EU-SOLARIS ERIC
Strategic Plan
2023-2026

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Plataforma Solar de Almería (PSA)
Carretera de Senés, km. 4,5
04200-Tabernas (Almería)
Spain
Tel. +34 950 820812

eu-solaris.eu

04200-Tabernas (Almería)
Spain
Tel. +34 950 820812

Content

1. INTRODUCTION 3
2. VISION, MISSION AND OBJECTIVES 4
3. GOVERNANCE & SUSTAINABILITY 5
4. TASKS AND ACTIVITIES 7
5. MEMBERS & FACILITIES 8
6. PORTFOLIO OF TECHNICAL SERVICES 10
7. LINES OF WORK 11
   - 7.1 DEVELOPMENT OF COMMON STANDARDS AND TESTING PROTOCOLS 11
   - 7.2 DEVELOPMENT OF NEW MEASUREMENT TOOLS AND TECHNIQUES AND IMPROVEMENT OF EXISTING ONES 11
   - 7.3 DEVELOPMENT OF SOLUTIONS TO IMPROVE FLEXIBILITY AND EFFICIENCY OF EXISTING TEST FACILITIES 12
   - 7.4 DEVELOPMENT OF TOOLS AND TECHNIQUES RELATED TO MATERIALS FOR CST TECHNOLOGIES 13
   - 7.5 DEVELOPMENT OF NEW CAPACITIES AND POSSIBILITIES FOR OPTIMIZING ACCESS TO EUROPEAN CST INFRASTRUCTURES 14
8. THE NEXT TWO-YEAR PERIOD 15

1. INTRODUCTION

The development of solar energy using concentrating systems has a European dimension that demands a strong alliance between the European research teams with a particular focus on the Research Infrastructures (RI) in order to enhance the research efficiency and the technology development.

The EU SOLARIS initiative aims at strengthening human and scientific links between the signatory countries to promote and stimulate researches and innovations for the sustainable development of Concentrating Solar Thermal Energy (CST) technologies at the European level.

The Members have been collaborating for several years in the field of research on CST systems in order to efficiently transform this energy into electrical power and renewable energy carriers, to store it, to elaborate or to test materials, to study reliable measurement methods and to optimise components and that they have high level skills and operate complementary research infrastructures.

EU-SOLARIS ERIC has established and operates a world-class distributed research infrastructure on CST, set up as a Central Hub responsible for the coordinated operation of national research infrastructures dedicating part of their research and development capacities to EU-SOLARIS ERIC, sharing contents, tools and know-how related to CST technologies.

All research facilities that are part of the ERIC will remain property of their institutions as well as the rights to handle the access to them and the conditions under which it is granted.

The relationship between EU-SOLARIS ERIC and the national research centres is regulated through the signature of specific Service-Level Agreements.

This document exhibits the Strategic Plan of EU-SOLARIS ERIC for the period 2023-2026, with an update by the end of year 2024.

The goal is to make the most out of the set of Research Infrastructures and capabilities made available by the consortium Members. With this in mind, the activities to be carried out and the goals to be achieved within the next two years are described.

2. VISION, MISSION AND OBJECTIVES

To that end, the following constitute the purposes and objectives of EU-SOLARIS ERIC:

VISION

To become the European Research Infrastructure (RI) of reference in the technological development of CST and related applications

MISSION

To offer the best conditions for the development of CST research activities for the scientific and industrial communities

STRATEGIC OBJECTIVES

a) To coordinate, as a unique infrastructure of distributed character, main existing R&D installations in Europe, providing the most complete and high quality scientific infrastructure portfolio at international level to the CST sector.

b) To establish a Single Entry Point where highly specialised facilities, resources and research services are effectively and optimally offered to users demanding CST related services.

c) To reinforce the collaboration between the scientific institutions, academia and industry, also fostering collaborative research among main European research centres of the sector.

d) To identify new requirements for the improvement of the research facilities, and for the construction of new ones (when needed), also optimizing and promoting the specialization of existing ones avoiding unnecessary technological duplication and repetition.

e) To identify and establish the best research and experimental practices, leading and coordinating the open dissemination of results and experimental data whenever possible, thus contributing to the reinforcement of the European leadership position at an international level.

f) To maintain Europe at the forefront and leadership of CST technologies development.

3. GOVERNANCE & SUSTAINABILITY

The scheme below shows the functional organization of EU-SOLARIS ERIC.

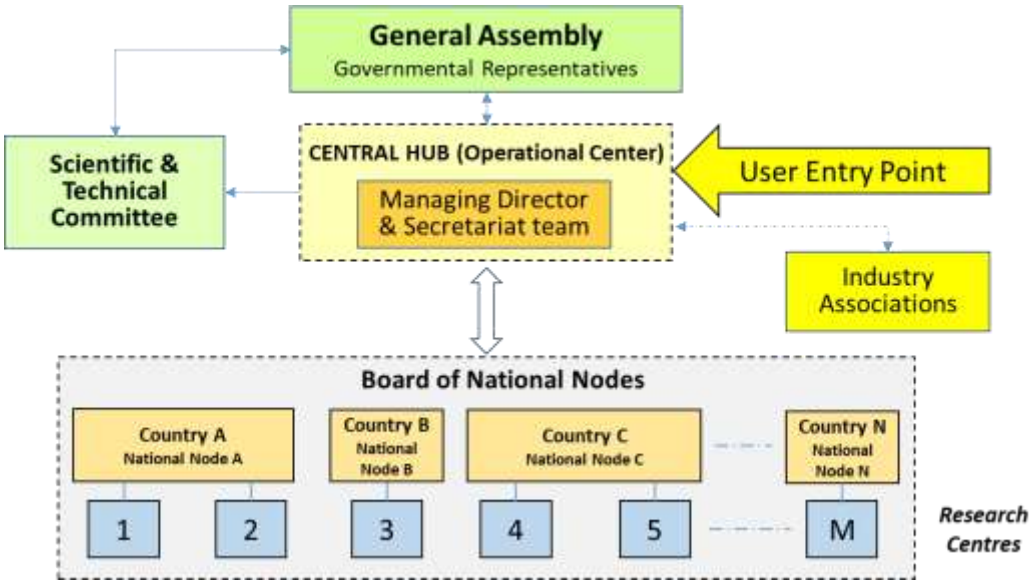

Figure 1. Functional organization of EU-SOLARIS ERIC

Profiles:

General Assembly:

- Representatives of the Members (States).
- Duly empowered to bind Members when voting in the General Assembly.
- Acting as collegiate decision body of the ERIC in corporate and strategic issues.

Managing Director and Secretariat Team:

- Appointed by the General Assembly.
- Acting as sole administrator of EU-SOLARIS ERIC.
- Project management, economic and technical expertise.
- It also implies administrative personnel and staff of EU-SOLARIS ERIC.

Scientific & Technical Committee:

- Appointed by the General Assembly.
- Independent and prestigious experts in the energy field
- Upon request, it may also advice the General Assembly.

National Nodes:

- Composed of all entities contributing their experience, capacities and services to the ERIC within the CST field.
- A Service Level Agreement with EU-SOLARIS is necessary.

Board of National Nodes

- Integrated by all the representatives of the National Nodes.
- Coordination activities within EU-SOLARIS ERIC.
- Advice the Managing Director

4. TASKS AND ACTIVITIES

In order to fulfil its purposes and objectives, EU-SOLARIS ERIC shall, directly or via third parties, engage in the following activities:

a) grant effective access to resources and services made available by the Research Centres which are part of the National Nodes, in accordance with the rules established in these Statutes, for the European research and industrial community;

b) improve the interoperability between the Research Centres specialised in the field of CST technologies of the Members and Observers;

c) establish and apply technological advances related to resources and services associated to CST;

d) enter into collaboration agreements with third parties;

e) provide training and facilitate the mobility of researchers in order to reinforce and structure the European Research Area;

f) establish international relations with other organizations and authorities, public or private, European and non-European, interested in its activities and in related fields;

g) coordinate activities with other European R&D actors in the field of CST;

h) to share experiences in the implementation of the best practices in the operation and management of large research infrastructures;

i) any other activities required to fulfil the ERIC' purposes and objectives.

In addition, EU-SOLARIS ERIC shall offer access to a portfolio of research infrastructures and joint research and development activities through a coordinated, long-term development program among National Nodes for non-economic purposes.

Nevertheless, EU-SOLARIS ERIC may engage in limited profit-making activities, provided that:

a) they are closely linked to its main activities and;

b) they do not jeopardize achieving EU-SOLARIS ERIC' purposes or objectives;

c) they do not jeopardize the non-profit nature of EU-SOLARIS and its impartiality towards its members.

5. MEMBERS & FACILITIES

The founding Members of EU-SOLARIS ERIC are Spain, France, Germany and Cyprus. Portugal is currently participating as an Observer.

Such Members and Observers are represented in the General Assembly by a leading governmental institution per country, which are:

- **Spain**: General Secretariat for Research. Spanish Ministry of Science, Innovation and Universities.
- **France**: Direction Générale de la Recherche et de l'Innovation au Ministére de L'Enseignement Superieur, la Recherche at L'Innovation.
- **Germany**: Bundesministerium für Wirtschaft und Energie. Referat II C6 Energieforschung – Projektförderung und Internationales
- **Cyprus**: Directorate for Research and Innovation at the Deputy Ministry Research, Innovation and Digital Policy
- **Portugal:** Fundação para a Ciência e a Tecnologia (FCT)

On the other hand, those Research Centres offering its capacities and services to EU-SOLARIS ERIC in a specific country are organized around a National Node. As can be seen in Figure 1 above, the National Nodes make up the **Board of National Nodes**, which is an advisory body for the Managing Director.

During the whole inception process of the ERIC, every country has been represented by a leading Research Centre of its National Node, as follows:

Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas
PSA-CIEMAT
Site Tabernas

Centre National de la Recherche Scientifique
PROMES-CNRS
Site Odeillo

German Aerospace Research Institute
Institute of Solar Research
Site Jülich

The Cyprus Institute
PROTEAS
Site Pentakomo

University of Évora and LNEG - National Energy and Geology Laboratory (jointly)
INIESC - National Research Infrastructure in Solar Energy Concentration (Évora and Lisbon nodes, respectively)
Site INIESC Évora, Pólo da Mitra

Figure 2. Leading R&D facilities of the Member & Observer countries

EU-SOLARIS makes available solar facilities with a thermal power of up to several MW which allow to carry out research in the range of laboratory-to-utility scale applications.

The research facilities can be divided into two groups, one group of facilities with high thermal power of several MW, the other group with low and medium power, up to 500 kW. The first group includes towers and parabolic trough systems and the second group includes solar parabolic dishes, solar simulators, linear Fresnel systems and solar furnaces. In all cases the facility power is evaluated from the total reflective area, field design, reflectivity, the average DNI (Direct Normal Irradiance) and losses estimation.

6. PORTFOLIO OF TECHNICAL SERVICES

The partners' R&D in CST technology covers many disciplines including: material science, optics and radiometry, heat transfer, chemical kinetics and thermodynamics, meteorology, beam analysis, system control and tracking accuracy, modelling and optimization, fluid dynamics, calibration and measurements, and system analysis.

Applied R&D starts by executing small scale experiments in the laboratory. Scale-up of the new developed technology is based on the experimental results and associated models. Applied R&D consists of two laboratory types: the first is the research laboratory and the second is the testing laboratory.

The development of new materials and technologies is performed in the research laboratories. Equipment testing and calibrations are executed in testing laboratories. Meteorology measurements typically have outdoor sensors in the solar facility site. Theoretical R&D is executed using software and matching the model's predictions to the experimental results. Matching between the model's predictions and experiments results is essential to prove the model assumptions.

Laboratories for CST can be found in RI facilities but also in universities working on solar research. The scheme below summarizes the available EU-SOLARIS ERIC partners' test services.

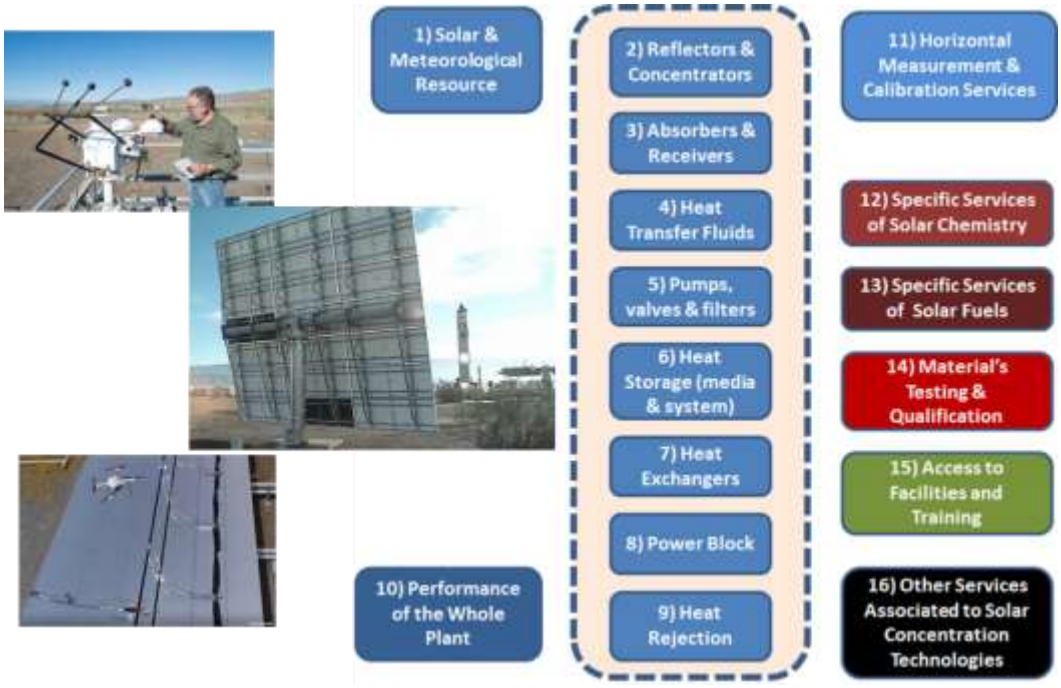

Figure 3. Summary scheme of available technical services

7. LINES OF WORK

As a RI-focused organization, EU-SOLARIS ERIC's lines of work will focus on making the most out of the existing research infrastructures, trying to make of them a crucial factor for the success of the CST technology as part of the global energy mix in the current times of energy crisis and climate emergency.

7.1 DEVELOPMENT OF COMMON STANDARDS AND TESTING PROTOCOLS

It is proposed a further development of joint guidelines and procedures for standardized testing of components (including interconnecting elements), full-scale solar collectors, commercial utility-scale plants and also other plant components such as receivers, storage systems, etc.

The intended protocols will include not only the testing procedure for overall characterization of solar concentrators (i.e., determination of their optical and geometrical quality) but also the protocols for characterization of their key components: reflectors, steel structure and interconnections (ball joints, flexible hoses and hybrid interconnections).

Some steps have been already given in this field within different projects, for example, the characterization of secondary concentrating optics and definition of standard guidelines to evaluate some of the parameters of CST technology performance carried out under the umbrella of the SFERA project[1], as well as in national (AEN/CTN-206) and international (IEC/TC-117, ISO 9806) standardization committees.

Nevertheless, the need to prepare additional protocols to complement what has been already defined in previous projects and initiatives has become evident to underpin the efficient and joint use of the research and test facilities of the participating entities.

The intended protocols will enhance the comparison of test results obtained in different research infrastructures, which will be of great benefit for both external users and the facility owners.

7.2 DEVELOPMENT OF NEW MEASUREMENT TOOLS AND TECHNIQUES AND IMPROVEMENT OF EXISTING ONES

Research centres and industry need joint calibration facilities and agreed procedures to calibrate sensors which are used for thermal performance testing and for measuring the solar resource.

[1] Solar Facilities for the European Research Area (https://cordis.europa.eu/project/id/312643/es)

These sensor calibrations lead to the required high measurement accuracy and reliable test results over all European research centres. In addition, sensor calibration provided as a service will support the industry in the implementation of the technology. Only by achieving high accuracy in the European test facilities, innovative products (collectors, receivers, solar sensors, etc.) can be qualified and developed together with industrial partners.

Some tentative lines within this topic could be, for instance:

- Improvement of direct normal irradiance sensors accuracy;
- Study of sunshape influence on solar flux map delivered to the receiver;
- Mass flow and thermal heat capacity of heat transfer fluids;
- Optical, thermal and geometrical characterization of solar collectors;
- Development of pyrometric temperature measurement methods for high-concentration solar facilities and solar simulators;
- On-target/receiver heat flux measurement.

7.3 DEVELOPMENT OF SOLUTIONS TO IMPROVE FLEXIBILITY AND EFFICIENCY OF EXISTING TEST FACILITIES

The goal of these actions is to make possible that existing facilities can be used by a higher number of users, minimizing dead times because of failures in the test specification or enabling simultaneous use of the same facility by several experiments (a central receiver system, for instance).

Some of the actions to be considered are:

- Develop operation strategies and technologies for the greening of CST technologies used at the RIs, aiming at the definition and implementation the best practices to increase the efficiency in the use of resources at the RIs considering its sustainability, taking into consideration economic, social and environmental aspects. Techniques to decrease the water and power consumption at CST RIs will be collected and studied and, last but not least, a carbon footprint assessment for a whole facility will be carried out within this line of activity.

- Further development of control algorithms to achieve and keep the desired temperatures on samples or the heat transfer fluid in the receiver.

- Development of virtual simulators to allow the users to receive a training course on the operation peculiarities of CST systems. This way, test campaigns would be planned better and the efficiency in the use of available testing time will be higher. Previous activities in this field (e.g., the *SolarCV Erasmus+* project aimed at setting up of a software to train future solar field operators) will be taken into consideration to avoid duplication of effort and to take advantage of their developments.

- Development of new experimental test beds and associated theoretical models will help users develop higher performance materials for higher process efficiency. A better evaluation of the material behaviour for CST applications will also lead to better estimations of the operating cost of innovative plants newly proposed or developed, such as towers with pressurized air turbines for high efficiency electricity production or with high temperature thermochemical processes for synthetic fuel production.

- Development of guidelines to adapt the existing or new infrastructures for training purposes of scientists or industry.

7.4 DEVELOPMENT OF TOOLS AND TECHNIQUES RELATED TO MATERIALS FOR CST TECHNOLOGIES

- Development of accelerated aging procedures and durability tests under real-life conditions, namely those in dry-arid areas.

- Protocols and tools for thermal and optical characterization of materials used for mirrors, receivers and coatings under concentrated solar radiation (emissivity, heat transfer coefficients, etc.). Thermal energy storage materials are to be considered also.

- Determination of physical properties of CST materials under concentrated solar irradiation.

- Implementation of an open data base within a web site, where the main characteristics of each usable heat transfer fluid, heat storage material and structural materials for CST applications as well, (from literature and where necessary completed by laboratory tests) are reported along with the related components characteristics and application areas. This service would also support industrial users in the design and scale up of concepts that have been tested in the research facilities.

7.5 DEVELOPMENT OF NEW CAPACITIES AND POSSIBILITIES FOR OPTIMIZING ACCESS TO EUROPEAN CST INFRASTRUCTURES

The goal of these actions is to provide the CST sector with new services like, for instance, training with courses and seminars or to implement a European e-infrastructure linking all the R&D centres. The existence of this e-infrastructure would enhance the access to the EU-SOLARIS RIs via the so-called 'Virtual Access'.

Some of the proposed actions are:

- Definition of a harmonized framework for data storage, management and access in compliance with FAIR principles;
- Definition of a harmonized framework for the implementation of RI access rules, aimed at different visiting audiences and including operation access fees, personnel security procedures and data and IP protection
- Definition of topics for special seminars, workshops and courses to be organized by the R&D centres participating in EU-SOLARIS to provide the CST sector with specific skills (e.g., testing of prototypes, performance monitoring, etc.)
- Setting up of specific infrastructures for training and dissemination because current research infrastructures are specially aimed at testing & qualification.
- Implementation of a European e-infrastructure linking the R&D centres. This e-infrastructure would significantly enhance the access capacities of the consortium.

8. THE NEXT TWO-YEAR PERIOD (2023-2024)

Taking into account that EU-SOLARIS ERIC was formally approved by the European Commission on October 2022 and that its governing bodies were established just on January 2023, the list of strategic objectives should begin with a modest approach in this very first Strategic Plan, focusing on the consolidation of the institutional framework and on the acquisition of further resources to expand the portfolio of activities in a consistent and sustained manner.

1. Achieve full development of the ERIC institutional framework, which includes all governance and advisory bodies and the National Nodes. Develop all necessary policies and related operational procedures.
2. Establish and consolidate an annual call for internally funded projects focused on topics of common interest for the partnering research infrastructures, according to the list of topics described in the section 'Tasks and Activities'.
3. Adopt the celebration of the annual 'Doctoral Colloquium' and 'Summer School' events, established at the former SFERA projects, to keep going with them in year 2024 and beyond.
4. Review and update the catalogue of solar facilities available at the Member & Observer countries plus the portfolio of technical services related which are offered by all R&D institutes affiliated to the National Nodes.
5. As an e-infrastructure has been already designed under the umbrella of the SFERA-III[2] project, the goal is to get the necessary external funding to set up its Central Node at the Central Hub and, at least, one of its Secondary Nodes in one of the leading Research Centres.
6. Establish and consolidate a regular participation of the ERIC in EU-funded calls in order to achieve external funding necessary to expand the range of activities and services offered to the users, in particular, free access to the test facilities according to scientific merit criteria.
7. Strengthen the interaction with industrial stakeholders with the aim to steer the progress on the RI level to the requirements of the industry, thus enabling a sustainable innovation ecosystem and a closer collaboration to assist European industry to lead the CST sector.
8. Promote the enlargement of the membership. Some European countries have participated in former stages of the EU-SOLARIS creation process, though they have not joined at last for different reasons.

This reference document will be discussed by the General Assembly and duly updated by the end of year 2024, according to the results achieved in the 2023-2024 period. A new version setting the goals for the period 2025-2026 will be then released.

[2] SFERA-III (https://sfera3.sollab.eu/)