HyRail

Periodic Activity Report

Project no. TSA6-CT-2006-044730

Project acronym: HyRail

Project title: Hydrogen Railway Applications International Lighthouse

February 2008

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Project acronym:	HyRail
Project title:	**Hy**drogen **R**ailway **A**pplications **I**nternational **L**ighthouse
Instrument:	Specific Support Action
Thematic Priority:	1.6.2 Sustainable Surface Transport
Objectives 1	New technologies and concepts for all surface modes (road, rail, waterborne)

Periodic activity report

Period covered:	from 01/02/2007 to 31/01/2008
Date of preparation:	11/02/2008
Start date of project:	01/02/2007
Duration:	1 year

Project coordinator name: Enno Wiebe
Project coordinator organisation name: Union Internationale des Chemins de Fer (UIC) / International Union of Railways (UIC)/ Internationaler Eisenbahnverband (UIC)

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1 Executive Summary

HyRail made an assessment of the state of the art of hydrogen and fuel cells technologies available, R&D activities and research projects related to hydrogen propulsion and fuel cells. The project drew possible scenarios of transport systems and energy supply related to railways. Gaps and technological innovations were identified and proposals put forward to solve fragmentation and to remove bottlenecks. These topics were discussed among international experts on the First HyRail Workshop in Bergamo on June 26th, 2007. HyRail provided a "vision" and developed a Position Paper for this technology's implementation in European Railways in the mid long term.

Particular attention was paid to identify user's needs and industrial suppliers, especially for SME. Costs and benefits from different points of view, as well as, energetic and environmental issues were analysed and discussed, in particular considering sustainable use of energy and resources. Areas of business related to possible use of Hydrogen in Fuel Cells as a railway fuel were investigated.

The results of discussions will now strengthen and update the vision, the deployment strategy (DS) and the strategic research agenda (SRA) of the EU's Hydrogen and Fuel Cells Platform (HFP), as basis for further projects to be set up as response to next call series of FP7 (JTI).

The project's final goal has been to strengthen European Rail actor's collaboration, rendering it more effective as well as corresponding to their major interests, showing in conclusion possible applicability areas of hydrogen in railway sector in order to provide a holistic view on the

hydrogen and fuel cells propulsion for the rail sector. The HyRail Final Conference was organised in Brussels on January 10th, 2008 bringing together international experts, railway undertakings and infrastructure managers, presenting the state of the art, the vision for the implementation of fuels cells in the railway sector. Further the conference provided a platform for discussions and preparations for further projects. (FP 7/ JTI)

The HyRail website (established in spring 2007) provided continuously upgraded information about the HyRail project the current work status, all meetings and links to other fuel cells initiatives (e.g. Hy**d**Rail) and (still) allows the download of all working documents and furthermore supporting UIC brochures (like Rail Diesel Emissions – Facts and Challenges, UIC Statistics, …) for further discussions.

2 Project Summary

2.1 Possible ways to implement the fuel cell in the railway sector

2.1.1 The political background

The European Union's White Book Mobility 2001 points out that the European rail system has to achieve the following objectives until 2020:

• 50 % gain in energy efficiency
• 50 % reduction in emissions of pollutants
• For rail to increase its market share of passenger traffic from 6 to 10 % and of goods traffic from 8 to 15 %

One of the conclusions in the White Book is that the train sector needs a veritable "cultural revolution" to remain one of the leading players in the transport system in the enlarged Europe**. The HyRail projects comes to the conclusion that hydrogen powered fuel cell hybrid trains have the potential to help the railways in EU in achieving these targets**. As a matter of fact, whilst it is imperative that the railways reduce costs and improve performance in the short run, it is of vital importance that we explore the possibilities in new technologies that in a longer term perspective can ensure that the railways become increasingly cost-effective while retaining the lead as the most environmentally beneficial means of powered transport. It has been a general assumption that hydrogen technology for railways will develop as a "spin—off" from a future commercial use of hydrogen on the road. Part of the technology from cars and busses could then be transferred and modified for railway use, and at that time the market price for fuel cells and other components would be reduced as a result of mass production for

the growing automotive market. Even if the general development of hydrogen and fuel cell technology will bring lower prices, longer cell lifetimes, better and cheaper solutions for hydrogen storage, production and other benefits, some areas of development are specific for railway use, and the technology needs to be tested, adapted to and demonstrated in railway vehicles to ensure feasible solutions.

2.1.2 Major problems to solve remain

- H_2 storage technology, or reformer solution (with on board CO_2 generation, that is carbon sequestration is no more possible)
- Reliability of the FC generator that must be largely improved to be use in railway applications
- Electrical storage system must be associated with FC generator; the first research effort might be on these technologies with the concept of hybrid architecture.

Since this process could easily take 10 years, even a moderately ambitious timetable for the introduction of hydrogen technology on rails in 2015-2020 calls for a systematic development program now, including different train types, applications and test sites.

A joint European development and demonstration program during the next 10 years can be one of the spearheads in this development. However European action is required now several demonstration projects in North America and Japan are already initiated or well under way, and if European train manufactures are to have a share of this potentially lucrative market, development and demonstration activities must be initiated now.

2.1.3 The timeframe for the implementation

Phase I

Stage 1**:** Area for initial commissioning and restricted train operation without passenger loading.

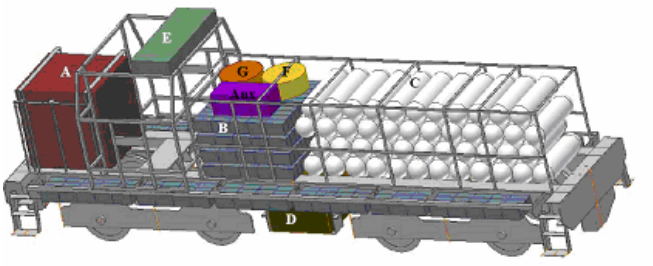
Stage 2: Operation in passenger service over small route to avoid operating vulnerabilities and difficult safety case.

Stage 3: Operation over a route with more arduous operating features, such as tunnels which may have been rejected in Stage 2 to facilitate safety case acceptance.

Most of the above reported criteria are common to rural zones or, better, switching yards and ports.

Phase II

Phase II Will develop new rail vehicles that will prove a more advanced state of the technology, especially regarding fuel cell system cost, durability and component reliability as well as application to higher power ranges. This phase covers the 2011-2015 timeframe and will also address some specific Member State constraints (for example, the small train body dimensions of UK and some narrow gauge systems).



This two-phase approach presents the added advantage that it aligns the timeframes with those currently under study by the Implementation Panel of the HFP. It is noted that the “Snapshot 2020” scenario given in the Deployment Strategy assumes **mass commercialisation by 2020, with a decision to launch mass production in 2015.**

2.1.4 Overview about the implementation of fuel cells

Application scenario	FC technology	FC system configuration	
Short/Mid term Shunting locomotives Tram-Trains Locomotives	**PAFC** pros: already commercialized cons: low efficiency **PEMFC** pros: high efficiency, suitable for transportation cons: lifetime, cost, water management	**Pure fuel cell or hybrid fuel cell**	
Long term Long distance train	Introduction of high temperature **SOFC** pros: fuel flexibility cons: thermal stresses, size	**Mostly hybrid power trains**	

3 Project objectives and major achievements during the reporting period

The following part of the report contains:

- an overview of general project objectives, show the project's current relation to the state-of-the-art
- the objectives for the reporting period, work performed, contractors involved and the main achievements in the period
- comments on the most important problems during the period including the corrective actions undertaken

The objectives for the work to be performed during the one year of the project were as follows:

- Minutes of the Kick-off Meeting
- Preliminary Report
- Website
- Communication Platform (Linking the world of hydrogen)
- Clustering Contact Data Base of International Rail Research Experts and Facilities
- State-of-the-art-report
- Final document (Position Paper)

3.1 The work carried out in the EC project HyRail during the first year (M1-12):

3.1.1 WP 0 - Project management (D0.1; D 0.2)

The HyRail project management was undertaken by Enno Wiebe. He ensured the close link to Hélène Lebreton being in charge of the financial affairs and Marina Grzanka responsible for the continuous upgrade of the HyRail website. The internal and external information exchange was mainly done by mail, supported by the UIC-Extranet as well as in the major meetings.

The quality of deliverables was monitored constantly and the feedback and contribution by the members was demanded regularly by the coordinator.

The smooth progress of the activities was controlled by the coordinator and fixed in an agreed GANTT diagram. The circulation of all pieces of information was ensured by the UIC Extranet. All information was regularly updated and accessible for all consortium partners as well as the EC and associated partners.

The kick-off meeting for the HyRail project was held at the UIC Headquarters in Paris on February 27th, 2007 with all Consortium members participating.

D 0.1 The Intermediate Activity report was published

D 0.2 The Final Activity Report was published in February 2008

3.1.2 WP 1 - Workshop organisation (D1.1)

The city of Bergamo in Northern Italy was the venue for UIC hosting the first HyRail workshop on June 27th, 2007. UIC and the HyRail consortium invited speakers and participants from RSSB, the British Department of Transport (DOT), NTDA Energia, Alphea Hydrogène, UNIFE and Bombardier as well as from the Hy**d**Rail consortium from Denmark, the U.S. and Canada.

The workshop's intention was to demonstrate and discuss the state of the art of the hydrogen and fuel cell's technology.
One outcome of the workshop was the common opinion that the hydrogen and fuel cells propulsion should be further examined for the propulsion of shunting locomotives. This new technology is mostly reasonable for this kind of traction. It was commonly agreed that the currently used electric traction is very efficient and environmental friendly but in some parts of the railway sector this kind of traction cannot be used easily. The fuel cell might find its application area in shunting yards and rail container terminals where a centenary system is interfering.

D 1.1 The Workshop organisation had been done in spring 2007 and the proceedings of the HyRail project were fixed with structuring the State-of-the-art report.

3.1.3 WP 2 - Position Paper development (D 2.1, D 2.2, D2.3)

The Position Paper included general information about needs for alternative propulsion, modes of alternative propulsion, an abstract of the state of the art, first thoughts about RU's and IM's issues and a vague vision about the implementation of the hydrogen and fuel cells propulsion for the European rail sector. It was conceived as the wrap-up off the Bergamo workshop send in combination with all workshop presentations to all major European RU and IM as well as interested stakeholders.

In order to prepare the state-of-the art document all available technical documents (UIC Leaflets, TSI, EC and other partner's documents) were evaluated and analysed. Further all currently ongoing research projects (like Hy**d**Rail, JR East) were examined. The examinations fall into two parts:

The first part is the description of hydrogen as an energy carrier, the construction of all different types of fuel cells, and hydrogen production.

The second parts deals with hydrogen storage and safety aspects.

All details were discussed and examples given from all over the world used to illustrate the state of the art.

The Position Paper is the third deliverable of the Work Package 2 for the HyRail project and contains all the contributions produced by the HyRail

partners. The Position Paper is based on this the State-of-the-Art Document, adding to it contributions coming from all partners and others following the 2nd Paris Workshop, and offers a vision shared by the HyRail SSA proposal participants, about the future of use of hydrogen as a energy carrier in railway systems.

As a matter of fact, the WP 2 objectives consist in availability of:

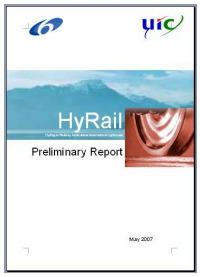
• organic set of technical documents, defining user needs and requirements, also in terms of safety standards & regulations, and identifying existing obstacles for implementing fuel cell technology,

• Proposal for the position paper, to be presented in the final SSA conference

The content of the report is consistent with the outcome of the Bergamo Workshop, therefore it is organized according the following topics:

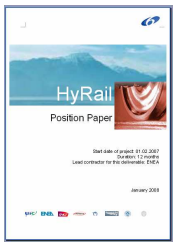
- Basic Background
- Storage
- Pressure tanks
- NiMH
- Cryogenic
- Safety (burst, fire) - Security
- •Well-to-wheels considerations (efficiency, CO_2, pollutants)
- Costs (capital, running)
- FC Technologies PEM
- SOFC
- Construction and operation of FC systems (BOP, Control)
- Synergies with other applications (stationary, Naval)
- Hybrids as a *bridge* to Hydrogen (esp. buses): state of the art
- Codes and Standards harmonisation
- Infrastructure (smaller issue for railway?)
- Main FC generation limitations (cost, life, reliability)
- Potential advantages

The conclusions, at the end of the document, are a proposal for the common discussion, to be held in Brussels in January. They are intended to be a base for the preparation of a roadmap for developments of Fuel Cell applications in railway transport and recommendations for joint RTD projects that should be developed in the 7th Framework Programme



D 2.1 The Preliminary Report was published in May 2007 including general information about the HyRail project, a brief overview about the state-of-the-art and a very first vision for the implementation of hydrogen and fuels cells applications

D.2.2 A first state-of-the art assessment was included in the Preliminary Report. The more detailed State-of-the-art-report comprising all information available about ongoing hydrogen and fuel cells research was published in December 2007



D 2.3. The Position Paper as a summary of the entire project and all information gathered was drafted in fall 2007 and latter published and presented in January 2008.

3.1.4 WP 3 - Dissemination and exploitation (D3.1; D 3.2; D 3.3)

The dissemination activity was carried out at European and world wide level through the HyRail website www.HyRail.eu and regular mailings. The website comprises the main information about the project, its objectives and members as well as the link to all documents available and to other ongoing hydrogen and fuel cells research projects. It further provided background information about hydrogen and documents about railway propulsion (diesel and electrification). The website had been constantly updated with all important information about meeting and events and the latest link to research projects.

Finally all project results were summarized in the Position Paper, which has been sent to the EC and DB (upon request) and is available as paper copy on request. The electronic version is available through the HyRail website and can be downloaded from the UIC extranet.

The Final Paper comprised the Position Paper and the State of the Art document and gives and overview about the state of the art of hydrogen and fuel cells propulsion, the specific needs from railway undertakings and infrastructure managers and provides the vision for the implementation of fuel cells in the European rail sector.

UIC and the HyRail Consortium finalised successfully with the Final Conference at the SNCB Headquarters in Brussels on January 10th, 2008.
UIC succeeded to invite 60 participants and 14 speakers from the entire world to this conference. With a very high level of speakers and presentations UIC placed an important event in a series of international conferences on fuel cells technology. The HyRail Final Conference was divided into two panels:

During the first panel the HyRail Consortium summarized the research it had been doing in 2007. ENEA gave an introduction to the state of the art of hydrogen and fuel cells propulsion and the University of Pisa presented the vision for the implementation of the fuel cells in the European railway sector.
In the second panel speakers from the United Kingdom, Japan and the USA provided an overview about fuel cells projects from abroad and resumed the positive discussion of the first panel.

ZSSK (Slovakia) presented the technical specifications for such locomotion from a railway operator's point of view. Network Rail in the UK added the specific needs of an infrastructure manager.

D3.1. The website with all information about the project, the most important information about events and links to other fuel cells project was created in spring 2007 and regularly updated.
D3.2 The final conference took place in Brussels on January 10th, 2008. The state-of-the-art and the vision for HyRail were presented to participants from all over the world.

D3.3 The Position Paper as a summary of the entire project and all information gathered was published and presented in January 2008. It is available as a softcopy on the UIC Extranet and as a hardcopy on request.

3.2 Comments on the most important problems during the period including the corrective actions undertaken:

UIC tried to link the hydrogen and fuel cells propulsion project for the rail sector to the projects currently going on in the automotive sector. UIC checked the ongoing activities of the major automotive manufactures regularly and included them into the mailings offering information about the work done in the rail sector. A cross fertilisation was regarded as fruitful but there was no sign of interest given form the automotive sector. No representatives joined the final conference or asked for the final report provided on the extranet.

Due to a disinterest of the automotive sector the research on hydrogen and fuel cells propulsion for the road and rail sector could not be linked.

4 Contractors

Partic. Role	Partic. No.	Participant name	Participant short name	Country	Date enter project	Date exit project
CO	1	International Union of the Railways	UIC	France	01/02/2008	31/01/2008
CR	2	Ente per le Nuove tecnologie, l'Energia e l'Ambiente	ENEA	Italy	01/02/2008	31/01/2008
CR	3	Institut National De Recherche Sur Les Transports et leur Sécurité	INRETS	France	01/02/2008	31/01/2008
CR	4	Société Nationale des Chemins de Fer	SNCF	France	01/02/2008	31/01/2008
CR	5	Zeleznicna spolcnost Slovensko, a.s	ZSSK	Slovakia	01/02/2008	31/01/2008
CR	6	Università di Pisa	UNIPI	Italy	01/02/2008	31/01/2008
CR	7	Network Rail Infrastructure Limited	NR	UK	01/02/2008	31/01/2008

5 Work Packages Progress of the Period

For your information, below you will find the original overview of work packages for the full duration of the project:

Work-package No	Work package title	Lead contractor No	Person-months	Start month	End month	Deliverable No
0	Management	1	1,25	0	12	D0.1, D0.2
1	Workshop Organisation	1	1,75	03	05	D1.1
2	Position Paper Development	1	12,25	06	12	D2.1, D2.2, D2.3
3	Dissemination and exploitation	1	1,25	02	12	D3.1, D3.2, D3.3
	TOTAL		16,50			

6 Original Deliverables list for the full duration of the project

Deliverable No	Deliverable title	Delivery month	Nature	Dissemination level
D0.1	Intermediate activity report	02/07	R	CO
D0.2	Final activity report	02/08	R	CO
D1.1	First workshop	06/07	O	PU
D2.1	Preliminary Report	05/07	R	PU
D2.2	State of the art assessment	12/07	R	RE
D2.3	Draft Position paper	12/07	R	CO
D3.1	Final Conference	01/08	O	PU
D3.2	Project website	02/08	O	PU
D3.3	Position Paper	01/08	R	RE

R = Report P = Prototype D = Demonstrator O = Other	PU = Public PP = Restricted to other programme participants (including the Commission Services) RE = Restricted to a group specified by the consortium (including the Commission Services) CO = Confidential, only for members of the consortium (including the Commission Services).