



Development of an **E**fficient  
microwave **S**ystem for material **T**ransformation  
in energy **I**ntensive processes  
for an improved **Y**ield

CE-SPIRE-02-2018  
G.A. 820783

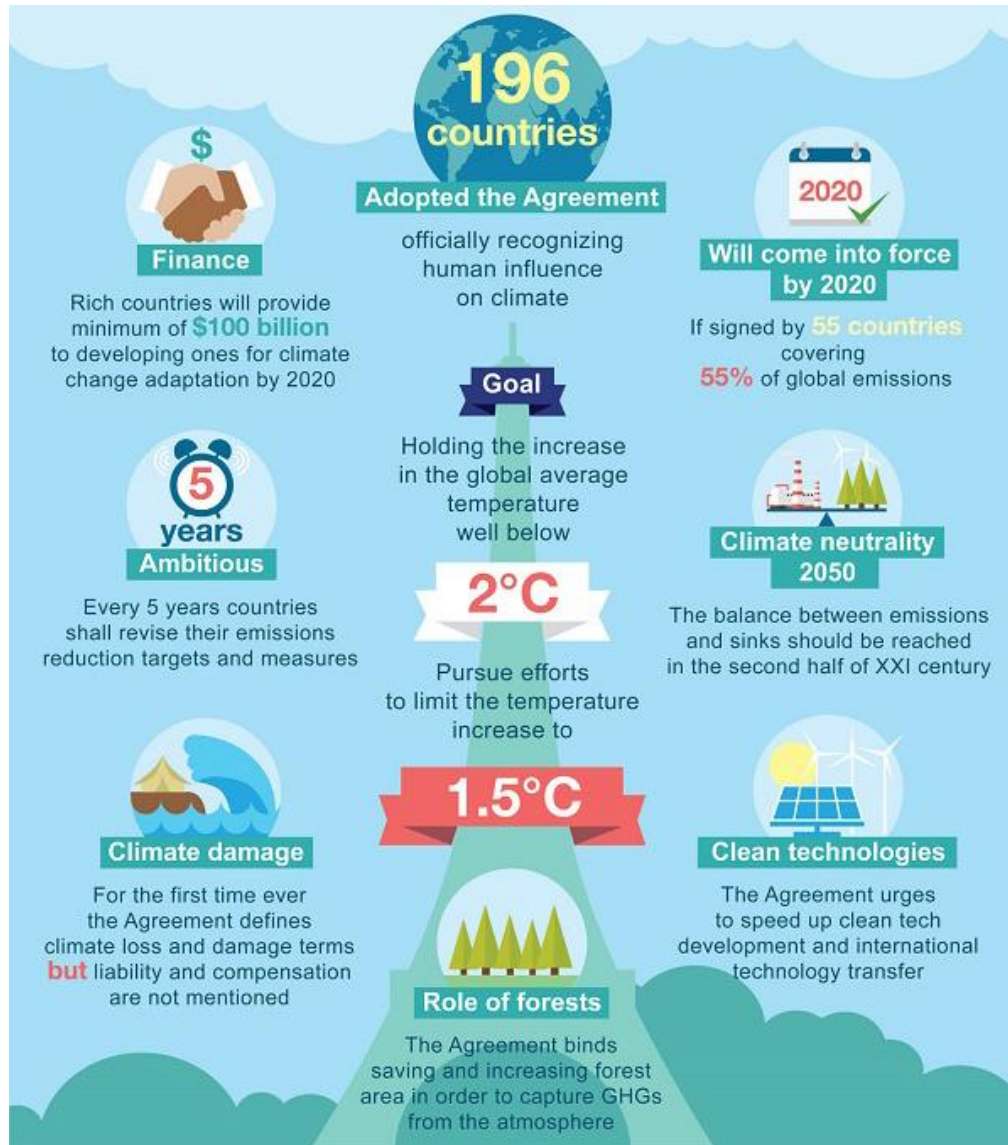
# DESTINY project

## GENERAL OVERVIEW

2019



This project has received funding from  
the European Union's Horizon 2020  
research and innovation programme  
under **Grant Agreement No. 820783**



## CLIMATE CHANGE

is one of the preeminent issues of our time.

The world is still far from being on track towards the objectives of the **Paris Climate Agreement**.

The **need to transition to a carbon-neutral economy** is more pressing than ever.



## PARIS CLIMATE AGREEMENT

is a historical document that legally binds the whole world to participate in climate change fight.

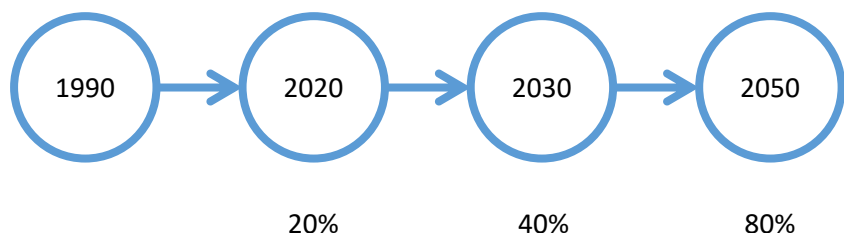
Source:  
infographic via [Climate Russia](#)



## EU TRENDS IN GHG EMISSIONS

Low-carbon  
economy  
roadmap

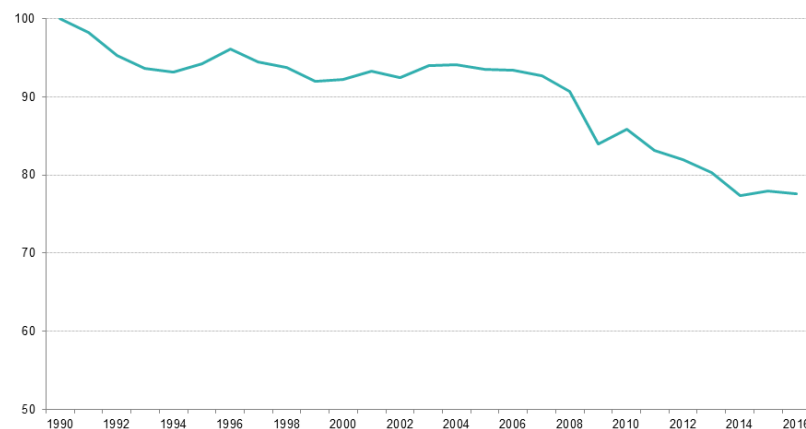
EU should cut GHG emissions by



In 2016, greenhouse gas emissions in the EU-28 were down by 22 % compared with 1990 levels, representing an absolute reduction of 1 279 million tonnes of CO<sub>2</sub>-equivalents, putting the EU on track to surpass its 2020 target, which is to reduce GHG emissions by 20 % by 2020 and by 40 % by 2030 compared with 1990.

By 2015, the SPIRE sectors had achieved a 37% reduction in absolute annual CO<sub>2</sub> eq emissions compared to 1990.

Greenhouse gas emissions trend, EU-28, 1990 - 2016 (Index 1990=100)



Source: European Environment Agency (online data code: env\_air\_gge)

eurostat

[https://ec.europa.eu/eurostat/statistics-explained/index.php/Greenhouse\\_gas\\_emission\\_statistics#Trends in greenhouse gas emissions](https://ec.europa.eu/eurostat/statistics-explained/index.php/Greenhouse_gas_emission_statistics#Trends_in_greenhouse_gas_emissions)



## SPIRE 2050 – VALUE PROPOSITION

**Innovative “industrial ecology” business models** must be developed to redesign the European industrial network.

**EU Industries must deliver technical solutions** enabling the transition of the global economy towards a “well-below 2 degrees” scenario.

Our ambition is to develop game changing technologies towards **carbon neutrality** and to scale them up to reach a step change in Carbon Productivity.

**The technological gap to achieve this Vision remains huge.**

**Electrification projects can drastically reduce CO2 emissions from the respective processes.**





**“ Development of an Efficient  
microwave System for material  
Transformation in energy Intensive  
processes for an improved Yield ”**

Start Date:  
**01-10-2018**

Duration:  
**42 Months**

**CALL [H2020-NMBP-SPIRE-2018]**

**TOPIC [CE-SPIRE-02-2018]**

*Processing of material feedstock  
using non-conventional  
energy sources*

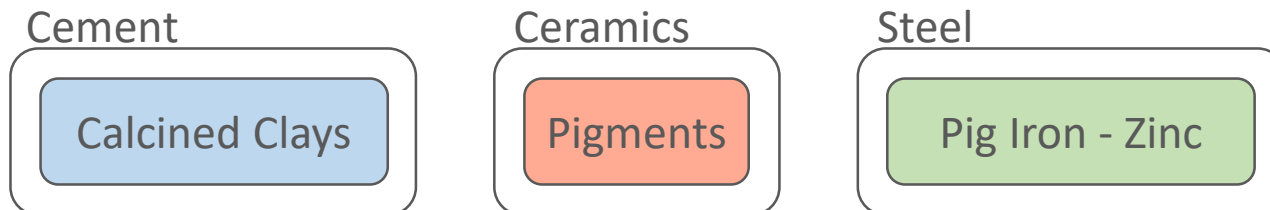
**IA – Innovation Action**

## AIM

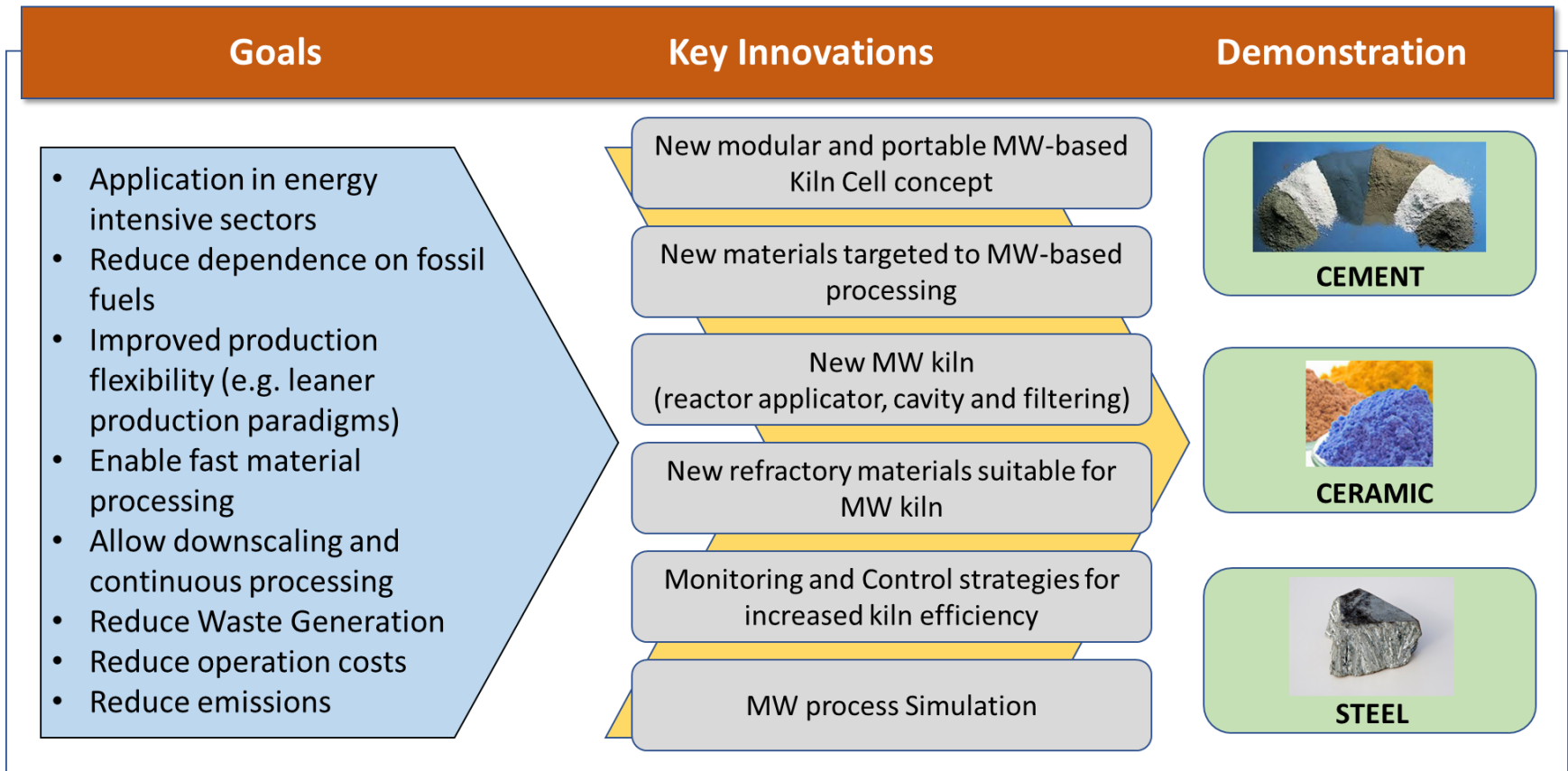
DESTINY aspires to introduce the “first-of-a-kind” **high temperature microwave processing system** at industrial level, offering a variety of vital benefits to energy intensive sectors: **reduced energy consumption, lower lifetime operating costs** and **enhanced sustainability profile**.

DESTINY will release a **container-size mobile microwave-powered plant** targeted to 3 energy-intensive sectors working on solid materials: cement, steel and ceramic. DESTINY proposes to exploit **fluidised bed transport, microwave heating and real-time process monitoring and control** for calcination of new pop calcined clay for low clinker cement (cement sector), intermediate steel and zinc product from recycling (steel sector), and high added value ceramic pigments (ceramic sector).

High temperature MW heating has not been implemented as a full-scale industrial-process before.



## SCOPE





## PARTNERS

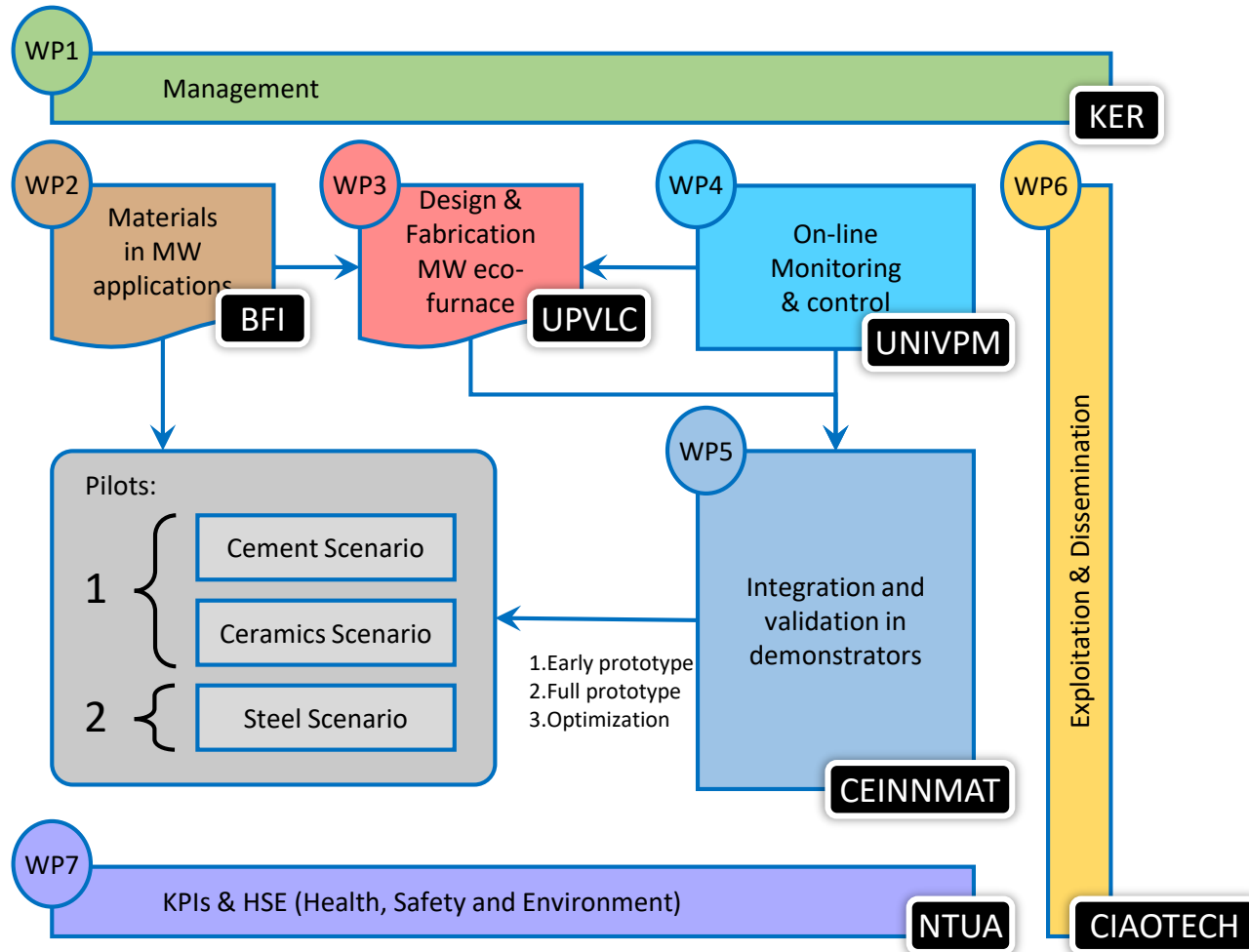
01. KERABEN	I L
02. CEINNMAT	T S
03. NTUA	R
04. UNIVPM	R
05. UPVLC	R
06. AL-FARBEN	I L
07. CHUMILLAS	T S
08. BFI	R
09. K1-MET	R
10. DK	I L
11. CEMEX	I L
12. CIAOTECH	C L
13. LABORELEC	R
14. IST	R

14	Partners	
8	Different countries	
5	Large Enterprises	L
2	SME	S
1	Consultancy companies	C
7	Researchers	R
2	Technology providers	T
4	Industrials	I





## WORK PACKAGES & PARTNERS ROLE



## CONCEPTS AND CHALLENGES

The complexity of the system to be developed requires a multidisciplinary approach with the participation of different specialists in materials, processing and design of MW applicators.



## SECTORS & MATERIALS

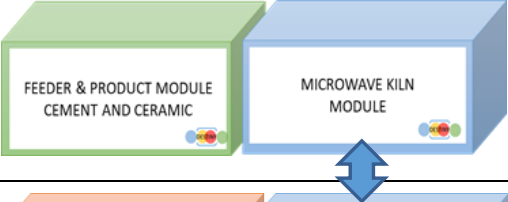
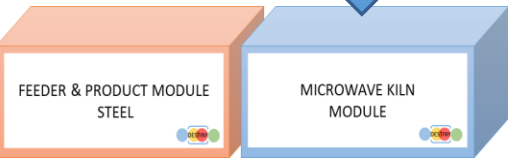
DESTINY establishes a new concept based on microwave technology for selective and efficient firing treatment in industrial processes for:



	CERAMIC	CEMENT	STEEL
Product	Pigment	Calcined Clays	Pig iron and zinc recycling
SECTOR	Ceramic	Cement	Steel
Temperature (°C)	1000	750	1000
PROCESS	Calcination	Dehydroxilation	Roasting
Microwave absorption capacity	Moderate absorber	Very low absorber	Good susceptor
SYSTEM	Fluidised bed/rotary	Fluidised bed	Fluidised bed/rotary
Current TRL	4	4	4
Final TRL	6	6	6
Target for validation in DESTINY	20 kg/h	20kg/h	10kg/h
Capacity at industrial level per MW cell*	130 kg/h	130 kg/h	67 kg/h
Number of cells per module (rate 1t/h)*	8	8	15
DEMO SITE	KERABEN	KERABEN	DK
Industrial end-user	ALFARBEN	CEMEX	DK

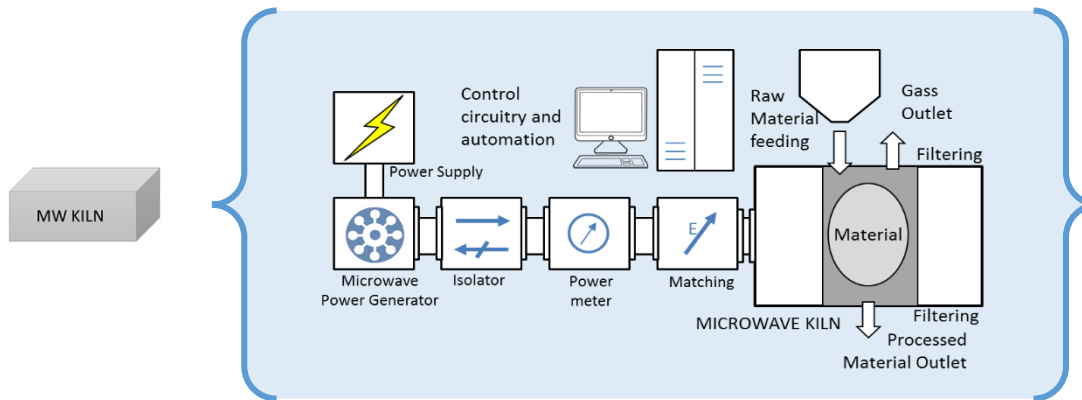
\*referred to standardised 100 kW power generator were DESTINY will be focused.

## PILOT SCALE DEMONSTRATION

	Hosting Site/Partner	Demonstration	Used Demonstrators / Prototypes
Pilot 1	KERABEN facilities	Pilot scale application to <b>calcined clays</b> for CEMENT sector based on adaption of the infrastructure of the Pilot 1.	
	KERABEN facilities	Pilot scale production of <b>ceramic pigments</b> for the CERAMIC sector	
Pilot 2	DK facilities	Demonstrable pilot scale of <b>intermediate steel products</b> of STEEL sector.	

The core MW system consist of a power unit, a microwave kiln and a control circuitry.

## SCHEMATIC MW SYSTEM SET-UP IN DESTINY

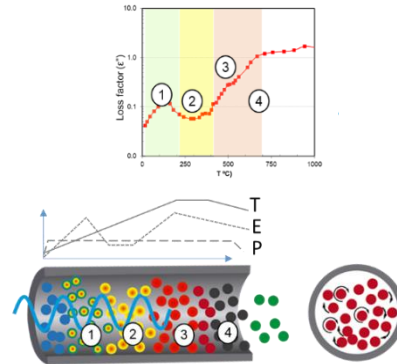


Even though the components of a system for MW processing are relatively simple, the interaction of materials with radiation and the changes that this produce on them makes design and scaling-up of the processes not always easy.

## PHASES OF THE PROJECT

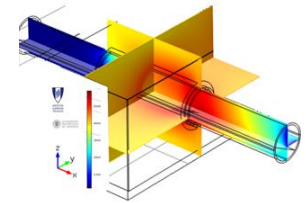
### 1. Microwave-material interaction at high temperatures

It is required a deep understanding of the process needs, knowledge about the interaction between MW and materials and an specific design that focus the electromagnetic energy in the target materials.



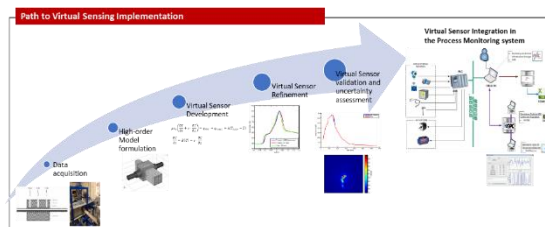
### 2. Microwave applicators design

DESTINY will exploit numerical simulation tools to drive the design of large scale applicators. Multiphysics approaches will represent key enabling technologies to face different characteristics of the design process.



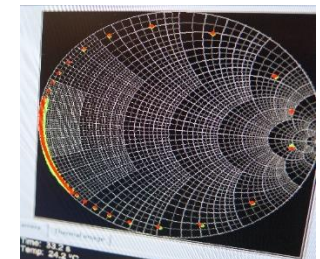
### 3. Monitoring and control strategies for efficient run of the firing process

Temperature growth due to thermal runaway can convert the microwave process in a difficult if not an uncontrollable process at industrial scale. New monitoring strategies will be developed enabling a finer control approaches tuned to optimize the efficiency of the firing process.



### 4. Consistency of Engineering over the whole Lifecycle. KPIs.

KPIs will be crucial for demonstrating how DESTINY meets the different challenges, and specially for providing benchmark and target values for the environmental / energetic / economic performance of the system, contributing to the development of the demo plants and supporting the market penetration strategy definition.



# Thank You for your attention



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