



Advanced Materials technologies to
QUADRUPLE Concentrated Solar Thermal
current POWER GENERATION



Developing Highly Efficient
Concentrated Solar Power
Architecture

H2020-NMBP-2016-2017

IA – Innovation action

From 01/01/2017 to 31/12/2020

EU contribution: 5M€

Coordinated by LEITAT (Spain)

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#	Participant Organization	Type	Country
1 (CO)	LEITAT	RTO	Spain
2	OHL	LE	Spain
3	NEMATIA	SME	Spain
4	KOLZER	SME	Italy
5	GEOCAD	SME	Spain
6	VOTTELER	SME	Germany
7	IK4-TEKNIKER	RTO	Spain
8	CEA-LITEN	RTO	France
9	FERTIBERIA	LE	Spain
10	ENEA	RTO	Italy

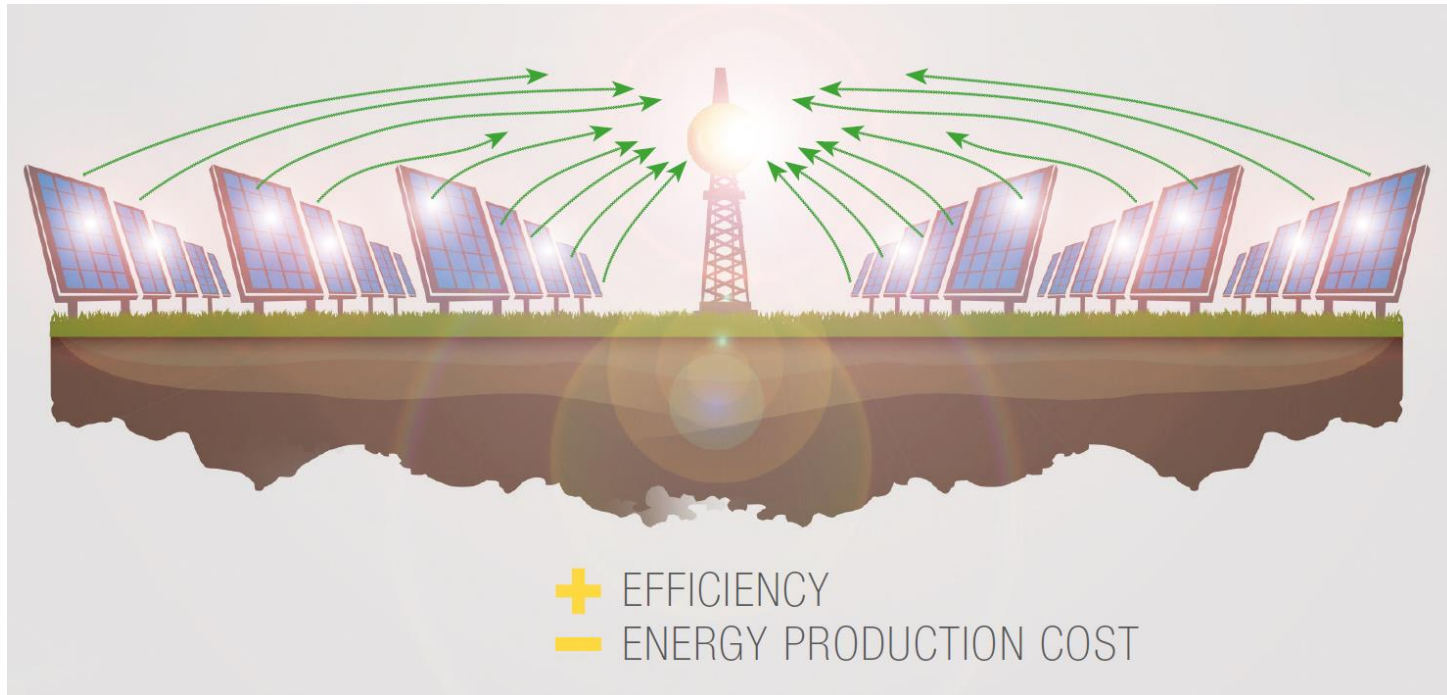


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General description

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- **IN-POWER** project develops highly efficient concentrated solar power architectures. This consists in developing and integrating new innovative material solutions into concentrated solar technology to increase the efficiency while simultaneously decreasing the energy production cost.



Objectives

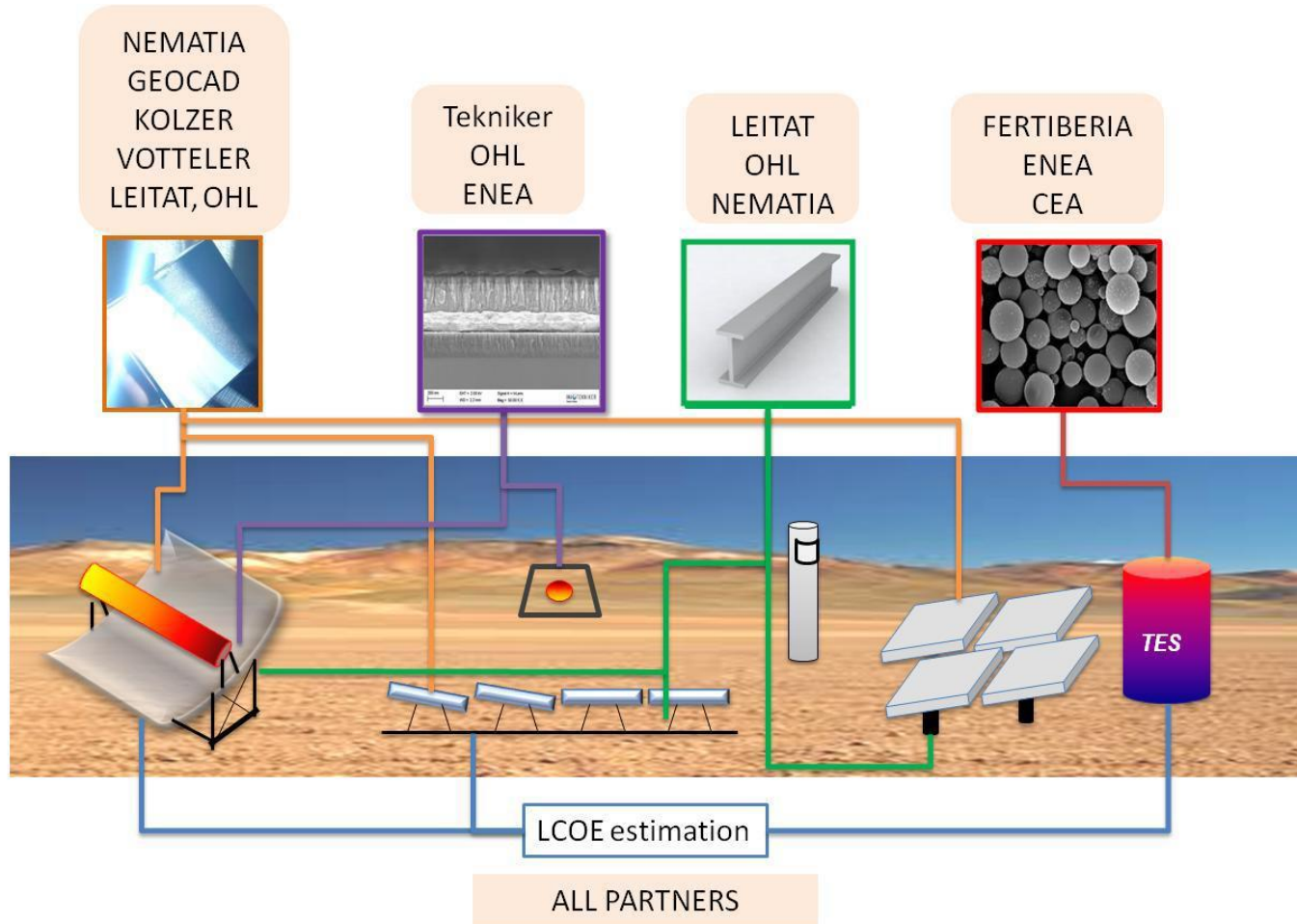
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BEFORE	BEFORE	BEFORE	BEFORE	BEFORE
↓	↓	↓	↓	↓
AFTER	AFTER	AFTER	AFTER	AFTER
<p>01</p> <ul style="list-style-type: none"> Higher reflectance Tailored shapes Robust glass-free mirrors Light mirrors support 	<p>02</p> <ul style="list-style-type: none"> Reduce 4 times the land use compared to current parabolic trough collector 	<p>03</p> <ul style="list-style-type: none"> High absorber Coating for vacuum free receivers 	<p>04</p> <ul style="list-style-type: none"> Increase 3 times standard thermal storage capacity by novel materials 	<p>05</p> <ul style="list-style-type: none"> Bring levelised cost of electricity below 0.10 /KWH beyond 2020 



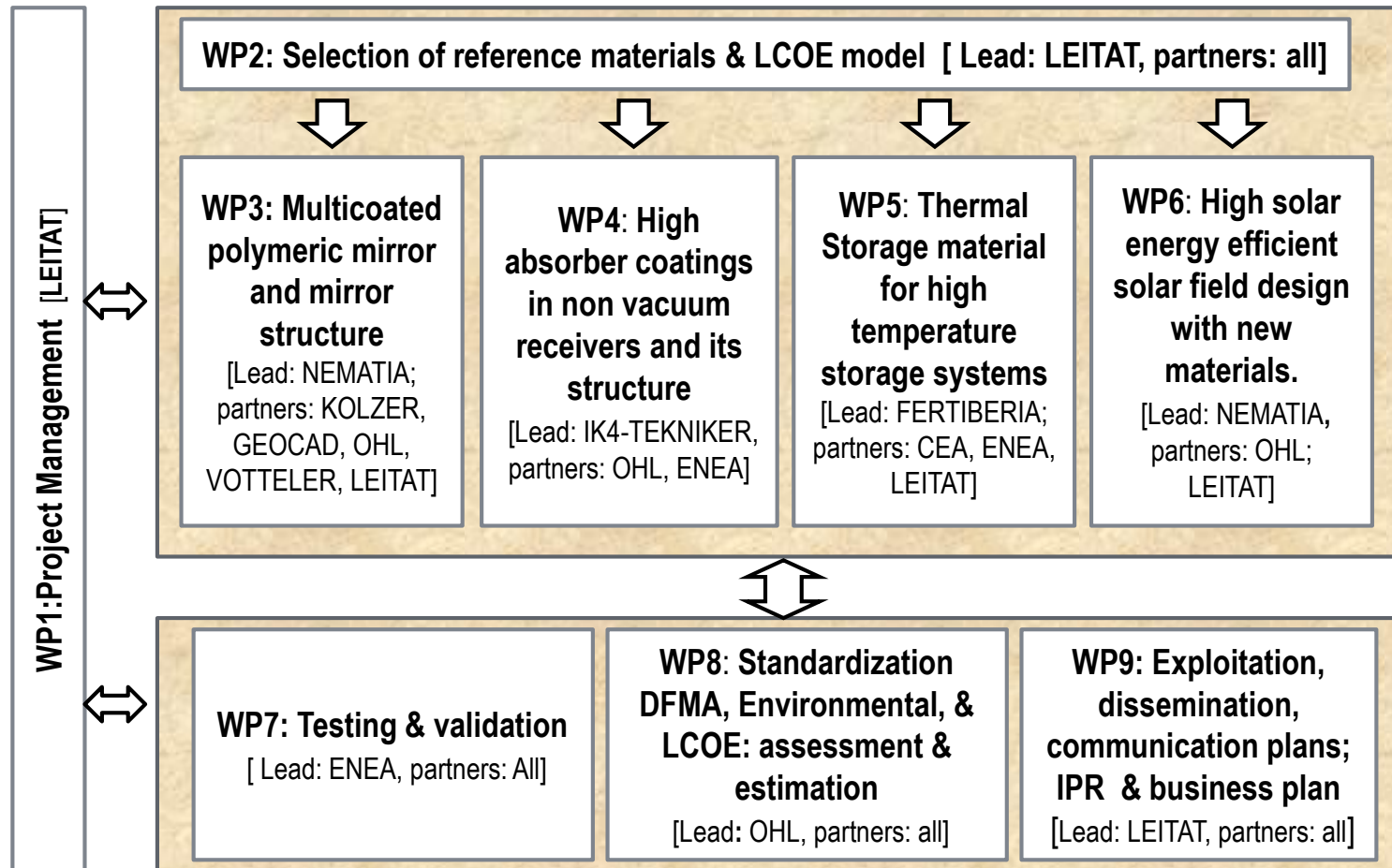
Who makes what

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WPs, Pert diagram

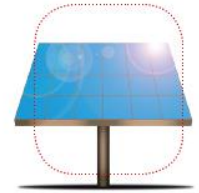
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- Development of **polymeric smart light mirrors with high optical and mechanical performance.**

IN-POWER mirror will be composed by robust polymeric substrate, with multilayered coatings such as 1) high Ag/Al based reflective, 2) self-healing and 3) anti-soiling functionalities. IN-POWER mirror properties compare to standard glass based mirror are:

- with **weight reduction by 35%** reducing 10% mirrors alignment problems
- High reflective silvered coating with **hemispherical reflectivity of 0.96, specular reflectivity above 0.95** and hemispherical average of 0.95 in the range of 450 to 1350nm
- **Robustness** due to transparent self-healing coating, and **higher durability**
- Reduction of the cost maintenance (reduction by 10% of water consumption) through **soiling rate reduction of 10%** with highly durable anti-soiling nano-layer
- A total **reduction in CAPEX by 20%** and an **increment of AEP by 10%**. Re-useable & recyclable.



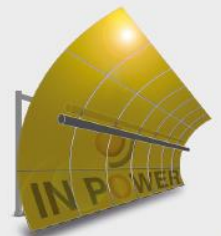
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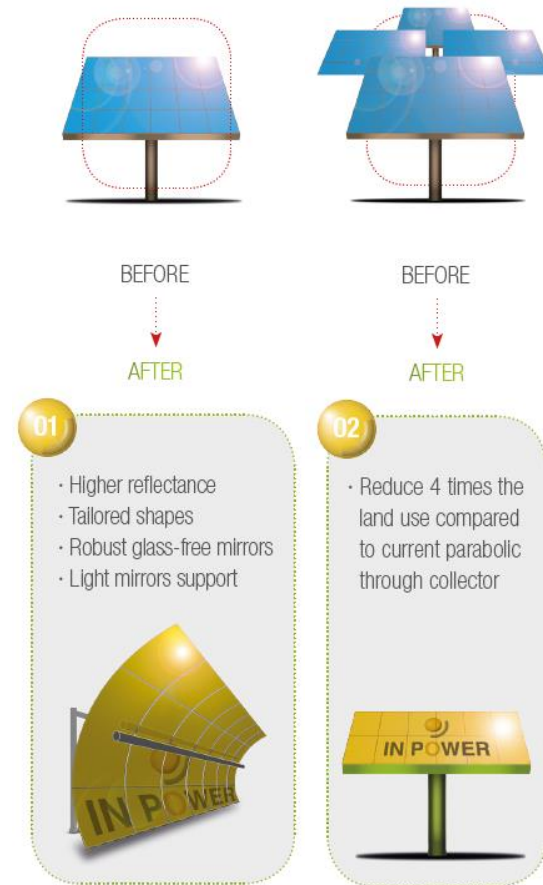
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- Higher reflectance
- Tailored shapes
- Robust glass-free mirrors
- Light mirrors support



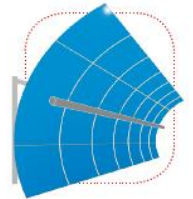
- **Innovative solar field design architecture will improve the design of existing solar plants reducing its size by up to four time for the same output:** The design of manufacture process of multicoated polymeric mirror opens the door to develop **numerous shapes allowing** a new design concept of the solar field. Taking IN-POWER concept as reference (1), the generation weighted average land use is 4.2:4.7:2.8 for Parabolic Though Collector (PTC): Central Tower (CT): Linear Fresnel Collector (LFC) respectively versus 0.6 of IN-POWER concept.
- **New complex materials** (advanced light composites) **for optimised mirror structure (new design)** will allow:

 - Mass **reduction** up to **30%** for the mirror support, using dedicated composition rate of GFRP, high pointing accuracy due to a lower flexion and torsion deformation with torsion and flection lower than 2mrad and 8mm respectively
 - Reduction in assembly time and manufacturing cost.
 - **Reduction in CAPEX by 25%, and 10% in OPEX.**
 - Reduction of whole mass inventory of the solar field up to 45%.



New selective absorbers and Vacuum free receiver designed for high temperature operation. Two huge technological breakthroughs will be developed:

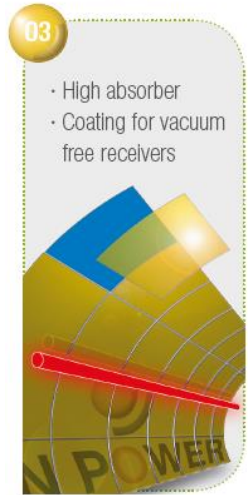
- (1) Advanced cermet designs allowing **0.97 absorbance** (high absorbance coating) , and improved **thermal efficiency** from 0.7 to **0.8** with new **vacuum free receiver's design** using 0.97 transmission of glass cover receptor in case of LFC. IN-POWER design will enhance safer and more robust receivers and then the long term performance of lineal receivers.
- (2) Metallic volumetric gas receivers where coatings will be designed to work in contact with inert gases will reduce maintenance cost
- Both cases, working at high operation regime (500-600°C), will reduce the global CAPEX by 20% (approximately 0.8 - 1 € /Wp) and reduction in global OPEX of 10% ($< 0.3\text{€}/\text{Wp}$) in 2020.



BEFORE



AFTER



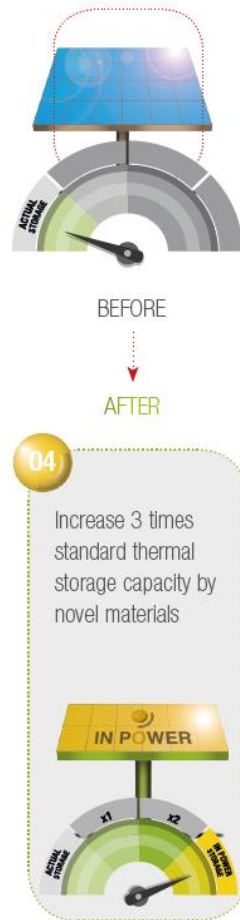
□ **Innovative thermal storage materials for medium and high temperature thermal storage systems:**

Support by TES systems, thermocline and multitank modelling and material compatibility behaviour simulation, TES material capabilities will be increased **up to three times**. Two high-temperature TES developments will be done:

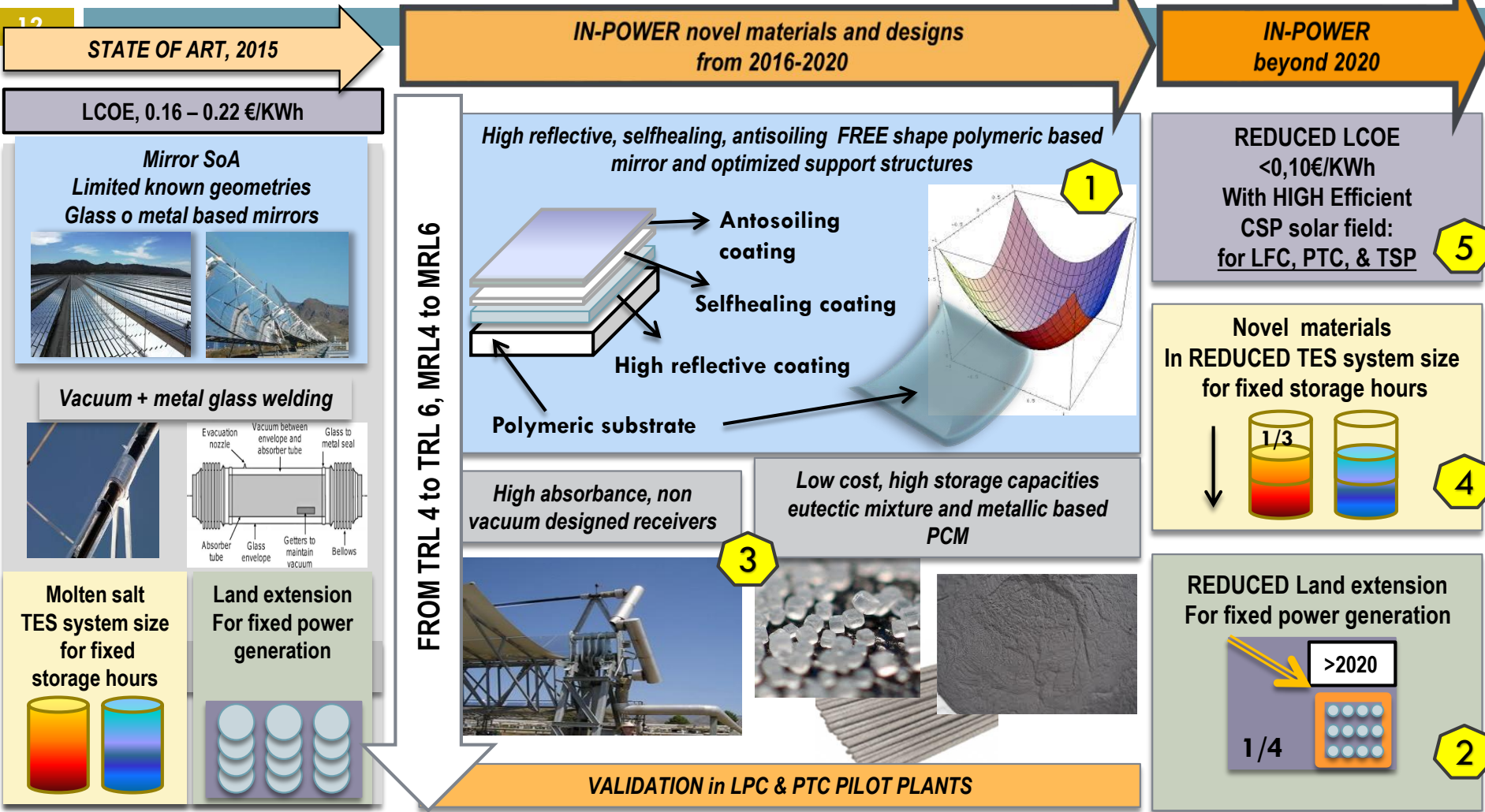
- (1) for CSP plants with oil or molten salts as HTF, **high temperature molten salts and encapsulated phase change material (PCM, aluminium alloys)** will be used in a thermocline tank to maintain a constant temperature during discharge
- (2) for CSP plants with direct steam generation (DSG), a combination of latent heat storage tank with sodium nitrate as **PCM** and **high temperature molten salts** sensible heat storage tanks will be developed

IN-POWER eutectic mixture will allow:

- Thermal storage capacity increase from $\Delta T < 100^{\circ}\text{C}$ to $\Delta T > 300^{\circ}\text{C}$ with optimised low melting point from 240 to 210°C, stable, affordable and non toxic salt formulation.
- Manufacturing cost reduction up to 20%
- High conductivity PCM suitable to store heat from high temperature HTF above 500°C
- Size reduction of TES system, with CAPEX reduction by 20% and AEP improvement by 15% at 500°C cycle working (actual cycle is working at 400°C).



Concept scheme



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STATE OF ART, 2015

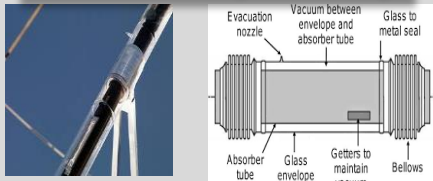
LCOE, 0.16 – 0.22 €/KWh

Mirror SoA

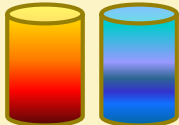
Limited known geometries
Glass or metal based mirrors



Vacuum + metal glass welding



Molten salt TES system size for fixed storage hours

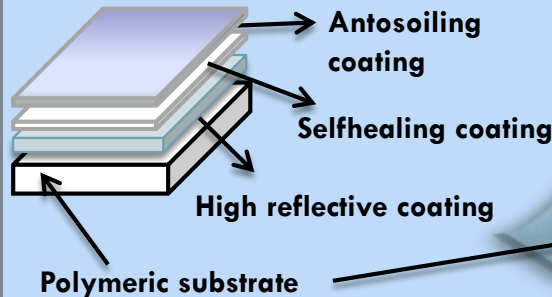


Land extension For fixed power generation



IN-POWER novel materials and designs from 2016-2020

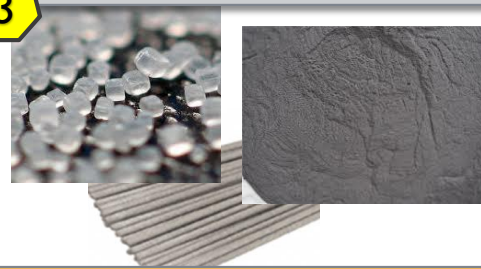
High reflective, selfhealing, antisoiling FREE shape polymeric based mirror and optimized support structures



High absorbance, non vacuum designed receivers



Low cost, high storage capacities eutectic mixture and metallic based PCM



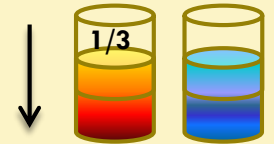
VALIDATION in LPC & PTC PILOT PLANTS

IN-POWER beyond 2020

REDUCED LCOE <0,10€/KWh
With HIGH Efficient CSP solar field: for LFC, PTC, & TSP

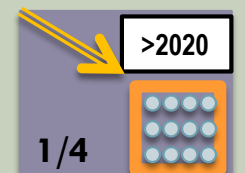
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Novel materials In REDUCED TES system size for fixed storage hours



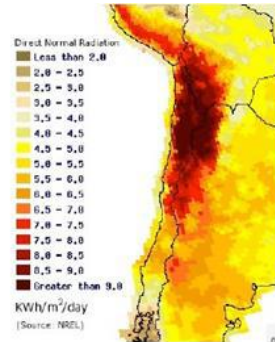
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REDUCED Land extension For fixed power generation

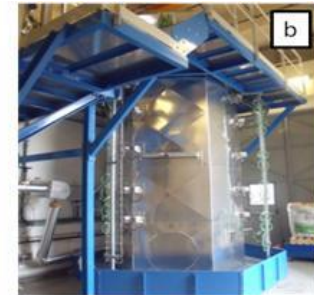
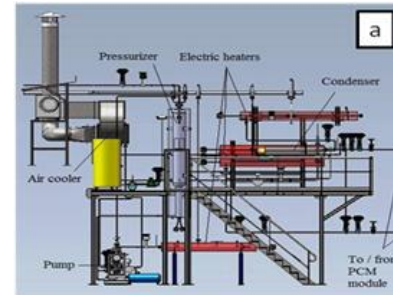


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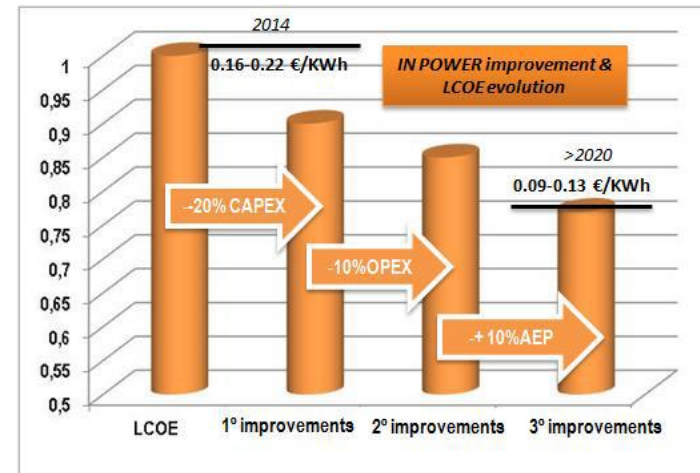




DEMO Sites: Spanish LFC OHLI's pilot plant (Top, left), Atacama LEITAT geosite (Top, right) and Italian PTC ENEA's loop (Bottom)



Demo Labs. (a) Layout of LHASA test facility; (b) Alsolen Sup latent storage test section



THANK YOU FOR THE ATTENTION



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