

Ingredients of a German Hydrogen and Fuel Cell Strategy

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From the past to today (1)

- **Lessons learned from more than 30 years R&D in energy technologies**
- **Strategy broadly defined in the 1st to 4th Federal Energy R&D Programme**
- **Regional (Federal State) Programmes since about 1995**

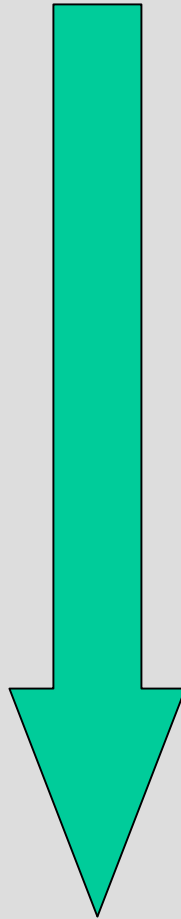
From the past to today (2)

1974 - 1987

- Thermochemical hydrogen production (based on High Temperature Nuclear Reactors)
- High temperature water electrolysis (HOT ELLY)
 - R&D activities phased out because of material problems.

1988 - 1995

- Extensive hydrogen R&D and demonstration programme
 - R&D on various technologies (production-electrolysis-storage-safety etc.)
 - demonstration projects HYSOLAR (with Saudi-Arabia), BAYSOLAR (in the Federal State of Bavaria):
 - full system integration on a few hundred kW level : PV -hydrogen production - storage - application



From the past to today (3)

1995

- Conclusion from results up to 1995:
 - all components of a solar hydrogen system were developed and functioning
 - economically not feasible because of high system costs

1996 - 2001

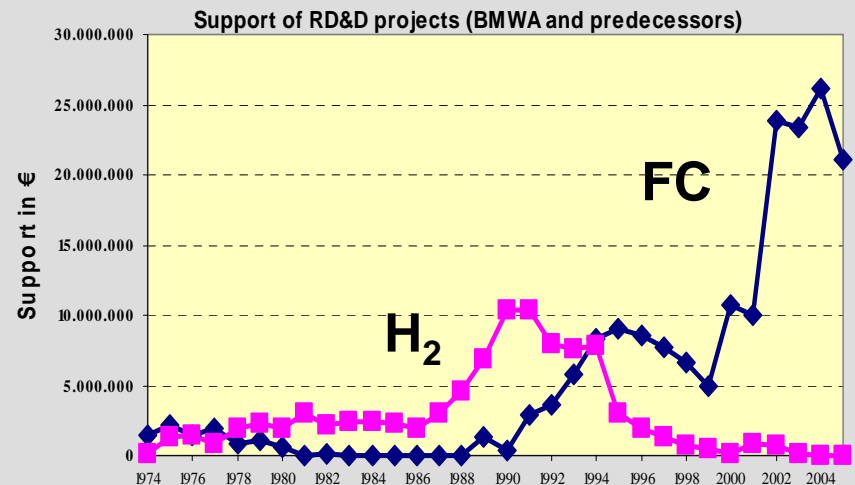
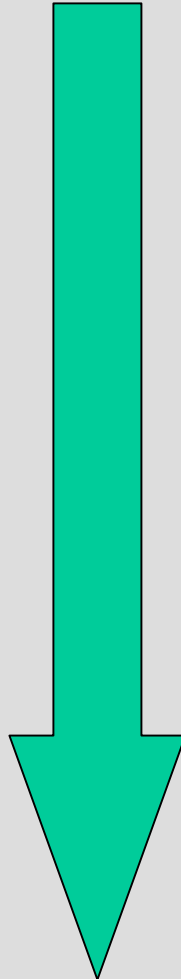
- Hydrogen R&D activities reduced
 - Priority for fuel cell R&D

2001- 2004

- Investing - into - the - Future Programme (ZIP) for fuel cell demonstration and market preparation

2004

- Clean Energy Partnership (CEP): Hydrogen demonstration project in Berlin



Investing - into - the - Future Program (2001-2003)

Zukunfts-
investitions-
programm

zip

- **Market stimulation with about 55 Mio. Euro support for fuel-cells projects**
- **by private-public partnership**

Fuel cells for decentralised cogeneration: 10 projects : ~ 18 Mio. Euro



33

**Small combined heat and power (CHP) units for family houses:
8 projects : ~ 17 Mio. Euro**



**Mobile and other applications:
10 projects : ~ 12 Mio. Euro**



**Industrial education and normative research to enable regulation and certification issues, handicraft education:
13 projects : ~ 8 Mio. Euro**



Clean Energy Partnership (CEP)

Hydrogen demonstration project in Berlin

- To demonstrate the reliability of hydrogen in everyday motor vehicle operation
- Start: Nov. 2004, duration: 5 years
- Hydrogen: gaseous and liquid
- 16 vehicles from BMW, Daimler-Chrysler, Ford and Opel with ICE and FC
- Total cost: 33 million €
- Supported by Federal Ministries of Transportation, Economy and Environment



From the past to today (4)

- 2000: Fuel Cell R&D Report by advisory group BERTA
- 2001: Transport Energy Strategy (TES) formulated (Federal Ministry of Transport, ...)
- 2001: The Investment into Future Programme (ZIP)
- 2003: COORETEC – an R&D concept for electricity & H₂ from fossil fuels with CO₂ capture and storage (Federal Ministry of Economics and Labour)
- 2003: Germany joins IPHE, CSLF and further IEA activities
- 2004 : European Hydrogen and Fuel Cell Technology Platform (HFP) established with strong German participation

BERTA



From today to the future (1)

- European R&D Framework Programmes and “European Research Area” (ERA) get stronger
- European HFP produces “Strategic Research Agenda” and “Deployment Strategy”
- “National Strategy on R&D Needs for Hydrogen Energy Technology” formulated
- Fuel Cell Association (Brennstoffzellen-Bündnis, BZB) established as industry / science representation
- National Coordination Office Juelich for H₂ and FC (NKJ) established
- National “HYBERT” Advisory Council (for H₂ and FC) founded



From today to the future (2)

- **Excellent R&D results open the road to markets**
- **5th Federal Energy R&D Programme in preparation**
- **BZB presents Market Introduction Plan**
- **Car manufacturers' market scenarios show convergence**
- **Industry proposes scenario for hydrogen automotive infrastructure**
- **Stationary FC system manufacturers' market scenarios show convergence**

Fuel Cells – a R&D strategy was developed by advisory group BERTA in 2000

- **Concentration on major FC types**
- **materials, components, manufacturing technology**
- **First stationary, then mobile application expected**
- **System integration, with a link to a possible H₂ economy**

- **Joint effort of private and public institutions**
- **Continuous and balanced RD&D efforts; integration with EU programmes; international co-operation**

Fuel cell strategy will take into account market uptake

Present status and future key factors of FC

Present status

- demonstration projects show feasibility
- but still no competitiveness



Future key factors

- commercial interest / market
- system cost (stack, BOP)
- fuel of choice
- subsidies, incentives, legal aspects

... but who is in charge ?

- ⇒ industry
- ⇒ R&D, industry, SME
- ⇒ R&D, industry / public policy
- ⇒ public policy

Hydrogen – qualitatively the goals are agreed upon

- Hydrogen and the security of energy supply
- Hydrogen as a bridging technology
- Hydrogen and renewable energies
- Hydrogen and climate protection
- Hydrogen and fuel cells
- Hydrogen and competitiveness

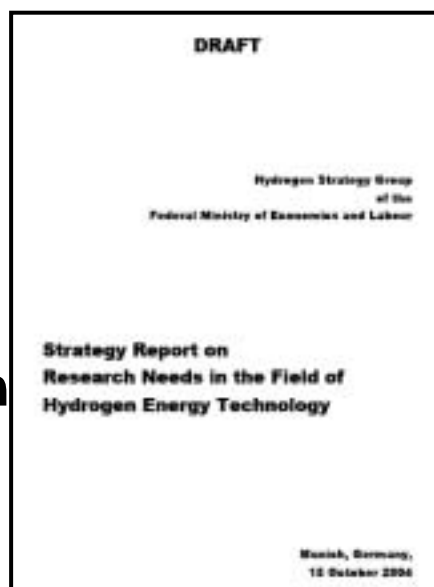
Quantitative targets are specific for each group of stakeholders

Strategy on R&D-Requirements for Hydrogen Technology in Germany

Main goals:

Recommendations for a German R&D strategy on hydrogen technology and future emphases in public funding

Discussion and coordination with other national and international boards and initiatives



1. Energy economy and political boundary conditions
2. Technology state of the art and need for research
3. Legal framework conditions
4. Comparative evaluation of hydrogen energy technology
5. Recommendations from the strategy group



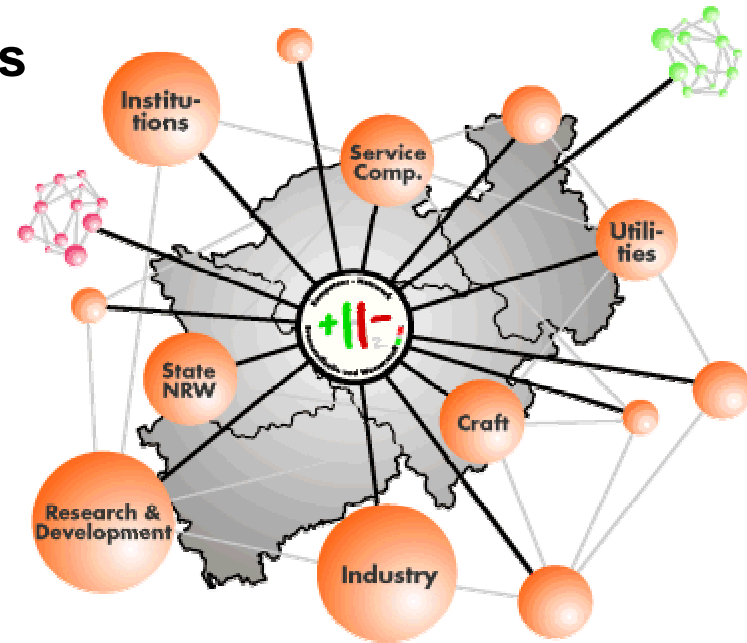
Recommendations from the H₂ Strategy Group

- **Updating funding policy in the field of hydrogen technology**
- **Selected priorities in R&D funding**
- **Demonstration projects**
- **Legislation and standardization**
- **Interfaces with international activities**

Strategic Activities in the Federal State Nordrhein-Westfalen

□ General objectives:

- ◆ Positioning as an internationally recognized location for the fuel cell and hydrogen technology
- ◆ **Introduction of the fuel cell into early markets as bridges for the mass market**
- ◆ Support the development of the fuel cell and of adapted system components accompanied by a targeted basic research
- ◆ Support the establishment of a ready-to-market and sustainable hydrogen energy economy



Strategic Activities in the Federal State Nordrhein-Westfalen (2)

□ Development of early markets:

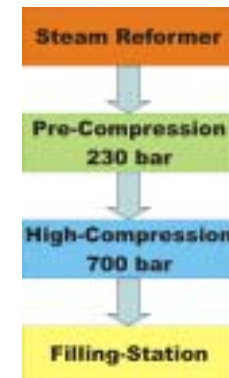
- ◆ Type of market: small buses, delivery trikes, fork lifts etc.
- ◆ Reason: support of companies, particularly SME
- ◆ Requirement: achievement of a critical mass, agreement on standards, minimisation of investment, preparation of infrastructure
- ◆ Instrument: partnerships with regions pursuing the same objectives with the same strength
 - ⇒ MoU with **California** (United States)
 - ⇒ MoU with **British Columbia** (Canada)



Strategic Activities in the Federal State Nordrhein-Westfalen (3)

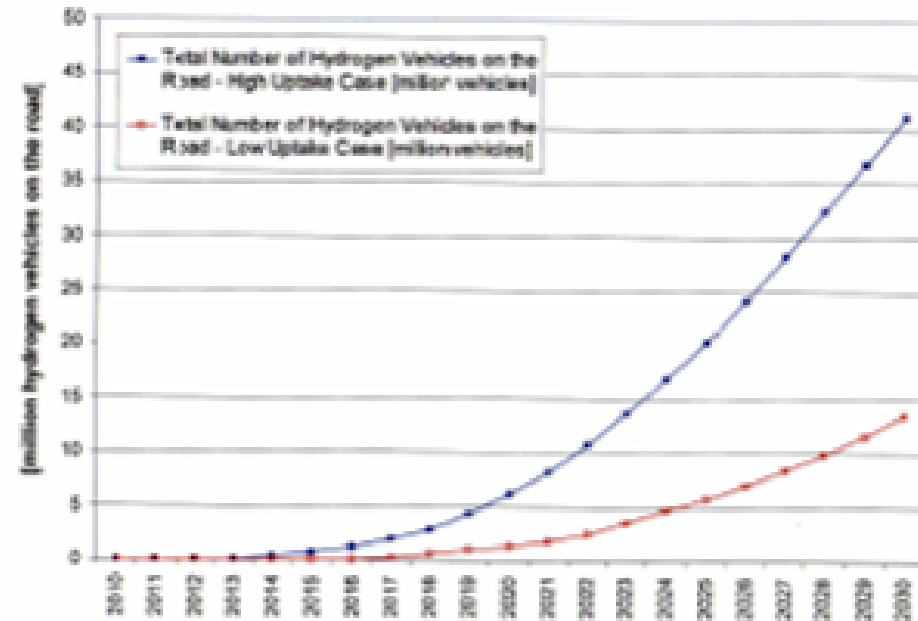
□ Hydrogen infrastructure for portable and small mobile fuel cell applications

- ◆ Exchangeable and portable hydrogen cartridge
 - Storage: 2 litres, 700 bar
 - Prototype expected for May 2005
 - Partners: Operathing, Dynetek Germany
- ◆ 700 bar re-filling station in NRW
 - Final capacity: 800 bottles per day
 - Start-up: before summer 2005
 - Filling, distribution and logistics: Air Liquide Germany
- ◆ More information: www.fuelcell-nrw.de



A European Hydrogen Automotive Infrastructure (1)

- Presented by Linde AG at “International Hydrogen Day”, Berlin, 24.02.05
- A perspective on how fully-functional infrastructure may be developed, **once** vehicle and supporting technologies have been tested and vehicles are available (high and low uptake case)



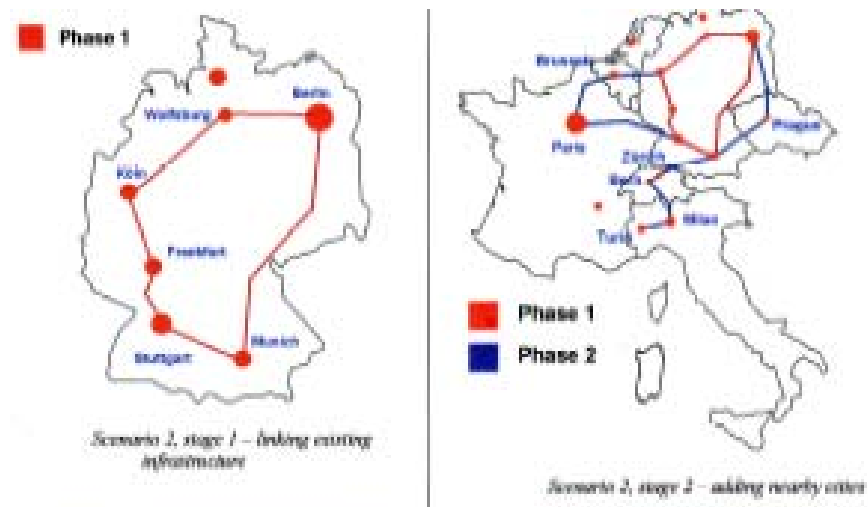
A European Hydrogen Automotive Infrastructure (2)

- A staged process

high uptake case

year	cars Mio	fuelling stations	cost Mio €
2015	0.7	885	453
2020	6.1	2,791	3,524
2030	41.2	18,628	18,512

- Starts not before 2010, but needs action soon



Market introduction of fuel cells (1)

Proposed by Fuel Cell Association (Brennstoffzellen-Bündnis, BZB) in December 2004

Qualitative Proposal:

- **Technological progress and larger number of FC produced will lead to cost reduction and reliable products**
- **Request for time-limited and degressive market introduction instruments**
- **“Partnership for Innovation” of industry, science and policy**

Support measures and budget currently under investigation

Market introduction of fuel cells (2)

Quantitative proposal:

Stationary production of electricity for industrial use

- 2006: 15 MW per year
- 2010: 300 MW per year
- 2015: 1,3 GW per year

Stationary systems for homes

- 2008-2010: several thousand units per year
- 2010-2015: several ten thousand units per year

Transport systems

- (see Linde proposal)

Portable systems

- Market penetration in niches over the next years
- Large market in 2010

Outlook

- **Improved coordination and networking through industry/science association and national coordination on policy level**
- **Comprehensive H2 / FC Roadmap for Germany will include regional, national, European and international cooperation**
- **Industry is pressing for action – policy has to respond**
- **IPHE exchange of experience on roadmapping will be of importance and influence Germany's strategy**

Information sources

- **Transport Energy Strategy (TES)**
www.bmwbw.de/Alle-Artikel-zum-Thema-Verkehr-.392.2179/Fuel-of-the-Future-Transport-Energy-Strategy.htm?sort=VeroeffentlichungAm
- **Clean Energy Partnership (CEP)**
www.cep.de
- **FC Report from BERTA (in German)**
www.zsw-bw.de/de/docs/info/docs/FuE-Brennzell.pdf
- **H2 Technology Strategy Report**
www.iphe.net/2-11-05/SKH2_eng%20as%20distributed.pdf
- **ZIP Conference Report (in German)**
www.nkj-ptj.de
- **ERA-NET project HY-CO**
www.hy-co-era.net
- **Linde proposal**
www.hydrogenday.de
- **BZB proposal (in German)**
<http://www.brennstoffzelle-nds.de/download/4033/Strategie.pdf> und [.../4034/Text.pdf](http://www.brennstoffzelle-nds.de/download/4034/Text.pdf)
- **National Coordination Office Juelich (NKJ) (in German)**
www.nkj-ptj.de

Thank you