METAWAVE

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

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

ita

USE CASES

COPHA · GRES ARAGÓN · Metlen

PARTNERS

imec · Tampere University · idener.ai · SYXIS · aimen · coreIC · core · NXT CONTROL · kmop · R&D Carbon · :fm · UNIMORE · avanzare · crit · IRES · EUROCORE

Founded by the European Union

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ASPIRE PROCESSES 4 PLANET RESEARCH ASSOCIATION

ALUMINIUM

ASPHALT

CERAMIC

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

3 INDUSTRIAL USE CASES

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.

Material development
Circular refractories
Nanostructured additives
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Simulation-driven design
Microwave-based heating system
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Microwave-based heating systems prototypes
Microwave plasma torch
Microwaves plus hot air flux
Microwaves plus induction heating
COPHA
GRES ARAGÓN
Metlen Energy & Metals
R&D Carbon
:fm

Controls
Distributed process control system
NXT CONTROL

Sensors
Fiber optics
Sensor networks
aimen Technology Centre

Data infrastructure
Cloud-based data infrastructure
SYXIS innovate together

Hybrid Process Digital Twin
ROMs
Data-driven models
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Virtual Power Plant
RES planning
Storage
Flexibility optimisation
Tampere University
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Common UI
Dashboard
DSS
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Acceptance and adoption
LCA/LCC tool
Training activities and modules
Innovation roadmap
Replication and transferability assessment
Metaverse readiness
IRES Innovation in Research & Engineering Solutions
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Dissemination and networking
Risk assessment
Exploitation
crit
EUROCORE Consulting
core|IC

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.