Title: Metrological support for LNG and LBG as transport fuel

Abstract

Liquefied Natural Gas (LNG) has been an integral part of the EU security of energy policy for many years. In addition it has been identified as one of the pillars of the EU clean fuel strategy. In comparison with other commodities like natural gas or gasoline the total uncertainty of measured energy is very high for LNG and has been estimated to be up to 1.5 %. The current lack of sound traceability leads to the delayed introduction of new measurement methods in the LNG sector.

In the two previous EMRP "Metrology for LNG" projects many important metrological tools have been designed, developed and to a large extent validated. Further developments in cost-effective measurement sensors and techniques and in reducing the (onsite) measurement uncertainties in the full chain of small- and mid-scale applications are now required to provide metrological support to LNG and Liquefied Bio Gas (LBG) as transport fuel.

Keywords

LNG, LBG, fuelling, breaking bulk, cryogenic flow metering, composition and density measurement, onsite measurement uncertainty, methane number, methane slip, clean fuel strategy, transport fuel

Background to the Metrological Challenges

A sound metrological framework will be an indispensable element for the development of LNG as a transport fuel, which has been identified as one of the pillars of the EU clean fuel strategy. Within Europe, many LNG fuelling stations are already in operation and many more stations are planned and will be built in the coming years. LNG, whether from natural or renewable sources (as LBG), is particularly suited for long-distance road freight transport for which alternatives to diesel are limited. Its use will allow the industry to meet stringent pollutant emission limits of future EURO VI standards more cost-efficiently. Furthermore, engines running on LNG produce much less noise than diesel operated engines and therefore trucks on LNG are becoming the preferred choice for deliveries in urban areas. LNG is also an attractive fuel to meet the new limits for sulphur content in marine fuels.

With the large scale roll-out of LNG as a transport fuel, a number of key metrological challenges remain, including a high total uncertainty in measured energy (estimated up to 1.5 %), as well as issues surrounding custody transfer involved in fuelling, metrological assessment of LNG emissions, engine performance, composition and density. For example, there are currently no traceable LNG flow calibration facilities available. Further, the typical onsite conditions give rise to additional uncertainty sources. Aspects that have unknown impact on the metering accuracy are flow meter insulation and inclination, flow disturbances and two phase flow. Because of the lack of a calibration facility and a good understanding of the impact of the onsite conditions, the measurement uncertainty is currently unknown or unacceptably high. Research into the impact of onsite conditions will facilitate reaching acceptable measurement uncertainties, ultimately comparable to conventional fuels (0.5 %).

A crucial element for the use of LNG in this sector is the development of a harmonised method and related measurement technology for the determination of the methane number (a parameter related to the knocking behaviour of natural gas and the LNG counterpart of the octane number for gasoline), including a correlation of the methane number with the LNG composition. Various methods to determine the methane number have already been proposed; these now require validation and agreement over the full range of LNG applications (including full scale truck engines) in order to feed into updated ISO standards.

LNG from biogas (LBG) can contain small particles which may affect the engine performance. Further, silicium oxide particles can be generated from the combustion of silanes present in the biogas. Determination of the content and the source of particles in the LBG will inform usability decisions in practice, such as service intervals and the type of particle filters used at fuelling stations.

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 LNG and LBG, to support their marketplace roll-out as transport fuel.

The specific objectives are:

1. To reduce the onsite flow measurement uncertainty for small- and mid-scale LNG applications to the level comparable to conventional fuels (0.5 %). To include a systematic assessment of the impact of flow disturbances, two-phase flow and the impact of meter insulation and inclination.
2. To undertake a technical feasibility study to develop an LNG flow calibration facility for flow rates typically encountered in small- and mid-scale applications (400 ~ 1000 m^3/h). The CMC of this facility should be low enough to at least meet the current OIML recommendations (1.5%), however ultimately the uncertainty should be comparable to conventional fluids. Further, to assess whether the (onsite) measurement uncertainty can be reduced with a cryogenic piston prover.
3. To develop and validate a reference liquefaction technique (small scale liquefier) for the validation of LBG and LNG sampling and composition measurement systems.
4. To improve methods and (inline) sensors for cost-effective measurement of the composition, methane number and methane slip. In particular to i) develop a traceable density calibration method; ii) validate cost effective (inline) density sensors; iii) validate sensors for composition and methane slip to enable real-time engine management, engine performance and the measurement of methane slip; iv) validate existing methane number algorithm and reaction kinetics through full scale truck experiments; v) assess the source, content and potential impact of particles in especially LBG fuels.
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 (ISO, CEN) and end users (transport and energy sectors). In particular to i) develop an ISO standard for cryogenic flow metering, including recommendations on water calibration transferability; ii) develop an ISO standard for the calculation of the methane number and iii) implement relevant deliverables from the three LNG projects as an annex in the GIIGNL handbook for LNG custody transfer.

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 research goes beyond this. In particular, proposers should outline the achievements of the EMRP projects ENG03 “LNG” and ENG60 “LNG II” and how their proposal will build on those.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 2.0 M€, and has defined an upper limit of 2.3 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 35 % of the total EU Contribution to the project.

Any industrial partners that will receive significant benefit from the results of the proposed project are expected to be unfunded 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 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 energy sector.

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 EMPIR 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.