Deployment of Hydrogen and Fuel Cell Technology in Germany

EHEC | Málaga, Spain | March 15th, 2018 | Thorsten Herbert | Divisional Head Transport and Infrastructure, NOW GmbH
FIRST OF ALL
I DON’T WANT TO TALK ABOUT CHICKEN AND EGG ANYMORE!

Which came first, the chicken or the egg?

Turtles  Lizards  Snakes  Crocodiles  Birds

Chickens appear here

Eggs already existed here

Source: https://twitter.com/Protohedgehog/status/969929755817664512
THE CHALLENGE
THE CHALLENGE (I) – CLIMATE ACTION PLAN 2050 DEFINES SECTOR TARGETS FOR CO2-EMISSION REDUCTION

- Development of concepts for target achievement 2030 and long term agenda setting for 2050
- Submittal of concepts in 2018

Climate Action Plan 2050
Principles and goals of the German government’s climate policy

CO₂-Einsparungen in einzelnen Bereichen
Treibhausgas-Emissionen in Millionen Tonnen CO₂-Äquivalente
- 40 % in transport sector!

- 358
- 181
- 160
- 119
- <183
- <143
- <61

- gesamt: 902
- maximal: 562

heute
2030

www.bmw.de
THE CHALLENGE (II) – VARIOUS MODES OF MOBILITY NEED TO BE ADDRESSED


1. Battery-hydrogen hybrid to ensure sufficient power.
2. Split in A- and D-segment LDVs (small cars) and C-segment LDVs (medium to large cars) based on a 30% market share of A/D-segment cars and a 50% less energy demand.

Source: Toyota, Hyundai, Daimler

THE CHALLENGE (III) – BATTERIES AND FUEL CELLS: COMPLIMENTARY ZERO EMISSION SOLUTIONS

system cost comparison between BEV and FCEV

Source: Toyota

infrastructure investment costs comparison for BEVs and FCEVs in mass market

including investments into 100% green hydrogen production

Source: FZ Jülich, H2 Mobility; EVS, Stuttgart 2018
THE CHALLENGE (IV) – 0,2 IN 100 ELECTRIC CARS TODAY
(AS OF KRAFTFAHRT-BUNDESAMT (KBA) / DECEMBER 31ST, 2017)

45.800.000 total passenger car stock

109.819 electric cars

50.410 plug-in-hybrid cars

59.078 battery-electric cars

331 fuel cell-electric cars
NOW GMBH
NATIONAL ORGANISATION HYDROGEN AND FUEL CELL TECHNOLOGY
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)
THE NATIONAL INNOVATION PROGRAMME
HYDROGEN AND FUEL CELL TECHNOLOGY (NIP)
THE ROLE OF FUEL CELLS IN TOMORROW’S INTEGRATED ENERGY SYSTEM

Renewable energies

- Power-to-X

Trade & industry

- Logistics
- Industry
- Public buildings
- Offices
- Base load FC CHP

Mobility

- Gas grid
- Ships
- Airports
- Battery-electric
- FC-electric

Domestic energy supply

- "Smart Grids":
  - H₂
  - Gas
  - Electricity
  - Heat
  - Refrigeration

Electric grid

- Fuel cell
- Hydrogen
- Gas
- Electricity
- Heating
- Vapour
- Cooling
- Power-to-liquid
- Fire safety

21.03.2018

Thorstien Herbert
THE NATIONAL INNOVATION PROGRAM
HYDROGEN AND FUEL CELL TECHNOLOGY (NIP)
PHASE 1 (2007 – 2016)…

...TRIGGERED FOLLOW-ON-INVESTMENTS

...710 MILLION EURO PUBLIC R&D FUNDING

...ACCELERATED MARKET DEVELOPMENT

...SAFEGUARDED GERMANY’S POSITION AS TECHNOLOGY LEADER

21.03.2018
Thorsten Herbert
## GOVERNMENT PROGRAMME 2016 - 2026
CONTINUING THE NATIONAL INNOVATION PROGRAMME HYDROGEN AND FUEL CELL TECHNOLOGIES (NIP)

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10 years → Federal funding € 1.4 bn → Combining R&D funding with market activation
SPOTLIGHT ON LATEST PROJECTS AND ACTIVITIES – TRANSPORT
R&D-PROJECTS ADDRESS KEY COMPONENTS OF AN AUTOMOTIVE FUEL CELL DRIVE TRAIN (EXAMPLES)

700 bar Hydrogen Storage
• improving the manufacturing process
• 04/01/2017 - 03/31/2019
• public funding (BMVI): 1.432 Mio. Euro

Fuel Cell Stack
• joint specifications
• preparing mass production
• 05/01/2017 - 09/30/2019
• public funding (BMVI): 18.548 Mio. Euro

System Development
• next generation automotive fuel cell
• 03/01/2017 - 08/31/2019
• public funding (BMVI): 4.842 Mio. Euro
NIP – MARKET ACTIVATION SUCCESSFUL FIRST FUNDING CALLS

51 FC-Buses / 3 Refueling stations at bus depots
- Regional public transport operator in Cologne orders 30 FC-Buses

235 FC-Cars
- More than 200 Toyota Mirai
- 20 + 15 at Clever Shuttle (German ride sharing provider)
- 30 at Alphabet (large leasing company)

14 FC-Trains / 1 Refueling station at train depot
- Call open until March 31st, 2018
NIP SUCCESS STORY – REGIONAL TRAINS WITH FUEL CELLS FOR NON-ELECTRIFIED RAILWAYS
E4SHIPS: FUEL CELLS IN MARITIME APPLICATIONS
- MULTIFUNCTIONAL & FLEXIBLE -

**Fuel**
- Methanol
- Natural gas
- Automotive diesel

**Reformer**
- Hydrogen
- Air

**Fuel cell**
- Electricity
- Heat
- Fire protection

**Output**
- Cooling
- Steam

**Techn. services**
- Cabins
- Kitchen
- Laundry

**Technical services**
- Car ferry / cruise ship
- Multi-purpose vessel
- Yacht

**Improved air quality**
by reducing pollutants such as nitrous oxides (NOx) and sulphur dioxides (SOx)

**Reduction of CO2 emissions**
by 25 to 30%, as a contribution to climate protection and in response to stricter emission regulations

**Economic viability**
by being independent from finite fossil resources

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SPOTLIGHT ON LATEST PROJECTS AND ACTIVITIES – INFRASTRUCTURE
The national strategic framework covers electricity, CNG/LNG and hydrogen

- Assessment of the state of play and future market developments
- National targets and objectives
- Measures to reach targets and objectives
- European coordination
NATIONAL STRATEGIC FRAMEWORKS – HYDROGEN

National strategies in place
No feedback
GERMANY’S NATIONAL STRATEGIC FRAMEWORK - HYDROGEN INFRASTRUCTURE (PASSENGER CARS)

**Innentitle**

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

**Basic coverage for Germany**
- **until 2020**: 100 stations

**Support market roll-out**
- **until 2025**: 400 stations

**Commercial roll-out**
- **until 2030**: 1000 stations

**Tasks**

**GOAL**

**Independent of vehicles**
- 50 stations

**Dependent of vehicles**
- 100 stations
- 400 stations
- 1000 stations
FILLING UP WITH HYDROGEN WILL SOON BE POSSIBLE GERMANY-WIDE – 43 STATIONS IN OPERATION TODAY

Shareholders

DAIMLER
AIR LIQUIDE
THE LINDE GROUP
OMV
TOTAL

Associated partners and advisors

HONDA
HYUNDAI
TOYOTA
VOLKSWAGEN
NOW

Berlin, October 13, 2015

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SPOTLIGHT ON LATEST PROJECTS AND ACTIVITIES – ELECTROLYSIS AND PTX
PTG FOR HYDROGEN PRODUCTION – PROJECTS IN GERMANY AND WORLDWIDE

Germany
- 30 Pilot projects
- 43 H2 fueling stations
- >20 over 20 MW installed

Scandinavia
- Norway: 20MW PtL in 2020 for Blue Crude production
- Norway: Utsira Wind power hydrogen project
- Denmark: Hydrogen community Vestenskov
- 20 MW

China
- 4 MW PtG plant for hydrogen production
- Goal of 5000 fuel cell buses until 2020
- 5 Fueling stations

Japan
- 200,000 fuel cell systems for domestic homes
- 90 fueling stations
- 2800 fuel cell cars and 2 buses
- Goal of 100 buses in Tokyo until 2020

Great Britain
- 17 fueling stations
- Project of EasyJet for hybrid planes

France
- 1 MW PtG in Jupiter 1000 project
- 185 fuel cell cars and 100 forklifts

USA
- 1500 fuel cell cars and 33 buses
- 73 fuel cell stations
- 225 MW fuel cells for stationary applications
- 2600 km of hydrogen grid

Canada
- 2 MW PtG plant in Mississauga for injection into the gas grid
- 200 kW plant in Quebec

Argentina
- 1.4 MW PtG plant from Hychico
- Pilot project for hydrogen storage

1.4 MW

Source: Roadmap Power-to-Gas der Strategieplattform Power-to-Gas, Dena 2017
GREEN HYDROGEN REQUIRES A SUPPORTIVE REGULATORY FRAMEWORK

- Low-cost electricity
  - (Partial) exemption from grid fees, taxes or levies
  - Access to curtailed electricity

- Access to grid service revenues
  - Remuneration for grid frequency control

- Recognition of green hydrogen
  - Level playing field for the injection of carbon lean gas into the gas grid
  - Recognition of green hydrogen as option to reduce carbon intensity of conventional fuels
“Investing in electro mobility, amongst others in hydrogen and fuel cells.”

“We want to set up a Fraunhofer Institute for Storage Technology and integrate existing competences. We want to strengthen hydrogen technologies.”

We want to push electromobility (battery electric, hydrogen and fuel cell) forward in Germany and enhance and increase the existing subsidies framework beyond the year 2020.

We want to intensify the construction of a nationwide charging and refueling infrastructure.

We want to continue the National Innovation Program on Hydrogen and fuel cell technologies. We want to develop the mobility and fuel strategy (MKS) technology-neutral and increase the means to their implementation. We want to advance “sectorcoupling” and change the regulative framework, so that "green hydrogen" and hydrogen as a product from industrial processes (byproduct) be utilized as a fuel or for the production of conventional fuels (eg natural gas).

Concerning rail passenger transport we want to set up a comprehensive funding program...

We want to increase subsidies for fuel cell hybrid railcars incl. Equipment / conversion of depots and construction and operation of hydrogen refueling stations.

At national level, we want to strengthen and stabilize our technology-neutral initiatives in favor of alternative drivetrains and energy sources in shipping and in ports (LNG, Hydrogen / fuel cell, methanol, electromobility).

Thank you very much for your attention!

Thorsten Herbert
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