HYDROSOL-beyond

Thermochemical HYDROgen production in SOLar structured reactors: overcoming the challenges and beyond

European Hydrogen Week

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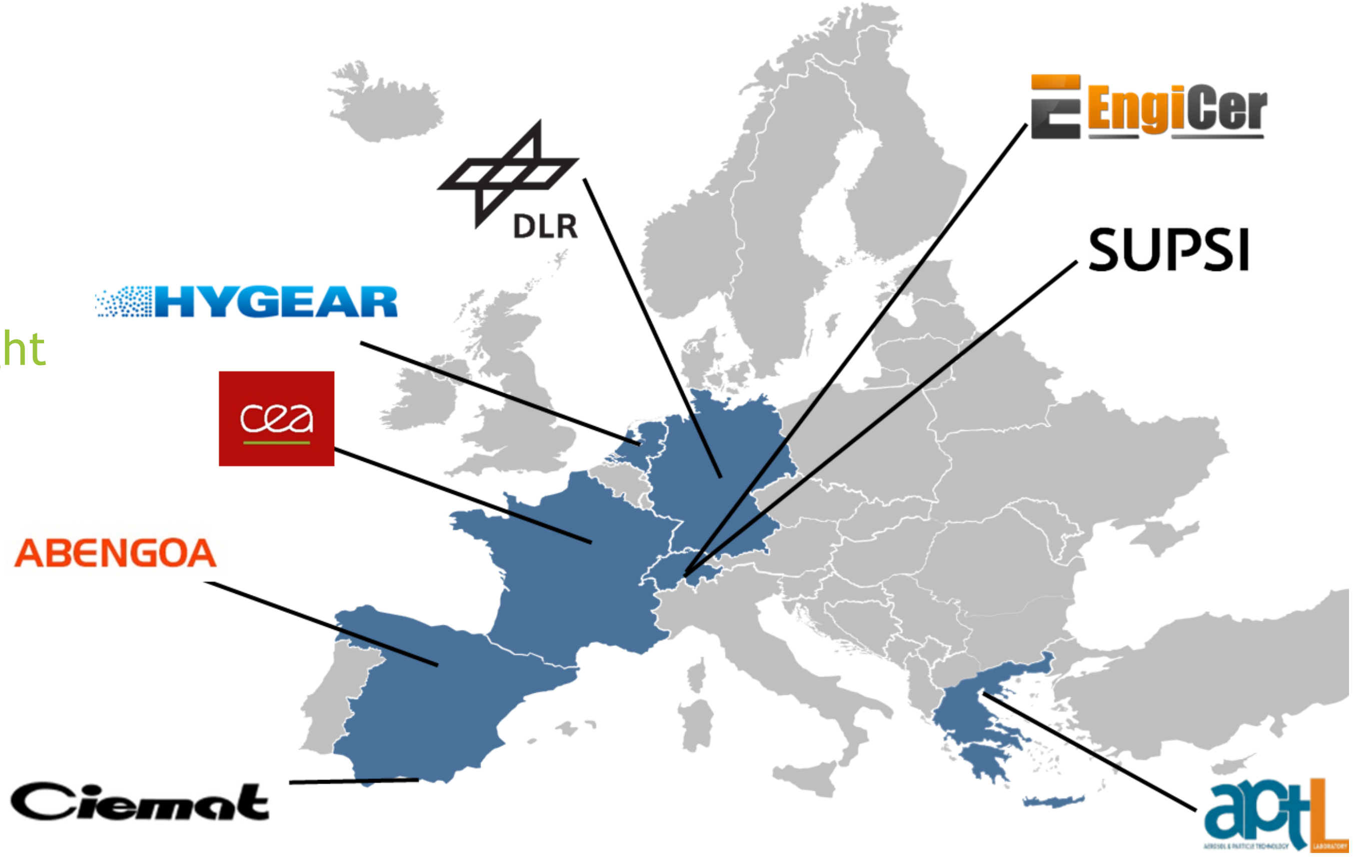
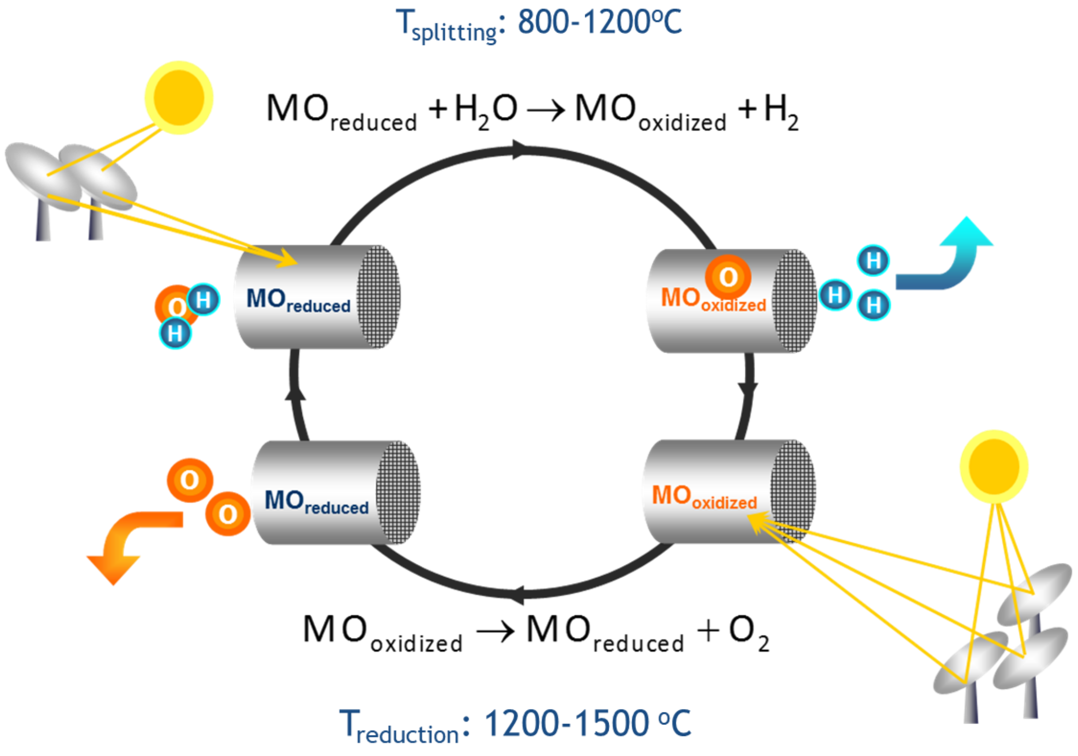
Project Overview

- Call year: 2018
- Call topic: FCH-02-4-2018 | Thermochemical Hydrogen Production from Concentrated Sunlight
- Project dates: 01/01/2019 – 31/12/2023
- % stage of implementation : [50 %]
- Total project budget: [2,999,940.00 €]
- FCH JU max. contribution: [2,999,940.00 €]
- Partners: APTL/CERTH, DLR, CIEMAT, HYGEAR, ENGICER, SUPSI, CEA, ABENGOA



Project Summary

Structured redox materials for direct water dissociation with the aid of concentrated solar irradiation



- Main Objectives
  - Heat recovery
  - the minimization of the parasitic loses mostly related to the high consumption of inert
  - improvement of reactor design
  - development of technology with annual solar-to-fuel efficiency of 10%
- Global positioning vs international state-of the art
  - Largest solar platform for redox thermochemical H_2 production based on structured reactors
- Application and market area
  - Solar energy storage – Alternative routes for H_2 production

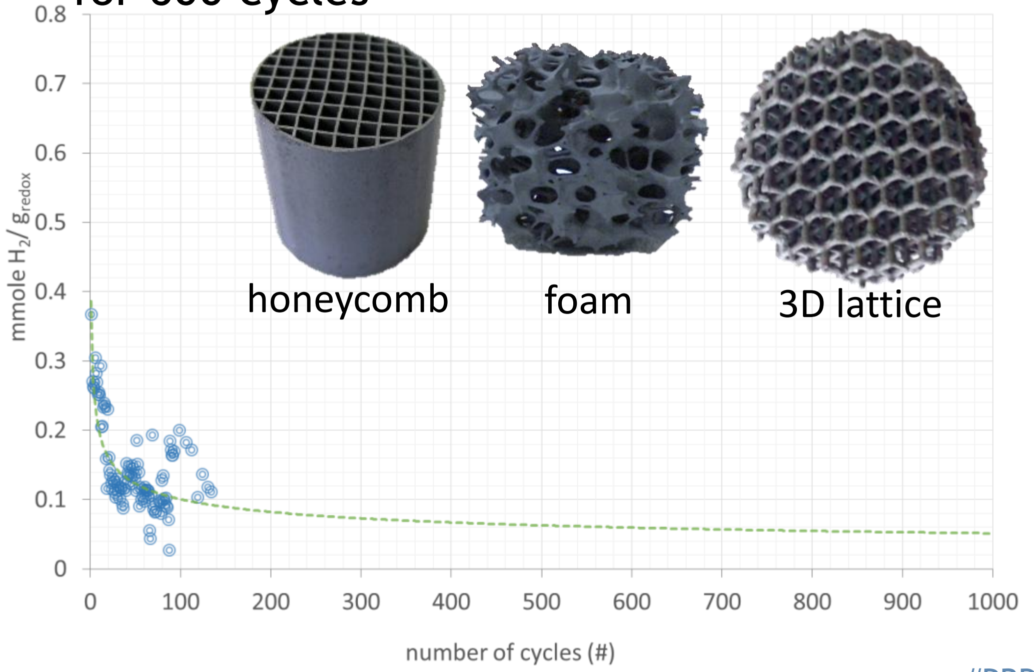
Project Progress/Actions - Durability

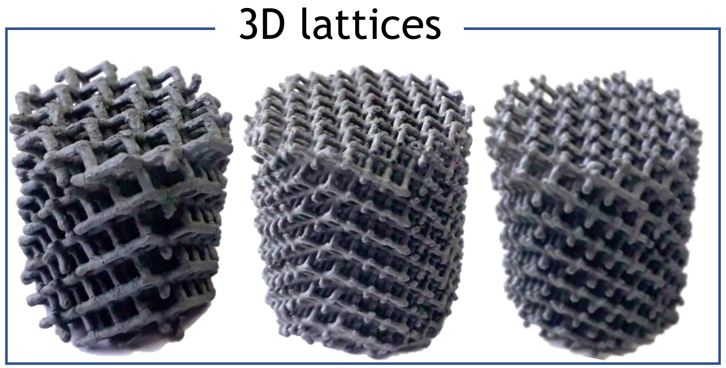
Suitable structures that would exhibit sufficient stability and activity over at least 1000 cycles of consecutive thermal reduction/water splitting

Redox materials & structures — 600cycles → 1000cycles

25% 50% 75%

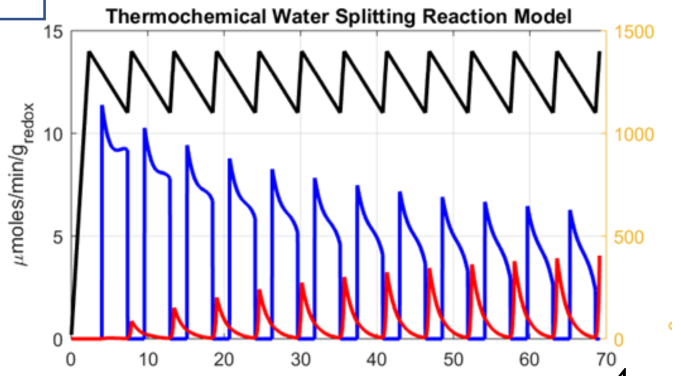
- SoA: Ni-ferrite honeycomb monolith tested for 600 cycles





- Ceramic lattice structures based on 3D-printed polymeric matrices to be tested

- Fast aging protocol to simulate the process and accelerate assessment



Project Progress/Actions - Parasitic loses minimization

Recovery of heat and minimization of consumption of auxiliaries like inert gas.

Parasitic loses minimization

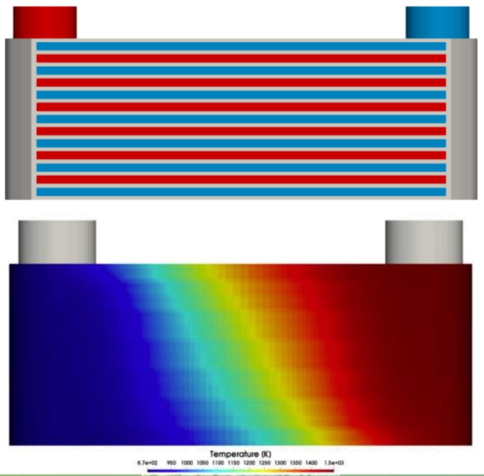
Heat loss
Inert gas consumption

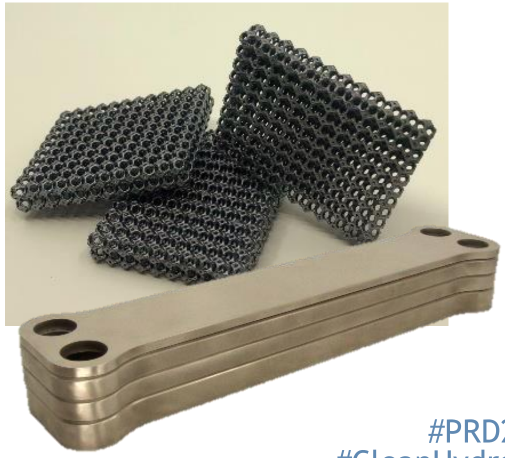
25% 50% 75%

>50% heat recovery
<25% of energy output

Hybrid ceramic-metallic heat exchanger

- Design of hybrid heat exchanger
- Small scale unit constructed
- Current status: testing at laboratory

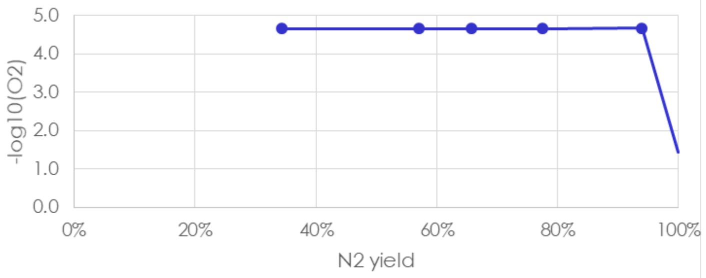




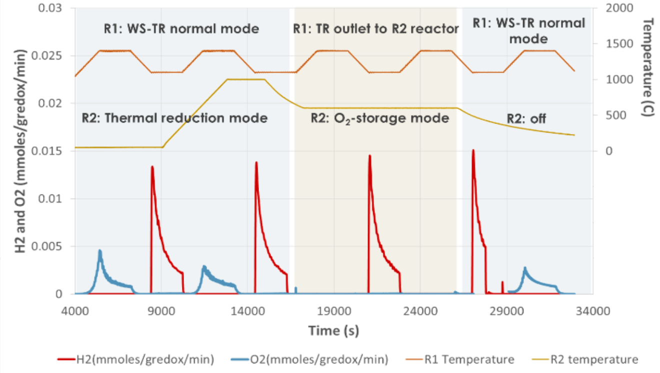
Minimization of inert gas consumption

- Thermal reduction with lower N_2 flow.
- N_2 recycling via purification-Laboratory assessment.

Vacuum Swing Adsorption



Oxygen trap via redox reaction

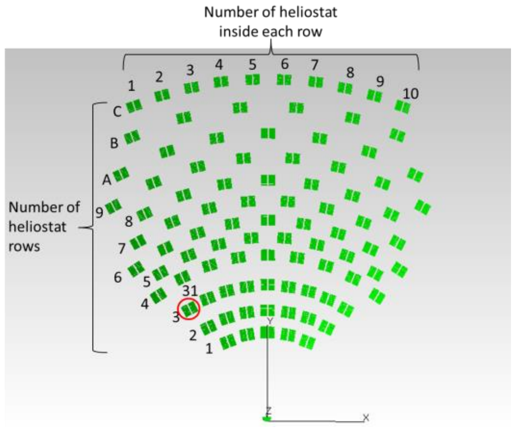


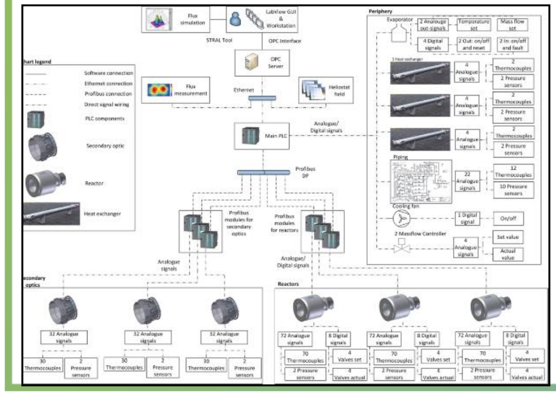
Progress/Actions - Technology efficiency

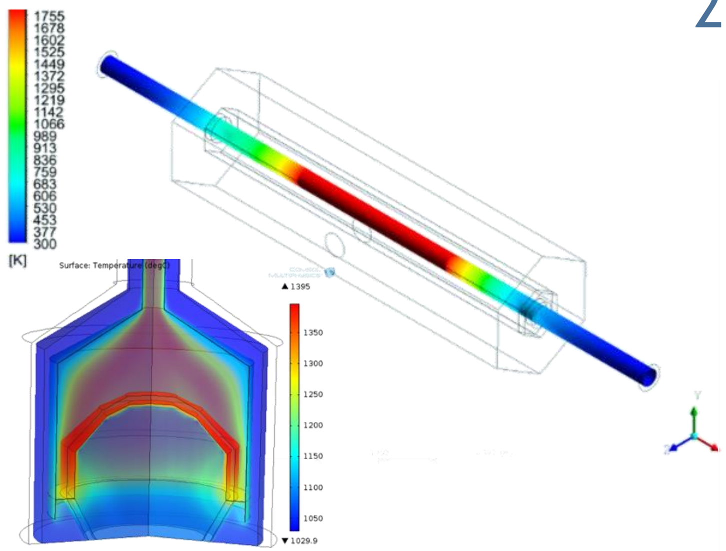
Finalization of a design and development of a technology with annual solar-to-fuel efficiencies in the range efficiency of 10 % (ratio of solar radiation entering the plant to calorific value of the fuel exiting the plant)

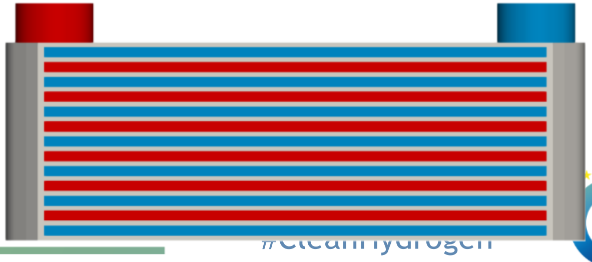
Technology efficiency 2% → 10%

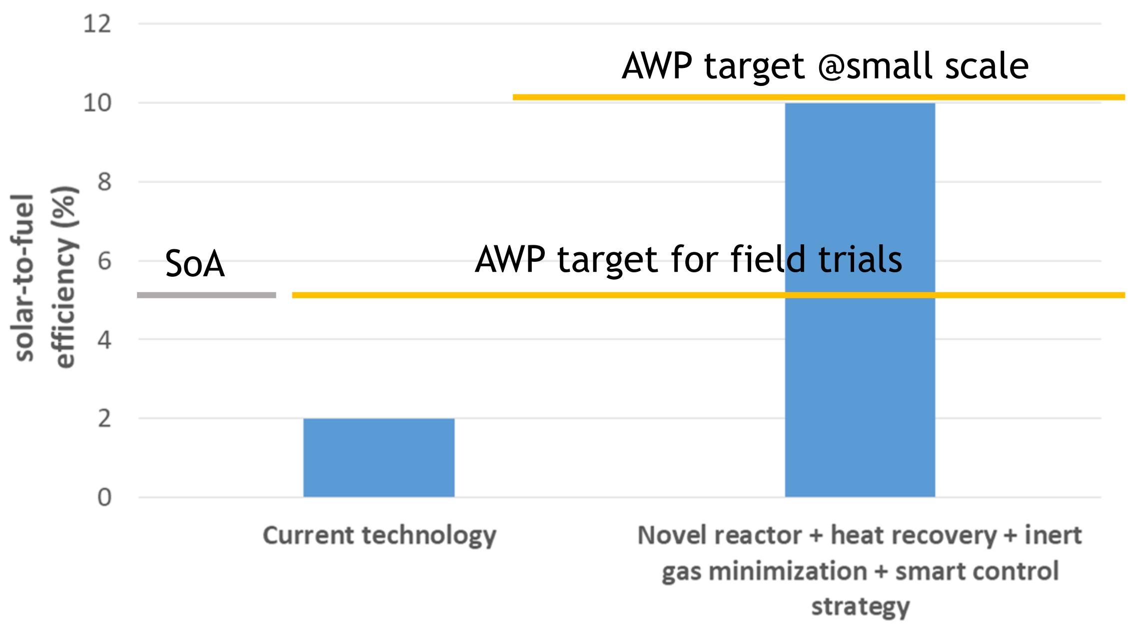
25% 50% 75%











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Risks, Challenges and Lessons Learned

Risk-Challenge	Mitigation
Delays in durability evaluation tests at the laboratory	Fast aging protocols to simulate longterm exposure of materials
Structures with improved heat and mass-transport properties do not reach required thermomechanical properties	Modification of architecture to more robust morphologies. Utilization of conventional substrates with acceptable standard performance. Extensive pre-testing in smaller-scale facilities
Heat recovery rate of 60% is not reached	Small scale unit testing at the lab scale and iterative simulation to optimize design until target is reached
Technology efficiency of 5% in the field is not reached	Process modification at simulation and scale-down of experimental level but still under relevant conditions to demonstrate feasibility of such efficiency values Definition of a roadmap for their implementation at full scale in the framework of relevant postproject activities

Exploitation Plan/Expected Impact

Exploitation Plan

The consortium is Planning to focus on three Key Exploitable Results:

1. **Solar Hydrogen production Process**, including Solar plant & materials performance
2. **Novel reactor design**
3. **Novel high temperature heat exchanger design**

The udpdated Exploitation plan was a result of the collaboration of the consortium with the HORIZON results Booster Team

Impact

- Attract major stakeholders and external experts
- Establish doctoral and master dissertation thesis
- Promote interdisciplinary training by encouraging mobility and personnel exchange among the consortium partners

Dissemination Activities

Dissemination activities		
Publications	3	González-Pardo A., Denk T., Vidal A., "Lessons learnt during the construction and start-up of 3 cylindrical cavity-receivers facility integrated in a 750 kW solar tower plant for hydrogen production", AIP Conference Proceedings 2303, 170008 (2020)
		Lidor A., Fend T., Roeb M., Sattler C., Parametric investigation of a volumetric solar receiver-reactor, Solar Energy, Volume 204, 2020, pp 256-269
		Pelanconi M., Zavattoni S., Cornolti L., Puragliesi R., Arrivabeni E., Ferrari L., Gianella S., Barbato M., Ortona A., "Application of Ceramic Lattice Structures to Design Compact, High Temperature Heat Exchangers: Material and Architecture Selection", Materials 2021, 14, 3225
Public deliverables	14	public deliverables and publishable summary reports
Conferences and workshops	15	Conferences: Global Energy & Renewable Energy Summit; Hydrogen+Fuel Cells; US Hydrogen & Fuel Cells Energy Summit; SolarPACES; World Hydrogen Energy Conf.; IECON; Int. Conf. & Expo on Adv. Cer.&Comp.; Energy Storage World Forum; EU Control Conf.; Int. Conf. on Smart Energy Systems & Technology; Journées Nationales de l'Energie Solaire 1 project workshop at the end of the project

Communications Activities

HYDROSOL-beyond website
http://www.hydrosol-beyond.certh.gr/

LinkedIn Account
HYDROSOL-beyond Profile

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Videos related to HYDROSOL-Technology

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