

Title: Metrology for sustainable hydrogen energy applications

Abstract

Hydrogen is a sustainable energy solution to the depletion of fossil fuels and to the greenhouse effect. It is produced from renewable energy sources, such as water or bio-hydrocarbons and can be used for mobile and stationary energy applications as well as combined heat and power generation or transportation (for fuel cell electric vehicles or internal combustion engines). Currently, CEN/TC 268 is working to develop standards for hydrogen technologies in order to meet the requirements of Directive 2014/94/EU on the deployment of alternative fuels infrastructure. However, to support this standardisation process improved metrological methods and measurement techniques need to be developed that enable the safe introduction of hydrogen into the energy and transport sectors.

Keywords

Hydrogen, energy, impurity analysis, fuel cell, Directive 2014/94/EU, CEN, ISO, standardisation

Background to the Metrological Challenges

Hydrogen represents a unique clean and storable energy solution that could meet worldwide energy demands. Currently, priorities expressed in the business plans of standardisation bodies CEN/TC 268 'Cryogenic vessels and specific hydrogen technologies applications' [1] and ISO/TC 197 'Hydrogen technologies' [2] are to prepare standards for hydrogen technologies that meet the requirements of European Mandate M468 supporting Directive 2014/94/EU [3]. As part of this, new techniques for the storage and transport of hydrogen need to be developed and harmonised. This need has been backed by experts in ISO/TC 197 and a new working group (WG 25) has been proposed in order to help progress work related to ISO 16111 'Developing Transportable gas storage devices - Hydrogen absorbed in reversible metal hydride' [4].

For hydrogen to be widely used in industrial applications, power generation and transport applications, the specifications of the product need to be defined in order to ensure its quality. ISO 14687 'Hydrogen fuel' [5] currently defines this, but as end-user applications develop the need to redefine the characteristics of hydrogen fuels based on their application may arise. In support of this, ISO/TC 197 plans to revise ISO 14687 to cover the needs of Proton Exchange Membrane (PEM) fuel cell applications for road vehicles.

Further to this, current methods specified in ISO 14687-2 are not suitable for achieving the level of purity required for hydrogen in order to improve fuel cell performance. This is because the measurement of the fourteen components specified in the standard requires very low detection limits, which is both time-consuming and expensive as several sampling and analytical techniques must be set up. Moreover, a number of the 14 components are either unstable and/or reactive.

Techniques for hydrogen storage differ according to the phase of hydrogen and the selected application. The gas phase is commonly used for mobile applications (transportation), the liquid phase is used for space flights and the solid phase, absorbed in metal hydrides, can be used for both mobile and stationary applications. However, the current capacity for this latter technique is only 4 kg of hydrogen for every 100 kg of absorbent materials and present standards do not include validated methods for increasing the absorption capabilities of metal hydrides so that they can safely store large quantities of hydrogen. In addition to this, there is a lack of standardised and traceable methods for the measurement of the amount of hydrogen absorbed in metal hydrides and the different methods available (i.e. mass methods, mass and volumetric flowmeters) do not provide accurate results.

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 metrology research necessary to support standardisation in hydrogen energy applications in order to meet the requirements of Directive 2014/94/UE on the deployment of alternative fuels infrastructure.

The specific objectives are

1. To develop hydrogen quality specifications for fuel cell vehicles, including tolerance levels for impurities in hydrogen and limits for the degradation of fuel cells performance as per ISO 14687-2 'Hydrogen fuel - Product specification – Part 2: Proton exchange membrane (PEM) fuel cell applications for road vehicles 2012'.
2. To develop metrological methods and validate a multicomponent instrument for hydrogen impurity analysis. The multicomponent instrument should have optimised sampling analysis and meet the required detection limits as per business plans ISO/TC 197 "Hydrogen technologies" 2005-11-07 and CEN/TC 268 Cryogenic vessels and specific hydrogen technologies applications" 2014-04-04.
3. To develop test procedures for adaptive measurement control to cope with fluctuating gas composition and hence varying gas quality as indicated in JRC report <https://ec.europa.eu/jrc/sites/default/files/hcng-2014-final-report.pdf>.
4. To develop and validate traceable methods for measuring the hydrogen mass absorbed in storage tanks, with reference to ISO 16111 'Developing Transportable gas storage devices - Hydrogen absorbed in reversible metal hydride'.
5. To contribute to the standards development work of the key European and International Standards Developing Organisations to ensure that the outputs of the project are aligned with their needs, communicated quickly to those developing the standards and to those who will use them, and in a form that can be incorporated into the standards at the earliest opportunity.

The proposed research shall be justified by clear reference to the measurement needs within strategic documents published by the relevant Standards Developing Organisation or by a letter signed by the convenor of the respective TC/WG. EURAMET encourages proposals that include representatives from industry, regulators and standardisation bodies actively participating in the projects.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 0.4 M€, and has defined an upper limit of 0.5 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 30 % of the total EU Contribution to the project. Any deviation from this must be justified.

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 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 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.

Additional information

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

[1] Business plan CEN/TC 268 Cryogenic vessels and specific hydrogen technologies applications, 2014-04-04

[2] Business plan ISO/TC 197 Hydrogen technologies, 2005-11-07

[3] Directive 2014/94/EU of the European Parliament and of the Council on the deployment of alternative fuels infrastructure

[4] ISO 16111 Developing Transportable gas storage devices - Hydrogen absorbed in reversible metal hydride

[5] ISO 14687-2 Hydrogen Fuel - Product Specification - Part 2: Proton exchange membrane (PEM) fuel cell applications for road vehicles, 2012