TECHNOLOGY DEVELOPMENT FOR ORE BASED METALLICS IN STEELMAKING

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Thomas Buergler

Steel Division
www.voestalpine.com

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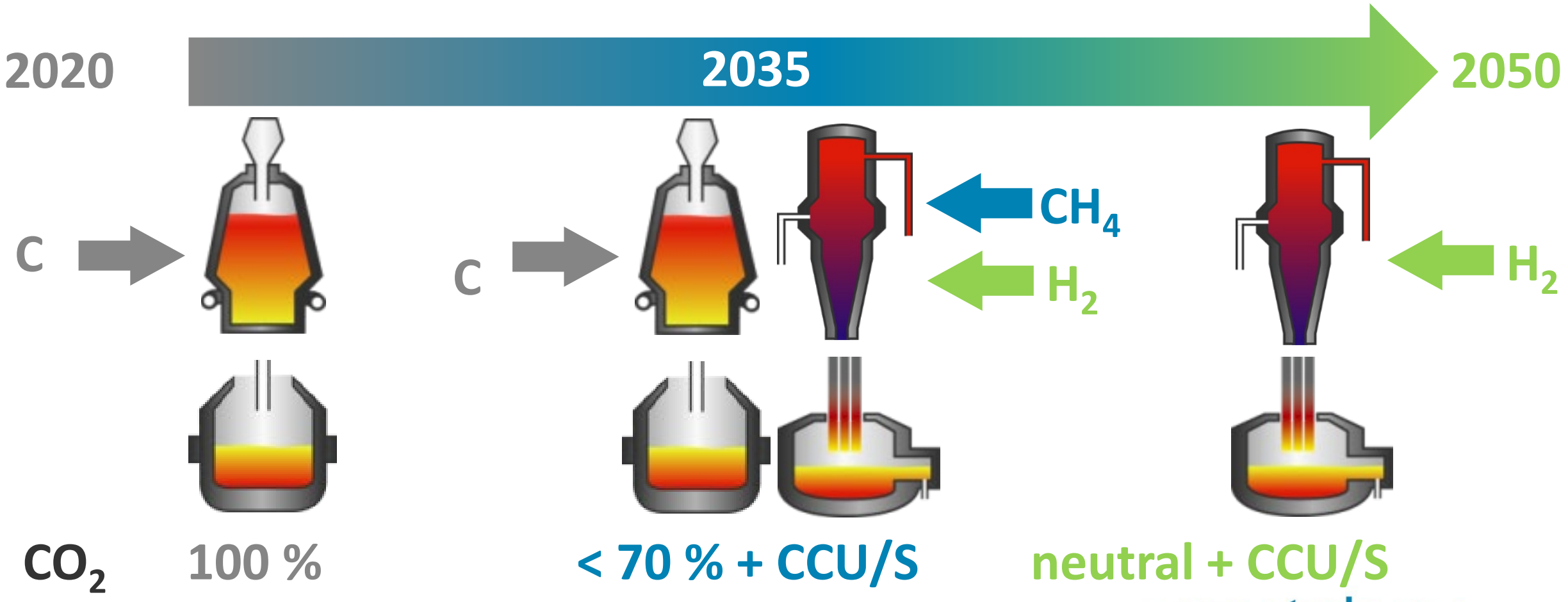
CLIMATE NEUTRAL STEELMAKING
FROM CARBON TO HYDROGEN



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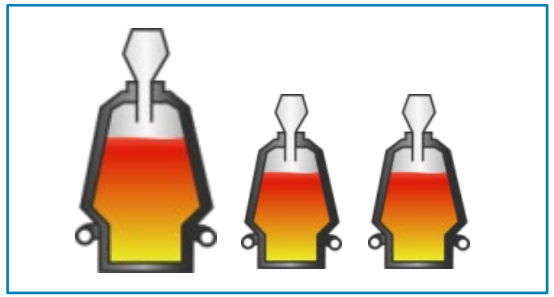
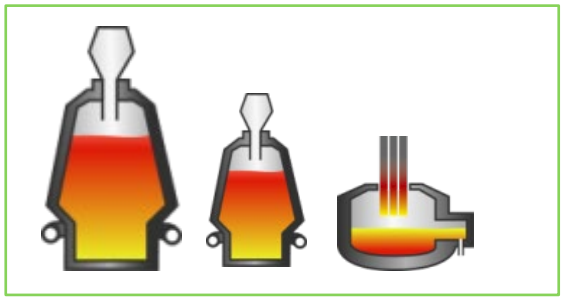
CLIMATE NEUTRAL STEELMAKING
FIRST STEP HYBRID PROCESS CONCEPT

voestalpine Linz site

Status Quo

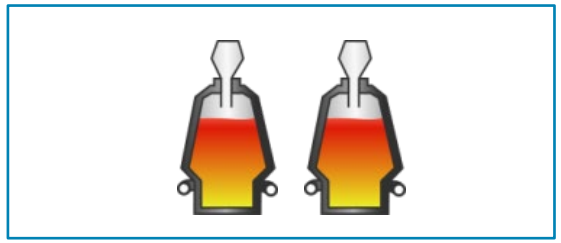


2027



voestalpine Donawitz site

Status Quo



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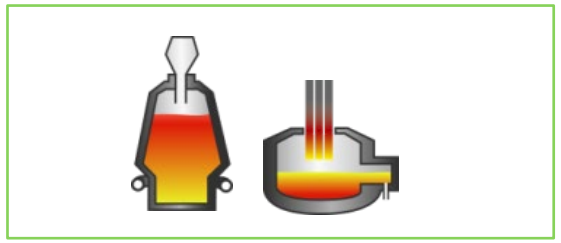
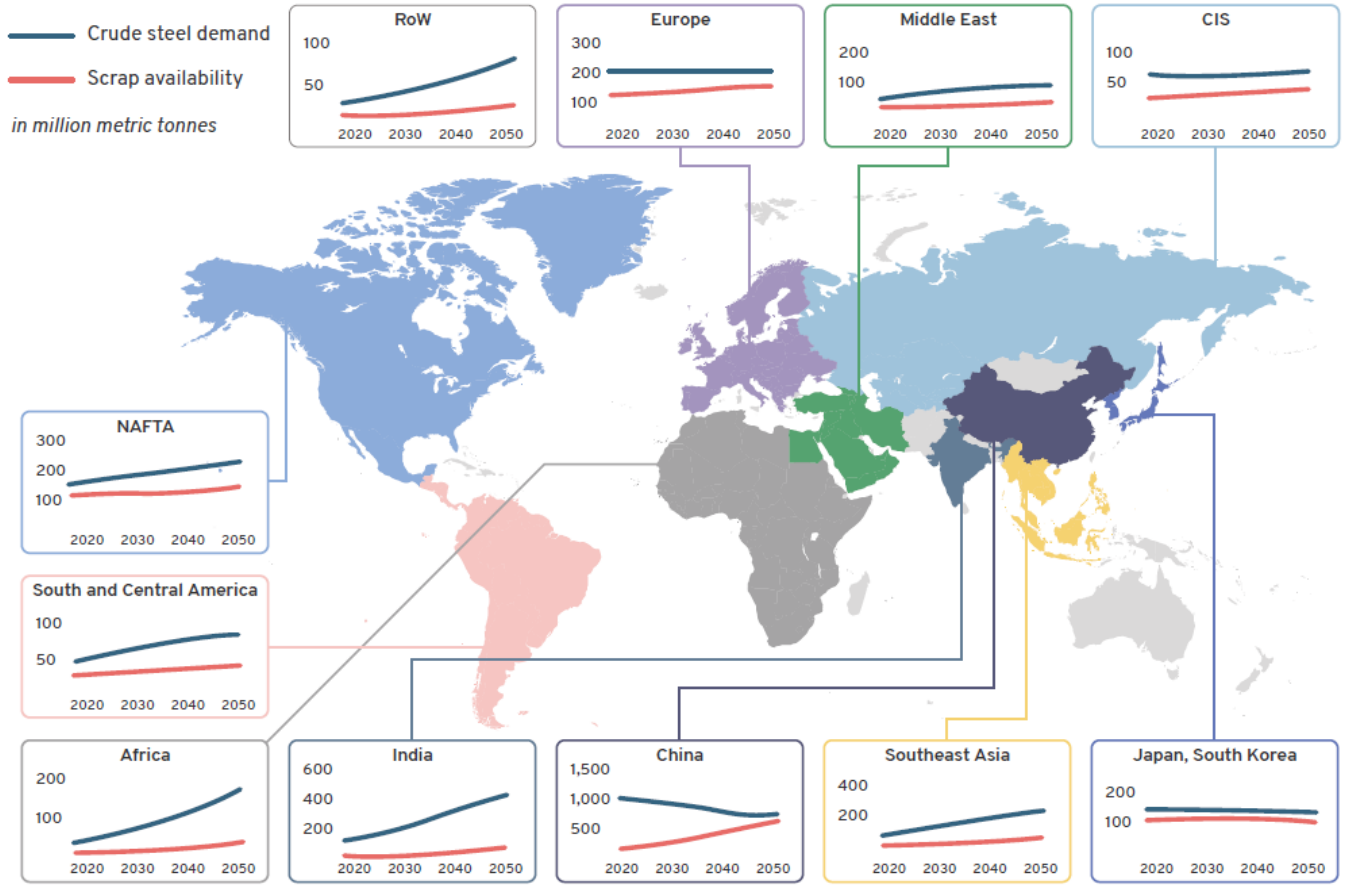


- Hybrid technology with EAF process additional to BF/DR/BOF until 2030
- Stepwise decrease of BF/BOF capacity at integrated sites
- Up to 30 % CO_2 reduction independent from green hydrogen
- High potential for further CO_2 decrease as soon as green hydrogen is economical available
- Concept ready for integration of breakthrough technologies 2035+

TECHNOLOGY DEVELOPMENT OBM
GLOBAL TRENDS FOR SCRAP AVAILABILITY



https://missionpossiblepartnership.org/

- Crude steel demand will be 30 % higher in 2050 than 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 up to 50 % in 2050 from 30 % than today
- Process technologies for OBM will have an important role in future CO_2 neutral steelmaking

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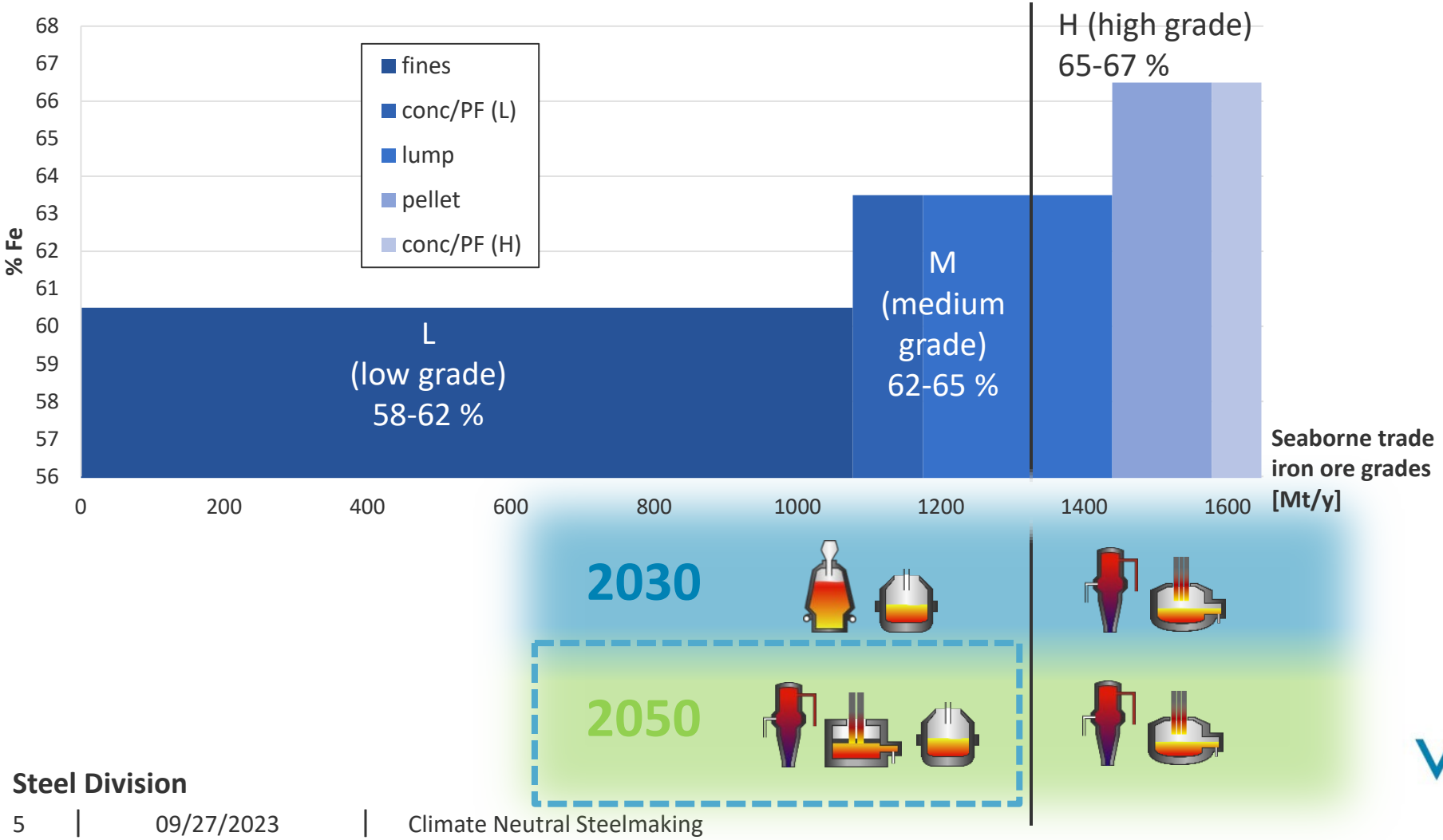
TECHNOLOGY DEVELOPMENT OBM
IRON ORE GRADES AND PROCESS ROUTES



- World iron ore market is dominated by low and medium grade iron ores
- Replacement BF/BOF by DR/EAF process route requires an adapted concept for steelmaking from low and medium grades iron ores

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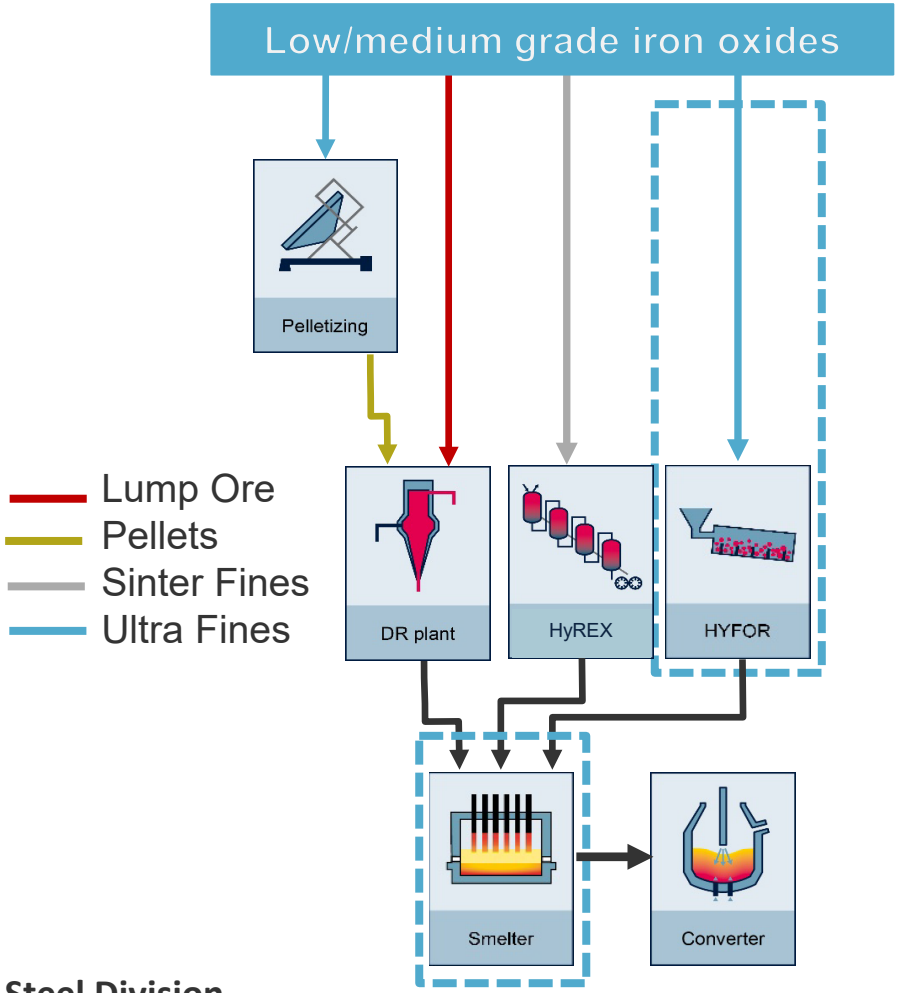
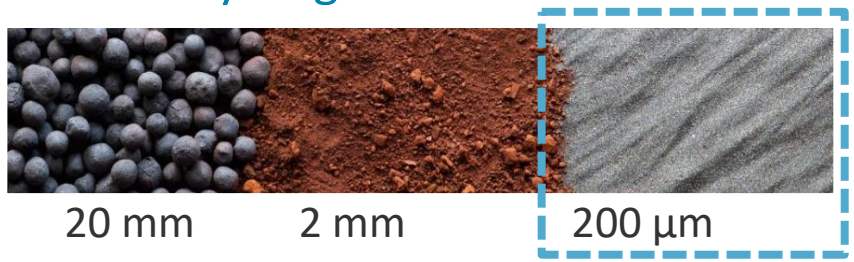
TECHNOLOGY DEVELOPMENT OBM
PROCESS ROUTES FOR GREEN HOT METAL



- HYFOR is an alternative direct reduction process for ultrafine iron ores that will not require any agglomeration steps
- A combination with Smelter technology 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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DIRECT REDUCTION TECHNOLOGY
PROCESS DEVELOPMENT 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 in fluidized bed reactor at 700 °C up to a metallization degree of 97 %
- Typical grain size: 100 % < 150 µm
  Max. grain size: < 500 µm (up to 1 mm possible)
- 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

PRIMETALS TECHNOLOGIES
K1 MET metallurgical competence center
MONTAN UNIVERSITÄT WWW.UNILEOBEN.AC.AT
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FFG Promoting Innovation.

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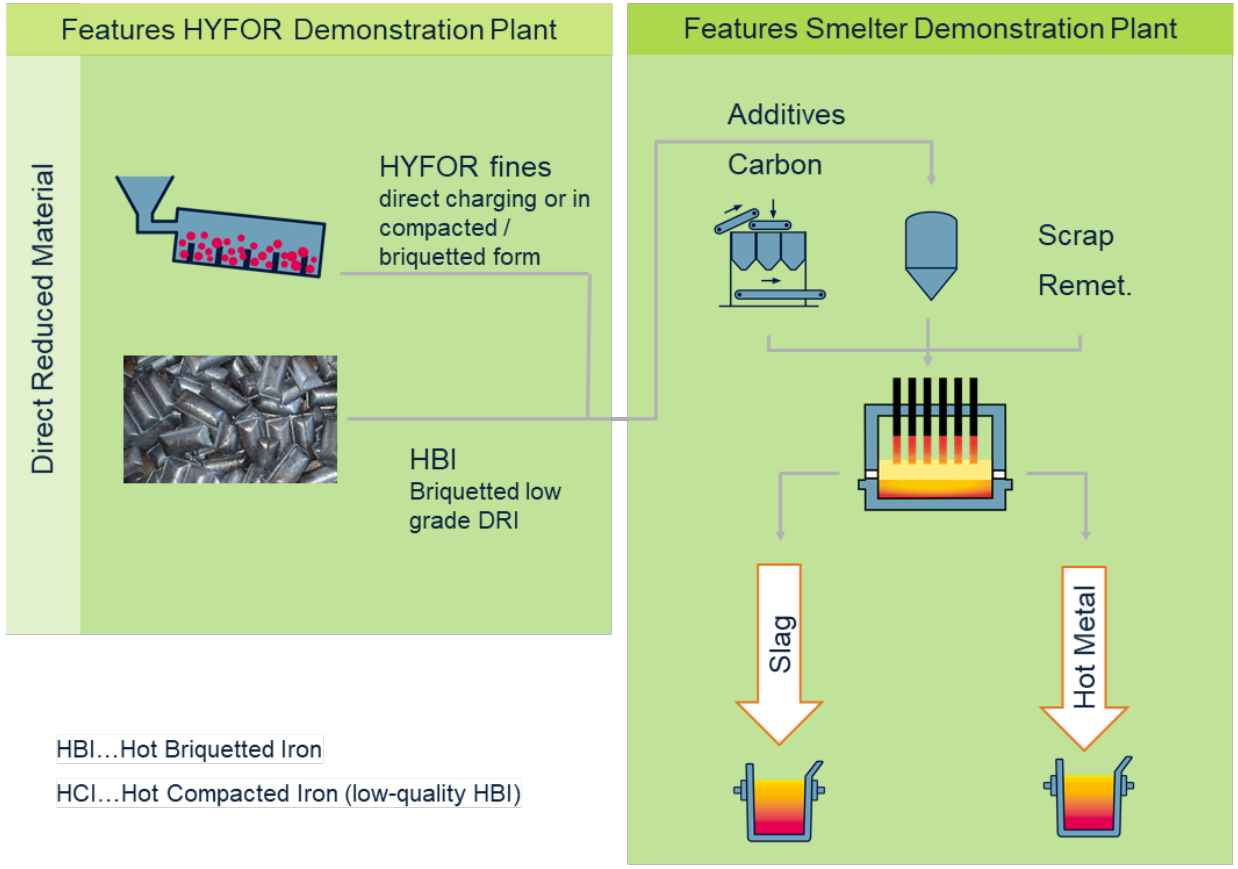
DEMONSTRATION PLANT
BUILDING BLOCKS FOR GREEN HOT METAL



- Continuous operation from preheating iron ores to hot metal (HBI) in longer campaigns
- Flexible Ore Basis - Utilization of multiple iron ore qualities (low to high grades)
- Carbon addition – Based on bio-char and other carbon carriers
- Hot link of DRI fines to Smelter (alternatively HCI) and addition of HBI/Scrap
- Addition of slag forming materials → slag shall be utilized in the cement industry (cross-sectorial approach)
- Autonomous operation of Smelter part

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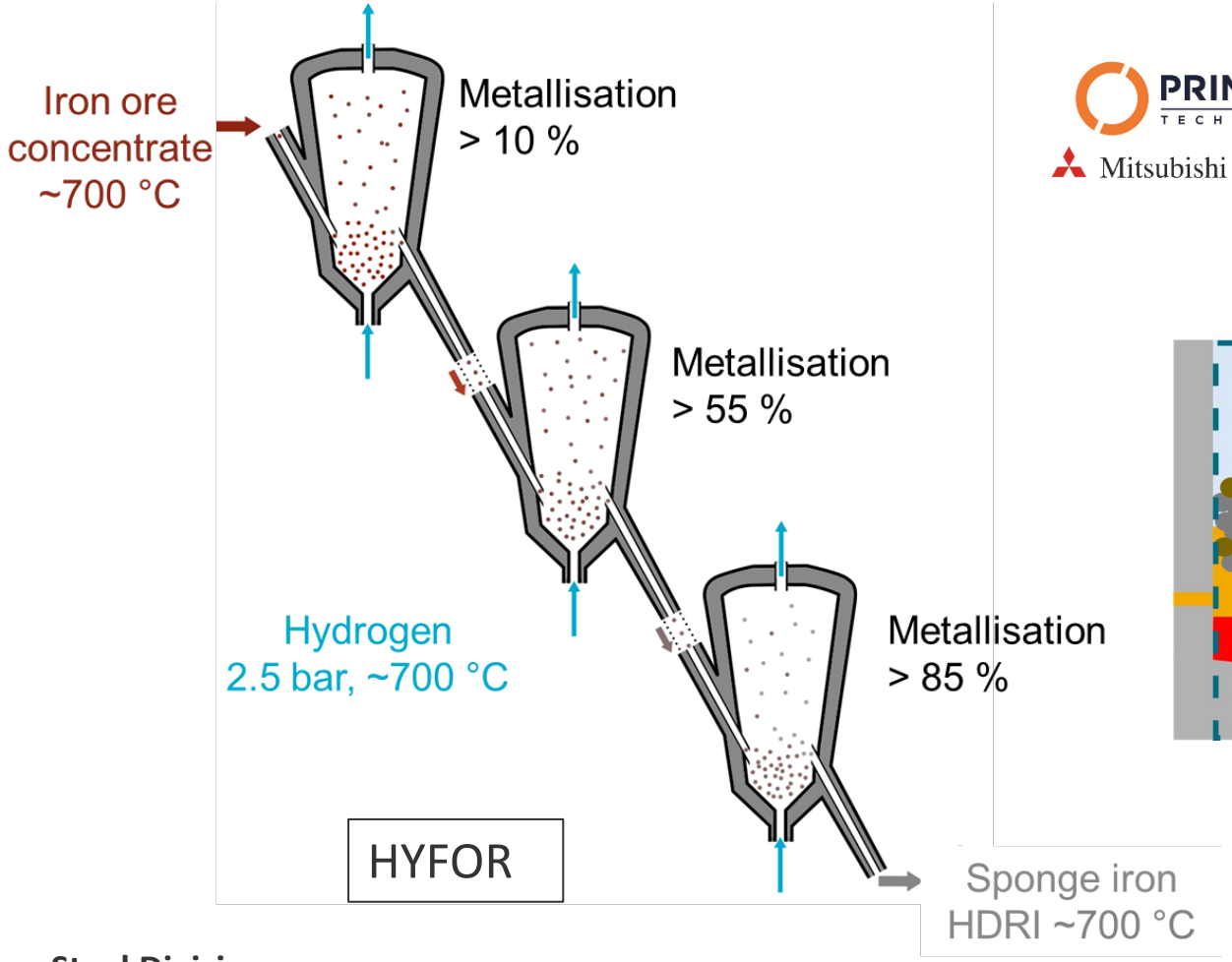
DEMONSTRATION PLANT
METALLURGICAL TASKS HYFOR/SMELTER



HYFOR

PRIMETALS TECHNOLOGIES
Mitsubishi Corporation
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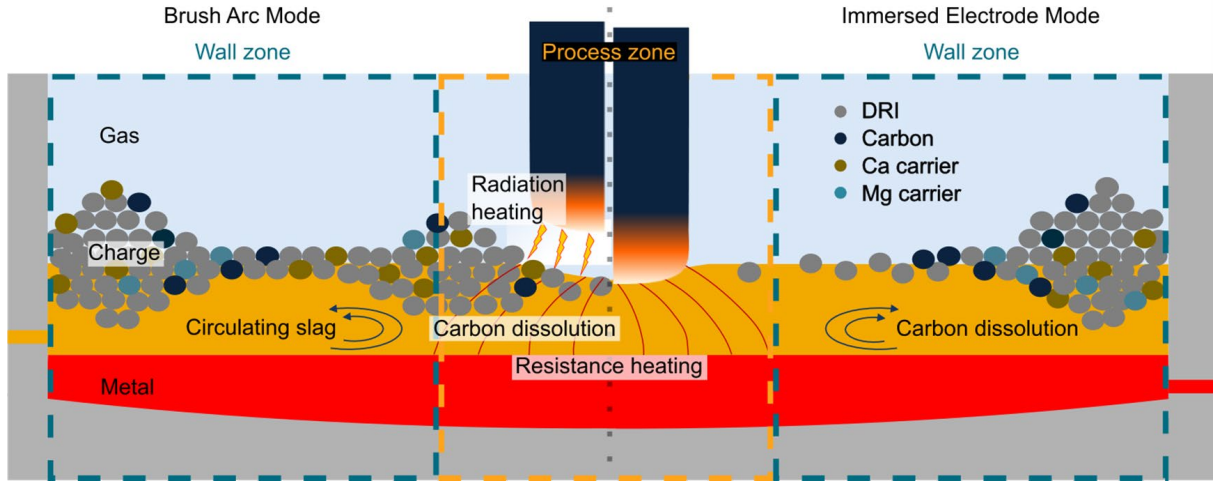
FMG Fortescue The New Force in Iron Ore
K1 MET metallurgical competence center



SMELTER

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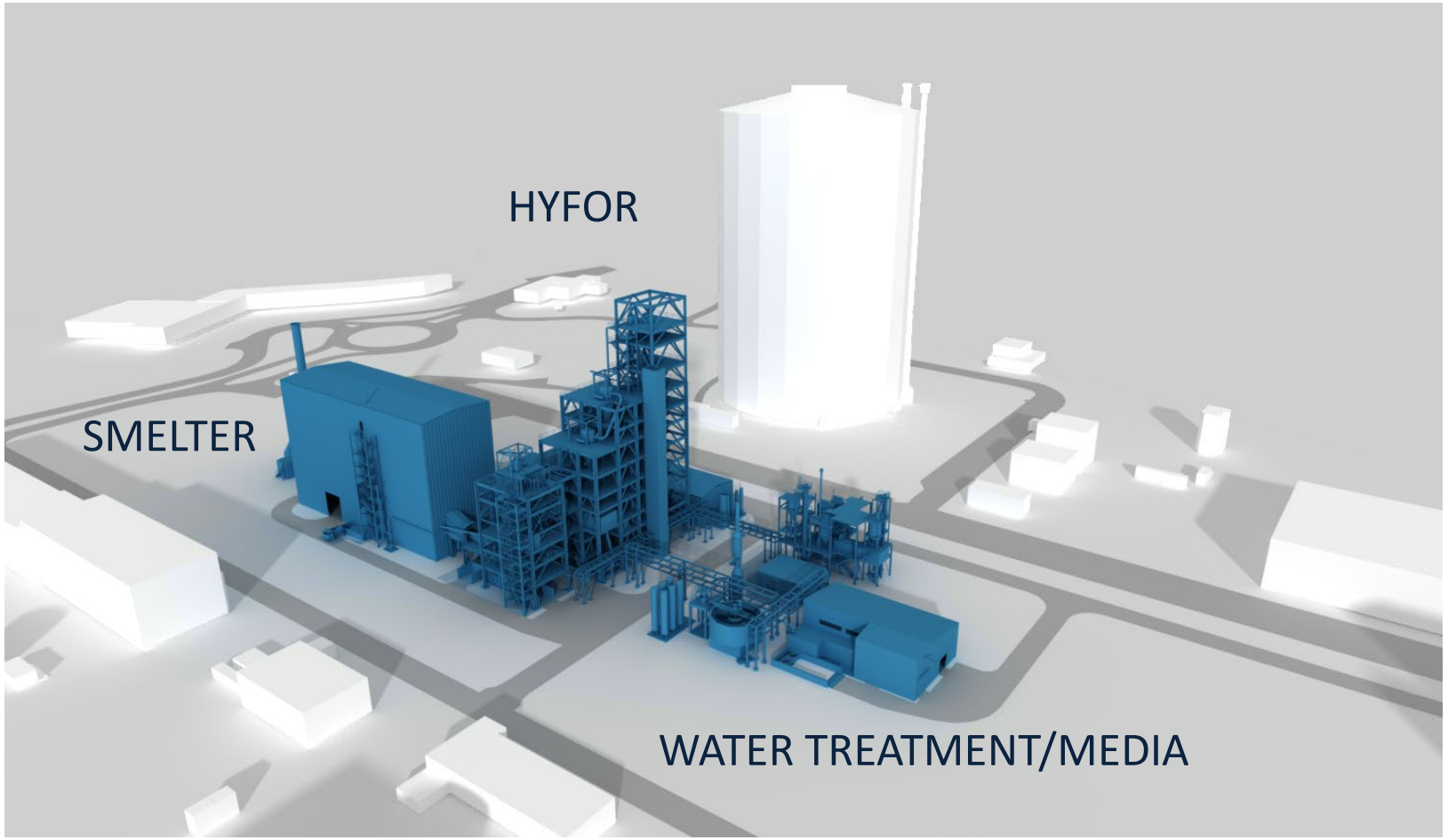
DEMONSTRATION PLANT
BASIC DESIGN HYFOR/SMELTER



Hy4Smelt

Iron ore	2 – 3 t/h
Hydrogen	1.500 m^3/h
Hot metal	2 – 3 t/h
Slag	< 1 t/h

Location	voestalpine Linz site

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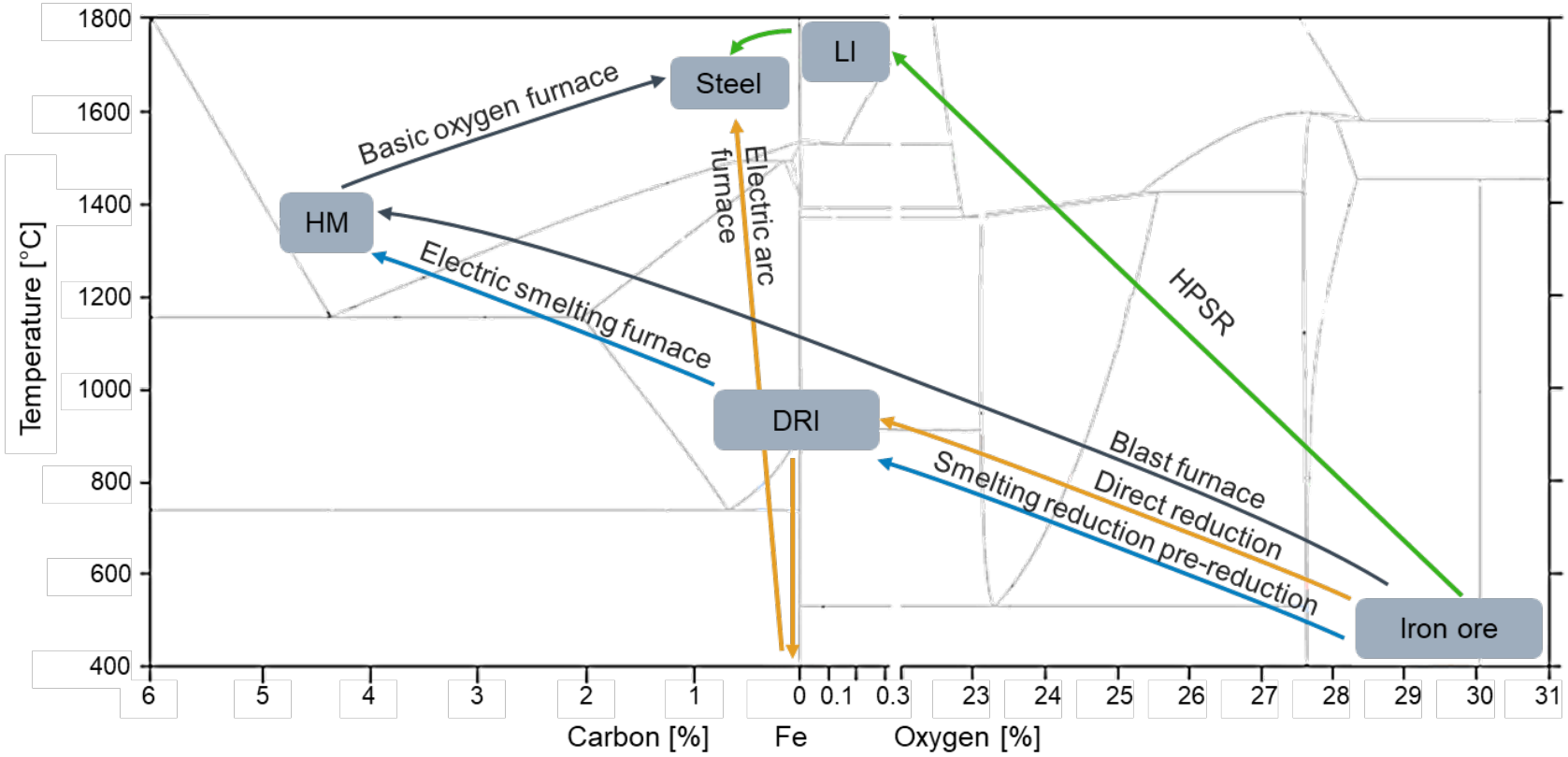
STEELMAKING PROCESS ROUTES
PROCESS DEVELOPMENT SUSTEEL



DRI … direct reduced iron
HM … hot metal (pig iron)
LI … liquid iron (steel-like liquid product)
HPSR … hydrogen plasma smelting reduction

- Steelmaking from iron ores is a multi step process within the phase diagrams Fe-C and Fe-O.
- Scrap based EAF is the State-of-the-art process for direct steelmaking.
- Hydrogen Plasma Smelting Reduction (HPSR) is a breakthrough technology for direct steelmaking from iron ores.

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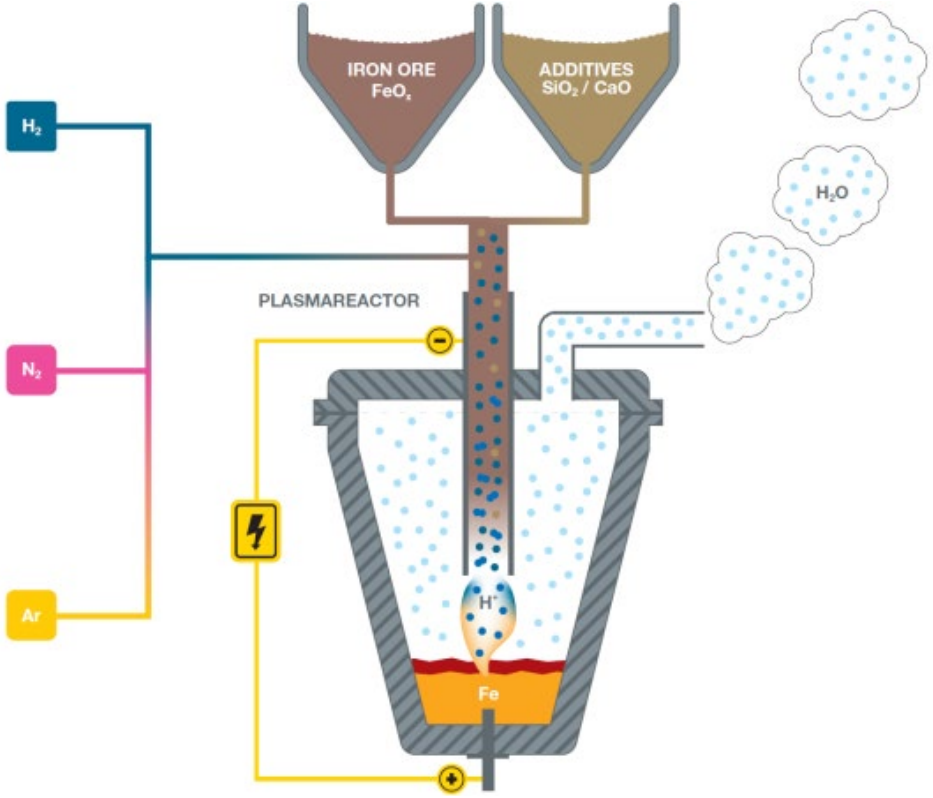
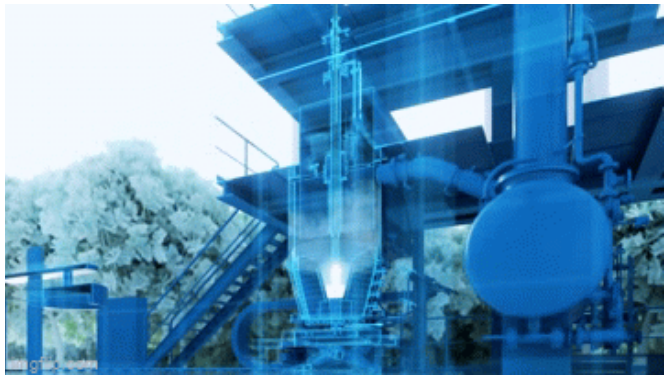
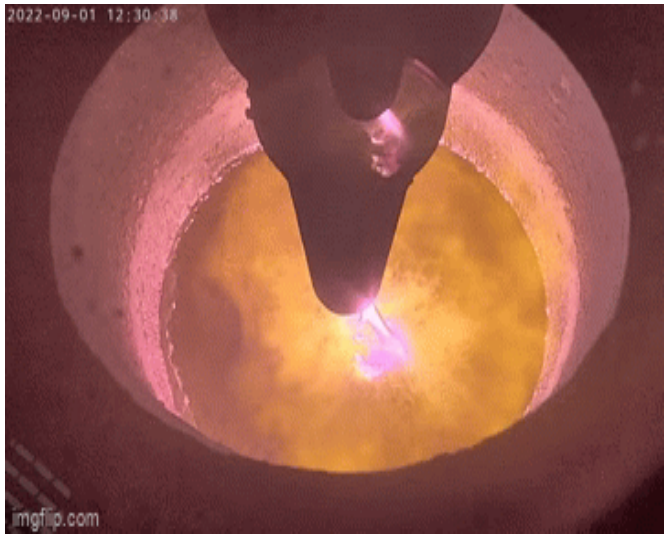
HYDROGEN PLASMA SMELTING REDUCTION
PROCESS DEVELOPMENT SUSTEEL

- Fundamental research project for direct steelmaking from iron oxides with H_2 plasma smelting reduction (HPSR)
- Verify of process concept with batch operation in a DC electric arc furnace (EAF) with 250 kVA
- Upscaling the technology from 100 g to 50 kg tapping weight
- Creating design parameters for an increased reactor size and continuous operation
- Demo plant located at voestalpine Donawitz

HYDROGEN PLASMA SMELTING REDUCTION
PILOT PLANT CONCEPT







- Iron ore and hydrogen enter the reactor via a hollow electrode
- Transferred arc for the energy input
- Hydrogen is ionised into plasma where iron ore is melted and reduced
- At the end of the process, crude steel is produced and only water vapour escapes

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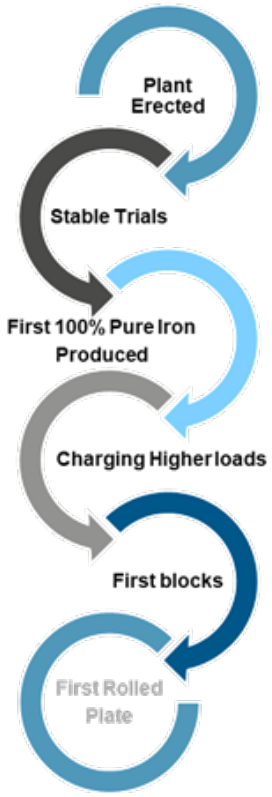
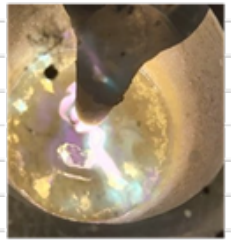
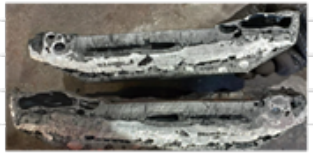
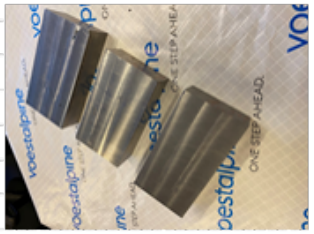
HYDROGEN PLASMA SMELTING REDUCTION
CURRENT STATUS SUSTEEL



March 21 | May 22 | February 23 | April 23 | May 23



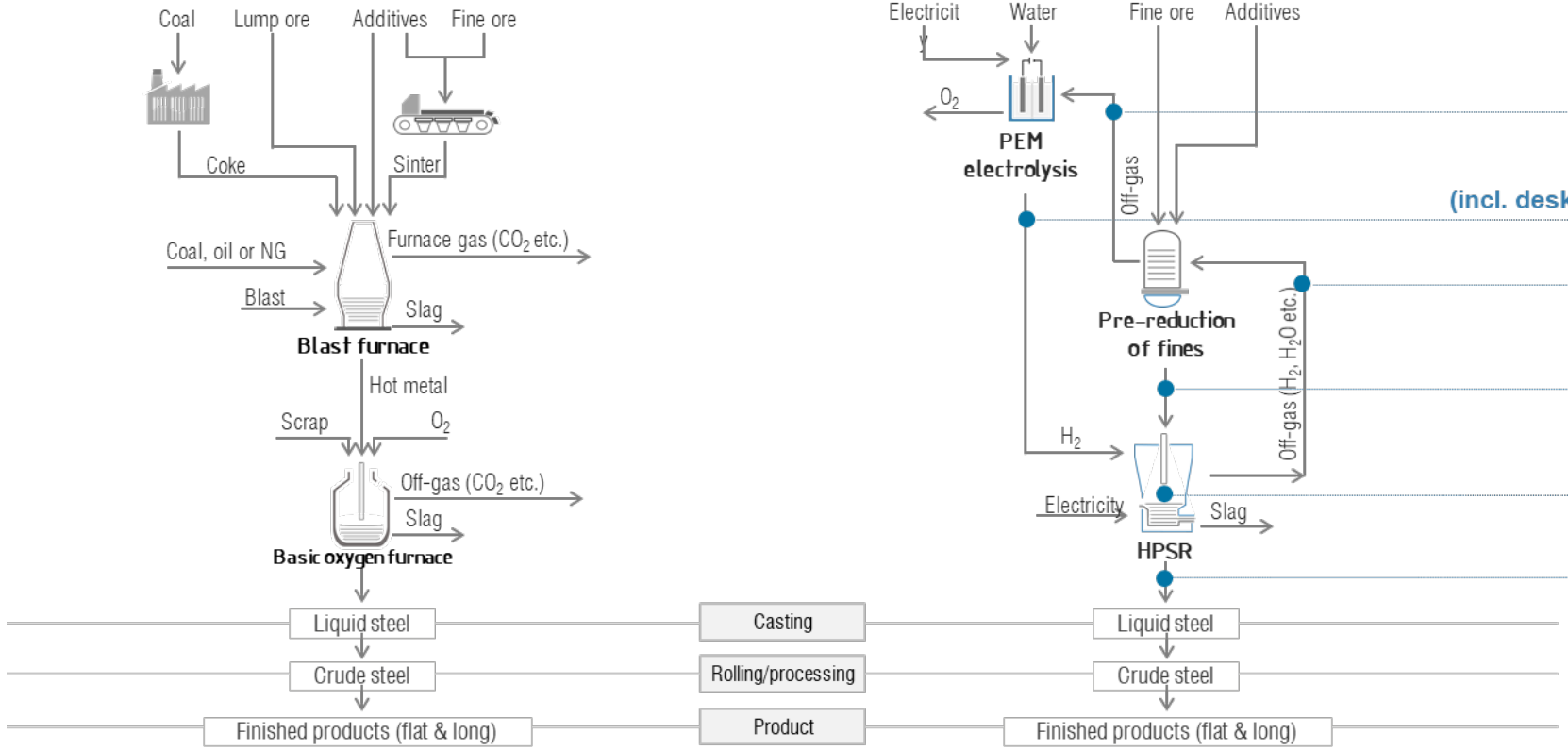




HYDROGEN PLASMA SMELTING REDUCTION
TASKS FOR FURTHER DEVELOPMENT

INTEGRATED ROUTE (STATE OF THE ART)

Integrated route consisting of raw material preparation, blast furnace (iron making) and basic oxygen furnace (steel making)



HYDROGEN PLASMA SMELTING REDUCTION

HPSR route consisting of green hydrogen supply, pre-reduction of fines and HPSR

SUS-F

Objectives

- Recycling of water
- Continuous supply of green hydrogen (incl. desktop study of integrated hydrogen production)
- Recycling & further use of off-gas
- Continuous feeding of ultra fine ore
- Automated and digitalized system
- Semi-continuous tapping of carbon lean steel
- Dissemination

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HYDROGEN PLASMA SMELTING REDUCTION
PILOT PLANT voestalpine DONAWITZ SITE

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Thank you! Questions?

Thomas Buergler
T. +43/664/615 5506
thomas.buergler@voestalpine.com

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