Daimler's perspective on alternative propulsion systems and the new Mercedes GLC F-CELL
Daimler is shaping the future of mobility in many aspects. We re-invent the car!
Fuel Cell Technology is an Integral Part of Daimler’s Powertrain Strategy

<table>
<thead>
<tr>
<th>Highly efficient combustion engines</th>
<th>Full- and plug-in-hybrids</th>
<th>Electric vehicles with battery and fuel cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 180 CDI BlueEFFICIENCY</td>
<td>S 560 e</td>
<td>Combined H2-Consumption: 0,34 kg/100 km, Combined CO₂-Emissions: 0 g/km, Combined electrical consumption: 13,7 kWh/100 km</td>
</tr>
<tr>
<td>3,5 l/100 km, 89 g CO₂/km</td>
<td>2,1 l/100 km, 49 g CO₂/km</td>
<td></td>
</tr>
</tbody>
</table>
Well-to-Wheel Comparison of Greenhouse Gas Emissions and Energy Consumption of EUCAR Reference Vehicles (C-segment passenger car) 2020+

Conventional

Gasoline (Crude oil)
Gasoline Hybrid (Crude oil)
Diesel Hybrid (Crude oil)
Diesel (Crude oil)
CNG (Compressed Natural Gas)

Biofuels and Synthetic fuels
Syn. Diesel (H2 from ren. Energy, CO2 from exhaust gas)
DICI (BTL Wood)
Syn. Diesel (H2 from ren. Energy, CO2 from air)
PISI CNG (H2 from ren. Energy, CO2 from Biogas)
DICI (Biodiesel FAME)
DICI (Ethanol Wheat)

Hybridisation FC-Powertrain (Plug-In)
BEV (Wind)
BEV (Natural Gas)
BEV (EU-Mix)
FCEV (Wind)
FCEV (Natural Gas)
FCEV (Biomass)

Well-to-Wheel energy consumption [MJ/100km]
100 MJ = 27.8 kWh

Vehicles 2020

Well-to-Wheel Consideration of Fuel Cell Plug-in-Hybrid

Comparison of WTW Green House Gas-emission and energy consumption of EUCAR reference vehicle 2020+

- FCEV 2020+ (without on-board-charger) 100% H₂-mode
- BEV 2020+ Electricity
- FC Plug-in 2020+ (with on-board-charger) Energy consumption/Green House Gas-emissions calculated analogous to ICE Plug-in (ECE R101)

Sources: IRC, EUCAR (CONCawe, 2013); WW report, version 4a, Daimler internal calculations
Highly efficient combustion engines with additional 48 volt onboard network with a belt-driven starter/alternator

Example **C 200 Estate**

Fuel consumption combined: 6,2 l/100 km; CO₂-emission combined: 142 g/km
Next milestone in hybridization

Example **560 e Plug-in-Hybrid**

Fuel consumption combined: 2.1 l/100 km, CO₂-emissions combined: 49 g/km, weighted power consumption: 15.5 kWh/100 km, all-electric range of around 50 kilometres.
Clear Commitment to E-Mobility

10 bn Euro invest in electric vehicle fleet

Various electrified alternatives in every segment - from the compact car to the major SUV

New brand EQ for electric vehicles

> 10 Electric vehicles on the market by 2022

Significantly more than 130 electrified vehicle variants on the market by 2022
World premiere EQC – First Mercedes-Benz vehicle to be launched under the EQ brand
smart fully electric in Europe & US by 2020

- Mercedes Benz Cars -
eVito: Electrically powered, mid-sized van has been available to order since the end of 2017

- Ecosystem to electrify commercial fleets
- Range of up to 150 km
- Designed for inner-city delivery, commercial and passenger transport
Electric, locally emission-free and silent:
Our battery-powered commercial vehicles for urban areas

Thomas Built Buses
Jouley
- 2017: World premiere
- 2018: Innovation fleet
- 2019: Small series

Mercedes-Benz
eActros
- 2016: World premiere
- 2018: Innovation fleet
- ~2021: Market introduction

FUSO
eCanter

Freightliner
eCascadia & eM2
- 2018: World premiere
- 2019: Innovation fleet
- 2021: Market introduction
The all-electric Citaro: Emission-free through the city

- Modular design of battery packs allows range to be tailored
- Innovative thermal management
- eMobility system:
  - eConsulting before procurement
  - eMobility service of brand OMNIplus
- World premiere IAA Commercial Vehicle Sept. 2018
- New generation FC bus with FC range extender
Daimler has the broadest experience with fuel cell Technology: Highlights from fleet operation

B-Class F-CELL
- > 10 million km in Europe and USA
- > 300,000 km driven in one single vehicle
- < 3 minutes average refueling time on the basis of 36,000 refuelings

Customer - Feedback
Consistent positive feedback
- „After driving the F-CELL, you don’t want to get back to your old car!“
- „My next car will be a Fuel Cell car again!“

Citaro FuelCELL-Hybrid
- > 5 million km in Europe
- Press release of an operator
  - > 1 million km in regular operation
  - 1,200 tons of CO₂ avoided
Wide field of applications for fuel cell drive - with different configurations

A. Individual Mobility demand with long range requirements > 500 km also in middle segment
B. High speed highway use cases requires higher storage capacity
C. Use-on-demand applications (carsharing) with FCEV more robust vs. availability of cars
D. Significant number of larger & heavier cars in the portfolio
The current generation of fuel cell vehicles: Mercedes-Benz B-Class F-CELL

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle</td>
<td>Mercedes-Benz B-Class F-CELL</td>
</tr>
<tr>
<td>Fuel Cell System</td>
<td>90 kW (122 PS)</td>
</tr>
<tr>
<td>Traction Motor</td>
<td>Power (cont./peak): 70/100 kW (136 PS)</td>
</tr>
<tr>
<td>Range</td>
<td>380 km (NEDC)</td>
</tr>
<tr>
<td>Maximum Speed</td>
<td>170 km/h</td>
</tr>
<tr>
<td>Acceleration</td>
<td>0-100 km/h (0-60 mph)</td>
</tr>
<tr>
<td></td>
<td>11.4 s</td>
</tr>
<tr>
<td>High Voltage Battery (Lithium-Ion)</td>
<td>Power (cont./peak): 24/30 kW</td>
</tr>
<tr>
<td></td>
<td>Capacity: 6.8 Ah, 1.4 kWh</td>
</tr>
</tbody>
</table>
The current generation of fuel cell vehicles: Mercedes-Benz Citaro FuelCELL-Hybrid

Two identical fuel cell systems of the Mercedes-Benz B-class F-CELL

<table>
<thead>
<tr>
<th>Characteristics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle</td>
<td>Mercedes-Benz Citaro FuelCELL-Hybrid</td>
</tr>
<tr>
<td>Fuel Cell System</td>
<td>120 kW (cont.) / 140 kW (peak)</td>
</tr>
<tr>
<td>Traction motor</td>
<td>Power (continuous/peak)</td>
</tr>
<tr>
<td></td>
<td>2 x 80 kW / 2 x 120 kW</td>
</tr>
<tr>
<td>Range</td>
<td>&gt; 250 km</td>
</tr>
<tr>
<td>Hydrogen storage</td>
<td>35 kg hydrogen at 350 bar</td>
</tr>
<tr>
<td>H₂ consumption</td>
<td>10 – 14 kg/100 km</td>
</tr>
<tr>
<td>High-voltage battery</td>
<td>Power: 250 kW Capacity: 6.9 kWh</td>
</tr>
</tbody>
</table>
### Next generation fuel cell powertrain

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined electrical consumption (kWh/100 km)</td>
<td>13.7</td>
</tr>
<tr>
<td>H₂-Range in hybrid mode (NEDC) (km)</td>
<td>478</td>
</tr>
<tr>
<td>Battery electric range in battery mode (NEDC) (km)</td>
<td>51</td>
</tr>
<tr>
<td>Engine Rated output (kW/PS)</td>
<td>155 (211)</td>
</tr>
<tr>
<td>Engine Peak torque (Nm)</td>
<td>365</td>
</tr>
<tr>
<td>Battery</td>
<td>Lithium-Ion</td>
</tr>
<tr>
<td>Energy content (gross/net) (kWh)</td>
<td>13.5 /9.3</td>
</tr>
<tr>
<td>Fuel cell</td>
<td>PEM</td>
</tr>
<tr>
<td>Hydrogen tank capacity (kg) (usable for SAE J2601, 2014 or more recent)</td>
<td>4.4</td>
</tr>
<tr>
<td>Top speed (km/h)</td>
<td>160 (governed)</td>
</tr>
</tbody>
</table>
Next Generation Fuel Cell Vehicle: „The Fuel Cell gets a Plug!“

- Increase in range to 478 km from hydrogen and 51 km from HV-battery
- Driving power: 155 kW
- Volume of fuel cell engine: - 30 %
- Reduction of platinum in fuel cell stack: - 90 %
- Switch to plug-in-battery, in order to satisfy the gradual build-up of hydrogen infrastructure
- Cost-efficient carry-over of various high-voltage components from the Mercedes-Benz modular system
Daimler’s Next Generation Fuel Cell Engine

- High level of component integration
- Increase in fuel cell stack power density by ~ 100% compared to B-Class F-CELL
- Introduction of electric turbo-compressor for air supply
- Absolute platinum content in fuel cell stack reduced by 90% compared to B-Class F-CELL
- Increased amount of series-produced carry-over parts (e. g. air filter, coolant pump)
Mercedes Concept Sprinter F-CELL presented in Hamburg July 2, 2018
Important Parameters for Optimization of Fuel Cell Drive

Technology
- Power density
- Energy density (Battery)
- Storeable amount of hydrogen
- Lifetime

H₂-Infrastructure
- Reliable refueling technology
- Built up of nationwide H₂-Infrastructure
- H₂-Production at competitive cost
- Renewable produced hydrogen

Cost
- Fuel cell system and stack
- HV-Battery
- H₂-Storage and H₂-Infrastructure
- Power electronics
- Electric drive
- Cost of hydrogen

Customer Wishes
- Attractive vehicle platform
- High range and low consumption
- Convincing driving performance
- Unrestricted availability of the drive system
H$_2$-Infrastructure – Activities Worldwide Overview

Expected H$_2$-Infrastructure Development in Germany

- No activities
- Some HRS in usage
- 100 HRS in usage
- > 100 HRS in usage

- H$_2$-Infrastructure development based on availability of the vehicle
- Currently* 328 HRS worldwide in usage, 227 HRS of them are useable in public

HRS: Hydrogen Refueling Station (700 bar PKW) | JV: Joint Venture


Source: Scandinavian Hydrogen Highway Partnership
Source: California Fuel Cell Partnership
Source: UK H2Mobility Initiative

- USA/California
  - Network planning CARB
  - 35 HRS in operation
  - 33 HRS planned
  - < 50 HRS until 2018
  - Source: California Fuel Cell Partnership

- UK
  - Initiative UK H2-Mobility
  - 15 HRS in operation
  - >15 HRS in 2018
  - Source: UK H2Mobility Initiative

- Europe
  - Diverse situation in the different member states

- Germany
  - H2-Mobility JV founded
  - 52 HRS in operation
  - 100 HRS by 2019

- China
  - First activities started

- Japan
  - 96 HRS in operation
  - <100 HRS in 2017/18
  - H2-Mobility Japan founded

- South Korea
  - ~ 16 HRS in operation
  - <100 HRS by 2020

- Scandinavia
  - DNK: 10 HRS
  - NOR: 9 HRS
  - SWE: 4 HRS
  - FIN: 2 HRS
  - Source: Scandinavian Hydrogen Highway Partnership
H2Mobility Initiative in Germany
Build-up of a Hydrogen Refueling Station-Network

**Partners (Shareholders) of Initiative**
- DAIMLER
- Shell
- TOTAL
- Linde
- OMV
- AIR LIQUIDE

**Implementation-Plan**
Build-up of a hydrogen refueling station network in Germany

- ~ 400 public accessible HRS to be built-up in Germany
- ~ 90 km distance between HRS on the Highways & around the Lighthouse-Regions
- > 10 HRS available in Metropolitan areas

**H2 Mobility Signing Ceremony**
Berlin – October 13th, 2015

**NIP-Contact**

**Associated Partners**
- Honda
- Hyundai
- TOYOTA
- Volkswagen
Thank you very much for your attention!