

HyApproval

Handbook for Approval of Hydrogen Refuelling Stations(SES6 - 019813)

Goals, Achievements and key Recommendations



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*On behalf of the members of the former
HyApproval Project (www.HyApproval.org)*



ludwig bolkow
systemtechnik

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Technical Feasibility of an HRS



Total
CEP station
Berlin,
Germany



Aral/BP
CEP station
Berlin,
Germany



BP
SinoHytec
Station
Beijing
P.R.China



Agip,
Zero Regio,
Frankfurt-Höchst
Germany



Shell,
Washington DC,
USA

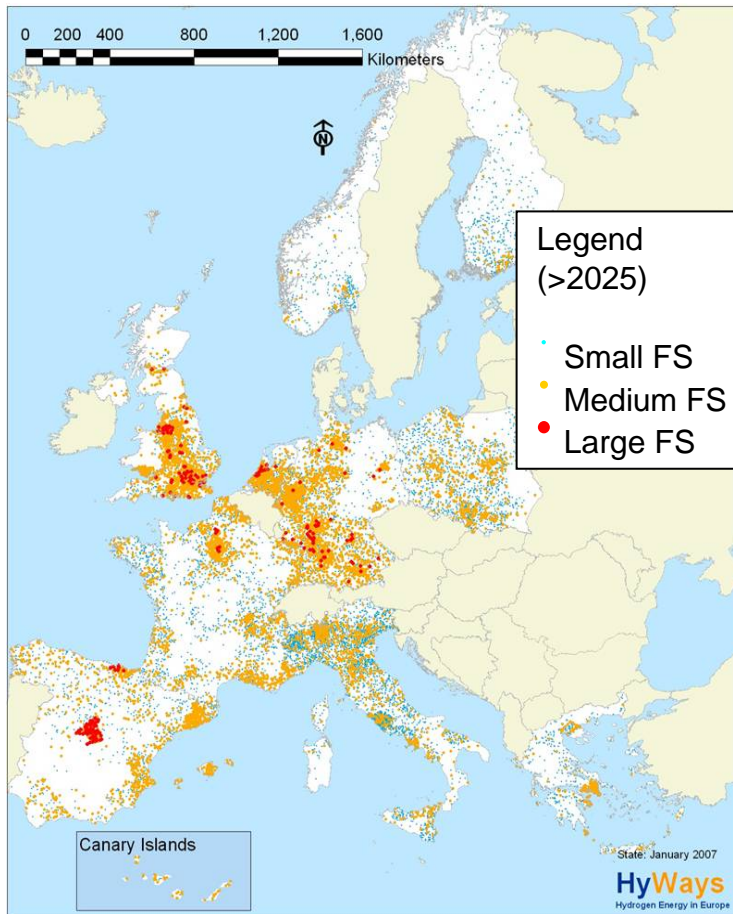


Iwatani
Ariake Tokyo,
Japan



Spatial coverage of fuelling stations

Demand for HRS proven by HyWays



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- **First phase (2010-2015):**

- A limited number (400) of small H₂ stations
- serving around 10.000 H₂ cars (25 cars/station in average)
- for corridors another app. 500 small fuelling stations would be required

- **Demand develops (2015 – 2025):**

- also bigger filling stations will come in
- between 13,000 and 20,000 H₂ stations and 10 mill. H₂ vehicles in Europe.

- **Massive rollout of H₂ (post 2025):**

- Gradually, same patterns as today's conventional refuelling network is reached

Example:

fuelling stations spatial coverage for 8% vehicle penetration (8% of 220 m → ~ 16 m)

Lessons Learned by EIHP, UNECE and HyWays

The development of an EC Regulation for H₂ Motor Vehicles **took almost 11 years** from the start of EIHP1 on 01FEB1998 to the expected date of approval in FEB2009



Industry participating in HyWays [www.hyways.de] has identified an H₂ vehicle population of between 1 and 5 million units on European roads by 2020 with a rapidly growing introduction after 2015.

This requires about $\leq 1,000$ HRs between 2010 and 2015 and between 13,000 and 20,000 between 2015 and 2025.

This requires a regulatory framework for HRS approval in Europe shortly after 2010 in place (i.e. max. 5 years left).



Reality in approving Hydrogen refuelling Stations (HRS) in Europe



HRS Approval Reality in Europe (1)

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- In several European countries Hydrogen Refuelling Stations (HRS) can be approved since several years, usually without H₂-specific regulations in place, only applying existing regulatory frameworks
- In some European countries this is almost impossible (e.g. France) or laborious and time consuming (e.g. Italy) due to a complete lack of applicable legislation (e.g. France) or due to only recent introduction of such legislation which is limited to mono-fuel H₂ stations only and does not take into account multi-fuel stations (e.g. Italy)
- HyApproval (www.hyapproval.org) was working on the development of a Handbook for the approval of HRS in Europe (with partners from China, Japan and the USA) between 01OCT2005 and 30SEP2007
- The HyApproval project has delivered a first finalised Handbook (which will remain a “living document” for some time, i.e. undergo continuous improvements)
- ISO TC197 WG11 works on a standardised/ uniform HRS layout ISO/DTS 20012 (HyApproval assists ISO in this endeavour)

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HRS Approval Reality in Europe (2)

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- Some countries have need for a document like the HyApproval Handbook and some have already articulated interest in applying it (e.g. China, Italy)
- A first transportable skid-mounted HRS developed by Air Liquide in France taking into account all European legal requirements in existence has been shown to be certified for limited periods also in France (Challenge Bibendum, Paris, and WHEC16, Lyon, in June 2006)
- Two first H₂-CNG/H₂ HRS in France (Dunquerk and Toulouse) are planned for approval in 2007 and 2008
- The first public HRSs in Italy have been approved: Collesalvetti, Mantova (with some difficulties due to its multi-fuel characteristics not covered in the new Italian directive of AUG2006 and due to its size) and to be approved by February 2008 will be Bicocca (Milano)
- Handbook validated for France, Germany, Italy, Netherlands, Spain, China and the USA



HRS Approval Reality in Europe (3)

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- The HyApproval Handbook has become public (Dec. 2007) and could be transferred **into an EU directive/or regulation** later on (re-drafting required)
- The Handbook shall assist in educating approval authorities on the state of the art of HRS technology and refuelling processes/ procedures
- The Handbook shall serve as a working document to help and support authorities to deliver permits to install HRS in Europe
- The Handbook will allow infrastructure companies in the future to develop non-country specific products (essential parts of the layout are uniform)



**Project HyApproval
FP6 STREP (SES6 – 019813)
Oct.05-Sept.07**



Main Project Goals

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- Finalise the hydrogen refuelling station (HRS) draft guideline document started under EIHP2 (European Integrated Hydrogen Project) and to be pursued under ISO TC197, WG 11, addressing global recommendations to the technology providers, and representing the initial basis for developing a Handbook for the approval of HRS
- Come up with a Handbook which assists all gas technology companies, fuel retailers/ HRS operators and the relevant approval authorities in laying out, installing, approving and operating HRS for CGH2 or LH2 on an EU-wide level, with the potential to also apply it to non-EU regions
[An *Approval in Principle* contributes to reducing uncertainties and improving confidence for stakeholders, investors and funding bodies]



HyApproval Partnership

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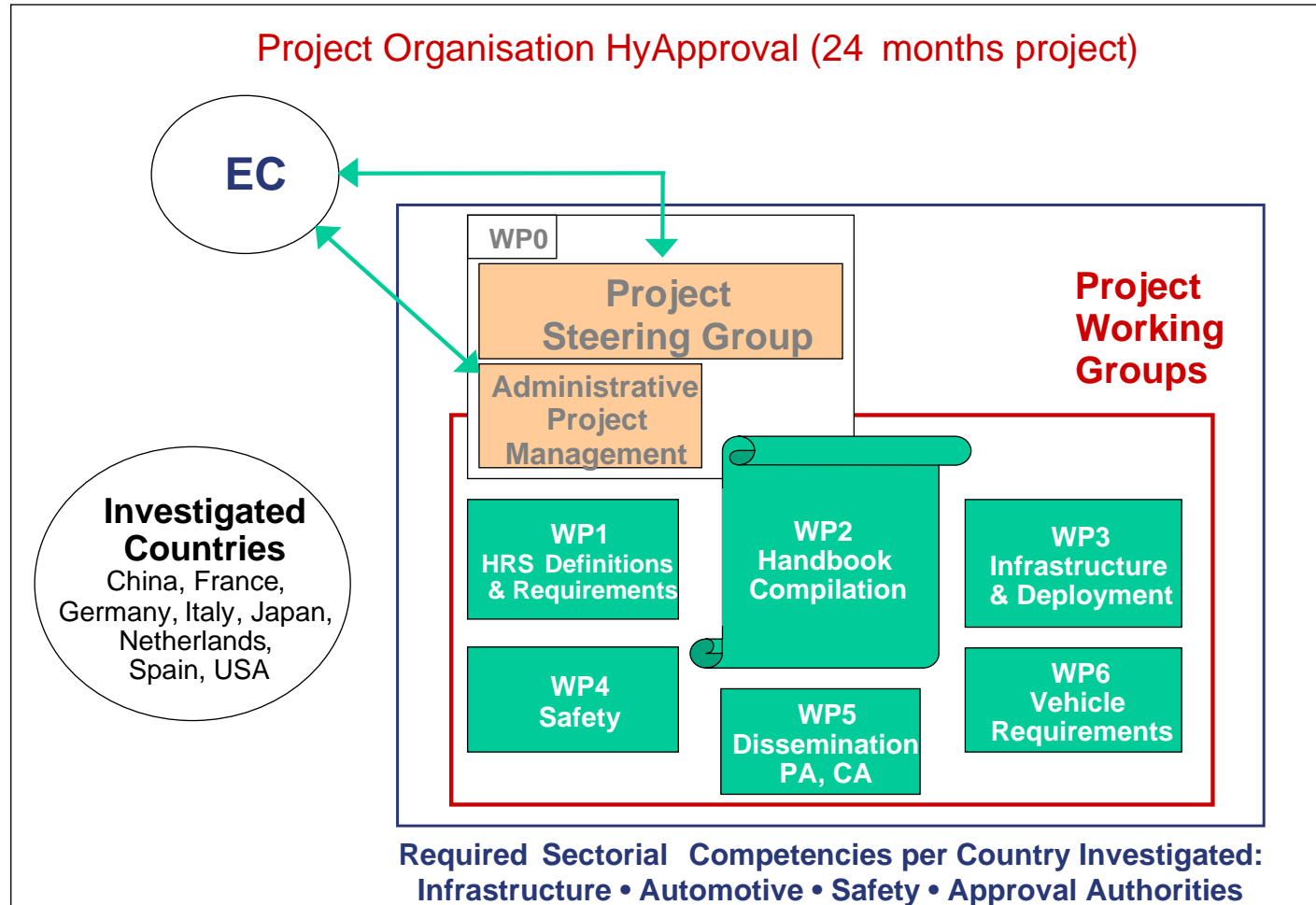
Air Liquide S.A. (AL)
Air Products PLC (APL)
BP plc
Chinese Academy of Sciences, Technical Institute of Physics and Chemistry (CAS)
Commissariat à l'Energie Atomique (CEA)
Demokritos National Center for Scientific Research (NCSR-D)
Det Norske Veritas AS (DNV)
EniTecnologie S.p.A. (ET)
Engineering Advancement Association of Japan (ENAA)
Federazione delle Associazioni Scientifiche e Tecniche (FAST) in collaboration with H2IT
Forschungszentrum Karlsruhe GmbH (FZK)
GM/Opel

Health and Safety Executive (HSE)
Hydrogenics Europe N.V.
Icelandic New Energy Ltd. (INE)
Institut National de l'Environnement Industriel et des Risques (INERIS)
Instituto Nacional de Técnica Aeroespacial (INTA)
Joint Research Centre of the European Commission (JRC)
Linde AG
National Renewable Energy Laboratory (NREL)
Norsk Hydro ASA (Hydro)
Netherlands Organisation for Applied Scientific Research (TNO)
Shell Hydrogen B.V.
Total France
Ludwig-Bölkow-Systemtechnik GmbH (LBST)

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Project Organogram



Main achievements and lessons learned by HyApproval



Main Achievements by HyApproval (1)

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- Originally planned *Final Design Paper* will become a side-document to the Handbook containing this information which has been collected in the framework of the HyApproval project and which would have disturbed the integrity of the HB document. [WP1]
- *Handbook for HRS approval* in Europe providing *guidelines for design, operation & maintenance of HRS* [WP2]
- *Outline of the permitting process* for obtaining an approved HRS [WP2]
- General refuelling *interface description, data exchange* vehicle-HRS, *refuelling process* and *safety during refuelling* [WP6]
- *Authority feedback* from five European countries, the US and China on the Handbook structure and contents [WP3]
- *List of contacts* to European fire brigades and authorities, *General seminar outline & calendar, Dissemination models* for different countries, *Dissemination packages* – Dissemination in preparation for Q4 of 2007 [WP5]



Main Achievements by HyApproval (2)

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- Safety findings [WP4]:
 - *Review of Best Practices* based on actual experiences with Hydrogen Refuelling Stations across Europe, US & Japan / Risk acceptance criteria / Safety studies (D4.1)
 - *Establishment of Best Practices for Safety* (D4.2)
 - Agreement on *safety documentation* for Handbook and actions to complete HRS documentation & Agreement on required *safety documentations* (D4.3&4.5)
 - Identification and critical review of *databases for reliability data* (D4.4)
 - Agreement on required *modelling tools & techniques for risk assessments and simulations, accident scenarios, credible leak rates* (D4.6)
 - *Guidance for Safety Aspects* of Hydrogen Infrastructure Projects including safety documentation and safety plan checklist (D4.7&D4.10)
 - *Proposed list of scenarios* for the modelling task (D4.8)
 - *Quantitative risk assessment* of hydrogen refuelling stations with on-site production (D4.9)
 - *Risk assessments & accident simulations* including assumption and study basis, consequence assessments, description of example case study HRS, frequency assessments and event tree assessments (D4.11&D4.12)



Lessons Learned by HyApproval

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- Everything takes **much longer** than anticipated
- Safety analysis work took **almost half of all efforts** in the project well into year two
- **Handbook compilation** and finalisation was a time critical and iterative activity and therefore delayed with **its finalisation until submission of the final Handbook in December 2007**
- **Diverging views** on **how soon** certain processes should be fixed and proposed as guideline (e.g. based on still not sufficiently mature technology or processes applied)
- **Common position** among partners **for the need of maintaining the Handbook** alive after project end
- **No common position** among partners **for an immediate effort to transfer the Handbook to an EC Regulation or Directive**
- During 1st half of 2008, the **need to include an action to develop a harmonised European regulatory framework for HRS** was articulated



INTRODUCTORY SECTON

- 1 ACRONYMS
- 2 EXECUTIVE SUMMARY
- 3 INTRODUCTION
- 4 RECOMMENDATIONS FOR AN EU27 UNIFORM APPROVAL PROCESS FOR HYDROGEN REFUELLING STATIONS

PART I: GUIDELINES FOR DESIGN, OPERATION & MAINTENANCE OF A HYDROGEN REFUELLING STATION

- 5 PROPERTIES OF HYDROGEN
- 6 BASICS OF HYDROGEN DISPENSING
- 7 REGULATIONS, STANDARDS AND CODES OF PRACTICE AFFECTING THE DESIGN, INSTALLATION, OPERATION AND MAINTENANCE OF A HYDROGEN REFUELLING STATION

- 8 HRS DESIGN AND CONSTRUCTION RECOMMENDATIONS
- 9 OPERATION AND MAINTENANCE OF AN HRS
- 10 VEHICLE INTERFACE REQUIREMENTS
- 11 REVIEW OF TECHNICAL AND SAFETY MEASURES
- 12 RISK ASSESSMENT METHODOLOGIES FOR HRS APPROVAL

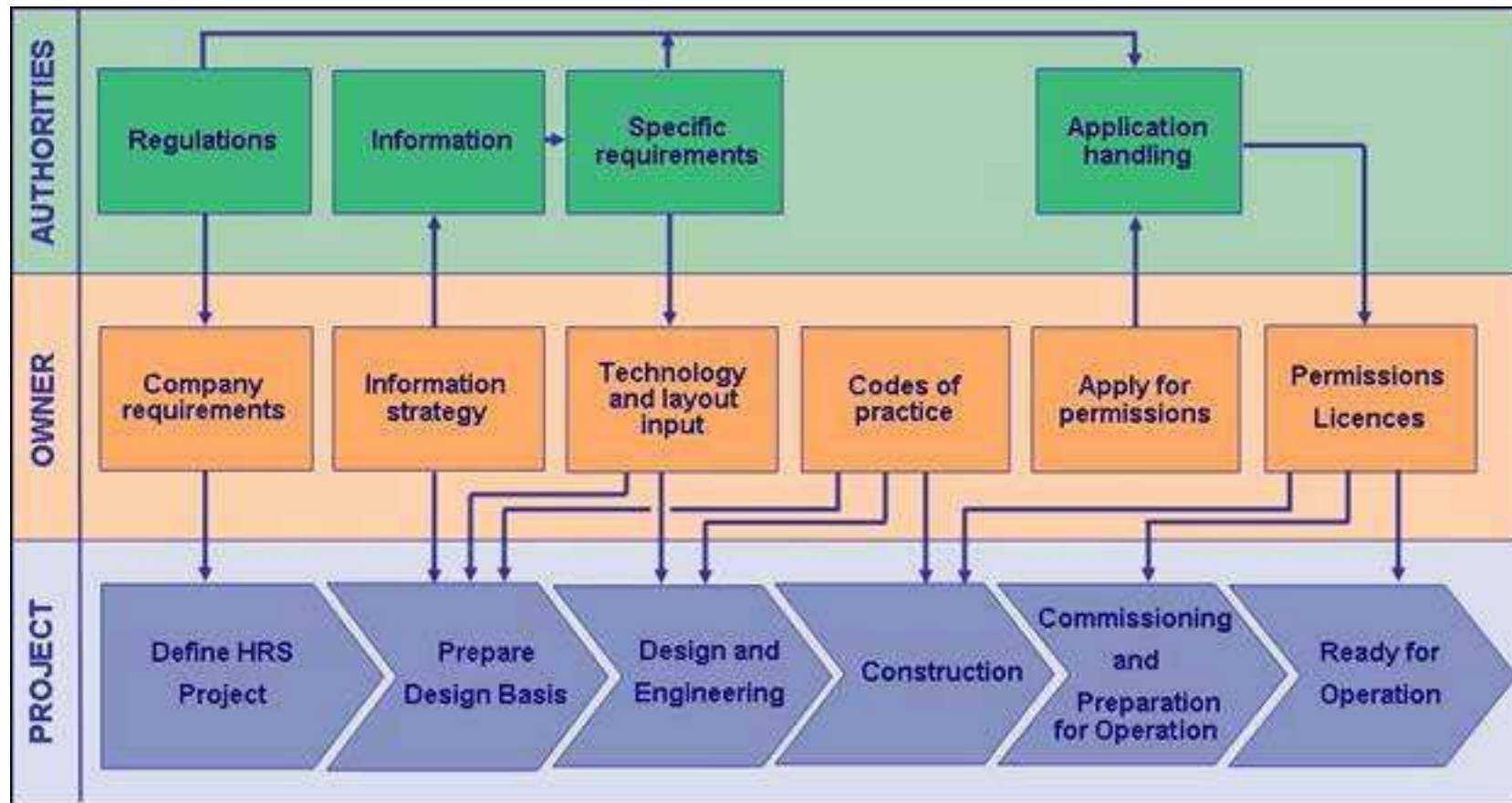
PART II: PERMITTING PROCESS

- 13 DESCRIPTION OF THE RECOMMENDED APPROVAL PROCESS FOR HRS
- 14 COUNTRY SPECIFIC ISSUES
- 15 LIST OF APPENDICES

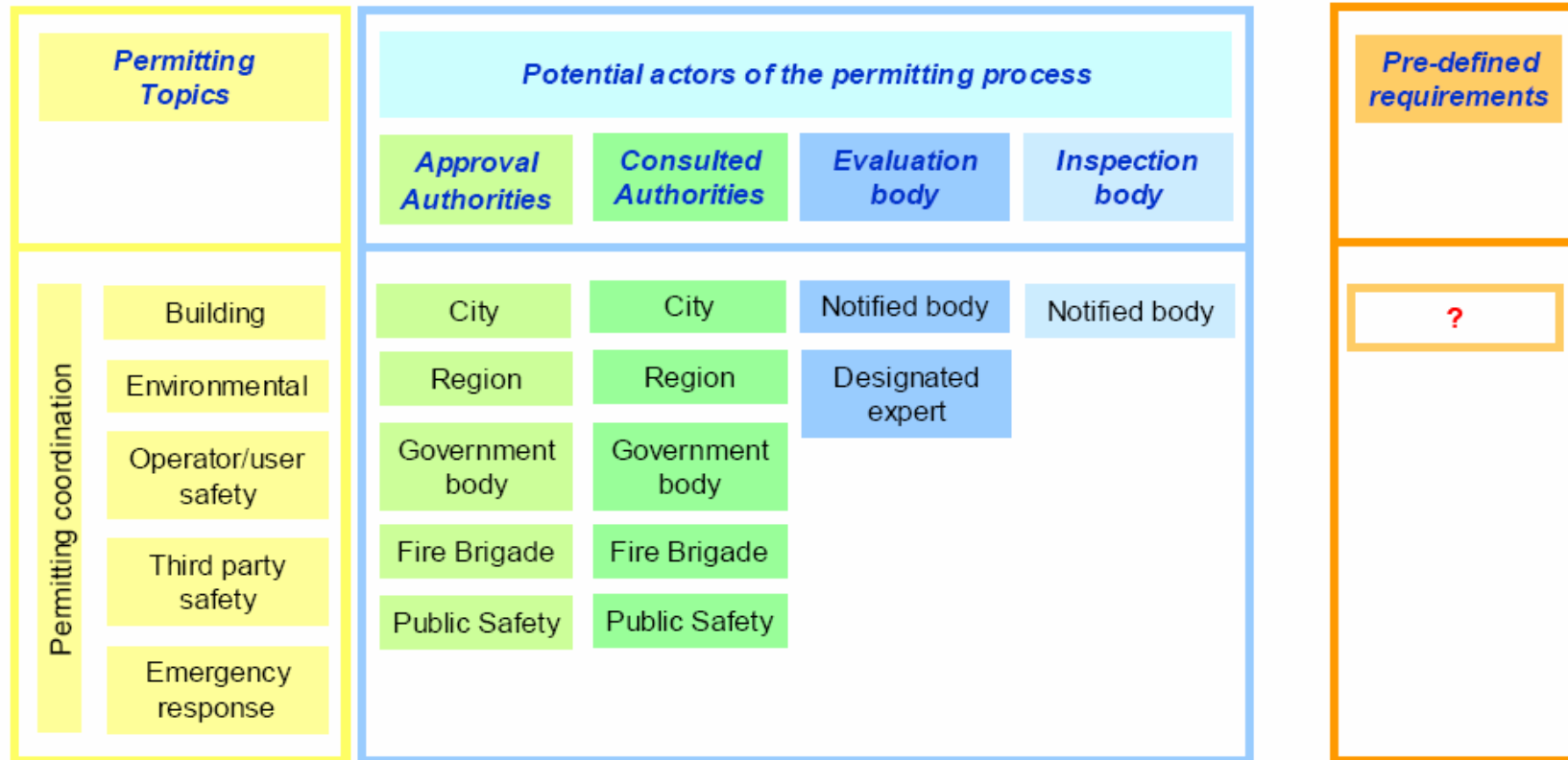


Recommended HRS approval process

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Potential permitting process complexity



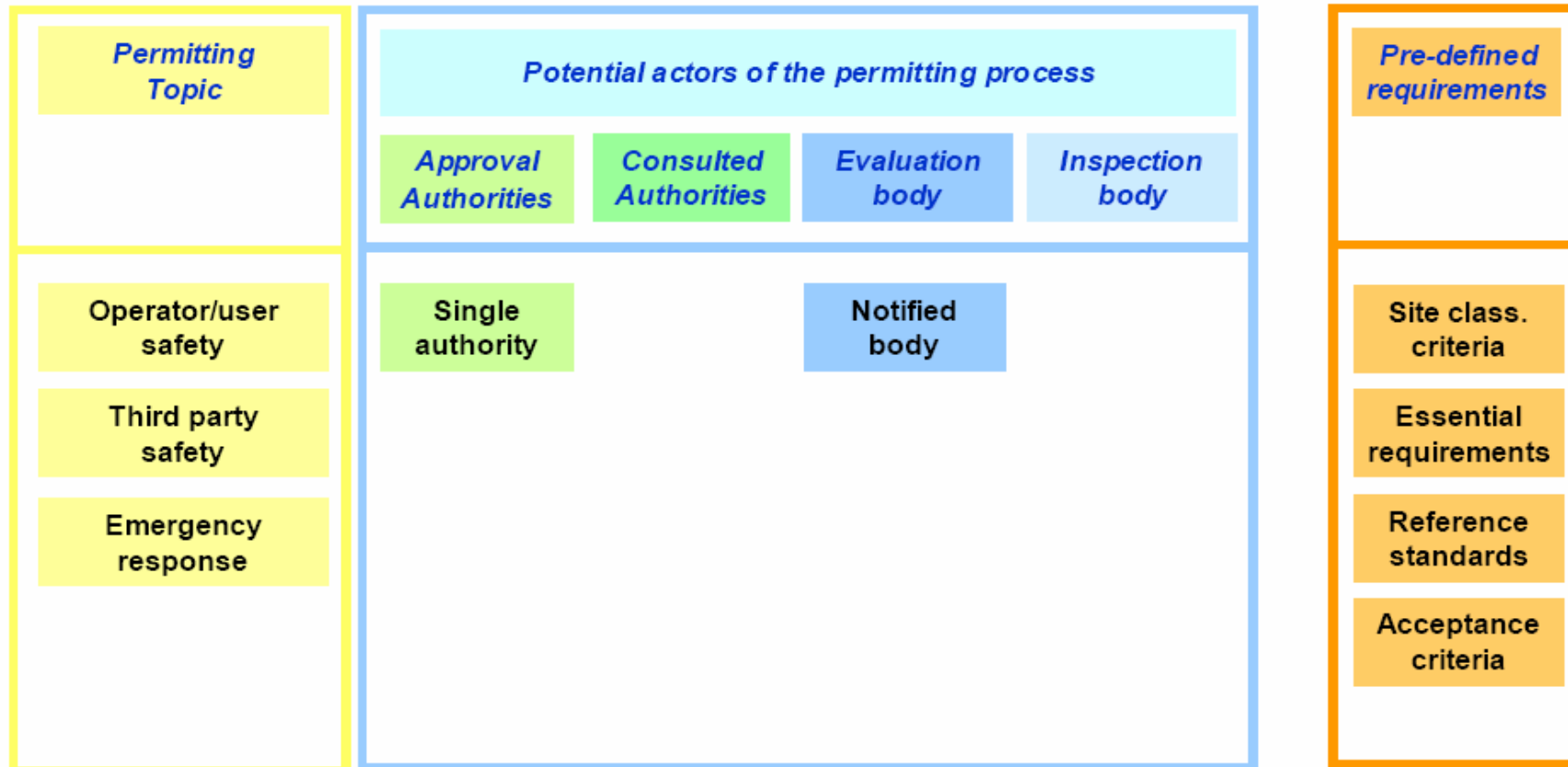
Recommendations for an EU27 uniform approval process for HRS



Key Recommendations (1)

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- To develop an EC regulatory framework for hydrogen refuelling stations based on the proven combination of Essential requirements, Harmonized standards, and Notified bodies. This could be most efficiently achieved through the development of an EC Regulation (as opposed to an EC Directive).



Key Recommendations (2)

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- Cross-reference to the ISO TS 20012 on HRS layout (under development at ISO TC197 WG 11) from such a framework can be very suitable (leading to a lean regulation document)
- Such a framework, which allows to address the key safety issues without impeding continued technological development, **would establish a very streamlined EU 27 uniform permitting process**
- Going a step further, such a framework **would allow for a mechanism of fuelling station “type approval”** (similar to that of road vehicles), allowing a given station design to be approved for deployment in number in all EU 27 countries.
- Until such a framework is fully established at EC level, national authorities are encouraged to adopt a permitting process structured similarly: **one single authority, relying on the evaluation of one expert body, and referring to pre-established set of requirements and approval criteria**

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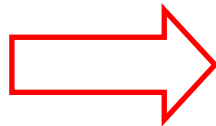


Useful HyApproval References

HyApproval

- HyApproval [10/2005 - 09/2007] - www.hyapproval.org
- HySafe [03/2004 - 02/2009] - www.hysafe.net
- HarmonHy [05/2005 - 04/2006] - www.harmonhy.com
- European Integrated Hydrogen Project [1998-2000, 2001-2004] - www.eihp.org
- EU projects on H2/FC - http://europa.eu.int/comm/research/energy/pdf/h2fuell_cell_en.pdf

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