ELECTRIC GAS HEATER FOR DECARBONIZING INDUSTRIAL HIGH TEMPERATURE HEATING

Authors:

Andrea Castelli, Katia Papalia, Fabio Cravino

Table of content

EH prototype test rig

Electric Heater Technology

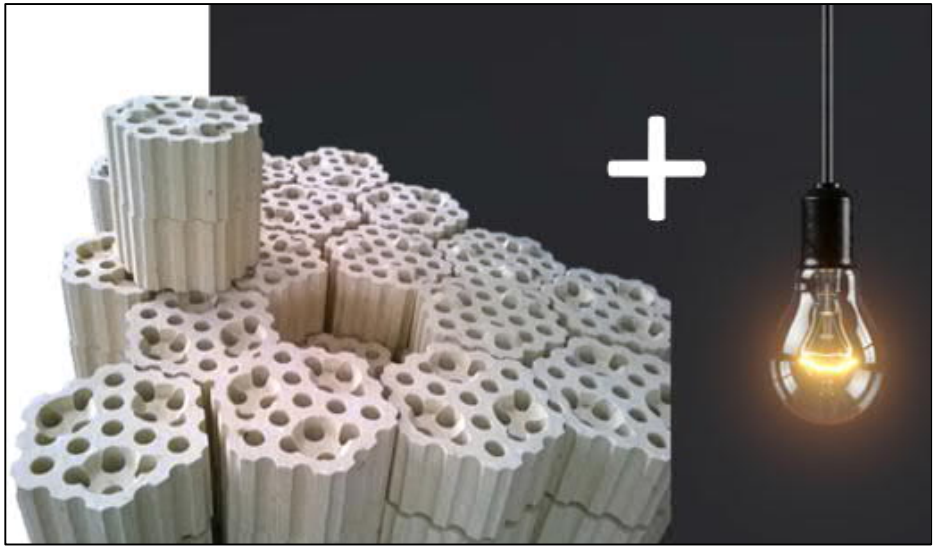
Invention background

Hot Blast Stoves plant (TSL - Tata BF "H" - India)

The solution

The EH is the combination of two technologies:

- *Checkers* (holed refractories) from Hot Blast Stoves technology
- *Electrified wires* as heating elements within the checker holes



Checker bricks typically installed in Hot Blast Stoves

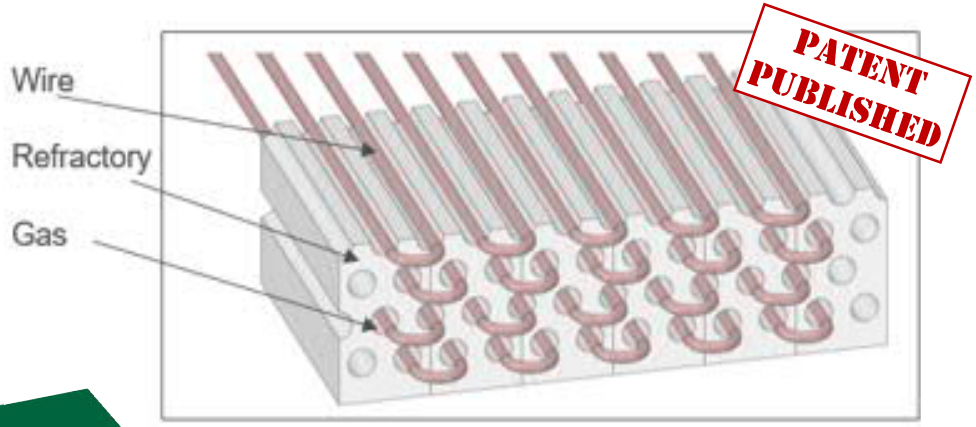
Electric Heater Technology

Functioning principle

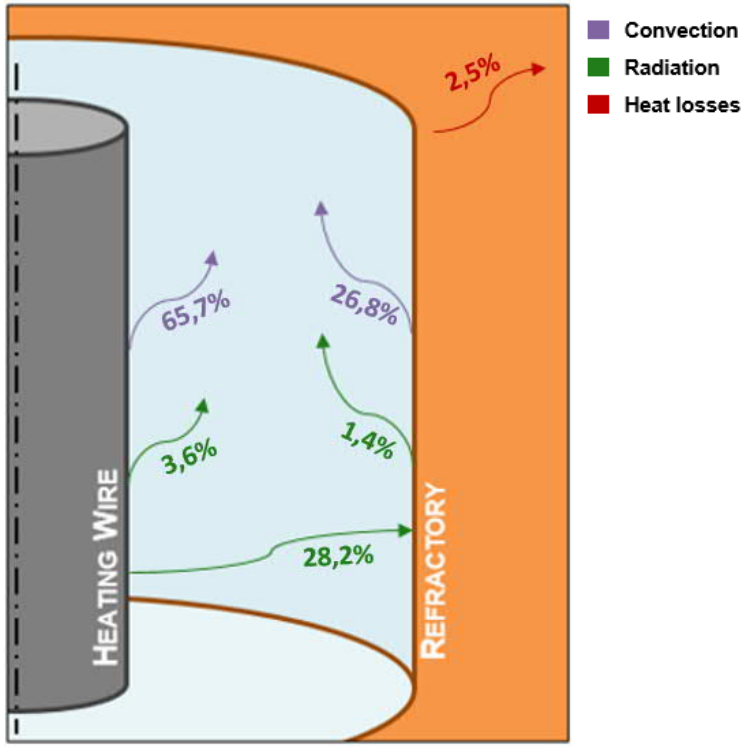
Basic principle

Ele. Power ($P = R \cdot I^2$) is converted into heat by Joule effect and directly exchanged with the gas flow:

- Channels geometry & direct heating boosts the heat transfer, allowing high gas temperature
- Checkers geometry adds high specific surface (m^2/m^3) to allow high power density
- Checkers bricks provides self-electrical insulation between heating wires



Channels geometry



How channels geometry boosts heat transfer

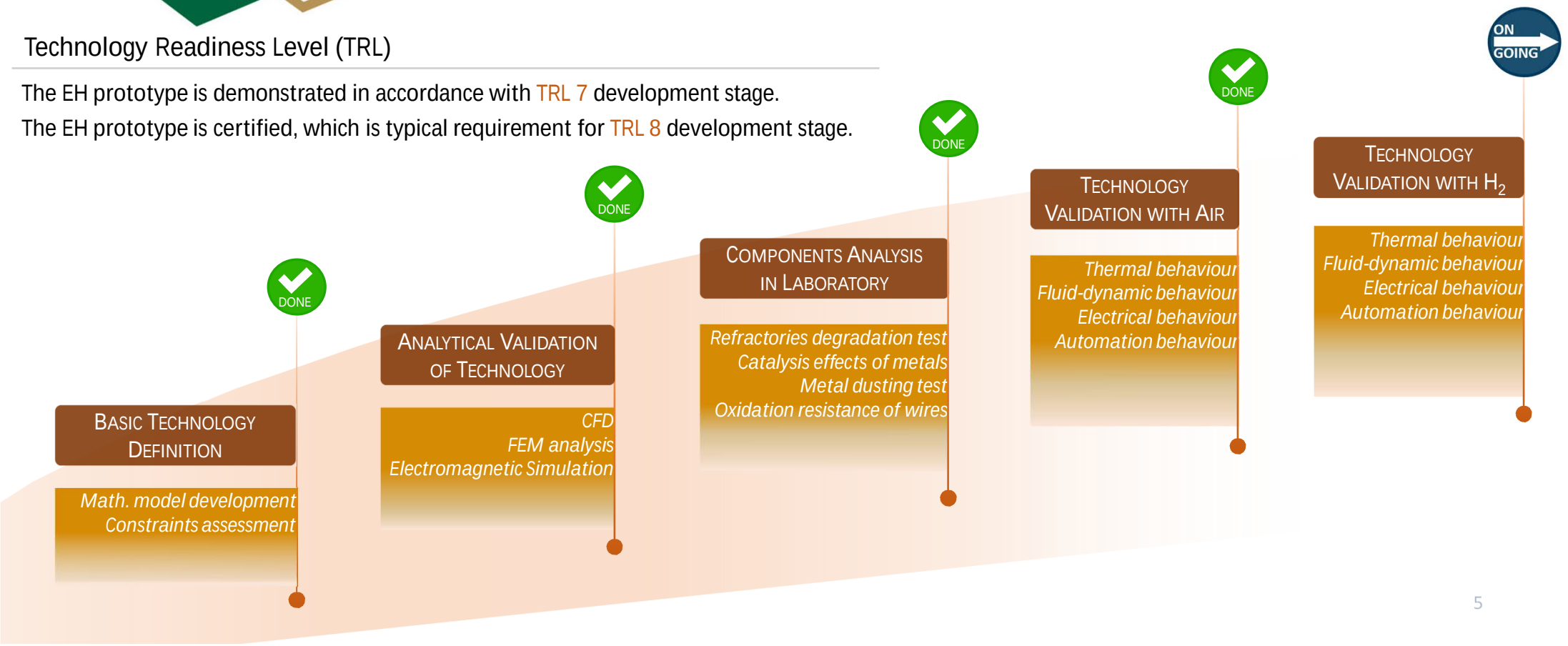
Development Status

Technology roadmap

Technology Readiness Level (TRL)

The EH prototype is demonstrated in accordance with TRL 7 development stage.

The EH prototype is certified, which is typical requirement for TRL 8 development stage.



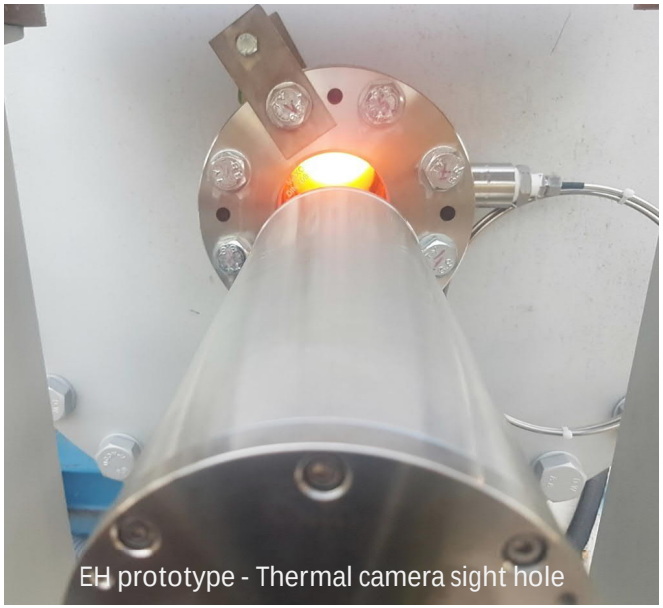
Development Status

Electric Heater prototype

EH prototype

PROTOTYPE DESIGN DATA

• Apparent Power	444 kVA
• Voltage (ph-ph) max.	690 V
• Gas inlet P max.	10,2 bar (g)
• Gas inlet / outlet T max.	300 / 1000 °C
• Ave. shell temperature	100 °C



EH prototype - Thermal camera sight hole

AISTech2025

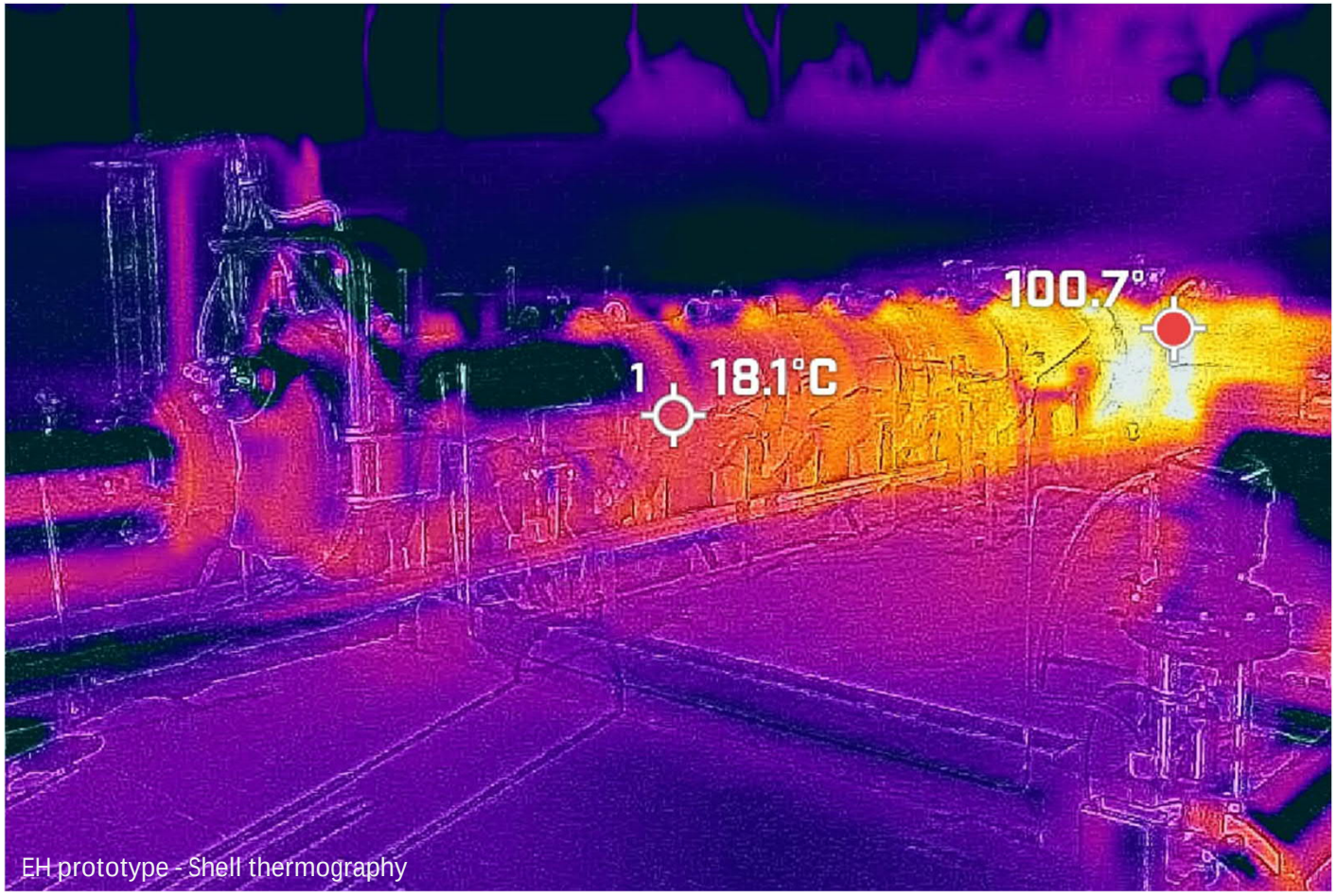
Development Status

Tests results

1st iteration set of tests has been performed over a 5 days continuous operation:

- Gas composition: 80% H_2 20% N_2
- Gas max. flow-rate: 1200 Nm^3/h
- Gas max. outlet temp.: 1080 °C
- Power Factor: 0.9995
- Total efficiency: >95%

EH prototype - Thermal camera sight hole



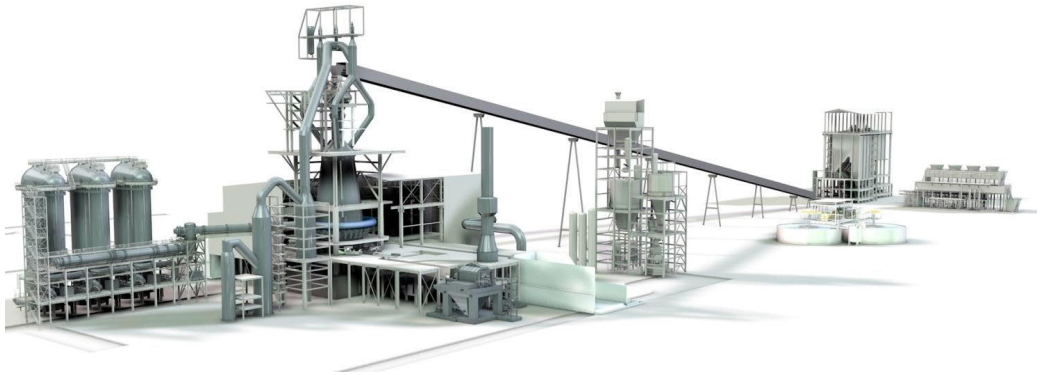
EH prototype - Shell thermography

AISTech2025

Industrial Applications

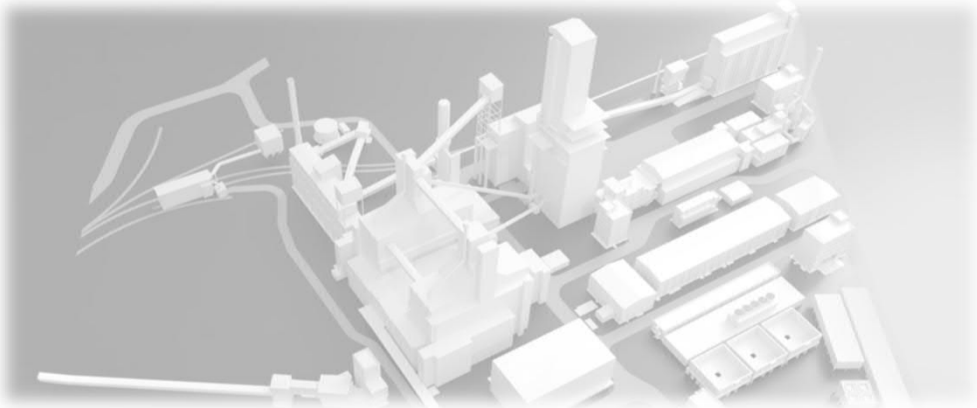
Flexible application for multiple tasks

Iron & Steel - Blast Furnace complex



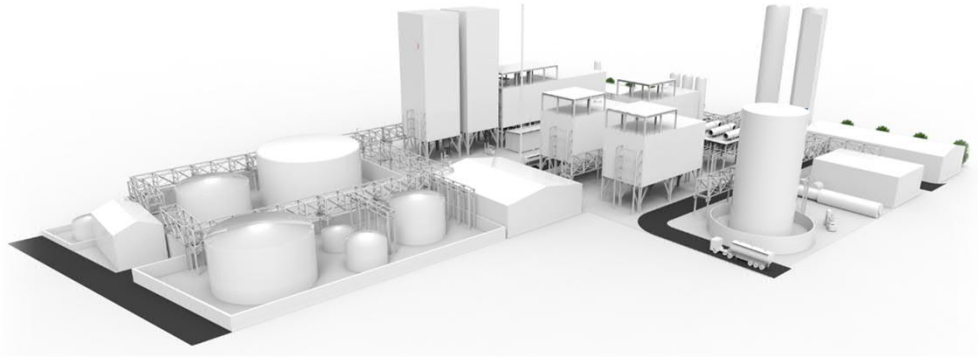
- Syngas electric heating for BF shaft injection
- Auxiliary gas fuel electric heating for tuyeres injection

Iron & Steel - Direct Reduction plant



- Feed gas electric heating for Shaft Furnace

Oil & Gas - Sustainable Aviation Fuel (SAF) complex



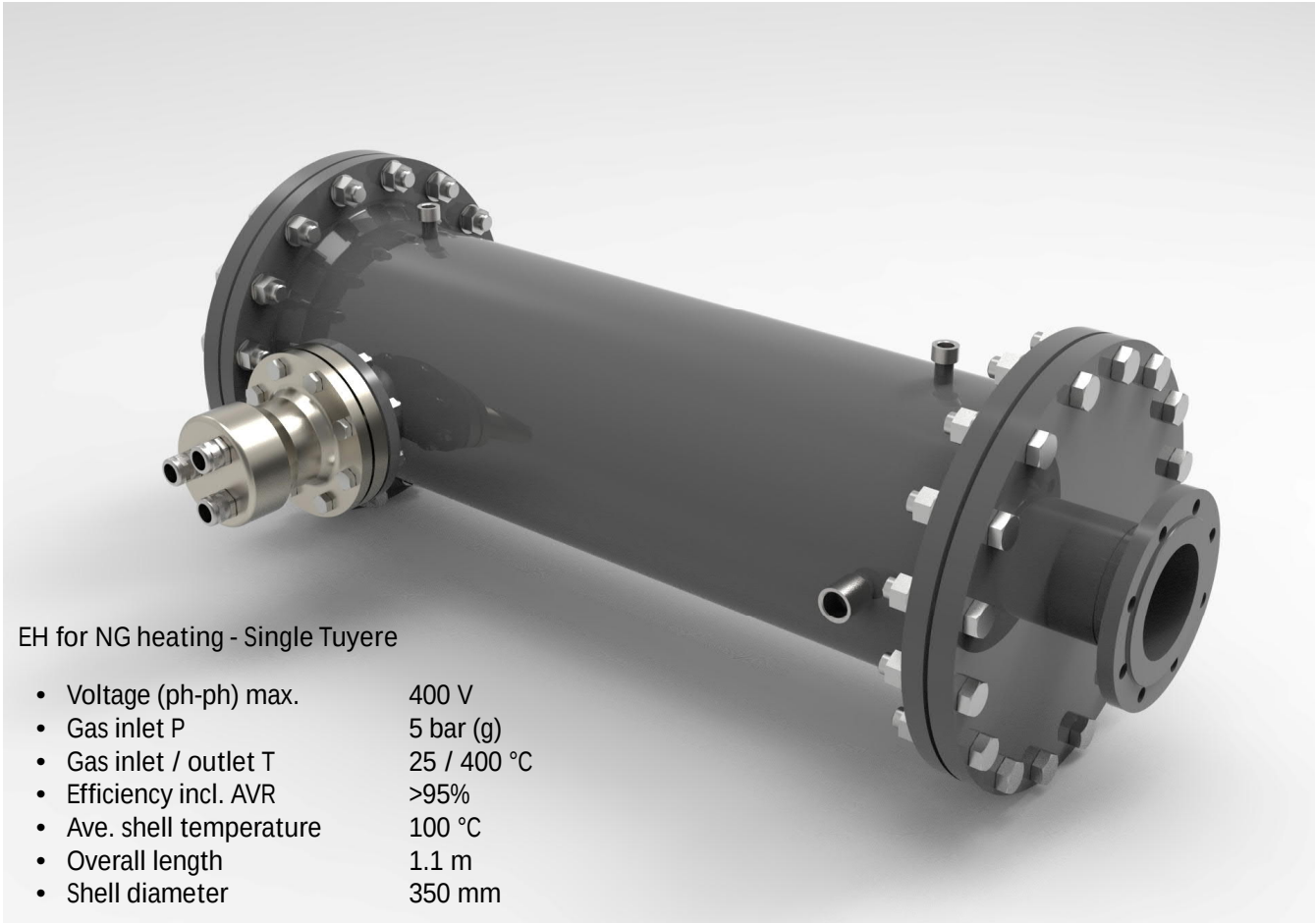
- Feed gas electric heating for Reverse Water Gas Shift Reactor

Industrial Applications

A case study - Hot NG injection

Hot NG injection allows coke-rate reduction in general, lowering coke making CO_2 emissions. Additionally, electric heating brings further specific advantages:

- Independent tuyere injection temperature control
- No combustion emissions for heating purposes
- Higher heat transfer efficiency compared to fired heating
- Compact EH fitting BF layout in tuyeres area
- No hot NG distribution pipelines



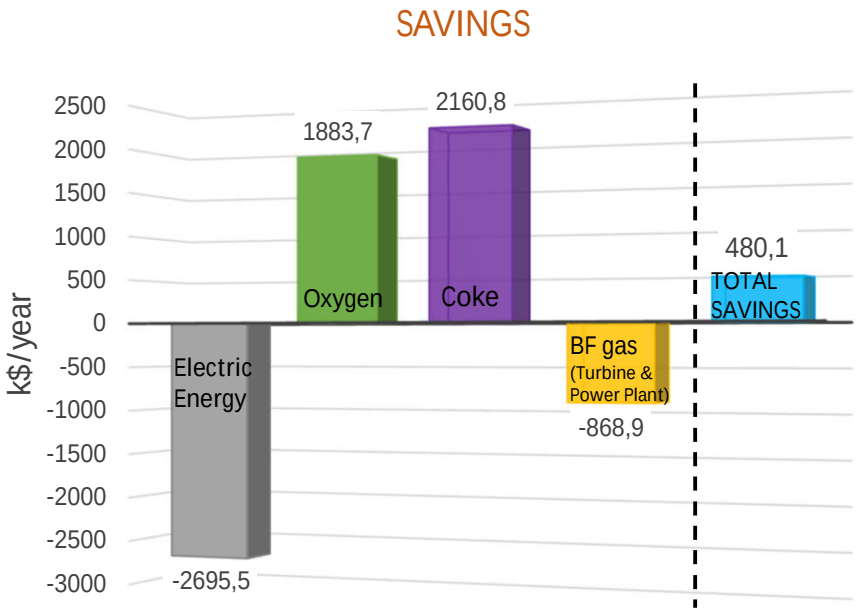
EH for NG heating - Single Tuyere

• Voltage (ph-ph) max.	400 V
• Gas inlet P	5 bar (g)
• Gas inlet / outlet T	25 / 400 °C
• Efficiency incl. AVR	>95%
• Ave. shell temperature	100 °C
• Overall length	1.1 m
• Shell diameter	350 mm

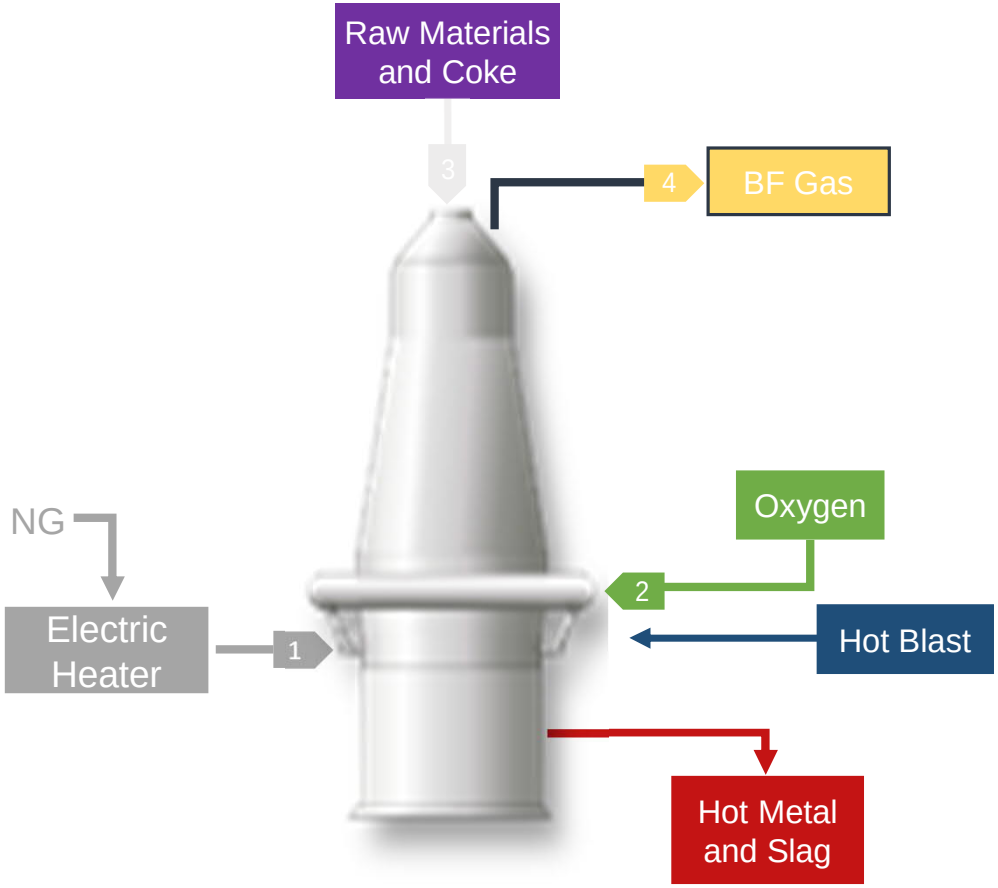
Industrial Applications

A case study - Hot NG injection

Savings are defined between cold (25°C) and hot (400°C) NG injection with reference to 22 tuyeres BF operated at both fixed production and NG injection rate (132 Nm^3/HMt)

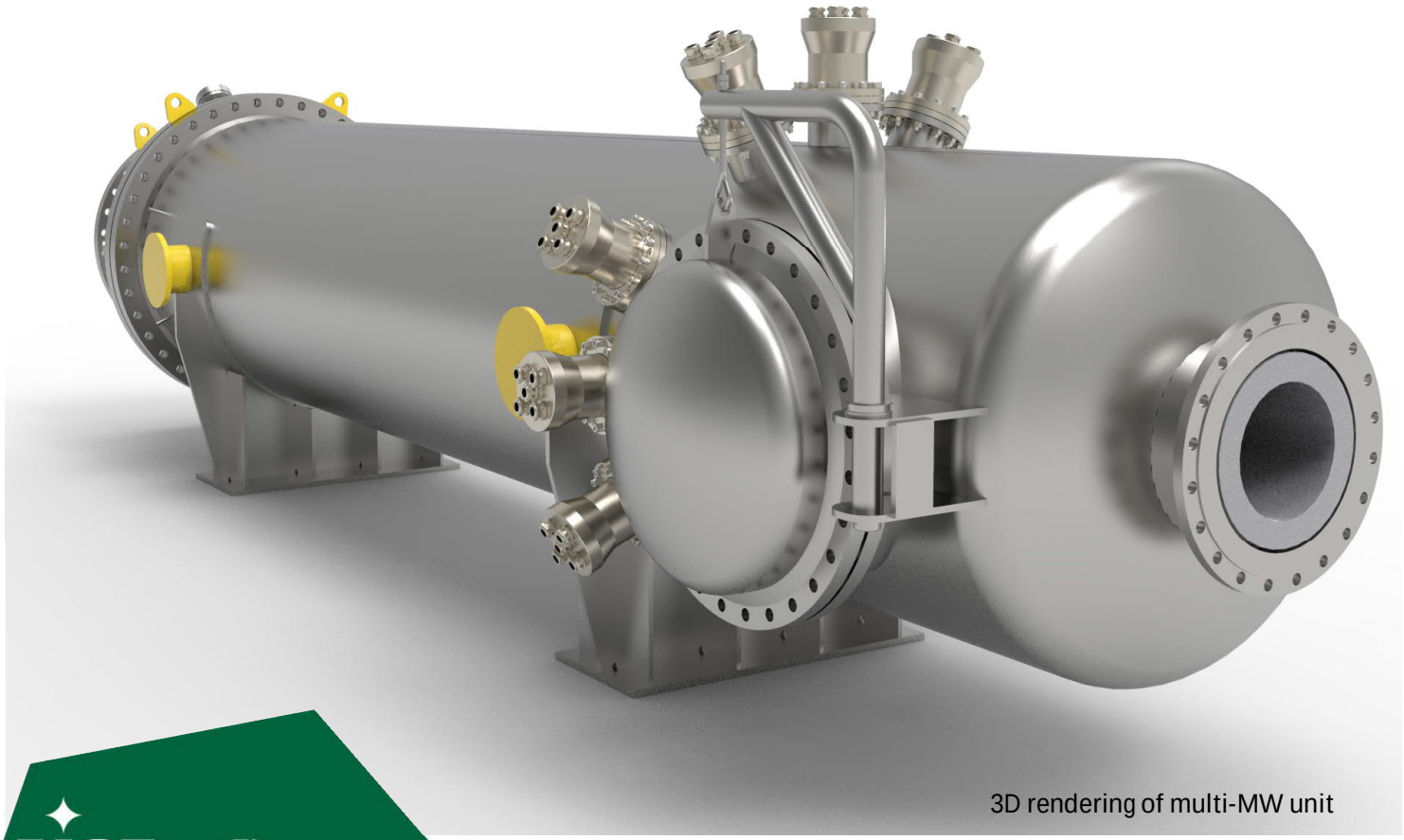


Commodities costs (ref. to January 2025)		
O_2 El. Consumption	1,4	kWh/Nm^3
Electricity Industrial Price	78,9	$/MWh
Coke Price	250	$/ton



Conclusions

Features at glance



3D rendering of multi-MW unit

TECHNOLOGY PROPER

- Refractory technology is meant for high temperature
- High efficiency, low shell temperature
- Checkers bricks provides self-electrical insulation between wires
- Thermal inertia against flow variations and cooling improves wires campaign life
- Checkers design enhances specific heating surface (m^2/m^3) and then power density
- Designed for continuous operation in harsh industrial environment

STANDARDS & NORMS

- PED & ATEX certification covered

AISTech2025

Thank you!

CONTACT PERSONS:

Andrea Castelli
Product Manager - Electric gas heating
andrea.castelli@sms-group.com
Phone: +39 010 6409294

Katia Papalia
Senior Business Development Engineer
katia.papalia@sms-group.com
Phone: +39 010 6409639

Fabio Cravino
Technology Director
fabio.cravino@sms-group.com
Phone: +39 010 6409663

SMS group

AISTech 2025