NEXT-CSP
A NOVEL CONCEPT
HIGH TEMPERATURE CONCENTRATED SOLAR THERMAL POWER PLANT WITH PARTICLE RECEIVER AND DIRECT THERMAL STORAGE

PRESS PACK FOR THE MEDIA
July 2021
The Next-CSP project is the result of more than 40 years of research on the use of particles in concentrated solar energy conversion. I published (in French) the concept of Next-CSP in 1980. Then came the original idea of the fluidized particles-in-tube solar receiver patented in 2010. The CNRS and then the European Union funded the research rapidly in 2011. The CSP2 (Concentrated Solar Power in Particles) European project, funded under FP7, resulted in the successful operation of a 150 kW solar receiver with fluidized particle recirculation.

Next-CSP’s ambition is to demonstrate the project at industrial pilot scale with the testing of a 3-MW solar receiver and the complete solid and conversion loops including a gas turbine. A great challenge that strengthens the leadership position of Europe in the domain of CSP technology innovation.

After nearly 5 years of collaborative research between 10 partners from 7 countries, Next-CSP will come to an end in July 2021. Therefore, we will organise the project’s final event: an hybrid Info Day showcasing Next-CSP’s key results and scientific achievements as well as a side visit to the CNRS-PROMES solar facilities. In this publication, you will find more information about this special event, as well as all the key features about Next-CSP.
Press Release: Next-CSP Final InfoDay

On behalf of the Next-CSP project team, we are pleased to announce the organisation of the Next-CSP Final Info Day! This hybrid event will take place on Thursday, 8 July 2021, from 09:30 to 13:00 CET.

Due to the health context, the Info Day will be organised online, through the Zoom platform. Nonetheless, there is also an option to attend the Info Day on site at the CNRS-PROMES facilities in Font Romeu Odeillo, France (limited). Registration is free, but mandatory.

Come and find out about the innovative technologies for Concentrated Solar Power as well as the main challenges, results and perspectives of the project! In the programme:

**09:30**
Concentrated solar power in particles: concepts and challenges  
Gilles Flamant, CNRS, France

**10:00**
Particles in solar heat capture, heat storage and heat recovery  
Renaud Ansart, INPT, France and Jan Baeyens, EPPT, Belgium

**10:30**
Construction and implementation of the Next-CSP prototype  
Ken Whittaker, Whittaker Engineering, UK

**11:00**
First operation results in the Next-CSP prototype  
Alex Le Gal, CNRS, France

**11:30**
Scaling-up the Next-CSP concept at commercial size:  
• High efficiency conversion cycles - Manuel Romero, IMDEA Energy, Spain  
• Positioning of CSP in Future Electricity Networks – Frédéric Siros, EDF, France

**12:30**
Q&A and closing session

In the afternoon of 8 July 2021, after the InfoDay, journalists and stakeholders are invited to an on-site visit of the CNRS-PROMES facilities in Font-Romeu to showcase the concrete experiments and innovations from Next-CSP. If you wish to participate, don’t hesitate to contact us!
Concentrated Solar Power to tackle climate change

To accelerate the fight against climate change and to reach the EU target of 27% of renewable energies by 2030, Europe needs to rapidly expand the use of all renewable energy sources, such as solar energy. However, this requires developing further new solutions that are emerging today, particularly technologies that solve the key issue of energy storage.

The Next-CSP project responds to this need and addresses significant improvements related to concentrated solar power (CSP):
- heat transfer fluids, which can be used for direct thermal energy storage;
- solar field;
- high temperature receivers allowing new high efficiency thermodynamic cycles.

WHAT IS CONCENTRATED SOLAR POWER?
Concentrated Solar Power (CSP) plants use mirrors to concentrate sunlight onto receivers where it is converted into heat. A heat transfer fluid transports the thermal energy to a storage system or a power block where it is used to produce steam that drives a steam turbine to generate electricity. The integration of a storage system enables power production during cloudy periods and after sunset.

The four main CSP technologies

Parabolic Dish Parabolic Trough Linear Fresnel Solar Tower

Next-CSP: Innovative components for Concentrated Solar Power plants

Launched in 2016, the Next-CSP project stands for “High Temperature concentrated solar thermal power plan with particle receiver and direct thermal storage”. It responds to 4 main objectives:
- improve the reliability and performance of Concentrated Solar Power (CSP) plants
- develop and integrate a new technology into CSP plants
- use high temperature particles as heat transfer fluid and storage medium
- demonstrate the technology in a relevant environment and at the MW size.

The project proposes a breakthrough innovation: a fluidised particle-in-tube concept, which opens the route to the development of a new generation of CSP plants. It would allow:
- high efficiency new cycles (50% and more),
- 20% improvement of CSP plant efficiency,
- modular concept
- and an electricity cost reduction of about 38%

Next-CSP aims to demonstrate the validity of the fluidized particle-in-tube (PIT-CSP) concept atop the THEMIS solar power tower in France, at large prototype scale (TRL5). A 3-MWth tubular solar receiver able to heat particles up to 650-750°C is being tested, as well as the rest of the conversion loop (a two-tank particle heat storage and a particle-to-pressurized air heat exchanger coupled to a 1.2 MWel gas turbine). The full system is being tested and evaluated in 2021, paving the way for future prototype demonstration and commercial development.
A collaborative project funded by the European Union

The Next-CSP project has been supported by Horizon 2020, the European Union’s Framework Programme for Research and Innovation. It was funded by the “Secure, clean and efficient energy” programme, under the specific topic “Developing the next generation technologies of renewable electricity and heating/cooling” (LCE-07-2016-2017).

TOTAL BUDGET € 4,947,420

EU CONTRIBUTION € 4,947,420

CONSORTIUM 10 Partners 5 Countries

COORDINATOR CNRS-PROMES France

DURATION 58 Months from Oct. 2016 to July 2021
Main innovations and results of the project

**SOLAR RECEIVER**
- Develop an innovative solar receiver using fluidized particles that circulate in 40 solar irradiated tubes at pilot scale,
- Manufacture a 3 MWth solar receiver and test it in a wide range of operation parameters, develop and integrate a new technology into CSP plants.

**HEAT TRANSFER FLUID**
- Use particle as heat transfer fluid (HTF) instead of molten salt in solar power tower and develop the adapted solar receiver (new product),
- Increase the HTF temperature by about 200°C,
- Identify the main limitations of the fluidized particle-in-tube technology (PIT-CSP technology) with respect to the scaling-up issues and propose solutions to overcome them.

**STORAGE**
- Use the same solid particles used as HTF to store thermal energy in a close loop without dust emission,
- Increase the storage capacity of the two-tank thermal energy storage (TES) by increasing the temperature difference between the hot and cold tanks: about 400°C instead of 270°C for molten salt,
- Prove and identify the issues related to the storage technology principle, in particular the hot particles handling and conveying.

**POWER BLOCK**
- Design and test a multistage fluidized bed heat exchanger that transfers the energy from the particles to the working fluid,
- Construct a 2.5 MWth particle-to-pressurized air fluidized bed heat exchanger and assess its performance,
- Operate a solarized 1.2 MWel gas turbine in hybrid mode

**INTEGRATION**
- Integrate the particle loop (solar receiver + TES) with the energy conversion loop (particle heat exchanger + hybrid gas turbine) in a single industrial pilot,
- Measure the performance of the complete system at Themis solar tower,
- Design a commercial scale (150 MWel) power plant on the basis of the technology and estimate the cost,
- Identify the main bottlenecks for large-scale development of the particle-in-tube technology (PIT) technology,
- Analyse the environmental impact of the technology and compare it to the state-of-the-art.

Impacts of the project

- **CSP TECHNOLOGY PERFORMANCE**
  - The project prepares the next generation of CSP plants with high performance thermodynamic cycles at temperature higher than 650°C. 50% efficiency is targeted by comparison with 42% for state-of-the-art CSP technology.

- **REDUCTION OF CO2 EMISSION**
  - While operating, CSP is a CO2 free technology that can produce dispatchable electricity. The project features a 40% emissions reduction target.

- **COMPETITIVENESS AND INCREASE OF SOLAR ENERGY USE**
  - The Next-CSP technology provides optimised dispatchability thanks to thermal storage at reasonable cost. The cost target is about 80 €/MWhel (LCOE) in 2030. This cost depends on the operation mode of the plant, higher costs are acceptable for a plant operating as a peaker.

- **REDUCTION OF OPERATIONAL COSTS**
  - The heliostat field accounts for about 40% of the CAPEX (Capital expenditure) and OPEX (Operating expense) of a solar tower power plant. This field be downsized by 20% thanks to the increased conversion efficiency thus reducing considerably the CAPEX.

- **INCREASING THE RELIABILITY AND LIFETIME OF CSP PLANTS**
  - The project prepares the next generation of CSP plants with high performance thermodynamic cycles at temperature higher than 650°C. 50% efficiency is targeted by comparison with 42% for state-of-the-art CSP technology.
Communication and dissemination material

PRINT MATERIAL

- The Next-CSP Brochure: a 12-page publication with key information – objectives, innovations, impact and expected results – about the project. Available for download [here](#).
- The Next-CSP Flyer: all you need to know about the project in a nutshell! Available for download [here](#).
- The Next-CSP Timeline: the key achievements and milestones of the project in 12 key dates. Available for download in [PDF](#) and [JPG](#).

VIDEOS

- The Next-CSP Video (02:48) produced in 2021, with takes from the Themis solar tower in France and a testimony of Next-CSP coordinator Gilles Flamant (CNRS-PROMES). Watch [here](#).
- An animated video explaining the principles of the Next-CSP solar thermal power plant. Watch [here](#).
- An animation of the Themis solar field simulation and interaction with the solar receiver. Watch [here](#).
- An animated video of the Heliostat optical optimisation. Watch [here](#).

INTERVIEWS OF THE NEXT-CSP PARTNERS

- Jean-Florian Brau, EDF R&D (France). Watch [here](#).
- Miguel Reyes, IMDEA Energy Institute (Spain). Watch [here](#).
- Renaud Ansart, INP Toulouse (France). Watch [here](#).
- Raf Dewil, KU Leuven (Belgium). Watch [here](#).
- Ken Whittaker, Whittaker Engineering (UK). Watch [here](#).

EVENTS

- The Next-CSP Online Workshop, organised on 16 June 2021. In the [programme](#), an overview of the achievements of the project, its technology and the commercial perspectives by 4 Next-CSP partners. You can watch the replay of the webinar on [YouTube](#).
- The Workshop “Dispatchable Renewable Energies: From a Myth to Reality”, organised on 6 June 2018 in Edinburgh (UK). Discover the [programme](#) and [download the presentations](#).

VISUALS

- The Next-CSP Logo available for download [here](#).
- Discover a selection of pictures related to Next-CSP ready to use for publications. Download the image file [here](#).

All the communication material are also available on the Next-CSP Website: [http://next-csp.eu/dissemination/communication-materials/](http://next-csp.eu/dissemination/communication-materials/)

You can also watch all the videos related to Next-CSP on the “Next-CSP - Horizon 2020 Project” playlist on YouTube: [https://youtube.com/playlist?list=PLBNLB4hteTtKGDzjPDaaB8ddXMwvYt75](https://youtube.com/playlist?list=PLBNLB4hteTtKGDzjPDaaB8ddXMwvYt75)
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<tr>
<th>Title</th>
<th>Partner Authors</th>
<th>Published in / DOI</th>
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<tr>
<td>Aiming Strategy on a Prototype-Scale Solar Receiver: Coupling of Tabu Search, Ray-Tracing and Thermal Models</td>
<td>CNRS</td>
<td>Sustainability 2021, 13(7), 3920 <a href="https://doi.org/10.3390/su13073920">https://doi.org/10.3390/su13073920</a></td>
</tr>
<tr>
<td>Shaping High Efficiency, High Temperature Cavity Tubular Solar Central Receivers (Not in Open Access)</td>
<td>CNRS</td>
<td>Energies 2020, 13(18), 4803 <a href="https://doi.org/10.3390/en13184803">https://doi.org/10.3390/en13184803</a></td>
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<td>Computation of canting errors in heliostats by flux map fitting: experimental assessment</td>
<td>CNRS</td>
<td>Optics Express Vol. 28, Issue 26, pp. 39868-39889 (2020) <a href="https://doi.org/10.1364/OE.412116">https://doi.org/10.1364/OE.412116</a></td>
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<td>Flexible electricity dispatch for CSP plant using unfired closed air Brayton cycle with particles based thermal energy storage system</td>
<td>IMDEA</td>
<td>Energy 173 (2019) 971-984 <a href="https://doi.org/10.1016/j.energy.2019.02.135">https://doi.org/10.1016/j.energy.2019.02.135</a></td>
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<tr>
<td>Particles in a circulation loop for solar energy capture and storage (Not in Open Access)</td>
<td>KU LEUVEN CNRS EPPT</td>
<td>Particuology 43 (2019) 149-156 <a href="https://doi.org/10.1016/j.partic.2018.01.009">https://doi.org/10.1016/j.partic.2018.01.009</a></td>
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<tr>
<td>High-efficiency solar power towers using particle suspensions as heat carrier in the receiver and in the thermal energy storage (Not in Open Access)</td>
<td>CNRS EPPT</td>
<td>Renewable Energy 111 (2017) 438-446 <a href="https://doi.org/10.1016/j.renene.2017.03.101">https://doi.org/10.1016/j.renene.2017.03.101</a></td>
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<td>Bubbling and Slugging of Geldart Group A Powders in Small Diameter Columns (Not in Open Access)</td>
<td>EPPT CNRS</td>
<td>Ind. Eng. Chem. Res. 2017, 56, 14, 4136–4144 <a href="https://doi.org/10.1021/acs.iecr.6b04798">https://doi.org/10.1021/acs.iecr.6b04798</a></td>
</tr>
<tr>
<td>Experiments support an improved model for particle transport in fluidized beds</td>
<td>KU LEUVEN EPPT CNRS</td>
<td>Sci Rep 7, 10178 (2017) <a href="https://doi.org/10.1038/s41598-017-10597-3">https://doi.org/10.1038/s41598-017-10597-3</a></td>
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The list and all the abstracts of the Next-CSP publications are available on our Website: [http://next-csp.eu/documents/scientific-productions/](http://next-csp.eu/documents/scientific-productions/)
Conference Proceedings

SolarPACES 2017

- Fluidized particle-in-tube solar receiver and reactor: A versatile concept for particulate calcination and high efficiency thermodynamic cycles (CNRS) | https://doi.org/10.1063/1.5067053
- Optimization of an integrated solar combined cycle (IMDEA) | https://doi.org/10.1063/1.5067214
- Particles-based thermal energy storage systems for concentrated solar power (IMDEA) | https://doi.org/10.1063/1.5067215

SolarPACES 2018

- Application of un-fired closed Brayton cycle with mass flow regulation and particles-based thermal energy storage systems for CSP (IMDEA) | https://doi.org/10.1063/1.5117559
- Scale-up considerations of the UBFB solar receiver (CNRS, EPPT) | https://doi.org/10.1063/1.5117579
- Optimization of a decoupled combined cycle gas turbine integrated in a particle receiver solar power plant (EDF) | https://doi.org/10.1063/1.5117655
- The fluidized bed air heat exchanger in a hybrid Brayton-cycle solar power plant (CNRS, EPPT) | https://doi.org/10.1063/1.5117650

SolarPACES 2019

- Application of SbpRAY for simulation and optimization of a heliostat field and cavity receiver (SBP) | https://doi.org/10.1063/10.0030257
- Hybrid optical method for characterizing a heliostat field in a concentrated solar power plant (CNRS) | https://doi.org/10.1063/10.0029270
- Particle flow and heat transfer in fluidized bed-in-tube solar receivers (CNRS) | https://doi.org/10.1063/10.0028761
- Integrated solar combined cycle using particles as heat transfer fluid and thermal energy storage medium for flexible electricity dispatch (IMDEA) | https://doi.org/10.1063/10.0029297

SolarPACES 2020

- The Conference Proceedings for the 2020 edition have not been published yet. However, Next-CSP presented 5 papers as well as a poster. More information here.

International Conference on Environment Science and Engineering (ICESE 2020)


Next-CSP in the media

**European Commission – CORDIS Results Pack (September 2020)**
Fluidised particles turn up the heat in a novel solar power design. [LINK](#)

**CSP Focus (May 2018)**
The assembly of the Next-CSP pilot solar loop at the Themis solar tower started end of April 2019. [LINK](#)

**China Solar Thermal Alliance (May 2018)**
NEXT-CSP pilot solar loop will be ready soon, using 800°C particles as heat transfer and storage medium. [LINK](#)

**HELIoCSP – Solar Thermal Energy News (November 2017)**
A breath of fresh air for concentrated solar power. [LINK](#)
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