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# Safe Hydrogen technologies for Transport and Energy

**EU Policy Related to Hydrogen**

EU Framework Programmes have given increasing levels of funding to fuel cell and hydrogen technologies. In Horizon 2020, the current EU Research and Innovation funding programme (2014 - 2020), the fuel cell and hydrogen technologies are considered one of the solutions for enabling the EU to reach its ambitious goals in reduction in greenhouse gas emissions and increase of renewables and energy efficiency.

In May 2014 the European Council has decided for a follow up of the Fuel Cells and Hydrogen Joint Undertaking (FCH JU), now called FCH2JU, which will run for from 2014 and 2024 as a public-private partnership between the European Commission, European industry and research organisations to facilitate the commercial deployment of fuel cell and hydrogen technologies.

In the area of the market take-up of alternative fuel solutions for transport, the Clean Power for Transport package aims at facilitating the development of a single market for alternative fuels for transport in Europe (COM(2013) 17 and 18). This European alternative fuels strategy include also a proposal for the deployment of alternative fuels infrastructure (under approval in 2014). One of its goals is to guarantee that a hydrogen vehicle is able to travel and tank at refuelling stations all across the whole EU territory.

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## Why Hydrogen?

Hydrogen is not a primary energy source such as coal or gas but is an energy carrier (similar to electricity) and can store and deliver energy in a widely useable form. It is one of the alternative fuels considered for future, low-carbon transport applications. When produced from renewable sources it provides pollution-free transport, without carbon dioxide (CO2) emissions, and decreases our dependence on dwindling oil reserves. However, developments are still needed before hydrogen can be exploited in the same way as conventional fossil fuels.

## How does JRC-IET contribute to the Safe Use of Hydrogen?

Safety, performance and end-use efficiency must be all assured before mass public use of hydrogen is possible. This is the motivation behind the laboratories of the IET Institute, as it supports the EU drive towards clean and efficient transport technologies. The scientists, engineers, computer modellers and technical staff of this project perform pre-normative and underpinning research for the development and improvement of performance characterisation methodologies for hydrogen storage, detection and safety. In addition, they provide scientific and technological (S&T) support to EU and international standardisation and regulatory bodies in this field, and act as a reference on hydrogen storage, detection and safety-related activities in the Fuel Cells and Hydrogen Joint Undertaking (FCH2JU).

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Dedicated state-of-the-art testing facilities include those for:
• testing full-scale high-pressure hydrogen (and natural gas) tanks for vehicles;
• performance characterisation of materials for solid-state hydrogen storage;
• performance characterisation of hydrogen sensors for safety.
• numerical modelling centre for the simulation of hydrogen releases, dispersion and safety scenarios by means of computational tools.

These facilities are completed by a small group collecting and updating performance data for the monitoring of hydrogen technologies development.

## Compressed Hydrogen Storage

Storage of gases under pressure, including hydrogen, is a rather well known technique. However, the use of hydrogen tanks in vehicles, and in particular the challenge of using very high pressures, requires new safety and performance studies. The Gas Testing Facility GasTeF is made of the basic components needed for a hydrogen refuelling station and is used for carrying out tests on high-pressure hydrogen vehicle tanks.
Typical on-going tests are at present:

**Hydrogen refuelling:** a typical refuelling of a hydrogen vehicle occurs in approximately 3 minutes and must ensure that the tank reaches its maximal capacity. On the other side, safety limits in term of pressure and temperature may not be trespassed. GasTeF simulates the refuelling process under every expected environmental condition, while monitoring pressure and temperature evolution inside and outside the tank using an ad hoc designed thermocouple array system.

**Tank testing under real operative conditions:** vehicle tanks are repeatedly fast-filled using real gas and emptied slowly at least 1,000 times to simulate their lifetime in a road vehicle. The maximum pressure is 700 bar and the filling time is less than 3 minutes. During this cycling process, the tank is monitored for leaks and permeation rates, and the internal and external temperatures measured.

## Hydrogen Sensors and Safety

The Sensor Testing Facility assesses the performance of hydrogen sensors under a wide range of environmental conditions. Hydrogen cannot be detected by human senses making the use of suitable detection devices (sensors) necessary. Since hydrogen leaks can be hazardous if not detected quickly, reliable detection systems need to be tested, and their performance validated so that they can be effectively deployed wherever hydrogen is produced, stored, distributed or used.
In collaboration with international and European partners, the facility is used in inter-laboratory experimental programmes aimed at preparing guidelines for testing hydrogen sensors, assessing their performance and reliability, and providing feedback on the results to sensor manufacturers and end users.

## Numerical Modelling

The widespread use of hydrogen requires the distribution and storage of large quantities of hydrogen. Bearing this in mind it is essential to understand the safety implications of potential accident situations. The modelling group makes use of Computational Fluid Dynamics (CFD) tools to simulate release, dispersion and combustion of hydrogen and to compare with releases of other gases (e.g. natural gas) to understand and minimise the risks involved in hydrogen use.

## Solid-State Hydrogen Storage

The Solid-State Hydrogen Storage Testing Facility is dedicated to the testing and performance assessment of potential hydrogen storage materials. The laboratory is equipped with instruments that can measure how much and how quickly materials can store and release hydrogen and under which conditions. Instrumentation covers a variety of testing conditions suitable for the investigation of most materials. The research is complemented by micro-structural analysis capabilities.
In view of many disparities on hydrogen sorption data still present in the literature, the laboratory focuses on comparing measurements performed using different techniques. International inter-laboratories comparisons have been organised to identify discrepancies and to suggest improvements in testing procedures to achieve reliable, reproducible and accurate data. The laboratory is also involved in FCH JU projects for testing hydrogen storage materials. It acts as a reference laboratory to interested research groups developing new materials which lack the appropriate analytical capabilities or need 'second opinion' measurements. Finally, the laboratory is a training ground for aspiring young scientists active in the challenging field of hydrogen storage.