

MAIN OUTCOMES:

- Increase the energy efficiency of energy intensive industrial processes by reducing energy use by at least 30%.
- Enable the potential of an increased use of renewable energy.
- Enable the techno-economic feasibility of novel technologies and processes, validated and demonstrated at suitable scale against industrial processes' state of the art.
- Contribute to achieving the EU climate neutrality goal and becoming independent from fossil fuel as stated in the REPowerEU Plan.

MAIN INNOVATIONS:

- Microwave plasma torch for porcelain tile firing
- Direct-microwave heating with hot air flux for aggregate heating
- Direct-microwave and induction heating for carbon anode baking
- Geopolymeric microwave refractories/susceptors
- Nanostructured additives for improved microwave absorption
- Selection charts for the design of successful microwave processing and applicators
- Multiparametric and multipoint Fiber Optic Sensor monitoring and control system
- Thermography using SWIR multispectral cameras
- Reduced Order Models (ROMs) of the novel heating processes
- Data-driven optimisation of the heating process
- Virtual Power Plant for hybrid centralized-distributed and autonomous energy flexibility
- Increase process energy efficiency with multi-criteria optimization
- Distributed process control system

 **48 MONTHS**
from 1 January 2024
to 31 December 2027

 **9.5 MILLION €**
funded by the European Union

 **20 PARTNERS**
from Spain, Greece, Belgium,
Italy, Germany, Finland, Lithuania,
Switzerland, Austria

 **3 PILOTS**
to demonstrate the
METAWAVE solutions

CONSORTIUM

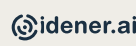
COORDINATOR



USE CASES



PARTNERS



**Founded by
the European Union**

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METAWAVE

**High-temperature heating processes
with breakthrough microwave
and digital technologies
for increased energy efficiency**



MAIN OBJECTIVES:

- Develop new design methods and strategies to replace conventional fossil-based heating systems with microwave kilns
- Develop, deploy and validate 3 modular microwave-based heating systems with highly energy-efficient breakthroughs and increased productivity
- Convincingly demonstrate the microwave kilns at TRL 6 in 3 industrial environments (ceramics, asphalt and aluminium industries), towards accelerating the approach to market readiness
- Fully capture the potential of RES integration and energy flexibility through a Virtual Power Plant
- Maximize the energy efficiency of the microwave kilns by integrating novel digital technologies: Hybrid Digital Twins and Energy Management Systems
- Ensure the techno-economic feasibility of the proposed systems and pave the way towards their wide acceptance, technological adoption and upscale



FOLLOW THE PROJECT

CERAMIC



PROCESS:
porcelain tiles firing
(ceramic production)

CONVENTIONAL HEATING PROCESS:

- Continuous
- Process temperature (1000-1300 °C)
- Energy source: natural gas

TECHNOLOGICAL BENEFITS:
Microwave heating increases energy efficiency, reduces emissions, and boosts productivity, making the process more sustainable.

ASPHALT



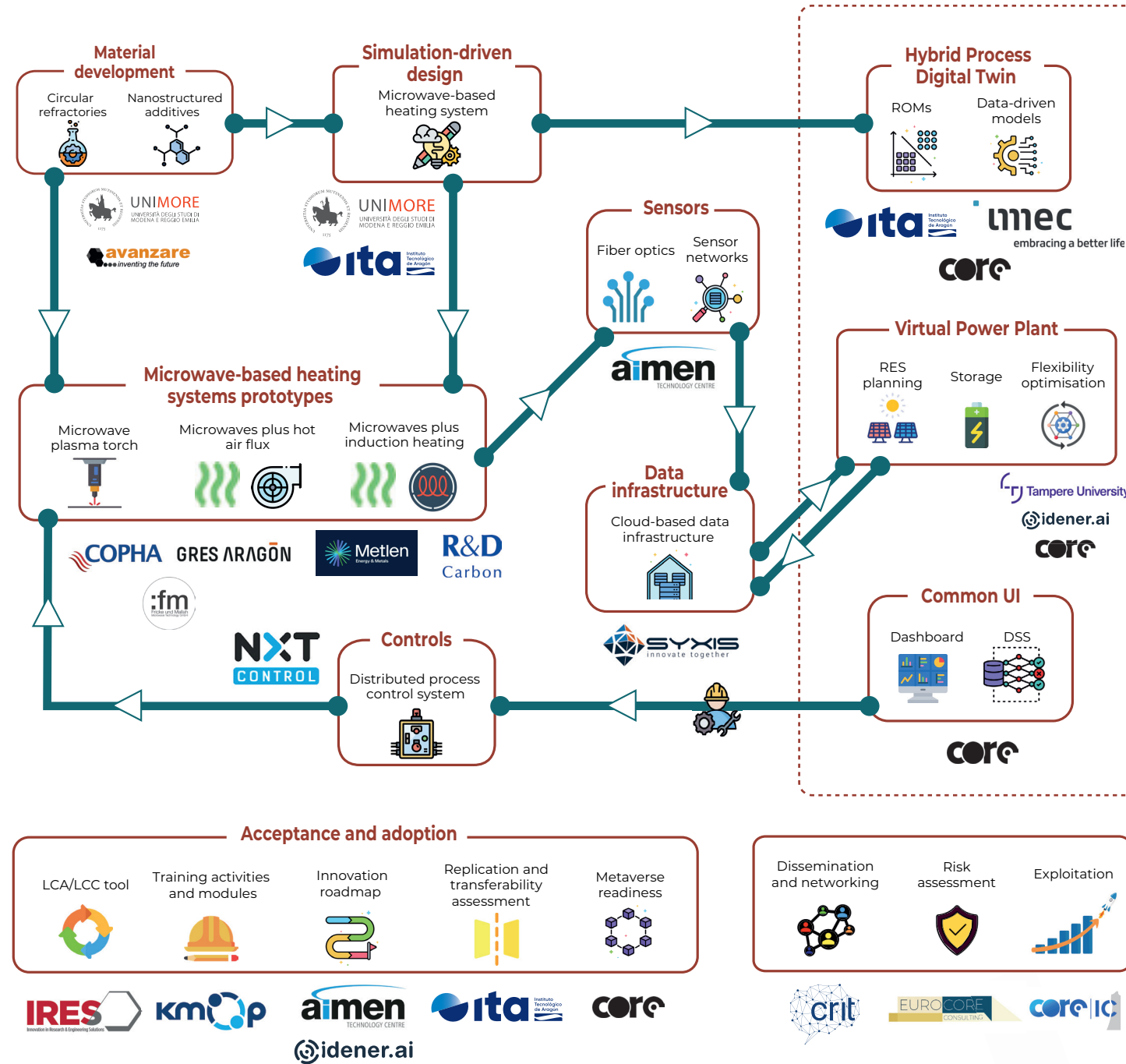
PROCESS:
aggregate heating
(asphalt production)

CONVENTIONAL HEATING PROCESS:

- Continuous
- Process temperature (1400 °C)
- Energy source: low-sulfur heating oil

TECHNOLOGICAL BENEFITS:
Energy-efficient technologies improve productivity and significantly reduce emissions, enhancing overall sustainability.

3 INDUSTRIAL USE CASES



ALUMINIUM



PROCESS:
anode production
(aluminium production)

CONVENTIONAL HEATING PROCESS:

- Batch
- Process temperature (800-1000 °C)
- Energy source: natural gas + hydrocarbon volatiles

TECHNOLOGICAL BENEFITS:
Advanced heating systems increase productivity, lower energy use, and reduce emissions, supporting a greener production process.

