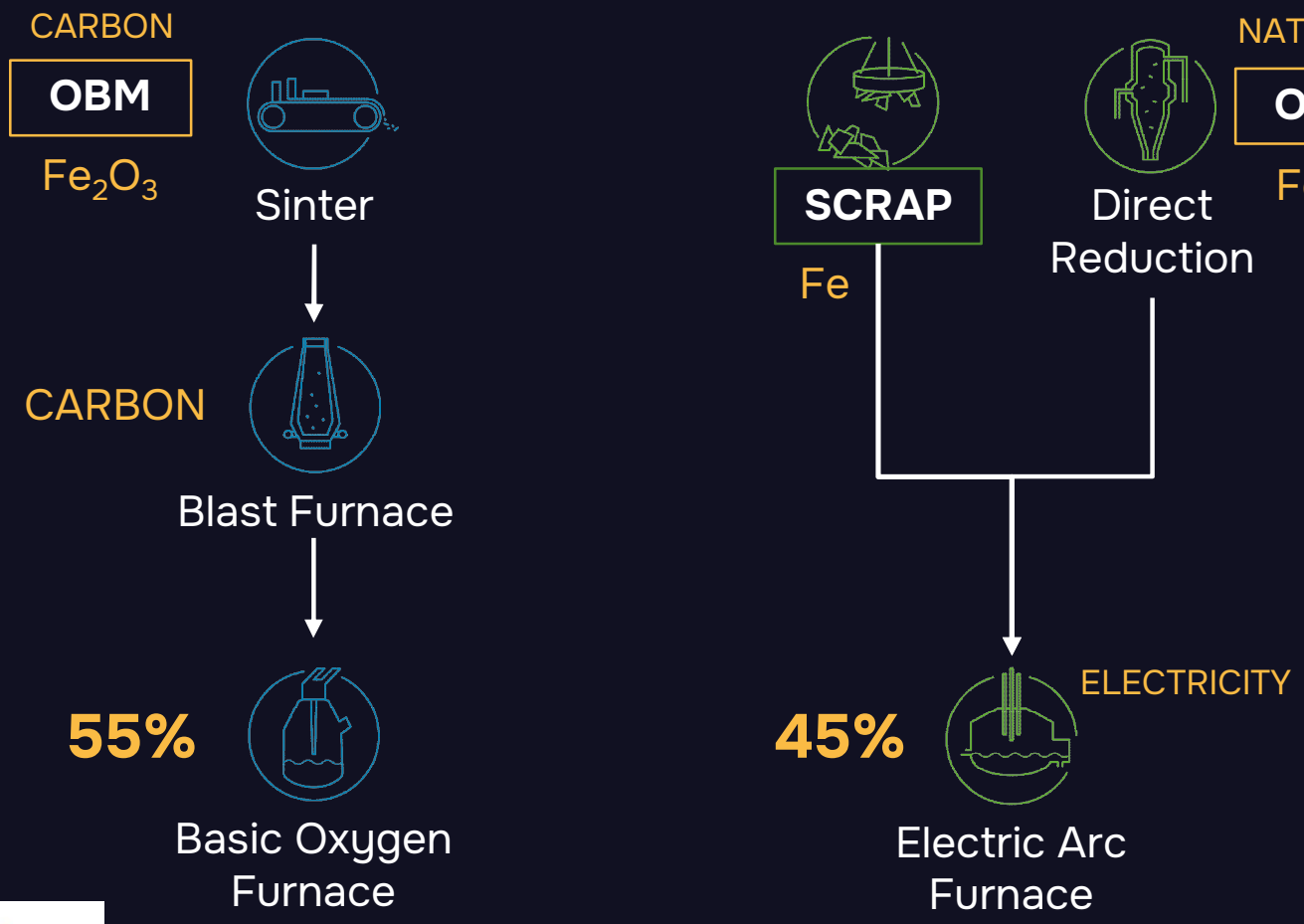
Existing Steelmaking Routes: BF-BOF, DR-EAF



OBM: ore based material

EU production share 2023

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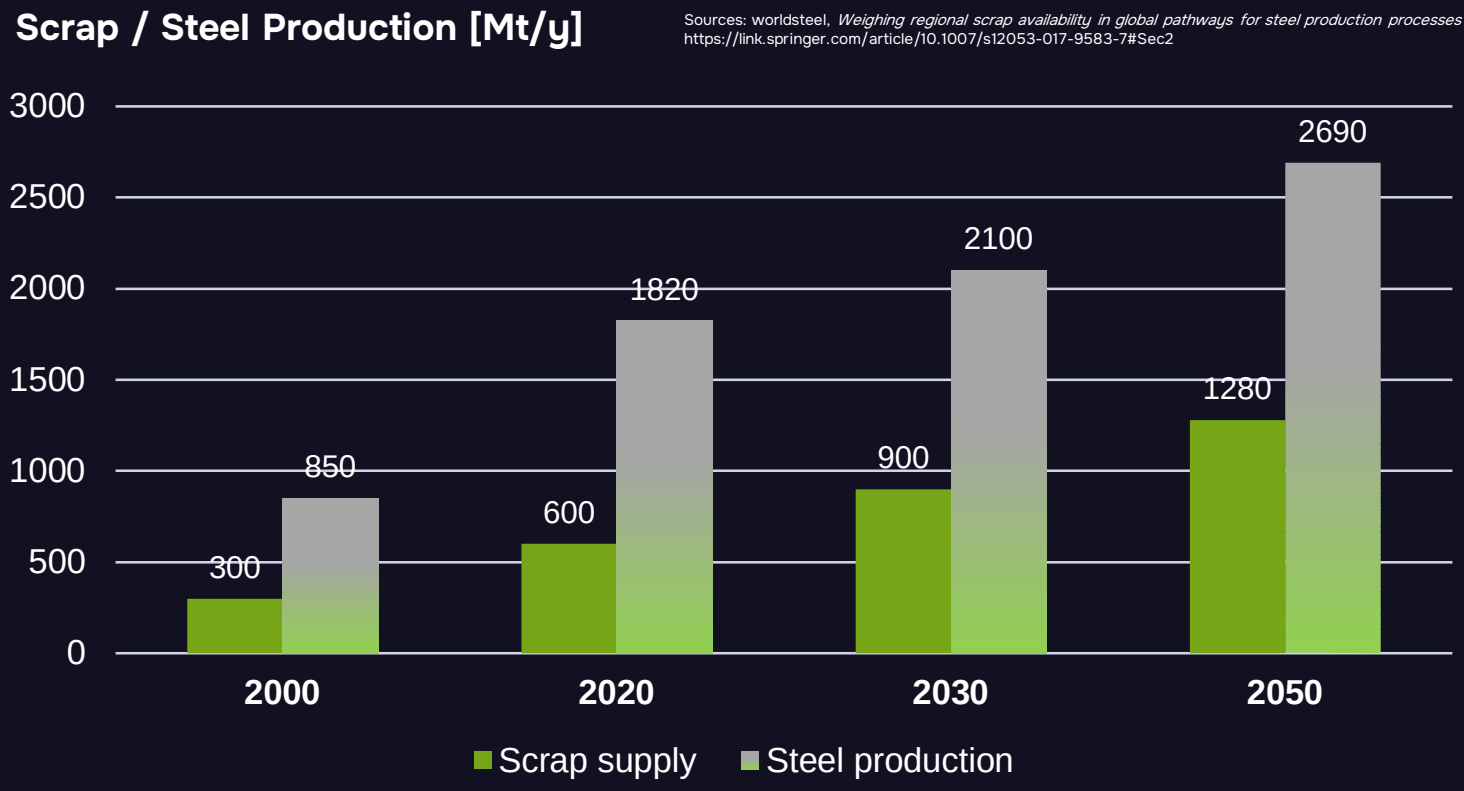
Scrap is not enough!



We need OBM!

- Steel demand is higher than scrap supply!
- Scrap contains impurities!

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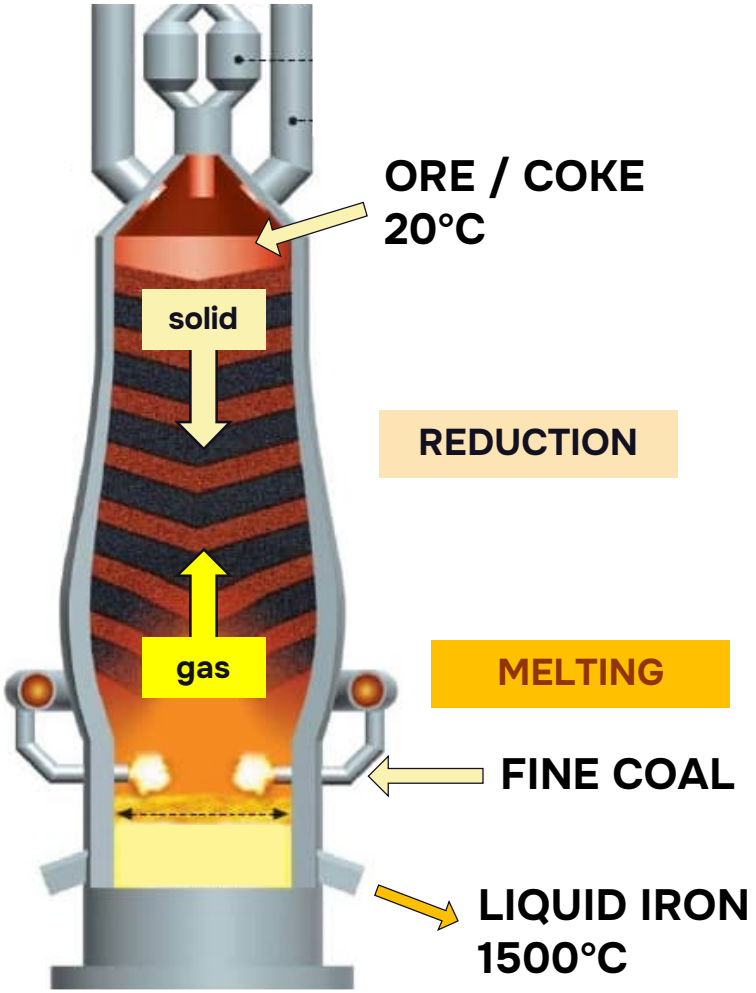
Blast Furnace Process



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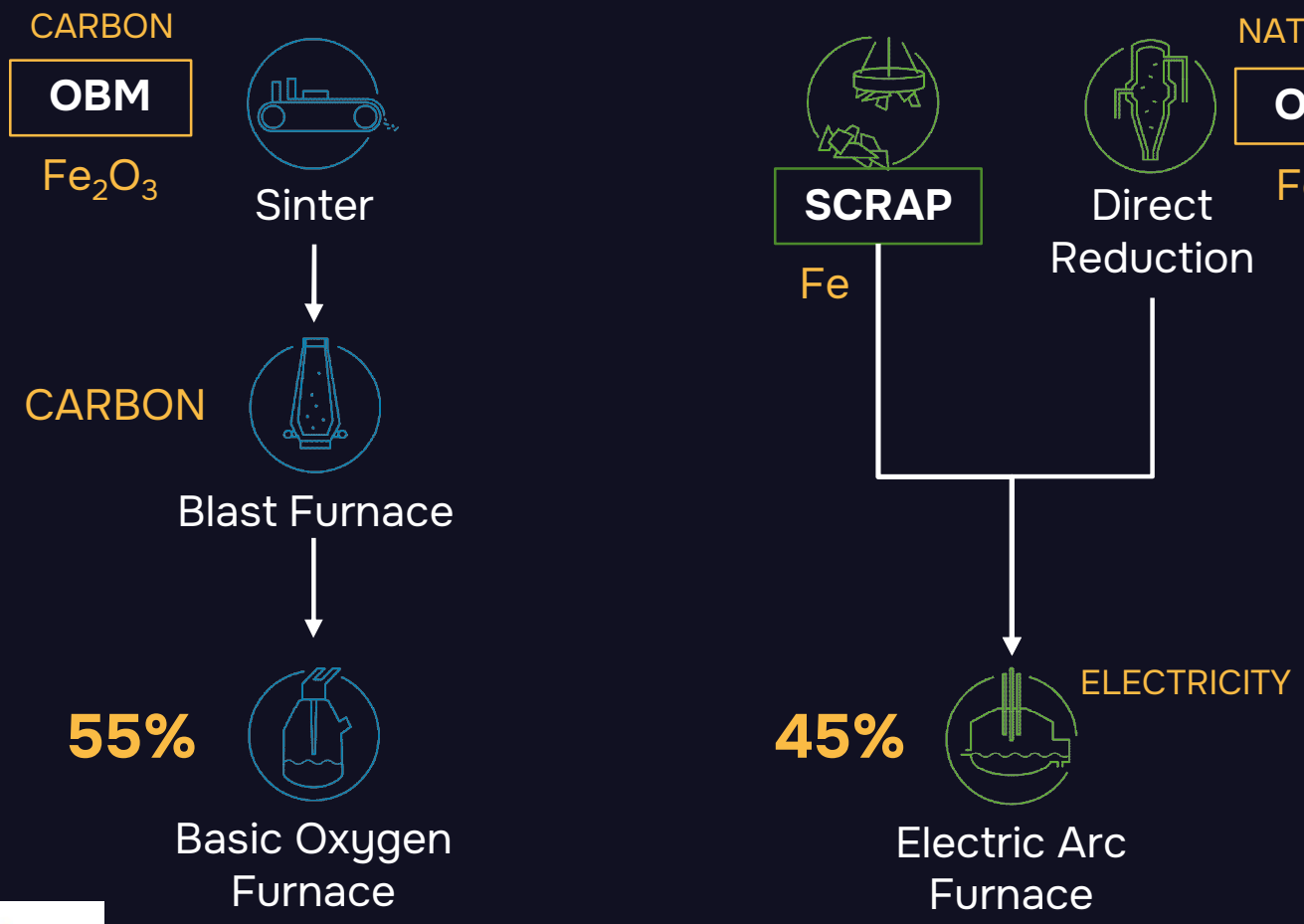
OBM: lump ore

coke

pulverized coal (PCI)

Material	kg/t iron	Carbon	Replaceable
Ore	1.600 kg	0%	0%
Coke	300 kg	88%	0%
PCI	150 kg	80%	100%

Existing Steelmaking Routes: BF-BOF, DR-EAF



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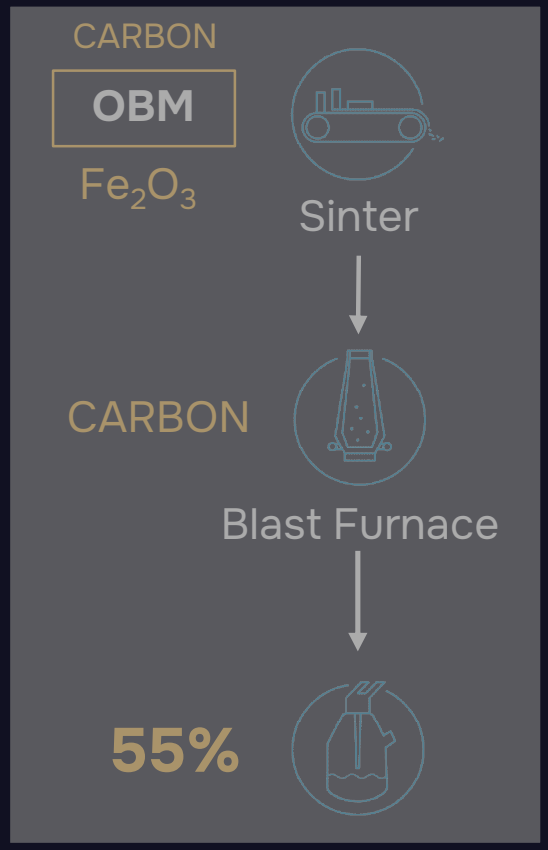
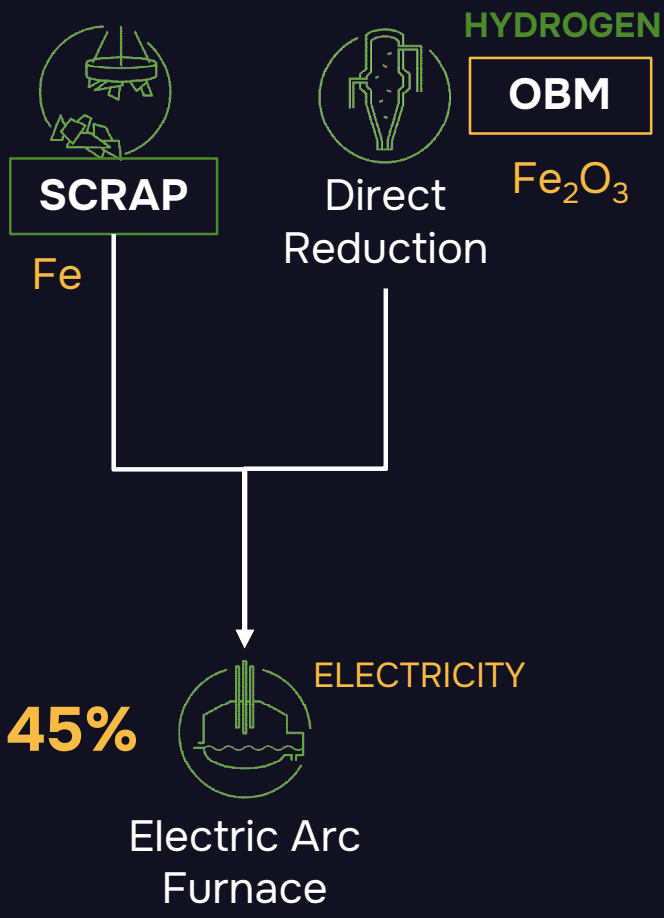
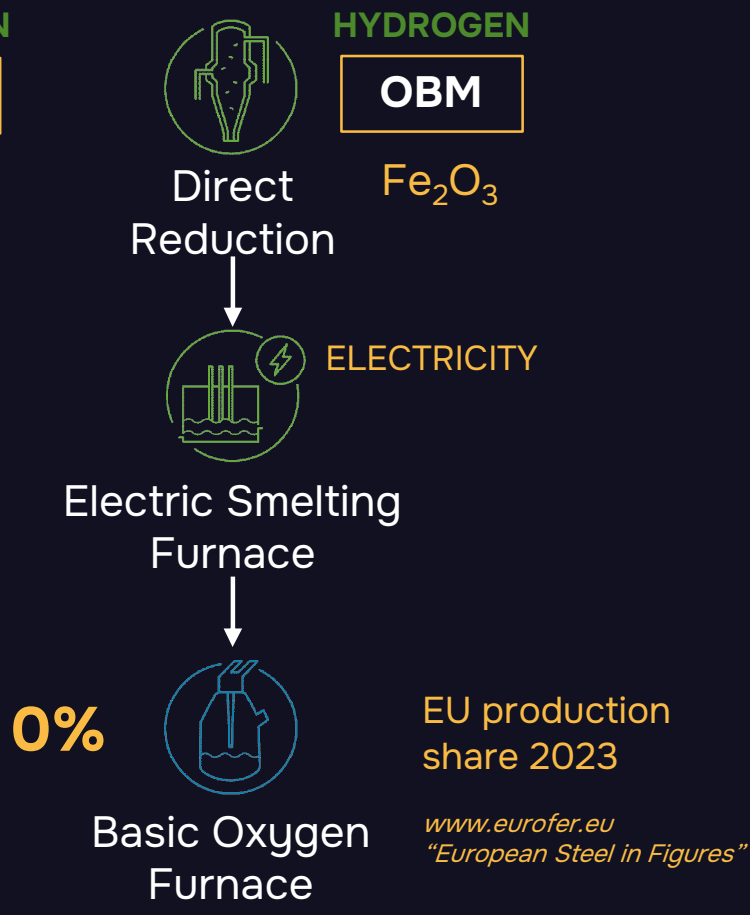
Transformation of steelmaking: DR-EAF, DR-ESF-BOF







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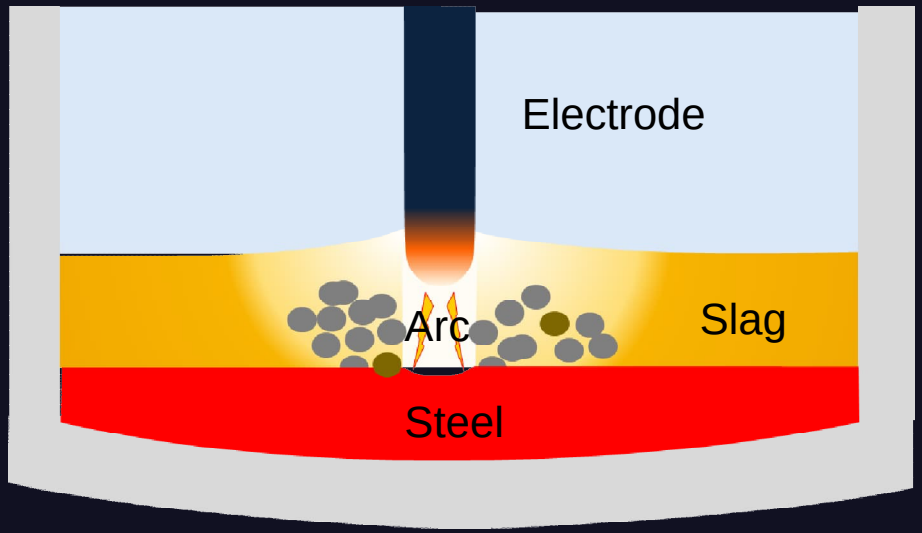
How does an Electric Arc Furnace (EAF) work?

- Energy input through arc between electrode and metal bath
- Main input materials are scrap or direct reduced iron from high grade ore
- Open vessel resulting in oxidising atmosphere
- Batch operation



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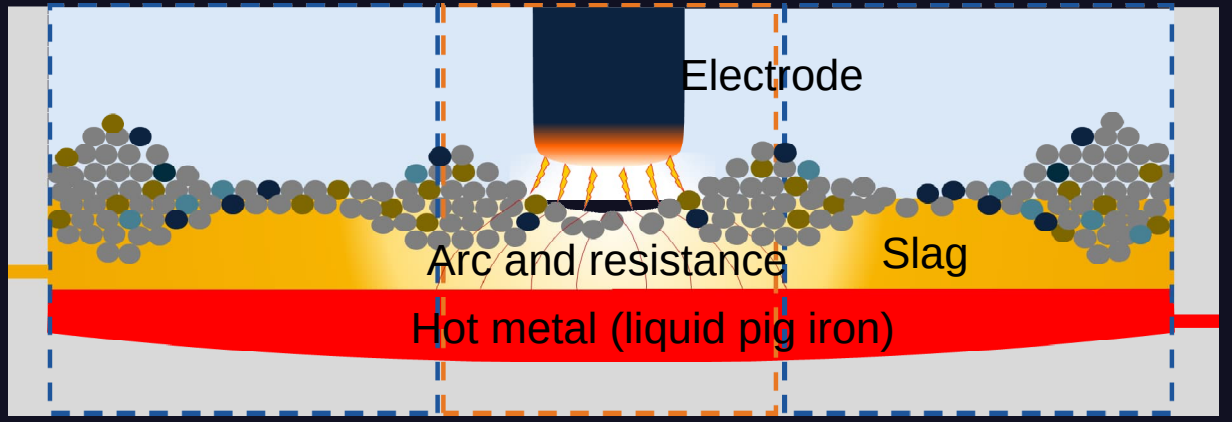
CARBON in an EAF

- Carbon can be **charged** (lump) and **injected** (fine)
- Relatively low **carbon** demand of **12 - 25 kg/t of crude steel** due to high grade input materials
- Purpose of carbon:
  - Slag foaming (insulation)
  - Reduction, around 30 % FeO in slag
  - Lower melting point of DRI
  - Chemical energy input

How does an Electric Smelting Furnace work?

- Power through resistance heating of slag and some arc formation
- Continuous operation
- Sealed vessel → reducing atmosphere through addition of carbon
- Products similar to blast furnace: hot metal



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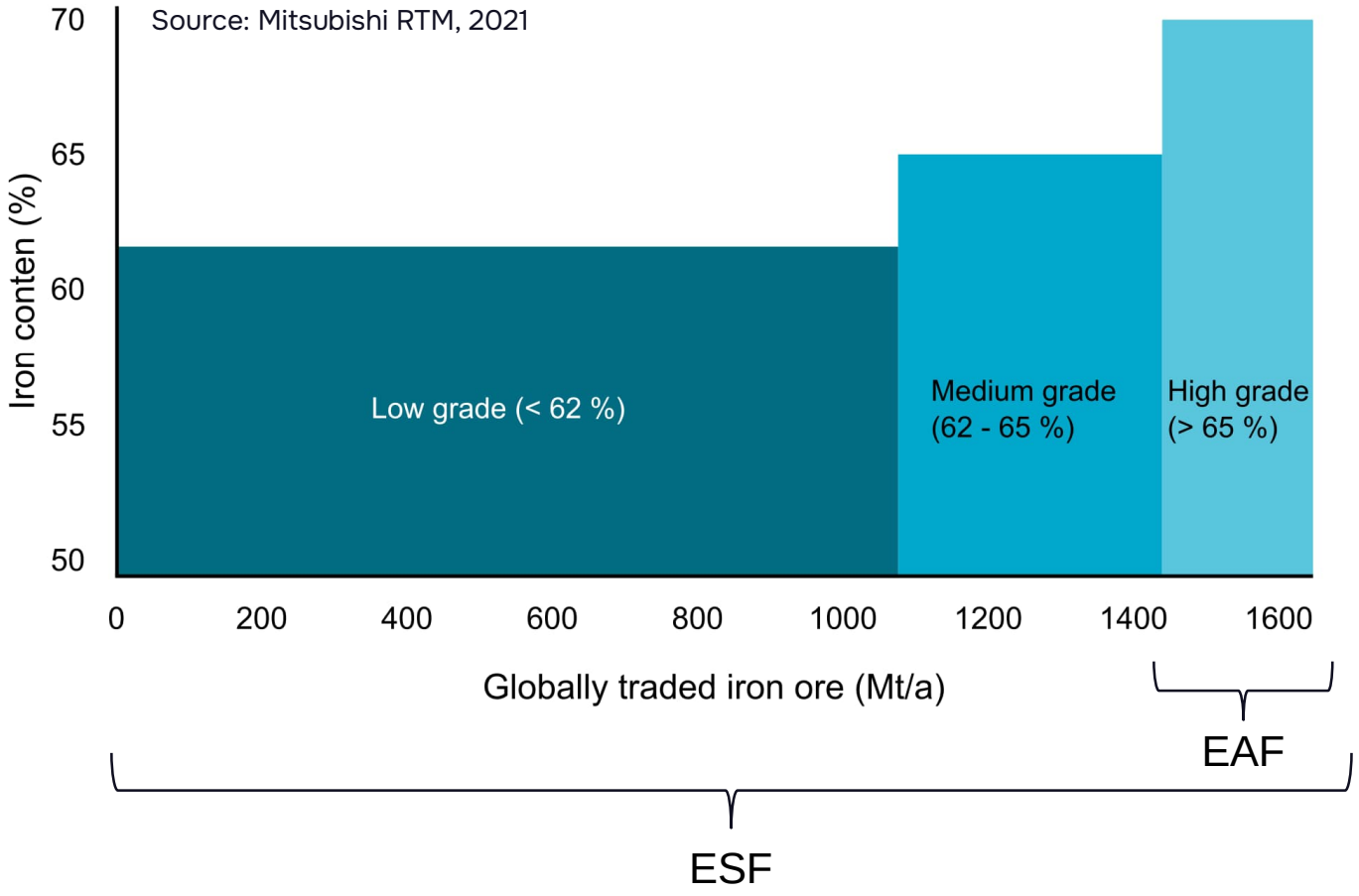
CARBON in an ESF

- Carbon can be **charged** (lump) or **injected** (fine)
- Using H_2-DRI results in **50 - 100 kg C/t of hot metal**
- Main purposes are:
    - Full reduction of FeO (< 1% in slag)
    - Lowering of melting point of metal
    - Carburisation of iron
    - Chemical energy

Why are ESF and EAF required for OBM?



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SUMMARY - example case for 5 Mta steel production

Route	Carbon carrier kg/t product	Carbon in %	Carbon kt/y	Replacement with biochar (equivalent C) in %	Replaceable carbon kt/y	Process product
BF-BOF	400	85 %	**1709**	32 %	**542**	Steel
 Sinter	45	80 %	96	40 %	38	Sinter
 BF coke	300	88 %	1109	0 %	0	hot metal
 BF PCI	150	80 %	504	100 %	504	hot metal
 **EAF**	12-25	80 %	**48 - 100**	100 %	**48 - 100**	Steel
 **ESF-BOF***	50-100	80 %	**200 - 400**	100 %	**200 - 400**	Steel

*based on H2-DRI

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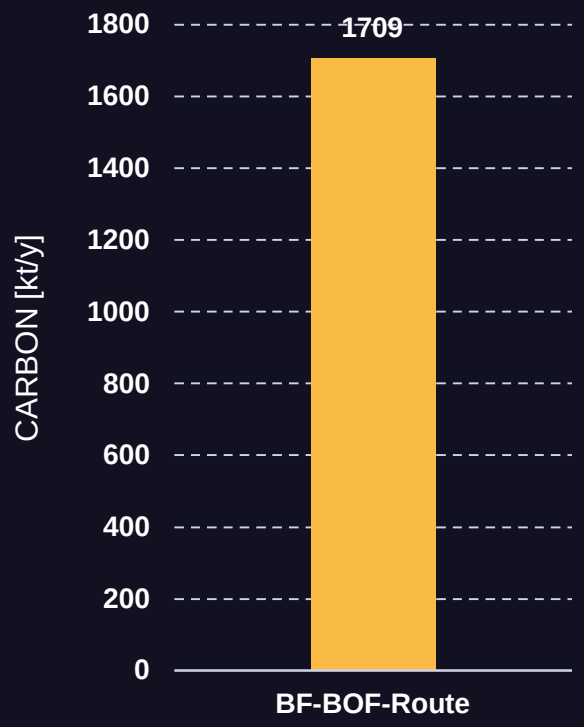
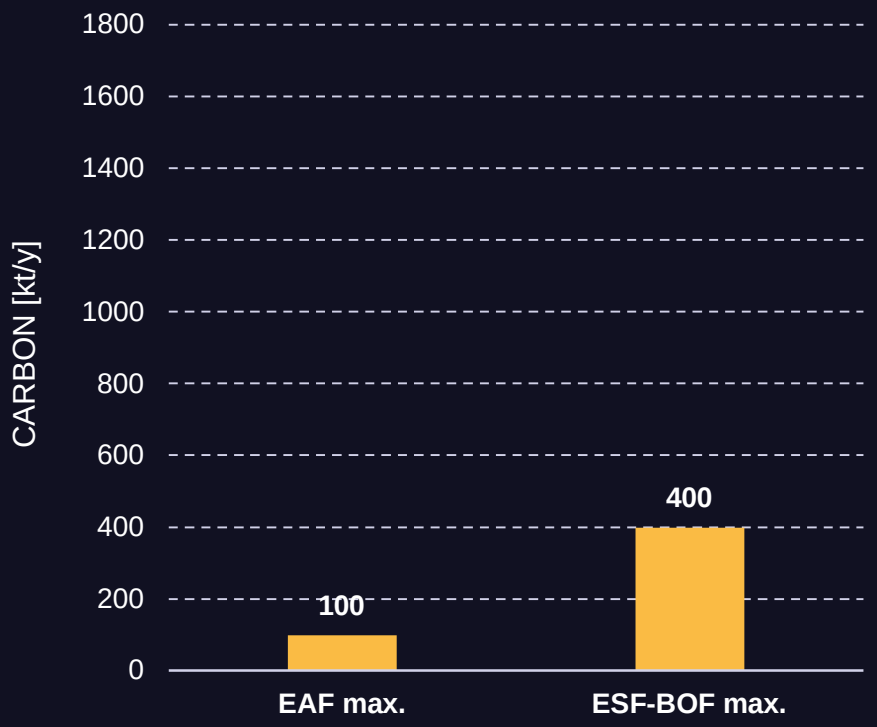
NEED FOR CARBON – for 5 Mta Steel

Classical Route



… after TRANSFORMATION



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Thank you!

Christoph Feilmayr

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