

Title: Metrology for decarbonising the gas grid II

Abstract

The decarbonisation and diversification of European gas networks is necessary in order to meet carbon targets and improve energy security, by reducing dependencies on gas imports. The transport of mixtures of natural gas with biomethane, e-methane and hydrogen will require the development of composition measurement methods with wide measurement ranges. Proposers should also aim to provide stakeholders the required standards, best practice guides and training materials to support the needs of future European gas grids.

Keywords

Decarbonisation, natural gas, hydrogen, biomethane, gas blending, sampling, sensors, purity, flow, leak detection

Background to the Metrological Challenges

The substitution of natural gas with hydrogen, biomethane and e-methane is already a long-term goal for many countries, with incremental changes planned to blending fractions for these renewable gases with natural gas. There is a need for additional measurement infrastructure, standardisation and governing legislation to support wider-scale adoption within homes and industry.

The transport of mixtures of natural gas with biomethane, e-methane and hydrogen will require the development of composition measurement methods with wide measurement ranges. This is especially difficult to achieve with field methods that use simple sensors and single-point calibration procedures. Therefore, it is important to develop and validate on-line measurement procedures that are resistant to the variability of the sample composition over time for indoor/outdoor environments. Field deployable calibration standards are required for the performance assessment of the emerging measurement infrastructure that will be implemented across the gas network during grid transitioning from natural gas to hydrogen, biomethane and e-methane.

Fast methods that can alert industry to blend quality control are required to improve safety and efficiency of hydrogen, biomethane and e-methane blending. Also, safety odourisation is a key topic, that currently lacks dedicated metrological research on blends of natural gas with hydrogen, including transition to sustainable sulphur-free odourising agents. Stable reference standards for odourants within blends of hydrogen, biomethane, e-methane and natural gas have not been developed and confirmed as suitable via dedicated olfactometry testing. In addition, suitable odourants for pure hydrogen are still under revision and require research for blend scenarios.

New types of analytes will require specific procedures for collecting gas samples for analysis. Sampling procedures do not currently take into account issues related to the determination of the content of the main components and trace components (e.g. terpenes, formic acid), in fuel blends of natural gas/hydrogen and natural gas /biomethane. Trace determinations may require the use of passive coatings on sample containers, and sample preconcentration.

Moreover, the measurement of flow within gas pipelines currently relies heavily on knowledge of thermophysical properties. Depending on the metering technology, properties such as density and viscosity are required either as direct input to the flow calculation, or to adapt a Reynolds number-based calibration curve to field conditions. Additionally, since billing is normally calculated on energy basis, reliable calculation methods are needed for calorific value of mixtures containing hydrogen. Only a small amount of available flow measurement devices is independent of thermophysical property measurements and provide direct mass flow measurement. These emerging devices require validation against primary reference methods in order to become viable. The thermodynamic models and equations of state (EoSs) need to be assessed and optimised for different hydrogen/natural gas blends and variety of hydrogen containing mixtures in presence of various concentrations of hydrogen in the system, as well as for different pressure and temperature operating conditions.

Last, an in-depth analysis of hydrogen gas leakage and compositional monitoring is an industrial need that could be addressed via innovative integrations of thermodynamic modelling, development of advanced Machine Learning (ML) models, and geographic information system (GIS). Portable gas concentration sensors (sniffer) should be developed to locate these leaks.

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 gases.

The specific objectives are

1. To develop SI-traceable Primary Reference Materials (PRMs) for quantification of biogenic methane content within natural gas and biomethane blends. To develop working standards (WSs) for dynamic gas generation systems suitable for measurements of natural gas/ hydrogen blends (0 – 20 % hydrogen), natural gas/ biomethane/ e-methane blends (0 - 100 % methane) and natural gas/ hydrogen/biomethane/ e-methane blends (0 - 20 % hydrogen , 0 - 100 % methane). The WSs should be field-deployable and contain sulphur-free odorants and relevant analytes, as specified within EN 16723-1, ISO 14687 and EN 16726. Stability tests of at least 1 year should be applied for both the PRMs and WSs. The relative target uncertainties for WSs are less than 20 % and should be appropriate for the relevant documentary standard.
2. To develop field-deployable validated measurement methods for natural gas/ hydrogen blends (0 - 20 % hydrogen), natural gas/ biomethane/ e-methane blends (0 - 100 % methane) and natural gas/ hydrogen/biomethane/ e-methane blends (0 - 20 % hydrogen, 0 - 100 % methane), applicable to laboratory and industrial environments. Developed methods should focus on the quantification of biogenic methane content, olfactometry testing of novel safety odorants including sulphur-free odorants and leak detection (building upon EN 15446). Relative target uncertainties are less than 20 % and should be appropriate for the analytes of emerging industry needs and relevant documentary standards, such as EN 16723-1, ISO 14687 and EN 16726.
3. To develop standardised sampling protocols appropriate for blends of natural gas with hydrogen (0 - 20 % hydrogen), natural gas/ biomethane/ e-methane (0 - 100 % methane) and natural gas/ hydrogen/biomethane/ e-methane blends (0 - 20 % hydrogen, 0 - 100 % methane). Sampling procedures should also take into account issues related to the determination of the content of main components and trace components, as specified within ISO 10715, EN 16723-1, ISO 14687 and EN 16726. To demonstrate the accuracy of the developed protocols in both laboratory and industrial environments (e.g. biomethane, hydrogen production plants) via proficiency testing schemes.
4. To develop thermodynamic models for blends of natural gas/ hydrogen, natural gas/ biomethane/ e-methane and natural gas/ hydrogen/biomethane/ e-methane. To evaluate the thermodynamic models and equations of state (EoSs) by experimental datasets optimised for different hydrogen/natural gas blends (0 - 20 % hydrogen). To assess the EoSs for different compositions, pressure and temperature operating conditions. To develop traceable monitoring methods based on the integration of thermodynamic modelling/ML models/Geographic Information System (GIS) for early leak detection.
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/TC197/WG27, ISO/TC193, CEN/TC408, CEN/TC264, CEN TC 234), and end users (e.g. hydrogen industry, gas network operators and suppliers).

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 industrial needs and include measures to support transfer into industry by cooperation and by standardisation. An active involvement of industrial stakeholders is expected in order to align the project with their needs – both through project steering boards and participation in the research activities.

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 EMPIR project 20IND10 Decarb and how their proposal will build on those.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 1.9 M€ and has defined an upper limit of 2.3 M€ for this project.

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 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,
- 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 gas 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 the 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.

Time-scale

The project should be of up to 3 years duration.