Nationale Organisation Wasserstoff- und Brennstoffzellentechnologie

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)

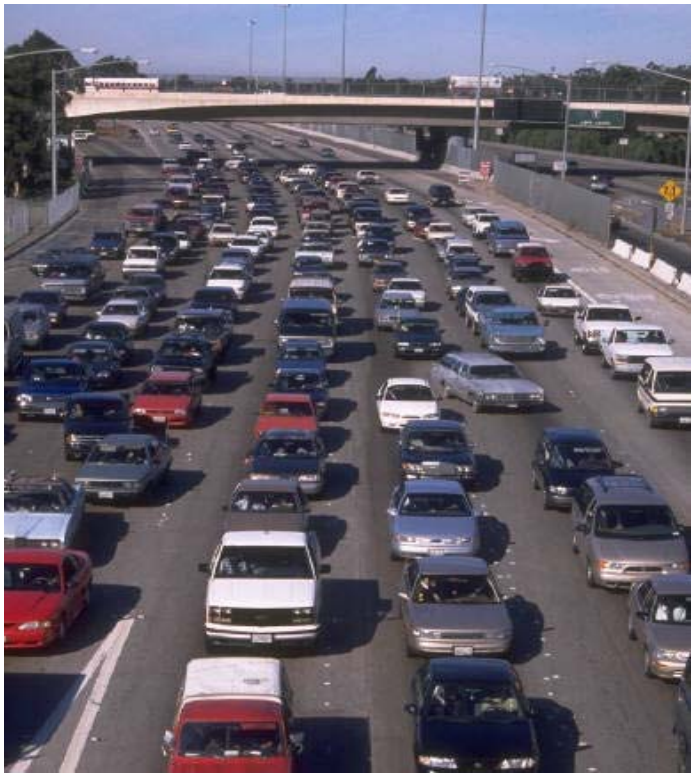
The core objective of transport policy:

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

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

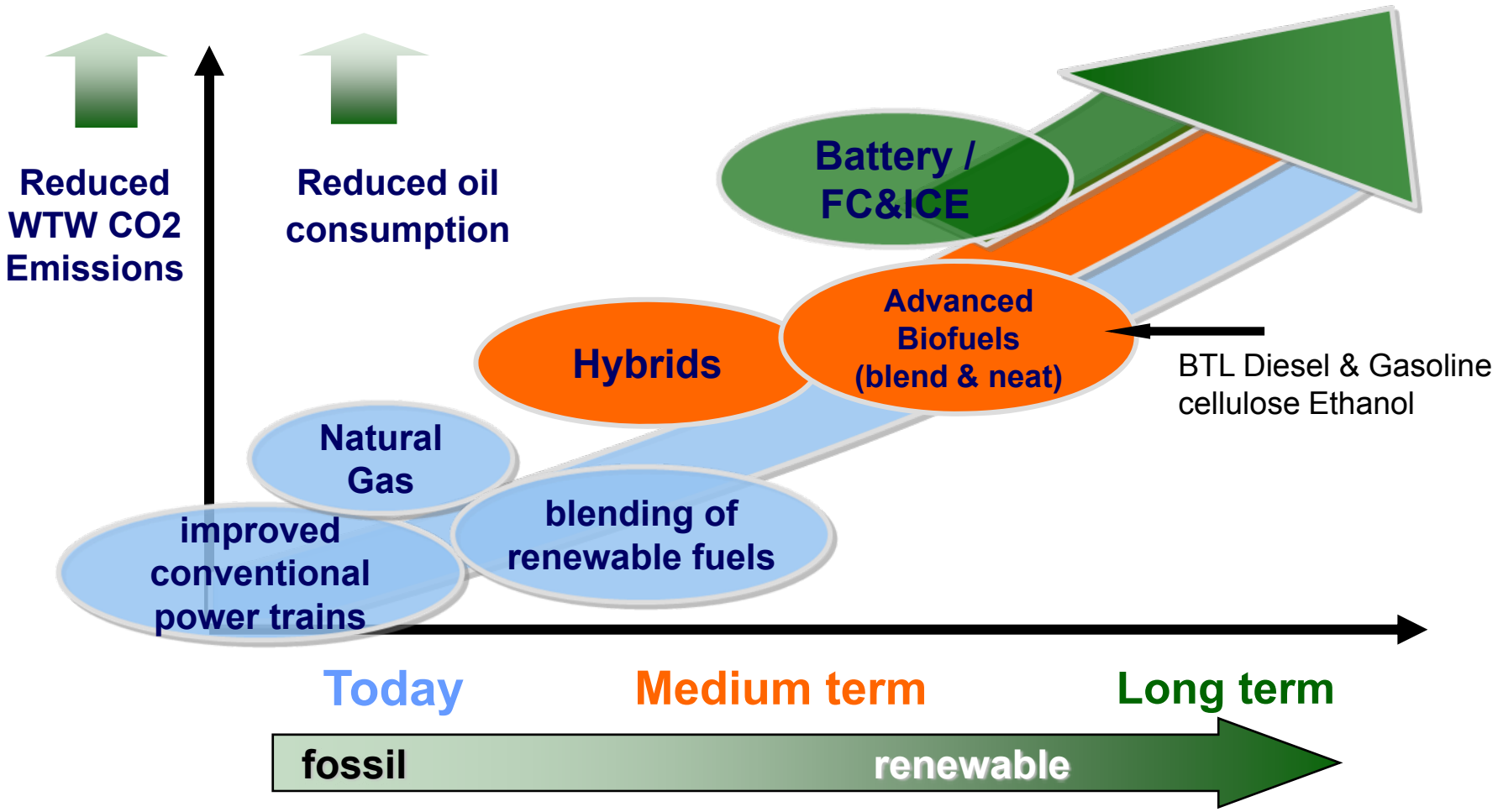


Economics & customer preference remain key

Economics & customer preference remain key

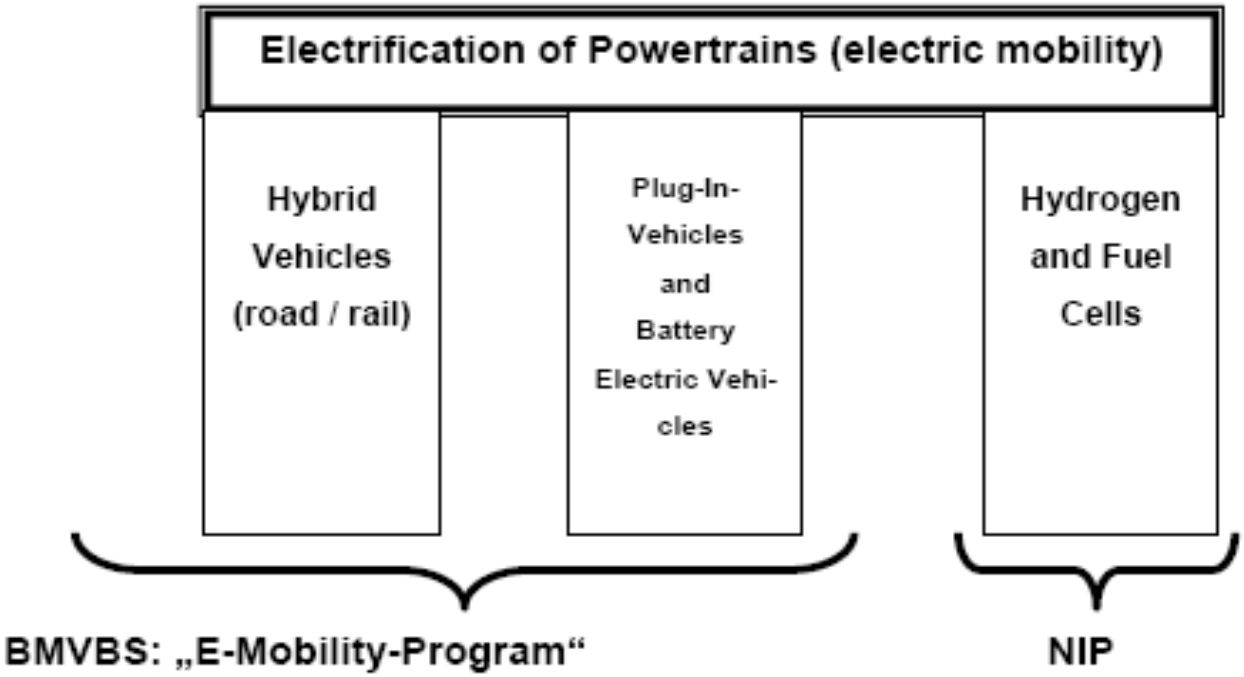
National „Fuel Strategy“:

Evolution of Alternative Fuels and Vehicle Technology



Federal Ministry of Transport, Building and Urban Affairs
Division A13

3 pillars
of the electrification of powertrains



Federal Ministry of Transport, Building and Urban Affairs
Division A13

NOW – The National Organisation Hydrogen and Fuel Cell Technologies

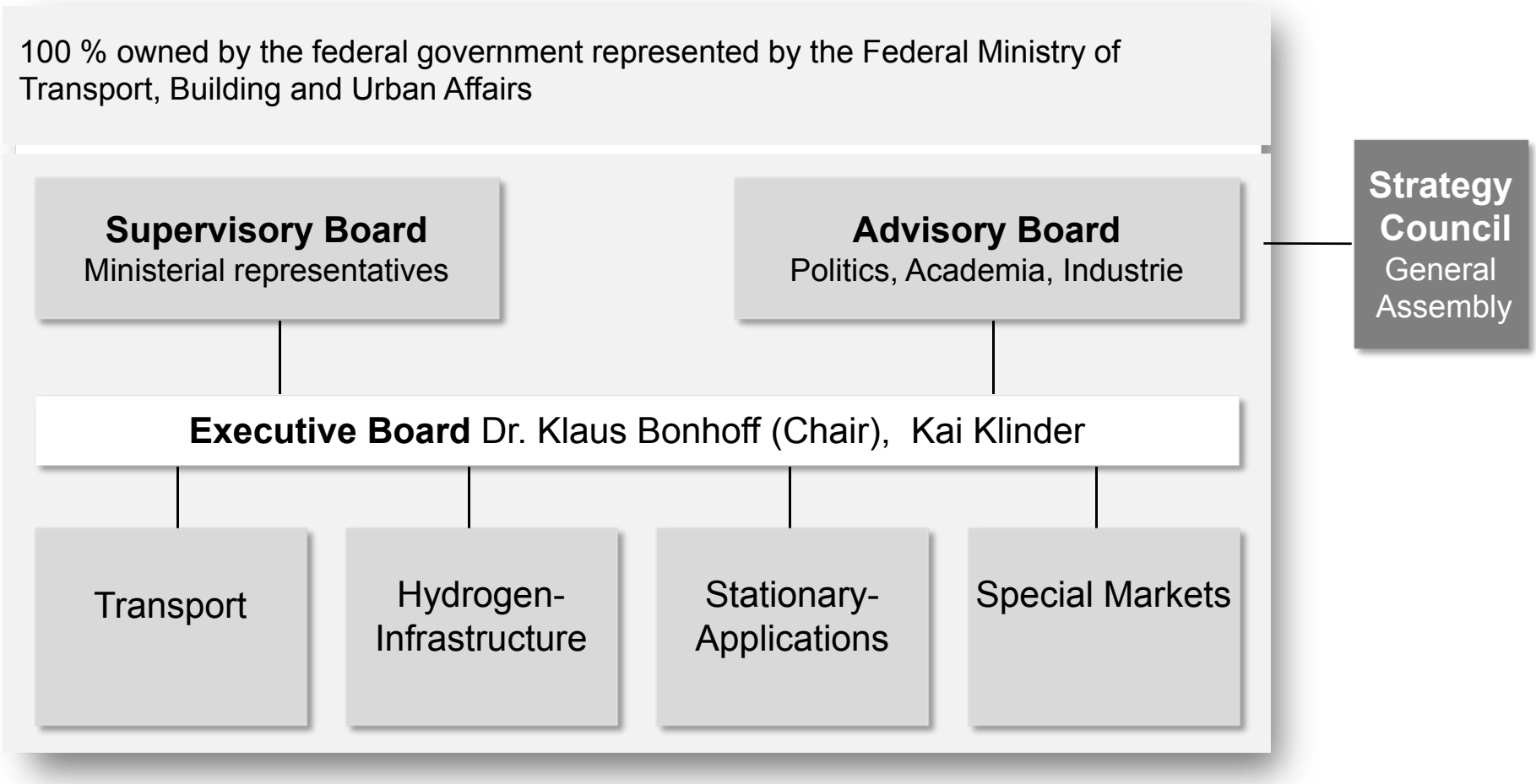
NOW is the

- 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



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

NIP is supported by:

- Federal Ministry of Transport, Building and Urban Affairs
- Federal Ministry of Economics and Technology
- Federal Ministry of Education and Research
- Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

- **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

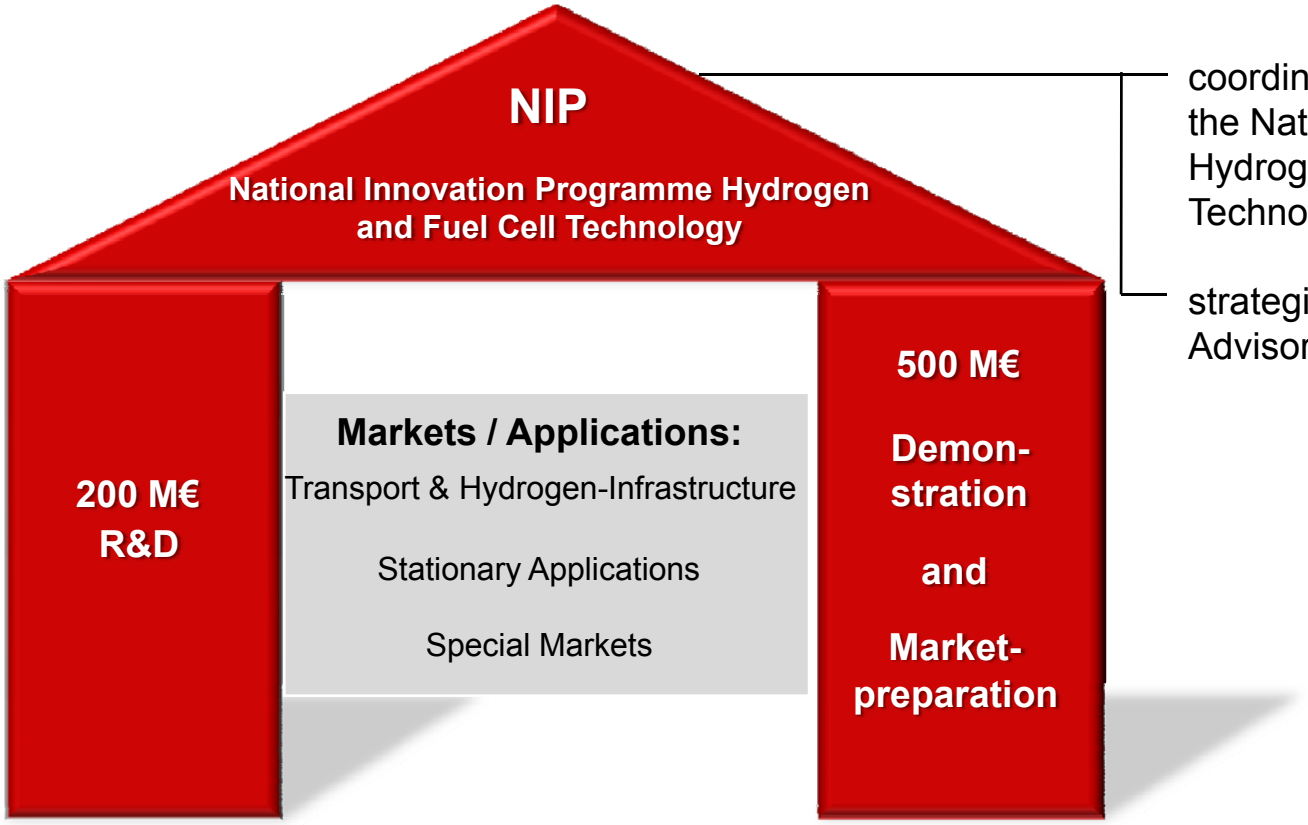
- Duration: 2007-2016

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



coordinated and managed by the National Organisation Hydrogen and Fuel Cell Technology (NOW)

strategic guidelines through Advisory Board

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)

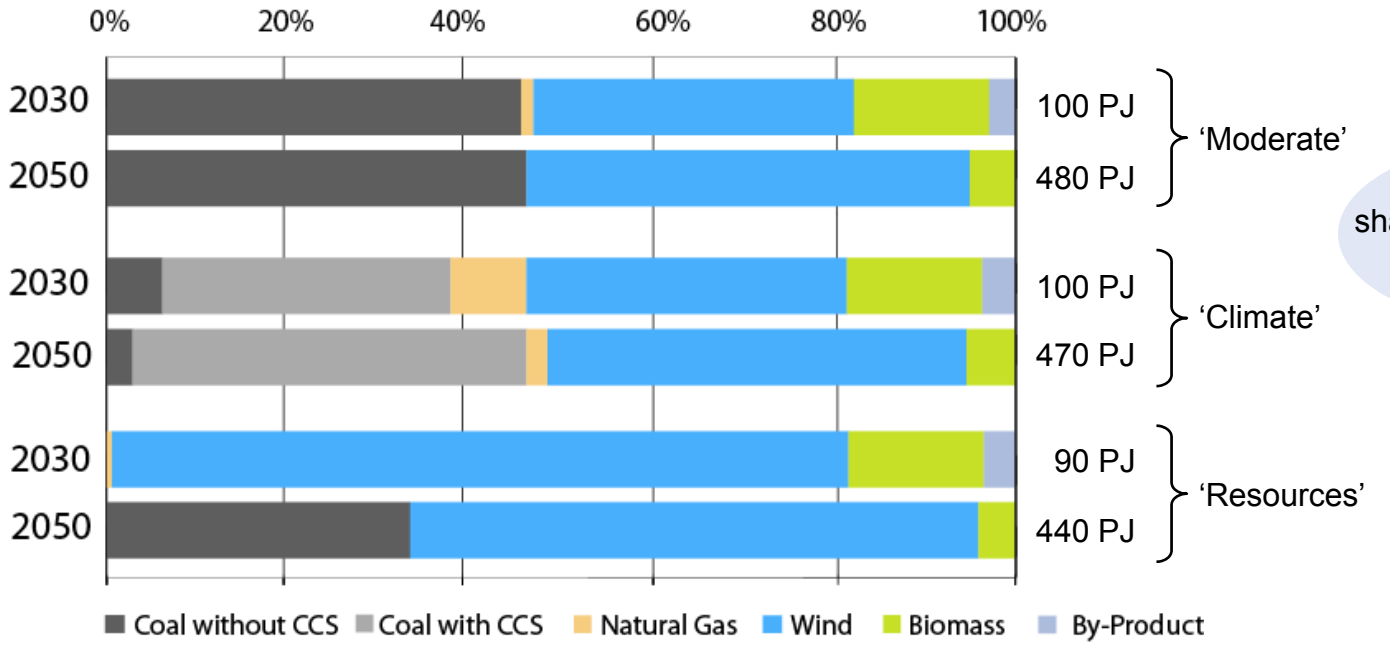
Ein Projekt im Nationalen Innovationsprogramm Wasserstoff- und Brennstoffzellentechnologie

- 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

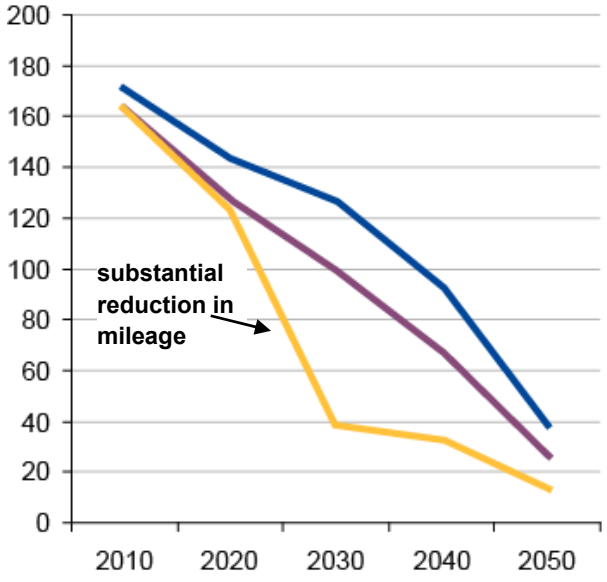
Reduction of CO_2 and other Emissions

hydrogen and fuel cells reduce greenhouse gas emissions dramatically

fleet emissions (passenger cars)

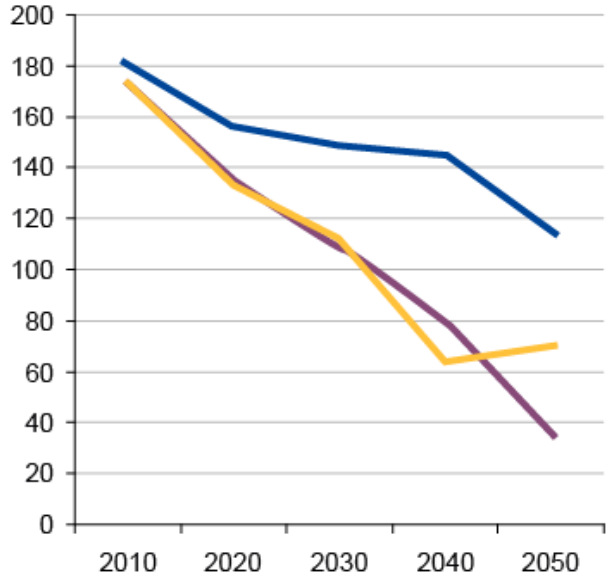
without fuel production (tank-to-wheel)

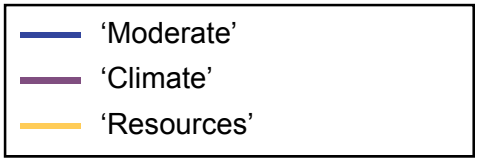
g CO_2/km



with fuel production (well-to-wheel)

g CO_2/km



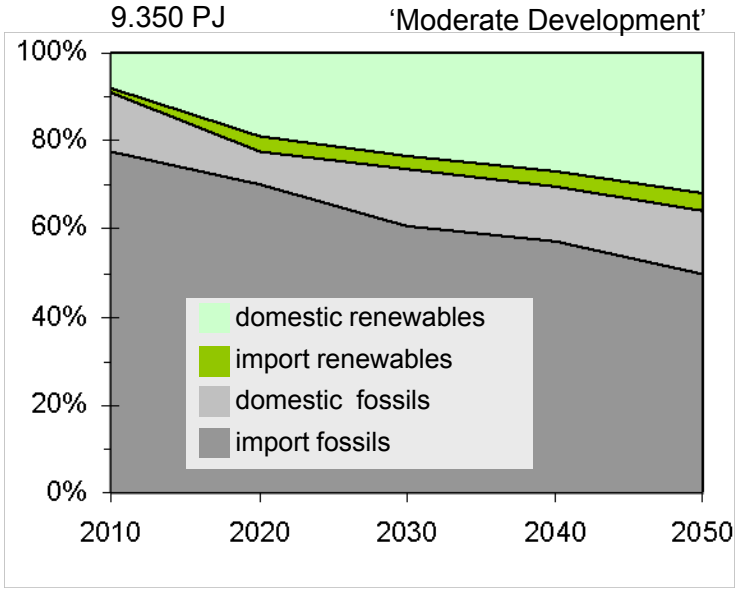


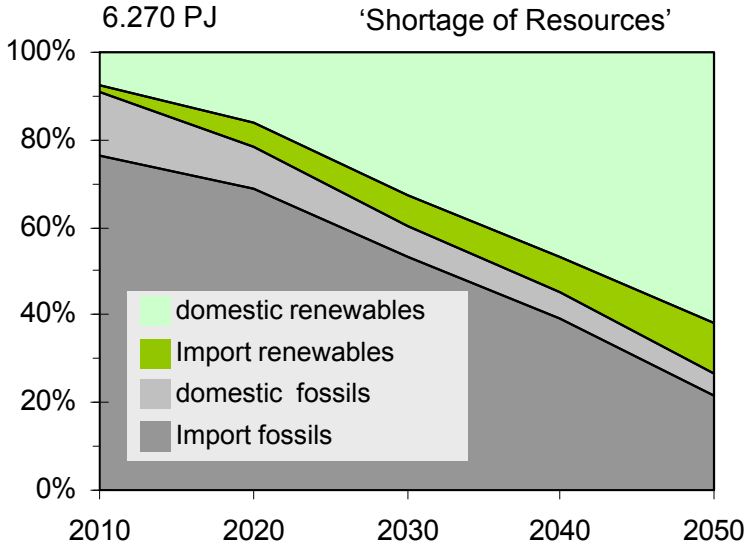
- carbon-dioxide emissions of passenger cars can be substantially reduced with hydrogen (fleet average may be as low as 20 g/km tank-to-wheel, and 36 g/km well-to-wheel emissions, if hydrogen is generated from renewable energies, or fossil energies using CCS)
- hydrogen-driven fuel cell vehicles cause 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



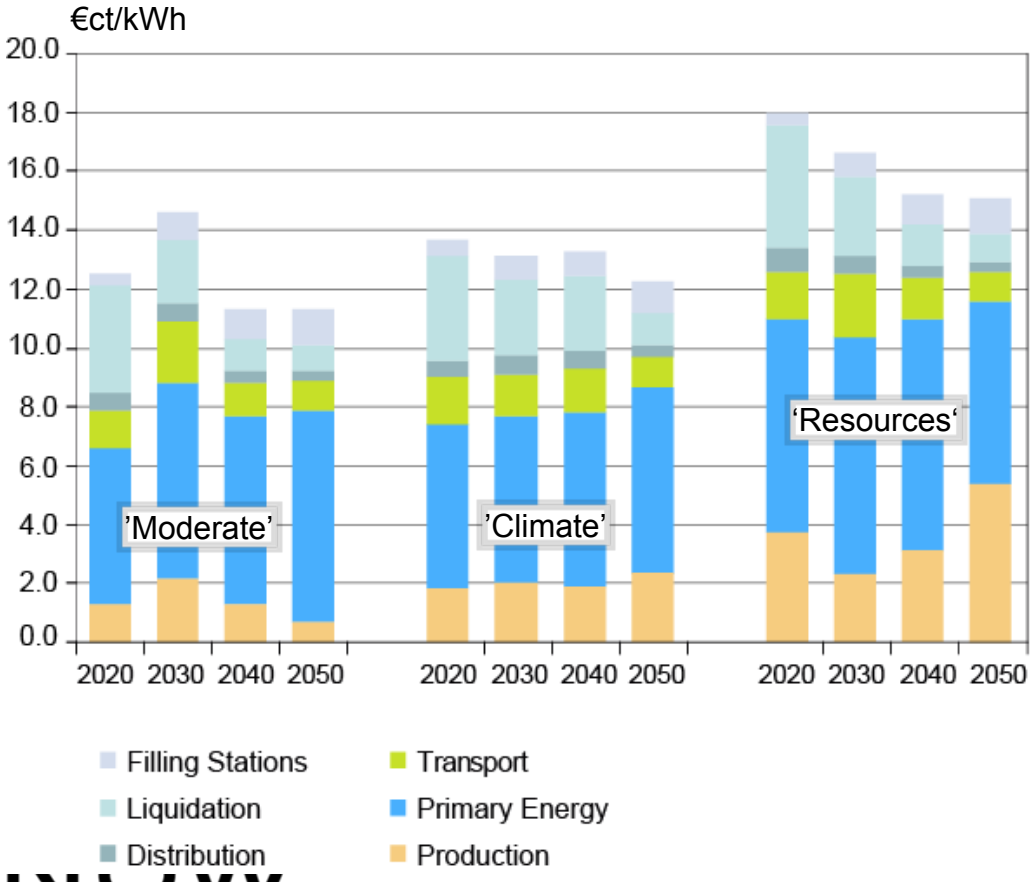


- dependency on energy imports drops from over 90% to 55% or even 35%, depending on scenario
- share of renewable energies rises from 10% to 30% or even 75%

- 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



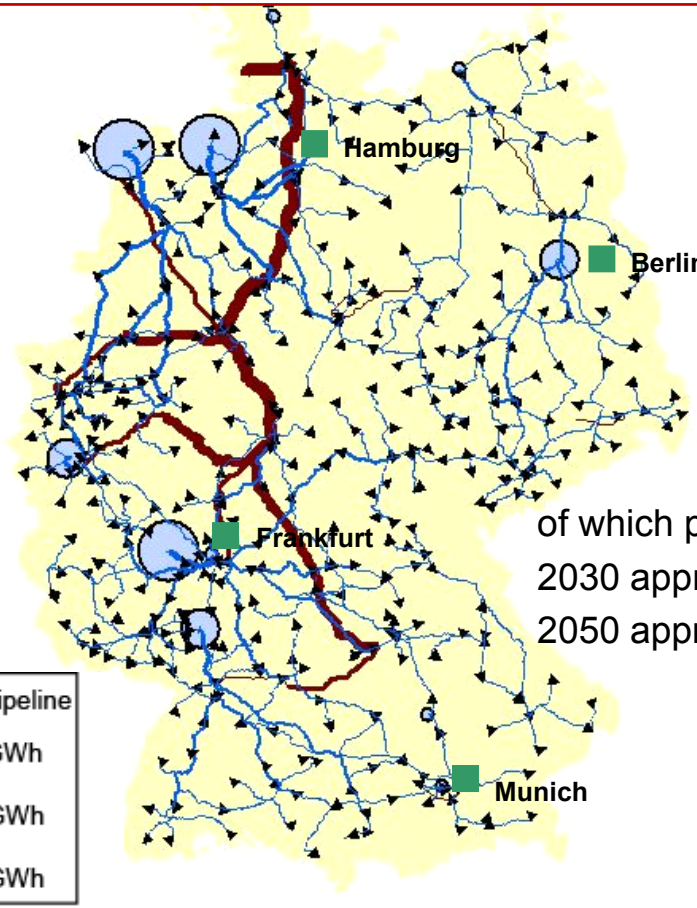
- fuel costs of hydrogen are comparable to today's costs of fossil fuels (both before tax)
- 50 to 80% of costs stem from primary energy and hydrogen production
- during the introductory phase higher costs arise from underutilization of infrastructure
- important factors of influence: political targets on climate protection and renewable energies, development of energy prices and viability of CO_2 capture and sequestration

GermanHy

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

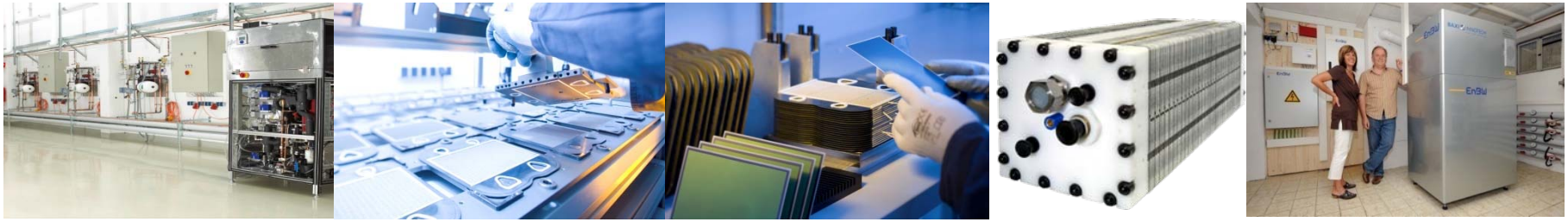


of which pipeline
2030 approx. 20%
2050 approx. 80%

LH_2 Production	H_2 Liquid Transport by Trailer	CH_2 Transport by Pipeline
800 - 2400 GWh	800 - 2392 GWh	6641 - 6911 GWh
248 - 800 GWh	393 - 800 GWh	5947 - 6640 GWh
24 - 248 GWh	<103 - 393 GWh	5 - 2310 GWh

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

callux nip
Praxistest Brennstoffzelle fürs Eigenheim
Ein Projekt im Nationalen Innovationsprogramm Wasserstoff- und Brennstoffzellentechnologie

NEEDS
Supply of CO_2-free energy

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

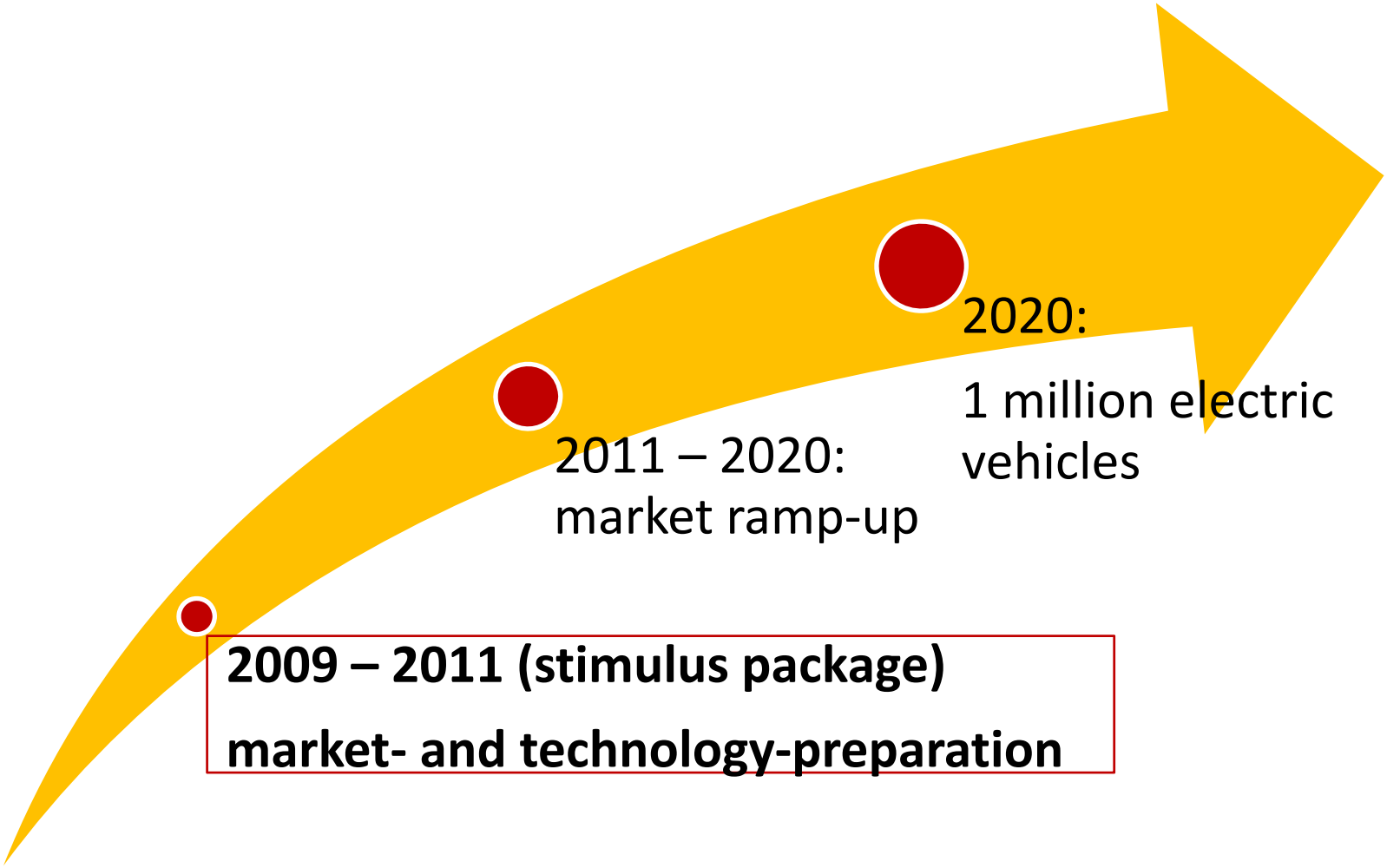
NIP – Special Markets





- 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 (BMWi)

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

Federal Ministry of Transport, Building and Urban Affairs
Division A13

Nationale Organisation Wasserstoff- und Brennstoffzellentechnologie

Thank you for your attention

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

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

www.now-gmbh.de