

Electrification of Future Mobility – National Programs and Activities in Germany

Hydrogen & Fuel Cells and Battery Technologies

Annual Merit Review & Peer Evaluating Meeting | Arlington, Virginia | 18-22 May 2009 |

Dr. Klaus Bonhoff | NOW | Managing Director (Chair)



The core objective of transport policy:

- meet the people's mobility needs
- promote the forces of economic growth
- save the environment



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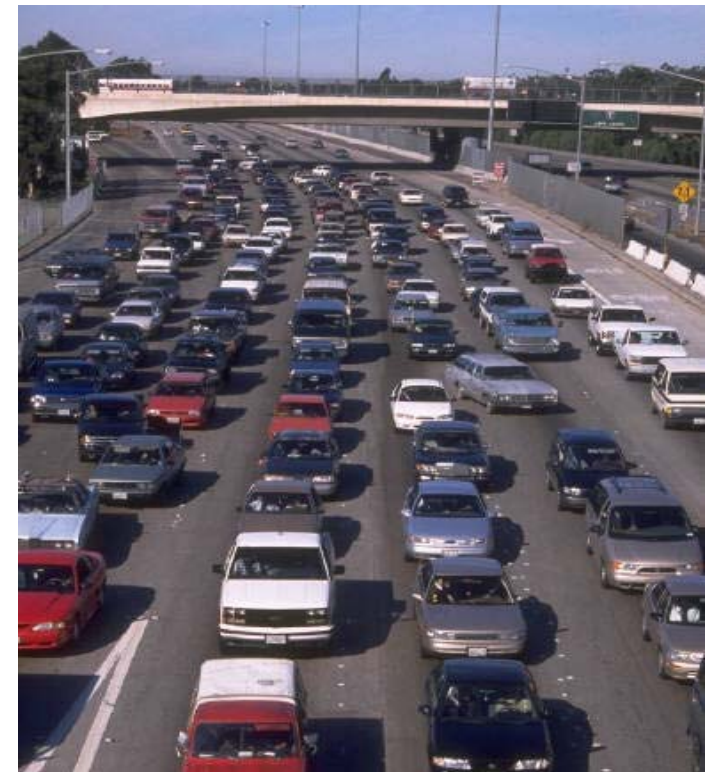
The sources of energy available in the field of transport will be a major factor in deciding the future of mobility

3 key factors for moving towards more sustainable mobility solutions:

- Energy diversification & security of energy supply
- Climate change issues
- Air quality

Economics & customer preference remain key

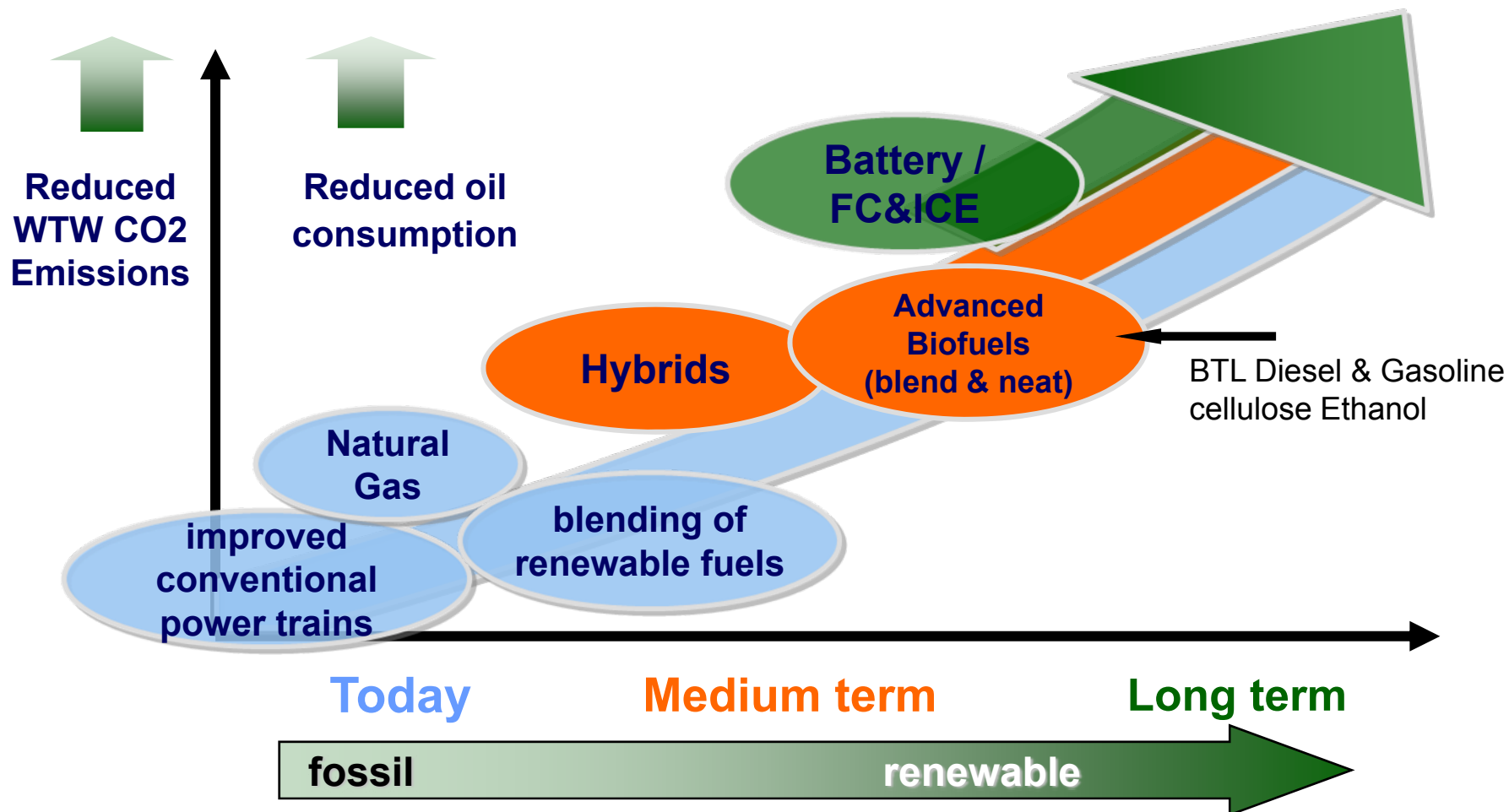
Economics & customer preference remain key



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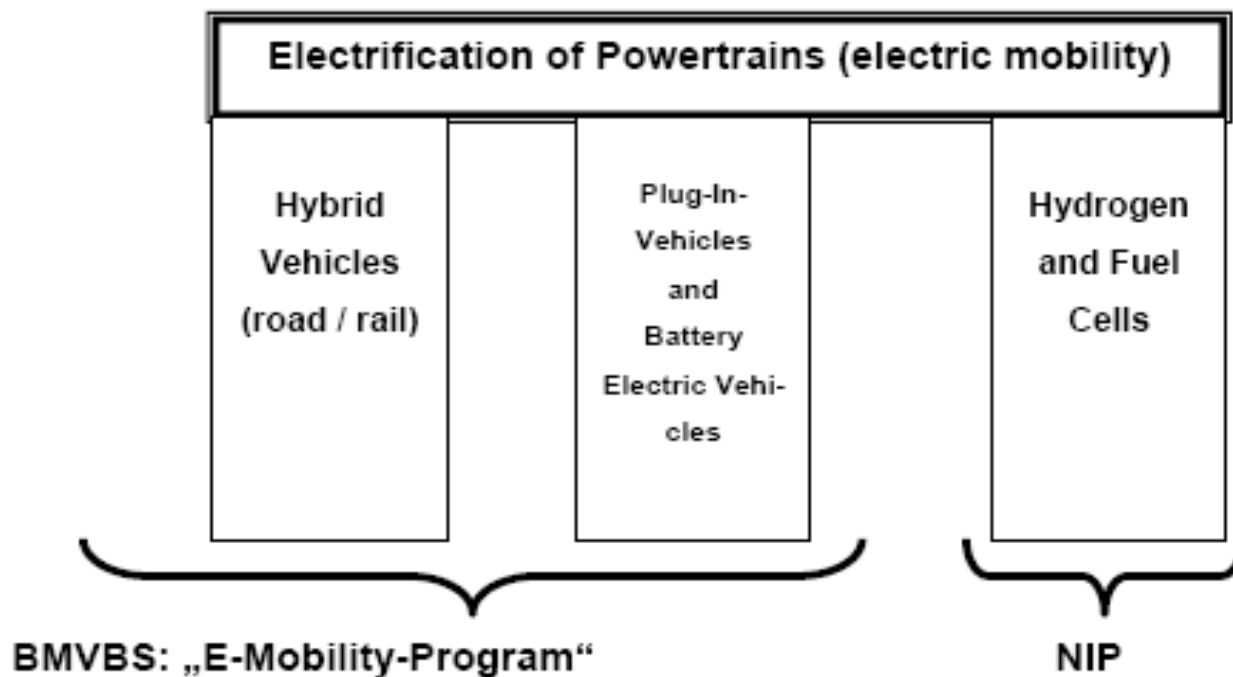
National „Fuel Strategy“:

Evolution of Alternative Fuels and Vehicle Technology



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3 pillars of the electrification of powertrains



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NOW – The National Organisation Hydrogen and Fuel Cell Technologies

NOW is the

- programme management organisation responsible for the implementation of the NIP
- central point of contact for H₂/FC technologies in Germany

NOWs responsibilities include

- overall coordination of the NIP
- implementation of demonstration activities
- communication & international collaboration

NOW – Structure

100 % owned by the federal government represented by the Federal Ministry of Transport, Building and Urban Affairs

Supervisory Board
Ministerial representatives

Advisory Board
Politics, Academia, Industrie

Strategy Council
General Assembly

Executive Board Dr. Klaus Bonhoff (Chair), Kai Klinder

Transport

Hydrogen-
Infrastructure

Stationary-
Applications

Special Markets

German National Innovation Program (NIP) Hydrogen and Fuel Cell Technology

NIP is supported by:



- **200 M€** funded by Fed. Ministry of Economics
- focus R&D
 - **500 M€** funded by Fed. Min of Transport, Building, Urban Affairs
- focus demonstration
 - **700 M€** industry contribution
-
- **1.400 M€** total budget
 - Duration: 2007-2016

NIP is a strategic alliance b/w German politics, industry and academia

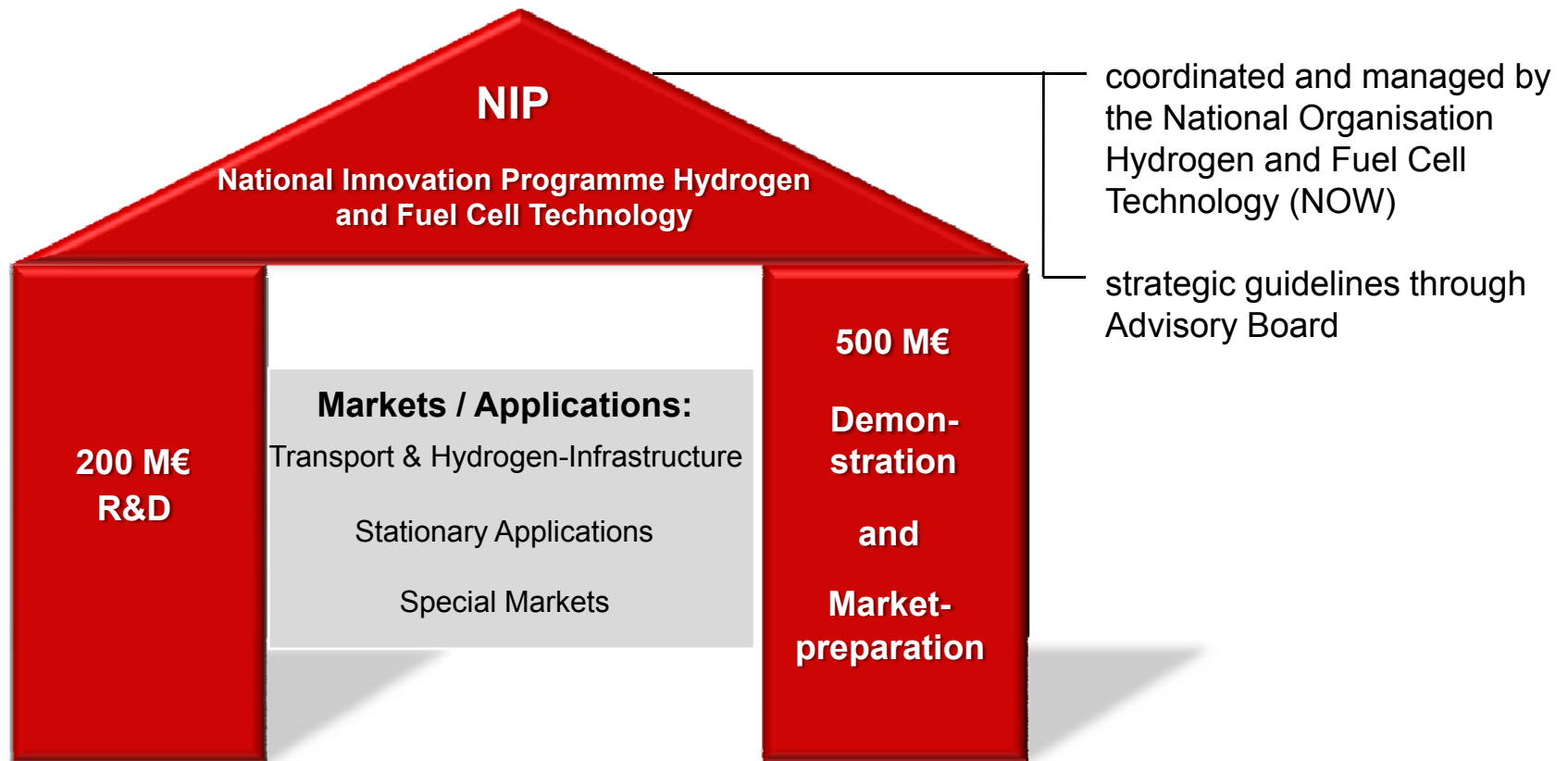
German National Innovation Program (NIP) Hydrogen and Fuel Cell Technology



- Market entry of H₂/FC applications
- Global competitiveness
- High-Tech competencies
- Sustainable jobs
- saving energy and protecting the climate



NIP- Structure



NIP – Markets and Applications

Transportation:

- 54% of NIP
- incl. H₂-production and H₂-infrastructure



- Expanding vehicle fleet (passenger cars and busses) and hydrogen infrastructure starting from key-regions (Berlin, Hamburg)

Stationary Applications:

- 36% of NIP
- fuel cell heating appliances in homes
- industrial fuel cell combined heat and power plants



Special Markets:

- 10% of NIP
- Critical power supply: IT, telecommunications
- Logistics, leisure and tourism markets

NIP Transportation – Clean Energy Partnership (CEP)



Ein Projekt im Nationalen Innovationsprogramm
Wasserstoff- und Brennstoffzellentechnologie 

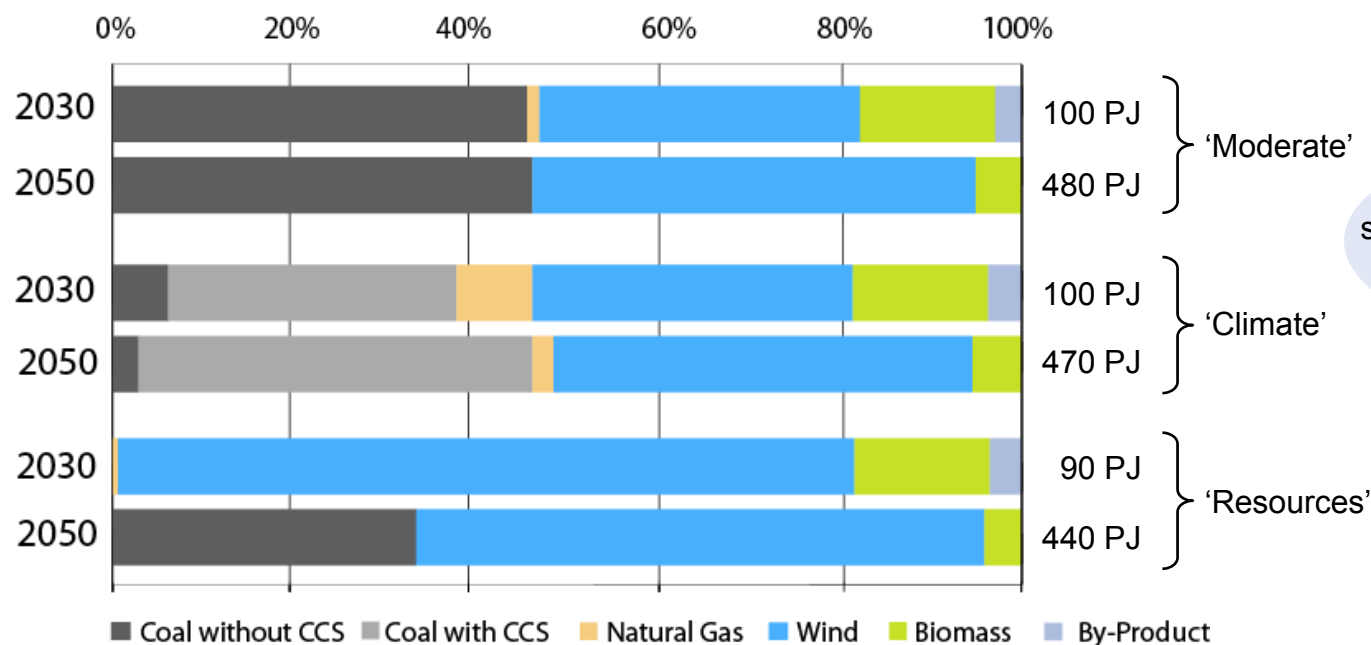


- Since 2008 in phase II
- Key regions (Berlin and Hamburg)
- 30+ H2 cars, H2 bus-fleets, several H2 fuel-stations

Sources for Hydrogen in Germany

large amounts of hydrogen will be produced from a mix of primary energies

shares of primary energy carriers in hydrogen production



political imperative:
share of renewable energies
at least 50%

hydrogen will be produced from different primary energy sources. depending on the scenario applied, the respective share of individual sources varies

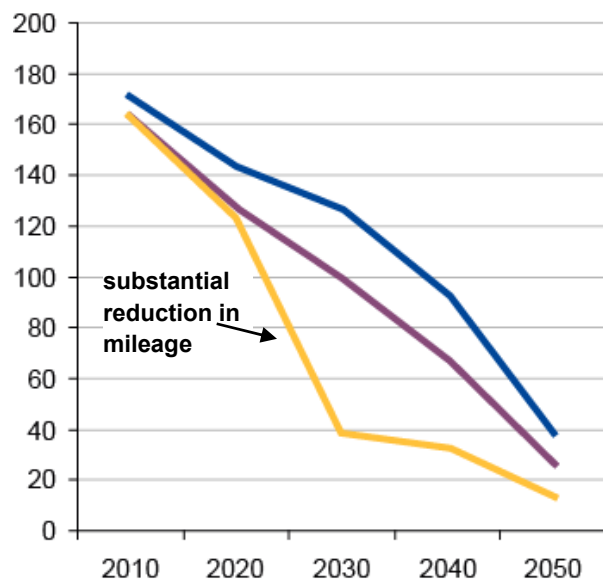
the future mix of energies used for hydrogen production will depend on political targets and framework conditions, as well as achievements on technological development

Reduction of CO₂ and other Emissions

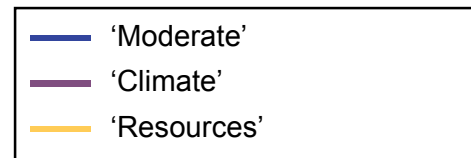
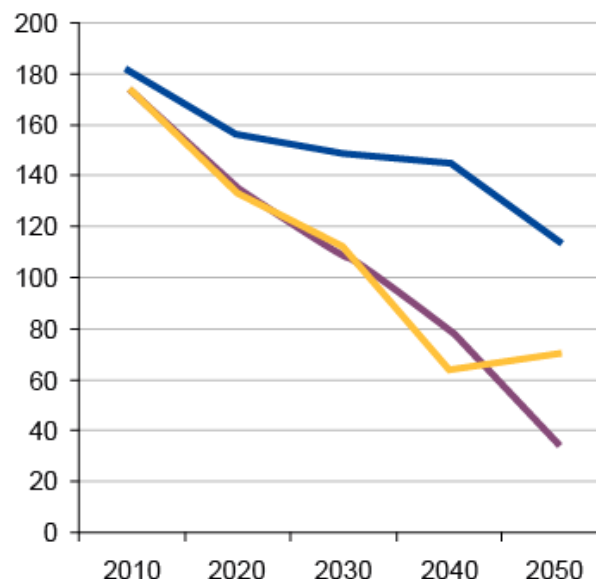
hydrogen and fuel cells reduce greenhouse gas emissions dramatically

fleet emissions (passenger cars)

without fuel production (tank-to-wheel)
g CO₂/km



with fuel production (well-to-wheel)
g CO₂/km

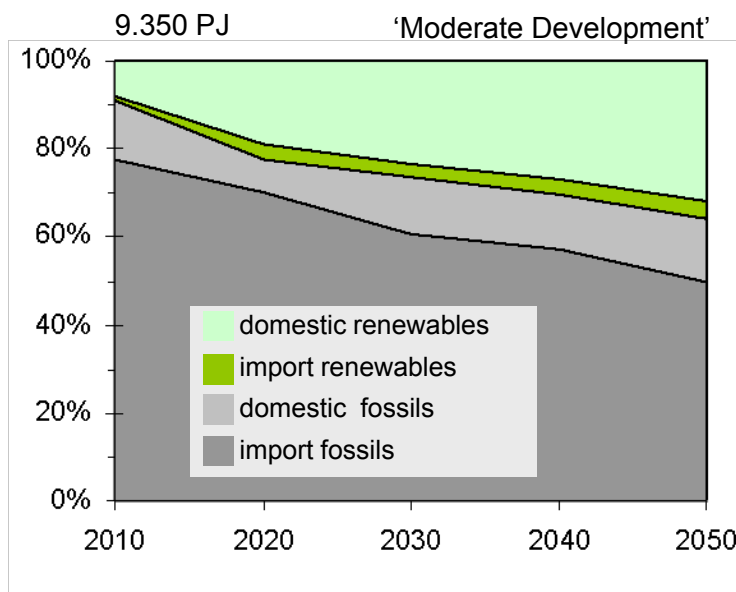


- carbon-dioxide emissions of passenger cars can be substantially reduced with hydrogen (fleet average may be as low as 20 g/km tank-to-wheel, and 36 g/km well-to-wheel emissions, if hydrogen is generated from renewable energies, or fossil energies using CCS)
- hydrogen-driven fuel cell vehicles cause no local air pollutants and only insignificant noise emissions

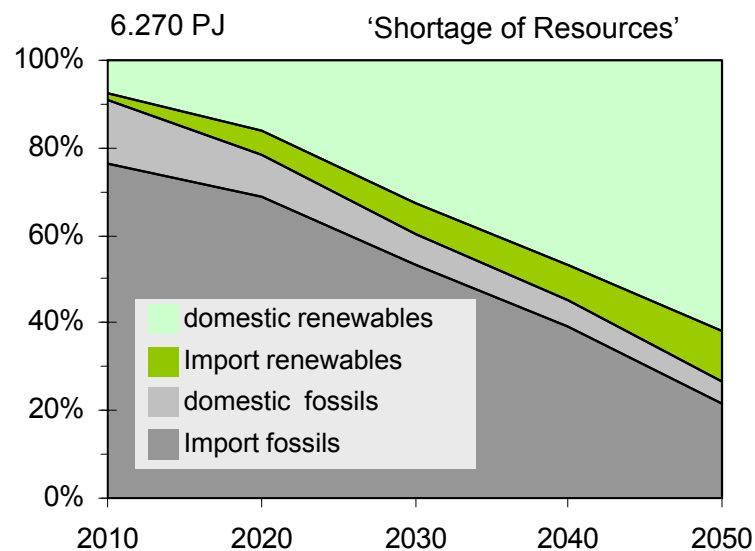
Energy-Imports and Renewable Energies

hydrogen increases use of domestic energy sources

primary energy supply in Germany



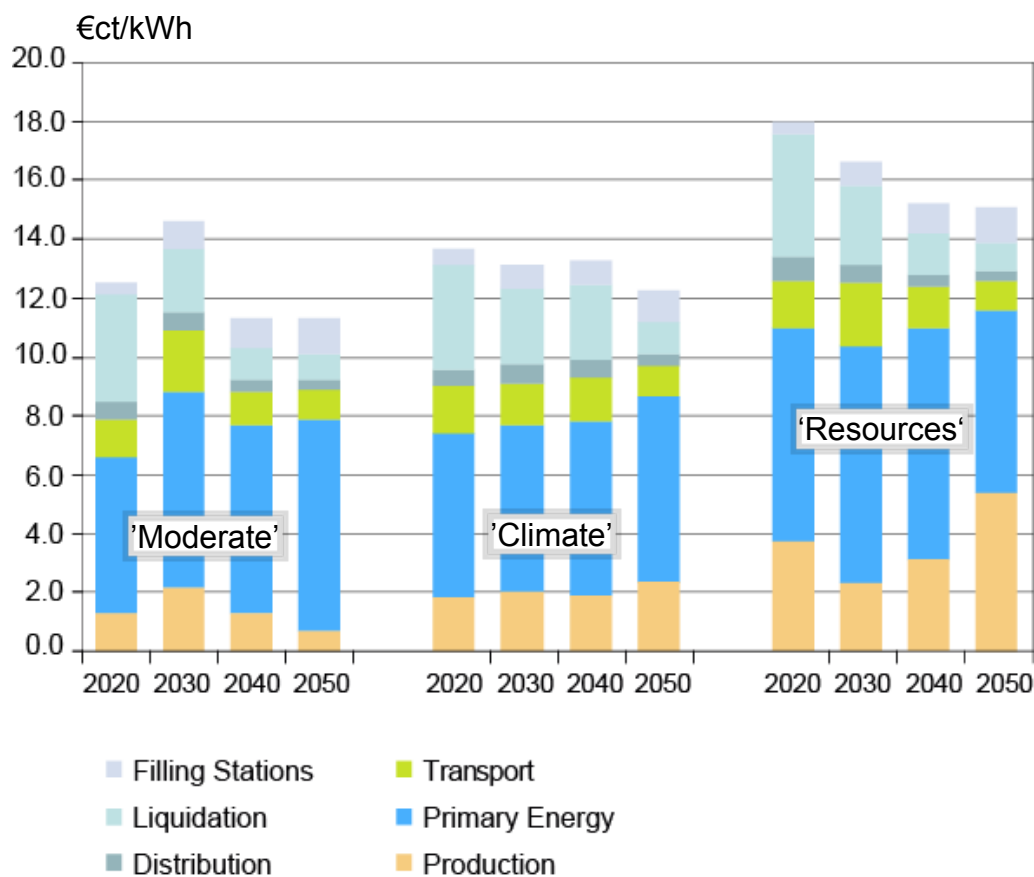
- dependency on energy imports drops from over 90% to 55% or even 35%, depending on scenario
- share of renewable energies rises from 10% to 30% or even 75%



- share of renewables in transport sector rises from below 10% to above 50%
- availability of domestic lignite is reduced drastically in scenario 'Shortage of Resources'

Costs of Hydrogen

Mobility using hydrogen is affordable

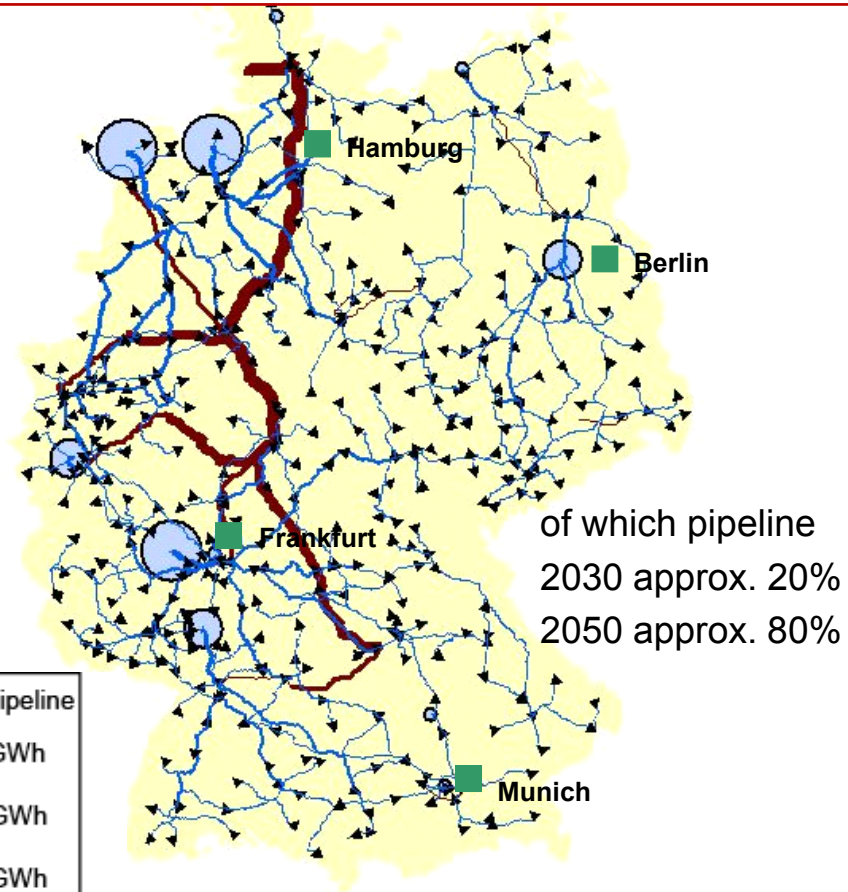


- fuel costs of hydrogen are comparable to today's costs of fossil fuels (both before tax)
- 50 to 80% of costs stem from primary energy and hydrogen production
- during the introductory phase higher costs arise from underutilization of infrastructure
- important factors of influence: political targets on climate protection and renewable energies, development of energy prices and viability of CO₂ capture and sequestration

Development of a Hydrogen-Infrastructure

regionally different infrastructure technologies (pipeline, trucked, decentral production) will be needed

- the build-up of infrastructure happens step by step, starting from densely populated/urban areas
- during the introductory phase (until 2030) the transport by trailer of centrally produced liquid hydrogen to filling stations dominates (e.g. to integrate offshore wind and by-product hydrogen)
- with growing demand most hydrogen will be distributed by pipelines in compressed form
- on-site production of hydrogen from natural gas, biomass and electrolysis may play a role regionally



scenario 2030 "Moderate"

NIP - Stationary Energy Supply



- Electricity and Heating through Fuel Cells
- Residential buildings, commercial premises, industrial plants, ships

CALLUX Lighthouse Project 2008 - 2015

- Installation of 800 devices in 5 regions
- Cooperation of leading HVAC producers with energy service providers, institutes, skilled craftsmen and end-users.
- Synergies through concerted demonstration, development, qualification, RCS and communication activities
- Details see www.callux.net



Supply of CO₂-free energy

- Up to 60 high-temperature fuel cells, 200-700 kW, $\text{Eta}_{\text{el}}=47\%$
- Combined with facilities for biogas, gas scrubbing, organic-rankine (ORC), energy-recovery, cooling
- Cooperation of plant developers and energy providers

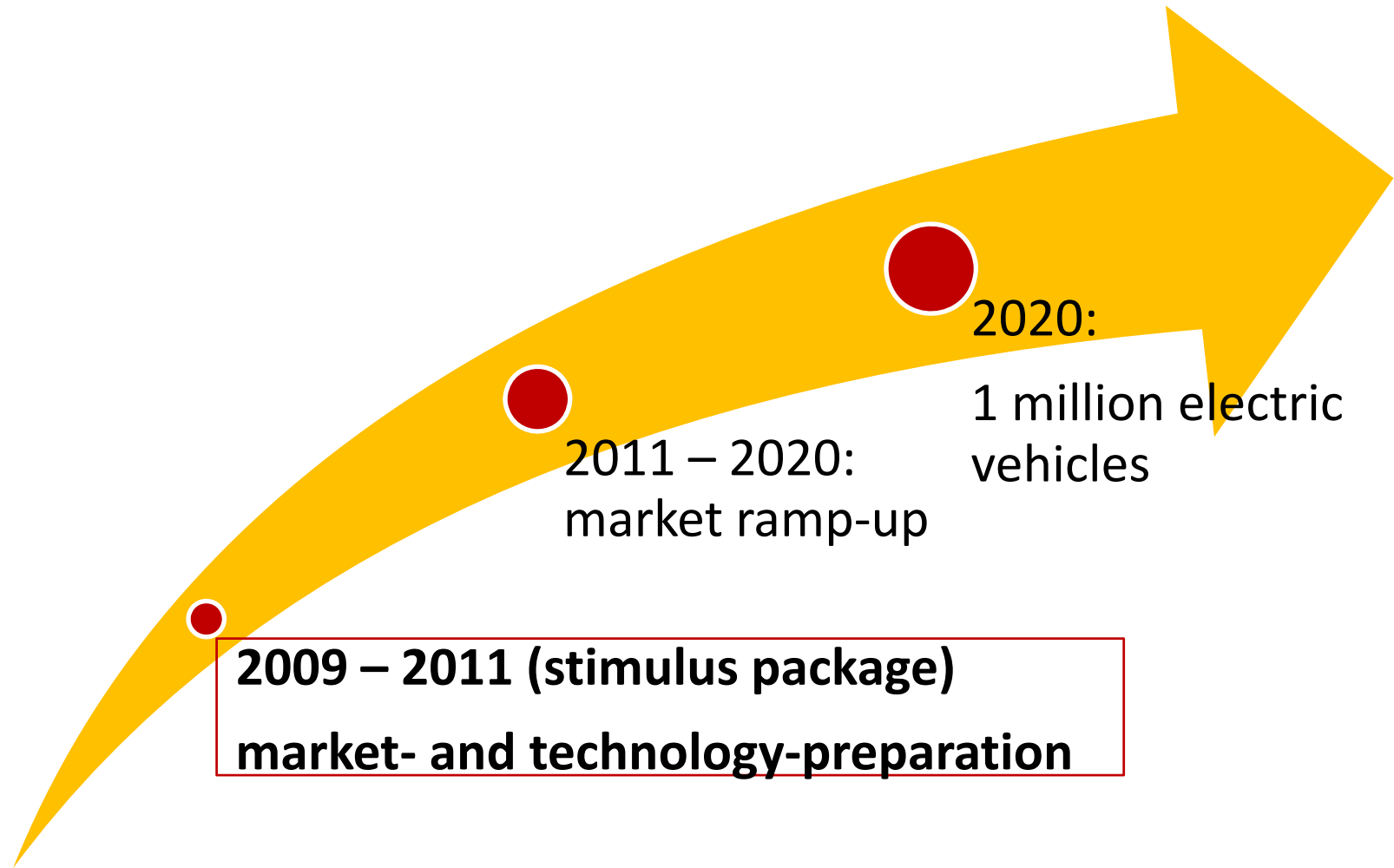


NIP – Special Markets



- Particular marketability / Wide spectrum range
- BODENSEE / Lake Constance Project
 - fuel cell applications in leisure-/tourism market (boats, bikes, caravans, etc.)
- Critical power supply
 - high-security telecommunication networks
- Special vehicles (forklifts etc.)

Electric Mobility – from basic research to marketable applications



Electric Mobility – Federal Economic Stimulus Package 2009-2011

- €500 Mio. from Federal Economic Stimulus Package (total > 50bn. €)
- Lead market in future-tech e-mobility
- Technological competencies, competitiveness
- Cross-sector alliance between industry, science and politics
- Four Federal Ministries:
 - Transport
 - Economy
 - Environment
 - Research

Electric Mobility 2009-2011

– Specific Funding Areas I

- Competence network for system research e-mobility
- Research centres (focus: electrochemistry)
- Energy research (storage, grids, integration)
- Production technologies for battery-technologies
- Transport research (braking energy recovery)
- Expanding “E-Energy” projects (BMW i)

Electric Mobility (2009-2011)

– Specific Funding Areas II

- E-mobility in transport / Field tests e-mobility / Model regions
 - Individual transport, public transport, commercial vehicles
- Battery test centres
- Pilot-facilities for recycling
- Hybrid-busses in public transport
- hydrogen-fuel-stations
- Demonstration activities for Biomethane
- Pilot facility for synthetic fuels

Electric Mobility – Model Regions

- Integration of producers, users, infrastructure-operators, etc
- Mobility patterns with e-mobility
- Demonstration
- Integration of modes of transport
- New business models

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Thank you for your attention

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www.now-gmbh.de