FEUERFEST Symposium 2022

RHI MAGNESITA

Decarbonisation of the Steel Industry

Opportunities & Challenges for the Refractory Solution Providers

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Pathway towards CO_2 reduction for the steel industry:

Opportunities & challenges for the refractory solution providers

RHI MAGNESITA

The presentation focuses on two aspects…

Decarbonisation of the steel industry

EMERGING TECHNOLOGIES IN STEELMAKING & CHANGE IN PROCESS CONDITIONS

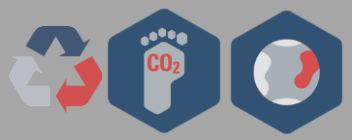
- New emerging technologies (e.g. Smelter) for steelmaking require high-grade refractory materials
- Change in process conditions requires adjusted refractory concepts

HYDROGEN AS REDUCTANT & COMBUSTIBLE

- 100% Hydrogen as reductant → influence on process conditions possibly requires adaption of refractories
- Hydrogen as combustible → how will it affect refractories?

FOCUS OF DECARBONISATION WITHIN RHIM

- Innovative refractory solutions enabling customers to reduce their CO_2 Footprint
- Reduction of Scope 1 + 2 + 3 emissions in our own production plants
- Increase of recycling rate up to 10% until 2025



CHALLENGES & OPPORTUNITIES

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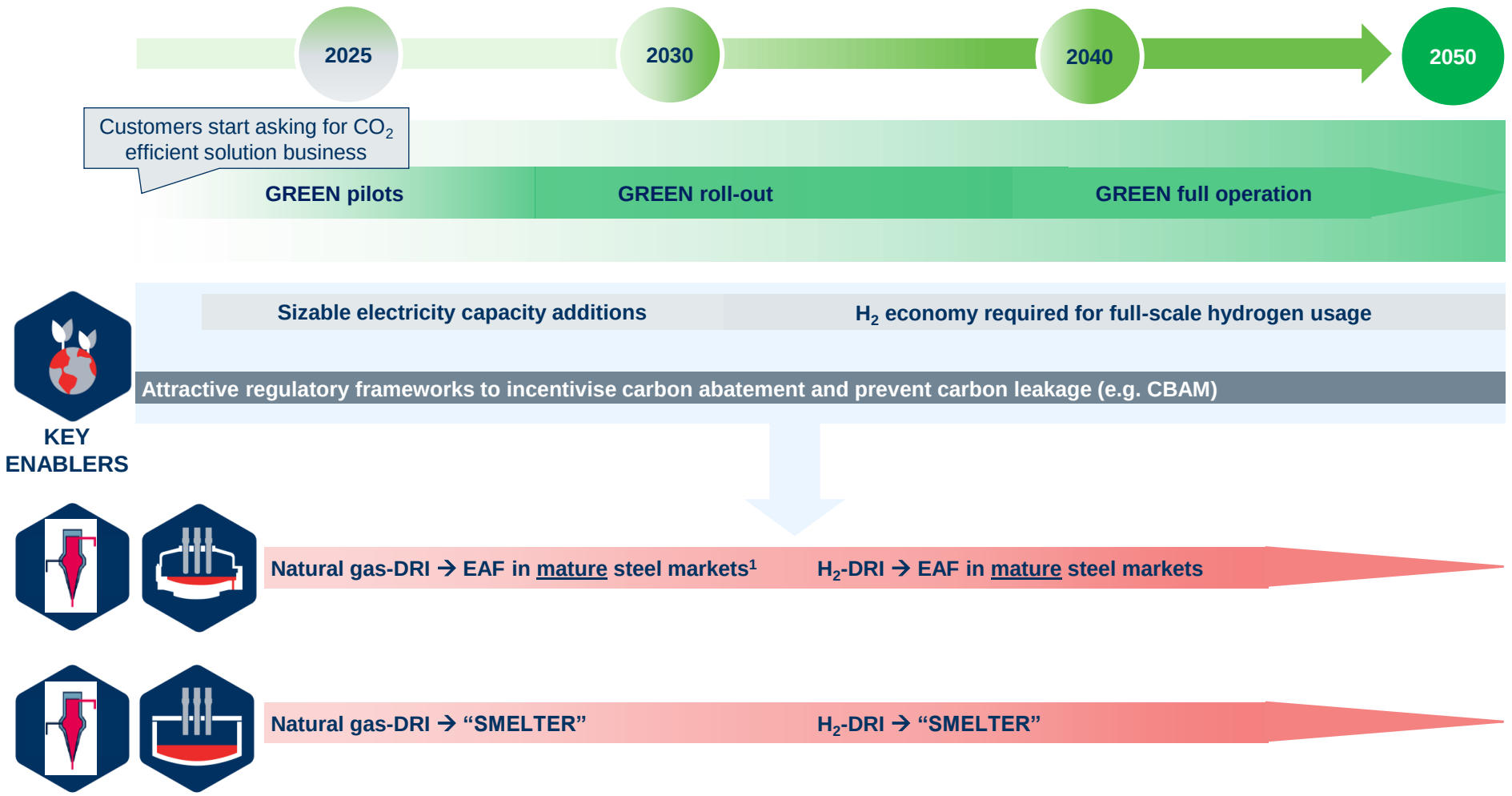
Reducing the CO_2 Footprint: Timeline for the steel industry

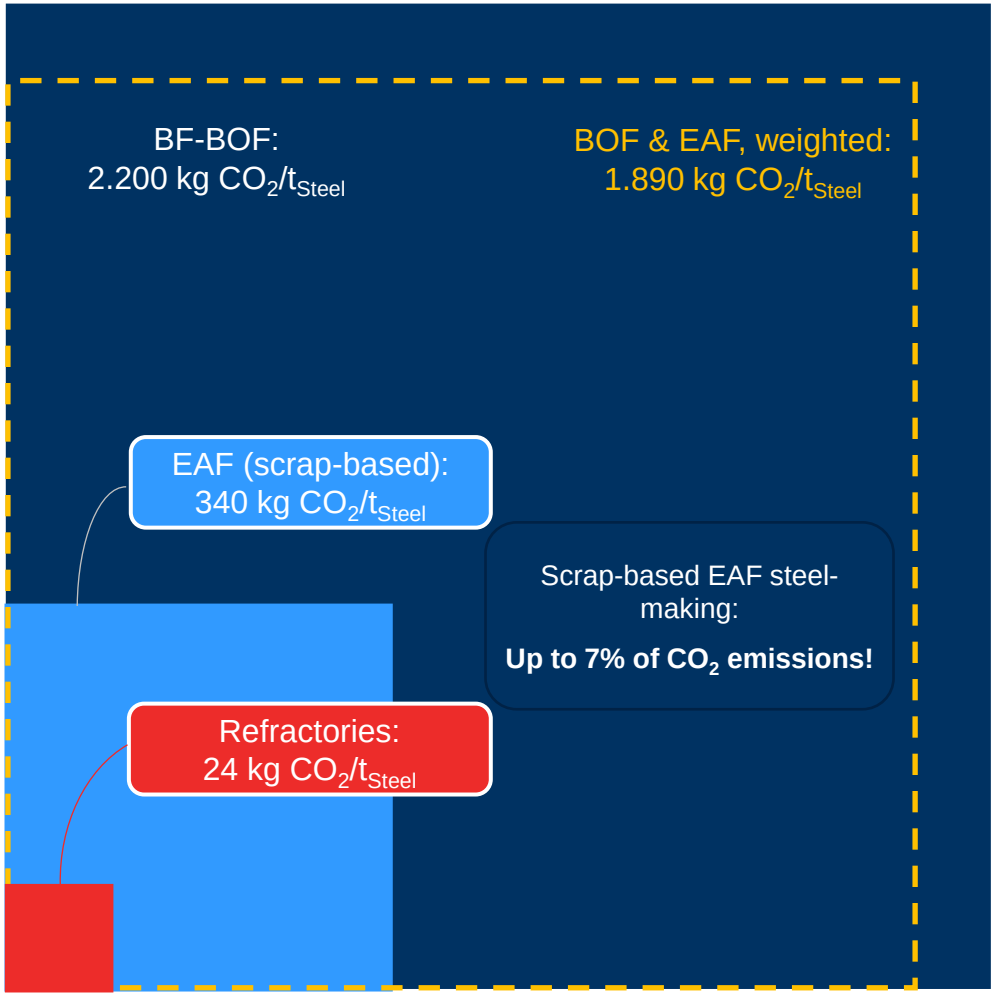
Steelmaking technology to transition stepwise to H_2-DRI-EAF & H_2-DRI-SAF



1 e.g. Europe, USA, MEA, CIS, North East Asia

Refractories in the realm of challenges for steel makers

CO_2 emissions for steel making



- **Total emissions per ton of BF-BOF steel:** 2.200 kg CO_2/t_{Steel}
- **Total emissions per ton of EAF steel:** 340 kg CO_2/t_{Steel}
  - **Charge material EAF:** Scrap
  - **Charge material BOF:** Hot metal, scrap
  - **Source:** International Energy Agency (IEA)
  - **Scope of calculation:** Direct emission intensities: IEA calorific and carbon content values for each fuel (IEA, 2020b). Indirect emission intensities: Global average CO2 intensity of power generation for electricity imported from the grid
- **Total emissions of refractories per ton of steel:** ~24 kg CO_2/t_{Steel}
  - **Source:** RHIM assumptions
  - **Scope of calculation:** Gradle-to-Gate calculation, including Scope 1, 2 and Scope 3 downstream emissions
- **Total emissions per ton of crude steel cast:** 1.890 kg CO_2/t_{Steel}
  - **Routes:** BOF & EAF, weighted
  - **Source:** World Steel Association
  - **Scope of calculation:** BOF and EAF route, weighted based on the production share of each route and includes scope 1, 2 and 3 according to the GHG protocol, excluding the upstream value of mining and transport to the steel site

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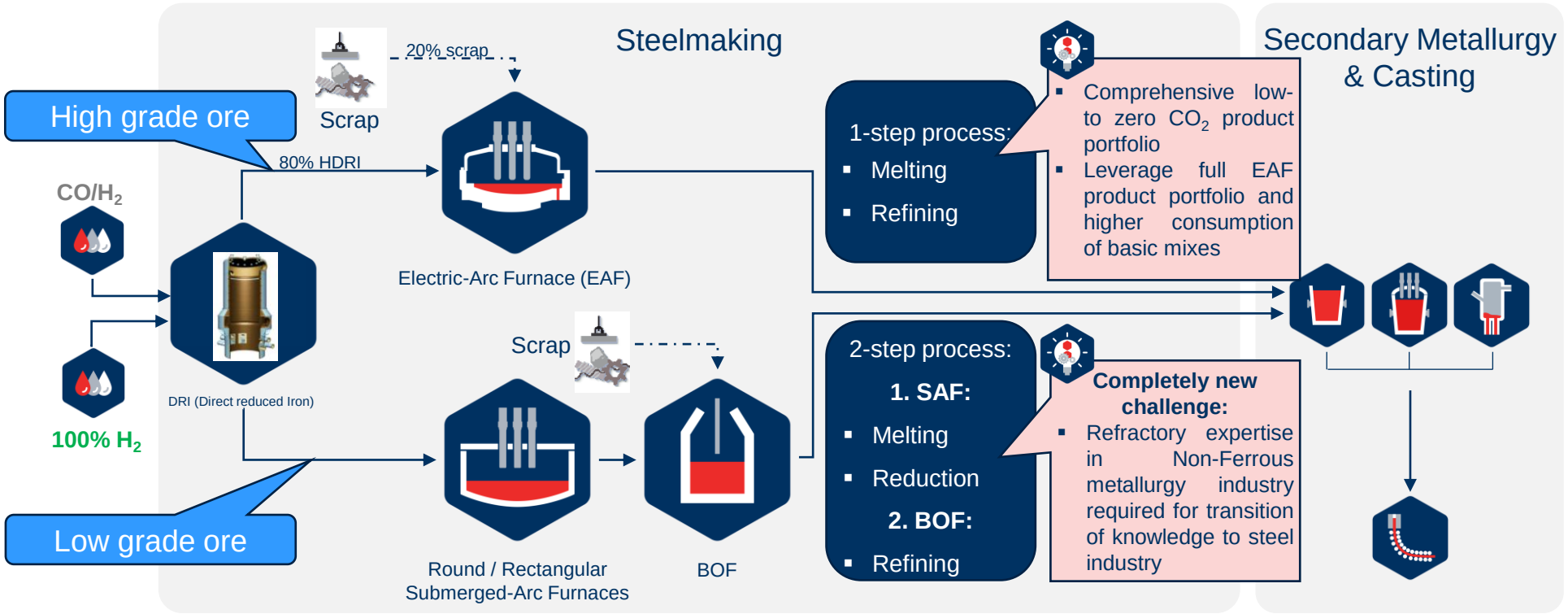
Transformation of the steel industry

New emerging technologies for steelmaking require adjusted refractory concepts

- **20+ DRI projects** are officially announced in Europe
- Two dominant routes for steelmaking

  1.) Direct reduction plant feeding an Electric-Arc Furnace (EAF)

  2.) Direct reduction plant in combination with Submerged-Arc Furnace



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Transformation of the steel industry

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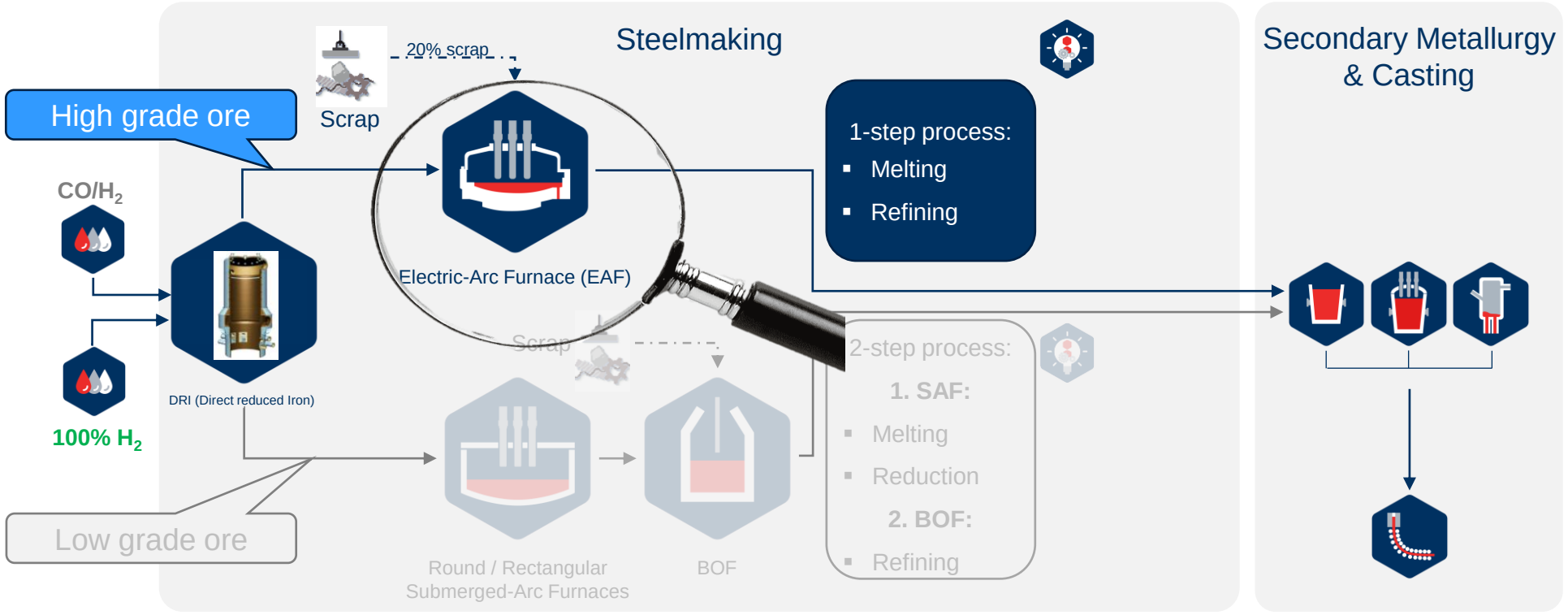
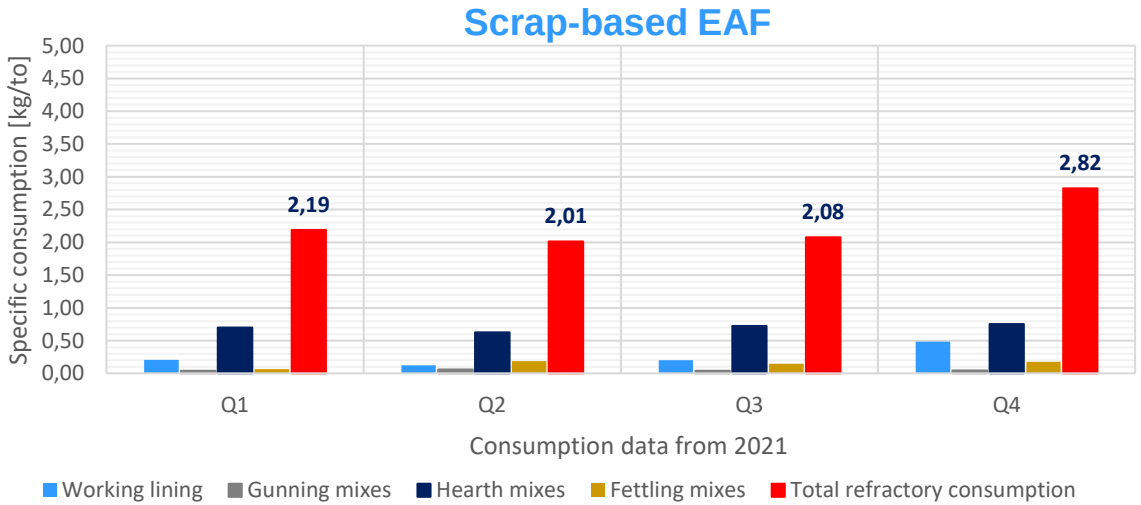


Scrap-based vs. DRI-based EAF Process

Long-term evolution of EAF consumption



REFERENCE 1

- Plant capacity: 1.500 kt
- EAF capacity: 145 t
- Deoxidation: Silicon, Aluminum
- EAF type: AC
- **Campaign length 1.600 heats**

Process Route:

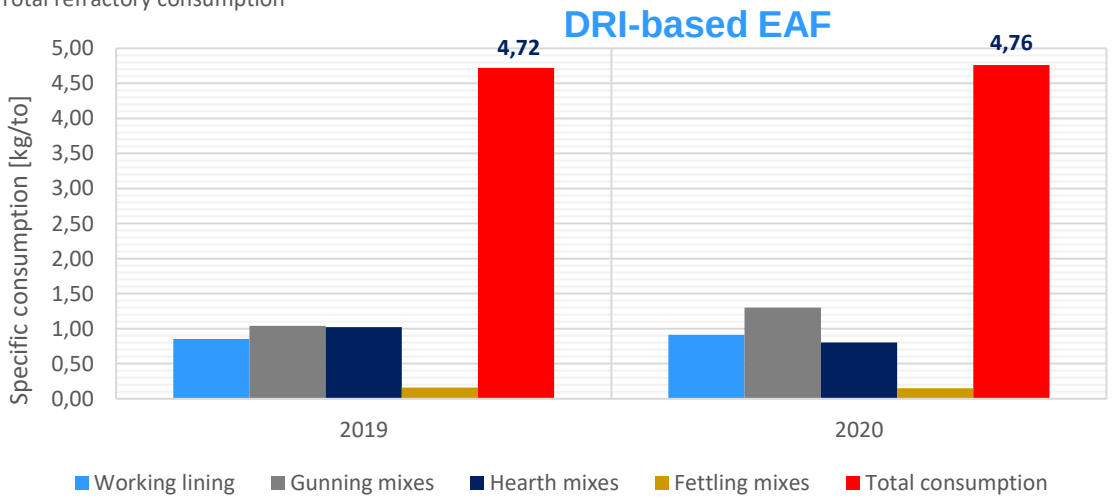
- EAF → LF → Billet Caster
- All heats processed through LF
- **Charge mix: 100% scrap**

REFERENCE 2

- Plant capacity: 1.100 kt
- EAF capacity: 130 t
- Deoxidation: Silicon killed
- EAF type: AC
- **Campaign length: 465 heats**

Process Route:

- EAF → LF → Billet Caster
- All heats processed through LF
- **Charge mix: 98-99% hot DRI max. 2% scrap**



Note: Value for Total Consumption includes all refractory products of EAF including permanent lining, roof, EBT filler etc.

Transformation of the steel industry

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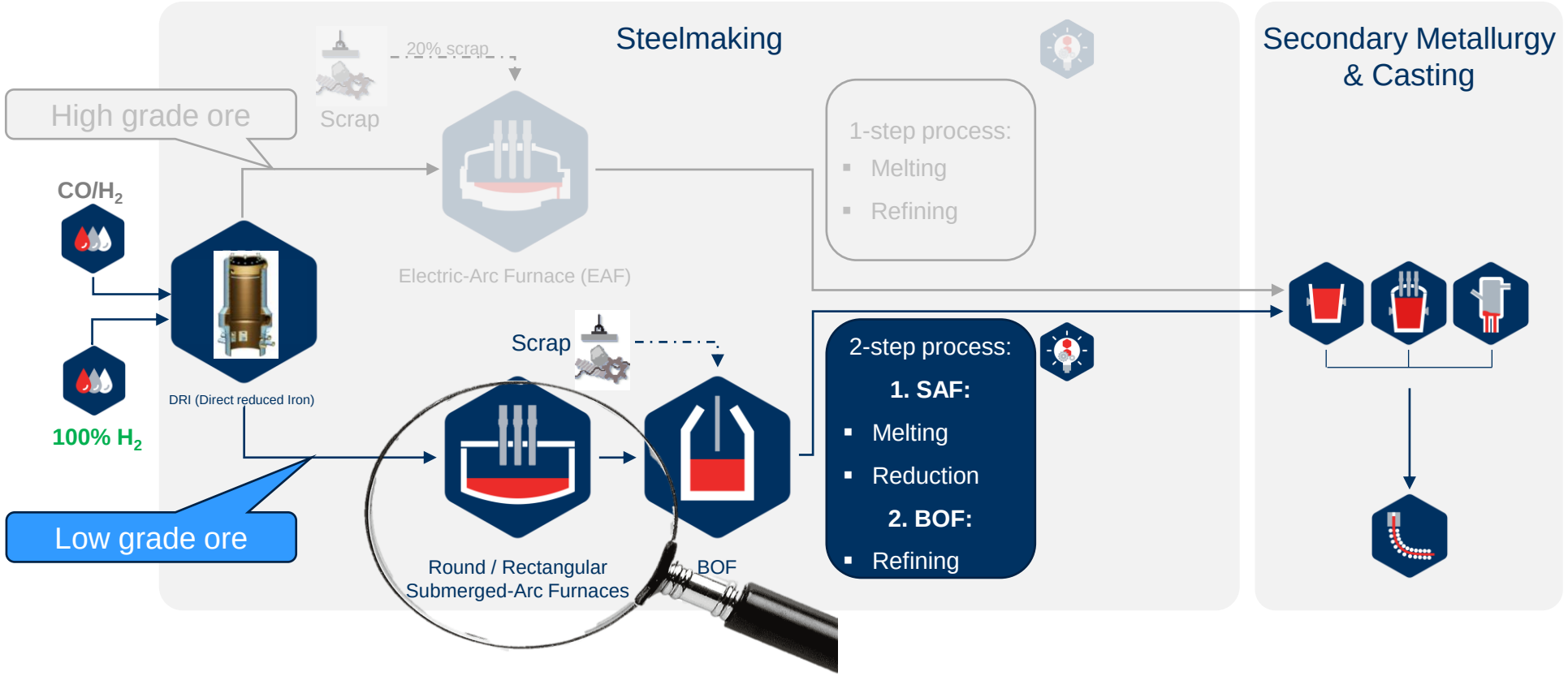
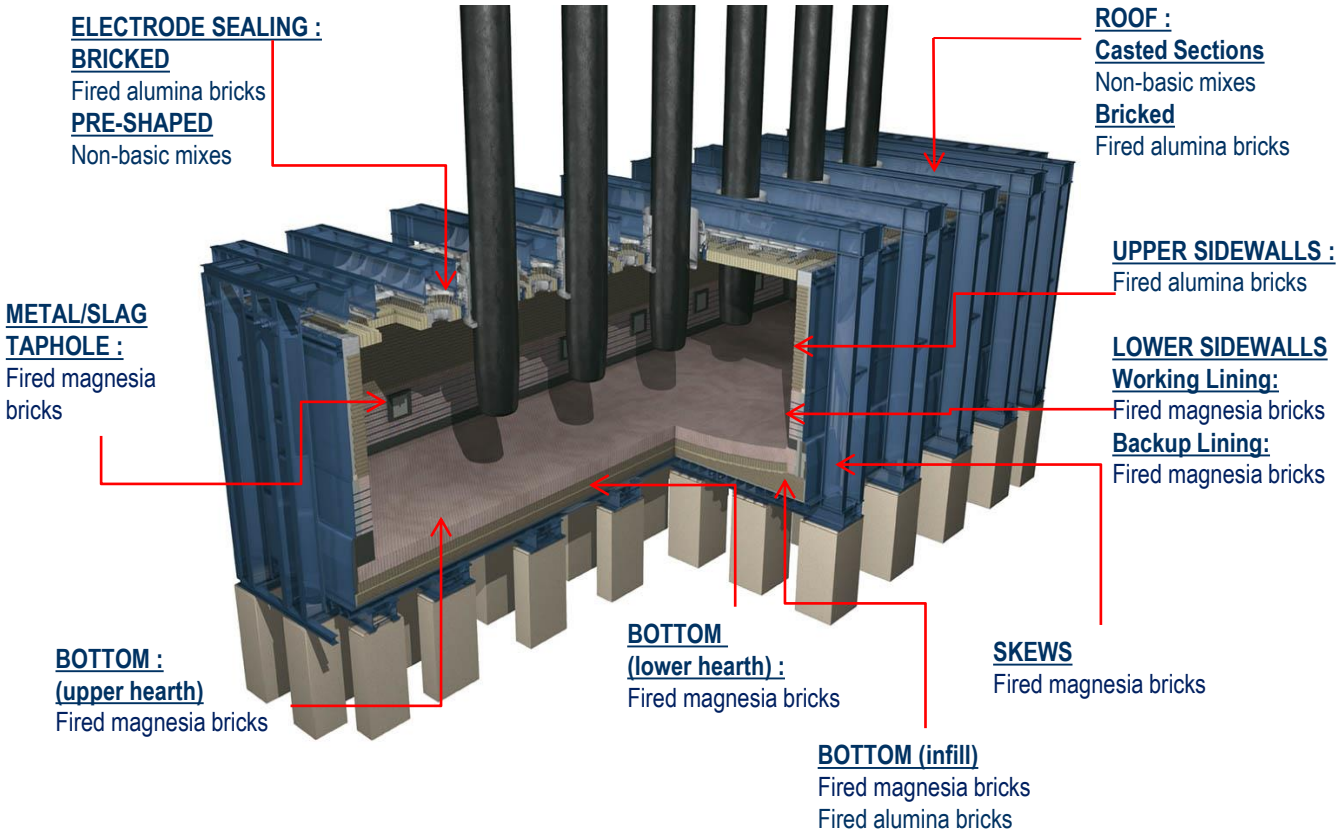


Steelmaking technology trends require expertise in refractories for Submerged-Arc Furnaces (SAF)



Upcoming challenges

- Design of refractory concept adapted to process conditions of DRI-melting
  - Adaption to temperatures
  - Adaption to composition of slag
  - Adaption to metal composition
- Cover future demands of refractories
  - Huge volumes → ~ 1.500-3.500 tons of refractories per SAF

Long-term refractory expertise in NFM-industry as a foundation for providing full support on DRI-Smelter Solutions

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CHALLENGES & OPPORTUNITIES

H_2 at RHI Magnesita

Hydrogen is technology of strategic importance for RHI Magnesita

H_2

Adapt our own processes

CO_2 utilisation
To take the CO_2 and convert it with H_2 into a product

Generation

Firing
Substitution of the NG to prevent CO_2 in the off-gas

Kiln running on hydrogen as fuel

- Joint projects with external academic and industrial partners
- Pilot projects (RD and CAPEX)

Adapt our refractory solutions

Product application

Change of processes will require further specific process know-how

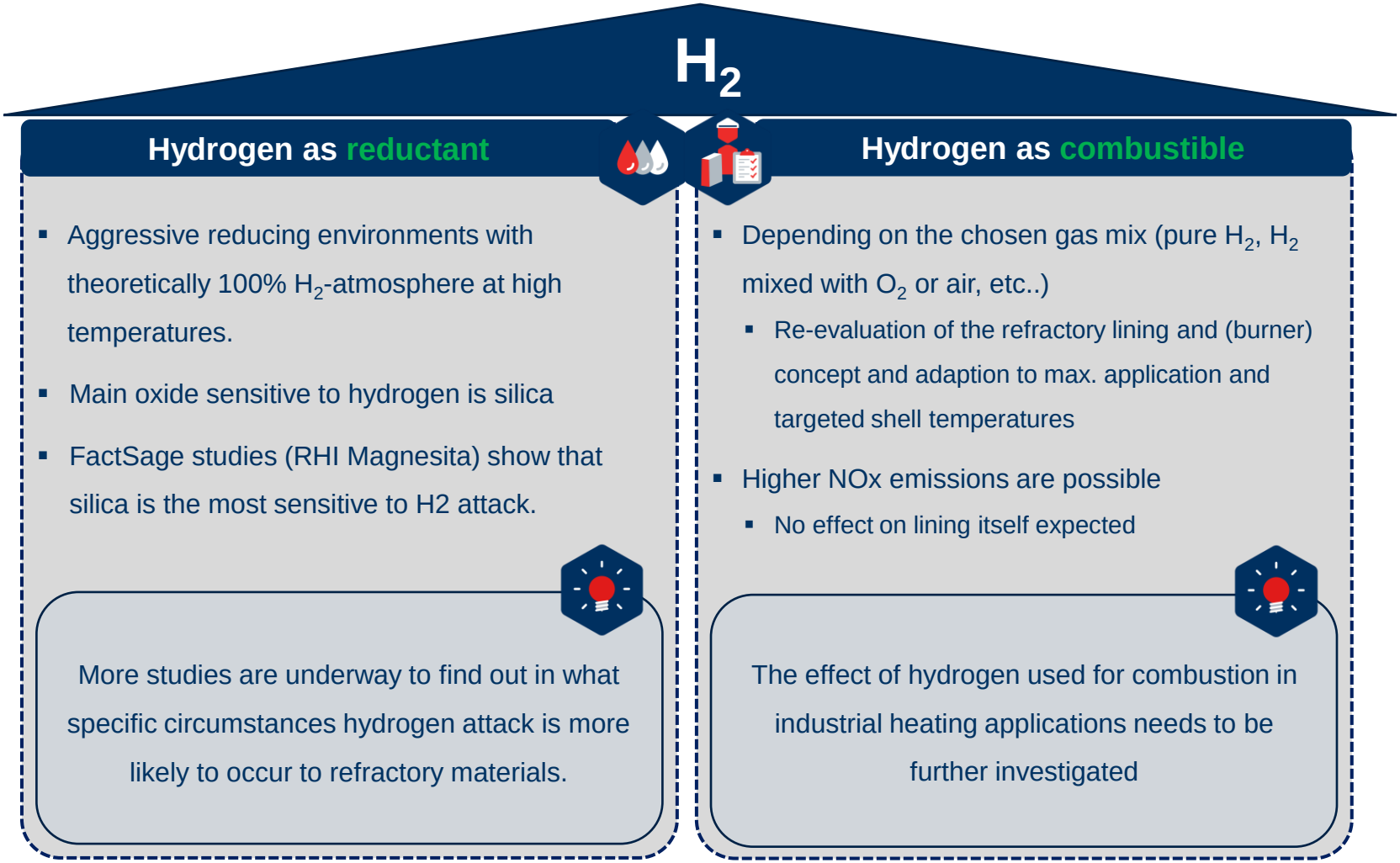
Refractories for Hydrogen Compatibility

- Hydrogen containing atmospheres
- Hydrogen combustion atmospheres

Infrastructure:
Transport

H_2 at RHI Magnesita

Hydrogen is technology of strategic importance for RHI Magnesita



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Summary

Opportunities & challenges for the refractory solution providers

Challenges will be…

- R&D efforts needed to make new required refractory grades available for the altered and more demanding steelmaking process
- Understand the implications the new processes will have on refractory products
- Ability to supply and engineer all qualities for a DRI, Smelter or EAF is not a given for all suppliers

Opportunities will be…

- Assist both the OEM's and the steel producers with the challenges the new processes have on the lining
- Transformation from traditional refractory supplier to solution provider
- Application of proven concepts and learnings of one industry into another industry

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