NATIONAL INNOVATION PROGRAMME
HYDROGEN AND FUEL CELL TECHNOLOGY (NIP)

Franco-German Conference on Hydrogen | Paris | 22 October 2018 |
Wolfgang Axthammer | Managing Director and Divisional Head Special Markets, NOW GmbH
NOW
PARTNER OF THE GERMAN GOVERNMENT FOR SUSTAINABLE MOBILITY

Battery Electric Mobility
- Research and Development
- Communal mobility concepts
- Vehicle procurement

Federal Programme Charging Infrastructure
- Nationwide buildup
- Normal charging
- Fast charging

Mobility and Fuels Strategy
- Alternative fuels (efficient, emission-free)
- LNG as a marine fuel
- Pilot projects

National Innovation-Programme Hydrogen and Fuel Cell Technology
- Research and Development
- Market activation

Export Initiative Environmental Technology
- German-Japanese cooperation PtG
- H2/FC technology in developing countries (cooperation with GIZ)

Coordination
Implementation
Strategy
Networking
Visibility

22 October 2018
Wolfgang Axthammer | Managing Director
THE NIP I
PHASE 1 (2006 – 2016)


September 2017

22 October 2018

Wolfgang Axthammer | Managing Director

TRIGGERED FOLLOW-ON-INVESTMENTS

Investments follow-on investments EUR million, n= 221

Leverage of 1:3 ~ 2,000 - 2,600 ~ 2,100 - 2,300 ~ 600 - 600 ~ 1,300 - 1,400 ~ 2,706 - 3,300 ~ 605 - 600 ~ 700 - 700 ~ 1,400 - 1,300

NIP grants Third-party funds Own funds Follow-on investigations Total

693 17 682 700

Source: Survey of NIP I grant recipients 2017

€710 MILLION PUBLIC R&D FUNDING

Total volume and grant proportion

Basic research^1 Applied R&D^1 Demonstration projects^1 Market activities^2 Support activities^2 Total

Transport 44 (44%) 471 (46%) 235 (24%) - 0 (0%) 754
Household power 8 (8%) 105 (10%) 33 (34%) 13 (14%) 9 (9%) 225
Special markets 4 (4%) 130 (26%) 40 (40%) 3 (4%) - 152
Industry 8 (8%) 32 (9%) 78 (16%) - 1 (1%) 130
Transportation topics 8 (8%) 67 (25%) 14 (5%) - 8 (8%) 83
Hydrogen production 5 (5%) 16 (5%) 30 (25%) - 2 (25%) 60
Total 71 193 403 21 15 2 1,417

...SAFEGUARDED GERMANY’S POSITION AS TECHNOLOGY LEADER

Cost efficiency and long-term market leadership

Further significant investment in hydrogen 2030 to 2050

High variation between types and applications

Example of stationary applications for households

- 1,600 patents

- 400 papers

- 250 publications

...ACCELERATED MARKET DEVELOPMENT

Market in preparatory phase: Investment and purchasing, significantly increased revenues, revenue growing factor increase from 35% to 58% – expected growth from 45% to 65%
National innovation programme hydrogen and fuel cell technology 2016 to 2026 (€1.4 bn.)

Measures by the BMVI within the scope of NIP II (€250 million until 2019)

Funding guidelines of the BMVI in the course of NIP II

- Measures of research, development and innovation
- Measures of market activation

- Funding rates of up to 100%, depending on the respective TRL
- Constantly open to submissions

- Funding rates of 40-45% of the extra costs compared to a conventional technology
- Regular calls addressing different applications
MOBILITY WITH BATTERIES AND FUEL CELLS
COMPLIMENTARY ZERO EMISSION SOLUTIONS COVERING ALL MARKET REQUIREMENTS

System cost comparison between BEV and FCEV

Infrastructure investment costs comparison for BEVs and FCEVs in mass market

including investments into 100% green hydrogen production

Source: Toyota

Source: FZ Jülich, H2 Mobility: EVS, Stuttgart 2018

BEV: Base Case
FCEV: Base Case

Source:
Toyota

Range

BEV
advantage for BEV
advantage for FCEV

Infrastructure investment

€ billion

0 10 20 30 40 50 60

0.1 1 3 5 10 15 20

Source:
FZ Jülich, H2 Mobility: EVS, Stuttgart 2018

Wolfgang Axthammer | Managing Director

22 October 2018
HYDROGEN REFUELING INFRASTRUCTURE
NETWORK OF 700 BAR RETAIL STATIONS

2006-2016
Secure technological basis, meet conditions for ramp up
50 stations

until 2020
Basic coverage for Germany
100 stations

INDEPENDENT OF NUMBER OF VEHICLES

In operation 51
Under construction 23
In planning 11

Secure technological basis, meet conditions for ramp up

Basic coverage for Germany

INDEPENDENT OF NUMBER OF VEHICLES

TASKS
GOAL

22 October 2018
Wolfgang Axthammer | Managing Director
FUEL CELL BUSES IN GERMANY

ELECTRIFYING PUBLIC TRANSPORT

Public funding EU & Germany

Wolfgang Axthammer | Managing Director

22 October 2018
DEPLOYMENT OF FUEL CELL RAILWAY VEHICLES
INDISPENSABLE OPTION FOR ELECTRIFYING THE GERMAN GRID

Merely ~54% of the German railway network is electrified.

~30% less energy demand per travelled distance by fuel cell train.

<table>
<thead>
<tr>
<th>Reference route</th>
<th>Comparative data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route length per round</td>
<td>Number of stations</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Buxtehude – Bremervörde – Cuxhaven – Buxtehude</td>
<td>240</td>
</tr>
<tr>
<td>Frankfurt – Königstein – Frankfurt</td>
<td>50.2</td>
</tr>
</tbody>
</table>
Common Tasks for the shipping Industry:

- Technology *demonstrators*
- Definition of functional *safety requirements* for fuel cell applications
- HAZID/FMEA: *design evaluation* by DNV GL for failure modes according to class rules and IGF code
- Derive of *IGF Code* requirements for fuel cells and conveyance of proposals for regulations to IMO by German Federal Ministry of Traffic and CESA
- Further development of *class rules*

http://www.e4ships.de/
Market-Pull from automotive industry in the EU

→ Users of fuel cells recognize **environmental impact** and **structural benefit** in production lines

→ In the medium term **TCO-benefits** predicted

→ [www.cleanintralogistics.net](http://www.cleanintralogistics.net) (in English)
Fuel Cells in Industry and Business

Backup Power Supply to Critical Infrastructure

Clean Power Net (CPN):
- Uninterruptible power supply, backup power supply, network backup systems, etc.
- 22 partners - manufacturers, users, research
- 5 Mio € funding by the German Ministry of Transport and Digital Infrastructure in 2018
  → BOS Digital radio network < 20 kW
- www.cleanpowernet.de (in English)
INDUSTRIALIZATION OF WATER ELECTROLYSIS
MEASURES TO REDUCE THE COSTS OF GREEN HYDROGEN

€/kg H₂

H₂ production costs with 15.4 ct/kWh energy costs

- Reward of 300 €/t CO₂
- No grid charges
- No further charges like EEG and taxes
- 50 % CAPEX funding, max. 400 €/kW
- Flexibility for purchasing green electricity
- Combination of both measures

Measures for market activation

Competitive production costs in target market

H₂ for fuel cell vehicles
H₂ for industry and the heat sector
INTERNATIONAL COLLABORATION
EXAMPLES FOR ONGOING ACTIVITIES

- Fuel Cell Technology Office (FCTO) of the DoE
- California Fuel Cell Partnership (CaFCP), California Air Resources Board (CARB)
- GSG, STF, AFI committee
- FCH JU
- Fr.-Ger. WG E-Mobility
- NEDO & METI
- Bilateral PtG-Project
- CATARC & MOST
- SGEC & 5 bilateral Projects: (MetropoLIS, Networked Mobility, RCS Cooperation, DeH2MLeak, CHIG)
Thank you very much for your attention!

Wolfgang Axthammer
Managing Director and Divisional Head  Special Markets
Fasanenstr. 5 | D-10623 Berlin | Germany
Phone: +49 30 311 61 16-20 | Mobile: +49 172 302 15 01 | Fax: +49 30 311 61 16-88
Email: wolfgang.axthammer@now-gmbh.de
Internet: www.now-gmbh.de