EMRP Call 2013 – Energy and Environment

Selected Research Topic number: **SRT-g13**
Version: 1.0

Title: Enhancing the efficiency of high-temperature solar thermal power plants

Abstract

Recently constructed high temperature solar power plants that use molten salt as a heat conveying fluid have shown the capacity to produce energy continuously and efficiently. This new technique has revealed that it is important to minimise the uncertainty of flow-rate and temperature measurement under process conditions (molten salt, 600 °C) in order to optimise the process control of the power plant. Establishing traceability and low uncertainty measurements, of flow rate, temperature, solar absorption and emissivity measurements as well as the corresponding thermophysical properties in the molten salt will be the key elements to enhance energy efficiency by 10 % and enable the use of the technology in Southern Europe.

Conformity with the Work Programme

This Call for JRPs conforms to the EMRP Outline 2008, section on “Grand Challenges” related to Energy and Environment on pages 8 and 9.

Keywords

Solar power plants, solar absorption, molten salt

Background to the Metrological Challenges

Currently there is no suitable primary flow standard for calibrating flow and temperature sensors under process conditions (molten salt with temperatures up to 600 °C, flow rates up to 1000 m³/h). The uncertainty of flow and temperature measurements in molten salts is too large, up to 12 to 15 % for flow rate and 5 to 8 K for non-invasive temperature measurements. In addition, most of the flow sensors and the commonly used resistive thermometers are in direct contact with a very aggressive medium and show very poor measurement durability. In many cases, sensors have to be replaced after two years in service.

Recent progress, in high-temperature solar thermal power plants that use molten salt as heat conveying fluid and heat storage, has showed the first important step towards improving energy efficiency. As a consequence, high-temperature solar thermal power plants show efficiencies between 20 and 30 %, enabling continuous production of energy which would allow this technique to replace conventional, carbon or nuclear operated, base-load power plants.

Enhancing the energy efficiency of solar power plants by more than 10 % will also allow the construction of large-scale solar thermal power plants in south Europe, solving the geo-strategic problem as well as bringing prosperity to economically underdeveloped regions.

Scientific and Technological 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 JRP-Protocol.

The JRP shall focus on optimising traceable measurement techniques which enable a significant improvement of the efficiency of high temperature solar thermal power plants by more than 10%.

The specific objectives are

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EMRP
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1. Establish a traceability chain with an overall uncertainty of <2 % for the use of ultrasound based flow measurement devices (non-intrusive clamp-on systems and intrusive multi-path systems) in molten salt.
2. Develop a metrological foundation for non-intrusive temperature measurements, with uncertainty of <1 K, in molten salt based on temperature dependence of the speed of sound.
3. Establish a measuring infrastructure for the precise determination of density, viscosity, thermal conductivity and heat capacity of molten salts with uncertainties small enough (around 0.1 %, 10 %, 3 % and 1 % respectively) to allow safe operation of the solar plant at the highest possible temperatures.
4. Develop methods for the determination of the relevant optical properties of absorber coatings used in high temperature solar power plants: absorptance and emissivity, at 1% relative uncertainty level. This shall enable their systematic improvement and quality control of the absorber tubes during production and installation in the field.

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 R&D work, the involvement of the user community such as industry, and standardisation and regulatory bodies, as appropriate, is strongly recommended.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this. In particular, proposers should outline the achievements of the EMRP project ENG06 “Power Plants” and how their proposal will build on those.

EURAMET expects the average size of JRPs in this call to be between 3.0 to 3.5 M€, and has defined an upper limit of 5 M€ for any project. The available budget for integral Research Excellence Grants is 30 months of effort.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community. This may be through the inclusion of unfunded JRP-Partners or collaborators, or by including links to industrial/policy advisory committees, standards committees or other bodies. Evidence of support from the “end user” community (e.g. letters of support) is encouraged.

You should detail how your JRP results are going to:

- the stakeholder industries associated with the development, instrumentation and operation of solar power plants
- solar energy research institutions
- feed into the development of urgent documentary standards through appropriate standards bodies

You should detail other impacts of your proposed JRP as detailed in the document “Guide 4: Writing a Joint Research Project”

You should also detail how your approach to realising the objectives will further the aim of the EMRP to develop a coherent approach at the European level in the field of metrology and includes 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 Member States and countries associated with the Seventh Framework Programme whose metrology programmes are at an early stage of development to be increased
- outside researchers & research organisations other than NMIs and DIs to be involved in the work

Time-scale

The project should be of up to 3 years duration.