DAIMLER

IPHE Workshop: Energy and transportation systems –A 2020 perspective, Grenoble, 03rd December 2015

Daimler's view on hydrogen and fuel cells: Connecting the transport and energy systems

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Daimler AG

Our Roadmap to a Sustainable Mobility

Highly Efficient Internal combustion engines

A 180 d BlueEFFICIENCY

3.5
l/100 km
89 g CO2/km

Full and Plug-In Hybrids

S 500 e

2.8
l/100 km
65 g CO2/km

Electric vehicles with battery and fuel cell

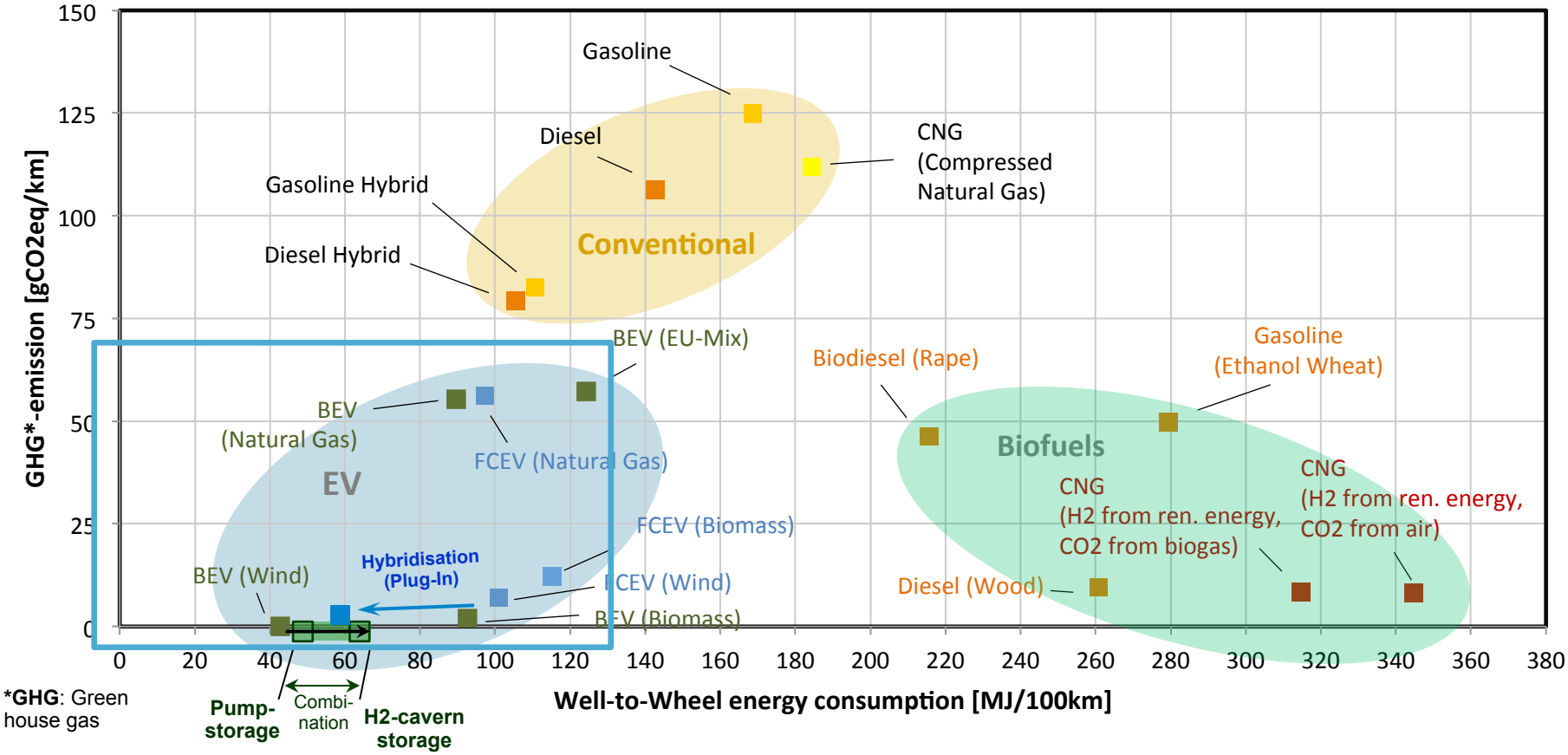
B-Class Electric Drive
smart electric drive
B-Class F-CELL

0
l/100 km
0 g CO2/km

Well-to-Wheel comparison of greenhouse gas emissions and energy consumption of EUCAR reference vehicles 2020+ (1)

Fuel Cell: High range (>400 km), short refuelling time (3 min)

Battery: Ideal in compact cars and city traffic (100-150 km), Charging overnight



*GHG: Green house gas

Source: WtW-Report 2014: EUCAR/ CONCAWE/ JRC, Version 4a

Mercedes-Benz Fuel Cell Vehicles

More than 12 million kilometers of experience

Mercedes-Benz F-Cell:

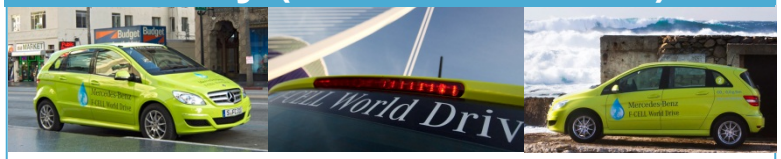
- More than 8 million kilometers by customers
- Over 4000 hrs fuel cell durability in real world driving

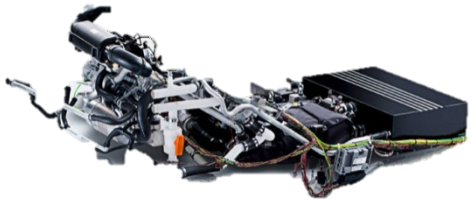
Citaro FuelCELL-Hybrid:

- More than 4 million kilometers in regular service
- Over 10,000 hrs fuel cell durability in real world driving

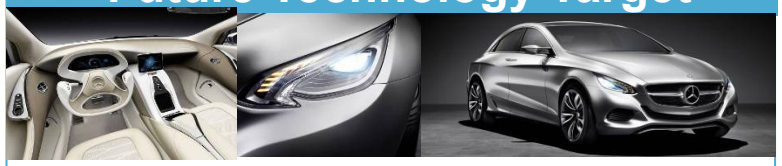
The Next Generation Fuel Cell System

Today (B-Class F-CELL)





Future Technology Target



Reduction of ~ 30%

➔ **The significantly more compact dimensions allow for the engine bay installation of the fuel cell "engine" in a conventional vehicle architecture.**

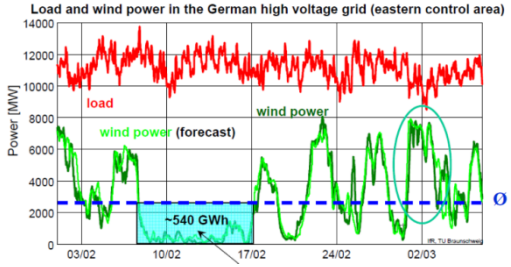
Daimler is actively stimulating H2 infrastructure

- Direct investment in 10 stations in Germany as initial contributon
- Example: First Autobahn-H2-refueling station
  as a connector station between metropolitan regions

- Daimler is shareholder of H2 Mobility Germany: Expand H2 refueling network in Germany to more than 400 stations until 2023
- Daimler also supports other H2 initiatives in Europe with expertise

The feed-in of renewable electricity will cause a volatile energy supply

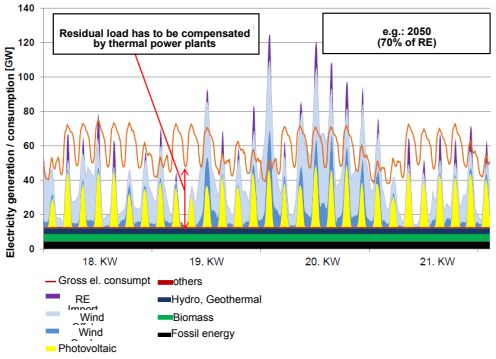
There will be a time-dependent over- or under-supply of renewable electricity.
➔ **highly-efficient and large-scale electricity storages will be required**



TODAY
The feed-in of wind energy already causes significant peaks in the energy supply.
[1] Vattenfall

- 2020 -
The supply of wind energy may exceed the aggregate demand temporarily
[2] E.ON

2050 -
In the future, peaks in energy supply and demand become normal.
[3] RWE

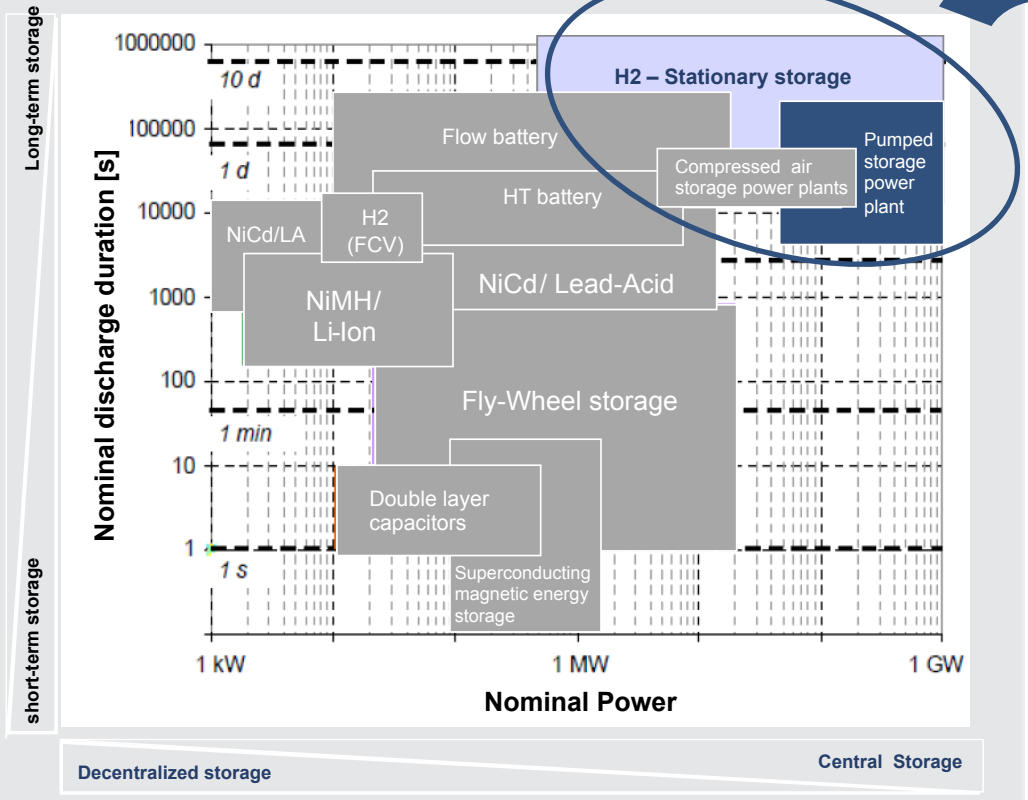


Sources: [1] FCBAT, J. Garche (2012): Elektrochemische Speicher für Regenerative Energien und Netzlastmanagement , S.3, Speichersimposium DLR 2012 [2] ENERTRAG, W. Diwald (2012): Hybridkraftwerke,
Basis der Energiewende, S.7, Speichersimposium DLR 2012; [3] RWE, P. Moser (2012): Zentrale stationäre Energiespeicher – Werkzeug zur Flexibilisierung der Stromerzeugung, S.2, Speichersymposium DLR 2012

Excess electricity can be stored in different storage systems

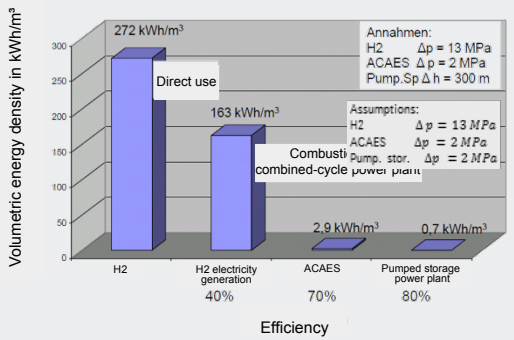
➔ Hydrogen is the ideal long- to mid-term storage for large amounts of energy

Application ranges of different energy storage systems



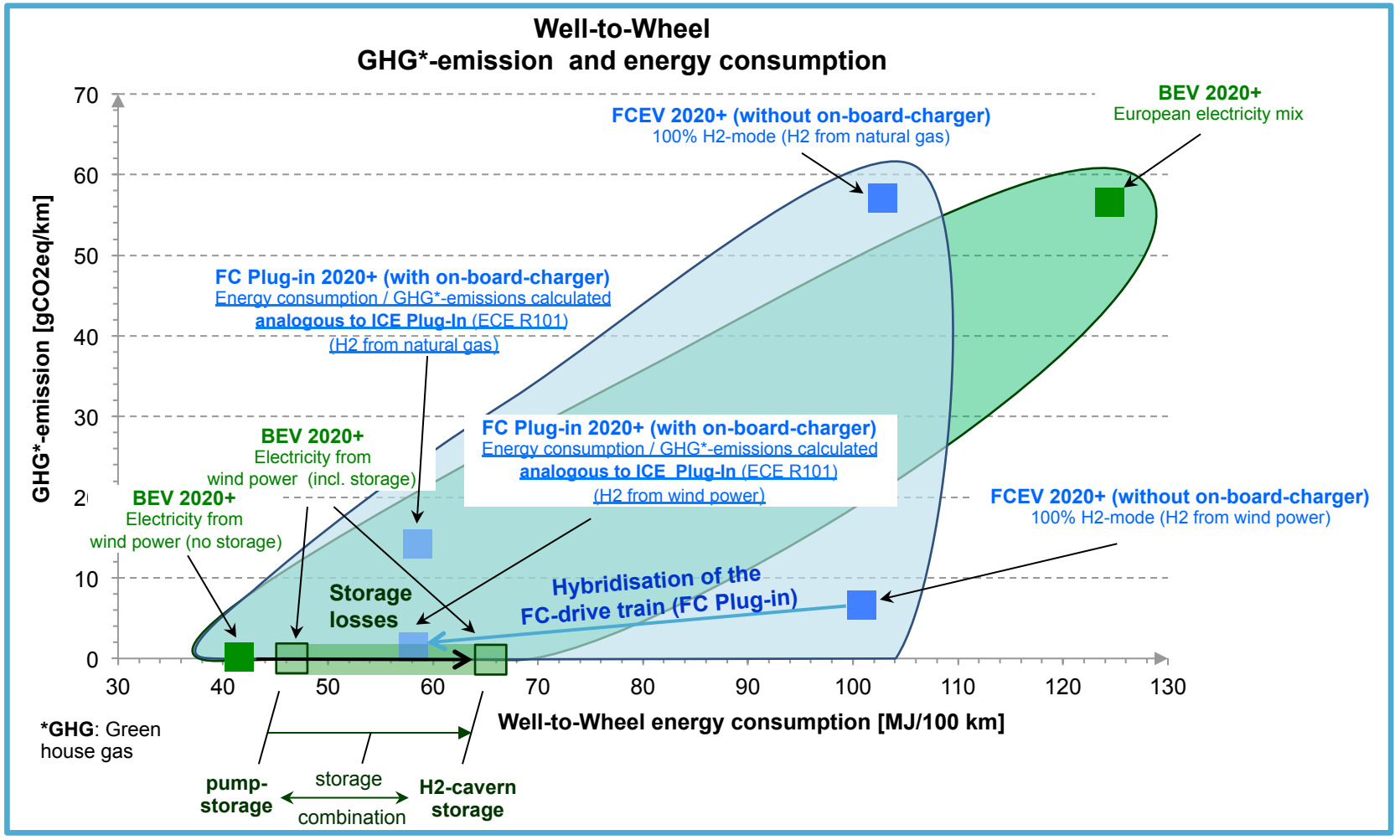
Central long-term storage

- At the moment only readily controllable fossil power plants are able to compensate long-term (days or weeks) fluctuations (e.g.: lack of wind).
- Replacing fossil power plants with energy storage systems helps to speed up the energy revolution.
- H2 cavern storage systems have the highest energy density.



Quelle: LBST (2011): Metastudie: Speicherung Erneuerbarer Energien, S.9 aus BMWi 2009

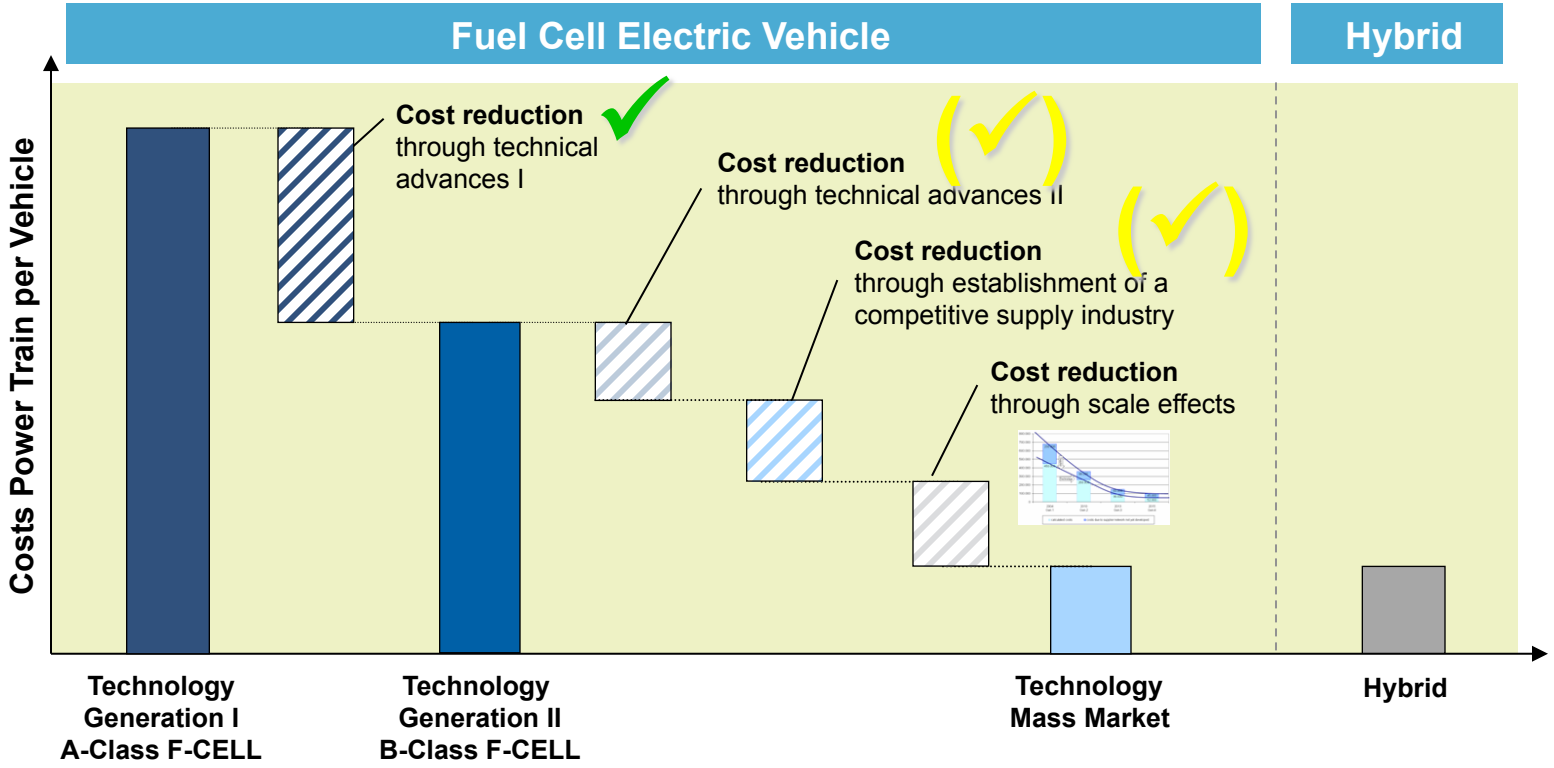
Well-to-Wheel comparison of greenhouse gas emissions and energy consumption of EUCAR reference vehicles 2020+ (1)



Sources: JRC/EUCAR/CONCAWE (2013): WtW report, version 4a, Daimler-internal calculations

* GHG: Green House Gas

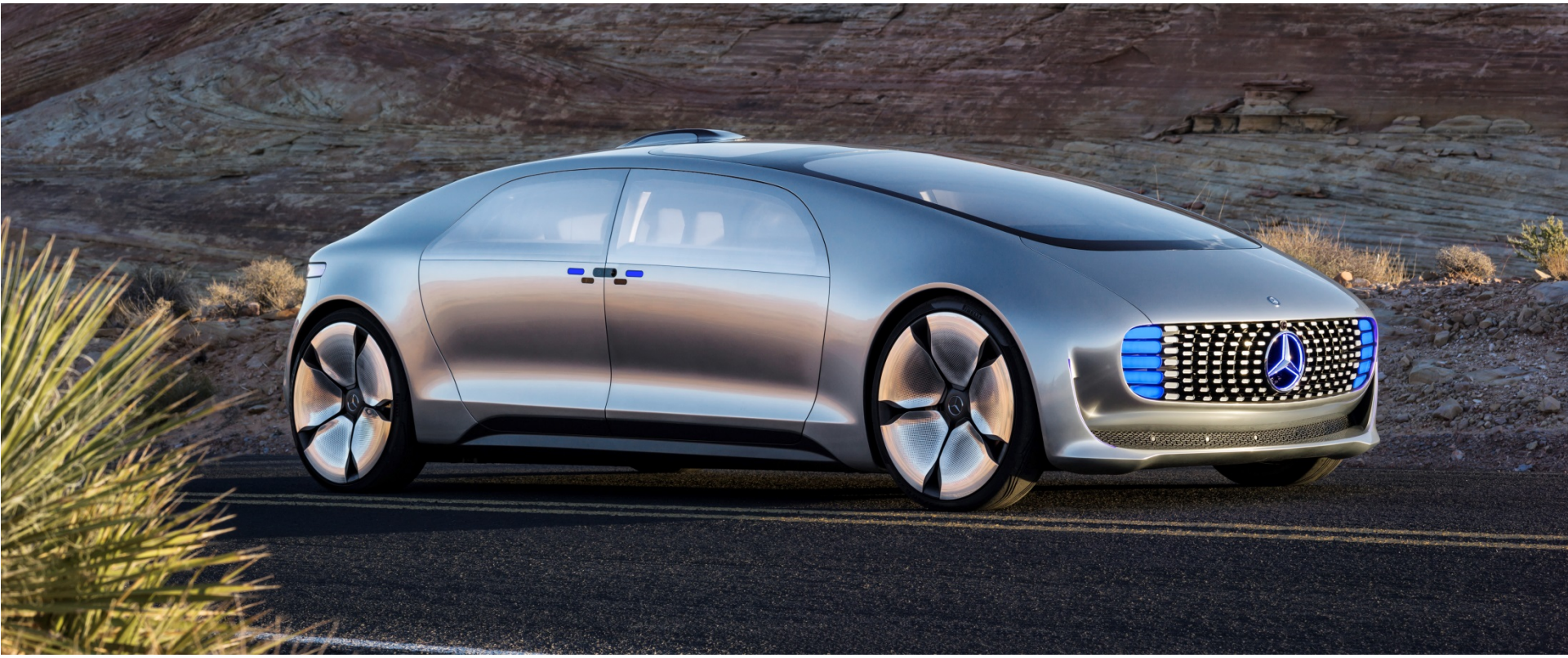
Cost Reduction is the Key to Fuel Cell Commercialization



FC powertrain cost currently much higher than for hybrid drive systems
Reduction achieavble by scale effects and technology advances

=> Daimler moves all levers (product, production, suppliers) to realize cost reduction

The future passenger car is autonomous, connected and ELECTRIC - with battery and fuel cell



Thank you very much for your attention!