NEWSLETTER

January 2026 | No. 2

The ASTERIx-CAESar project is a Horizon Europe funded project that started in October 2023.

The project's main goal is to develop a novel **high-efficiency solar thermal power plant** concept with an integrated electricity **storage solution**.

In this issue

Dear readers,

Happy new year 2026!

Our project recently celebrated its second anniversary, and it is already one year since we published our first newsletter. Therefore, we are proud to share with you the impressive progress we made during last year.

We have fully developed the simulation methodology to optimise the project power plant concept in work package 1 (WP1).

WP2 focused last year on numerical simulation of different sizes of solar absorbers.

WP3 completed activities related to low- and high-temperature heat exchanger design.

WP4 continues to advance the development and optimisation of the key turbomachinery and power cycle subsystems of ASTERIx-CAESar.

In WP5, among other activities, we continued developing the AI-enabled tracking system.

WP6 made an important progress in CAPTure prototype modifications for our project purpose.

You can read more about these developments and much more inside our newsletter. Have a good read and stay tuned for more project news!

Let us know if you have any questions – we are always happy to hear from you.

ASTERIx-CAESar team

Funded by the European Union

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ASTERIx-CAESar update

WP1 – Concept definition and Techno-economic Optimisation

The main activities can be divided into two areas:

1. Definition and optimisation of the ASTERIx-CAESar power plant concept

We have fully developed the simulation methodology to optimise the project power plant concept during 2025. The thermodynamic optimisation was published in a journal article: [Baigorri et al.](#) (2025). Further on, we continued with the techno-economic optimisation of the system, determining the optimum nominal discharging power rating, which was found to be at around 100 MWe. This power rating has been selected as reference case and is also input for the turbomachinery design study in WP4. Currently, the developed simulation and optimisation methodology is applied to the ASTERIx-CAESar use cases with the objective to optimise the project concept for different specific application cases around the world.

2. Definition of the ASTERIx-CAESar project's prototypes

Experimental testing is implemented at different scales. Small solar absorbers (12x12 cm) have been tested in the solar furnace at CIEMAT-PSA. These tests are now completed, and results are available to the consortium. Currently, larger absorber samples (25x25 cm) are being tested at the solar tower at IMDEA. Finally, during the last project year, a 300 kWth receiver with approximately 1 m^2 of aperture area will be tested at a solar tower at CIEMAT-PSA. This receiver will power a hot air turbine that will be connected to a small-scale CAES unit, providing between 1 or 2 hrs of nominal turbine mass flow. At the beginning of 2025, the prototype was fully specified, and all new components were ordered during 2025. Currently, the final project prototype (Fig. 1) is under construction and is planned to be operational at the end of 2026.

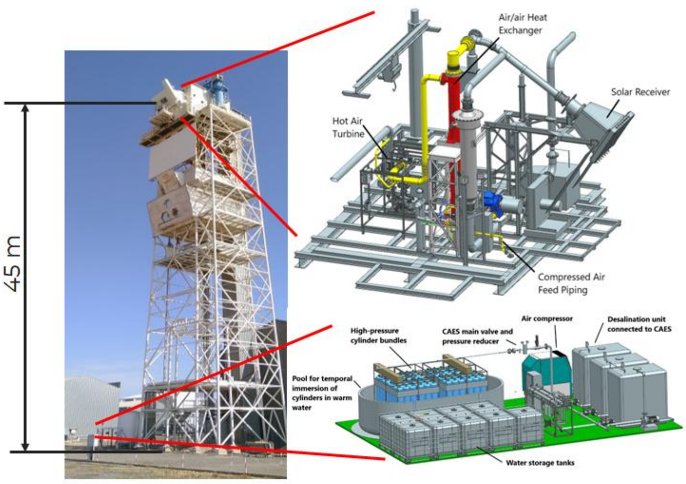

Figure 1: ASTERIx-CAESar prototype at CIEMAT-PSA

WP2 – Solar Receiver Development

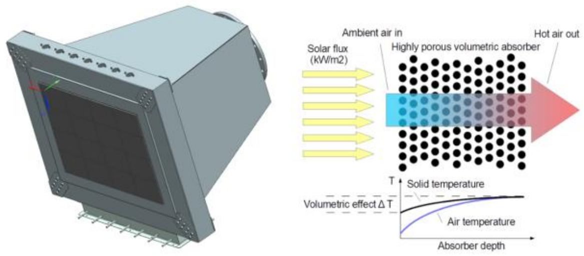

Figure 2: ASTERIx-CAESar solar receiver prototype

During 2025, large effort was spent on the numerical simulation of different sizes of solar absorbers. The project applies ceramic foam as solar absorber material (developed by Fraunhofer IKTS). The objective is to increase the solar absorber module size to reduce costs. Computational Fluid Dynamic (CFD) simulations and mechanical Finite Element Method (FEM) simulations were done at CENER, CIEMAT, as well as Fraunhofer IKTS to estimate thermal stress and to be able to select the most suitable absorber geometry. To obtain a conclusion, these numerical results will have to be supported by experimental tests of a large-size absorber, which is currently underway.

Apart from the question of absorber size, the local air mass flow adjustment to obtain a homogeneous air outlet temperature has been addressed via CFD simulations. Suitable orifice diameters have been determined for the final receiver prototype (Fig. 2). Furthermore, the absorber module and receiver geometry has been designed and optimised considering an advanced ceramic composite material (developed by Walter E.C. Pritzkow Spezialkeramik) for the receiver modules and module supporting structure. During 2025, the complete design of the ASTERIx-CAESar receiver prototype has been finished and the manufacturing is planned to be completed by summer 2026. In parallel, the consortium is working on the receiver upscaling, finding the most cost-effective solution for MW-scale high-temperature heat supply (up to about 800°C).

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WP3 – Advanced Heat Exchangers

Activities "Low-temperature heat exchange design (reuse of heat of compression)" and "High-temperature heat exchanger design (heat input in power cycle)", have been completed and the related deliverables were submitted to the EC.

In 2024, activities were mainly focused on medium- scale plant (20 MW). During 2025, also small- and large-scale plants (1 MW and 100 MW, respectively) have been taken into consideration.

Both regenerative and recuperative approaches have been addressed. The regenerative approach has proven its feasibility only for small-scale plant, due to the maximum size of commercially available crucial components. Concerning the recuperative approach, the design has been carried out by applying two different concepts: the traditional one based on shell-and-tube heat exchangers and an alternative concept based on the Heat Recovery Steam Generator (HRSG) technology commonly used in Gas-Steam Combined Plants. See the sketch of the first intercooler designed according to the two different concepts (Fig. 3) as an example.

For low temperature applications, the HRSG based design has led to a heat transfer area reduction in the order of 20-30% in respect the shell-and-tube one. For high temperature applications, however, no relevant savings in terms of heat transfer area are found. The HRSG approach shows a better performance in terms of reduced pressure losses on both hot and cold side and reduced capital cost. Actually, capital cost savings of approx. 20-30% have been estimated for low and high temperature heat transfer equipment. In conclusion, the achieved outcomes make the design approach based on the HRSG technology preferable.

Present activities are aimed at completing the task "Process control challenges (system level)", in February 2026. The task focuses on the identification of control issues and control policies to ensure safe and efficient plant operations.

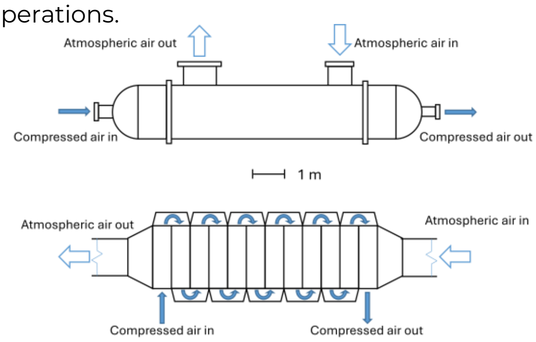

Figure 3: Sketch (in scale) of the first intercooler design: Shell&Tube based approach (upper), HRSG based approach (lower)

WP4 – Advanced CAES and power cycle development and Optimisation

WP4 continues to advance the development and optimisation of the key turbomachinery and power cycle subsystems of ASTERIx-CAESar. It addresses three tightly coupled areas: the compression train used during charging, the expansion train converting stored mechanical and thermal energy into electricity during discharge, and the bottoming cycle recovering residual heat downstream of the expanders.

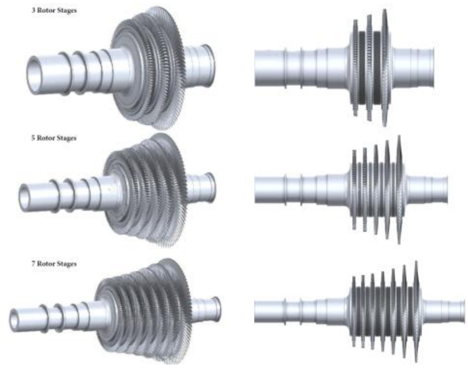

Figure 4: Low-pressure turbine flow path 2D meridional view (three, five and seven stages)

On the compression side, the University of Seville has progressed from preliminary casing design towards the development of dedicated mean-line design tools for multistage centrifugal compressor trains. These tools enable systematic exploration of design trade-offs between efficiency, operational flexibility and mechanical complexity, allowing cost-effective compressor configurations to be identified for different charging power levels and market-driven charging strategies.

Bluebox Energy has further developed and optimised the small-scale expansion train concept. The ongoing work focuses on identifying the most effective combination of expansion and reheat stages, with the aim of maximising performance while preserving modularity and controllability. At large scale, Doosan Škoda Power and SoftInWay have investigated alternative integration schemes for the high- and low-pressure axial turbines. Two discharge strategies have been analysed: constant-pressure operation, as implemented in existing CAES plants, and sliding-pressure operation starting from higher inlet pressures, which largely eliminates the need for throttling during discharge.

A key optimisation parameter emerging from this work is the inlet pressure to the low-pressure turbine, which directly governs the balance between expansion power and the heat recovery potential available to the bottoming cycle. To address this system-level challenge, two complementary actions have been undertaken within WP4.

First, SoftInWay has developed a portfolio of turbine designs with different numbers of stages, enabling adaptation to a wide range of inlet pressures (Fig. 4). Second, the interaction between the expansion train and the bottoming cycle has been analysed in detail. In this context, the University of Seville and CENER have published a joint study assessing organic and steam-based bottoming cycle solutions for different expander exit temperatures and power scales. The outcomes of these activities can be directly used as inputs to system-level optimisation platforms.

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WP5 – Automatization and improved plant operation and monitoring via AI methods

This work package addresses three main activities:

1. **Development of advanced AI-based high-accuracy aiming strategies.** To preserve the integrity of volumetric solar receivers, a homogeneous incident flux distribution is essential. IMDEA has generated several databases of heliostats' facets of its own solar field including ideal and laser-scanned geometries. These data enabled the creation of detailed, realistic flux-map distribution on the solar receiver area, which were used by CENER to train and test new aiming-point strategy methodologies. Selected aiming strategies will be validated experimentally at IMDEA's solar tower.

2. **Development of a reliable fiber-optic-based sensor system for measuring concentrated solar flux and receiver temperature distributions.** University of Seville (USE) has completed the damage assessment of fibers exposed to high radiation experiments at IMDEA's 42 kWe solar simulator using SEM microscopy. These results have been presented in a paper and several international conferences. USE has also conducted a new measurement campaign at CENER to evaluate optical fibers as DNI sensors and for concentrated flux characterisation under the high-flux solar simulator. Engionic, USE and IMDEA are developing new methods to mitigate thermally induced damage and increase the fibers' numerical aperture.

3. **AI-based heliostat tracking control for low-cost operation.** CIEMAT-PSA has continued developing the AI-enabled tracking system. The SCADA control and communication infrastructure has been upgraded to support smart heliostat deployment. Images are still being captured every 15 minutes, expanding the training dataset to more than 10,000 images. Preliminary tests highlight the need for greater algorithm robustness and improved model accuracy. Current efforts are focused on refactoring and enhancing the control software (resulting in a faster and more reliable system) and improving the AI for image-based object detection, yielding higher detection accuracy.

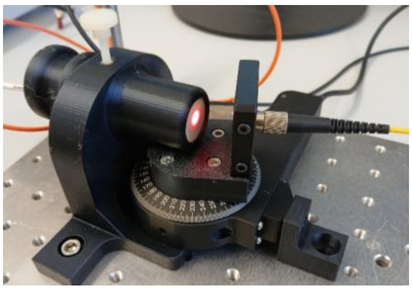

Figure 5: Measurement device for optical characterisation of diffusors to be attached to the optical fibers.

WP6 – Validation & Demonstration of receiver and power cycle

Figure 6: Solar tower facility at IMDEA and absorber test bench (right)

The work package is aimed at validating the concept under real-world conditions, as well as the testing absorber samples at smaller scales. The solar furnace testing of the receiver prototypes (10 kW thermal) at CIEMAT-PSA has been completed. The thermal performance of the absorber samples is now available for the consortium. As a next step, large-size 25 x 25 cm absorber samples are currently being tested at the tower of IMDEA in Madrid (Fig. 6).

In parallel, since the start of the project, modifications to the CAPTure prototype have been underway with the objective of integrating a small-scale CAES system into the existing solar-driven hot air turbine. In addition, to ensure reliable operation of the prototype, the original CAPTure regenerative system has been replaced with a conventional shell-and-tube heat exchanger.

During 2025, all new components were ordered and manufactured, including the aforementioned heat exchanger (Fig. 7), the small-scale CAES system (comprising bundles of industrial gas storage cylinders (Fig. 8)) as well as various valves and pressure regulators. The CAPTure hot air turbine was shipped to the facilities of Bluebox Energy, where it was modified and tested (iFAT – internal Factory Acceptance Testing). All components and subsystems are now available at CIEMAT-PSA and are currently being installed on the tower to complete the final ASTERIx-CAESar prototype.

Figure 7: New air-air shell-and-tube heat exchanger

Figure 8: High-pressure cylinder bundles at CIEMAT-PSA

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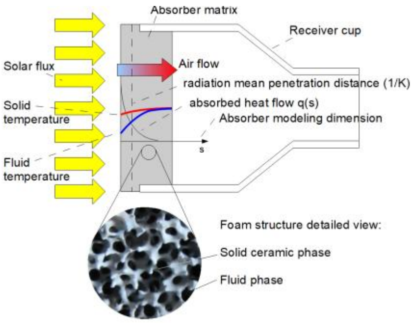
Interview with ASTERIx-CAESar partners – Fritz Zaversky (CENER) and Ricardo Conceição (IMDEA Energy)

Which type of solar receiver does the ASTERIx-CAESar project develop?

Fritz Zaversky (CENER)

Fritz: The ASTERIx-CAESar project develops a volumetric air solar receiver that is designed to heat ambient air to high temperature (up to about 800 °C). The working principle is very simple and can be compared to a hairdryer. A highly porous ceramic material is heated by concentrated solar radiation. The concentration of the sunlight is reached by focusing many mirrors on a very small spot, the location of the receiver aperture. At the same time, the heated ceramic material is cooled by ambient air that is forced through the fine pores of the material (see Fig 2 on page 2). In this way, the ambient air is heated to very high temperatures. The ASTERIx-CAESar project applies ceramic foam as solar absorber material (developed by Fraunhofer IKTS) and a highly resistant ceramic composite material (developed by Walter Pritzkow Spezialkeramik) as absorber holding and air flow guiding element (a so-called "cup" as shown in Fig. 9). The ASTERIx-CAESar receiver can be up-scaled in a simple manner and is suitable for renewable heat supply up to about 800 °C, from kW to MW scale. The application ranges from process heat supply to power generation.



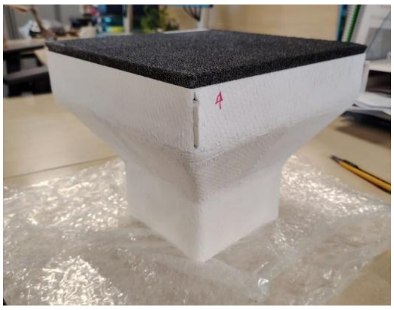


Figure 9: Solar absorber – the "cup"

What is the solar facility at IMDEA and how does it operate?

Ricardo Conceição (IMDEA Energy)

Ricardo: The solar facility at IMDEA (Fig. 10), named Very High Concentration Solar Tower (VHCST), is a unique facility offering a testing environment for components and devices under extremely high solar fluxes. It features a customized heliostat field which employs the latest advancements in small-sized heliostats and a tower with a reduced optical height of 18 meters to minimize visual impact. The heliostat field, with a capacity of 250 kWth and a reflective surface area of 500 m², consists of 169 small heliostats (1.9x1.6 m). When all heliostats are aligned, it achieves a specified flux above 2500 kW/m² for at least 50 kW with an aperture of 16 cm, and a peak flux of 3000 kW/m². The solar field is easily operated through a dedicated SCADA system.

Figure 10: The solar facility (VHCST) at IMDEA

Read the entire interview here

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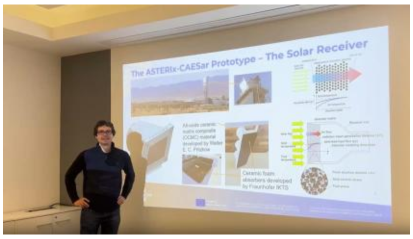
Project management

Meetings

The second General Assembly took place on 18 and 19 November 2025 in Pilsen, Czech Republic, hosted by our partner Doosan Škoda Power.

Apart from progress reporting presentations, we took part in a guided tour to the workshop and the experimental hall.



As a part of the GA, two videos were produced:

- Fritz Zaversky (CENER) talking about the ASTERIx-CAESar prototype;
- Tereza Kubíková (Doosan Škoda Power) explaining similarities between a turbine being developed for our project and a back pressure, multistage turbine developed by her company in 1927.

Click here to access both videos.

ASTERIx-CAESar on the stage

- Genera – International Week of Electrification and Decarbonisation (18-20 November 2025, Madrid, ES) – project dissemination
- IGTC – International Gas Turbine Conference (14-15 October 2025, Brussels, BE) – project expo
- SolarPACES (23-26 September 2025, Almería, ES) – project presentations and posters
- 80th ATI Annual Congress (10-12 September 2025, Benevento, IT) – paper presentation
- ECerS 2025 (31 August – 4 September 2025, Dresden, DE) – lecture
- Optica Sensing Congress 2025 (20-24 July 2025, Long Beach, California, US) – presentations and a poster
- OPTOEL 2025 (2-4 July 2026, Terrassa, ES) – posters
- New trends in CSP technologies , Politecnico di Torino (1-3 July 2025, Torino, IT) – course
- ASME Turbo Expo (16-20 June 2025, Memphis, US) – paper presentation, panel session, poster presentation, tutorial of basic, committee meeting, expo
- Solar Concentration Technologies for Flexibility on the Production Side (9 June 2025, online) – project presentation
- Joint workshop EERA (13-14 May 2025, Madrid, ES) – poster
- ETN Global's AGM and Workshop (15-27 March 2025, Bergen, NO) – EU projects panel session, expo

Only recent events are listed. See them all here → Read more

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Our scientific papers

Journal of Engineering for Gas Turbines and Power (January 2026)

- Multi-Objective Optimization of Expansion Trains in CAES: Incorporating Organic Rankine Cycles for Improved Efficiency

Journal of Physics (December 2025)

- Heat Transfer Equipment for a Compressed Air Energy Storage (CAES) Integrated with a Concentrated Solar System

SolarPACES (September 2025)

- Evaluation of a Hybrid CAES-Reverse Osmosis Plant Driven by Concentrated Solar Power
- CFD Analysis of an Open Volumetric Air Receiver and Comparison with 10 kWth Solar Tests
- Hydrodynamic, Thermal and Optical Evaluation of Ceramic Foam Solar Absorbers
- Advancing Heliostat Aiming Strategies in Solar Tower Plants

Sensors (August 2025)

- Optical Fiber Performance for High Solar Flux Measurements in Concentrating Solar Power Applications

Optica Sensing Congress (July 2025)

- Evaluating Fiber Bragg Grating Technologies for High Temperature Sensing in Concentrated Solar Power Plants
- Damage in Optical Fiber-based Sensors in Extreme Environments For High Flux Solar Measurements
- Concentrated Solar Flux Measurement in a High Flux Solar Simulator Using an Optical Fiber-Based Radiometer

Optoel (July 2025)

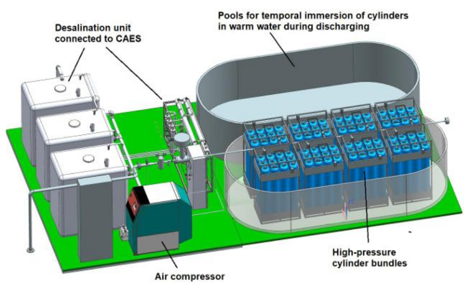
- Evaluation of FBGs as high-temperature sensors in concentrated solar power applications
- Using Semiconductor Photodiodes as Detector Element for Solar Radiation Measurements
- Concentrated solar flux measurement in a solar simulator, based on optical fiber and photodiode

Journal of Energy Storage (July 2025)

- Modeling of an innovative integration of compressed air energy storage (CAES) with high-temperature concentrated solar power (CSP): A comprehensive use-case study

Only recent papers are listed. See all of them here → Read more

Public deliverable available online



Our first public deliverable "*Specifications of the ASTERIx-CAESar prototypes*" was made available in February 2025.

More public deliverables will be out very soon.

Read the whole document here → Read more

ASTERIx-CAESar in the media

Our project appeared in Horizon – The EU Research & Innovation Magazine in March 2025. Michael Allen interviewed Fritz Zaversky (CENER) and David Sánchez (University of Seville).

Read the whole article here → Read more

Horizon
The EU Research & Innovation Magazine

From sunlight to stored power: how hot air could solve solar energy's biggest challenge

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Find more information about us!

- The project website 🌍 is accessible via the link www.asterix-caesar.eu and is regularly updated
- Our leaflet, poster, roll-up, and the public presentation are available for download here
- Check out our official project video as well as other short films on our YouTube channel
- Follow us on social media: LinkedIn

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