

Important information about these documents

This call is being held ahead of any agreement from the Commission that the relevant funding will be available. At present the relevant legislation is still under discussion in both Council and Parliament, and there is no certainty on the detailed arrangements for funding selected projects. The funding of any selected project, and the terms and conditions of participation in the projects, are dependent on completion of the legislative process and the subsequent contractual processes between the European Commission and EURAMET. Proposers submit to this call at their own risk.

Background

Last year, EURAMET submitted a draft proposal to the EC for a further research programme to be established under article 185 of the Treaty on the Functioning of the European Union (TFEU) to follow on from EMRP and EMPIR. This was published by the EC at https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/european-partnerships-horizon-europe/candidates-digital-industry-and-space_en

The initiative would be called the European Partnership on Metrology and would aim to create, by 2030, a sustainable and effective system for metrology at European level that ensures Europe has a world-class metrology system that:

- Provides metrology solutions, fundamental metrological reference data and methods, offering fit-for-purpose solutions supporting and stimulating European innovation and responding to societal challenges.
- Supports and enables effective design and implementation of regulation and standards that underpin public policies that address societal challenges.

The Commission commissioned an impact assessment into this proposal and 11 others in similar priority areas, and, based on those findings, published their own proposal for the Partnership, their response to the impact assessment and a draft of the Decision on 23rd February 2021. See:

<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:89:FIN>

https://ec.europa.eu/commission/presscorner/detail/en/ip_21_702

<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021SC0035&qid=1614677899327>

That draft Decision is currently under discussion in the European Council and the European Parliament.

Under the assumption that the Council and Parliament pass the basic act which would form the legal basis for this research programme, and that the participating countries named in the Draft Decision submit the required commitment letters, EURAMET is publishing these potential Selected Research Topics and draft guidance notes. These documents are not approved by the Commission nor will they lead to a binding decision by EURAMET e.V. for any further negotiation or funding. All published guides and templates are subject to amendment by the EC and EURAMET e.V. as further information becomes known.

Title: Solar thermal metrology: Provision of accurate measurements to energy conversion, transport, and storage in concentrating solar power plants

Abstract

Europe's target to substantially decarbonise its energy supply by 2050 requires the electricity system to be shifted towards renewable energies. Concentrating solar power (CSP) technologies utilise focussed solar radiation as a high-temperature heat source to generate electricity in power plants. Incorporating thermal energy storage systems enables such power plants to dispatchable electricity generation, allowing the energy supply to be adapted to the demand. Commercial CSP plants are available, but some constraints limit their widespread use. The characterisation of solar receivers and direct solar irradiance in conjunction with a reliable knowledge of flow, temperature and thermophysical properties of heat transfer fluid and heat storage fluid are required to increase the efficiency, security, and longevity in CSP plants. Proposals addressing this SRT should contribute to solar thermal metrology by tackling these issues.

Keywords

Renewable energy, concentrating solar thermal energy, energy storage, heat transport fluid, heat storage fluid, fibre-optic thermometry, solar receivers, emittance, absorptance, direct solar irradiance

Background to the Metrological Challenges

Europe aims to cut greenhouse gas emissions by 80 % - 95 % before 2050. This cut, in combination with a predicted higher demand of energy in the future, has many implications for the energy system since the EU's electricity supply should achieve essentially zero emissions of greenhouse gases by 2050. The Green Deal, and more specifically the European Directives 2018/2001, 2009/28 and the European Energy Roadmap 2050 establish the need for higher research investment in renewable technologies, such as CSPs, which have the potential to provide a key contribution to these ambitions. CSP plants, however, require further research to improve their performance and operation, and reduce maintenance cost. The efficiency of CSP plants depends on a comprehensive process control of the whole system involving different measurements quantities.

A key quantity is the flow of the heat transport fluid and heat storage fluid. Nowadays, flow meters are calibrated with water as fluid and at temperatures lower than 90 °C. These calibrations are extrapolated to the operational temperatures used in commercial CSP plants (300 °C) with molten salts or thermal oil as fluid. The differences between calibration conditions and operational conditions lead to inconsistencies in flow measurements that limit the efficiency of CSP plants.

Existing commercial CSP plants measure the fluid temperature using thermocouples. These measurements at discrete points do not give enough information about the distribution of the temperature along the pipes and in storage tanks, nor do they detect insufficient insulation. All the energy dissipated in the environment or not perfectly exchanged by the heat transfer fluid is not available for the electricity production. The use of fibre-optic thermometry could solve the problem for distributed temperature measurements, but additional work is still needed in terms of traceability and in terms of temperature range, given that up to now metrological fibre-optic measurements have only taken place in the range up to 100 °C. The metrological validation is insufficient and accepted calibration guidelines or procedures for determining the relevant measurement uncertainty contributions have not been established yet, in particular at high temperatures.

The accurate and traceable determination of thermophysical properties e.g. specific heat and thermal conductivity across the complete range of planned operating temperatures in CSP plants is important for the design of piping and heat exchangers, to allow a safe operation of the CSP plants at the highest possible efficiency. However, currently the thermophysical properties of heat transfer fluids and heat storage fluids are provided by the manufacturers of those fluids, determined by non-standardised procedures and without associated uncertainties. Homogenous metrological procedures for the determination of specific heat and thermal conductivity of the heat transfer and storage fluids together with an appropriate uncertainty evaluation are not yet available. The same applies to the fluids' long-term performance under operational conditions.

The emittance and absorptance of solar receivers are usually determined in laboratories at ambient temperatures and for flat surfaces, not at usual working temperatures nor for cylindrical surfaces, the most common shape in commercial CSP plants. The initial determination of emittance and solar absorptance, and their drift, in cylindrical solar receivers at normal working temperatures (540 °C for parabolic through CSP plant designs and 750 °C for tower CSP plant designs), has not yet been completed from a metrological point of

view. Furthermore, measurements of the concentrated direct solar irradiance, reaching the solar receivers' surface and the associated temperature (closely related with emittance drift of the receiver) are needed for the establishment of optimal operation and maintenance procedures. Currently, these measurements have technical and metrological limitations, resulting in an incomplete traceability chain and incomplete uncertainty evaluation for the on-site measurements as well as difficulties associated with the total solar receivers' surfaces.

Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the protocol.

The JRP shall focus on the traceable measurement and characterisation of energy conversion, transport, and storage in concentrating solar power (CSP) plants.

The specific objectives are

1. To develop validated methods for the traceable flow measurement of (i) the heat transfer fluid (e.g. oil or molten salts) and (ii) the thermal energy storage fluid (e.g. molten salts) used in CPS plants under real working conditions: temperature 300 °C, pressure 2.5 MPa to 3.0 MPa, and flow up to 1200 kg/s with a target uncertainty lower than 3 % ($k = 2$).
2. To adapt the existing technology and develop procedures and guidelines for traceable distributed fibre-optic thermometry based on back scattering (distributed temperature sensing) and multipoint sensors (fibre Bragg gratings). Additionally, to perform on-site distributed temperature measurements in CSP plants along the pipes and in the storage devices (containing heat transfer fluid or thermal energy storage fluid) using this technology under real working conditions, up to 575 °C, and with a target expanded uncertainty of 3 °C ($k = 2$).
3. To develop metrological methods for the traceable determination of the thermophysical properties, and associated drift, of the most common heat transfer fluids and storage fluids in CSP plants. The thermophysical properties to be determined include specific heat (up to at least 450 °C and up to 575 °C for high temperature molten salts) and thermal conductivity (up to 575 °C). The target expanded uncertainty should be 2 % and 5 % ($k = 2$), respectively.
4. To develop validated methods for the accurate and traceable determination of solar absorptance and emittance of the cylindrical solar receivers, their drift and aging, under application conditions, up to 750 °C, with a target expanded uncertainty of 0.03 ($k = 2$). Additionally, to perform the traceable on-site characterisation of the total solar receiver's surface in terms of (i) temperature homogeneity, by non-contact methods up to 750 °C, with a target expanded uncertainty of 10 % ($k = 2$) and (ii) concentrated direct solar irradiance, covering the range 50 kW/m² to 1000 kW/m², with an expanded uncertainty of 15 % ($k = 2$).
5. To interact with key contributors to the relevant measurement supply chain (e.g. manufacturers of instrumentation and reference materials, calibration laboratories, and NMIs under the umbrella of EMNs), to facilitate take up of projects outputs and to support the establishment of sustainable metrology support structures, as appropriate. Additionally, to engage with standardisation organisations, international organisations and end users, as appropriate, to facilitate the dissemination and the take up of the project outputs by those.

These objectives will require large-scale approaches that are beyond the capabilities of single National Metrology Institutes and Designated Institutes. To enhance the impact of the research, the involvement of the appropriate user community such as industry, standardisation and regulatory bodies is strongly recommended, both prior to and during methodology development.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 2.2 M€, and has defined an upper limit of 2.7 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 35 % of the total EU Contribution across all selected projects in this TP.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community, describing how the project partners will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the “end user” community (e.g. letters of support) is also encouraged.

You should detail how your JRP results are going to:

- Address the SRT objectives and deliver solutions to the documented needs,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Transfer knowledge to the renewable energy and photovoltaics sectors.

You should detail other impacts of your proposed JRP as specified in the document “Guide 4: Writing Joint Research Projects (JRPs)”.

You should also detail how your approach to realising the objectives will further the aim of the potential European Partnership on Metrology to develop a coherent approach at the European level in the field of metrology and include the best available contributions from across the metrology community. Specifically, the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of EURAMET Member States whose metrology programmes are at an early stage of development to be increased
- organisations other than NMIs and DIs to be involved in the work.

Time-scale

The project should be of up to 3 years duration.