Hy4Smelt – Demonstration Plant

Federal Ministry
Innovation, Mobility
and Infrastructure
Republic of Austria

Federal Ministry
Economy, Energy
and Tourism
Republic of Austria

Co-funded by
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Research Fund
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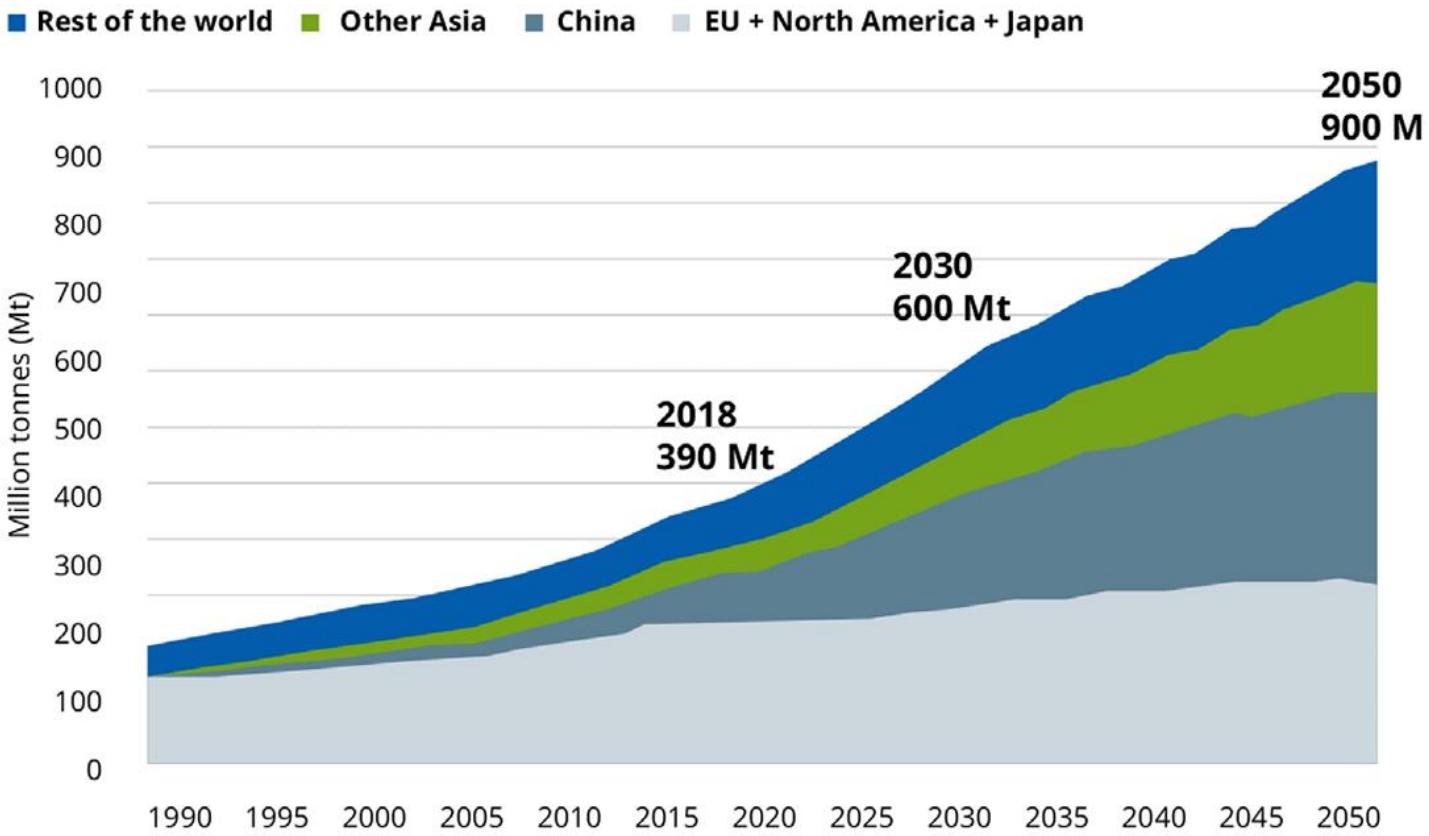
Global Trends for Scrap Availability



https://worldsteel.org/

- **Crude steel** demand will be **30 % higher in 2050** than it is today
- Much of this **growth** will be **in emerging economies** with declining demand in China, Europe, Japan, and South Korea
- **Contribution of scrap** in the total steel charge will likely grow to **40 % in 2050** from 30 % than today
- Process technologies for **OBM (ore based metallics)** will have an **important role** in future CO_2 neutral steelmaking

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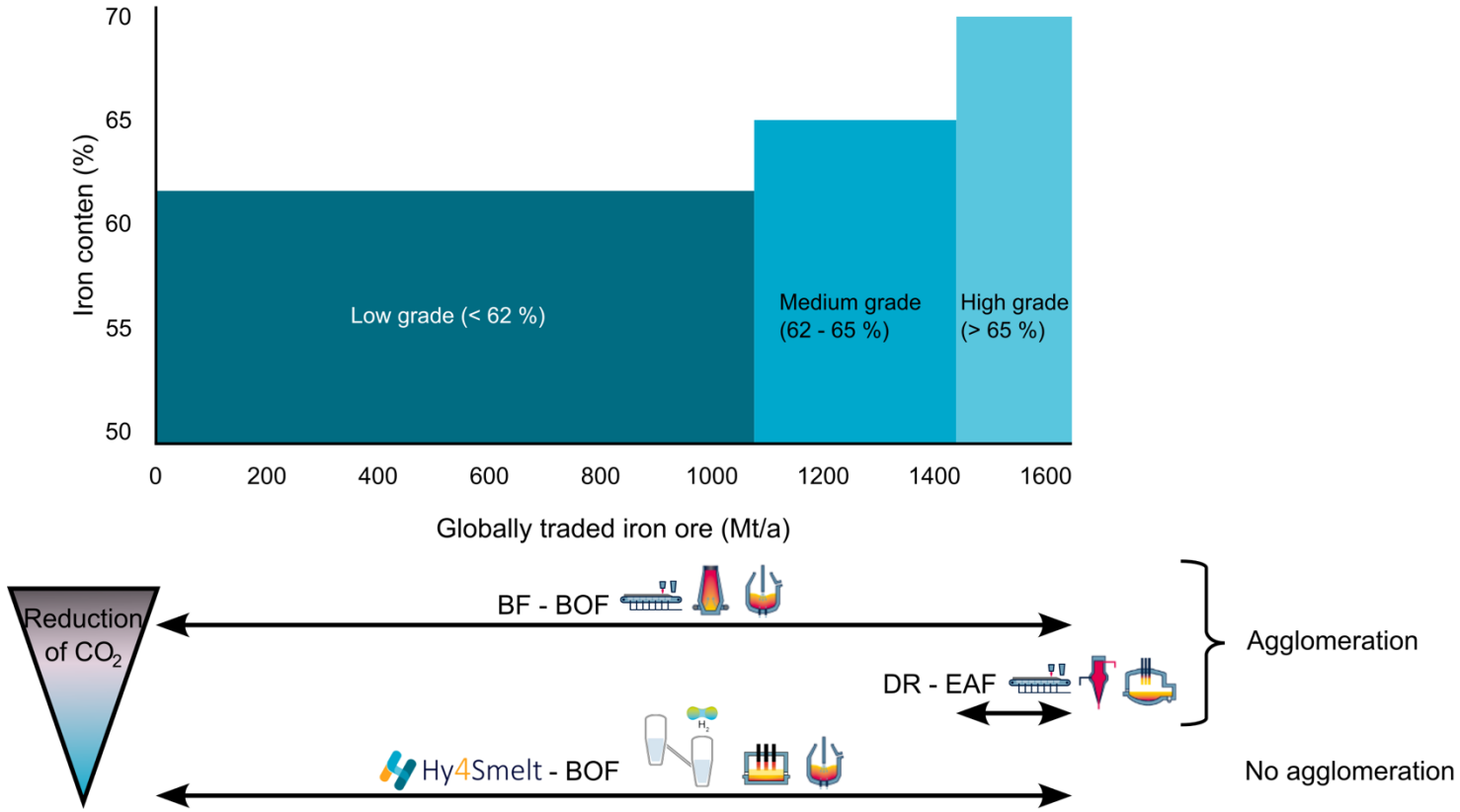
Iron Ore Grades and Process Routes



- **Majority of iron ores** for steel production are fine ores with **Fe < 65 %**
- **EAF** process is **not suitable for** melting DRI/HBI with **high slag quantities** of up to 300 kg/t
- **Iron ores with Fe > 65 %** will not be able to replace low/medium grade ores in the future
- **Electric smelting furnace (Smelter) in combination with direct reduction** enables slag separation for **BOF and EAF** similar to BF process

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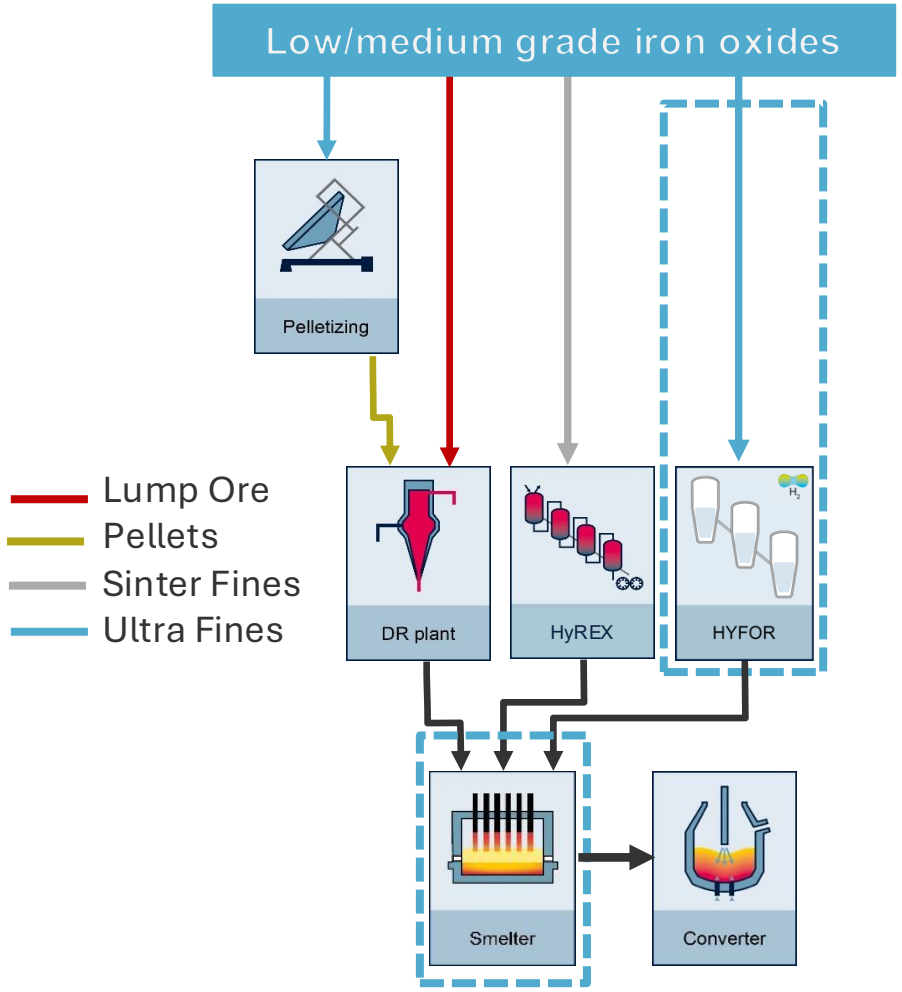
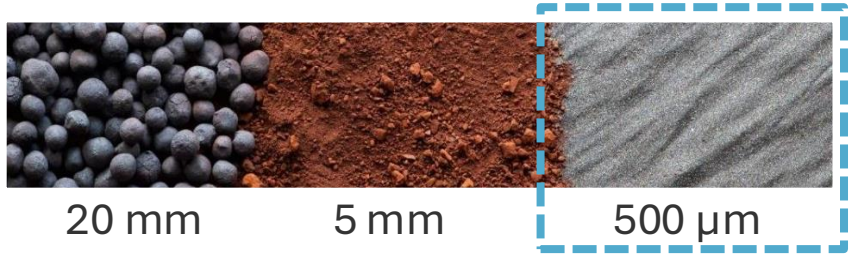
Process Routes for Green Hot Metal



- **HYFOR (Hydrogen-based fine ore reduction)**
- **HYFOR** technology owned by Primetals Technologies Austria is an alternative **direct reduction process** for **ultrafine iron ores** that will not require any agglomeration steps
- A combination with the **Smelter technology** (owned by Primetals Technologies Austria) is used for melting and final reduction of direct reduced iron (DRI) based on low and medium grade iron ores with Fe < 65 %
- In that way, **green hot metal** is produced with **hydrogen** for BOF or EAF steelmaking



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Pilot Plant HYFOR



- Test the performance of **HYFOR reactor** and **preheating/oxidation cyclone** under real operating conditions
- Direct reduction of **magnetite/hematite iron ore fines with H_2** in fluidized bed reactor at **700 °C** up to a **metallization degree of 97 %**
- Grain size: < 500 µm
- **Batch operation** with 800 kg ultrafine iron ore is equal to **200 kg DRI per hour**
- **Pilot plant at voestalpine Donawitz site** as technical basis for next development phase

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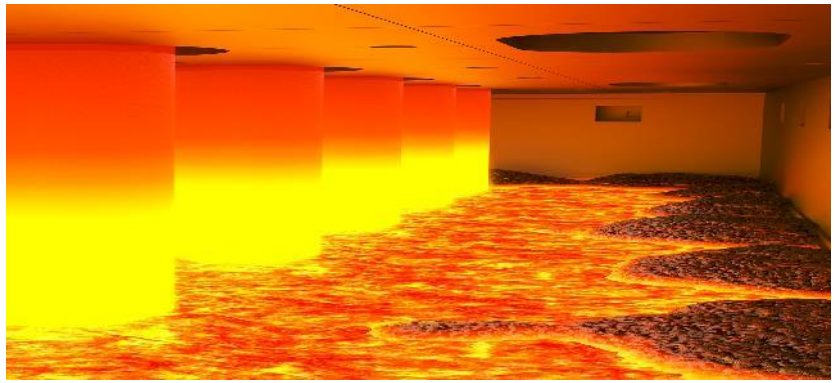
Smelter Process

- **DRI is molten, final reduction takes place** and an adjustment of the iron (carbon level) and slag (basicity, MgO-level)
  - Iron from the Smelter go the steel plant
  - Slag is granulated and used in cement industry
  - High calorific off-gas as substitute for natural gas
- Due to the **reducing atmosphere inside the Smelter**, the Smelter is well designed to **process other iron oxide containing materials from steel production** such as dusts, mill scale or slags to improve the **circularity of the production process**
- For the **Smelter** in large scale ironmaking **no reference plants exists yet**; however, principles were tested and verified by simulations, in the laboratory and on a modified furnace in the hundred kg scale



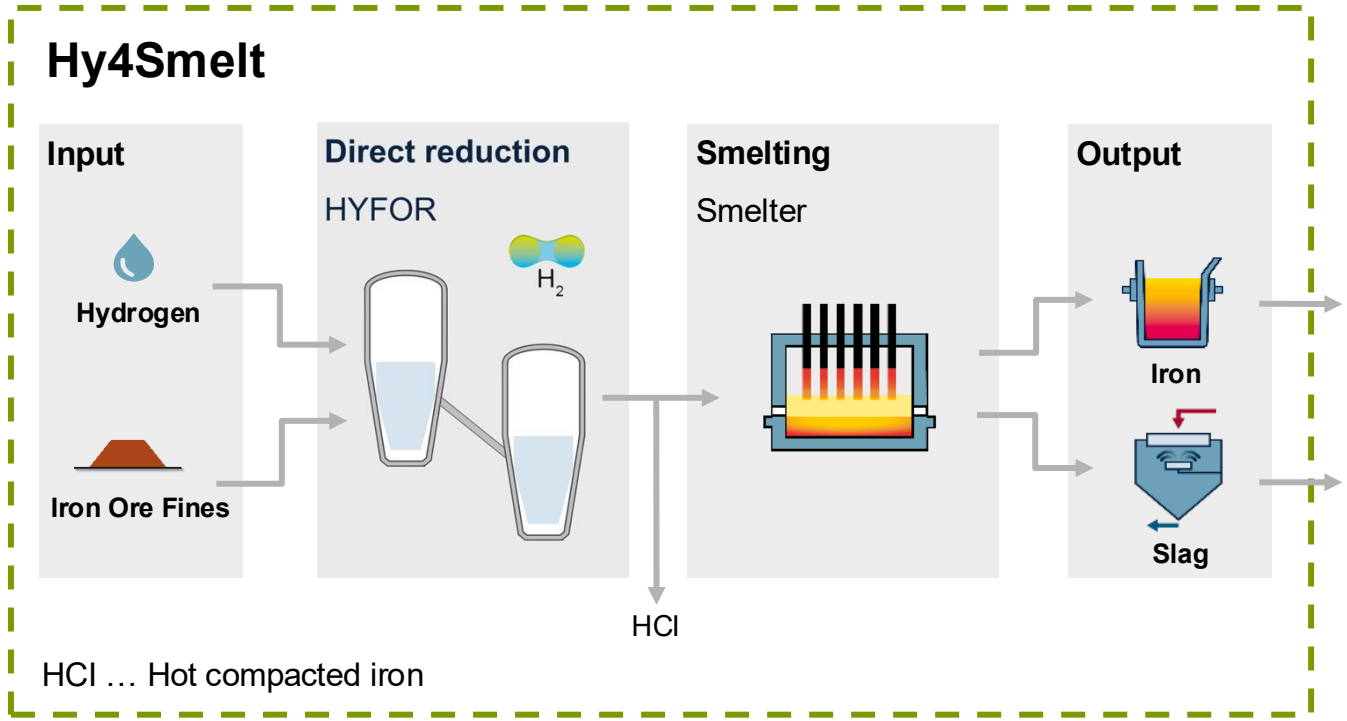
Cross section of a Smelter



Inside a Smelter

Building Blocks for Green Hot Metal

- Hy4Smelt is a **groundbreaking new process** combining direct reduction (HYFOR) and electrified smelting under reducing conditions (Smelter)
  - In the **direct reduction step** the iron oxide in the fine iron ore is reduced to metallic iron using only green hydrogen
  - In the **smelting step** the direct reduced iron is smelted using green electricity, the melt is adjusted, hot metal (HM) and slag are tapped separately from the furnace
- The Hy4Smelt plant is capable to process a **wide range of iron ore fines** coming from different mines worldwide
- Green energy and bio-carbon in Hy4Smelt allows for **carbon neutral iron production**



Iron is sent to steel plant for refining, replacing hot metal coming from BF.

Slag is granulated and used in cement industry as a clinker substitute.

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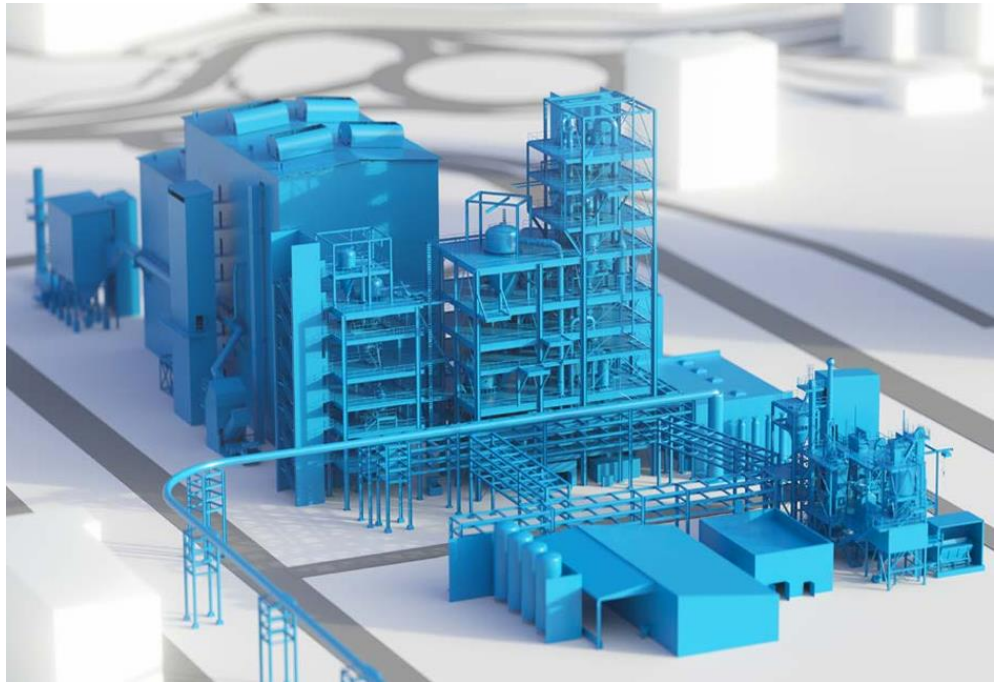
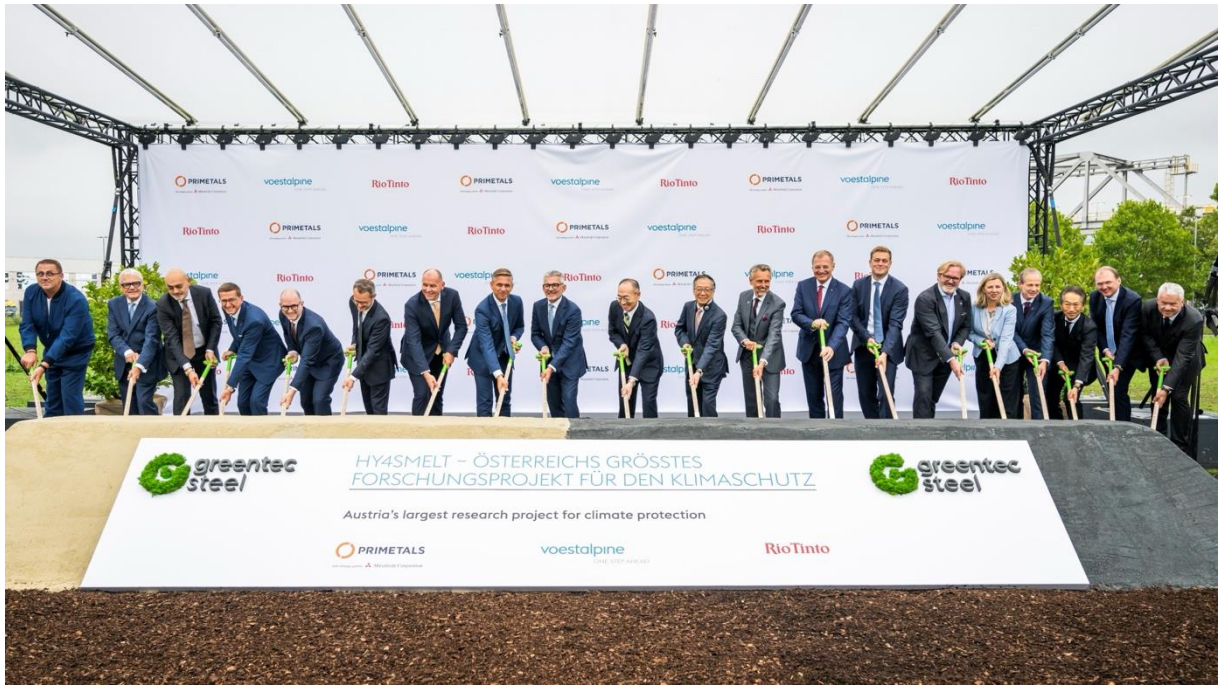
Basic Design Demonstration Plant



3D model of Hy4Smelt

Iron ore	2 – 3 t/h
Hydrogen	1 500 m^3/h
Hot metal	2 – 3 t/h
Slag	< 1 t/h



09/25/2025 Groundbreaking Ceremony

TRL	8
Location	voestalpine Linz site
FID*	04/2025
SOP**	11/2027

*Final Investment Decision **Start Of Operation

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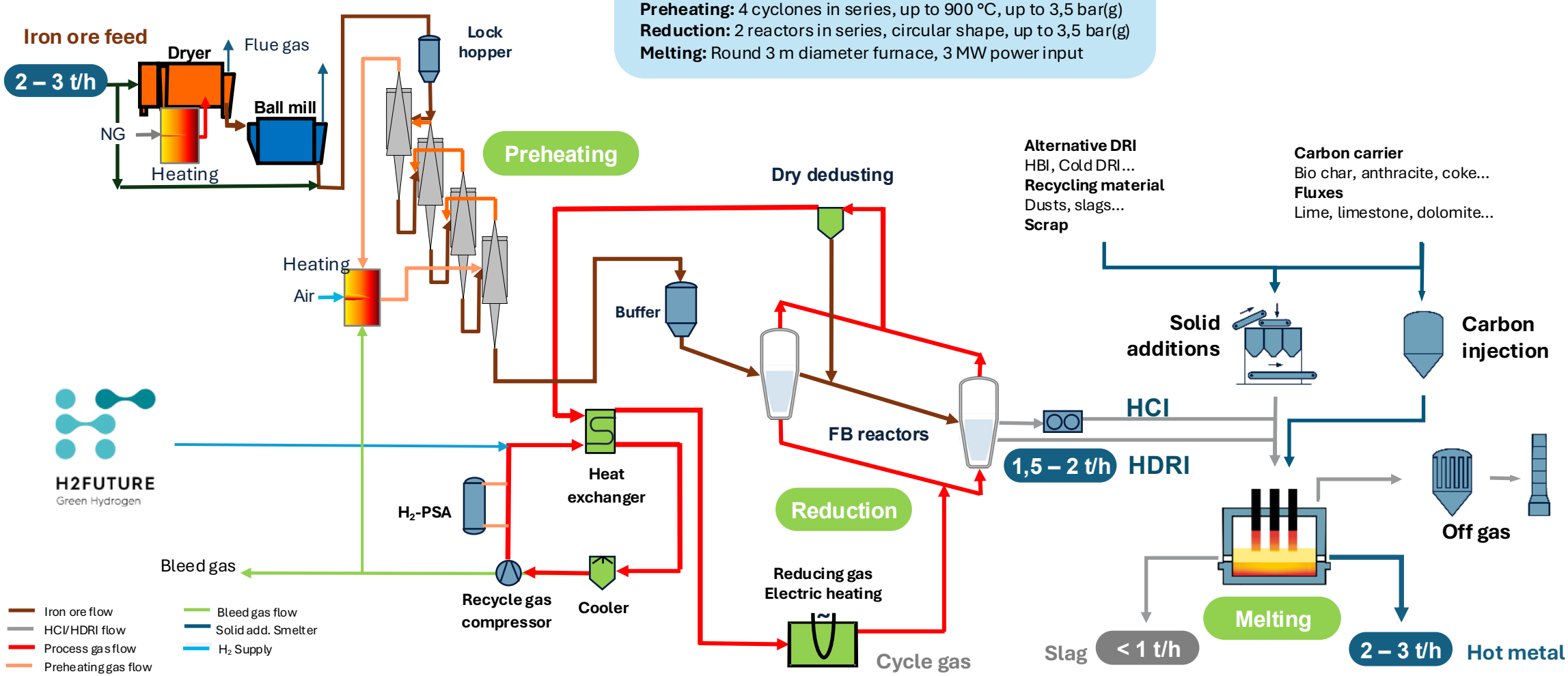
Flow Sheet Demonstration Plant

Hy4Smelt

Main Process data

Productivity:	2 – 3 t/h	Iron ore feed
	1,5 – 2 t/h	DRI (Hyfor)
	2 – 3 t/h	Hot metal (Smelter)

Preheating: 4 cyclones in series, up to 900 °C, up to 3,5 bar(g)
Reduction: 2 reactors in series, circular shape, up to 3,5 bar(g)
Melting: Round 3 m diameter furnace, 3 MW power input



Core Equipment for Reduction and Smelting

Hy4Smelt



www.voestalpine.com/greentecsteel/en/Net-zero-CO2-emissions-by-2050/

Co-Funding Strategy with National and European Sources

Hy4Smelt

CAPEX HYFOR-Part funded by aws „Twin Transition“

PRIMETALS TECHNOLOGIES
Mitsubishi Corporation

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austria wirtschafts service aws

Funding in EUR million

CAPEX Smelter-Part funded by KPC „Transformation of Industry“

voestalpine
ONE STEP AHEAD.

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KOMMUNAL KREDIT PUBLIC CONSULTING

R&D OPEX funded by RFCS/CSP „Big Tickets for Steel“

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R&D Deployment funded by EU Clean Hydrogen Partnership „HI2“

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1,4

HI2
Hydrogen Industrial Inland Valley

Clean Hydrogen Partnership

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