

European Integrated Hydrogen Project - Phase 2 - Results

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On behalf of the *European Integrated Hydrogen Project EIHP2* **EIHP**



Hydrogen Fuelled Vehicles - Challenges to be Resolved



TÜV

Vehicle
licensing



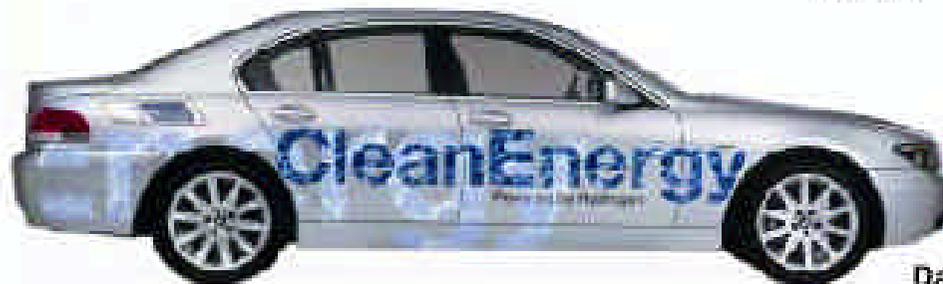
Filling Station



Parking,
Garaging



Tunnels



Data Transmission



Emergency
Services



Accidents



Repairs/maintenance



Service



European Integrated Hydrogen Project - Objectives

Objectives: Initiate and provide inputs for regulations on an EU and global level for the approval of hydrogen fuelled road vehicles, hydrogen refueling infrastructure and the relevant interfaces.

Phase 1: 1998 – 2000

- **Main focus on hydrogen fueled vehicles**
- **Vehicle - development of drafts for UNECE regulations**
- **Infrastructure - only very limited analysis**
- **Safety studies and limited computer simulations**

Phase 2: 2001 - 2004

- **Enhanced focus on hydrogen vehicle refueling infrastructure**
- **Vehicle - efforts for licensing and approval of hydrogen vehicles on a global level (GTR)**
- **Infrastructure - refueling stations and fueling interface - EU and North America**
- **Safety studies, computer simulations and first limited safety tests**



Results Achieved in EIHP2

WP1: Overall Co-ordination - EIHP2 webpage at <http://www.eihp.org>

WP2: Refuelling Station

- Input to risk assessment studies, risk reducing measures and recommendations of aspects to be addressed in future development of regulations and standard
- Gaseous hydrogen vehicle refuelling stations – Working Draft prepared
- Risk based maintenance and inspection protocol for hydrogen refuelling stations

WP3: Refuelling Interface

- it was concluded that for non-articulated single deck city buses an on-board storage pressure between 20 and 35MPa is the optimum
- better understanding of the thermodynamic flow phenomena occurring during the filling at high pressures and software development for a better definition of the tank filling process and a better tank design procedure
- different LH₂ refuelling procedures have been examined considering requirements and different fuelling concepts while testing nozzles and considering different operating parameters



Results Achieved in EIHP2 (2)

WP4: Vehicle

- Work on the draft ECE regulations has progressed to the most advanced state possible. Both the LH₂ draft and the CGH₂ draft have now reached the status of official documents at GRPE (working party on pollution and energy, subsidiary body of WP.29 the world forum for harmonisation of vehicle regulations, member of UNECE) and could be forwarded to WP.29 for political voting
- In terms of periodic inspection a draft amending the directive 96/96/EC has been created and prepared for forwarding to ACEA/OICA (European/world association of automobile manufacturers) in order to start the approval process
- Storage systems for liquid and compressed gaseous hydrogen have been manufactured and their safe and reliable functioning has been proved
- Automobiles using these H₂ storage systems have been developed or are currently progressing through the design phase
- Several meetings/ workshops were attended: a workshop with US authorities, several meetings with ISO TC 197, meetings with ISO and GRPE, a workshop with ELEDRIE, attendance to the launch of the European H₂ Technology Platform



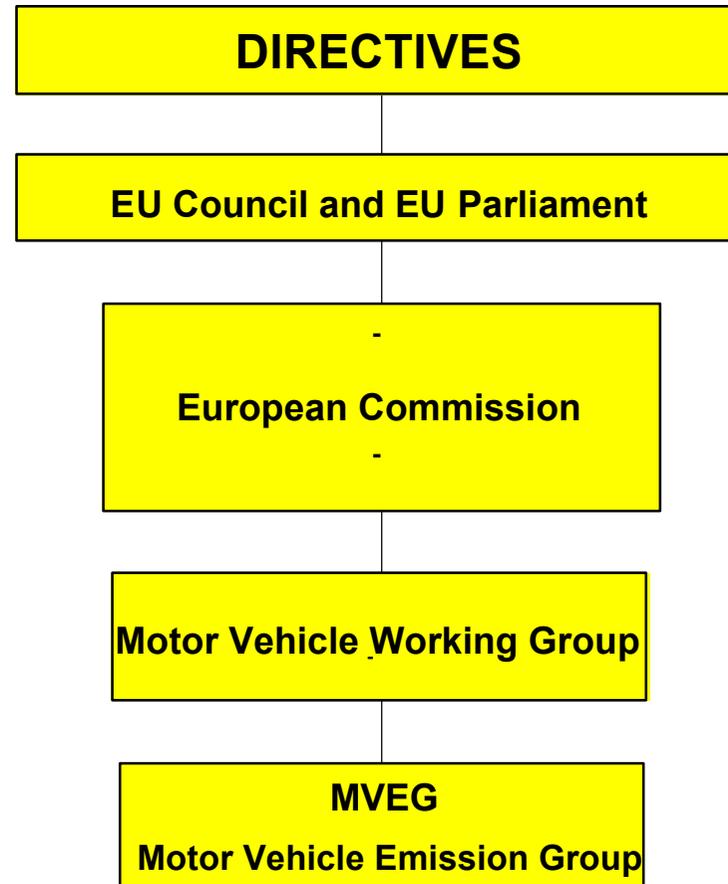
Two Pathways to Present a Proposal for a Regulation

UN-ECE



Voluntary (Valid for: EU, Jap., Aus.)

EC

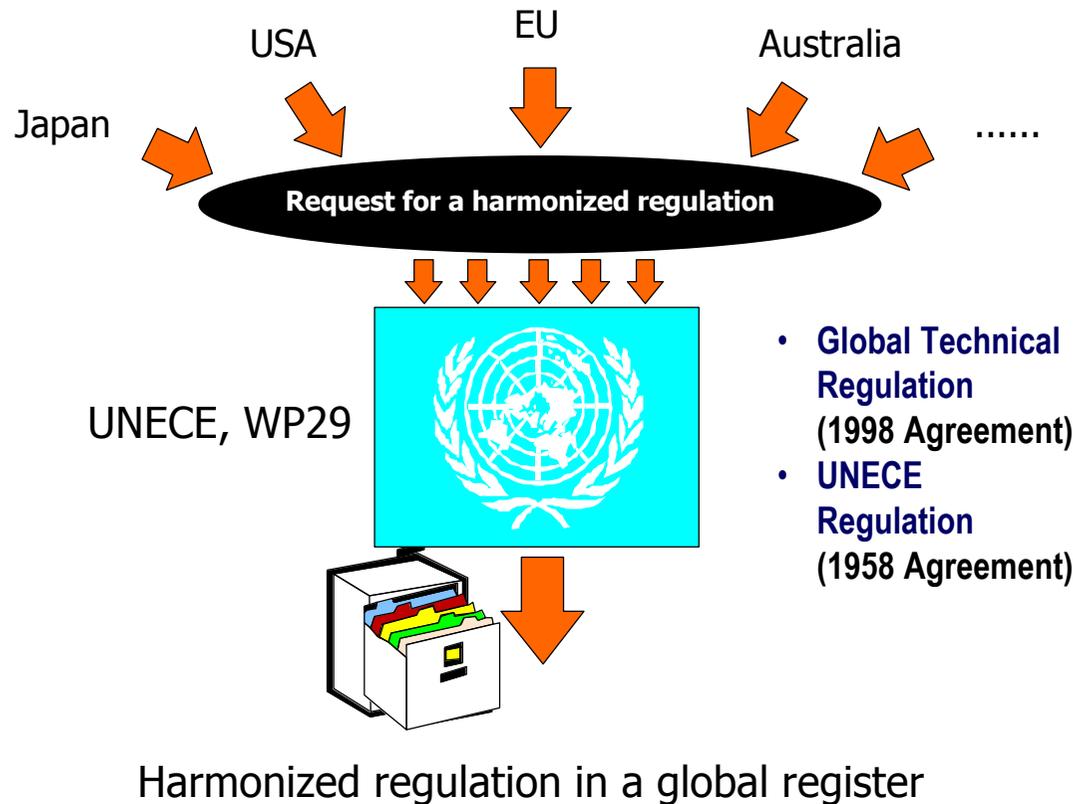


Binding for WVTA (Valid for: EU)



Globally Harmonized Vehicle Approval - Existing Agreements

UNECE WP29 - Global Platform for Harmonisation of Legal Requirements for Road Vehicles



MEMBERS OF THE **1958 AGREEMENT**:

[(E/ECE/324-E/ECE/TRANS/505/Rev.2)]

GERMANY, FRANCE, ITALY, NETHERLANDS, SWEDEN, BELGIUM, HUNGARY, CZECH REPUBLIC, SPAIN, YUGOSLAVIA, UNITED KINGDOM, AUSTRIA, LUXEMBOURG, SWITZERLAND, NORWAY, FINLAND, DENMARK, ROMANIA, POLAND, PORTUGAL, RUSSIAN FEDERATION, GREECE, IRELAND, CROATIA, SLOVENIA, SLOVAKIA, BELARUS, ESTONIA, BOSNIA AND HERZEGOVINA, LATVIA, BULGARIA, TURKEY, THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA, EUROPEAN COMMUNITY, JAPAN, AUSTRALIA, UKRAINE, REPUBLIC OF SOUTH AFRICA

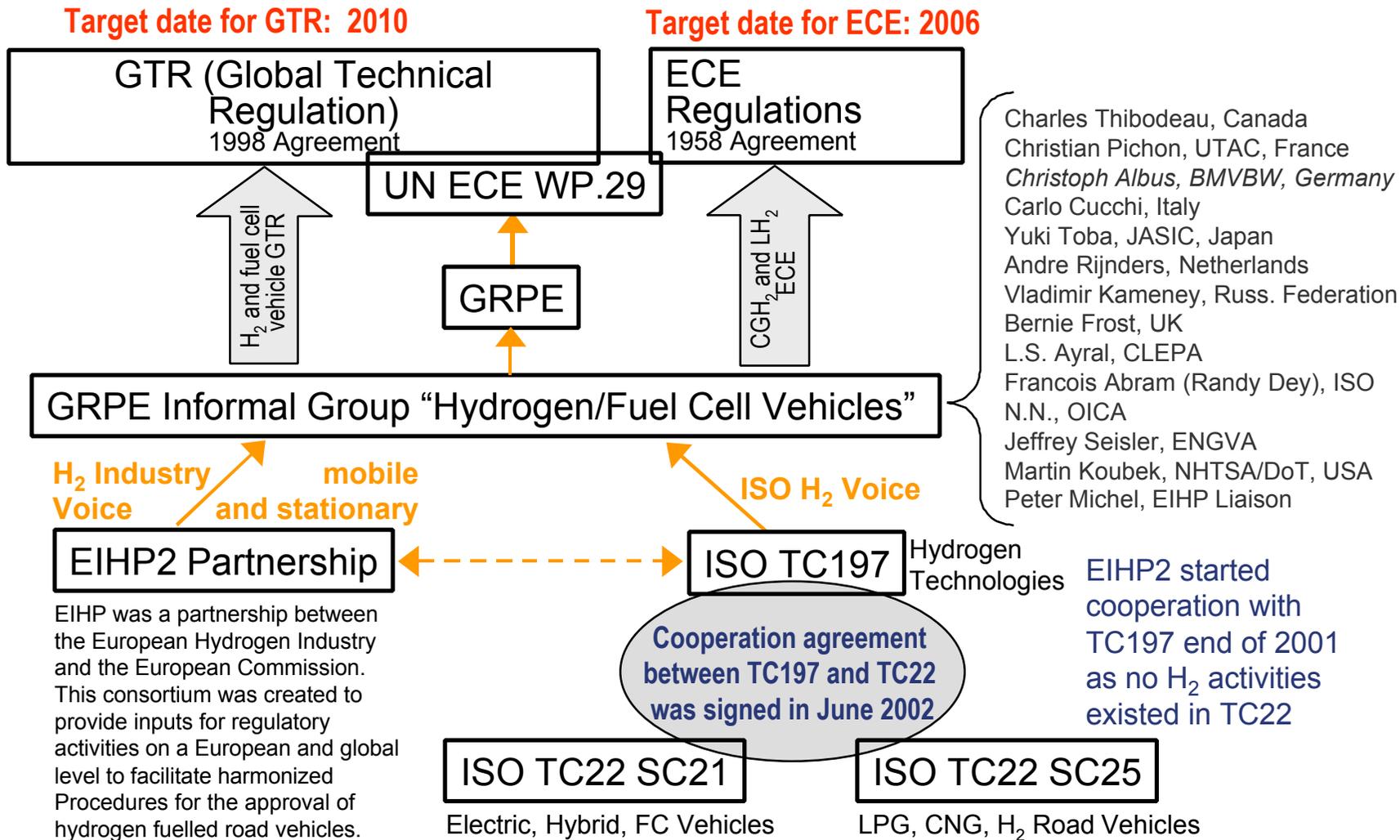
MEMBERS OF THE **1998 AGREEMENT**:

[(E/ECE/TRANS/132 AND Corr.1)]

CANADA, **UNITED STATES OF AMERICA**, JAPAN, FRANCE, UNITED KINGDOM, EUROPEAN COMMUNITY, GERMANY, RUSSIAN FEDERATION, **PEOPLE'S REPUBLIC OF CHINA**, **REPUBLIC OF KOREA**, ITALY, REPUBLIC OF SOUTH AFRICA, SPAIN



Globally Harmonized Vehicle Approval – Possible Pathway



Globally Harmonized Vehicle Approval – Parallel Development

Onboard storage-related issues

⇒

Two ECE Regulations under the 1958 Agreement
(with limited lifetime)

⇒

GTR
(to replace ECE Regs.)



Target date for a regulation 2006

Rest of H2-Vehicle
(FC, Safety in normal & crash conditions; Fuel Consumption; etc.)

⌘

⌘

⌘

⌘

GTR
under the
1998 Agreement
(referencing
ISO, IEC)

Target date for a regulation 2010

(still under discussion in the UNECE GRPE Informal Group on Hydrogen/Fuel Cell Vehicles)



Globally Harmonized Standards - an Example

Example: CGH₂ Filling Connector

With assistance of ISO/TC197, EIHP2 initiated the process of the transfer of a national US standard into an international ISO standard

SAE J2600 ⇒ ISO/DIS 17268

Gaseous hydrogen – Land vehicle filling connectors



Results Achieved in EIHP2 (3)

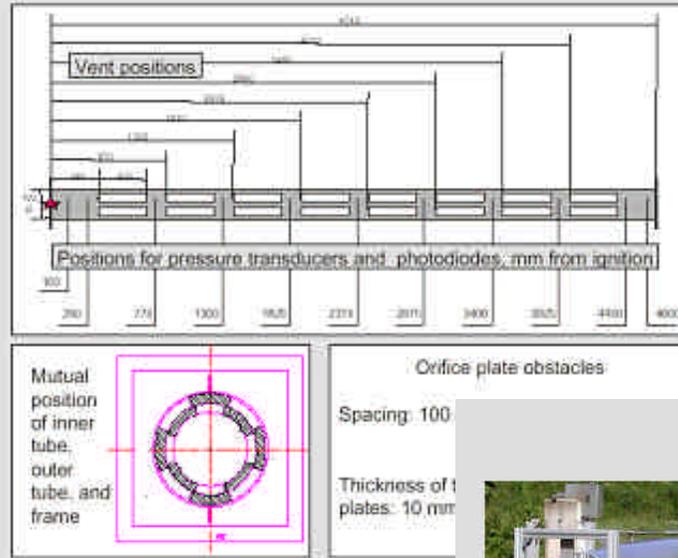
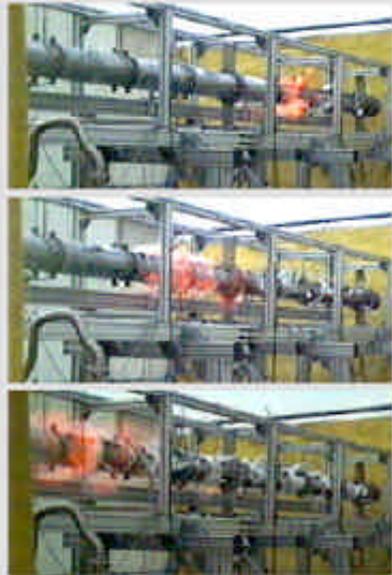
WP5: Safety

- In WP5.1 a state of the art review of existing safety data of hydrogen and other fuels reached the conclusion that a ranking of the relative safety of different fuels will depend on each specific application and potential accident scenario.
- In WP5.2 a Rapid Risk Ranking (RRR) methodology was developed and applied to different re-fuelling station concepts, identifying risk-reducing measures. Acceptance criteria for hydrogen re-fuelling station risk analysis were also developed. Recommendations for standards and codes of hydrogen re-fuelling stations were identified.
- In WP5.3 the numerical simulation of various hydrogen release scenarios for commercial vehicles was performed. The work has proven CFD modelling techniques to be a useful tool for investigating the release of hydrogen in real world situations
- In WP5.4, an extensive experimental programme was completed in order to improve the understanding and knowledge of gas combustion (hydrogen, methane and propane) in semi-confined geometries.
- In WP5.5. the comparative study of hydrogen and other fuels has shown that the accident consequences depend strongly on the initial and boundary conditions. Therefore each scenario requires a separate analysis. For the worst-case scenarios that were considered in the analysis such as the combination of large hydrogen release rates in confined environments, mitigation and risk-reducing measures have to be developed.



EIHP2 Combustion Tests in Semi-confined and Vented Tubes

Tests in vented tube

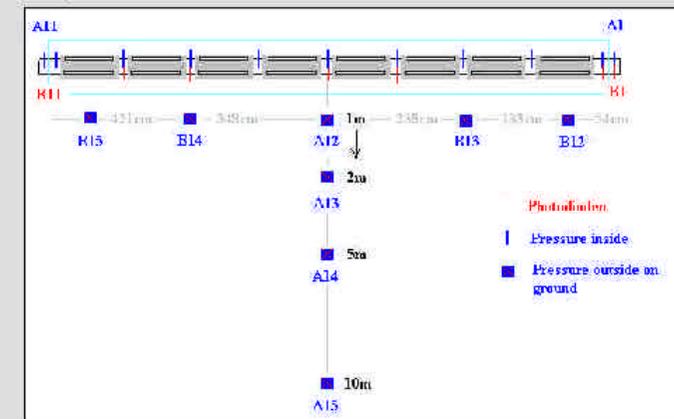


Supporting experiments on safety implications of hydrogen use in road transport

Tests in semi-confined geometry



Positions for pressure transducers and photodiodes. Top view.



Source: FZK in www.eihp.org



Results Achieved in EIHP2 (4)

WP6: Links "EU-USA" + other Cluster Activities

- Various US bodies including DoE and IHIG are now fully aware of the role and purpose of EIHP. This has been enabled by the unique ability of global companies to span regional divides
- Initial meetings with delegations from the Japanese Electric Vehicle Association and the Japanese Hydrogen Forum have provided a useful first view of the RC&S landscape in Japan
- Summaries of RC&S activities in Europe and the US have been produced and a preliminary high-level gap analysis of European C&S for hydrogen infrastructure has been carried out and shared with key stakeholders in the US

Some high level conclusions resulting from the above initiatives are stated here:

- The leadership of the DoE in the US has provided a much-needed framework for RC&S activities in the US which is enabling a focused approach
- Japan is viewed as the most advanced and coordinated with respect to RC&S activities, driven by their desire to commercialise hydrogen vehicles in 2005
- EIHP2 is viewed as a significant strength within Europe by the US but the view still persists that its main function is to create competitive advantage
- Comparison of US and EU gap analyses for infrastructure RC&S activities reveals a great deal of similarity in key areas requiring progress. This is a good basis for future international collaboration.



Further Work on Safety and RC&S Initiated from EIHP2

- EC-funded Network of Excellence “Safety of Hydrogen as an Energy Carrier” - HySafe
- UNECE GRPE Informal Group "Hydrogen/ Fuel Cell Vehicles" [<http://www.eihp.org/unece/index.html>]
- Expression of Interest “Hyapproval” Handbook for certification of public hydrogen filling stations



Conclusions from EIHP2 on RC&S

- ⇒ do not re-invent the wheel
- ⇒ join forces internationally in the largest automotive markets (Europe, USA, Japan, China)
- ⇒ use existing regulatory and standardization bodies (UN, ISO, IEC) and participate more actively
- ⇒ try to avoid misunderstandings and misperceptions as early as possible
- ⇒ avoid duplications and contradictory/ inconsistent approaches
- ⇒ learn for local implementation also from similarities in requirements all over the world (e.g. fire authorities, work safety authorities, environmental authorities) by informal international exchange between local experts



Thank You !

Thank you for your attention!



For the **Final Report** and for **any upcoming information** please visit

www.EIHP.org

