

## **Title: Metrology for reliable liquefied energy gases measurement**

### **Abstract**

As part of the European Green Deal, the EU aims to be climate-neutral by 2050. Supporting this, the hydrogen strategy for a climate-neutral Europe identifies liquid energy gases as a means of energy transport, as necessary for reaching climate-neutrality. Such liquefied energy gases include liquid hydrogen (LH<sub>2</sub>), liquefied natural gas (LNG) and liquefied biomethane (bio-LNG). To support their use and hence the EU's energy transition, reliable and accurate measurements are needed. The accuracy of current liquefied energy gas measuring equipment needs to be verified, as SI-traceable measurement campaigns are needed to determine the uncertainty for in-field custody transfer process conditions. Verified reference datasets are also needed to support methods for bio-LNG and LH<sub>2</sub> flow, composition, and temperature measurements as well as validated LH<sub>2</sub> custody transfer calibration procedures.

### **Keywords**

LNG, LH<sub>2</sub>, bio-LNG, flow metering, composition, temperature, calibration, reference data

### **Background to the Metrological Challenges**

Bio-LNG is a key component in the EU's Alternative Fuels Infrastructure Regulation (AFIR) and has the potential to significantly help in decarbonising transport as it can readily use existing LNG infrastructures. LNG imports into the EU have grown steadily in the past decades, with a sharp increase since 2021 i.e. from 39 to 98 billion cubic meters. LNG now accounts for approx. 42 % of EU's gas imports and is key in the EU's energy and Green Deal strategies. LNG (and other liquefied energy gas) use also supports the diversification of gas supplies, thus improving the EU's energy security.

The previous EMRP and EMPIR projects ENG03 LNG, ENG60 LNGII, and 16ENG09 LNG III developed validated, SI-traceable, LNG flow and LNG composition calibration equipment as well as providing the first insights into the achievable accuracy of LNG flow meters and composition measuring systems. However, to build confidence in these measuring systems, and to enable their adoption into documentary standards, reference datasets are needed.

The previous EMPIR project 20IND11MetHyInfra developed validated, traceable measurements for LH<sub>2</sub> mass flow with a target calibration uncertainty of 0.3 % - 0.8 %. In contrast other existing claims made in science and industry of 0.25 % LH<sub>2</sub> mass flow, have yet to be verified, and in particular for in-field conditions. Further to this, the accuracy claims ( $\pm 0.05$  °C) of recent prototype temperature sensors measuring LH<sub>2</sub> temperatures at -253 °C also need to be validated.

Existing SI-traceable calibration infrastructures can be used to provide partial traceability for liquefied energy gases, but this is only for basic calibrations typically under ambient conditions and in controlled laboratories. However, when performing measurements within bio-LNG/LH<sub>2</sub> under in-field conditions new, unquantified, uncertainty sources arise, thus the accuracy of measuring equipment (for flow, composition, and temperature) must be reassessed. Further to this, current infrastructures also lack bio-LNG and/or LH<sub>2</sub> standards that are directly traceable to the SI-units.

## 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 proposal shall focus on the traceable measurement and characterisation of liquefied energy gases, in particular for in-field custody transfer process conditions.

The specific objectives are

1. To determine the measurement reliability and uncertainty of (bio-)LNG flow meters in-field, including (i) 2-phase flow, (ii) meter insulation type, (iii) reproducibility, and (iv) temperature cycles. In addition, to develop traceable bio-LNG and LH<sub>2</sub> meter diagnostics and demonstrate, using SI-traceable reference datasets, a target accuracy of 0.5 % for (bio-)LNG flow meters.
2. To determine the reliability of bio-LNG composition measurement in in-field conditions, including sampling errors, and the achievable accuracy of LNG composition measurement equipment. Then to demonstrate, using SI-traceable reference datasets, a target uncertainty of less than 0.3 % (k = 2) for the online determination of LNG density.
3. To determine the accuracy of bio-LNG in field temperature measurements, including the impact of static and dynamic effects on the temperature measurement system. Then to demonstrate, using SI-traceable reference datasets, a target uncertainty of 0.1 °C - 0.5 °C at k = 2, for in-field conditions and for cryogenic temperatures down to -253 °C, (applicable for LH<sub>2</sub>).
4. To develop SI-traceable flow and temperature measurements in LH<sub>2</sub> conditions together with SI-traceable calibration procedures for LH<sub>2</sub> flow, composition, and temperature measurement systems. In addition, to verify the performance of the developed calibration procedures and existing LH<sub>2</sub> calibration standards through inter-comparisons.
5. To facilitate the take up of the technology and measurement infrastructure developed in the project by the measurement supply chain (accredited laboratories, instrument manufacturers), standards developing organisations (OIML TC 8, ISO/TC 28, CEN/TC 408, IEC/TC 65/SC 65B), the European Metrology Network for Energy Gases and end users (e.g. research institutes, plant operators, Transmission System Operators/ Distribution System Operators (TSOs/DSOs)).

These objectives will require large-scale approaches that are beyond the capabilities of single National Metrology Institutes and Designated Institutes. Proposers shall give priority to work that meets documented needs, in particular those supporting the European Green Deal. 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. In particular, proposers should outline the achievements of the EMRP ENG03 LNG, ENG60 LNG II, and EMPIR 16ENG09 LNG III, 16ENG05 Biomethane, and 20IND11 MethHyInfra, projects and how their proposal will build on those.

Proposers should note that the programme funds the activity of researchers to develop the capability, not the required infrastructure and capital equipment, which must be provided from other sources.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 2.8 M€ and has defined an upper limit of 3.5 M€ for this proposal.

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

Any industrial beneficiaries that will receive significant benefit from the results of the proposed project are expected to be beneficiaries without receiving funding or associated partners.

## 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 proposal's 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,
- Facilitate improved industrial capability, or improved quality of life for European citizens in terms of personal health, protection of the environment and the climate, or energy security,
- Transfer knowledge to the energy and transport 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 Metrology Partnership 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.

## **Timescale**

The project should be of up to 3 years duration.

## **Additional information**

The links provided in this section are only correct at the time of publication up until the end of the Call year.

The references below were provided by PRT submitters; proposers should therefore establish the relevance of any references.

- [1] EMN for Energy Gases Strategic Research Agenda  
<https://www.euramet.org/research-innovation/metrology-partnership/strategic-research-and-innovation-agendas>