Life cycle COMPACT

360° Environmental Check Mercedes-Benz GLC F-Cell

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360° environmental check Mercedes-Benz GLC F-CELL

The Mercedes-Benz GLC F-CELL (combined hydrogen consumption 0.34 kg/100km, combined CO_2 emissions 0 g/km, combined electrical consumption 13.7 kWh/100 km)[1] is a further milestone by Daimler AG on the road to emission-free driving, and underlines the company's commitment in this field of technology.

The new GLC F-CELL represent a world first in which a fuel cell operated electric car uses a lithium-ion battery as an additional energy source that can be externally charged by means of plugin technology.

Here the growth in electric mobility presents the automotive industry with new challenges. As a premium manufacturer, Mercedes-Benz aspires to develop products that are particularly environmentally compatible in their market segments. Environmental protection is therefore an integral part of the development process at Mercedes-Benz. Because the earlier this “Design for Environment” approach is integrated into the development process, the greater are the benefits in terms of minimized environmental impacts and costs.

It is likewise crucial to reduce the environmental impact caused by emissions and consumption of resources during the entire life cycle. This comprehensive and exhaustive Life Cycle Assessment (LCA) we call ‘360° environmental check‘. It scrutinizes all environmentally relevant aspects of a car‘s life:
from manufacture of the raw materials to production, vehicle operation and then recycling at the end of the vehicle‘s life – a long way off in the case of a new Mercedes-Benz.

This brochure summarises the results of the GLC F-CELL LCA for you.

By the way: this brochure is available for download from http://www.mercedes-benz.com.

[1] Figures for fuel consumption, electrical consumption and CO_2 emissions are provisional and were determined by the technical service for the certification process in accordance with the WLTP test method and correlated into NEDC figures. EC type approval and certificate of conformity with official figures are not yet available. Differences between the stated figures and the official figures are possible.

Mercedes-Benz GLC F-CELL

Unique Hybrid Combination

The Mercedes-Benz GLC F-CELL is a unique plug-in hybrid as it combines innovative fuel-cell and battery technologies for the first time: apart from electricity, it also runs on pure hydrogen.

Intelligent interplay between battery and fuel cell, long range, and short refuelling times make the GLC F-CELL a vehicle of high everyday practicality and also suitable for short and long-distance motoring.

The GLC F-CELL represents an important step by Mercedes-Benz in the development of fuel cell technology. It features a totally new fuel cell system which is so compact that the entire system can be housed in the engine compartment for the first time and installed at the same mounting points as a conventional engine. In addition, the use of platinum in the fuel cell has been reduced by 90 percent in comparison to the predecessor generation. Consequently resources are conserved, and system costs are cut without impairing performance.

The lithium-ion battery has a gross capacity of 13.5 kWh and additionally serves as an energy source for the electric motor. Plug-in technology makes it easy to charge via the 7.4 kW on-board charger at a standard household socket, a wallbox or a public charging station – from 10 to 100 percent SoC (State of Charge) in approx. 1.5 hours if the full power is used. Just like the drive motor, an asynchronous motor with an output of 155 kW (211 hp) and a torque of 365 Nm, the powerful storage battery is space-savingly installed in the rear of the SUV. Two carbon-fibre-encased tanks built into the vehicle floor hold 4.4 kg of hydrogen. Thanks to globally standardised 700-bar tank technology, the supply of hydrogen can be replenished within just three minutes - as quickly as is customary when refuelling a combustion-engined car.

Operating Strategy with a high Variety of Combinations

The innovative plug-in fuel-cell drive combines the advantages of both zero-emission drive technologies and, thanks to its intelligent operating strategy, continuously optimises the use of both energy sources in line with the current operating situation. This is also influenced by the selected drive program: ECO, COMFORT or SPORT.

There are four operating modes:
HYBRID: the vehicle draws power from both energy sources. Power peaks are handled by the battery, while the fuel cell runs in the optimum efficiency range.
F-CELL: the state of charge of the high-voltage battery is kept constant by the energy from the fuel cell. Only hydrogen is consumed. This mode is ideal for steady cruising over long distances.
BATTERY: the GLC F-CELL runs all-electrically and is powered by the high-voltage battery. The fuel cell system is not in operation. This is the ideal mode for short distances.
CHARGE: charging the high-voltage battery has priority, for example in order to recharge the battery for the maximum overall range prior to refuelling with hydrogen or to create power reserves.

In all operating modes, the system features an energy recovery function, which makes it possible to recover energy during braking or coasting and to store it in the battery.

Mercedes-Benz‘s safety assistance systems are also all on board the GLC F-CELL. Their sensors have an additional purpose in vehicles that run purely on electric power in that their signals assist the powertrain control with the selection of a range-preserving, efficient strategy for using the on-board energy sources. The energy employed for accelerating the car is used intelligently, taking account of the route characteristics, topography and traffic situation.
The driver can always set other priorities, of course, but subtle hints inform them of what they can do intuitively to optimise the vehicle range.

The facts

The Mercedes-Benz GLC F-CELL 360° environmental check

Early in the development stage of a new model, Mercedes-Benz starts looking at environmental performance over the car's entire life cycle. On the following pages you can read about how the new GLC F-CELL fares in the key areas of the comprehensive Life Cycle Assessment (LCA): consumption of resources and emissions.

Environmentally friendly plug-in hybrid drive:
Locally emission-free driving with high vehicle range.

Economical (NEDC values):
Only 0.34 kg H_2 /100 km combined in Hybrid mode; combined electrical consumption 13.7 kWh/100 km, up to 51 kilometers battery electric range.

Resource-efficient:
The use of platinum in the fuel cell has been reduced by 90 percent in comparison to the predecessor fuel cell generation.

The resources: what is needed to produce a car

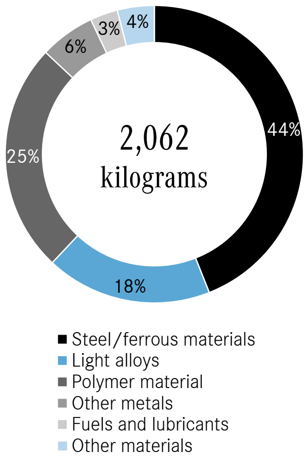
Achieve more with less

When it comes to the overall life cycle assessment, however, the GLC F-CELL benefits from continuous locally emission-free operation and the high efficiency of the electric powertrain.

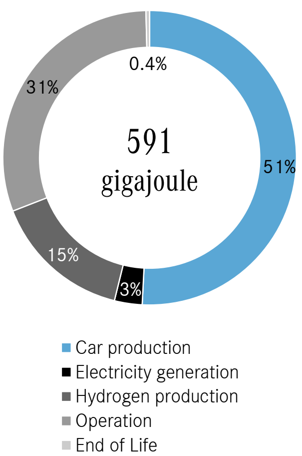
Material ressources

In production, the drive components specific to the GLC F-CELL require a greater use of material and energy resources. The proportion of steel and iron is reduced by the omission of a combustion engine and transmission plus their peripheral units. On the other hand, the proportion of polymers, light alloys and other metals is increased. The importance of the production process for the primary energy requirement increases accordingly.

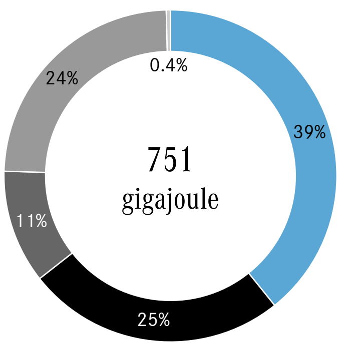
Mercedes-Benz GLC F-CELL



renewable H_2- and electricity production



H_2 Mobility / EU electricity mix



Energy ressources

During its operating phase, the GLC F-CELL benefits from the high efficiency of the electric powertrain.

For an analysis of the GLC F-CELL's operating phase, different sources of the necessary hydrogen and the electrical power used for external battery charging were examined.

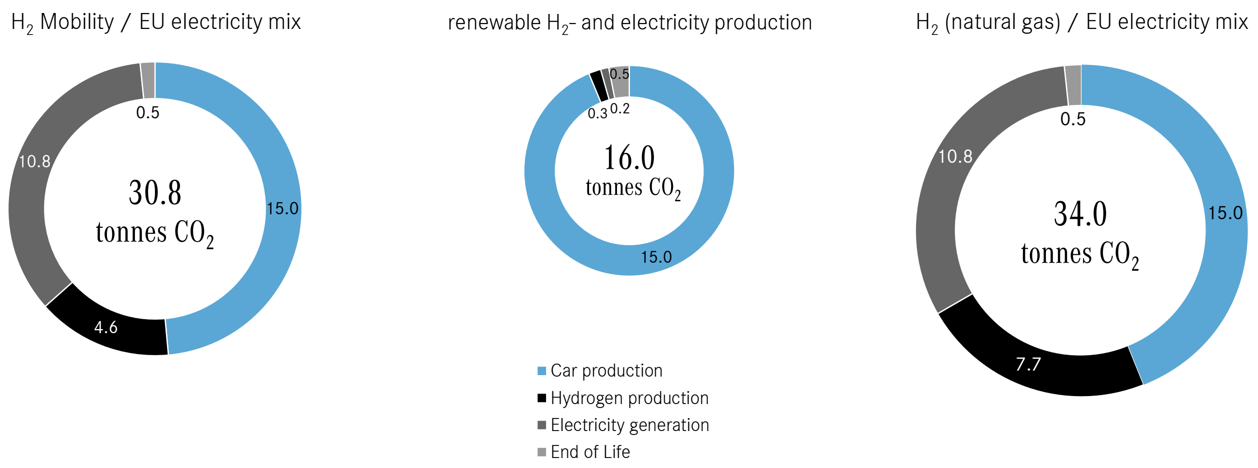
Two methods of hydrogen production were analysed: production from natural gas using the steam reformation process and production by electrolysis using hydroelectric power. The „H_2 Mobility“ scenario is based on a 50/50 mix of these two methods.

The greatest energy efficiency is achieved by the use of renewable power sources for hydrogen production (by electrolysis) and charging of the high-voltage battery. Over the vehicle‘s entire life cycle the analysis shows a primary energy requirement of 591 GJ, of which 235 GJ come from fossil resources and 357 GJ from renewable. If the fuel cell is operated with the H_2 Mobility hydrogen mix, and the EU power mix is used for external charging of the high-voltage battery, the GLC F-CELL has a primary energy requirement of 751 GJ.

The emissions: the carbon footprint over the life cycle

Hydrogen and electricity are crucial

It is of decisive importance for the CO_2 balance whether the hydrogen for the fuel cell and the power for external charging of the battery are produced from renewable or fossil sources.



Values are rounded

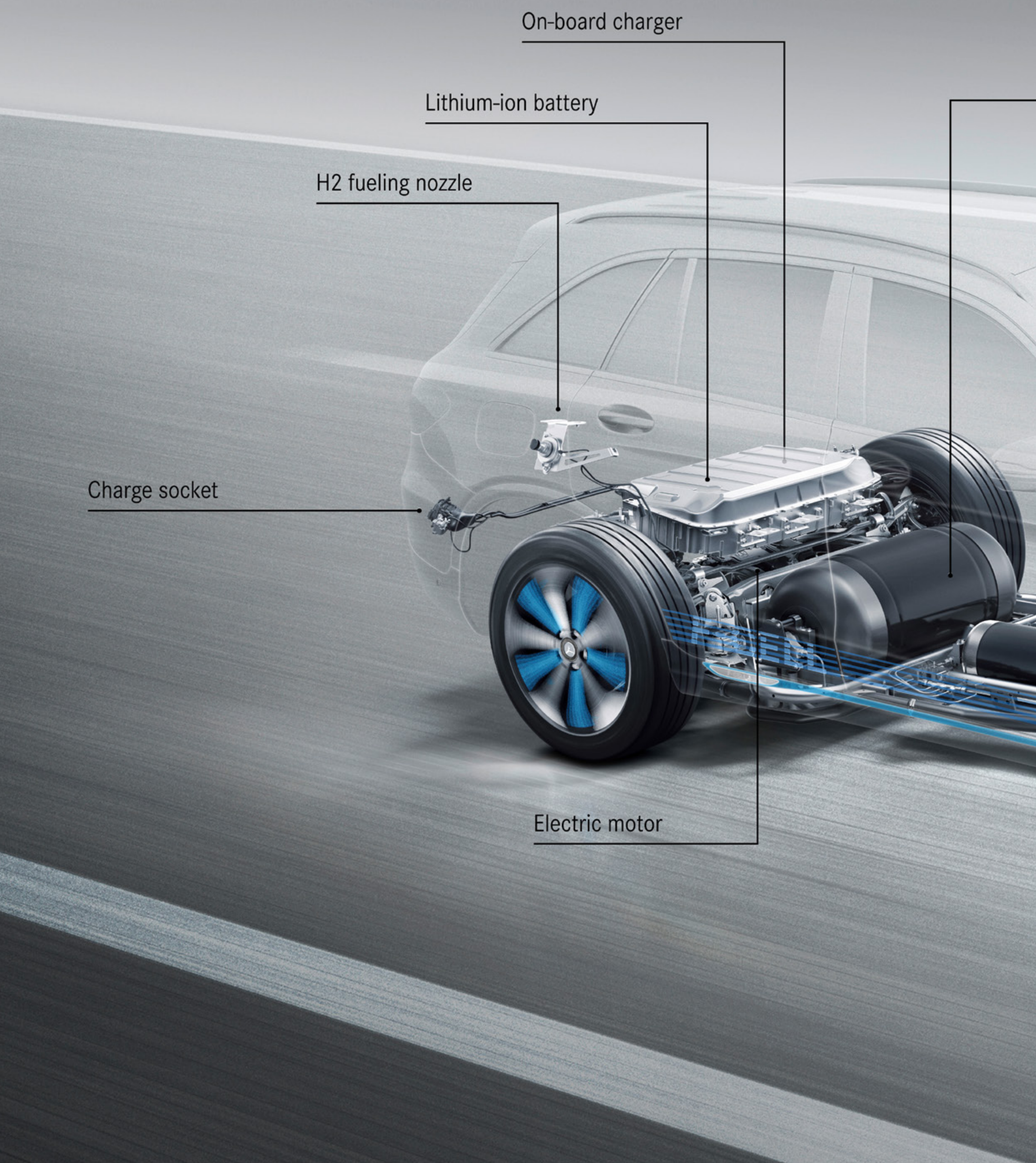
CO_2 emissions

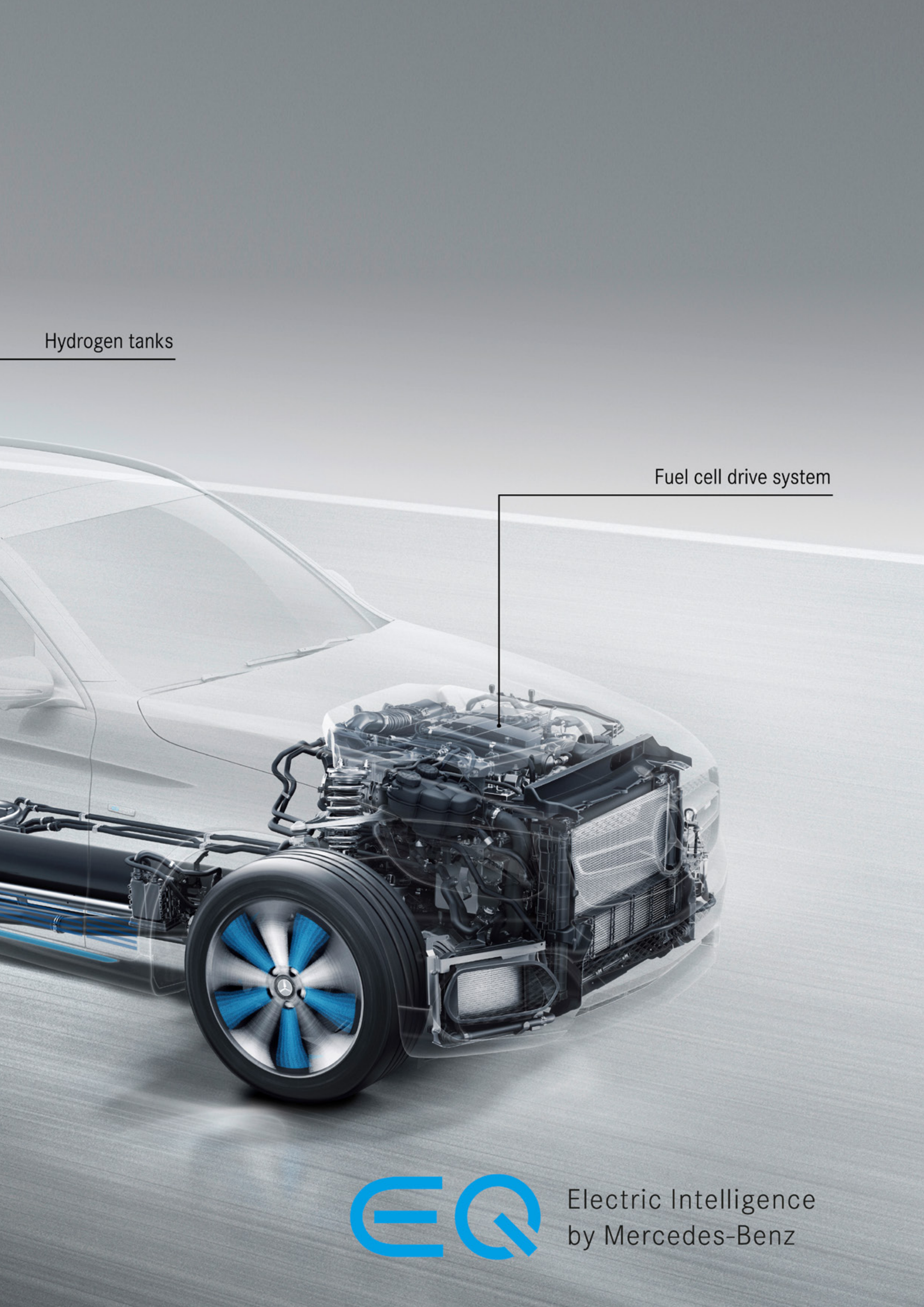
Analysis of the emissions during the individual phases of the life cycle makes it very clear: it is still the actual process of car operation that offers the greatest potential to reduce CO_2 emissions in particular. Incidentally, this is also an incentive for the driver to drive as efficiently as possible.

As more and more vehicles are turning to electric power, a further factor is becoming increasingly important: the generation of the electricity, especially for charging the batteries and the hydrogen production for the fuel cell. If generation takes place by renewable means using wind power or hydro power, CO_2 emissions can be reduced and almost kept to the level of car production. If the EU electricity mix is used for external battery charging, and the hydrogen is produced from natural gas, the GLC F-CELL emits a total of 34 tonnes of CO_2 over the entire life cycle. If the H_2 Mobility hydrogen mix (50% renewable) is used, the CO_2 emissions can already be reduced by 3.2 tonnes to 30.8 t. The use of power and hydrogen completely generated from renewable resources even makes a reduction to 16 tonnes of CO_2 possible.

X-ray view of Mercedes-Benz GLC F-CELL

The key components of the GLC F-CELL




Hydrogen tanks
Fuel cell drive system
Electric Intelligence
by Mercedes-Benz

Energy from the fuel cell

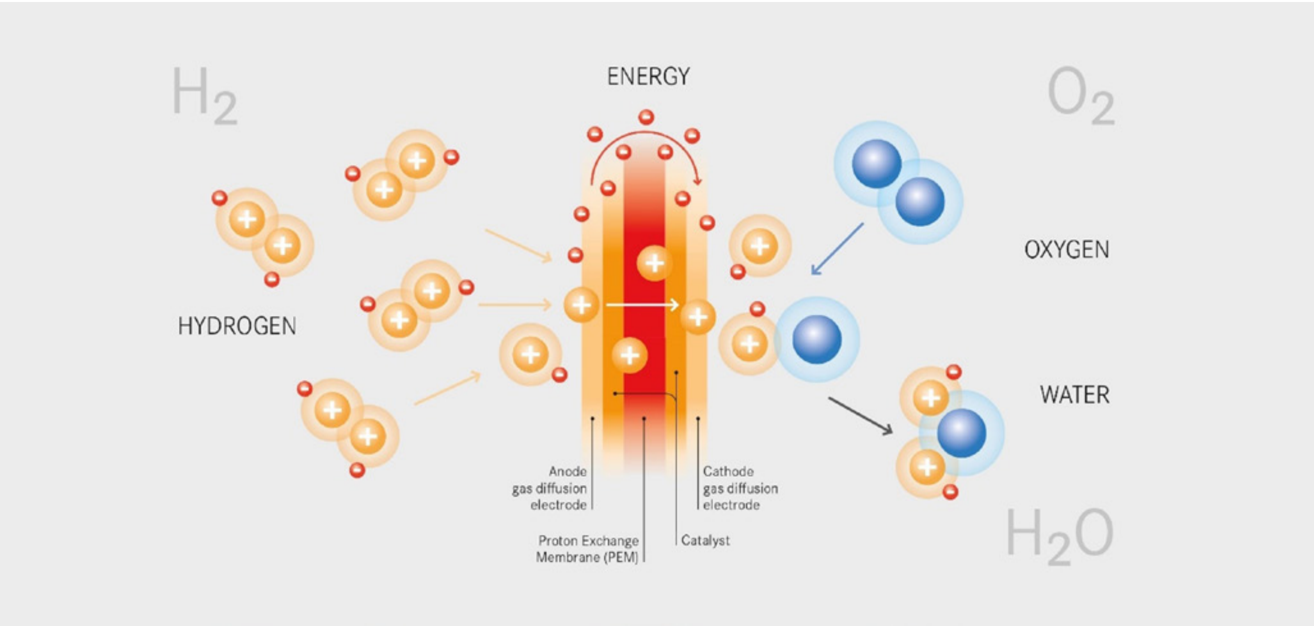
Simple principle with high efficiency

Compared to the preceding generation, the fuel cell system is 30 percent more compact, 40 percent more powerful and for the first time fits into a conventional engine compartment.

The PEM fuel cell is structured like a sandwich. In the centre is a thin plastic film, the Proton Exchange Membrane (or PEM). This membrane is coated on both sides with a thin catalyst layer and a gas permeable electrode made of graphite paper. The membrane is surrounded by two so called bipolar plates into which gas ducts have been milled. Through these gas ducts flows hydrogen on the one side, and oxygen on the other.

The catalyst breaks down the hydrogen atom into protons and electrons. The protons can penetrate the membrane but the electrons cannot. As a result, a voltage builds up between the two electrodes. If the two electrodes are then joined, a direct current is generated. Water and heat are created as by-products.

Several of these individual fuel cells can be stacked one behind the other to create a so-called fuel cell stack, thus forming a powerful energy source to drive the vehicle.



Continuous progress in the infrastructure

The network of hydrogen and electric filling stations is becoming denser

A full-coverage infrastructure is essential to the success of electric mobility. The spread of both charging stations and hydrogen filling stations is proceeding apace around the world.

Whether at home, at work, on the road or when shopping: there are various ways to supply electric vehicles with power. Also when it comes to the H_2 infrastructure, progress is constantly being made. Together with its partners in the H_2 Mobility joint venture, Daimler has already drawn up a concrete action plan. By the end of next year the H_2 filling station network is to be expanded from its current level of 51 to 100 stations. The partners' long-term objective is a network with up to 400 hydrogen refuelling stations.

Similar infrastructure projects are being promoted in Europe, the USA and Japan. The GLC F-CELL represent a world first in which a fuel cell operated electric car uses a lithium-ion battery as an additional energy source that can be externally charged by means of plug-in technology. There are various ways to supply this with power. The majority of charging will take place at home.

This is not only convenient but also quick with a wallbox, as the wallbox allows charging at up to 22 kW. Using the 7.4 kW onboard charger, the battery of the GLC F-CELL can be charged from 10 to 100 percent SoC (State of Charge) within around 1.5 hours if the entire output is used.

Facts and figures

Would you have known that ...

... the British legal expert and physicist Sir William Robert Grove (1811-1896) built the first fuel cell in 1839?
The idea is simple but ingenious: if the elements of hydrogen and oxygen are made to react with each other under controlled conditions, the process generates electrical energy. This is a direct chemical process which specialists also refer to as „cold combustion“. It was only over 120 years after Grove‘s breakthrough that the technology was adopted: in the 1960s the American space agency NASA was looking for an efficient energy system for the manned Gemini and Apollo missions.

... the development of the fuel cell powertrain already began at Daimler in the 1980s?
Back then, Daimler researchers for the first time studied cold combustion – the generation of electricity through the reaction of hydrogen with oxygen in a fuel cell. As a pioneer, Mercedes-Benz unveiled the first fuel cell vehicle with a polymer electrolyte membrane to the global public in 1994 – the NECAR 1. Many more vehicles followed, including the A-Class F-CELL test fleet (2003). In 2010 the B-Class F-CELL entered the market as the first fuel cell powered car manufactured under series production conditions. Since 2003 the Citaro FuelCELL Hybrid city bus has covered more than four million kilometres in regular service, with 23 buses currently undergoing trials in six European cities.

... the refuelling of fuel cell vehicles has already been standardised worldwide and for all manufacturers since 2002?
For a long time, the storage of hydrogen in vehicles was a tough nut for researchers to crack. In mid-2008, with the Mercedes-Benz A-Class F-CELL „plus“, Mercedes-Benz for the first time changed vehicles in its existing fuel cell fleet over from 350 to 700 bar tanking technology. This increased their range by around 70 percent. The breakthrough was achieved by multi-sector cooperation, not least within the Clean Energy Partnership. Since then, 700 bar technology has been the worldwide standard for all manufacturers.

... the Mercedes-Benz F-CELL World Drive in 2011 was the first circumnavigation of the globe by fuel cell powered vehicles?
During this event, three B-Class F-CELL vehicles drove more about 30,000 kilometres in 14 countries over the course of 125 days. In all, around 200 vehicles were built. They have so far covered more than ten million kilometres in customer operations and been refuelled 36,000 times during this period. On average this takes less than three minutes.

... the fuel cell system of the GLC F-CELL is not only able to power vehicles, but can also serve as a stationary energy provider?
Daimler, Hewlett Packard Enterprise (HPE) and Power Innovations are currently working on a pilot project in this field together with the National Renewable Energy Lab. For example, the IT company Hewlett Packard uses fuel cell technology for a computer centre in Colorado. Apart from supplying the computers with energy, this also combines the cooling circuits of the computers and fuel cell.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