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## Overview of European and international regulation and standardisation activities

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### ABSTRACT:

*International technical committees have been created inside the ISO and IEC organisations so as to facilitate the world-wide industrialisation and commercialisation of hydrogen systems and fuel cells. The working group ISO TC 197 entitled Hydrogen Technologies has already published international standards and is very active in the edition of standards for all the hydrogen chain from production to end use. The working group IEC TC 105 focuses on fuel cell technologies. It is also currently drafting many standards for fuel cell applications (mobile, stationary, portable and micro fuel cells). At an international level, the UNECE is actively working for the publication of two Global Technical Regulations for vehicles fuelled with gaseous or liquid hydrogen. And, finally, many European projects intend to facilitate the implementation of a harmonised and well-adapted regulation and standardisation framework.*

**KEYWORDS:** hydrogen, fuel cells, regulation, standards, safety.

## 1. Introduction and definitions

Hydrogen based economy and associated energy converters fuel cell systems are meant to be part of the response to increasingly worrying ecological and economical issues embodied by either global warming or the depletion of fossil energy sources.

Indeed, hydrogen shows many benefits in the field of air pollutant as its combustion reduces pollutant and greenhouse gas emissions (carbon dioxide...). Besides, energy conversion yields seem to be better and finally it allows fossil fuels dependant economy to rely on other energy loops. Hydrogen can virtually be produced from a wide variety of domestic sources. It can also provide a storage medium for intermittent and seasonal peak energy needs.

Hydrogen can be used as an energy carrier for many traditional technologies such as cars (direct combustion engines using hydrogen or hydrogen based mixtures, fuel cell systems), electrical plants, systems that provide heat and electricity for buildings, remote power unit systems, backup systems... .

Hydrogen technologies are under test across Europe (stationary power units, boats, city buses, cars...). Different challenges are being faced: technological, hydrogen production, hydrogen storage,... . Along with public acceptance, authorities legal approval for demonstration projects need to be gained.

In this context, regulation and standardisation will have to make their way to ease hydrogen technologies implementation.

A regulation could be a national or European statutory text that set compulsory expectations. It provides rules that are adopted by governmental bodies so as to regulate a particular kind of activity. Whereas standards do not have any legally compelling power, unless a regulation refers to this standard (harmonised standards).

Regulations are a mean to preserve public interests (health & safety or environmental issues for instance). Standards could suggest technical mean to fulfil legal expectation that serves public interests or could be for instance a way to standardised products and interface in order to ensure their world-wide technical compatibility.

## 2. Standardisation related to hydrogen and fuel cells

### 2.1. General overview

Standardisation related to Hydrogen systems is in the hands of the International Standardisation Organisation, which initiated in 1990 the ISO TC 197 dedicated to fuel cells. The scope of ISO TC 197 working group in order to develop and edit standards in the field of systems and devices for the production, storage, transport, measurement and use of hydrogen. As for fuel cell systems, they are considered as an electric device and therefore fall within the scope of the International Electrotechnical Committee. This Committee created in 1996 the IEC TC 105 dedicated to fuel cell systems with the purpose of preparing international standards regarding fuel cell (FC) technologies for all FC applications such as stationary FC power plants, FC for transportation, FC propulsion systems, auxiliary power units or portable FC power generation systems.

International standards, which are published by IEC and ISO should be transposed by CENELEC<sup>1</sup> and CEN<sup>2</sup> respectively and then would be applied at a national level. The illustration below shows the interfaces between International, European and national standardisation levels.

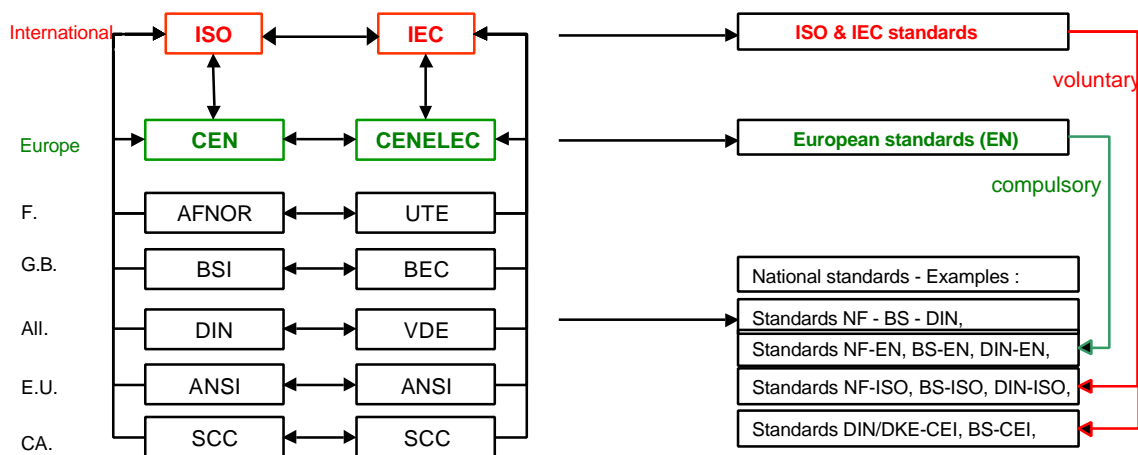


Illustration 1: liaisons between international, European and national standardisation

Each country can participate to the ISO and IEC standardisation activities:

- Whether as a P-member, in this case it can vote drafts which circulate for vote,
- Or as an O-member, in this case it can only participate to meetings without voting.

ISO TC 197 P-members include Belgium (IBN), Denmark (DS), France (AFNOR), Germany (DIN), Italy (UNI), Netherlands (NEN), Spain (AENOR), Sweden (SIS), USA (ANSI), United Kingdom (BSI), Norway (SN), etc.

Among IEC TC 105 P-members, we can find Canada, Germany, China, France, Denmark, Italy, United Kingdoms, United States, Japan, Netherlands, Spain, etc.

1 European Committee for Electrotechnical Standardization  
2 European Committee for Standardisation

During the standardisation process, several steps have to be made before the publication of a new standard as an International Standard. These steps are listed in the table below.

Stage	Contents	Voting period
Proposal	A new work item proposal (NP) is submitted for vote by the members of the relevant TC/SC <sup>3</sup> to determine the inclusion of the work item in the programme of work	3 months
Preparatory	A working group is set up Successive working drafts (WD) may be considered until the working group is satisfied that it has developed the best technical solution to the problem being addressed.	
Committee	First committee draft (CD) is available, it is registered by the ISO Central Secretariat. It is distributed for comments and, if required, voting, by the P-members of the TC/SC. Several CD may be required until consensus is reached.	3 to 6 months
Enquiry	A Draft International Standard is proposed and voted. If DIS is disapproved, a new one circulates for vote	5 months
Approval	Final DIS circulates for final vote. If FDIS is disapproved, a new one circulates for vote	2 months
Publication	The final text (with minor editorial changes, if necessary) is sent to the ISO Central Secretariat which publishes the International Standard.	2 months
Review	All International Standards are reviewed at least once every five years by the responsible TCs/SCs. P-members vote if the IS should be confirmed, revised or withdrawn	

*Table 1: Main stages of standardisation process*

As the duration to obtain international standards for Hydrogen and Fuel Cell systems may be quite long whereas sometimes standardisation can be an urgent need for new systems, intermediate documents can be produced by the standardisation technical committee (ISO or IEC) before international standards are made available.

All, these documents facilitate deployment of new Hydrogen or FC systems. The table below lists these standardisation committees output documents.

Deliverable	Type	Contents
Standards (IS)	Normative Consensus at international level	Standardisation in a specified technological field
Technical Specification (TS)	Normative Consensus within the technical committee or subcommittee	Similar to the standard but international consensus is not reached or standardisation is not possible yet
Technical Report (TR)	Informative Consensus within the TC or SC	An informative document containing information of a different kind from that normally published in a normative document.
Publicly Available Specification (PAS)	Normative Consensus within the working group	It is published to facilitate the development of a technology, before IS is published.

*Table 2: Main deliverables of ISO and IEC*

<sup>3</sup> Technical Committee and Sub-Committee

The illustration below illustrates the standards development processes and associated deliverables.

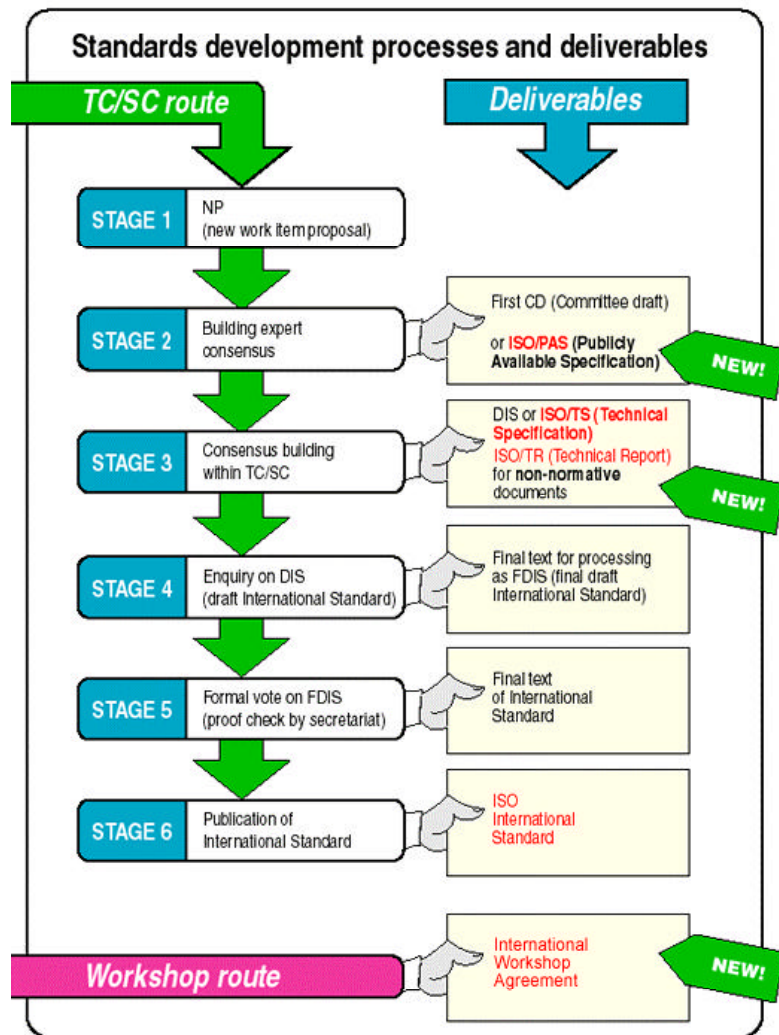


Illustration 2

## 2.2. ISO TC 197 activities

### 2.2.1. Published standards

Reference	Title
ISO 13984 : 1999	Liquid Hydrogen - Land vehicle fuelling system interface
ISO 14687 : 1999 & ISO 14687 : 1999/Cor 1 : 2001	Hydrogen fuel - Product specification
ISO/PAS 15594	Airport H2 fuelling facility
ISO/TR 15916 : 2004	Basic considerations for the safety of hydrogen systems

Table 3: Documents already published by ISO TC 197

2.2.2. Current standardisation activities of ISO TC 197

The following table proposes an update of ISO TC 197 working groups, activities and progress.

WG	Draft Standard	Update	Target date for IS
1	ISO/DIS 13985.3 Liquid H2 - Land vehicle fuel tanks	DIS has been approved . FDIS should be available in July	2006
5	ISO/FDIS 17268 Gaseous H2 - Land vehicle filling connectors	Joint working group (JWG) with ISO/TC 22(road vehicles) FDIS has been approved IS should be available in June 2006  The IS should be revised at the end of 2006	2006
6	ISO/DIS 15869-1 to 15869-5 Gaseous H2 and hydrogen blends - Land vehicle fuel tanks - Part 1: General requirements	JWG with ISO/TC 58/SC 3 (Gas cylinders- Design) and ISO/TC 22  The 5 parts have been consolidated in one document for a 2 <sup>nd</sup> DIS under vote in 2006	2007
8	ISO/DIS 22734-1 H2 generators using water electrolysis process. Part 1 : Industrial and commercial applications	DIS has been approved FDIS should be available in July 2006	2007
	ISO/CD 22734-2 H2 generators using water electrolysis process. Part 2 : Residential applications	CD currently under vote	2008
9	ISO/DIS 16110-1 H2 generators using fuel processing technologies. Part 1 : Safety	DIS has been approved	2007
	ISO/CD 16110-2 H2 generators using fuel processing technologies. Part 2 : Procedures to determine efficiency	CD will circulate for vote	2008
10	ISO/CD 16111 Transportable gas storage devices -- H2 absorbed in reversible metal hydride	DIS has been approved  The editing committee work on the draft technical specification is completed.	IS : end 2007 TS : 06/2006
11	ISO/AWI TS 20012 Gaseous H2 - Service Stations	Draft of TS should be available in October 2006	2007
12	ISO 14687-2 Hydrogen Fuel — Product Specification — Part 2: Proton exchange membrane (PEM) fuel cell applications for road vehicles	There will be a technical specification, which should be available in June 2006 and then a draft standard (CD in 2007)	TS : 2006 IS : 2010
13	ISO/AWI 26142 Hydrogen detectors	Work has just started for this new working group	2008

Table 4: Update of ISO TC 197 activities (10/05/2006)

### 2.2.3. Existing liaisons

Most important liaisons of ISO TC 197 with other standardisation committees are:

- ISO/TC 11 Boilers and pressure vessels,
- ISO/TC 22 Road vehicles,
- ISO/TC 58/SC 3 Gas cylinder design,
- ISO/TC 220 Cryogenic vessels,
- and IEC/TC 105 Fuel cell technologies.

Regarding the liaison with ISO TC 22, ISO/TC 22 and ISO/TC 197 jointly proposed in 2004 a new work item proposal on "Fuel cell road vehicles - Safety specifications - Part 2: Protection against hydrogen hazards for vehicles fuelled with compressed hydrogen" (ISO DIS 23723-2). The International Standards should be available in 2007.

## 2.3. IEC TC 105 activities

### 2.3.1. Published standards

Reference	Title
IEC/TS 62282-1 (2005-03) English and French	Fuel cell technologies - Part 1: Terminology Revision of the document is planned in 2006, so as to integrate documents of FCTESTNET Project <sup>4</sup> The glossary will be available as Edition 2 of IEC/TS 62282-1
IEC 62282-2 (2004-07) English and French	Fuel cell technologies - Part 2: Fuel cell modules
IEC 62282-3-2 (2006-03) English and French	Fuel cell technologies - Part 3-2: Stationary fuel cell power systems - Performance test methods
IEC/PAS 62282-6-1 (2006-02) English	Fuel cell technologies - Part 6-1: Micro fuel cell power systems - Safety

Table 5: Documents published by IEC TC 105

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<sup>4</sup> FCTESTNET is a European Project (achieved in 006) which aimed at compiling and harmonising testing procedures for fuel cells, stacks and systems

### 2.3.2. Current standardisation activities of IEC TC 105

The following table makes an update of activities of each WG of IEC TC 105.

WG	Draft Standard	Update	Target date for IS
3	IEC 62282-3-1 Stationary fuel cell power systems – Safety	Committee Draft for Vote is currently circulating FDIS should be available in December 2006 Has been proposed on the basis of CSA/ANSI Z21.83 and NFPA 853	2007
5	IEC 62282-3-3 Stationary fuel cell power systems – Installation	CD was proposed in 2005	2009
7	IEC 62282-5-1 Fuel cell technologies - Part 5-1: Portable fuel cell power systems - Safety	CDV has been approved FDIS should be available in 2006	2006
8	IEC 62282-6-1 Fuel cell technologies - Part 6-1: Micro fuel cell power systems - Safety	CDV was voted in 2005. A revised committee draft will be distributed as a committee draft for vote (CDV) by 2006.	2007
9	IEC 62282-6-2 Fuel cell technologies - Part 6-2: Micro fuel cell power systems - Performance	CD circulated for vote in January 2006	2008
10	IEC 62282-6-3 Fuel cell technologies - Part 6-3: Micro fuel cell power systems - Interchangeability	No new document until the New Work Item Proposal in 2004. CD should be available in August 2006	2009

Table 6: Update of IEC TC 105 activities (10/05/2006)

### 2.3.3. Liaisons with IEC TC 105

Existing liaisons are:

- ISO/TC 22/SC 21 : Road Vehicles – electrical vehicles
- ISO/TC197: Hydrogen Technologies
- IEC/TC 31: Equipment for explosive atmospheres

A liaison between TC 105 and the EC JRC (European Commission Joint Research Center) has also been agreed.

## 2.4. European standardisation activities

### 2.4.1. European Hydrogen and Fuel Cell Technology Platform (EHP)

The main goal of the European Hydrogen and Fuel Cell Technology Platform (EHP) is to facilitate and accelerate the development and deployment of cost-competitive, world class European hydrogen and fuel cell based energy systems and component technologies for applications in transport, stationary and portable power. The platform is steered by a high level Advisory Council. The establishment of the HFP has been facilitated by the European Commission. The structure of the EHP is illustrated below.



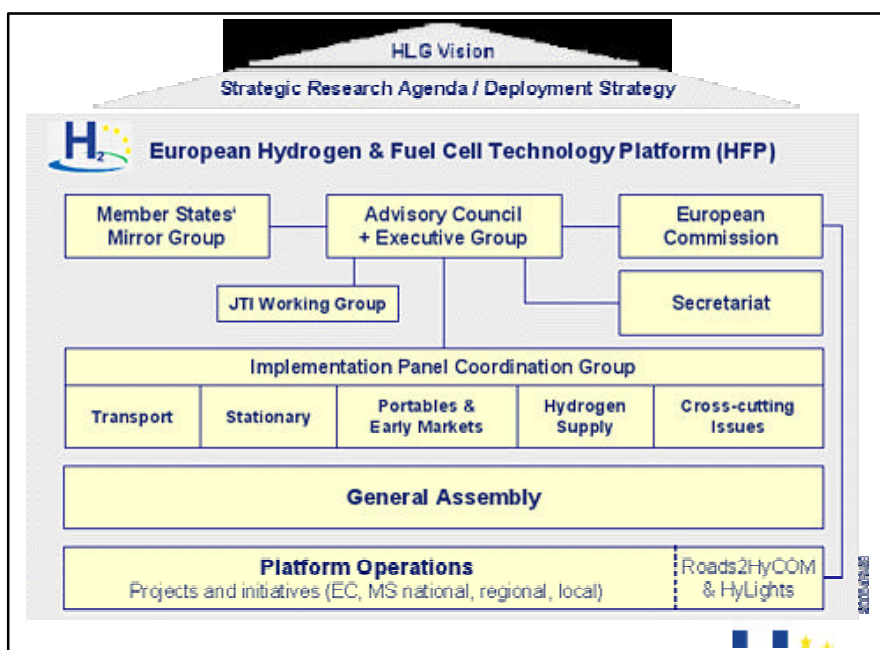


Illustration 3: EHP structure

The main objective of the Initiative Group on Regulation Codes and Standards is to accelerate the implementation of harmonised regulations and standards for hydrogen and fuel cell systems, commensurate with requirements for public safety and use for hydrogen and fuel cell technologies in the European Union. The IG RCS aims also at providing guidance and recommendations to the Advisory Council (AC) and competent bodies at EU level and providing inputs to the Steering Panels of the Strategic Research Agenda (SRA) and Deployment Strategy (DS).

The long-term objective is to develop and adopt a European regulation well adapted for hydrogen and fuel cell technologies. IG RCS works in close collaboration with:

- European projects dealing with regulation, codes and standards (HYSAFE, HarmonHy, HySociety, etc.),
- International, European and national standardisation committees (ISO, IEC, CEN, CENELEC, ICC<sup>5</sup>, NFPA<sup>6</sup>, etc.),
- The other Initiative Groups of the Platform.

#### 2.5. Joint Working Group CEN/CENELEC: Gas appliances - Fuel cell gas heating appliance - Fuel cell gas heating appliance of nominal heat input inferior or equal to 70 kW (prEN 50465)

This working group was initiated by Germany in order to accelerate the edition of a European standard on fuel cell systems. This under progress standard will be published as a European one and will then be proposed at international level.

<sup>5</sup> International Council Code (Etats-Unis)

<sup>6</sup> National Fire Protection Association (Etats-Unis)

### 3. Regulation related to hydrogen and fuel cells

#### 3.1. General overview

Up to now, in Europe, there is no specific regulation (Directive or International rule) dedicated to hydrogen and/or fuel cell systems.

##### 3.1.1. Stationary applications

Regarding stationary applications, systems should comply with relevant European Directives. Among these Directives, we can list:

Directive	Reference
Low voltage	73/23/EEC
Simple pressure vessels	87/404/EEC 90/448/EEC
Electromagnetic compatibility	89/336/EEC 92/31/EC 98/13/EC
Machine	98/37/EC
Equipment intended for use in potentially Explosive Atmospheres (ATEX)	94/9/EC
Pressure equipment	97/23/EC
Gas appliances	90/396/CE

Table 7: Directives that can be applied for H<sub>2</sub> and FC systems

These Directives are «New Approach» Directives. They set safety objectives. Means to reach these requirements are detailed in «harmonised standards». Up to now, there is no «harmonised standard» for hydrogen and fuel cell systems.

In France, there are many regulatory texts related to systems, using hydrogen as a chemical product depending on the context of use. Indeed, hydrogen systems safety requirements concern various regulation areas: health & safety at work, pressure vessels, electrical devices, transportation, industrial hazards etc. Most of these regulations evolve from European directives.

As far as stationary applications are concerned such as Hydrogen refuelling stations, fuel cell cogeneration unit, etc they should (among others) comply with industrial hazard related regulations. The Directive 96/61/CE related to major accidents (or its equivalent at national level) is therefore applicable. This Directive dedicated to industrial risk reduction, also known as the SEVESO Directive, concerns hazardous industrial plants. Hazardous plants are ranked in accordance with a formal list of activities and products and related thresholds. Hydrogen production falls within this list (Annex I - activity n°4.2).

It is interesting to point out that this Directive mentions that research / demonstration activities do not fall within the scope and constraints of its scope. This could concern for instance hydrogen refuelling stations built in the framework of a demonstration project.

### 3.1.2. Mobile applications

Today, there is no legislation, specifically dedicated to fuel cell and hydrogen vehicles. Nevertheless, hydrogen vehicles must be at some point approved so as to run on public roads with passengers onboard.

In this context, the UNECE (United Nations Economic Commission for Europe) aims at providing a regulation for hydrogen vehicles. The GRPE<sup>7</sup> of the WP29<sup>8</sup> in Geneva works on it. The GRPE created an ad-hoc working group to publish regulations dedicated to hydrogen vehicles. These regulations are based on consensus between countries' members. Besides, there should not be contradictions with standards under development. Draft regulatory texts come from the EHP project.

This ad-hoc group will propose two regulations dedicated to hydrogen vehicles and their components (liquid and gaseous) in the framework of the 1998 Agreement, which includes almost all countries (Europe, Japan, United States, China, Canada).

GTRs<sup>9</sup> should concern vehicles equipped with:

- a fuel cell fuelled by hydrogen,
- or a hydrogen internal combustion engine,
- and/or auxiliary power units running on hydrogen,
- and/or hydrogen storage equipment (gaseous, liquid, solid).

These GTRs will be made available in the next decade. There will not be any intermediate step with the introduction of an ECE regulation. In this perspective, the European Commission plans to publish a European Regulation on Hydrogen vehicles that compiles the two ECE draft Regulations. There will be two: documents: a political one for discussion and adoption in the European Parliament and in the Council and a technical one discussed and adopted at Commission level .

## 4. European projects dealing with RCS activities

In Europe, there are projects that deal specifically with regulation, codes and standards related to hydrogen and fuel cell systems. These projects aim at undertaking prenormative research towards harmonised regulations and standards. Projects' examples are given below.

### 4.1. HySociety project

HySociety is an European FP6<sup>10</sup> project aims to support the introduction of a safe and dependable hydrogen-based society in Europe. It addresses not only non-technical barriers such as codes and standards for infrastructure implementation, public safety concerns, social and economic impacts, but also the changing trends in industrial structures and in the European economy. It aims at analysing gaps and needs in the field of regulation, codes and standards for hydrogen systems and promotes international co-operation and dissemination for hydrogen regulation, codes and standards.

### 4.2. HarmonHy project

HarmonHy project is an European FP6 project which intends to make an assessment of activities on hydrogen and fuel cell regulations, codes and standards on a world-wide level. On this basis gaps will be identified and propositions to solve fragmentation will be made. It intends to realise the state of the art of current RCS activities related to hydrogen, as an energy carrier and of prenormative research (on the basis of current demonstration projects for hydrogen and fuel cell systems). Finally, HarmonHy intends to elaborate a proposal for action plan and roadmap for further work towards regulations, codes and standards harmonisation on an international level.

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<sup>7</sup> Working Party on Pollution and Energy (GRPE)

<sup>8</sup> World Forum for Harmonisation of Vehicles Regulations (WP29)

<sup>9</sup> Global Technical Regulations

<sup>10</sup> Framework Programme (EU)

### 4.3. HYSAFE Network of Excellence

The European Network of Excellence HYSAFE – Safety of Hydrogen as an Energy Carrier – is a FP6 programme which started in 2004 for a 5 years duration. The HySafe network focuses on safety issues relevant to improve and co-ordinate the knowledge and understanding of hydrogen safety and support the safe and efficient introduction and commercialisation of hydrogen as an energy carrier of the future, including the related hydrogen applications. The overall goal of HySafe is to contribute to the safe transition to a more sustainable development in Europe by facilitating the safe introduction of hydrogen technologies and applications.

Among its main objectives, HySafe shall provide contributions to EU safety requirements, standards and codes of practice. A work package co-ordinated by INERIS is specifically dedicated to this activity.

Main missions of this WP consist in:

- Ensuring by active participation to targeted standardisation (ISO, IEC) / UN ECE groups that consensual knowledge on hydrogen safety is adequately taken into account in the process of building new standards and regulatory requirements,
- Promoting consensus within EC countries on safety related standardisation / regulatory aspects,
- Following progress of appropriate RC&S related to hydrogen technologies,
- Following and report on the progress made by the European Hydrogen and Fuel Cell Technology Platform (EHP) and the HarmonHy project,
- Providing up to date information to HySafe partners on the status of standardisation and UN ECE regulatory development through our webpage,
- Reporting on standardisation and regulatory development and related WP16 contribution to the HySafe partners.

HYSAFE WP16 intends also to work in close co-operation with other EU and international projects in the field of prenormative research.

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