

HyApproval

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



*Reinhold Wurster (LBST)
on behalf of the
HyApproval Consortium (www.HyApproval.org)*

Stazioni di rifornimento di idrogeno/ Hydrogen Refuelling Stations - Workshop
Fiera Milano Rho, Milano, Italy, 09 February 2007

Prerequisites for a HRS

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Definition: HRS = Hydrogen Refuelling Station

Prerequisites:

- Technical feasibility shown → HRS realized
- Acceptable investment costs achievable → **HyWays**
- Clients on the road - Example: USA
- Demand/ supply for HRS infrastructure proven → **HyNet**
- Permitting processes in place → **HyApproval**



Technical Feasibility of an HRS

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Total
CEP station
Berlin,
Germany



Aral/BP
CEP station
Berlin,
Germany



Agip,
Collesalvetti
near Livorno,
Tuscany, Italy



Agip,
Zero Regio,
Frankfurt-Höchst
Germany

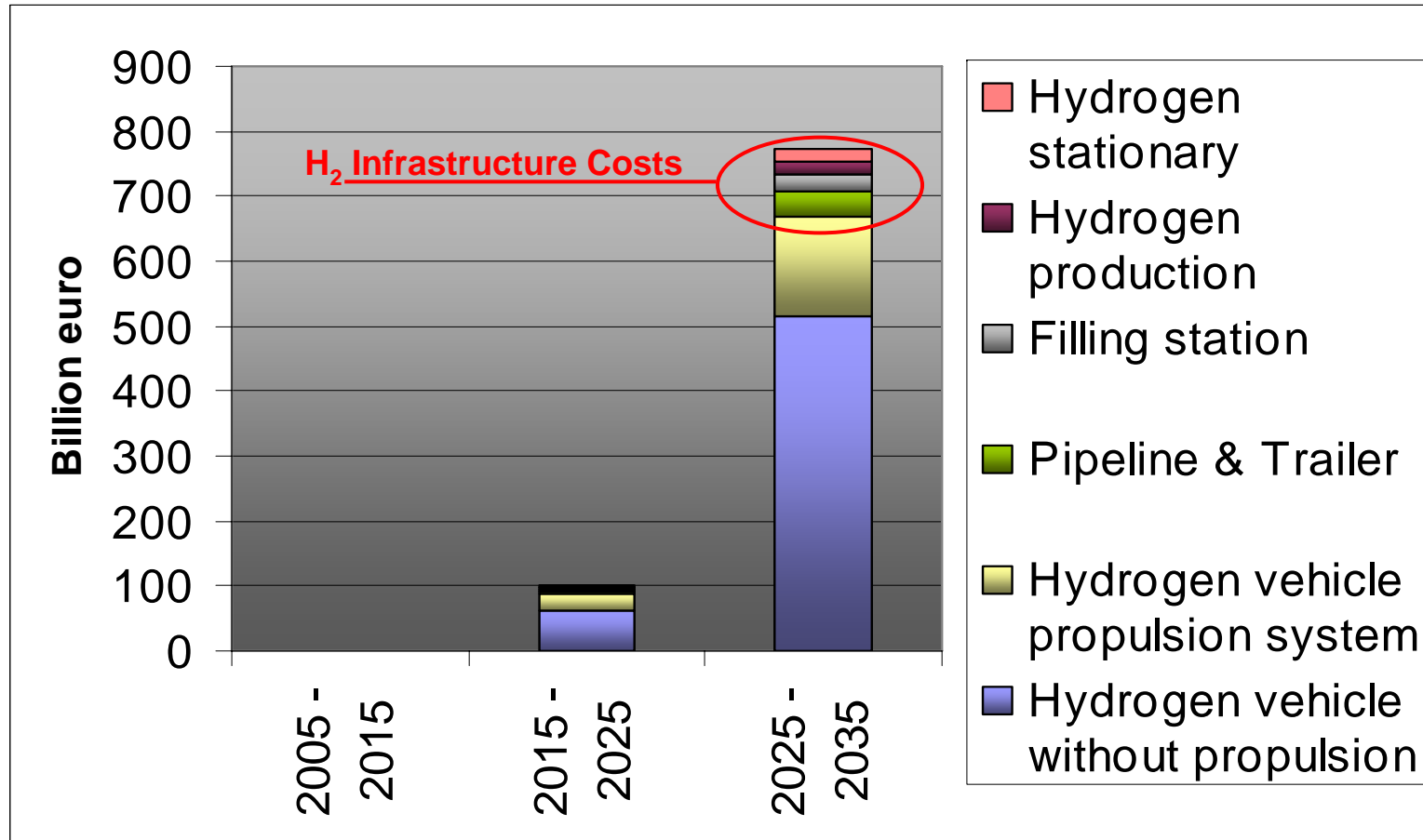


Shell,
Washington DC,
USA



Iwatani
Ariake Tokyo,
Japan

Acceptable Investment Costs of HRS - HyWays HyApproval



(cumulative investments for a ten-year period, hydrogen high penetration scenario, HyWays Phase I results based on six HyWays countries D, F, I, GR, N, NL)



Clients = Vehicles on the Road between Now and 2020 (Example: USA)

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California - ZEV requirement:

2001 – 2008:	250 FCVs (1 st ZEV Floor)
2009 – 2011:	2,500 FCVs (2 nd ZEV Floor)
2012 – 2014:	25,000 FCVs (3 rd ZEV Floor)
2015 – 2017:	50,000 FCVs (4 th ZEV Floor)

Applicable to all large volume manufacturers (i.e. > 60,000 LDVs per year): DC, Ford, GM, Honda, Nissan, Toyota (from 2010: BMW, from 2012+: VW)

[from 2011 on also obligatory for each other US ZEV state: MA, NY, VT, RI, CT, NJ, ME, OR, WA, MD]

Non-compliance leads to exclusion of conventional vehicles from the Californian market



In the US Energy Policy Act of 2005 [PUBLIC LAW 109–58—AUG. 8, 2005],

In SEC. 811. REPORTS, sub-sec (a), indent (4), the US have formulated the goal to produce and deploy not less than:

(A) 100,000 hydrogen-fueled vehicles in the United States by 2010

and

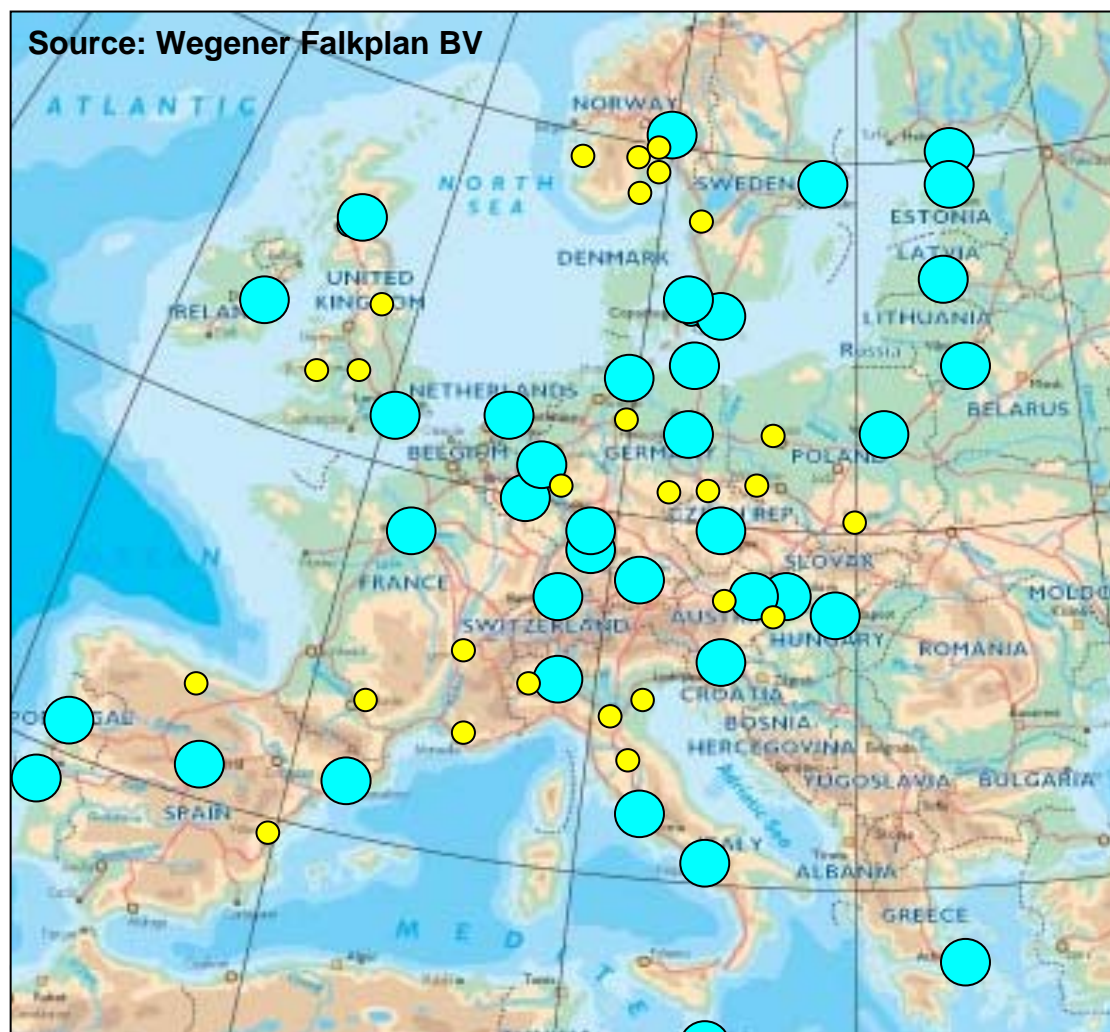
(B) 2,500,000 hydrogen-fueled vehicles in the United States by 2020



Demand for HRS Proven

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HyNet - European Basic HRS Network



Stazioni di rifornimento di idrogeno - Workshop, Fiera Milano Rho,

- **Phase III:**
growth in population centres
- extension to further population centres

Phase IV:
HyNet roadmap analysis (not graphical)

Phase IV - low

Up to **40%** of the population (or ~170 million) in ~1,100 cities > 50,000 inhabitants could have access to hydrogen as a fuel by building **~5,000** hydrogen fuelling stations (~4,000 in cities and ~1,000 along motorways)

Phase IV - high

Up to **55%** of the population (or ~250 million) in ~3,500 cities > 20,000 inhabitants could have access to hydrogen as a fuel by building **~10,000** hydrogen fuelling stations (~7,500 in cities and ~2,500 along motorways)

The HyApproval Project



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)

Det Norske Veritas AS (DNV)

Eni S.p.A. (ENI)

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)

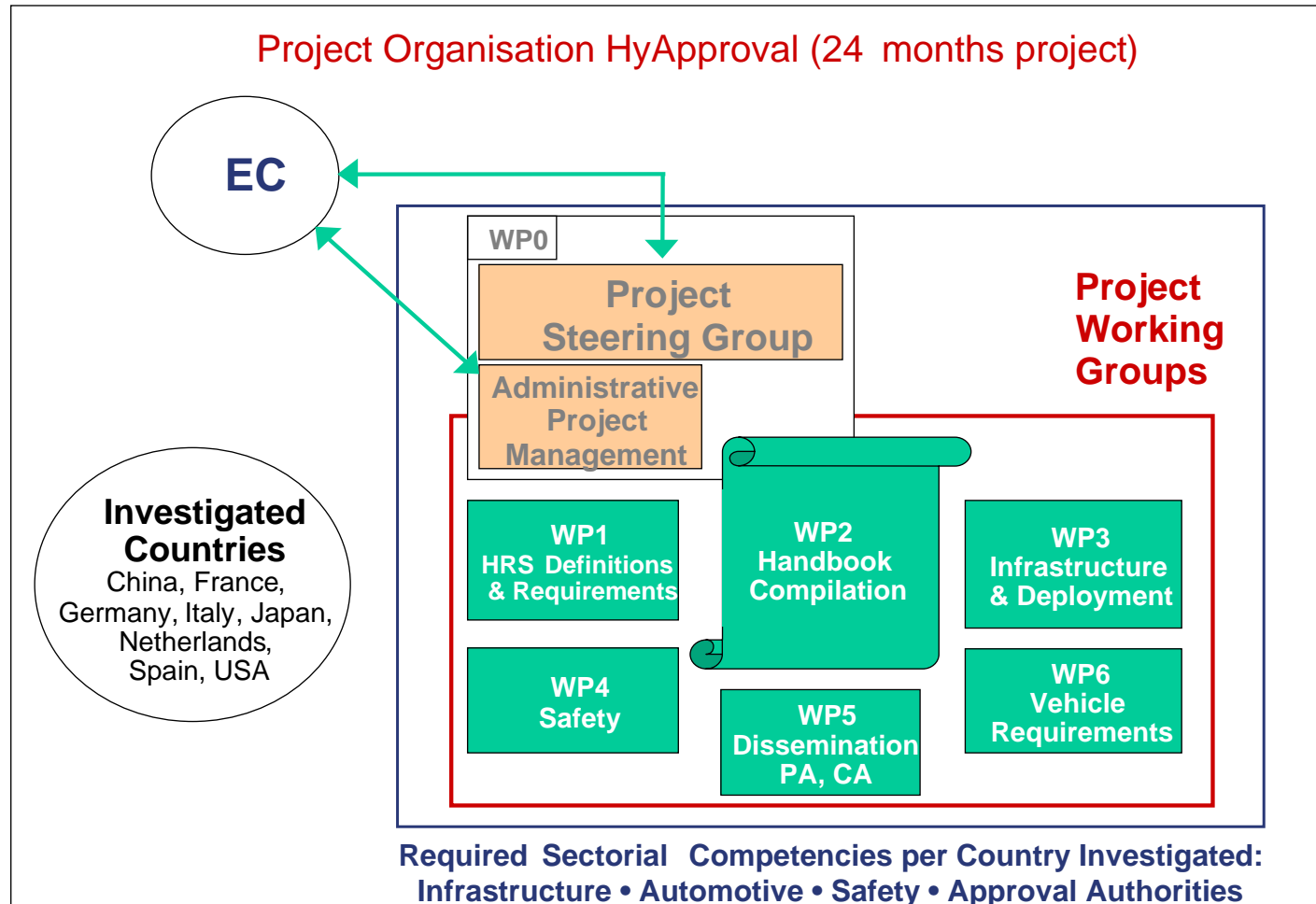
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Project Organigram

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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]



Major Activities

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- M0-3: Review and evaluation
 - Establishing safety matrix
- M3-4: Agreement on HRS concepts, safety documentation, modelling tools & techniques, target audience
- M5-8: Study phase
- M8-9: Agreement on HRS technical and on safety documentation, approval of EIHP2 draft, complete & agree matrix table of accident simulations & scenarios, risk assessment studies
- M9-12: Preparation of 1st Handbook draft and carry out risk assessments & accident simulations



Major Activities (2)

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- M12-15: Dissemination models for different countries and several dissemination packages completed.
- M15-21: Deployment in several Member States (MS) and support of WP3 “Infrastructure & Deployment”
- M21-23: Revision and adjustment phase for technical documentation, Handbook, EIHP2 draft, safety studies and sense check with MS and organisation of seminars in partner and non participating MS. A database of contacted agencies and officials on European and local level will be established.
- M23-24: Final partner agreement on Handbook



Main Safety Related Tasks (1)

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Safety-related tasks regarding HRS

- review and evaluate safety, codes & standards from existing projects
- establish safety matrix (RCS, safety studies, risk assessment criteria, etc.)
- establish best practices for safety
- develop realistic accident scenarios and their likelihood/ max. credible total H₂ leaks and leak rates
- agree on required modelling tools/ techniques for risk assessment and simulations
- finalisation of HRS draft guideline started by EIHP2 (→ WG11, ISO TC 197)
- prepare safety documentation for Handbook



Main Safety Related Tasks (2)

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Safety-related tasks regarding vehicle/HRS-interface

- general data interface description for LH₂ and CGH₂, according to SAE J2601 draft, standard receptacle
 - data exchange between vehicle and HRS (one standard data protocol)
 - refuelling process, time, frequency, procedures, pressure levels, etc.
 - definition of a safe refuelling area and process, e.g. additional grounding
 - definition of best practices, usage of FMEA (Failure Mode & Effect Analysis)
- Only a technical report so far, not yet recommended practice



Main Safety Related Tasks (3)

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Pre-normative research task

– Prioritisation and detailing for scenarios/ simulations of HRS component failures:

- » CGH₂ hose break/ nozzle/ dispenser failure at 35MPa and 70MPa
- » LH₂ dispenser failure
- » CGH₂ discharge hose break from tanker at 25 MPa and LH₂ discharge hose break from tanker
 - at dedicated/ multi-fuel HRS
 - of typically 300kg/ 1,500kg/ 3,500kg onsite storage volume

investigated in CFD (Computational Fluid Dynamics) simulations, if possible, in 2 independent release and dispersion calculations and 2 independent combustion calculations



Achievements to date (1)

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WP1 – HRS Definitions & Requirements:

- ST1: Basic HRS technology *completed*
- ST2: Safety Analysis of Equipment and Distances *in progress*
- ST3: Integration of ST1 and ST2 into three “generic” HRS sizes
→ Draft Design Paper *established*
- ST4: RCS Review & Comparison *in progress*

WP2 – HRS Handbook Compilation:

- Revised table of contents for Handbook *established*
- Delivery of the first draft version of the Handbook mid of November 2006
- Iterative process involving partners, authorities and external reviewers is on its way



Achievements to date (2)

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WP3 – Infrastructure & Deployment:

- Interview protocols *defined*, questionnaires and information package *prepared*, interview phase *first interviews performed* – *questionnaire continuously improved*, reporting on interviews *in progress and close to finalisation*

WP4 – Safety:

- Safety matrix *established*
- Identification of accident scenarios *finalised*
- Agreement on safety documentation for Handbook *in progress*
- Identification and critical review of reliability data from past data collections and risk studies *in progress*
- Digital layouts for CFD simulations *completed*



Achievements to date (3)

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WP5 – Dissemination, Public Awareness, Intl. Cluster Activities:

- Matrix of acceptability and awareness levels of different aspects of HRS *finalised*
- Database of Fire Associations & First Responders *established*
- Verification of existing studies/ formulation models: *ongoing*
- Calendar of relevant hydrogen events *established*

WP6 – Vehicle Requirements:

- General interface description for 35 MPa CGH₂ as J2600/ ISO 17268 *finalised* [recommended practice]
- General interface description for 70 MPa CGH₂ as draft *close to finalisation* – one common interface for Europe !
- General interface description for LH₂ as draft SAE J2783 *in progress*



Cooperation with European Projects

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HyApproval is closely interlinked to the following projects:

- » HySafe
- » HyFleet:CUTE and ECTOS
- » ZERO REGIO
- » CEP
- » open to further cooperation with similar upcoming EU projects



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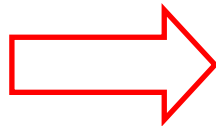
Next steps for taking forward the technical achievements of the project

- » HyApproval is the first EU project that aims at creating a universal handbook that collects the technical and regulatory requirements based on the expertise of all major companies and research institutes involved in the installation of the first HRS in Europe and abroad
- » HyApproval therefore offers a unique first opportunity to disseminate its results to local authorities and inform them about the wealth of knowledge and experience already existing in Europe and the rest of the world on the use of hydrogen in transport applications and the requirements of installing the necessary elements of a hydrogen infrastructure

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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Acknowledgement

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