SUNSON

NEWSLETTER | N°2 | JUNE 2025

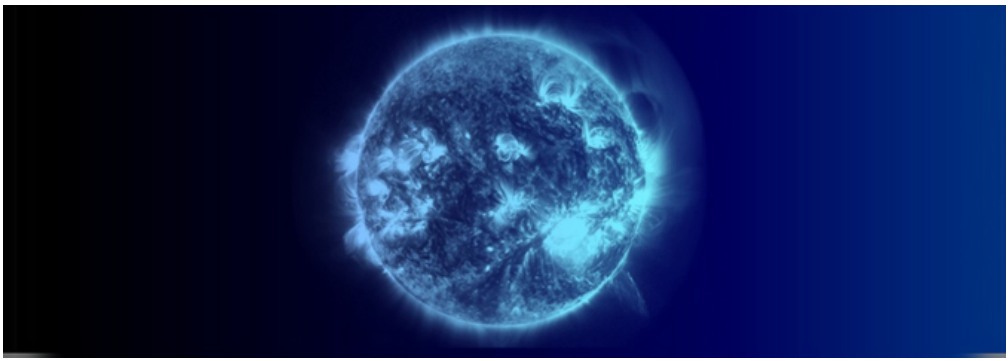
Progress of the project

CONTENT

Words from the coordinator

On behalf of the SUNSON consortium, I'm pleased to introduce our second newsletter. As we begin the third year of the project, we've entered a critical phase. Key components of the system—such as the silicon-based phase change materials and the thermophotovoltaic (TPV) converter—are being finalized, and we are preparing to integrate them into a full demonstrator that will be tested under concentrated sunlight.

Over the past year, we've achieved several key milestones. We filed two patents based on the system's conceptual design and initial modeling. Following an evaluation of more than 800 metallic alloys, we selected two final candidates to serve as the phase change materials in the demonstrator. Both materials provide latent heat storage capacities exceeding 1 MWh per cubic meter and operate at melting temperatures above 1200°C. Our TPV cells have now demonstrated more than 25% efficiency in converting heat to electricity. Work is ongoing to further improve technology performance and scale up production.



Key advances in technology and collaboration

Meanwhile, the complete final prototype, along with the optical system for sunlight concentration and beam splitting, is currently being manufactured and will soon undergo testing under real outdoor solar conditions**.** We've also completed the first phase of development of a Decision Support System (DSS) to evaluate the scalability of the SUNSON system. The DSS is already providing valuable performance predictions through AI-based algorithms for energy forecasting and physics-based models. In parallel, we've finalized a life cycle inventory, which will be used to assess the environmental and economic impacts of the technology.

We've continued to engage actively with the broader community. Over the past year, we held two in-person project meetings—first in Seville, Spain, and later in Porto, Portugal. We also organized our first stakeholder event during the 15th World Conference on Thermophotovoltaic Generation of Electricity in Madrid, where we connected with more than 100 experts from research and industry working on ultra-high-temperature energy storage and conversion.

Our goal remains ambitious: to develop the world's highest-temperature concentrated solar power (CSP) system, combining advanced thermal energy storage with solid-state energy conversion. With this innovation, we aim to help enable clean, efficient, and dispatchable solar power for the future.

Alejandro Datas

SUNSON video

"Sun's Son" aims to store solar energy with temperatures in excess of 1200ºC.The project aims to promote a new generation of highly compact and efficient CSP plants in order to create a more flexible renewable energy sector. To meet this challenge, the proposed solution combines solar concentrators with advanced optics, advanced phase change materials (PCMs) for thermal storage, and thermophotovoltaic converters for electricity generation in a single system. If you want to know more, check **our project video.**

Our mission

SUNSON outcomes pursue a technological breakthrough in compact Concentration solar power and Renewable Energy Sources conversion to generate electricity with a modular and scalable approach to increase its efficiency and cost-effectiveness. Operating at ultrahigh temperatures (>1200ºC) provides higher efficiency ratios in converters and it is of particular interest for latent heat storage systems, as they offer up to 10 times the storage capacity of current molten salt-based storages at arround 600ºC, resulting in a decrease of 10 times the overall system size and reducing the scale-size associated costs.

Main technical achivements since M12

- **Conceptual design of the SUNSON-Box**: The final design configuration and sizing, as well as the CAD documentation, were completed under the leadership of the technology partners, who obtained two patents.

- **Solar radiation simulation**: PSA-CIEMAT has carried out not only the definition of the"solar-to-heat" component, but also the radiation modeling in both the solar furnace and the absorbers of the SUNSON-Box prototype.

- **Advanced PCM development**: NTNU has explored and characterised promising phase-change materials (PCMs) and investigated pre-oxidation protection strategies before selecting two Fe-Si alloys for final evaluation.

- **Multiphysics modeling of the PCM-TES system**: IDENER.AI has conducted simulations to evaluate the system behavior and explore enhancement techniques for the design, as well as develop the optimization model of the SUNSON-BOX operation strategy.

- **Innovative TPV cells**: UPM has manufactured TPV cells capable of operating under high-temperature irradiance, a key component in the design and manufacture of the complete TPV module.

- **Research ethics and gender seminar**: HOLOSS organized a seminar for the consortium aligned with European R&I best practices.

- **LCA and LCC review**: HOLOSS compiled an updated literature review based on the ORIENTING approach, and recently submitted the mid-term LCA-LCC analysis.

- **Exploitation, dissemination, and communication plan**: Developed by IDENER.AI, this plan is ready to support the project's visibility and outreach activities.

Progress in the project milestones

CSP innovations for modular system design

- CIEMAT-PSA (MS5): Optical design, modeling, system configuration, and prototype adaptation for the SUNSON-Box.
- Preliminary testing results of the CSP optical system still in the process of acquisition and assembly of the hardware (D3.1).

PCM and container materials

- NTNU (MS6): Selection of the most promising PCM alloys operating in the 1200-1400ºC range (D3.5), and validated their interaction with crucible materials (D3.6 and D3.8). Crucibles and PCMs have already been sent to the testing facilities in Almeria.

Thermophotovoltaic conversion

- UPM (MS7): Manufacturing of TPV cells (D4.1) and continuing with design and development of the full TPV module and module characterization.
- IONVAC (WP4): Development of the SUNSON-Box emulator (D4.2).

SUNSON modeling and simulations

- IDENER.AI (MS8): Integration of validated models and algorithms for coupling energy generation and demand (D2.3), and development of the optimization governing the operational strategy (D2.4).

System deployment and demonstrators

- IONVAC: Engineering of pilot line integration (D5.1) including different components, starting with PCM-TES system.
- CIEMAT (MS11): First steps in the installation and commissioning of the SUNSON flagship demonstrator.

Sustainability and techno-economic analysis

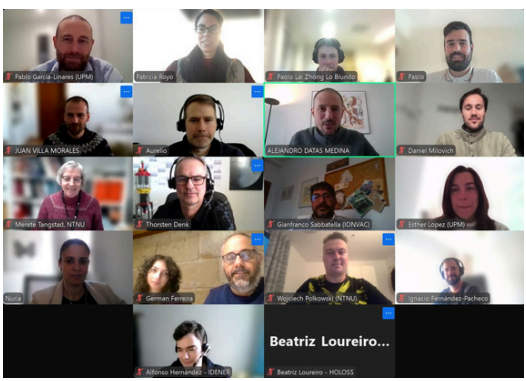
- HOLOSS organised the data collection by means of Life Cycle questionnaries at TRL4 completed by the partners for Sustainablity analyses (MS10).

Past & Upcoming events

2nd Consortium Meeting
24th January 2024 , Seville

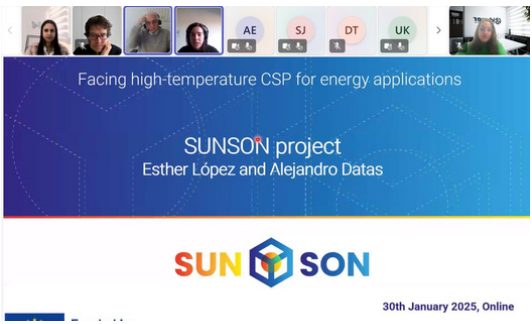
1st Review Meeting & 3rd Consortium Meeting
26th-27th June 2024, Porto

TPV-15 and UHTES-2 Hybrid Conference
1st-3rd October 2024, Madrid



3rd Consortium Meeting
14th January 2025 , Online

Past & Upcoming events



CSP Sisterhood Community internal workshop
30th January 2025, Online

What´s next?

- **5th Consortium Meeting** - 23th June, Italy
- **2nd Review Meeting** - 24th June, Italy
- **EUROMAT 2025 -** 14th September 2025, Spain

And more to come!

Don't forget to follow us on all our social media so you don't miss any of the events we attend.

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@sunson-project

Sisterhood projects

THERMOBAT

High-temperature TES SISTERHOOD

Storing sunshine and wind to make cheap energy available at all times

The Thermobat project will develop the first latent heat thermophotovoltaic battery to store large amounts of renewable energy.

www.thermobat.eu

ABraytCSPfuture

CSP SISTERHOOD High-temperature TES SISTERHOOD

Air-Brayton cycle Concentrated Solar Power future plants via redox oxides based structured thermochemical heat exchangers/thermal boosters

Carbon-neutral innovation to enhance future Concentrated Solar Power (CSP) plants by incorporating more efficient air-Brayton gas turbine cycles.

www.abraytcspfuturefuture.eu

ASTERIX CAESAR

CSP SISTERHOOD High-temperature TES SISTERHOOD

Air-based Solar Thermal Electricity for Efficient Renewable Energy Integration & Compressed Air Energy Storage

Combines air-based central receiver CSP and Compressed Air Energy Storage to maximize conversion efficiency and power grid energy management.

www.asterixcaesar.eu

Sisterhood projects

Breakthroughts in thermaL bAtteries through Zero-Emission high-temperature static Thermal-to-Electric Converters
Hybrid solid-state converters for ultra-high temperature thermal batteries Innovative solutions for the storage and the conversion of heat

www.blazetec.eu

High-Temperature Thermochemical Heat Storage Powered by Renewable Electricity for Industrial Heating Applications
Novel breakthrough approach towards thermal energy storage of surplus renewable energy via a hybrid thermochemical/sensible heat storage concept

www.project-hercules.utwente.nl

Leading-edge cooperative advances towards the next generation of concentrated solar power (CSP) technology: Advances CSP and hybrid TES technology by overcoming challenges like high-temperature operations, on-demand availability and environmental impact, enabling dispatchable and cost-effective solar energy production

www.cooperant-project.eu

Women in STEM

Merete Tangstad from NTNU My decision to pursue a research career in renewable energy, engineering, or related STEM fields was driven by my initial interest in material science. The field's blend of chemistry, physics, and technology fascinated me, and it offered a direct connection to industrial processes that I found incredibly appealing.
Working with other women researchers on my project has been a normal part of my daily experience. In our group, which consists of three female professors and two men, I tend not to focus on gender. Instead, I see my colleagues for their backgrounds and scientific skills, which are the most important aspects in our collaborative efforts.
As for changes I'd like to see in STEM, it's essential to communicate that being an engineer or scientist is a viable and rewarding career, rather than a calling. We need to underscore that these professions are jobs that anyone can aspire to and succeed in, regardless of gender. This perspective could help make STEM careers more accessible and equitable for future generations of female researchers. It's about normalizing these career paths and showing their value in a practical, everyday context.

Patricia Royo Gutiérrez from IDENER.AI I've always been fascinated by how science and technology can lead to societal progress through innovative research. It challenges my own thinking day by day. Engaging with diverse disciplines within STEM is fundamental- it enables us to learn from each other and push the boundaries to find sustainable solutions for renewable energies, like those we're developing in the SUNSON project. The professionalism and dedication of women in this project demonstrate the potential that we have always held in these traditionally underrepresented fields. That's why collaborating with these inspiring women is an enlightening and empowering experience! When I began my engineering career, there were fewer than ten women in my class. Fortunately, it is heartening to see an increasing number of women and people of diverse genders applying for STEM and IT degrees each year. Still, we all need to support young students to pursue their aspirations and dreams, breaking down biases and barriers from the start. Furthermore,actively supporting work-life integration, addressing implicit biases in hiring and promotion processes, and ensuring equal opportunities are important steps.

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