



**Mission possible:  
technological pathways to decarbonize the global iron and steelmaking industry**

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# Gray steel



# Green steel

*Green Steel definition*  
*Green Steel premiums*  
*Trade regulation*  
**Hydrogen** Climate effects  
**Raw materials quality/availability/price**  
*Emission regulation* Reporting requirement  
Steel demand/type of products **Low-carbon energy availability/stability/price**  
CAPEX/OPEX support

De-risking the transition is the prime target!

1 | 5 | 0 YEARS  
of shaping  
the future



Gray steel



Green steel

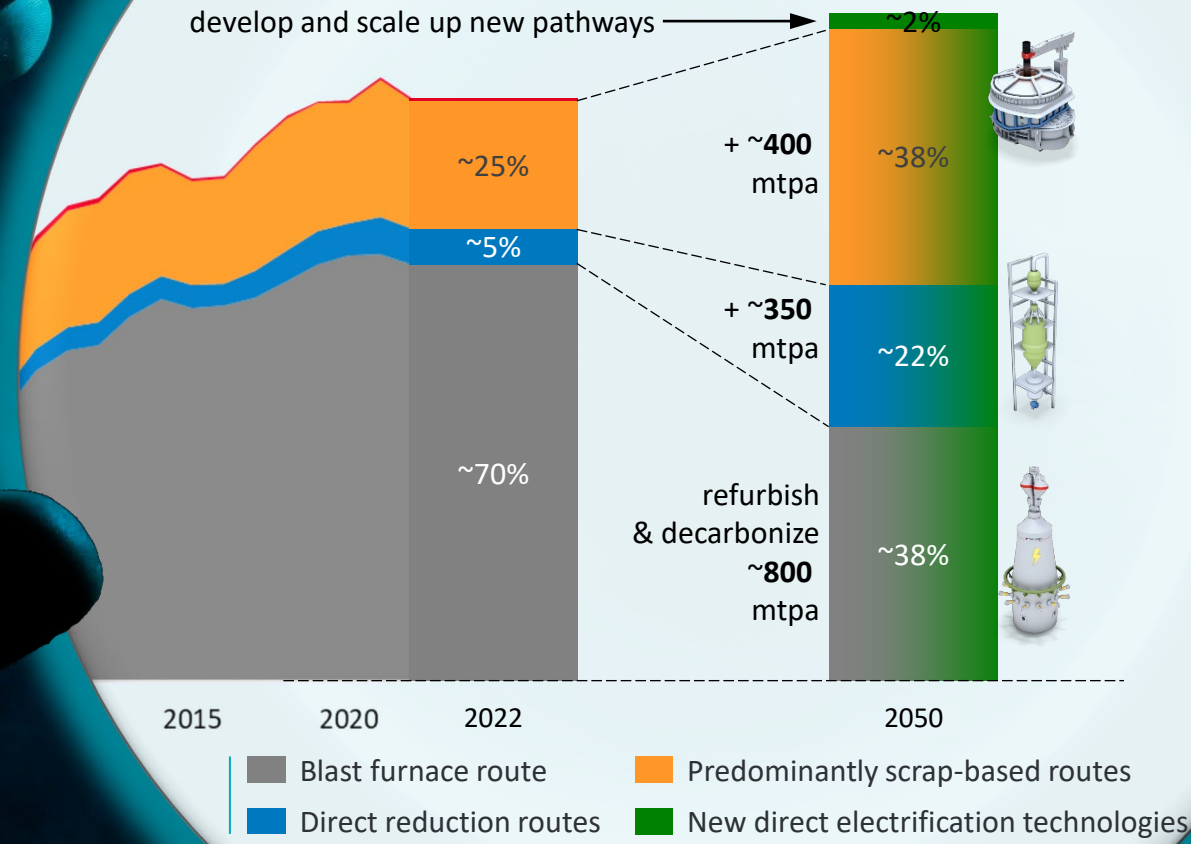
SMS  group

SMS  group



# 2050

## Global Crude Steel Production & Technology Mix



global crude steel production 2050 (~2.15 bn t) assuming stable steel use per capita as per 2022 levels (~222 kg/capita)

Fossil-based energy

Green energy



Status Quo

Conventional Blast Furnace



Blue Blast Furnace

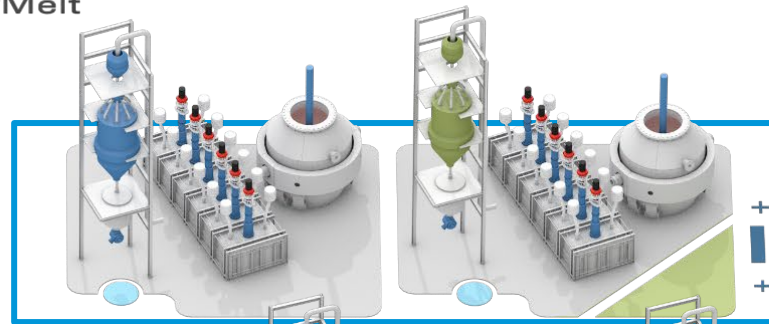


EASyMelt



**TATA STEEL**

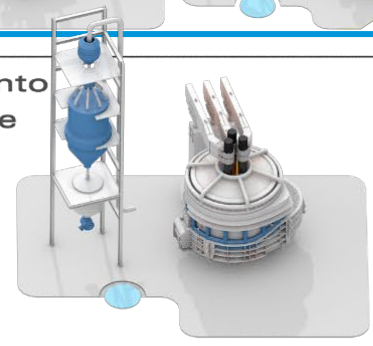
+CCS/CCU  
+carbon substitute



**thyssenkrupp**

+CCS/CCU  
+carbon substitute

Direct Reduction into Open Bath Furnace



**H2green steel**

+carbon substitute

Direct Reduction into Electric Arc Furnace



# DECARBONIZATION PATHWAYS FOR INTEGRATED STEEL PLANTS

EFFICIENCY THROUGH DIGITALIZATION

100%

75%

50%

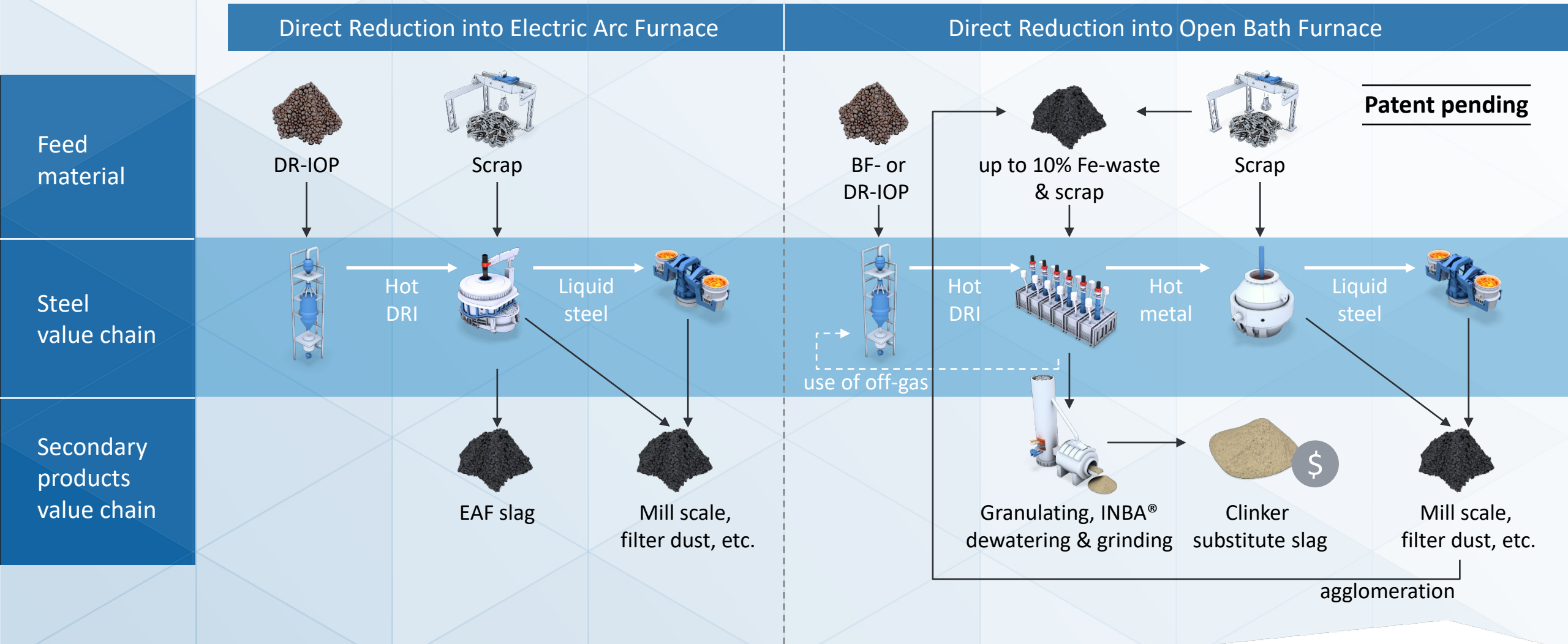
25%

CLIMATE NEUTRAL

CO<sub>2</sub>e EMISSIONS

SCOPE 1 + 2 (Low-emission electricity mix 80g CO<sub>2</sub>e/kWh)

# How to apply direct reduction to integrated quality steel



DR-IOP: Direct Reduction grade Iron Ore Pellets  
BF-IOP: Blast Furnace grade Iron Ore Pellets



# H2 Green Steel

## The world's first 100% hydrogen-based steel plant

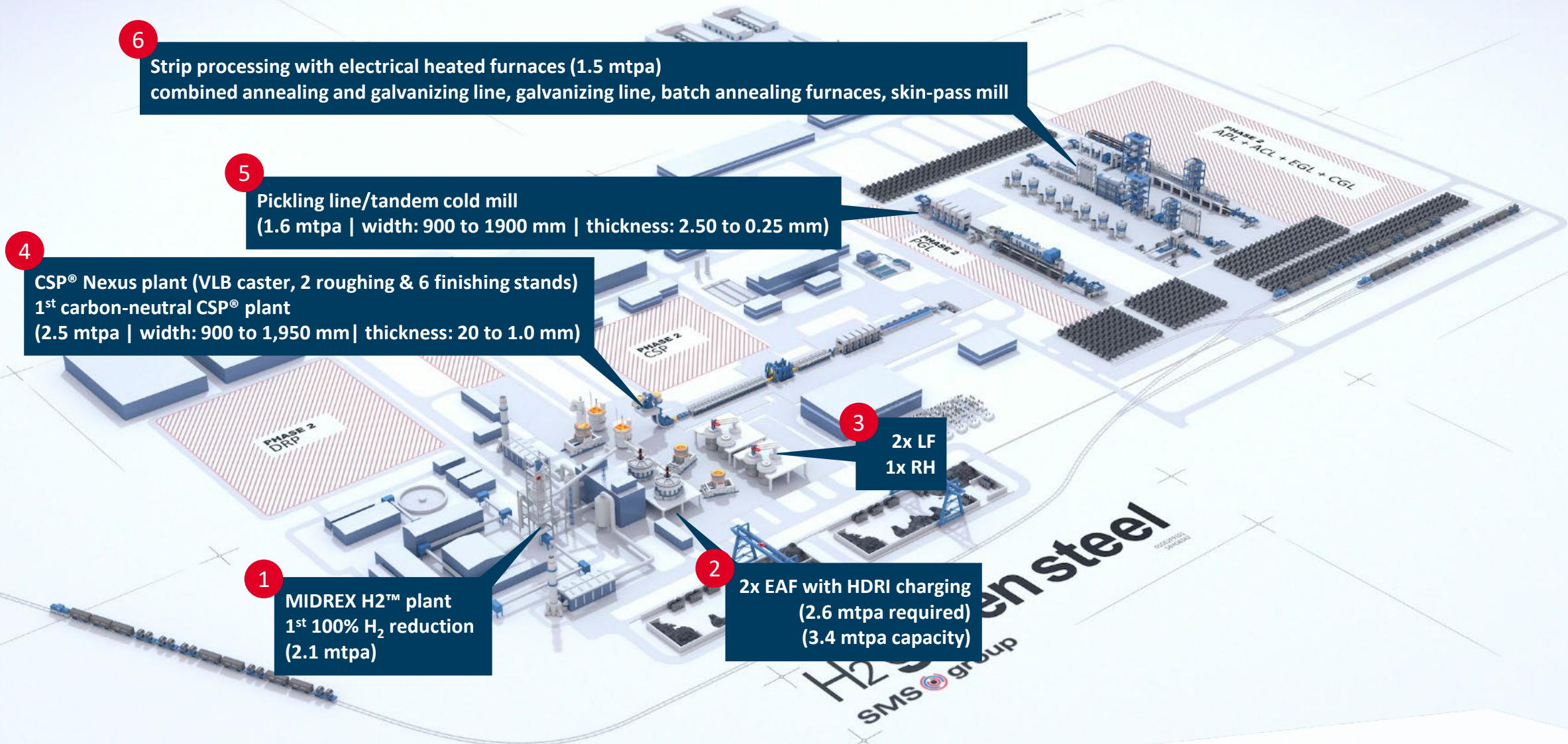
1 | 5 | 0 YEARS  
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- › **CO<sub>2</sub> emission** reduction up to **95%**
- › Based near **Boden, Northern Sweden**
- › Start-up of first plant: **2025**
- › Capacity of phase 1: **2.5 million t/year**, phase 2: **5 million t/year**
- › SMS group supply from **melt shop to finishing lines**

**SMS**  **group**



# H2 Green Steel





# Downstream decarbonization

1 | 5 | 0 YEARS  
of shaping  
the future

## Sustainable Heating

- › furnace electrification (e.g. induction, radiation)
- › flexible fuel switch (e.g. hybrid NG/H<sub>2</sub>)
- › use future by-product gases (e.g. EASyMelt, OBF)
- › reduction of NO<sub>x</sub> emissions

## Digitalization / Lifecycle Services

- › X-Pact® ecoGrids
- › X-Pact® DigiMod Control
- › X-Pact® Prometheus
- › Viridis Energy Management
- › Copper-as-a-Service
- › Quality Execution System

## Energy Retention & Efficiency

- › combined casting & rolling (CSP®, CSP® Nexus, CMT, ...)
- › hot charging
- › HI-Box heat insulation hoods
- › energy recovery
- › process efficiency

## Resource Efficiency

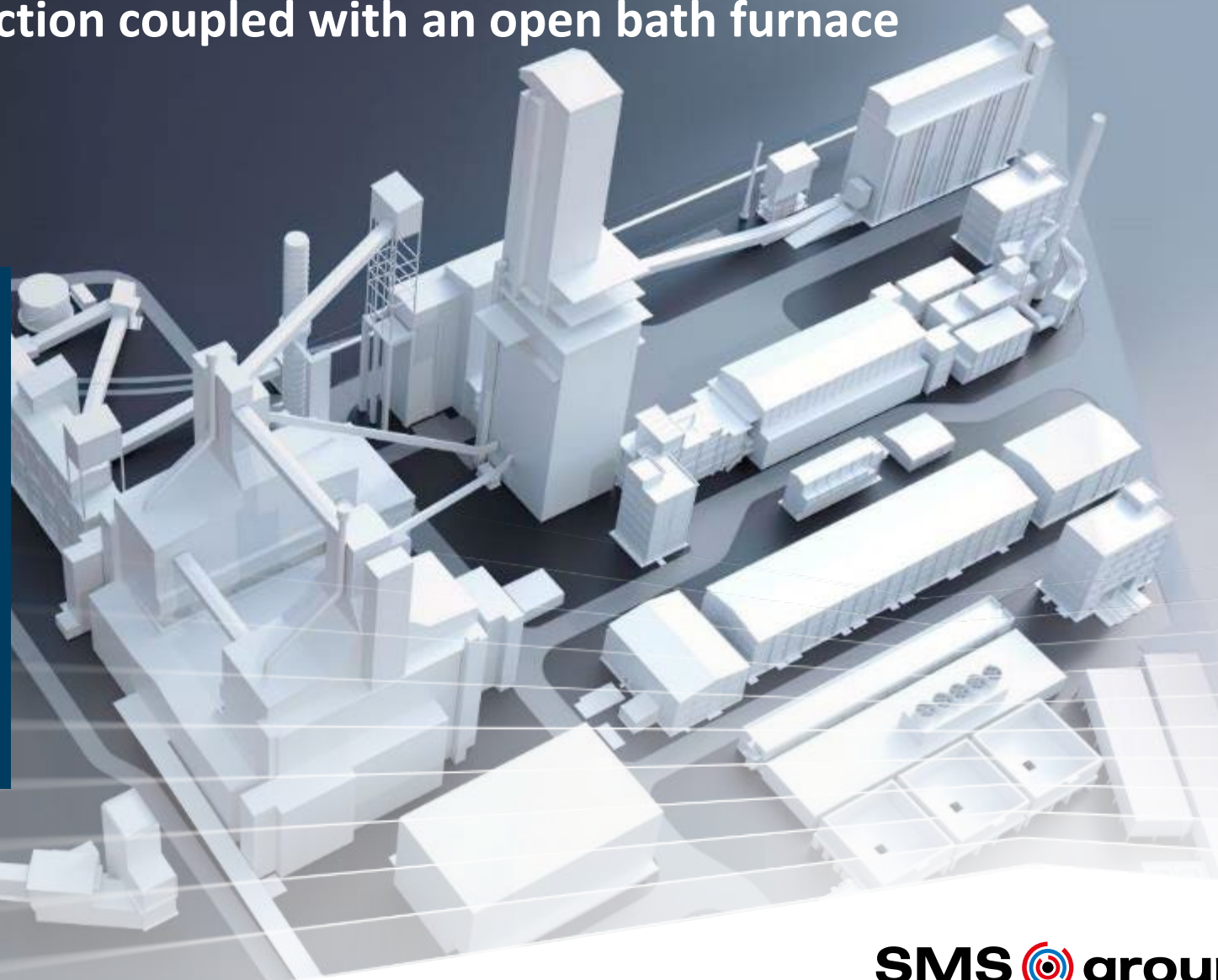
- › reduction of water & oil consumption
- › zero water discharge

# thyssenkrupp Steel

## Hydrogen-based direct reduction coupled with an open bath furnace



- › Annual saving of **over 3.5 million metric tons of CO<sub>2</sub>**
- › Based in Duisburg
- › Start-up of first plant: **2026**
- › Capacity of **2.5 million metric tons** of directly reduced iron
- › **Engineering, delivery and construction** of a hydrogen-powered direct reduction plant, two innovative melters

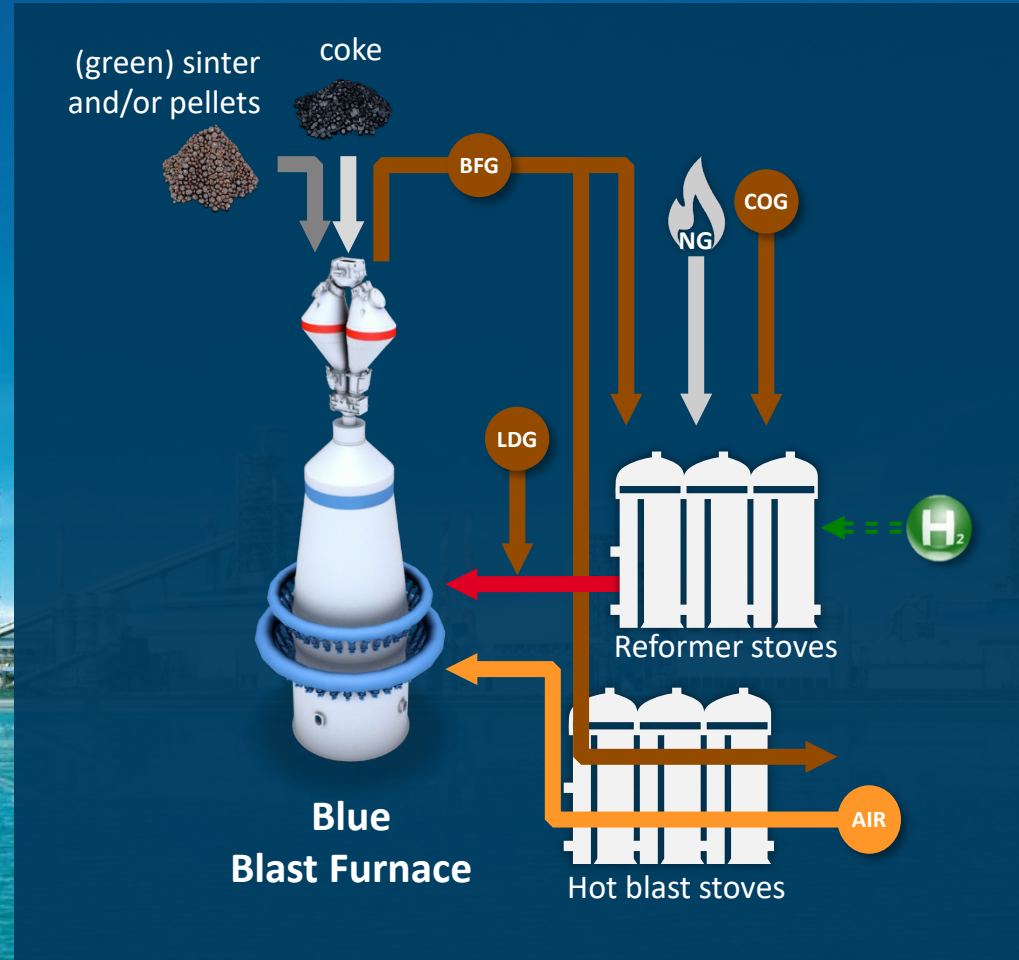




# Blast Furnace Conversion Step 1: The Blue Blast Furnace

## Shaft injection of reformed syngas

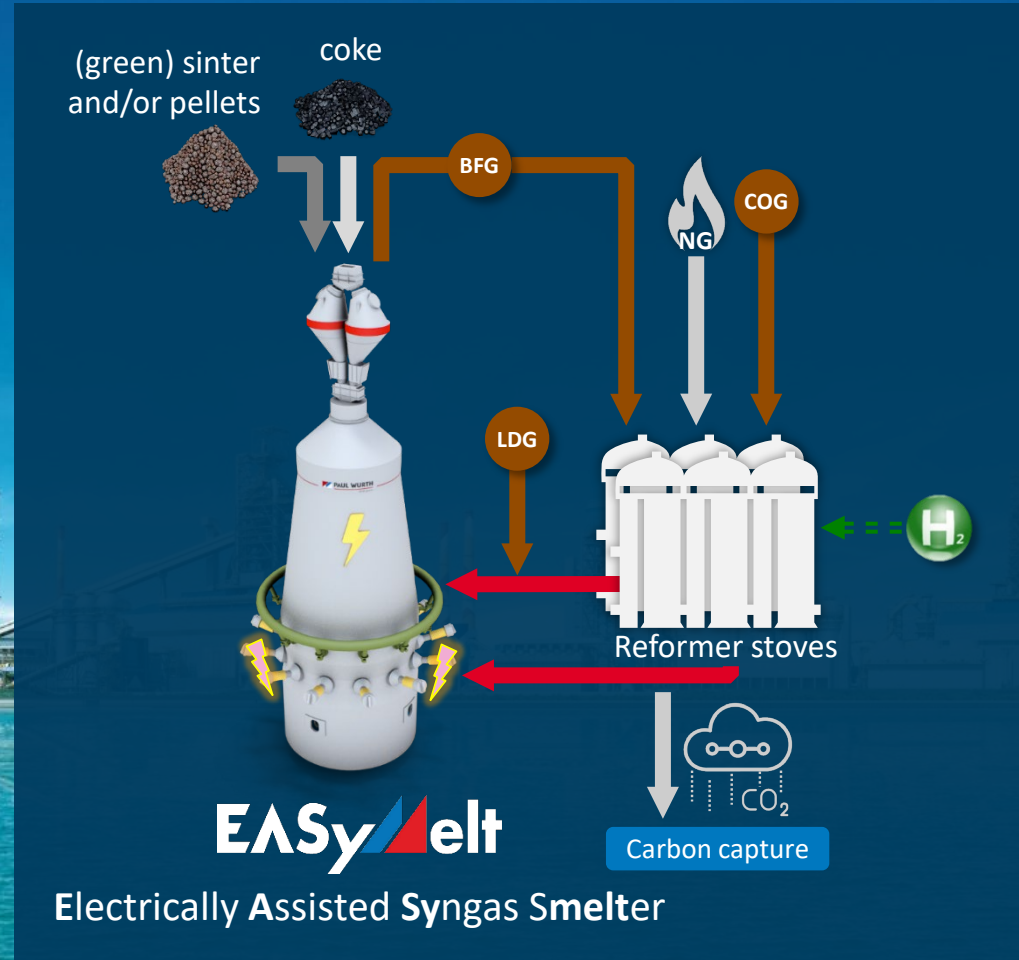
- › allows larger amounts of auxiliary fuel injection (e.g. COG, NG, H<sub>2</sub>, syngas) at tuyère level
- › reduced OPEX due to coke rate decrease
- › potential productivity increase due to decreased gas generation at bosh level
- › add-on technology not impacting tuyère area
- › **CO<sub>2</sub> emission reduction up to 28%**



# Blast Furnace Conversion Step 2: EASyelt

Full replacement of hot blast with reformed syngas  
Electrification of melting heat

- > lowest CAPEX
- > integrated into existing steel plant
- > stepwise low risk approach
- > lowest OPEX
- > energy & ore flexibility
- > waste recycling in sinter still possible
- > high production rate & quality
- > more than 60% direct CO<sub>2</sub> avoidance



Patent pending



# Blast Furnace Decarbonization Strategies

## 2. Technology upgrades

*coke oven gas injection, natural gas injection, PCI dynamic distribution*

## 4. EASyMelt without green hydrogen

*replacement of hot blast by syngas super-heated by plasma torches*

## 6. CCUS and renewable carbon

*final decarbonization options*

## 1. Energy and process efficiency

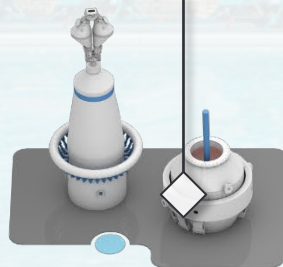
*BFXpert, BLTXpert, PCIXpert, Heat and Gas Recovery Systems, VFD for dedusting and Hot Stoves, TRT, CDQ*

## 3. Blue Blast Furnace

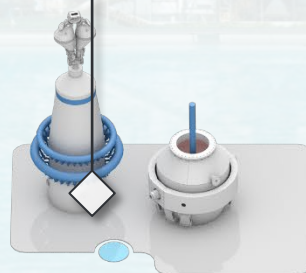
*syngas shaft injection; reforming technologies for circular carbon*

## 5. EASyMelt with green hydrogen

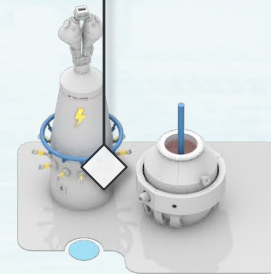
*enrichment of reducing gas by hydrogen or ammonia*



Status Quo  
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Blue Blast Furnace

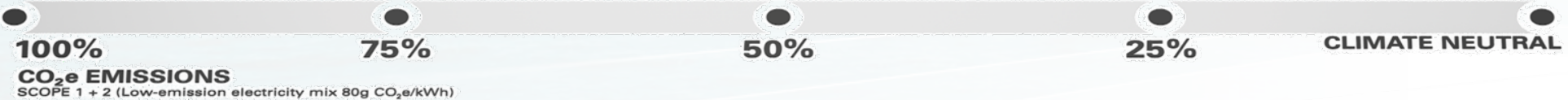


EASyMelt



+CCS/CCU  
+carbon substitute

EFFICIENCY THROUGH DIGITALIZATION



# Hydrogen activities in SMS group

1 | 5 | 0 YEARS  
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the future



## Power-to-X (gas or liquids)

SMS group and partners are developing a fully integrated carbon valorization cycle to produce e-fuels for the aviation industries.



## Hydrogen Generation

SMS group is partner of Sunfire, which is the leading electrolyzer technology developer.



REDUCING CO<sub>2</sub>  
EMISSIONS



## Green Steel

Using green hydrogen as a reducing agent in direct reduction plants allows a carbon-neutral steel production.



**SMS  group**