

# NEXT TOWER

Advanced materials solutions for NEXT generation high efficiency concentrated solar power (CSP) tower systems

GA 721045  
H2020-NMBP-17-2016

## Highlights of the NEXTOWER concept

Antonio Rinaldi on behalf of the NEXTOWER Consortium

# Project Details

**PROJECT TITLE:** Advanced materials solutions for next generation high efficiency concentrated solar power (CSP) tower systems

**PROJECT ACRONYM:** NEXTOWER

**FUNDING PROGRAMME:** Horizon 2020

**CALL IDENTIFIER:** H2020-NMBP-2016-two-stage

**TOPIC:** NMBP-17-2016 - Advanced materials solutions and architectures for high efficiency solar energy harvesting

**FUNDING SCHEME:** IA - Innovation Action

**PROJECT ID:** 721045

**HIGH TRL (i.e.TRL 7) = CLOSE TO MARKET**

**START/END:** Jan 2017 - Dec 2020

**TOTAL COST:** EUR 6 221 105,19

**EU CONTRIBUTION:** EUR 4 981 304,32

**PROJECT WEBSITE:** <http://www.h2020-nexttower.eu>



# NEXTOWER – The Consortium

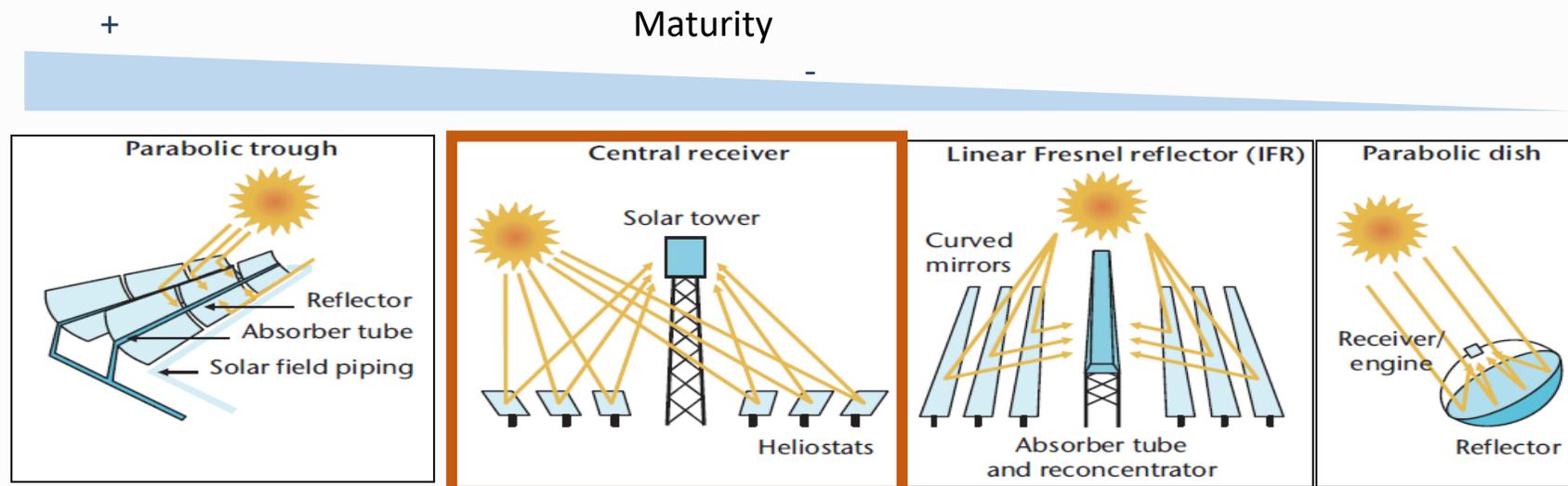


# THE CONTEXT:

## Concentrated Solar Power Technologies

Concentrated Solar Power (CSP) is an important building block in installing a secure, competitive and sustainable energy system.

Today, the diverse solar thermal energy solutions commercially available differ with respect to concentration technology, receiver type and shape, nature of the heat transfer fluid (HTF) and capability to store thermal energy, to turn it later into process heat or electricity on demand.



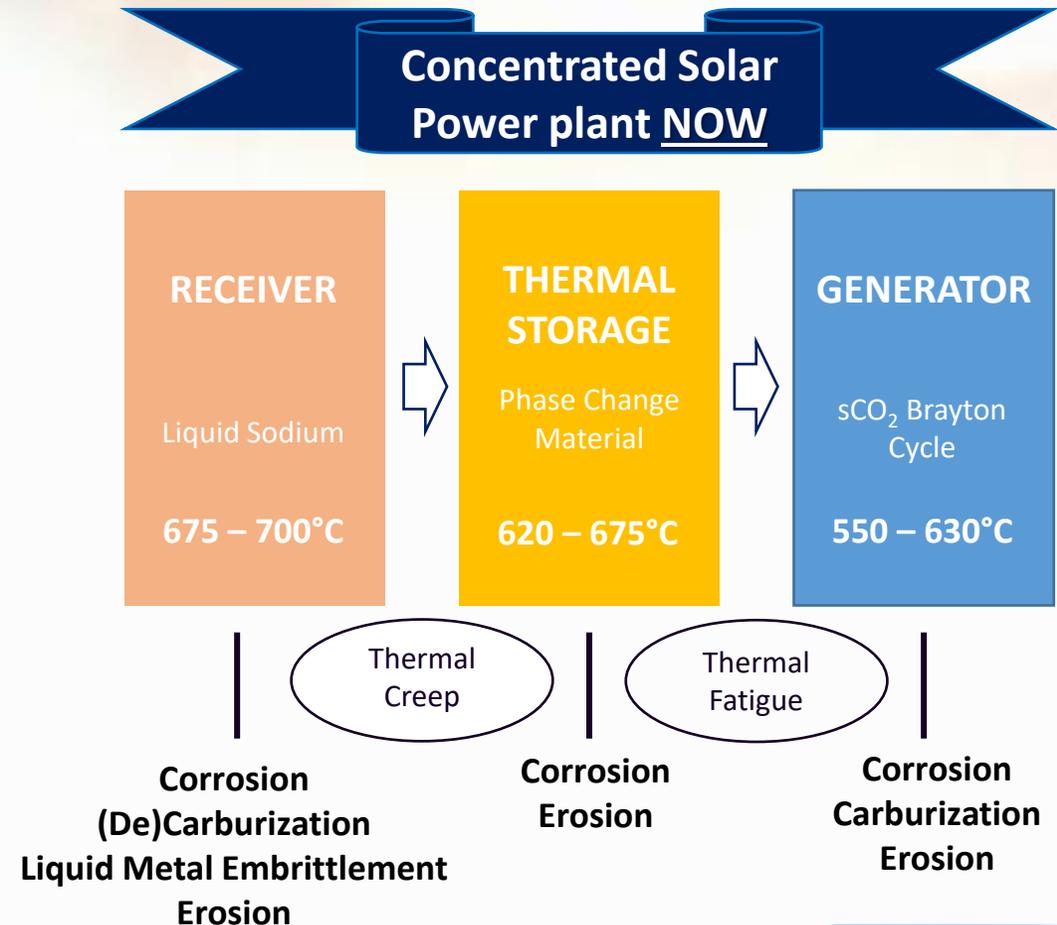
Main STE technologies and maturity levels (from more to less mature).

# THE CONTEXT: Concentrated Solar Power Technologies

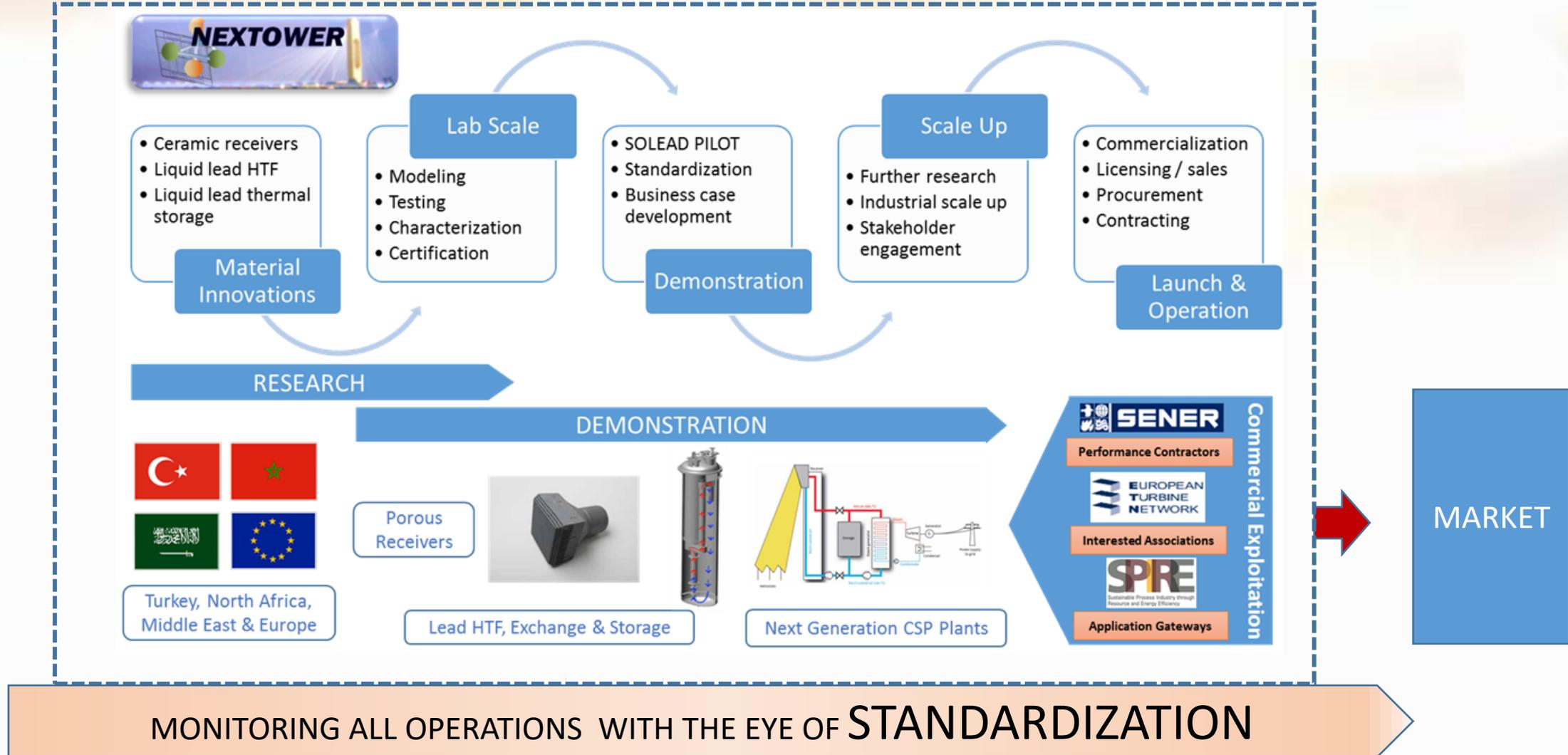
## STATE OF THE ART:

However, more **cost-effective solutions** are required for a wider-scale deployment of the CSP technology.

**Novel functional materials** and material combinations throughout the manufacturing chain are therefore needed to enhance the efficiency of solar energy harvesting beyond that of the current state-of-the-art technologies.



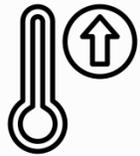
# NEXTOWER – The Concept



# NEXTOWER – The solutions: innovative advanced materials and architectures



Improved durable monolithic ceramic materials for open volumetric receivers of CSP systems of different size



New thermal energy storage system for very-high-temperature ( $> 600^{\circ}\text{C}$ ) based on liquid lead



Innovative corrosion-creep resistant steels for high temperature thermal storage ( $> 600^{\circ}$ )



# NEXTOWER - The Objectives



## **Durable solar receivers.**

Develop new mechanically tough and highly thermally conductive ceramic receivers, working under extreme thermal cycling without failure at a maximum materials temperature of at least 800°C and delivering over 20 years of continued operations.

WORKING ON STANDARDIZATION



## **High temperature steels for thermal storage by liquid lead.**

Develop coextruded-tubes and liner technologies from proprietary corrosion-resistant alumina forming steels (FeCrAl by SMT) to build high-capacity, high-efficiency lead-based heat storage that can work with high temperature receivers to supply gas turbines or industrial processes, thus expanding the boundaries of CSP technology.

WORKING ON STANDARDIZATION



## **New SOLEAD demos of CSP with lead loop.**

Set up a full scale CSP demonstrator (SOLEAD) for unprecedented field testing of materials for CSP lead-towers, encompassing a large solar receiver (*ca 4 m<sup>2</sup>, 100 tiles, up to 500 KWth for parallel testing of several receiver types*) interfaced to a single-chamber lead storage pool, in turns connected to a secondary "heat sink".

- **SOLEAD #1: PSA – CIEMAT at Almeria (ES) for testing new ceramic solar receiver**
- **SOLEAD #2: ENEA site at Brasimone (IT) for testing new alloy materials for liquid lead thermal storage**



ADDITIONAL INFO:

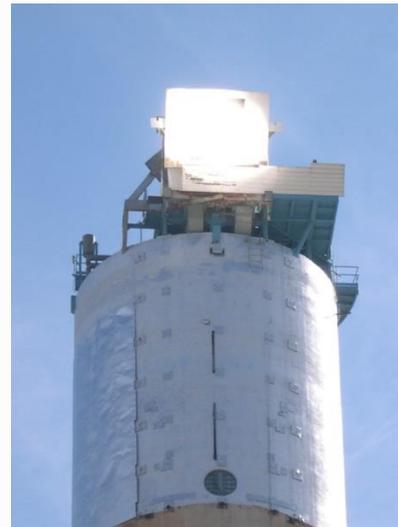
# **NEXTOWER SOLUTIONS: Ceramic solar receivers (DEMO SOLEAD #1)**



# THE CONTEXT:

## solar towers using atmospheric air as heat transfer fluid for large scale power generation

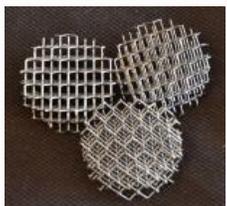
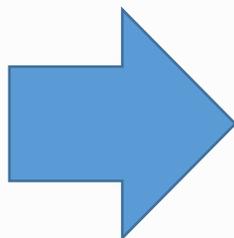
### Challenges and Technological needs



## Improving the central receiver

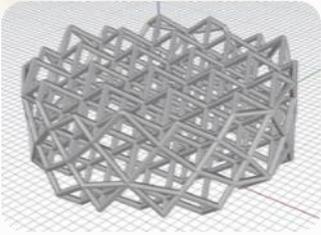
Possibly re-engineering the whole systems downstream to work longer and at much higher temperature, especially in the thermal storage compartment.

# NEXTOWER SOLUTIONS: Demo Plant in Plataforma Solar de Almeria

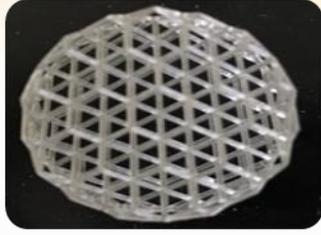


# CERAMICS DEMO

Production and delivery of 150 ceramic receivers according to PSA specifications from ENGICER /POLITO and LIQTECH



3D model



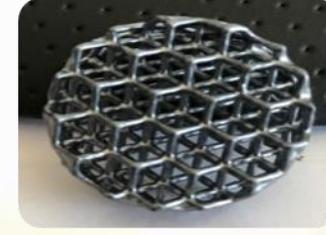
Polymeric template



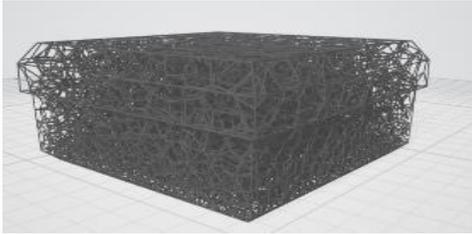
Coating



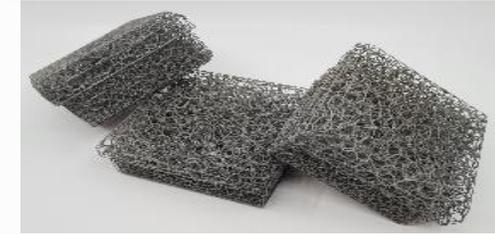
Debinding



Si-Infiltration



*Voronoi design*



*3D printed template*



*Final items with cups*

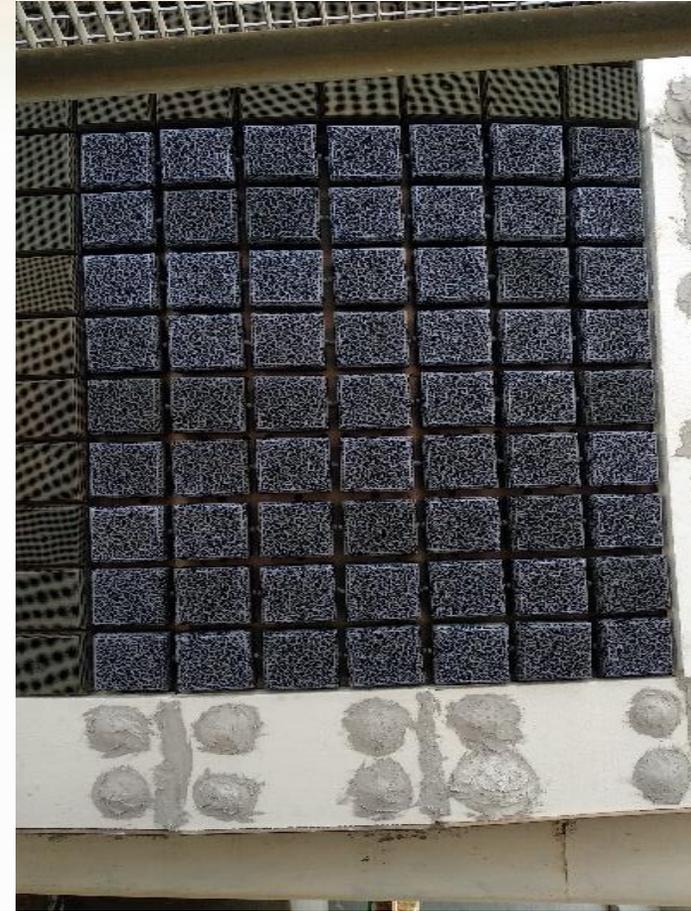


*Coated template (green body)*



# CERAMICS DEMO

Actual installation on CESA tower at 54m of height at PSA CIEMAT



ADDITIONAL INFO:

# **NEXTOWER SOLUTIONS: Thermal storage architecture and materials (DEMO SOLEAD #2)**

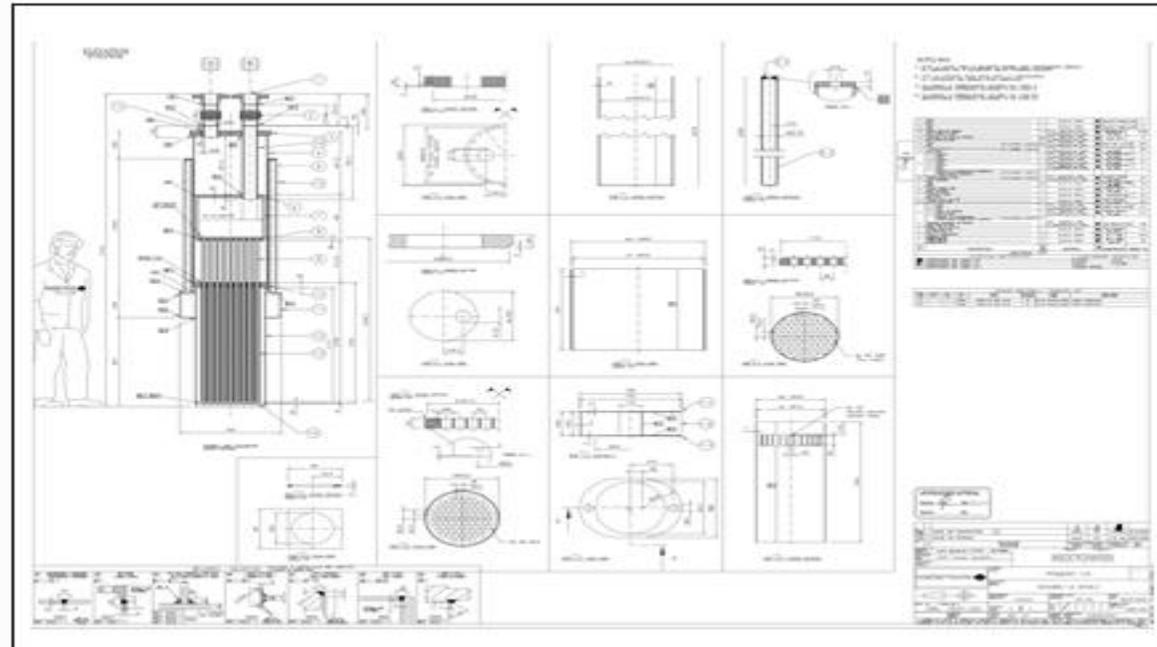


# DEMO LIQUID LEAD STORAGE ALLOYS/COMPONENTS



## Design of S200 Heat Exchangers

Design of S200 HX's from cradle to prototype. Starting from ENEA conceptual design, all the way to engineering and manufacturing drawings finalized by WTO and approved by CALEF-SRS.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 721045.

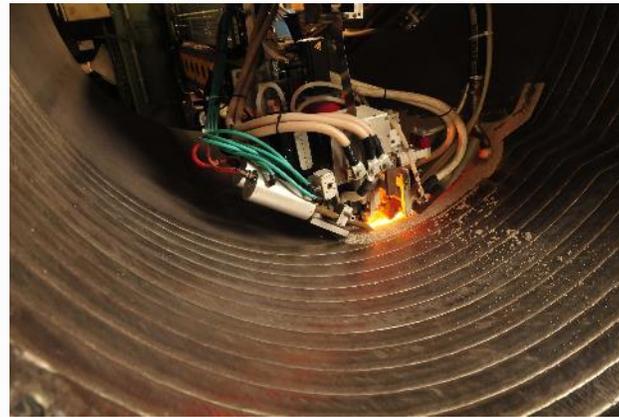
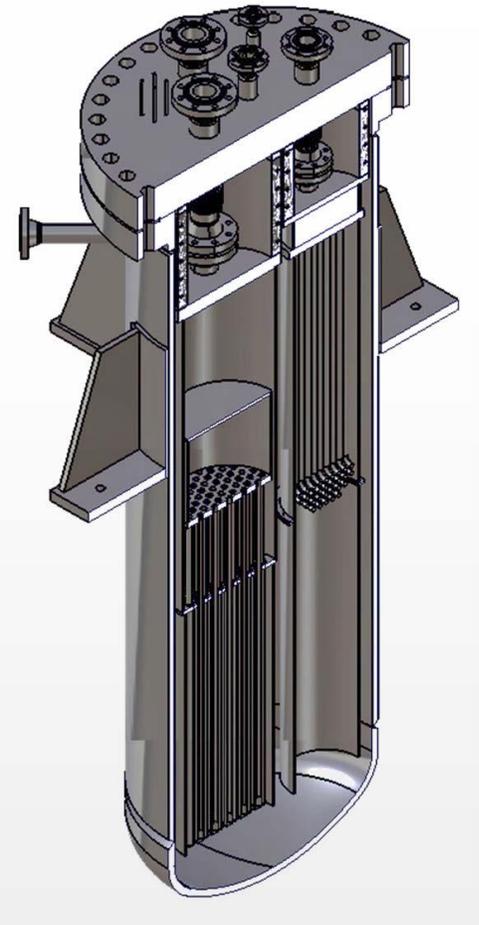


# NEXTOWER solutions: Demo SOLEAD #2 Plant in ENEA Brasimone

Scale testing of liquid lead storage block  
at 800°C

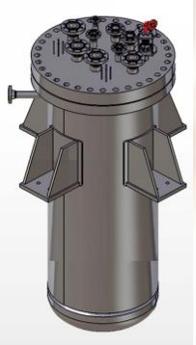
- CERTIFIED WELDING PROCEDURE
- PED CERTIFIED

- 50t SOLEAD demonstrator, over 35 tons of liquid lead
- Several months of testing of full scale components for proving engineering and new materials
- New manufacturing process by overlay welding of 10km- equivalent alloy coating



Credit : Nextower Consortium

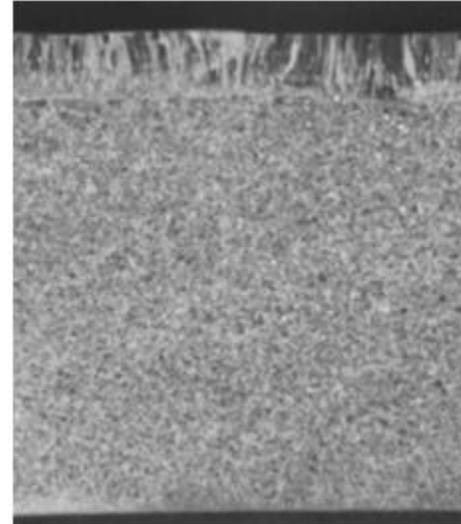




# NEXTOWER solutions: Demo SOLEAD #2 Plant in ENEA Brasimone

- Lab-scale testing of liquid lead storage block at 800°C
- Certification of welding processes

CERTIFIED WELDING  
PROCEDURE



Credit : Nextower Consortium

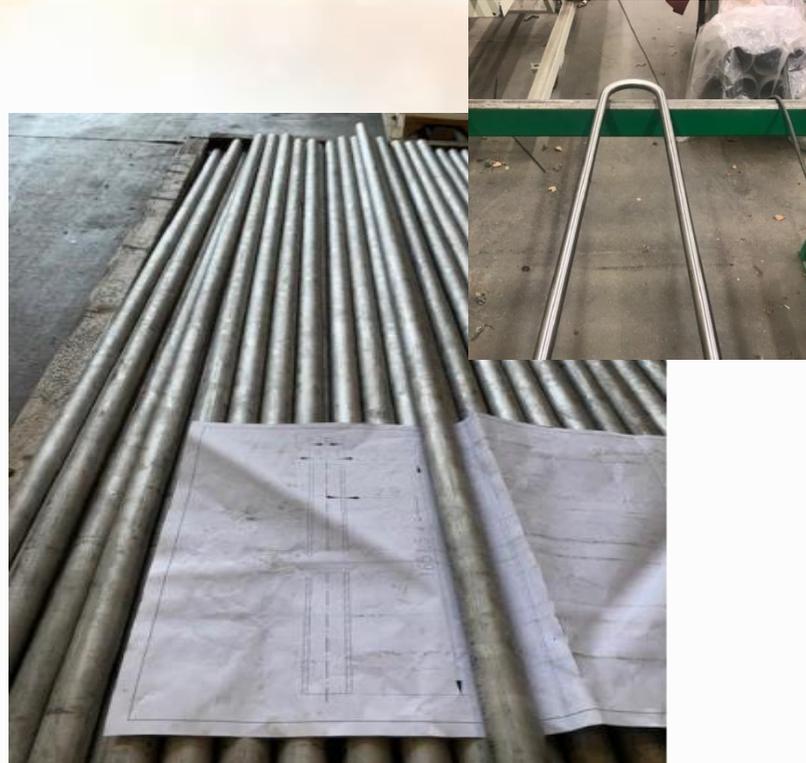


# DEMO LIQUID LEAD STORAGE ALLOYS/COMPONENTS

Heat exchangers manufacturing: operations in Italy after receipt of SMT parts



Higher tube-sheet of the primary HX



Incoloy 800H pipe ready to be assembled



Tube-sheet of the secondary HX



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# DEMO LIQUID LEAD STORAGE ALLOYS/COMPONENTS



Figure 5 – S200 main flange



Figure 6 – S200 cover



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# DEMO LIQUID LEAD STORAGE ALLOYS/COMPONENTS

## S200 manufacturing progress

The flange nozzles have been machined and assembled to the cover and shell.



Figure 7a – Flange nozzles



Figure 7b – Flange nozzles



Figure 7c – Flange nozzles



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# DEMO LIQUID LEAD STORAGE ALLOYS/COMPONENTS

Details and innovation about primary heat exchanger manufacturing

**KANTHAL**  
Part of Sandvik Group



**FeCrAl main subassembly of primary HX**



# DEMO LIQUID LEAD STORAGE ALLOYS/COMPONENTS

## Weld overlaying activities on S200



Circular joint between two halves of S200 main vessel



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# DEMO LIQUID LEAD STORAGE ALLOYS/COMPONENTS

## Weld overlaying activities on S200

main flange is completed and assembled on the vessel.



Main flange of S200



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# DEMO LIQUID LEAD STORAGE ALLOYS/COMPONENTS



## Weld overlaying activities on S200: production tests



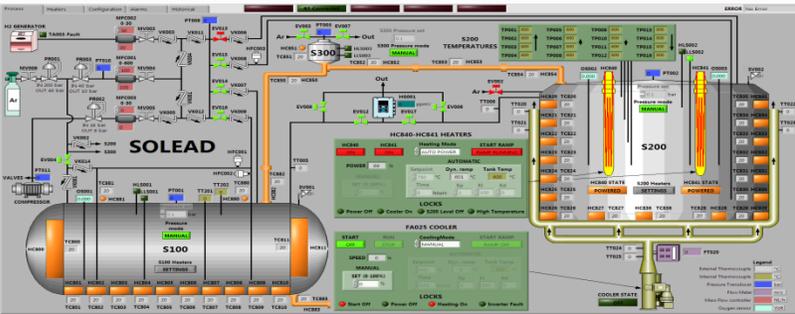
Hydraulic test of S200



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# SOLEAD : tracing of vessels @ ENEA Brasimone Research Centre



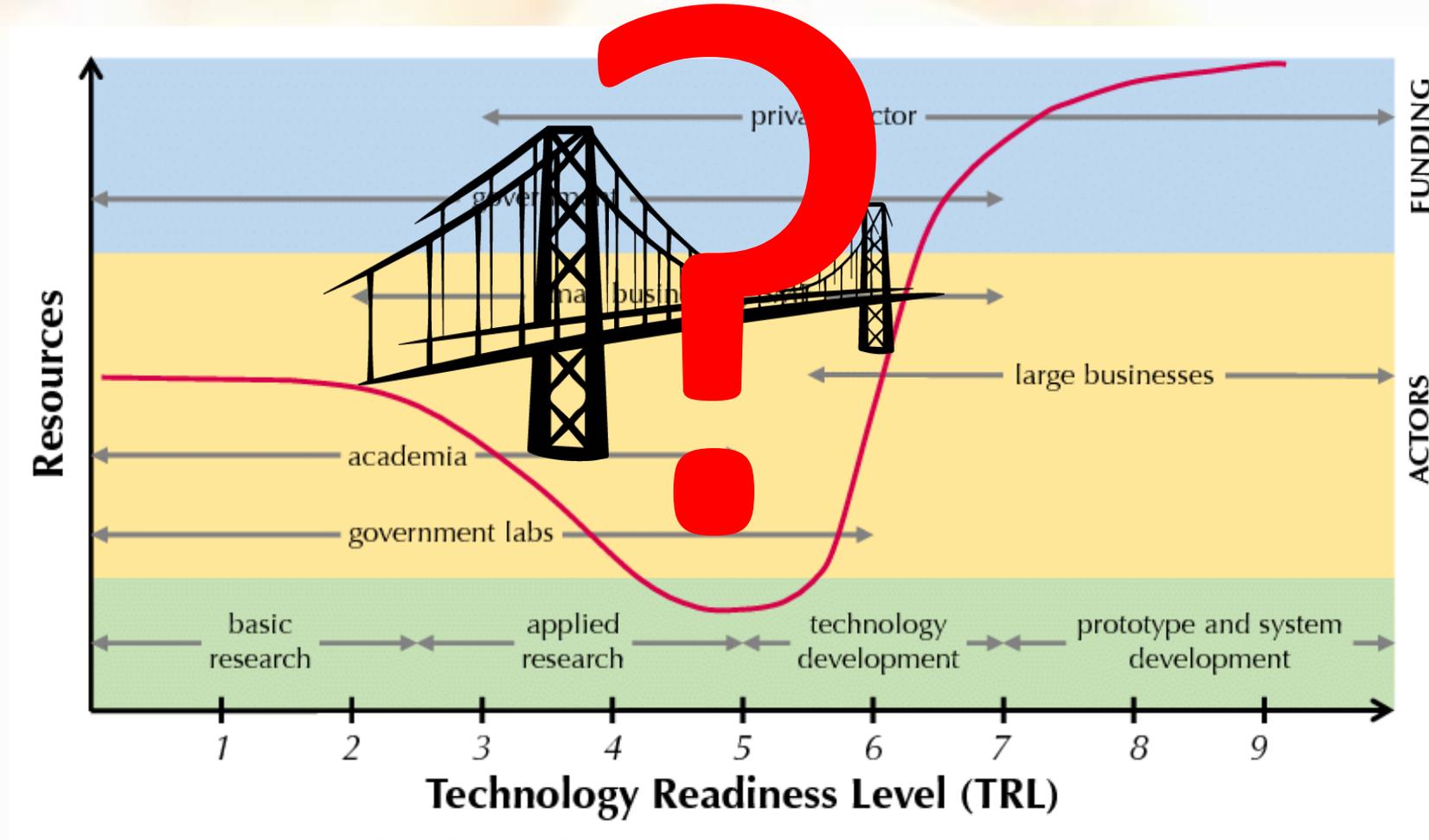
(TOP) naked storage tank and (BOTTOM) tracing by ENEA with heating cables & thermocouples



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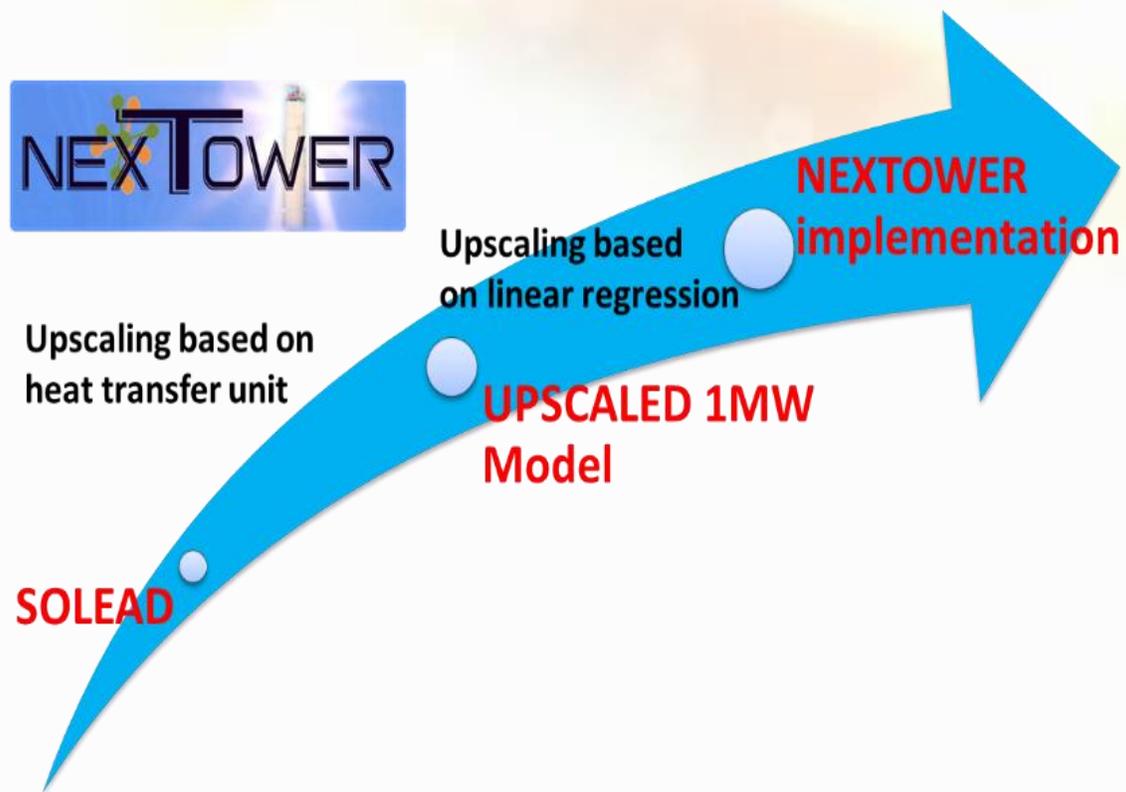
# The role of LCA: Technological valley of death



Death causes: Technological: TRL, SRL

Other causes: Costs, environmental or social impacts

# SOLEAD upscaling scheme



From Critical Raw Materials viewpoint , Cr is the most critical element for the new SOLEAD alloys

# NEXTOWER IMPACT: metallic and ceramic materials applications

Durable components working at high temperatures for:



# NEXTOWER IMPACT: heat and electricity production by CSP plants



PHARMACEUTICAL  
COMPANIES



BREWERIES



STEAM/GAS TURBINES



BIOMASS PLANTS



CEMENT PLANTS



METAL INDUSTRIES



GLASS INDUSTRIES



SOLAR ENHANCED OIL RECOVERY  
AND DESALINATION OF SEA WATER



# Thank you for your attention

The research leading to these results has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 721045.

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