EMPIR Call 2016 – Energy, Environment, Normative and Research Potential

Selected Research Topic number: **SRT-g07**
Version: 1.0

Title: Metrology for Hydrogen Vehicles

Abstract

Hydrogen vehicles are starting to be introduced across Europe; the implementation of these vehicles will help Europe to meet targets for lowering carbon dioxide levels and reducing reliance on imported fuels and non-renewable sources. A current barrier for introducing these technologies arises from European Directive 2014/94/EU which specifies several standards that must be followed by all European hydrogen refuelling stations; due to a lack of metrological infrastructure for this new sector several measurement challenges have been identified by stakeholders that currently prevent a hydrogen market from being realised in the near future. These measurement challenges must be addressed before the hydrogen market can launch.

Keywords

Hydrogen, hydrogen vehicles, renewable energy, fuel cell, refuelling stations, gas analysis, flow metering, Directive 2014/94/EU

Background to the Metrological Challenges

Hydrogen fuel cell vehicles have been trialled in the market with successful results, and the number of hydrogen refuelling stations across Europe are steadily growing to support the hydrogen infrastructure. However, this industry is still in its infancy; the stakeholders have identified several prominent measurement challenges that must be addressed before a hydrogen market can progress. These measurement challenges arise from international regulations and recommendations; some enforced by European Directive 2014/94/EU. The European Commission has issued a mandate [1] to CEN and CENELEC to draft European standards for alternative fuels infrastructure. Compliance with the standards developed by CEN and CENELEC and recognised by the European Commission is one way of demonstrating compliance with the essential requirements of Directive 2014/94/EU.

For example, in order that consumers may be correctly billed when refuelling, the hydrogen dispenser must provide a reading for the quantity of hydrogen dispensed, as specified in ISO/DTR 19880-1. However, no reliable standards for hydrogen metering are currently available in Europe; flow meters must be developed.

In addition, to ensure that particulates do not reach the fuel cell system (causing potential fuel cell degradation and damage to vehicle gas valves), European Directive 2014/94/EU stipulates that all hydrogen provided to a fuel cell vehicle must comply with the purity specifications in ISO 14687, where particulate content in hydrogen leaving the refueller nozzle must be less than 1 mg/kg. However, the method recommended by ISO 14687 has not been validated against traceable standards nor is it applicable for sampling at the refuelling nozzle without using a pressure regulator, which could cause a bias. Work is therefore required to develop a suitable, validated method for particulate measurement.

Further, it is known that impurities in the hydrogen can cause degradation of the fuel cell vehicle and dramatically reduce fuel cell lifetime. ISO 14687 provides maximum limits for 13 gaseous impurities ranging from 4 nmol mol^{-1} to 300 µmol mol^{-1} yet currently the calibration gas standards and validated methods for measuring these 13 impurities are not all available. Metrology to support the introduction of appropriate, low cost analysis instruments and services is therefore required.

Finally, within hydrogen refuelling stations, greater hydrogen quality control is required, for which commercial online analysers must be tested and validated for use with hydrogen. In addition, the refuelling stations rely on the use of high pressure sampling vessels to transport samples of fuel cell hydrogen from the station to the laboratories that are performing ISO 14687 purity analysis. Stakeholders have faced issues from contamination of air or residual moisture during sampling, and additionally sampling vessels have not yet been tested to ensure they keep impurity levels in hydrogen stable during transport. This research must be carried out to

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ensure representative samples can be provided for analysis, otherwise hydrogen that is safe for fuel cell vehicles may be incorrectly labelled as contaminated, or even worse, contaminated hydrogen could be supplied to consumers.

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 development of metrology to support the safe use of hydrogen in refuelling stations for the transport sector.

The specific objectives are

1. To develop a metrological framework for testing hydrogen meters used to measure the mass of hydrogen dispensed into a fuel cell vehicle from a refuelling station. The metrological and technical requirements stipulated in OIML R 139-1 and international standard SAE J2601 - Fuelling Protocols for Light Duty Gaseous Hydrogen Surface Vehicles should be followed, with a target accuracy of 1%.
2. To support hydrogen purity testing as specified in ISO 14687 by developing traceable offline gas analysis methods, stable and accurate primary reference gas mixtures and the metrological tools to enable the introduction of low cost gas analysers suitable for use by commercial gas analysis laboratories. In addition, to develop a robust method for accurately performing online measurement of particulates (to determine whether levels are above or below 1 mg/kg) in hydrogen provided at the refuelling station, as specified in ISO 14687.
3. To perform purity measurements of hydrogen following the implementation of quality control techniques specified in ISO/AWI 19880-8 and validate continuous online hydrogen purity analysers for measuring canary species (the key impurities that identify a refueller fault) at the hydrogen refuelling station.
4. To develop a robust protocol for taking a representative sample of hydrogen gas from a refuelling station and testing suitability of high pressure sampling vessels for delivering hydrogen to gas analysis laboratories for offline purity analysis; as required by ISO 14687.
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/CENELEC) and end users (hydrogen industry, vehicle manufacturers and suppliers).

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 expected achievements of the EMPIR project 15NRM03 “Hydrogen” 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 hydrogen industry 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.

Additional information

[1] M/533 EN, COMMISSION IMPLEMENTING DECISION C(2015) 1330 of 12.3.2015 on a standardisation request addressed to the European standardisation organisations, in accordance with Regulation (EU) No 1025/2012 of the European Parliament and of the Council, to draft European standards for alternative fuels infrastructure (http://ec.europa.eu/growth/tools-databases/mandates/index.cfm?fuseaction=search.detail&id=552)