Using Hydrogen to Decarbonize the Brick and Tile Industry

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Graz, 09.-11.04.2024

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Stahl

Research project „H_2-Ziegel“

Name of project

Energieeffizienz und Emissionsreduzierung – Einsatz von Wasserstoff in der Ziegelindustrie (H_2-Ziegel)

Funding

Ferderal government of NRW (progress.nrw – Innovation), FKZ: EFO 0058

Project partners

Institut für Ziegelforschung Essen e.V., Essen
VDEh-Betriebsforschungsinstitut GmbH, Düsseldorf
Kueppers Solutions GmbH, Dortmund
KELLER HCW GmbH, Ibbenbüren
Klinkerwerk Hagemeister GmbH & Co. KG, Nottuln

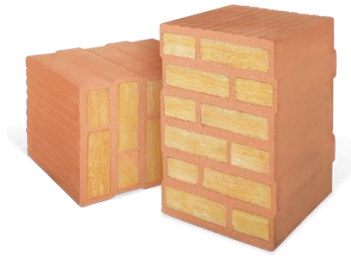
Key facts

Investigation on the usage of H_2 for firing bricks and tiles

- Baseline measurements on the tunnel kiln at Hagemeister
- Testing the existing burner with H_2 on a test rig at BFI
- Development of a new burner which can be operated with natural gas and hydrogen as well as mixtures
- Test firings of bricks on a test rig at IZF with a downscaled model of the new burner
- Testing of the new burner in industrial scale at BFI
- Installation of the new burner and revamping the existing tunnel kiln to operate with H_2 by Keller
- Measurements during production with the new burner operating with H_2

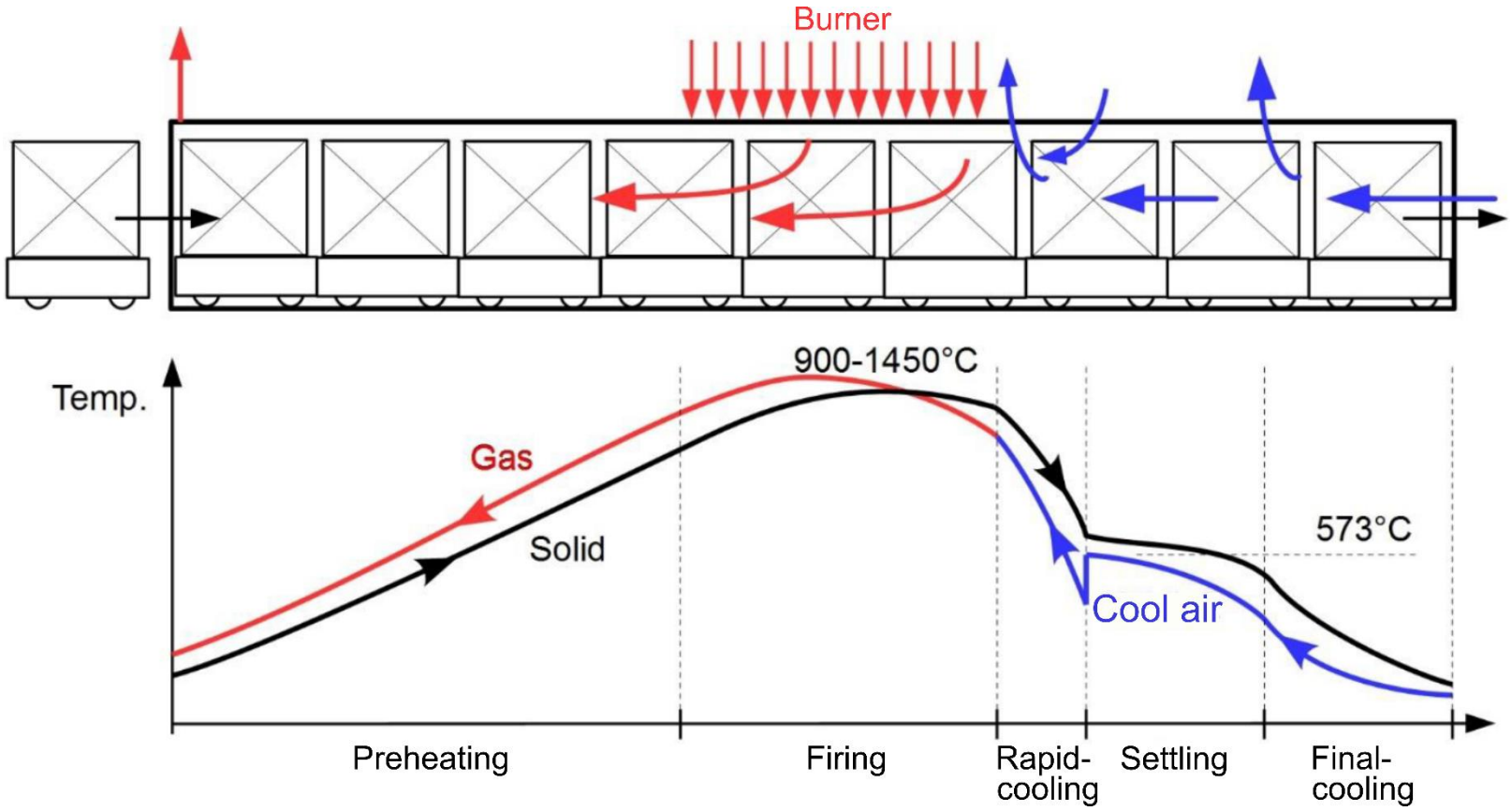
Energy demand and CO_2-emissions of the brick and tile industry

- Energy consumption in brick and tile industry
- 5.380 GWh
- 1.086.760 t CO_2



	Gas consumption	CO_2 equivalent	Target for 2021-2025
Building bricks	380 kWh/t	77 kg/t	58 kg/t
Facing bricks	690 kWh/t	139 kg/t	106 kg/t
Roof tiles	970 kWh/t	196 kg/t	148 kg/t

Tunnel kiln process for firing bricks and tiles



Roof of the kiln with burners and gas supply

Challenges using H_2 in the firing process

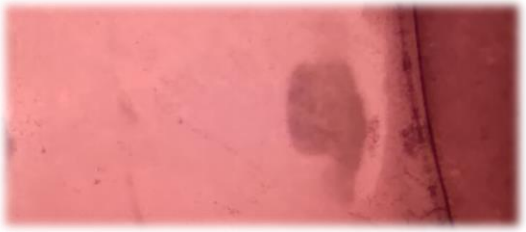
- **100 % H_2-availability**
  → pipeline, electrolyser, gas storage
- **Combustion**
  → mixing process, stoichiometry, flame stability
- **Burner operation**
  → ignition, flame monitoring, NO_x, thermal load (products, burner, kiln)
- **Product quality (colour, strength, porosity, …)**
- **Safety-regulations and guidelines**

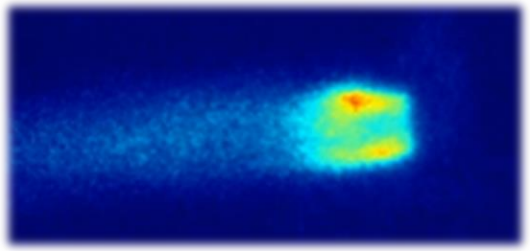
Investigation of the existing burner

- Traversing measurement T, O_2, NO_x, CO
- Flue gas composition
- Photos and UV images of flame and burner tip

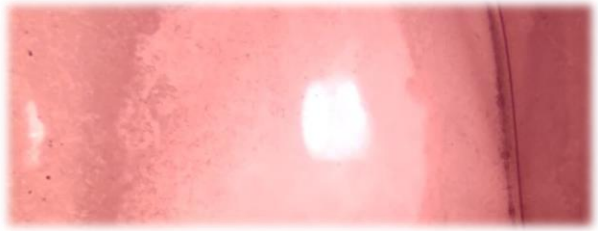
Cold startup
100 % NG

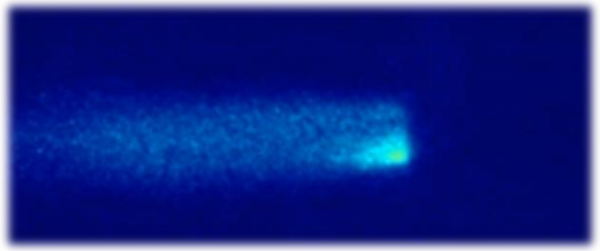
T_{CC} = 1200 °C
100 % NG





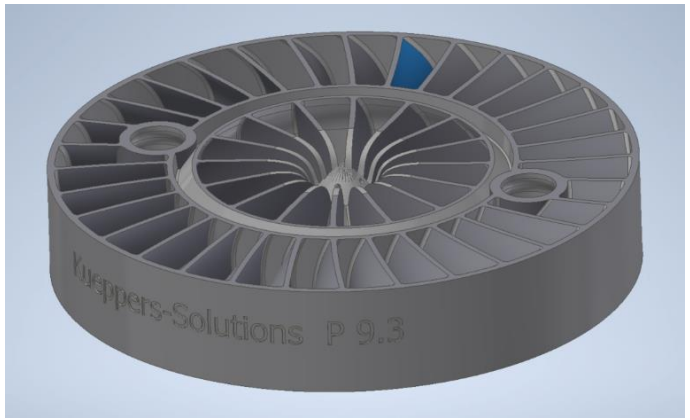
T_{CC} = 1200 °C
80 Vol.-% NG / 20 Vol.-% H_2





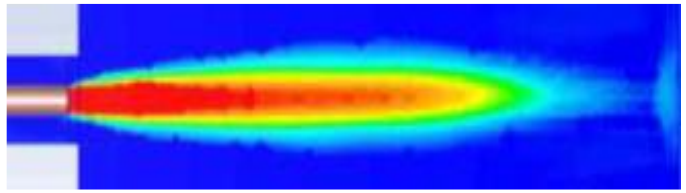
Investigation of the dual-fuel-burner

- Developed dual-fuel-burner
- Additive manufactured mixing unit
- Down-scaled version for lab tests
- Tests in lab, combustion chamber and in production
- CFD-simulations

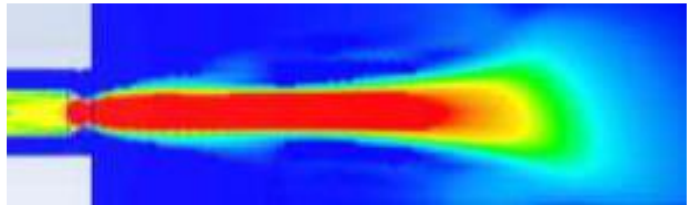


Trials with natural gas in cold environment

Existing burner



Dual-fuel-burner



*Quelle: Kueppers Solutions

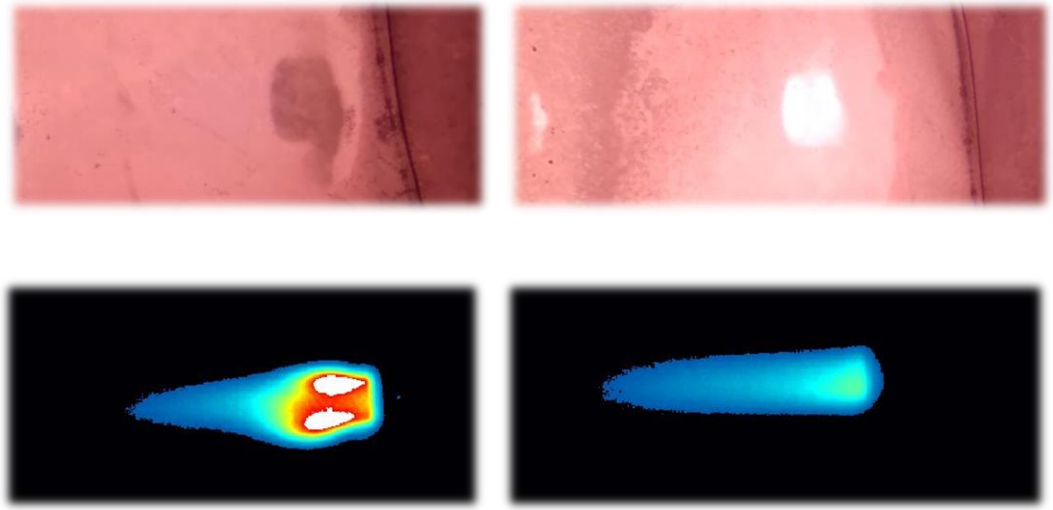
Investigation of the dual-fuel-burner

VDEh-Betriebsforschungsinstitut GmbH

Existing burner

100 % NG

80 Vol.-% NG/20 Vol.-% H_2

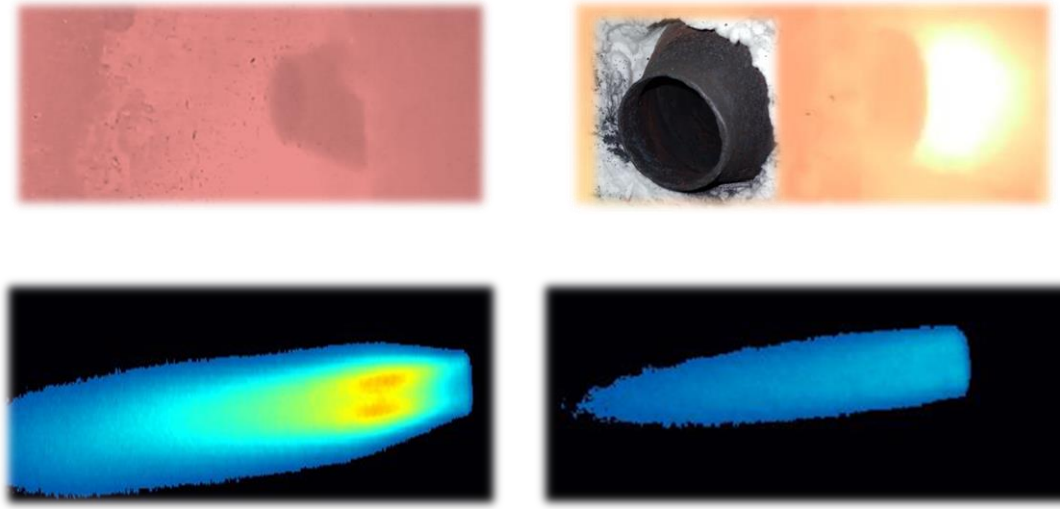


Dual-fuel-burner

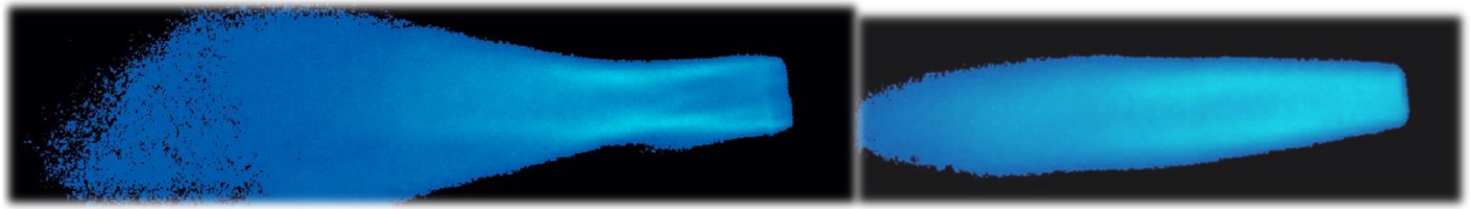
100 % NG

100 % H_2

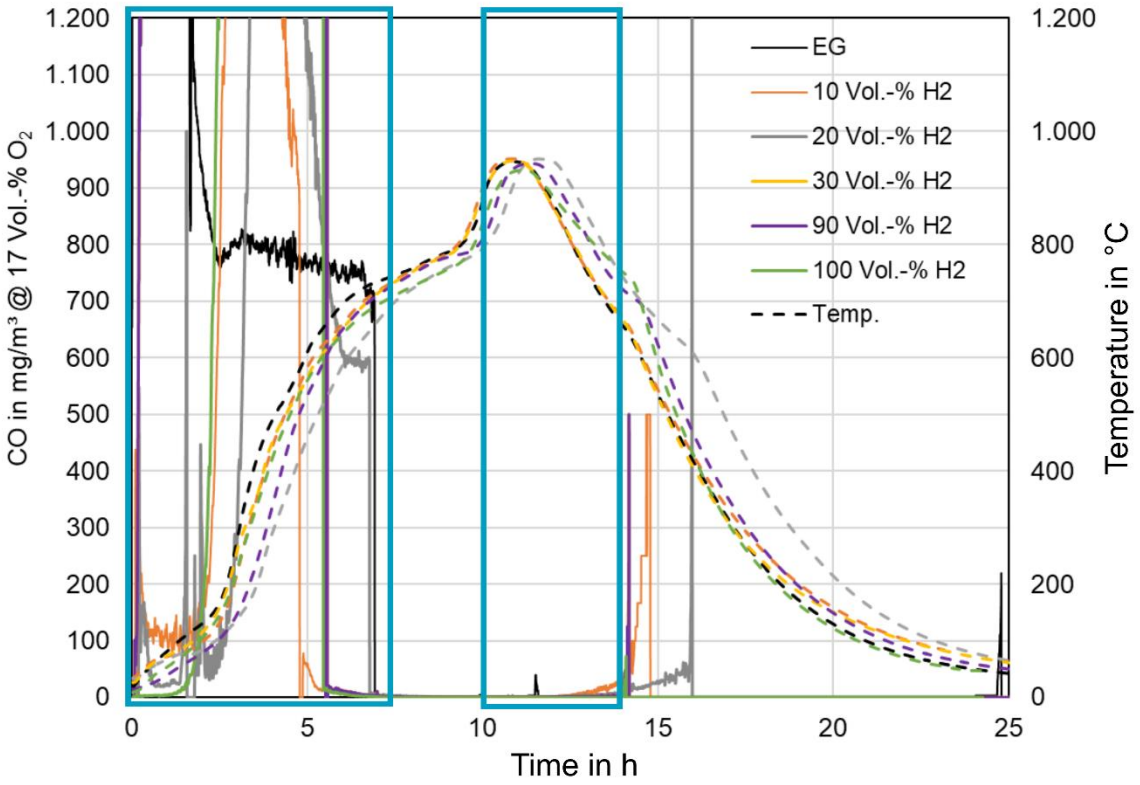
1st version

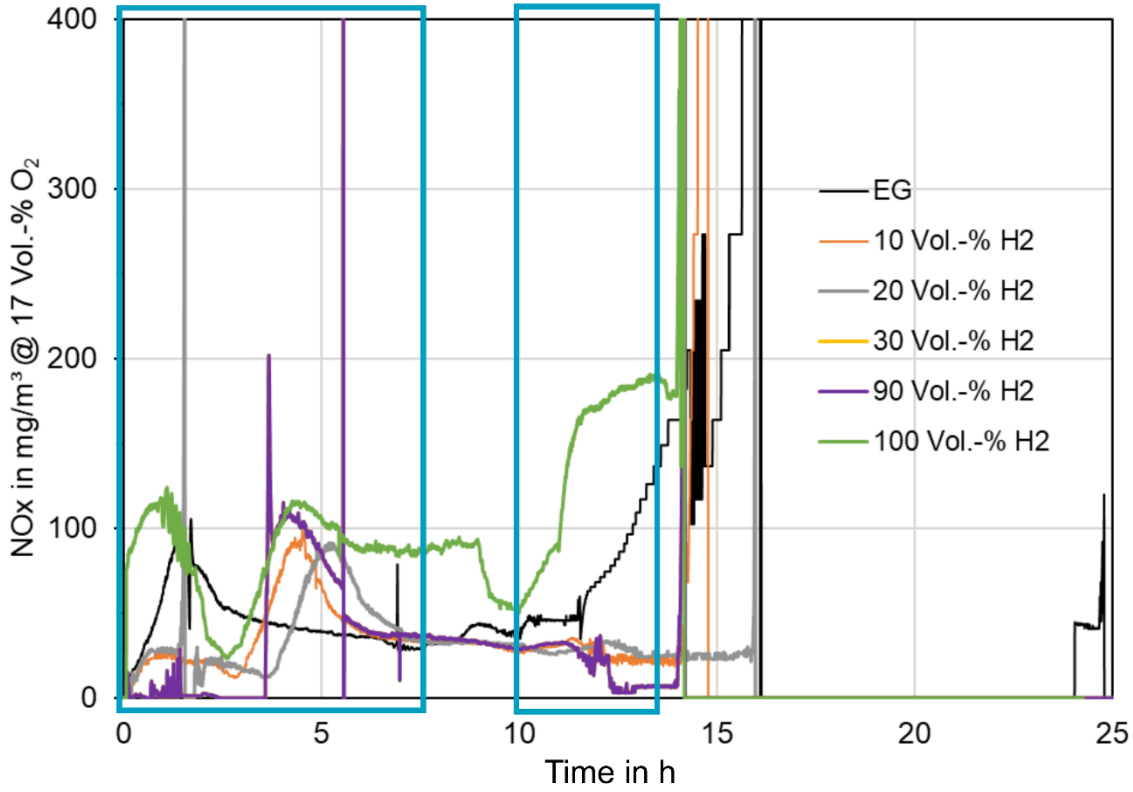


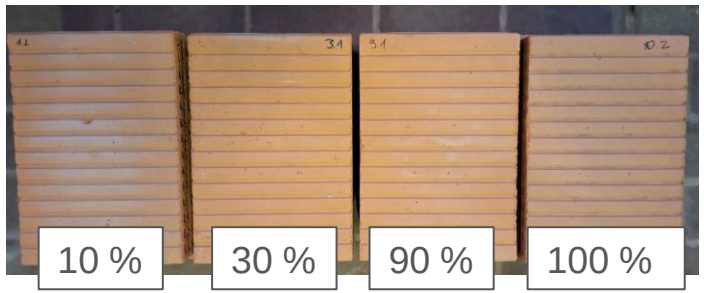
2nd version



Test firings with NG and H_2







Material analyses in the laboratory after test firings

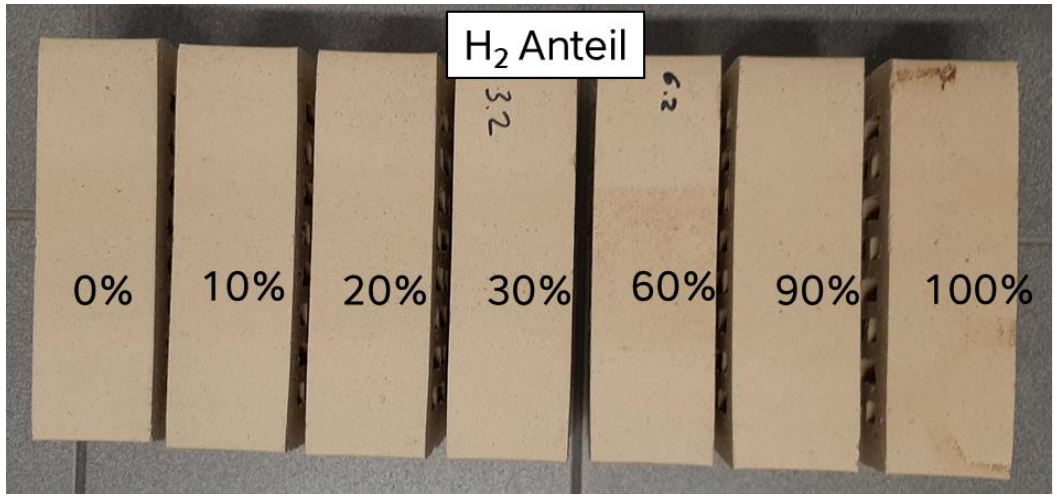
Testing of facing bricks, roof tiles, building bricks
Fuel gas: Natural gas with H_2 admixtures from 0 to 100 %

Comparison of colour by eye and with spectrophotometer:
→ mostly tolerable deviations

Material values investigated
- Total shrinkage
- Burning loss
- Water absorption
- Bulk density
- Compressive strength

→ mostly tolerable deviations

fired bricks with increasing amount of H_2 in NG/H_2 mixture



With increasing amount of H_2, product quality can be maintained for most of the products.

Conclusion

- Dual-fuel-burner for NG and H_2 successfully tested
- Model tests, full scale tests and operational tests
- A zone of an existing tunnel kiln was retrofitted for operation with H_2
- Successful trials carried out in production

- Quality can be maintained when operating with H_2
- Existing tunnel kilns can be adapted to H_2 operation
- Dual-fuel burners make flexible operation with switching between NG/H_2 or mixing possible
- Availability of hydrogen will be the challenge

This project shows the way and the possibilities for decarbonizing the brick and tile industry.

Thank you for your attention!

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Further fields of work

CO_2-reduction by H_2

Hybrid heating (fuel/power)

safety engineering

Gas composition / measurement technology

Waste heat utilisation

Burner technology for high temperature

Energetic optimisation

Fuel and power department work

Simulation of combustion plants, burners, components and gas networks

1 MW pilot plant
Investigation of burner-, measurement- and furnace- components under near-operational conditions

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Fuel gas characteristics

	Methane	H_2
Density ratio to air	0,56	0,07
Explosion limit in Vol.-%	4,4 - 17	44 - 77
Ignition temperature in °C	595	560
Minimum ignition energy in mJ	0,29	0,017

NG-H_2; P_{th} = 2 MW; λ = 1,05; T_{AG} = 600 °C