Deutsches Zentrum
für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

Green Mobility Technology Roadmap

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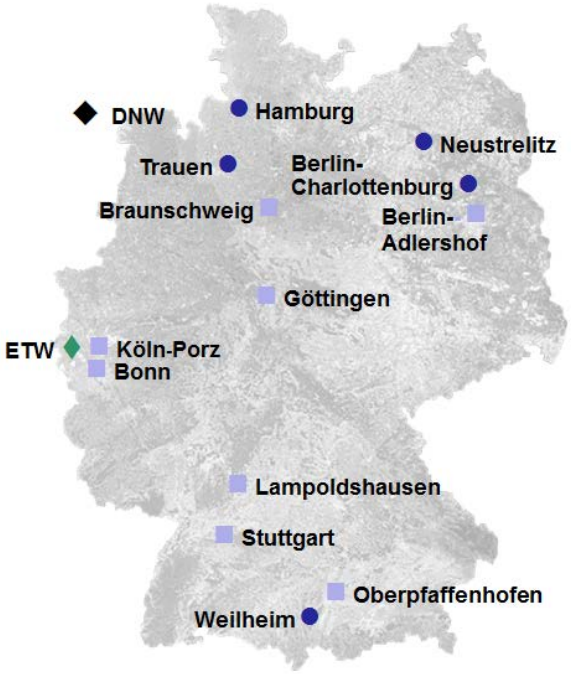
11th September 2014

DLR – Overview

DLR's mission:

- exploration of the Earth and the solar system
- research aimed at protecting the environment
- development of environmentally-friendly technologies to promote mobility, communication and security.

8.000 employee are working at 33 research institutes and facilities in ■ 9 locations and ● 7 branch offices.



SPACE	AERONAUTICS	TRANSPORT	ENERGY

SECURITY

DLR Transport – Goals and strategies

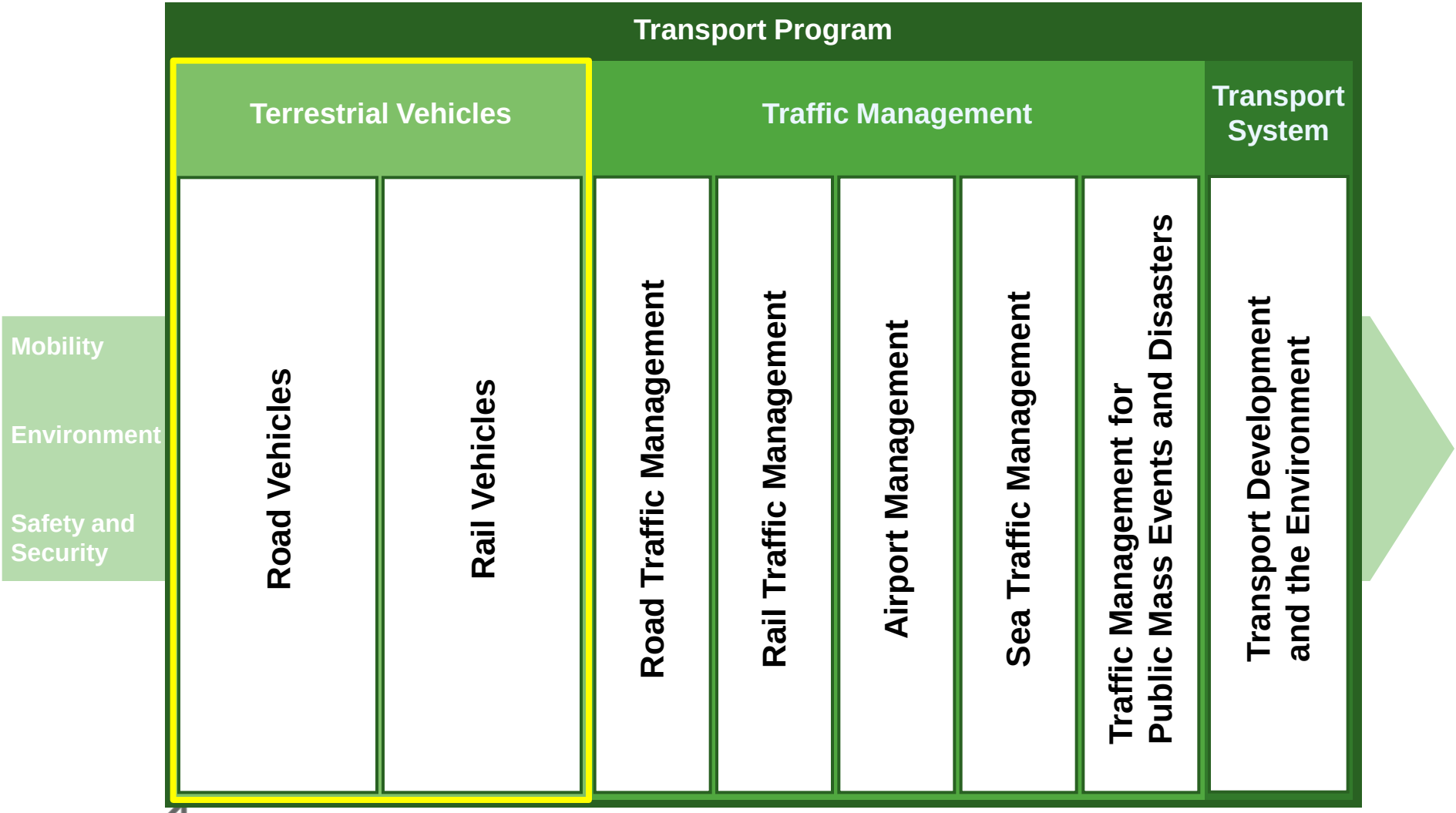
Superior Goals

- Assurance of mobility
- Protection of environment and resources
- Improvement of safety

Strategic basis elements

- Independent transport strategy
- Extension of the transport-specific range of skills
- Use of DLR internal synergies
- Intensified focus on applications
- Complex systems research
- Design and use of large-scale plant
- Cooperation with excellent partners from industry and science on a strategic basis

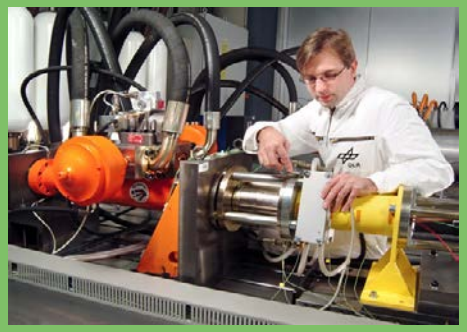
Transport – Portfolio



Transport – Portfolio

Transport Program

Terrestrial Vehicles



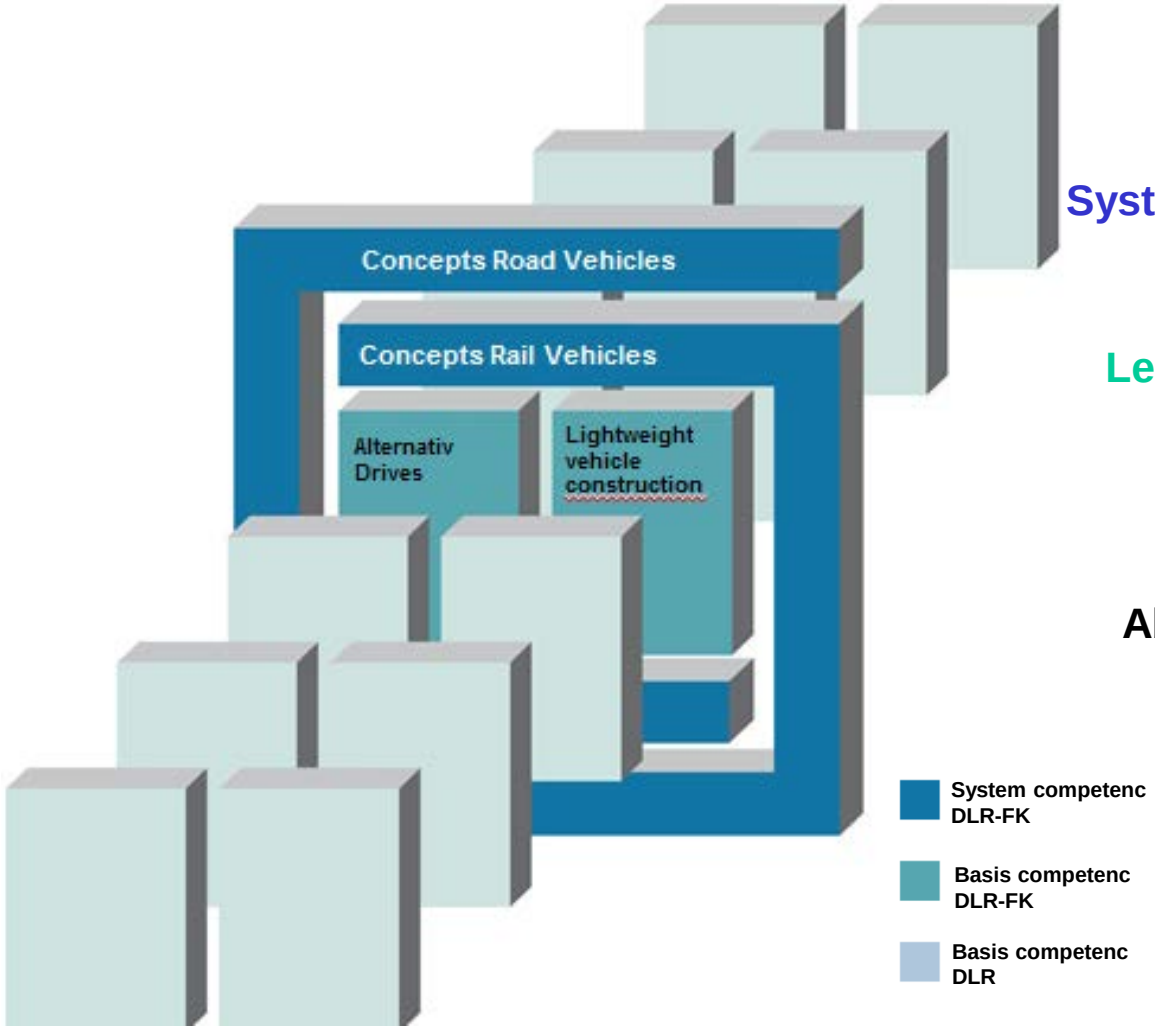
- Improvement of modeling for vehicle energy systems
- Reduction of driving resistance and vehicle weight
- Improvement of navigation support and driver Assistance
- Novel train concepts covering aerodynamics, material sciences and lightweight construction, optimized energy management

Mobility

Environment

Safety and Security

DLR's Research Network – "One DLR!"
Institutes orientation and Researchfields



System and concept research for road and rail vehicles

+

Leading-edge research in selected technology

Ability to synthesize with research institutes and DLR network

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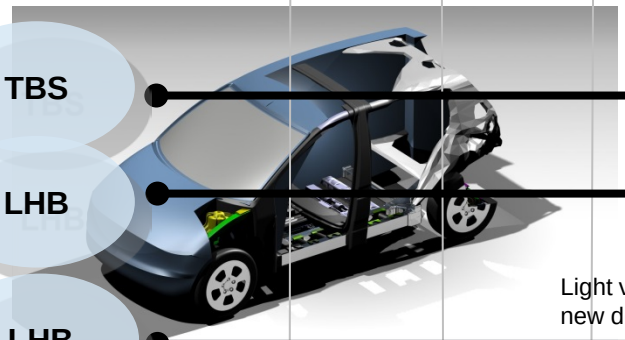
Institute of Vehicle Concepts

Vehicle systems and technology assessment	TBS
Vehicle energy concepts	FEK
Alternative energy conversion	AEW
Lightweight and hybrid design methods	LHB
Next Generation Train	NGT
Next Generation Car	NGC

* Demonstrator
** Feasibility study

Roadmap FK 2020



TBS
LHB
LHB
AEW
FEK
TBS

Founding *VECTOR2050*

Intelligent-adaptive vehicle structure*

NGC-Concept virtually realized*

Light vehicle new design*

Contactless energy transmission main-line track*

Highly efficient doubly excited electrical machine for wide speed range

TEG-System with worldwide highest power density*

HT-BZ (PEM) as REX*

BZ-drive system for feeder trains

Vehicle-Scenario Lab (interactive)*

Crash concepts NGT HGV*

NGC

NGT

2013 2014 2015 2016 2017 2018 2019 2020

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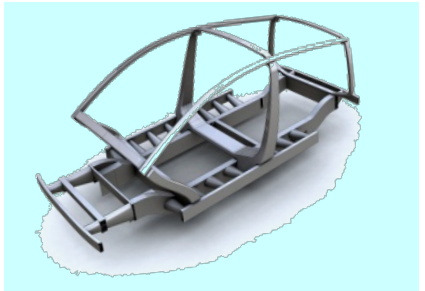
Novel Vehicle Structures

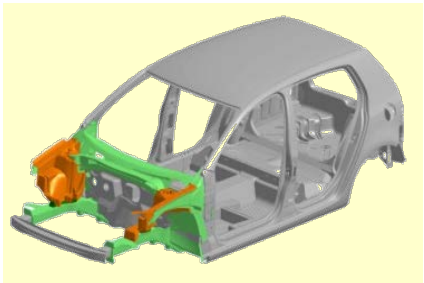
Challenges

- Reducing energy consumption and/or CO_2 emissions
- Improving passive safety

Solutions

- New vehicle concepts for urban mobility
- Lightweight design
- Reduced vehicle mass
- Improved crash safety through structural integrity and new materials
- Usage of cost-attractive technologies
- Increased flexibility and modularity





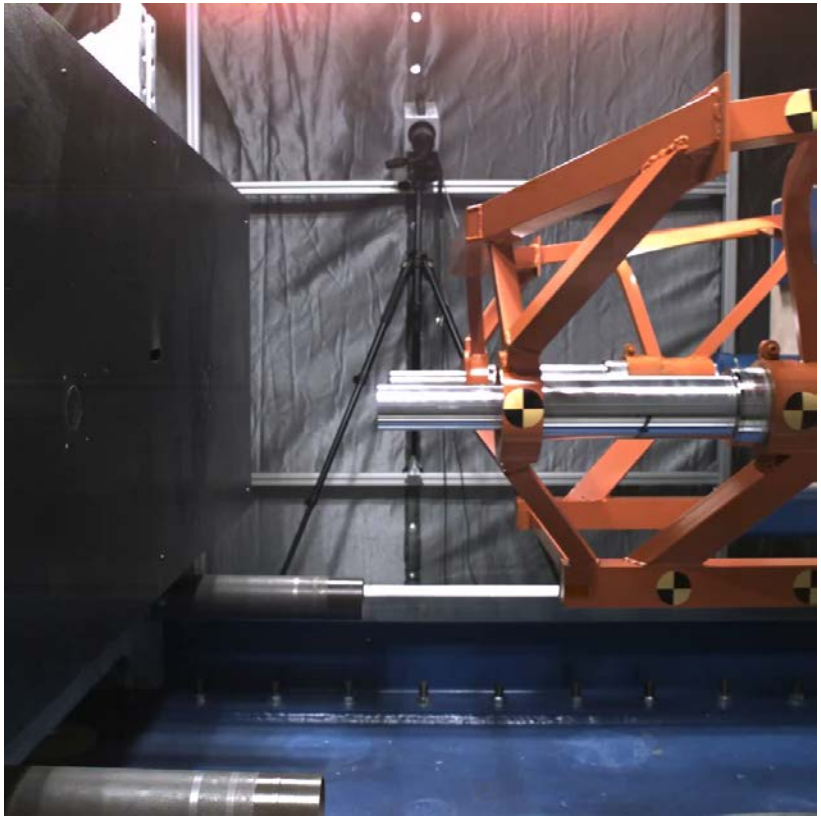
Front Structure

Challenges

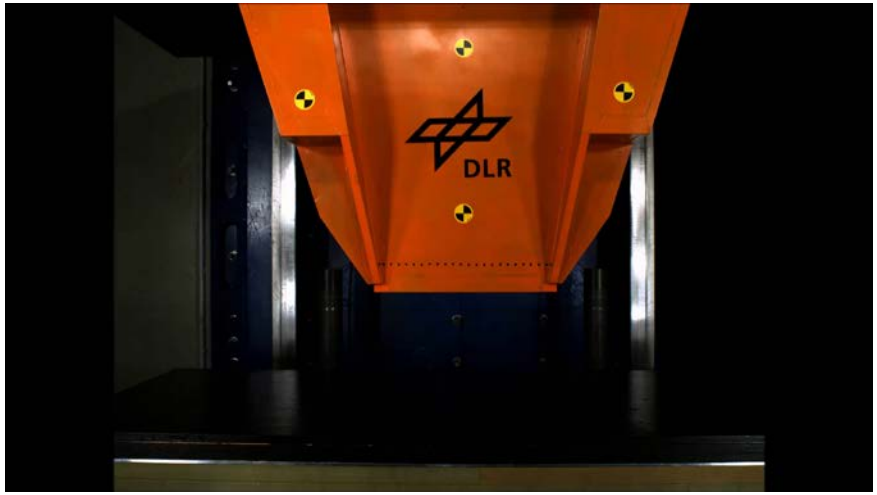
- Increase of passive safety

Solutions

- Energy absorption in frontal crash load cases



Crash of peeling tube front structure



Crash of sandwich front structure

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Vehicle Energy Systems

Challenges

- Reducing energy consumption and/or CO_2 emissions
- Lowering of geo-political dependency

Solutions

- Range-Extenders
- Efficient energy converters (i.a. free-piston linear generator, micro gas turbine)
- Aggregates for use of waste energy (i.a. thermoelectric generator)
- Optimized energy management
- Fuel cell systems for in-vehicle application
- Powerful hydrogen tanks

Hydrogen range extender

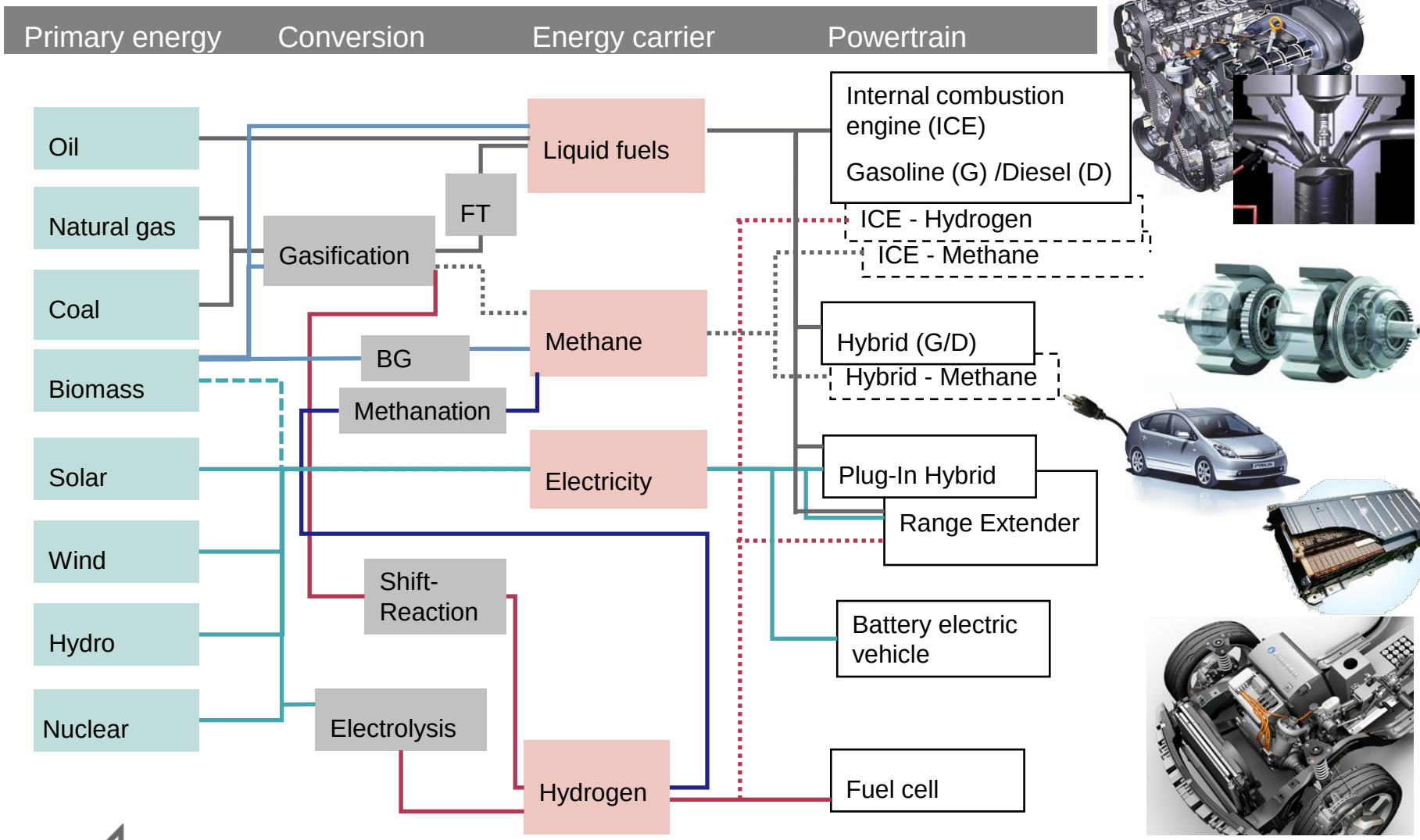
Challenges

- Doubling the range of battery electric vehicle, which has extreme low available space

Solutions

- Integration of a high temperature fuel cell as on-board charger
- Innovative thermo-management for HVAC and range extension

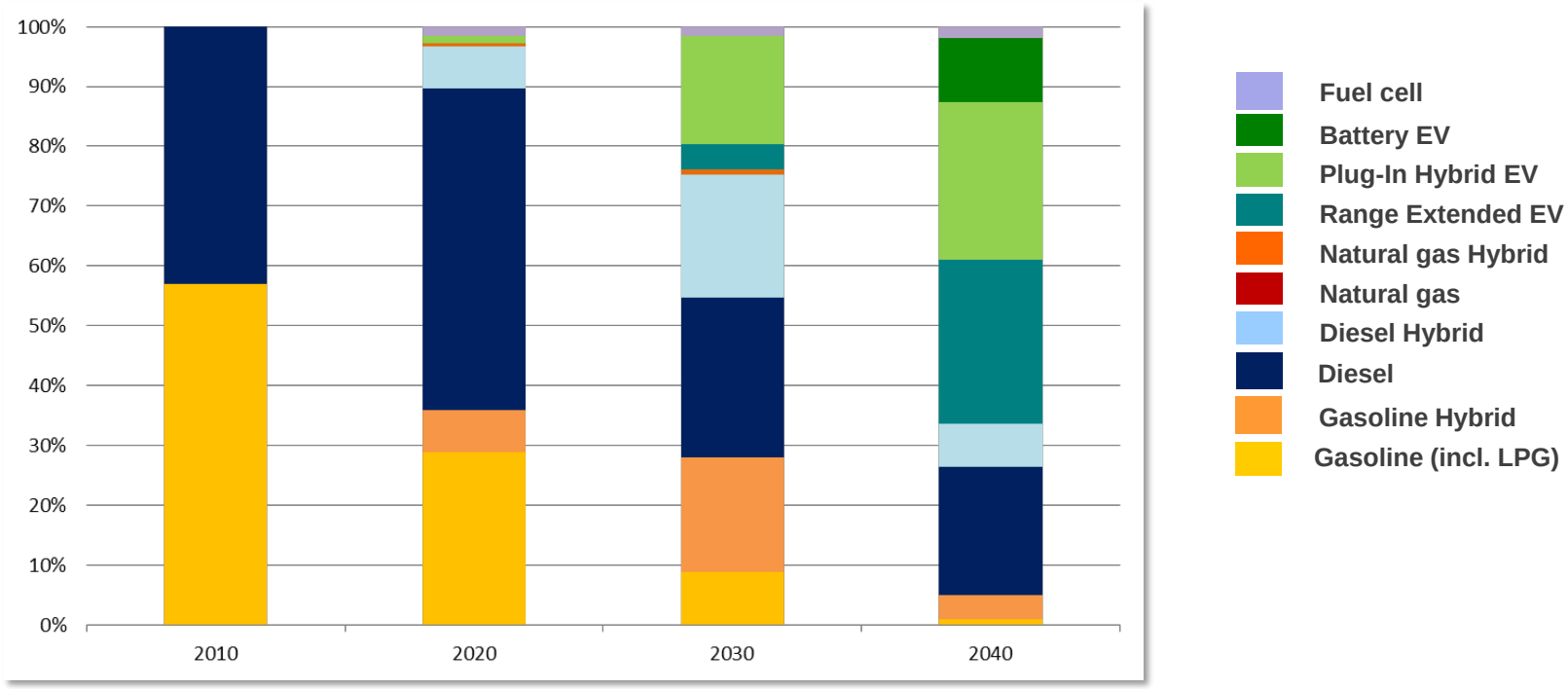
Alternative fuels and powertrains



FT: Fischer-Tropsch process
BG: Anaaerobic digestion (biogas) process and upgrading the biogas to methane
Power2gas: Electrolysis + methanation

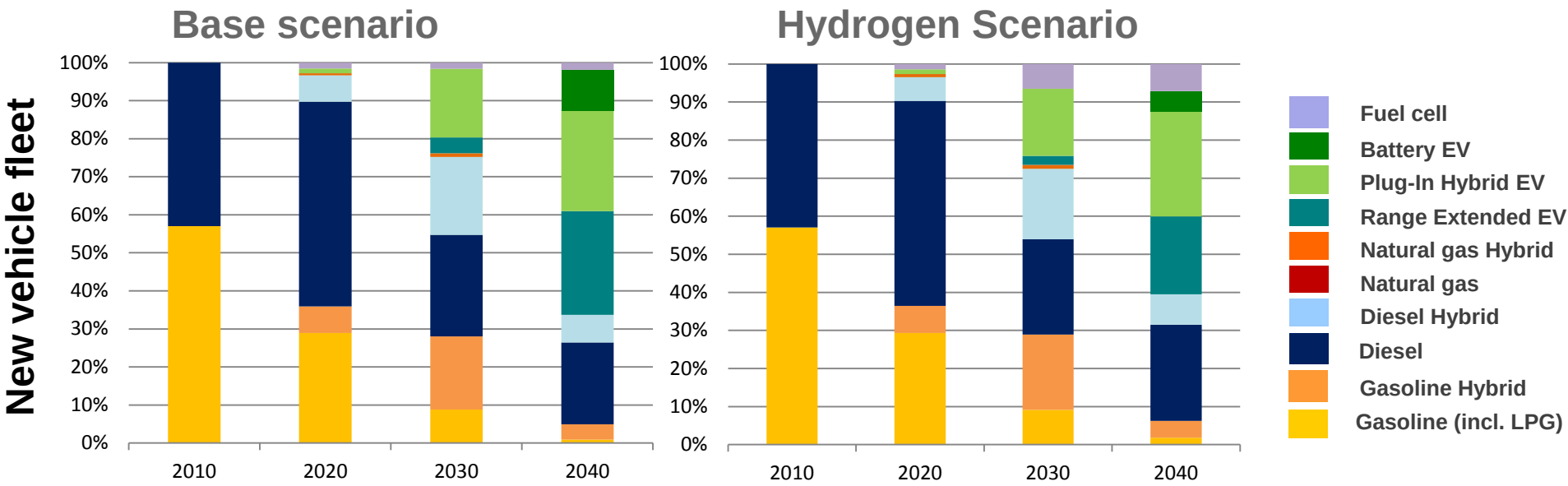
Vector 21

Base scenario, new vehicle fleet in Germany



- CO_2-targets lead to efficiency increase in ICE and increasing share of electrified powertrains
- Conventional powertrains are substituted by electrified ones (2040: 85% with ICE, 80% with battery)
- In the long run, no powertrain is expected to dominate the market

Alternative scenario: Best hydrogen availability



Changes compared to base scenario: → 100% H_2 availability (no restrictions for infrastructure)

Impact on the new vehicle fleet:

- Cumulative about 2.3 million more fuel cell vehicles between 2010 and 2040 compared to base scenario

What may be important for the future?

Question to be addressed

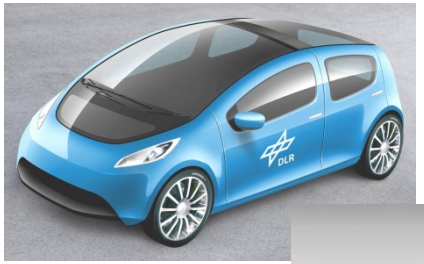
- What chance has e-mobility?
- Options for hydrogen?
- Is where a potential for e-gas?
- …

Research platform

Some answers

- Differentiation of fuels and vehicle concepts
- Hydrogen and electricity
- Urban vehicle concepts for urban mobility
- Assisted and autonomous driving
- Alternative vehicle concepts, e.g. new people mover, SkyTrains
- …

“Future mobility has to be energy efficient, sustainable and economically attractive”



Thank you for your attention!

DLR