HRS Infrastructure in Germany and Europe
- Current activities

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NOW GmbH National Organization Hydrogen and Fuel Cell Technology
NOW GmbH
National Organization Hydrogen and Fuel Cell Technology

- Government-owned company (100 %) funded in 2008
- Co-financing by industry (project overheads)
- Supervisory board: BMVBS (Chair), BMWi, BMBF, BMU
- Advisory board: strategic controlling and development of programs

Program Management / International cooperation / Communication

NIP
Preparing hydrogen and fuel cell markets

BMVBS Electric Mobility
Electric Mobility with Battery-Technologies

Lighthouse projects

Model regions

programs addressing market preparation
Market Preparation for Eletro-Mobility

Three pillars of electrifying the powertrain

- Electric Powertrain Technologies
- Hybrid vehicles (rail/road)
- Plug-in-vehicles and pure battery electric vehicles
- Hydrogen and fuel cells

Battery technology

- 500 mio. € budget (2009-2014);
  - Incl. 150 mio. € BMVBS (2009-2011)
  - ~ 100 mio. € (2011-2014)

Hydrogen and fuel cell technologies

- 1,4 bn. € budget (2007-2016);
  - Incl. 700 mio. € federal funding:
    BMVBS (500 mio. €) and
    BMWi (200 mio. €)

batteries and hydrogen / fuel cells are key technologies for a sustainable mobility
Political Framework for the Transport Sector

• Share of transport in final energy consumption nearly 30%
• Tripling of energy consumption in transport since 1960, even five-fold increase in road traffic

• Goals of the German Energy Concept (2010) for Transport:
  – about -10% until 2020 of energy consumption
  – about -40% until 2050 of energy consumption (vs. 2005)

⇒ The Mobility and Fuels Strategy of the German Government\(^2\) outlines the way how to achieve these objectives.

⇒ Electrification of the drive train (BEV’s and FCEV’s) is an key issue to reach the targets!
⇒ Targets only achievable with renewable power to gaseous fuels.
⇒ Further increase of RE mandatory to achieve the targets.
⇒ Large scale storage for Hydrogen is inevitable.
## Phased approach to a profitable commercial infrastructure ramp-up

<table>
<thead>
<tr>
<th>When? Who?</th>
<th>R&amp;D and demonstration</th>
<th>Market preparation and validation</th>
<th>Commercial ramp-up</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Since 2006</td>
<td>For the next 5 - 10 years</td>
<td>Around 2020</td>
</tr>
<tr>
<td></td>
<td>NOW / CEP</td>
<td>H₂ Mobility and NOW / CEP</td>
<td>H₂ Mobility and free market</td>
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### Goals

<table>
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<th>R&amp;D and demonstration</th>
<th>Market preparation and validation</th>
<th>Commercial ramp-up</th>
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<tbody>
<tr>
<td>HRS technology up and running</td>
<td>Proof of HRS, FCEV technology, and H₂ supply chain</td>
<td>Scaled nationwide HRS network to enable FCEV mass take-up</td>
</tr>
<tr>
<td>Costs significantly reduced</td>
<td>Customer acceptance of FCEVs</td>
<td>Profitable, high-growth business</td>
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</table>
Timeline HRS infrastructure build-up H2-Mobility including 50 HRS Program

Until 2015:
- 50 HRS are securely financed by NIP.

2015 - 2017:
- Build-up of a preliminary overcapacity of HRS as basis for an independent market development by H2 Mobility
- Build up is not related to (certified) FCEV numbers

2017 - 2023:
- Roll-out of HRS network will depend on (certified) FCEV numbers (internal H2-Mobility allocation key)
The Clean Energy Partnership

Fields of Activities:

- **Hydrogen Production**
  Technical improvement of electrolyzers, compressors and storage technologies.

- **Infrastructure**
  Technical improvement of refueling technology and deployment of an initial HRS infrastructure.

- **Mobility (Cars and Busses)**
  Technical improvement of the FC System and running demonstration fleets.
Current Hydrogen Refueling Stations (HRS) in Germany

Key achievements
- Safety of stations proven
- Refueling standards agreed
- Storage and compressor technology tested
- H₂ supply chain tested
- Bugs of station technology eliminated

Publicly Accessible Hydrogen Refueling Stations in Germany (GH₂, 700 bar)
50 HRS for Germany

- joint Letter of Intent to expand the network of hydrogen filling stations in Germany
  - signed by the German Ministry of Transport, Building and Urban Development (BMVBS) and several industrial companies
  - part of the National Innovation Programmed for Hydrogen and Fuel Cell Technology (NIP)
  - overall investment more than €40 million (US$51 million)
- coordination by NOW GmbH in the frame of the Clean Energy Partnership (CEP)

Current Status:
- Location planning of the 50 HRS has been finalized.
- Currently there are application for funding for 23 HRS, the remaining 12 HRS are in the planning phase.
- The majority of the HRS will be operated by H2-Mobility after the funded project time frame has ended.
- About ~110 FCEV’s are currently on the road.
# Work groups for inspecting filling stations

<table>
<thead>
<tr>
<th></th>
<th>H₂ filling</th>
<th>H₂ quality</th>
<th>Leak test filling system</th>
<th>H₂ flow measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Goal</strong></td>
<td>Inspect filling stations with regard to refuelling (pressure and temperature)</td>
<td>Take samples of hydrogen at filling stations and subject them to analysis/testing</td>
<td>Leak test of nozzle, hose and tear-away coupling</td>
<td>calibration of the hydrogen flow measurement</td>
</tr>
</tbody>
</table>

**Work group Participants**

- **Management**
  - BMW Group
  - DAIMLER
  - TOTAL
  - VATTENFALL
  - EnBW
  - AIR LIQUIDE
  - GM
  - The Lion Group
  - Shell
  - Linde
  - HONDA
  - VOLKSWAGEN
  - FORD

**Modelled on**

- SAE 2601 / CSA 4.3
- SAE 2719 / ASTM
- SAE 2600
CEP & H2 Mobility – Expansion of the filling station network in Germany

„Getting the job done!“
Continuously build-up of H2-stations, vehicle fleets, standards

German States
(associate CEP partners North Rhine-Westphalia, Baden-Württemberg, Hesse and others)

promote the expansion of the hydrogen infrastructure

„The big picture“
Framework requirements for the economic build-up of a nationwide H₂-Infrastructure

Nationwide H₂-Infrastructure in Germany. Standardised, safe, comfortable fuelling!
In-depth analysis investigating the potential development of a hydrogen infrastructure in Germany

<table>
<thead>
<tr>
<th>H₂ Mobility setup</th>
<th>H₂ Mobility business case (joint study)</th>
<th>H₂ Mobility business and implementation plan (joint study)</th>
<th>Negotiations for founding joint entity</th>
<th>Market preparation and validation</th>
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<tr>
<td>Memorandum of understanding for H₂ Mobility signed Sep 10, 2009 in Berlin</td>
<td>Consistent HRS and FCEV ramp-up scenarios for Germany agreed</td>
<td>Design of joint entity structure outlined</td>
<td>Negotiate joint entity agreement</td>
<td>Start HRS rollout in Germany via the CEP</td>
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<td>Business case calculated and implementation plan outlined</td>
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<td>Synchronize HRS rollout with FCEV ramp-up</td>
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**H₂ Mobility coalition objectives**

- Negotiate joint entity agreement
- Start HRS rollout in Germany via the CEP
- Synchronize HRS rollout with FCEV ramp-up

**Main achievements**

- Consistent HRS and FCEV ramp-up scenarios for Germany agreed
- Design of joint entity structure outlined
- Business case calculated and implementation plan outlined
- Negotiate joint entity agreement
- Start HRS rollout in Germany via the CEP
- Synchronize HRS rollout with FCEV ramp-up

**Partner:**

- DAIMLER
- TOTAL
- AIR LIQUIDE
- OMV
- Linde
- Shell

**Associated Partner:**

- NISSAN
- BMW GROUP
- HYUNDAI
- KIA
- VOLKSWAGEN
- TOYOTA
- HONDA
- Intelligent Energy
- NOW
Air Liquide, Daimler, Linde, OMV, Shell and Total agree on an action plan for the construction of a hydrogen refueling network in Germany.

Targets:

- **400 HRS** until **2023** (100 HRS until 2017).
- **350 mio. €** investment.
- Max. **90 km** distance between two HRS at the motorway.
- **10 HRS** in each metropolitan area.
Developing Commercial Hydrogen-Infrastructure

Key aspects of Public-Private-Partnerships / Learnings from H2-Mobility Germany

Success factors
- Synchronized ramp-up of hydrogen stations and vehicle deployment
- Risk sharing mechanisms (across industries / the role of public)

Key Elements of public-private deployment roadmaps
- Policy framework (e.g.: EU - CPT Directive, D – Mobility and Fuels Strategy)
- Implementation of standards (e.g. J2601, …)
- Continued R&D as a basis for increased performance and cost reduction
- Joint network planning in phases (based on defined milestones)
- Financing (from loss making business to positive ROI)

Investment decision of Infrastructure-Industry requires
- Active participation/involvement of OEMs to build trust between industry sectors
- Robust commitment from public stakeholders
Current European H2-Infrastructure Initiatives

UK:
- 4 existing
- 1 planned in 2014
- UK H2 Mobility:
  - 65 HRS until 2020
  - 330 HRS until 2025

Netherlands:
- 1 existing
- 3 planned until 2015
- HIT-I and HIT-II
- H2 Mobility NL:
  - 30 HRS until 2017

France:
- HIT-I Partner
- France H2 Mobility:
  - ~150 HRS until 2020
  - (estimation)

Germany:
- 50 HRS until 2015
- H2 Mobility:
  - 400 HRS until 2023

Sweden:
- 1 existing
- 5 planned until 2016
- HIT-I and HIT-II

Norway:
- 6 Existing

Denmark:
- 2 existing
- 4 planned in 2014
- HIT-I and HIT-II

Scandinavia:
- SHHP
  - 45 HRS until 2015
Clean Power for Transport Directive

General

Targets of the directive:

- Establishment of an EU market for alternative fuels and power trains.
- Enforcement of the EU’s innovation and competitiveness

CPT-directive covers specific infrastructure requirements for the following fuel options:

- Power for BEV’s as well as charging opportunities for ships in harbors.
- Hydrogen
- Methane (CNG and LNG: for street traffic and maritime applications)

Key elements of the CPT-directive:

- Member states (MS) have to develop national implementation plans (NIP); no specific guidelines for infrastructure by the directive: MS have to decide within their NIP about a “appropriate number” for “Charging/H2/LNG&CNG“-infrastructures
Clean Power for Transport Directive
Impact for Hydrogen Technology

- Integration of the directive into national laws: 24 month after empowerment (expected: mid of 2014)

- H2-Infrastructure: 31.12.2025 (just for MS which will use the H2 option)

- Relevant Standards:
  - The hydrogen purity dispensed by hydrogen refuelling points shall comply with the technical specifications included in the ISO 14687-2 standard.
  - Hydrogen refuelling points shall employ fuelling algorithms and equipment complying with the ISO/TS 20100 Gaseous Hydrogen Fuelling specification.
  - Connectors for motor vehicles for the refuelling of gaseous hydrogen shall comply with the ISO 17268 gaseous hydrogen motor vehicle refuelling connection devices standard.

- Transition period for all fuel options: 36 month after empowerment of the directive all new or renewed fuel infrastructure has to follow the mentioned standards.

  ➔ Council has approved the directive.
Thank you very much!

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download: www.now-gmbh.de