Hydrogen Rail Status
- Germany -

H2@Rail Workshop, U.S. Department of Energy
SHAPING SUSTAINABLE MOBILITY
Integrated implementation of German national funding programs

Battery Electric Mobility
Research and development, market activation, concepts

Charging Infrastructure
Nationwide buildup, normal and fast charging

Mobility and Fuels Strategy
Pilot projects, alternative fuels, LNG as a marine fuel

Export Initiative Environmental Technology
German-Japanese cooperation for PtG, development cooperation for H2/FC technologies, cooperation with the GIZ

NIP*
Research and development, market activation

Coordination
Implementation
Networking
Acceptance
Visibility

* National Innovation Programme Hydrogen and Fuel Cell Technology
NIP – VEHICLE AND INFRASTRUCTURE ACQUISITION

5 calls

241 Mio. € requested funding of which

191 Mio. € are requested funding for trains

85 Mio. € granted
AGENDA

1. Framework conditions
2. R&D projects – fuel cell and battery
3. Acquisition of hydrogen trains & infrastructure
4. European developments
5. Common challenges
6. Current activities

Towards zero emissions in rail transport

08.04.2019
Electrification through catenaries → feasible for tracks with a high level of traffic

Battery electric trains → lucrative for tracks with already existing catenaries in some parts

Fuel cell electric trains → lucrative for longer tracks (up to 1,000 km range) without catenaries and with availability of inexpensive hydrogen sources

Conclusion: SIGNIFICANT POTENTIAL FOR BOTH BATTERY AND FUEL CELL ELECTRIC TRAINS IN GERMANY
TRAFFIC FORECAST GERMANY 2030

Freight transport

- +43%
- +39%
- +23%

2010
2030

Passenger transport

- +19%
- +10%
- +65%

2010
2030

Source: https://www.bmwi.de/SharedDocs/DE/Anlage/MKS/energie-auf-neuen-wegen.pdf?__blob=publicationFile

Great potential for fuel cells in heavy duty applications!
R&D PROJECTS
Fuel cell and battery electric trains

X-EMU
Siemens, RWTH Aachen – Fuel cell drive for hybrid EMU trains

TALENT 3
Bombardier, TU Berlin, NVBW, SWEG – development of a battery electric train

iLint
Alstom, DLR – development & validation of a fuel cell electric train

EcoTrain
DB RegioNetz, TU Chemnitz, TU Dresden – modular battery drive and storage technology
SUCCESS STORY CORADIA ILINT
From intention to market launch

Letter of intent for the use of hydrogen trains in the federal states of Lower Saxony, Hesse, Baden-Württemberg and North Rhine-Westphalia

September 2014

Federal financial funding amounting to 9.04 million € for the project BetHy by Alstom for the development of the hydrogen train Coradia iLint

November 2014

Alstom receives the admission for passenger service within the German rail network for the Coradia iLint

July 2018

Start of the trial operation of the Coradia iLint on the route Cuxhaven – Bremerhaven – Bremervörde – Buxtehude in Lower Saxony

September 2018
Defined projects

**ACQUISITION OF HYDROGEN TRAINS IN GERMANY**

**LNVG, LOWER SAXONY**
Cuxhaven – Bremerhaven – Bremervörde – Buxtehude
14 trains + HRS in Bremervörde, acquisition until the end of 2021, operation starting in early 2022

**RMV/FAHMA, HESSE**
RMV lines 11, 12, 15 & 16
28 trains + HRS in Frankfurt-Höchst, acquisition and start of operation in 2022
### RAIL ELECTRIFICATION IN EUROPE

<table>
<thead>
<tr>
<th>Country</th>
<th>Degree of electrification (%)</th>
<th>Non-electrified tracks (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switzerland</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>Netherlands</td>
<td>76</td>
<td>3.058</td>
</tr>
<tr>
<td>France</td>
<td>51</td>
<td>14.809</td>
</tr>
<tr>
<td>Great Britain</td>
<td>34</td>
<td>10.770</td>
</tr>
<tr>
<td>Ireland</td>
<td>8</td>
<td>1.786</td>
</tr>
</tbody>
</table>
Alstom confirms plans to bring hydrogen trains to the UK

Alstom today confirms plans to bring its world leading hydrogen technology to trains in the UK. This is the first substantive industry response to the Government's challenge to remove diesel rolling stock by 2040. The company is working with Eversholt Rail on plans to convert Class 321 electric trains to hydrogen operation, fitting hydrogen tanks and fuel cells to upcycle trains that are some of the best proven on the network into Britain's most advanced rolling stock.

France on track for hydrogen train roll-out

Four lines in Nouvelle Aquitaine will be used to trial manufacturer Alstom's hydrogen-powered locomotives.

ZILLERTALBAHN HYDROGEN TRAIN

Fuel cell trains for Austria

The Zillertalbahn will be the first narrow gauge railway in the world with a hydrogen fuel cell propulsion. With this green technology, 800,000 liters of diesel and 2,160 tons of CO2 can be saved every year. Molinari provided a research study to electrify the train with alternative propulsion systems and has prepared the tender documents and accompanied the Zillertalbahn at the tender process. The pre-qualification has been completed successfully and now Molinari supports the Zillertalbahn with procurement of the fuel cell vehicles.
COSTS & FINANCING
– Battery and fuel cell electric trains currently cost approximately 1.5 Mio € more than a comparable diesel train
– Risk surcharges
– Who is responsible for the infrastructure (costs, risks)?
– Usually high costs for „green“ hydrogen production through electrolysis due to levies

REGULATION & LEGAL ASPECTS
– Lengthy approval and admission procedures
– Access to infrastructure owned by the „DB Netz AG“
– Legal aspects of tendering procedures

Common Challenges
FOR RAIL TRANSPORT WE INTEND TO ESTABLISH A COMPREHENSIVE FUNDING PROGRAM, WHICH COVERS BOTH THE ELECTRIFICATION OF TRACKS AND THE ACQUISITION OF VEHICLES AND THE RESPECTIVE CHARGING/REFUELING INFRASTRUCTURE. FURTHERMORE, REGIONAL RAIL TRANSPORT IS INTENDED TO BE SUPPORTED THROUGH INVESTMENT GRANTS FOR FUEL-CELL-HYBRID-RAILCARS INCLUDING FACILITIES & DEPOT MODIFICATIONS AS WELL AS THE CONSTRUCTION AND OPERATION OF HYDROGEN REFUELING STATIONS."

— TRANSLATED FROM THE COALITION AGREEMENT BETWEEN CDU, CSU & SPD, 2018

NEW FUNDING GUIDELINE

→ Applications for 164 fuel cell trains, 11 HRS and 4 onsite electrolyzers

→ expressions of interest for more than 300 battery and fuel cell electric trains until 2024

New funding program for the acquisition of trains with alternative drives

→ Announced budget 2019: 13.9 Mio € + 38.8 Mio € until 2024

→ Funding guideline in preparation
MARKET ANALYSIS

ALTERNATIVE DRIVES IN REGIONAL RAIL TRANSPORT

Comparison of European countries
Technology comparison
Status-quo of the German rail network
Detailed analysis of specific tracks
Market potential for battery and fuel cell
Derivations concerning funding
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