

Decarbonising the Ceramic Ecosystem

From evidence to industrial transformation

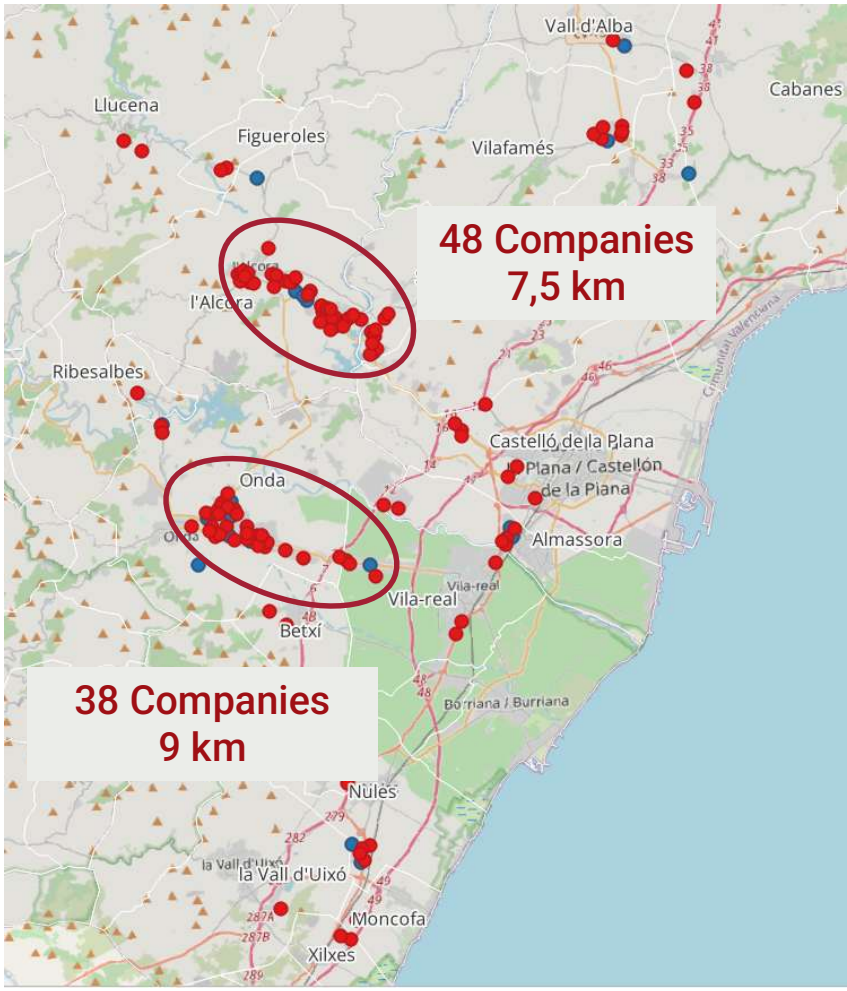
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Institute of Ceramic Technology (ITC)
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“Decarbonising a factory is a challenge …
…Decarbonising an industrial cluster is a transformation”
NATUCER

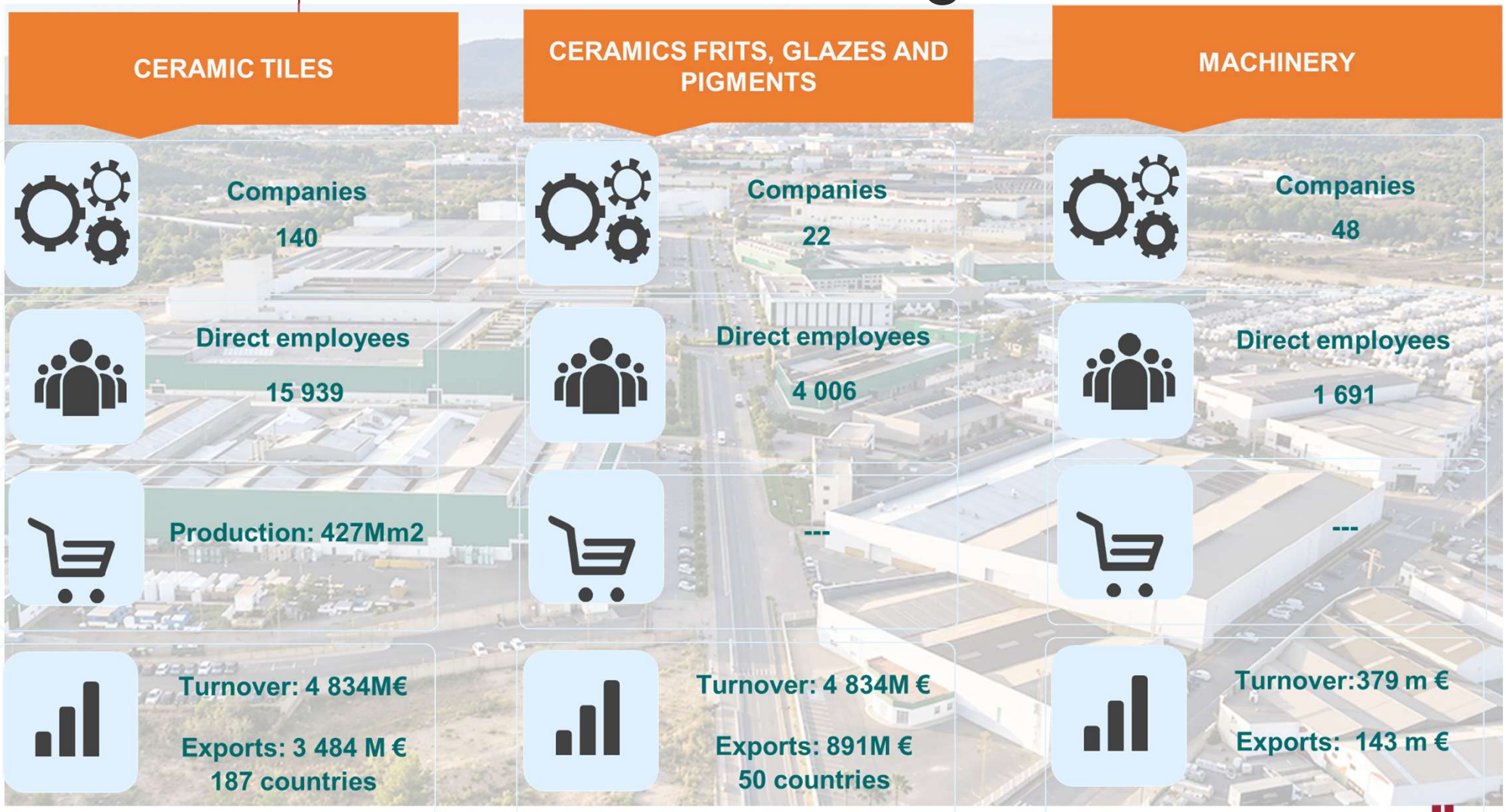
Cluster: Facts & Figures





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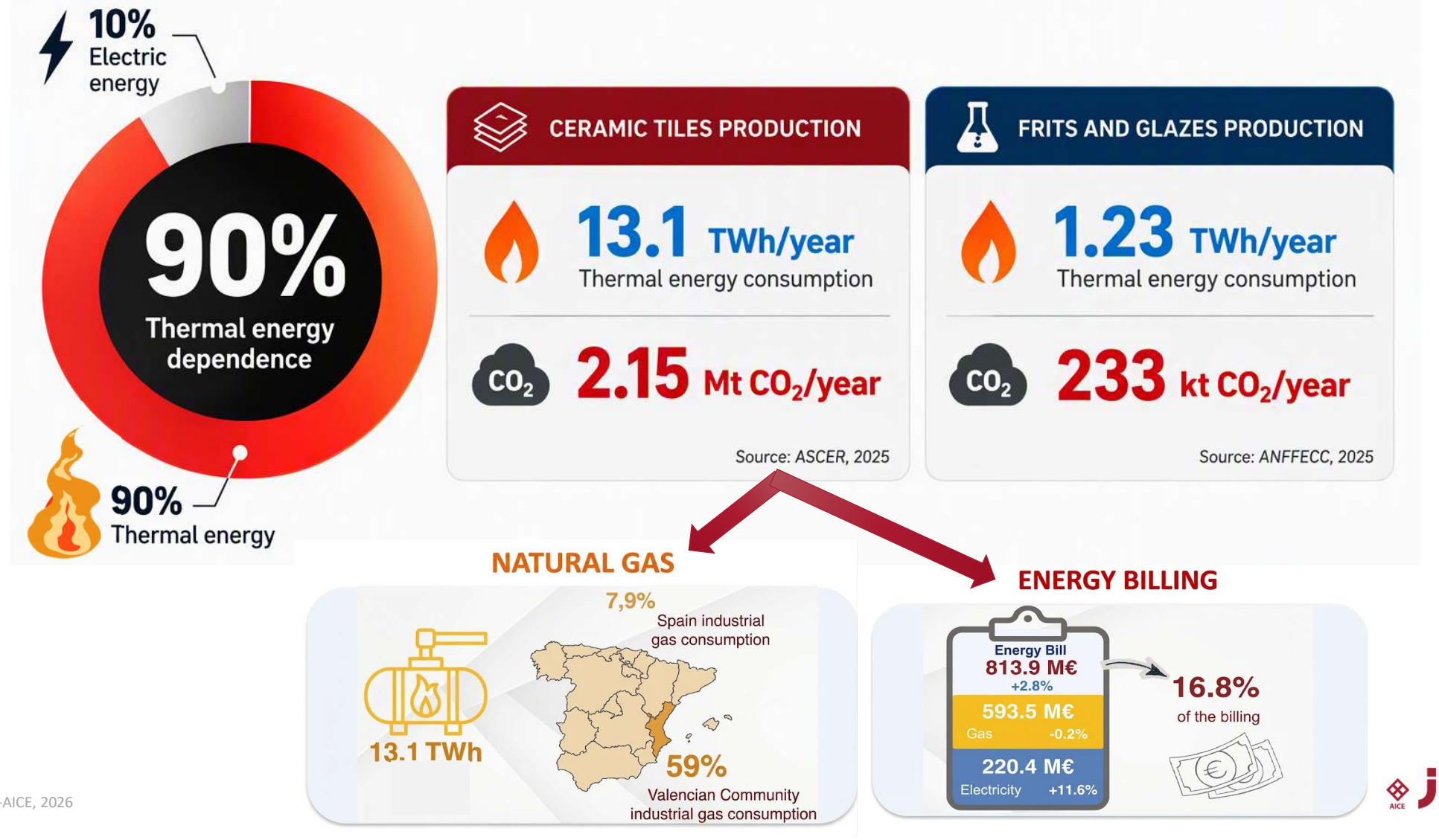
Cluster: Facts & Figures



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Source: ASCER, ANFFECC and ASEBEC 2025

Cluster: Facts & Figures



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Cluster: Facts & Figures

CO_2 EMISSIONS BY INDUSTRIAL SECTOR in Valencian Community

Verified CO_2 emissions are highly concentrated in a small number of industrial sectors

Sector	Emissions (t CO_2eq/year)	Share of total
Ceramic tiles	**2,153,891**	**31.4%**
Power generation	1,523,204	**22.2%**
Cement	1,317,676	**19.2%**
Refining	1,195,751	**17.4%**
Ceramic frits	**176,489**	**2.6%**
Industrial combustion	136,134	2.0%
Glass	110,824	1.6%
Metals (ferrous)	60,401	0.9%
Chemicals	51,776	0.8%
Lime	44,334	0.7%
Roof tiles & bricks	38,701	0.6%
Paper & cardboard	30,836	0.5%
Secondary aluminium	14,808	0.2%
Nitric acid	687	0.01%

34%

of total verified industrial CO_2 emissions originate from the **ceramic cluster** (tiles + frits)

2.33 Mt CO_2/year

Total verified emissions from the ceramic cluster (tiles + frits)

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The Cost of Carbon

From Environmental Issue to Competitiveness Challenge

🏭 Ceramic Tile Industry

2024: **37 M€ ETS**

2025: **56 M€ ETS**

2026-2030: **>100M€/year ETS**

🛸 Frits, Glazes & Pigments

2026-2030: **>50 M€/year ETS**

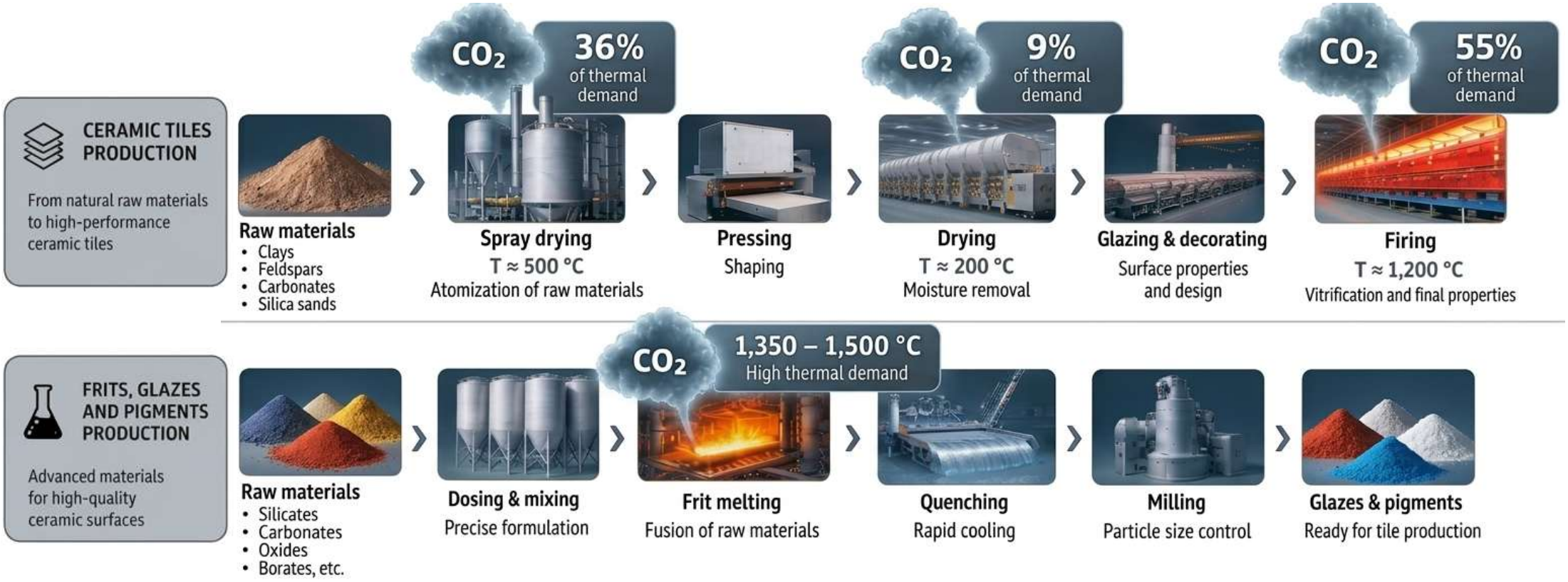
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Why is decarbonization so challenging?



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Where do CO_2 emissions come from?



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How to proceed?

Before recommending solutions, we need to understand the challenge . . .

- ⚡ Is electrification technically viable?
- 🌍 What's the real CO_2 impact?
- ⚙️ Are thermal components ready?
- 🎯 Can competitiveness be maintained?
- 🏭 Can existing assets evolved?

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ITC: Connecting Industry, Energy, Knowledge and Policy



From research to industrial implementation



SCAN ME

Technology Pathways Towards Net-Zero Ceramics

Energy Efficiency & Process Optimisation

Combustion digitalisation
Advanced heat recovery
Process modifications
Process Control

Electrification

Electric Kilns
Electric Dryers
Heat Pumps

Alternative fuels

Green Hydrogen
Biofuels

Renewable energy integration

Photovotaics
Solar Thermal Energy

CO_2 Capture Systems

CCU

Circular Economy

Recovery of Secondary Materials
Alternative Raw Materials

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From strategy to demonstration



1st example

Firing Electrification

From concept validation to industrial deployment

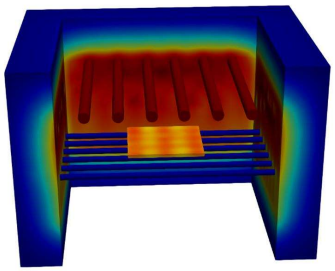
2nd example

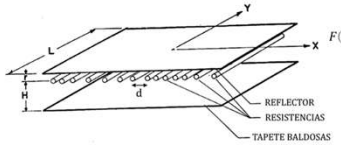
Hydrogen for frit production

Testing viability before industrial adoption

Firing Electrification: Knowledge-based decision making

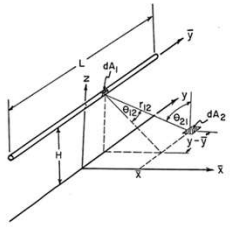
2020 – Technical Feasibility assessment

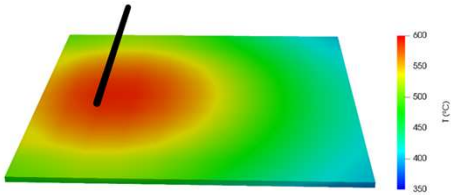




$$F(x,y;x_n,H) \equiv \frac{1}{2\pi^2 n_n}\left\{\frac{\gamma\left(\zeta+\frac{1}{2}\right)}{n_n^2+\gamma^2(\zeta+1/2)^2}-\frac{\gamma\left(\zeta-\frac{1}{2}\right)}{n_n^2+\gamma^2(\zeta-1/2)^2}+\frac{1}{n_n}\left[\tan^{-1}\frac{\gamma\left(\zeta+\frac{1}{2}\right)}{n_n}-\tan^{-1}\frac{\gamma\left(\zeta-\frac{1}{2}\right)}{n_n}\right]\right\}$$

$$F_\Sigma(x,y;x_n,R,H)=\frac{(R+H)^2}{\pi}\sum_{i=1}^{N_I}\sum_{j=1}^{N_J}\frac{F(u_i,v_j,x_n,R)\Delta u\Delta v}{\left[\left((R+H)^2+(x-u_j)^2+(y-v_j)^2\right]^2\right.}$$





2021-2022 – Pilot electric kiln module



Main advantages

- ✅ Higher energy efficiency
- ✅ Zero direct CO_2 emissions
- ✅ Pathway to renewable electricity integration

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Firing Electrification: Knowledge-based decision making

2024 – First industrial electric kiln

Result of four years of assessment, modelling and pilot validation

- ✅ Higher energy efficiency
- ✅ Zero direct CO_2 emissions
- ✅ Operational flexibility
- ✅ Compatibility with renewable electricity



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From knowledge generation to industrial deployment

Hydrogen for frit production: From expectations to evidence

- Hydrogen combustion behaviour
- Flame characteristics
- Heat transfer mechanisms
- Impact on industrial processes
- Impact on product quality
- Economic viability
- Infrastructure requirements



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Hydrogen for frit production: What we learnt

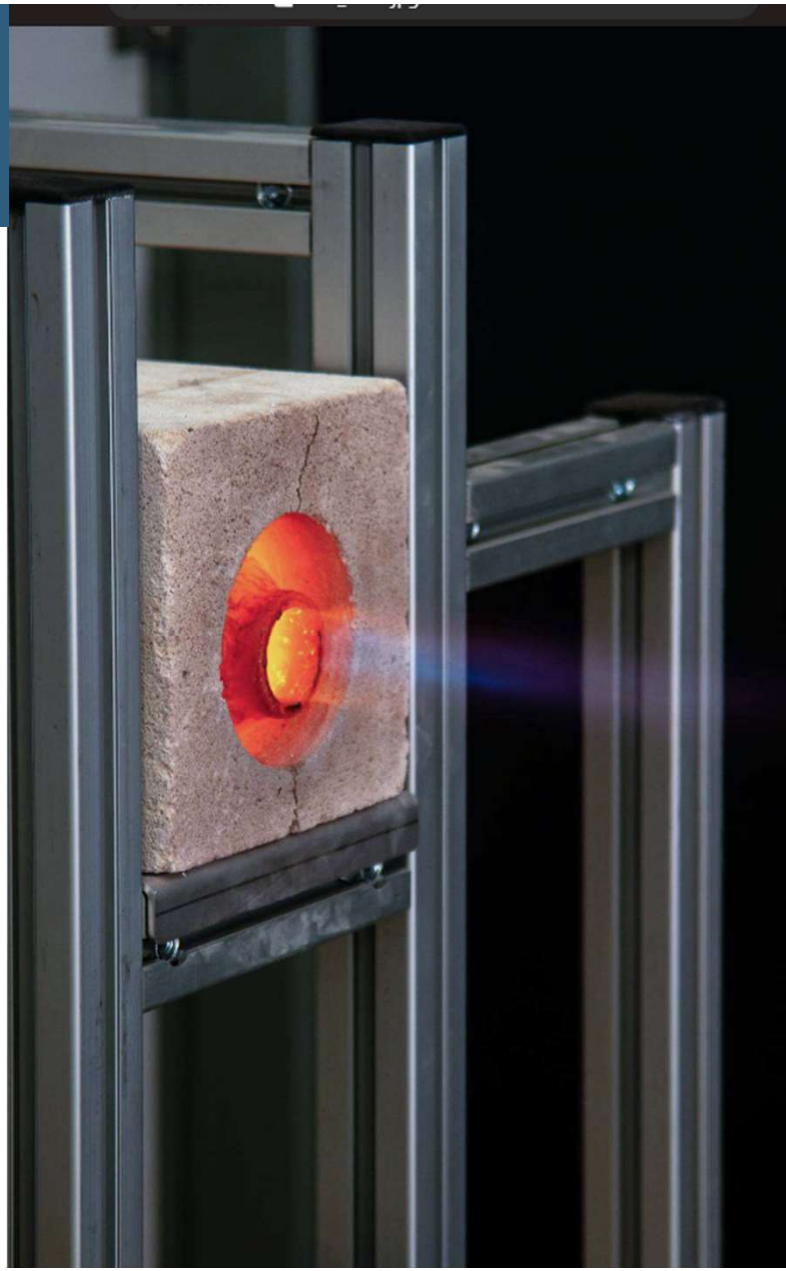
Hydrogen is technically feasible under industrially relevant conditions

Technology readiness and economics must be evaluated together

Product quality must be assessed

Infrastructure availability becomes a critical factor.

No single solution fits all applications.



What have we learnt?

- 🔬 Knowledge
- ⚙️ Validation through pilots
- 🤝 Collaboration across the value chain
- 🏭 Competitiveness and resilience as final objectives

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The next challenge

- Energy infrastructures
- Energy flexibility
- Industrial data ecosystems
- Industrial investment
- Energy independence

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Industrial resilience starts with energy resilience

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THANK YOU!

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