

## Title: Metrology for hydrogen-enriched natural gas

### Abstract

Hydrogen is a key energy vector (carrier) in a future sustainable energy economy. It has the potential of providing a unique method of reducing Europe's dependency on fossil fuels by increasing the contribution of renewable energy sources, decarbonising the gas market and creating a zero-carbon economy. An appealing approach is "Power To Gas" - hydrogen produced by electrolysis with surplus electrical energy from photovoltaics or wind turbines (energy which would otherwise not be captured or used). To enable these developments, traceability for the chemical and physical parameters of hydrogen-enriched natural gas including its energy content, need to be established.

### Conformity with the Work Programme

This Call for JRP's conforms to the EMRP Outline 2008, section on "Grand Challenges" related to Energy and Environment on page 23.

### Keywords

Fuel gas, non-conventional energy gas, natural gas, biogas, power to gas, hydrogen, energy content, calorific value, amount of gas, state reconstruction.

### Background to the Metrological Challenges

Natural gas is increasingly being replaced by non-conventional energy gases. Including hydrogen in this is seen as one of the key remedies for Europe's decarbonisation strategy to a CO<sub>2</sub> free energy supply. Electrical energy can be converted to hydrogen and i) transported to the customer through the existing gas grid without building additional power lines and ii) stored in the pipelines and the existing gas storage facilities and used in times without sunshine and wind. Now that initial safety and material compatibility issues have been solved (at a hydrogen level of up to 10 %), precise knowledge of the calorific value and the volume under standard conditions are required for the determination of the energy delivered with any amount of gas (which is the key figure determining the commercial value). Consequently, the required level of uncertainty depends on the application and amounts to approximately 1 % at the household level and as small as possible at the import/export station.

A European approach is necessary because natural gas is a commodity transported and traded internationally. To achieve a free flow of gas through agreed gas quality parameters in the EU, the EC has issued a mandate to the European Committee for Standardisation (CEN) [1] where hydrogen is not covered, although mentioned. The European Association for the Streamlining of Energy Exchange - gas (EASEE-gas) has defined quality requirements for natural gas again without taking hydrogen into account.

The ISO 6974-series describes the determination of the composition of natural gas by gas chromatography. Although ISO 6974-3 describes the quantification of hydrogen, the application range is limited to 0.5 mol-%, far below the hydrogen content envisaged for the natural gas. Thus there is a real need to address the parameters defined as critical for the international trade of gas, such as the hydrogen content, to provide the necessary traceability to ensure comparative measurements throughout Europe.

### 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 the traceable measurement and characterisation of physical and chemical parameters of hydrogen enriched natural gas in the technologically relevant concentration range  $1\% < x_{H_2} < 20\%$ .

The specific objectives are

1. Providing calorific values of the main constituents of fuel gases ( $H_2$ ,  $CH_4$ ,  $C_2H_6$ ,  $C_3H_8$ ,  $C_4H_{10}$ ) at a reduced uncertainty level (standard uncertainty less than 0.1 %).
2. Providing validated instrument technologies for the measurement of physical parameters of hydrogen enriched natural gases and proof of applicability of current metering equipment for use with hydrogen enriched natural gas.
3. Providing confidence in the applicability of widely used equations of state (e.g. GERG 2004, AGA8-92DC, SGERG-88) to hydrogen enriched natural gases.
4. Validation of the traceability chain from the energy content of the primary reference gases to the energy content extracted from the gas grid by the end consumer and assigning uncertainties and providing calibration means for validation.
5. Creating a system of calibration gases necessary for realising objectives 2-4.

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 ENG01 and how their proposal will build on these.

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 (eg letters of support) is encouraged.

You should detail how your JRP results are going to:

- 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 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.

## Additional information

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

[1] EC mandate M/400, issued to CEN for standardisation in the field of gas qualities. Available at <ftp://ftp.cen.eu/CEN/Sectors/List/Environment/Mandates/>