Life cycle **COMPACT**

360° Environmental check Mercedes-Benz E-Class

Mercedes-Benz


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360° Environmental check Mercedes-Benz E-Class

Thanks to systematic electrification and intelligent downsizing, the new E-Class sets new standards in efficiency. Half of all models offered will be fourth-generation plug-in hybrids. The product range already achieves this proportion at market launch.

Electrification of the Mercedes-Benz portfolio has been progressing in leaps and bounds for some time. The goal of Mercedes-Benz Cars is to be all-electric by 2030 wherever market conditions allow. On the road to all-electric mobility, plug-in hybrids represent an important bridging technology.

Mercedes-Benz is consistently pursuing the goal of net CO_2 neutrality along the entire value chain in the new car fleet from 2039 onwards. By 2030, we want to reduce the CO_2 emissions per passenger car in the new car fleet by at least 50 % along all stages of the value chain compared to 2020. To achieve this goal, the key levers include: electrifying the vehicle fleet, charging with green energy, improving battery technology, an extensive use of recycled materials and renewable energy in production. By 2030, it is planned to cover 70 percent of the energy demand in our own Mercedes-Benz Cars production plants with renewable energies. This is to be achieved by expanding solar and wind energy at our own sites and by concluding further corresponding power purchase agreements.

In the life cycle of an electric vehicle, charging with electricity from renewable sources is an essential factor in reducing CO_2 emissions. Mercedes-Benz makes it possible for customers to enjoy the benefits of “Green Charging” at public charging stations in Europe, the USA and Canada. For Green Charging, green power certificates are used to ensure that an equivalent amount of electricity from renewable sources is fed into the grid to compensate for the charging processes via Mercedes me Charge.

In this brochure we briefly summarise the results of the Mercedes-Benz E-Class LCA for you.

By the way: this brochure is available for download from https://group.mercedes-benz.com/responsibility/sustainability/.

Mercedes-Benz E-Class powertrain

Systematic electrification and intelligent downsizing

Right from the market launch, three of the six E-Class versions combine the advantages of a vehicle with combustion engine with those of an electric car.

The combustion engines are four and six-cylinder units from the current modular Mercedes-Benz engine family FAME (Family of Modular Engines). Accordingly, the engine range plays a major role in the flexibility of the international production network, with needs-based electrification.

In addition to turbocharging, both the diesel and petrol engines feature intelligent support from an integrated starter-generator (ISG). They are therefore mild hybrids. Thanks to a new battery, the power of the electric motor has been increased from 15 to 17 kW and the boost torque to 205 Nm. The ISG uses a 48 volt on-board electrical system that ensures functions such as gliding, boosting or energy recovery, and makes significant fuel savings possible.

Mercedes-Benz will offer no less than three fourth-generation plug-in hybrid models from the market launch of the new E-Class. With an all-electric range of up to over 100 kilometres (WLTP)[1], the models will operate in all-electric mode in many cases – and on many days without using the combustion engine at all. More plug-in hybrids with diesel engines will follow.

The high-voltage (HV) battery has been developed in-house by Mercedes-Benz AG. It is supplied by the Mercedes-Benz location in Jawor (Poland). The battery energy content is 25.4 kWh. To account for the high energy density, the HV battery has an internal cooling system. The thermal management system can therefore control the operating temperature irrespective of the climate control in the vehicle interior. In addition to continuous operation in hot and cold regions, this also allows quick charging with direct current with the optional 55 kW DC charger. A standard-fit 11 kW charger (depending on the market) is available for three-phase charging at a Wallbox connected to the domestic AC mains.

[1] The range was determined on the basis of Regulation (EC) No. 2017/1151

The new plug-in hybrid models under the microscope

Latest hybrid technology and intelligent operating strategy

The high power density of the hybrid traction head is achieved using a permanently excited synchronous motor with internal rotor. The 440 Nm peak torque resulting in high agility when moving off, along with dynamic driving performance. The full electric power is available up to 140 km/h, at which point it is softly capped.

Based on the information from the route guidance of the navigation system, the hybrid driving programme provides the electric driving mode for the most appropriate route sections in each case. Electric driving is prioritised on journeys in urban areas, for example. The operating strategy takes into account factors such as navigation data, topography, speed limits and the traffic conditions for the entire planned route.

Two additional driving modes enable the driver to make particularly advantageous use of the plug-in powertrain: In the “BATTERY HOLD” program, priority is given to maintaining the charge state of the high-voltage battery, e. g. when intending to drive in a city centre or green zone later on. In the “ELECTRIC” program, these are electric driving up to 140 km/h and the adaptation of Active Distance Assist DISTRONIC for electric driving, the combustion engine is activated via the pressure point of the accelerator pedal.

The energy recovery function allows kinetic energy to be recuperated during deceleration or downhill driving. In “D^{Auto}” mode, the system automatically selects the level of recuperation power according to the traffic situation. A driver wishing to influence the energy recovery rate can do so directly in three stages controlled by rocker switches behind the steering wheel. In driving mode “D-“, for example, the driver can experience the "one-pedal feeling": when the driver's foot leaves the accelerator the vehicle slows down purely electrically, to an extent that the hydraulic service brake is often not needed.

The facts

The Mercedes-Benz E 300 e 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 E-Class with the E 300 e variant (WLTP: combined fuel consumption 0.8 – 0.5 l/100 km, combined CO_2 emissions 18 – 12 g/km, combined power consumption 20.7 – 18.4 kWh/100 km)[2,3] fares in the key areas of the comprehensive Life Cycle Assessment (LCA): consumption of resources and emissions.

[2] The stated figures are the measured "WLTP CO_2 figures" in accordance with Art. 2 No. 3 Implementing Regulation (EU) 2017/1153. The fuel consumption figures were calculated based on these figures. Power consumption [and range] have been determined on the basis of Regulation (EC) No. 2017/1151.

[3] Further information on the official fuel consumption and the official specific CO_2 emissions of new passenger cars can be found in the publication "Leitfaden über den Kraftstoffverbrauch, die CO_2-Emissionen und den Stromverbrauch neuer Personenkraftwagen" [Guide to fuel consumption, CO_2 emissions and electrical consumption of new passenger cars] which is available free of charge at all sales outlets and from Deutsche Automobil Treuhand GmbH at www.dat.de.

Plug-in hybrid drive:
Locally CO_2 emission-free driving while electrical operation with high vehicle range up to 118 km.

Efficient drive (figures according to WLTP)[2,3]:
Combined electrical consumption 20.7 – 18.4 kWh/100 km
Combined fuel consumption 0.8 – 0.5 l/100 km,
Combined CO_2 emissions: 18 – 12 g/km,
100 – 118 kilometers battery-electric range

Resource-efficient:
175 components with a total weight of 99 kilograms can be produced partially from less resource consuming materials (recycled plastics and renewable raw materials).

The resources: what is needed to produce a car

Achieve more with less

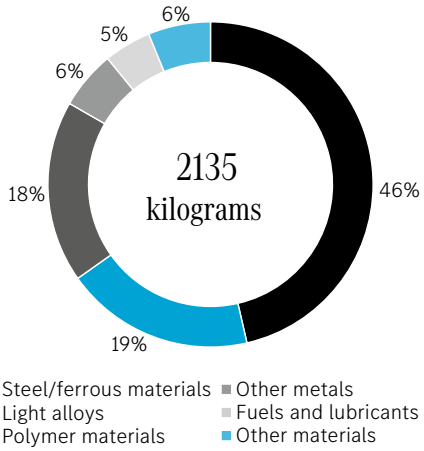
When it comes to the overall life cycle assessment, the E 300 e benefits from partly locally CO_2 emission-free operation and the high efficiency of the electrified powertrain.

Material resources

In the case of the E 300 e, steel and ferrous materials account for the largest share of the materials at 46 %. They are followed by light alloys at 19 %, polymer materials at 18 % and other metals (non-ferrous and special metals) at about 6 %. Fuels and lubricants account for around 5 %. The other materials (process polymers, electrics/electronics, etc.) account for around 6 %.

In production, the drive components of the plug-in hybrid E 300 e require a greater use of material and energy resources. The importance of the car production therefore increases compared to conventional combustion engines.

Mercedes-Benz E 300 e

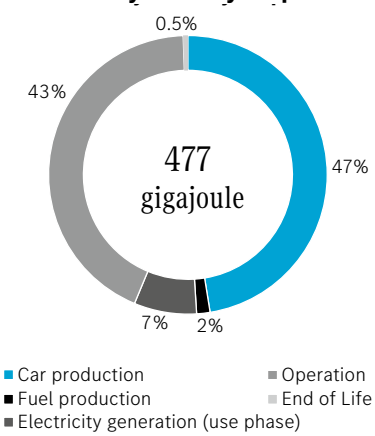


Energy resources

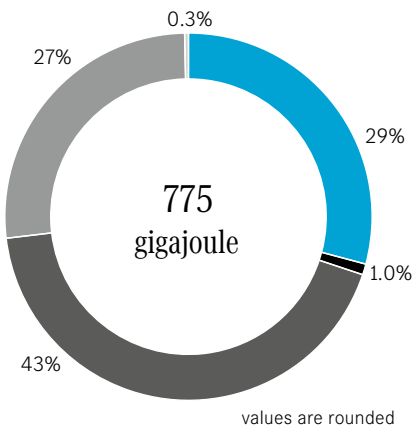
However, a comprehensive picture only emerges when the entire life cycle (material manufacturing, production, operation for 250,000 kilometres and end of life[4]) is examined. This is because during its operating phase, the E 300 e benefits from the high efficiency of the electrified powertrain.

For the analysis of the operation phase, two sources (electricity from hydropower and EU electricity mix)[5] for high-voltage battery external charging were examined. The higher energy efficiency can be achieved by the use of hydroelectric power[5]. Over the E 300 e entire life cycle the analysis shows a primary energy requirement of 477 GJ, of which 224 GJ come from fossil and 253 GJ from renewable resources. If the EU electricity mix[5] is used for the external charging of the high-voltage battery, the proportion of the primary energy demand for electricity generation increases visibly. Over the vehicle's entire life cycle, the primary energy requirement amounts to 775 GJ.

Electricity from hydropower



EU electricity mix



values are rounded

The materials used are not lost when this life cycle comes to an end. The valuable materials contained in high-voltage batteries can also be recovered to a large extent through targeted recycling. All in all, a recovery rate of 95 % is achieved for the E-Class according to ISO 22628.

[4] Not including scrap credits

[5] The LCA software and database (version: SP2023.01) by Sphera Solutions GmbH was used to carry out the life cycle assessment.

The emissions: the carbon footprint over the life cycle

It depends on the electricity mix

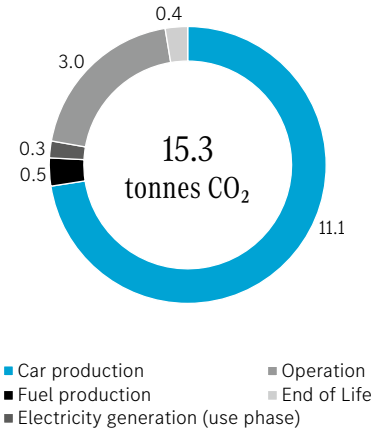
It is of decisive importance for the CO_2 balance, whether the power is produced from the renewable sources wind or hydro power, or whether the power mix forms the basis.

CO_2 emissions

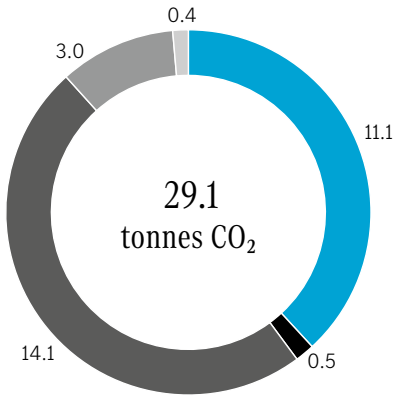
Analysis of the emissions during the individual phases of the life cycle makes it clear: As more and more vehicles are turning to electric power, two further factors are becoming increasingly important, the production of the high-voltage battery and the generation of the electricity for the external charging of the battery.

In E 300 e production, about a quarter of the CO_2 emissions are caused by the high-voltage lithium-ion battery and the battery peripherals. Furthermore, the vehicle bodyshell, the wheels/tyres and the entire powertrain contribute significantly to the CO_2 emissions of passenger car production. CO_2 emissions result primarily from the provision of energy for material production. This results in comparatively high values for components that have a large mass and are therefore material-intensive to manufacture. In addition to vehicle production, the choice of charging current in the use phase is a decisive factor for the overall carbon footprint. With the EU electricity mix the E 300 e emits a total of 29.1 tonnes of CO_2 over its life cycle (car production, driving over 250,000 km and end of life[6]). Of this, 11.1 tonnes are attributable to car production, 0.5 tonnes to fuel production, 14.1 tonnes to the generation of the charging current (EU electricity mix) and 3.0 tonnes to the driving. If renewable energy (electricity from hydropower) is used to charge the E 300 e, the life cycle CO_2 emissions can be almost halved (15.3 tonnes).

Electricity from hydropower



EU electricity mix



values are rounded

[6] Not including scrap credits

The charging

Mercedes me Charge

Mercedes me Charge gives customers access[7] to one of the world's largest charging networks. Currently, Mercedes me Charge includes more than 1,300,000 AC and DC charging points, of which more than 500,000 are in Europe.

The Mercedes me App shows the precise location, current availability, and price at the selected charging station in advance. This information can also be accessed via the navigation system in fully electric vehicles, and is used by the Navigation with Electric Intelligence to calculate a convenient and time-efficient route, including charging stops.

With the Mercedes me Charge Plug & Charge[8] function, charging at Plug & Charge-capable public charging points can be made even more convenient with the DC Charger option: when the charging cable is plugged in, the charging process starts automatically; no further authentication by the customer is required. The vehicle and the charging station communicate directly via the charging cable. Because a charging contract is stored in the system, each charging process is debited automatically – even abroad. The customer chooses the preferred payment method only once. The individual charging processes are clearly listed in a monthly invoice.

Mercedes me Charge makes it possible for customers to enjoy the benefits of green charging at public charging stations in Europe, the USA and Canada. For Green Charging, green power certificates are used to ensure that an equivalent amount of electricity from renewable sources is fed into the grid to compensate for the charging processes via Mercedes me Charge.

[7] In order to be able to use the Mercedes me connect service "Mercedes me Charge", a separate charging contract with a selected third-party provider is required, via which the charging processes are paid for and invoiced. The use of Mercedes me connect services requires a personal Mercedes me ID and consent to the Terms of Use for the Mercedes me connect services.

[8] In order to use Plug & Charge, on vehicles with the appropriate technical equipment you also have to activate the "Plug & Charge" service.

The charging infrastructure

Mercedes-Benz high-power charging stations

Mercedes-Benz to open its first high-power charging stations worldwide this fall. The long-term goal is to create more than 2,000 Charging Hubs with over 10,000 charging points by the end of the decade.

Mercedes-Benz announces far-reaching plans to launch a global high-power charging network. It will begin to be built this year in the US and Canada, followed by other regions around the globe. The Mercedes-Benz high-power charging network will greatly enhance customers' charging experience, accelerate the journey towards the all-electric future and create a global infrastructure asset with future value-creation potential.

The Mercedes-Benz charging hubs will be located in key cities and urban population centres, close to major arteries, convenient retail and service destinations, including participating Mercedes-Benz dealership sites. The company believes this strategic move will significantly enhance the usability and convenience of its new generation of electric vehicles and accelerate the EV transformation. The charging network will focus first and foremost on Mercedes-Benz customers, who will enjoy preferential access via a reservation function and other benefits. However, it will also be open to drivers of all other brands with compatible technology. In addition to the 1.3 million Mercedes me Charge charging points that are already accessible worldwide and the ongoing support of joint networks such as IONITY, this comprehensive initiative is also aimed at driving the global spread of electric mobility.

Holistic approach to battery value creation

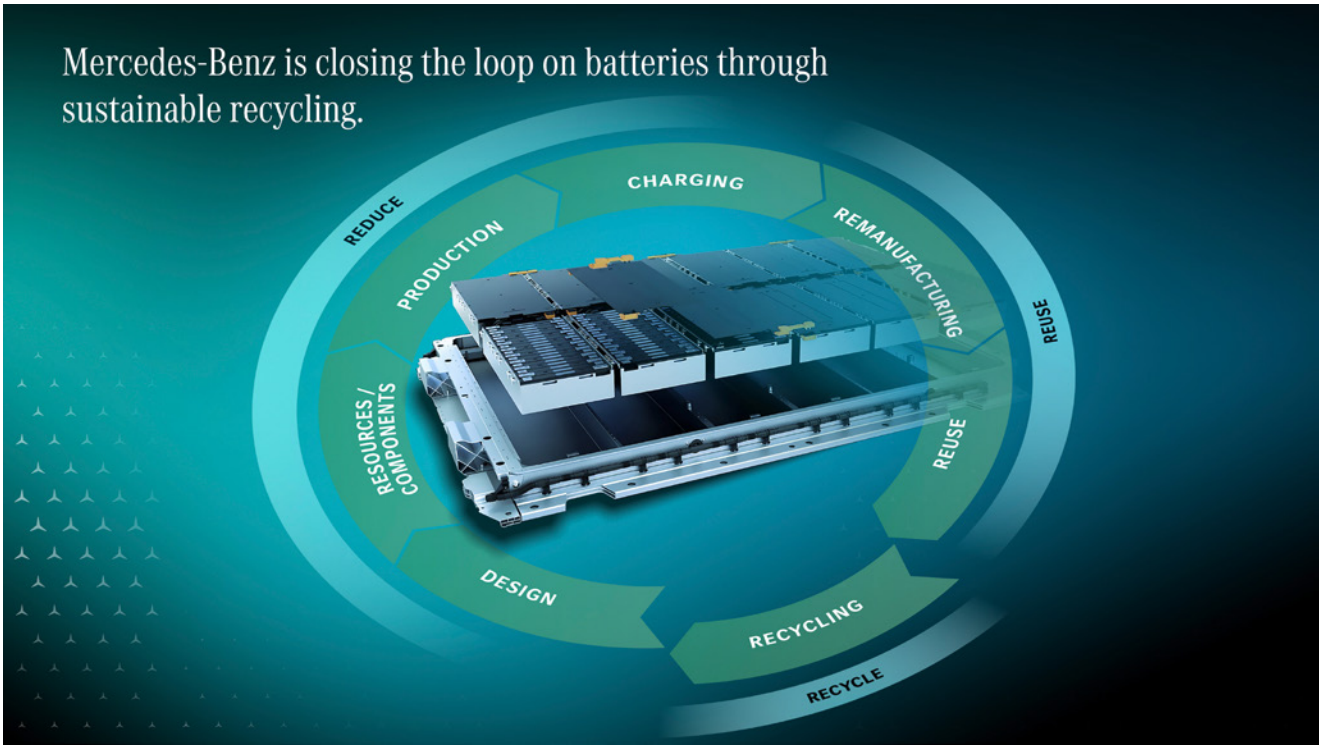
Battery recycling factory in Kuppenheim

Mercedes-Benz celebrates its groundbreaking ceremony for a new battery recycling factory at the Kuppenheim site in southern Germany. The first stage of the plant is scheduled to start ramping up at the end of this year.

Mercedes-Benz takes a holistic approach to the battery life cycle: Re-Use, Remanufacture, Recycle. Once the traction batteries of the Mercedes fleet reach the end of their life on the road, it's far from over. The company's focus is in particular on applications from the 2nd-life and replacement parts storage unit sector. Only then is it time for material recycling.

In view of the future return of lithium-ion battery systems from EQ vehicles, Mercedes-Benz is starting to build its own battery recycling factory based on hydrometallurgy in Germany.

In future, the Mercedes-Benz battery recycling factory in Kuppenheim will cover every step: From dismantling at the module level, to shredding and drying and processing of battery-grade materials. The hydrometallurgy process with a recovery rate of more than 96 percent enables a true circular economy of battery materials. Mercedes-Benz is cooperating with technology partner Primobius (joint venture of the German mechanical engineering company SMS group and the Australian project developer Neometals). As part of the overarching scientific research project, the entire process of battery recycling is also taken into account.



Usage of materials E-Class

Responsible resource utilisation

Closed-loop material cycles and the usage of renewable raw materials are the key levers for responsible resource utilisation.

Manufacturing vehicles requires a high degree of material usage. For this reason there is a developmental focus on further reducing the use of resources and the environmental impacts of the materials deployed. To this end, the use of less resource consuming materials such as recycled plastics and renewable raw materials in the vehicles is constantly being extended.

One example of a sustainable material in the new E-Class is MICROCUT microfibre. This consists of 45 percent recycled material. MICROCUT© is used for various interior trim parts. In the foam of the seats, certified recycled raw materials are used for the first time according to the “mass balance approach”, and their properties do not differ from those of raw materials produced from crude oil. In this way, the need for fossil resources can be reduced while maintaining product quality.

In the E-Class a total of 175 components plus small parts such as push buttons, plastic nuts and cable fasteners with a total weight of 99 kilograms can be produced partially from less resource consuming materials.

Facts and figures

LCA results

Input parameters

Material resources	**E 300 e (EU electricity mix)**	**E 300 e (electricity from hydropower)**	**Delta to E 300 e (EU electricity mix)**
Bauxite [kg]	1,766	1,762	-0.2 %
Dolomite [kg]	179	173	-3 %
Iron [kg]*	733	774	6 %
Non-ferrous metals (Cu, Pb, Zn) [kg]*	196	196	-0.3 %
* as elementary resoures			
Energy resoures			
ADP fossil [GJ]**	**375**	**203**	**-46 %**
Primary energy [GJ]	775	477	-39 %
Proportionately			
Lignite [GJ]	50	11	-78 %
Natural gas [GJ]	149	65	-56 %
Crude oil [GJ]	90	79	-13 %
Hard coal [GJ]	84	49	-42 %
Uranium [GJ]	160	20	-87 %
Other fossil resoures [GJ]	0.8	0.1	-81 %
Renewable energy resoures [GJ]	240	253	5 %
** CML 2001, as of August 2016			
ADP = abiotic depletion potential			

Output parameters

Emissions to air	**E 300 e (EU electricity mix)**	**E 300 e (electricity from hydropower)**	**Delta to E 300 e (EU electricity mix)**
GWP [t CO_2-equiv.]**	**31**	**16**	**-47 %**
AP [kg SO_2-equiv.]**	**110**	**79**	**-28 %**
EP [kg phosphate-equiv.]**	**11**	**7**	**-34 %**
POCP [kg ethene-equiv.]**	**17**	**15**	**-13 %**
CO_2 [t]	29	15	-47 %
CO [kg]	290	277	-4 %
NMVOC [kg]	24	22	-8 %
CH_4 [kg]	57	32	-44 %
NO_x [kg]	60	42	-29 %
SO_2 [kg]	58	44	-23 %
Emissions to water			
BOD (biological oxygen demand) [kg]	0.12	0.10	-19 %
Hydrocarbons [kg]	1.1	1.0	-9 %
NO_3- [kg]	5.4	1.9	-65 %
PO_4^{3-} [kg]	0.38	0.24	-38 %
SO_4^{2-} [kg]	58	30	-48 %
** CML 2001, as of August 2016			
AP = acidification potential, EP = eutrophication potential, GWP = global warming potential, POCP = photochemical ozone creation potential			

Validation

TÜV Rheinland Energy GmbH confirms that a critical review of the life cycle assessment (LCA) study and product-related environmental information of **Mercedes-Benz AG, Mercedesstraße 120, 70372 Stuttgart** for the following passenger car:

Mercedes-Benz E-Class – 2023 model year

was performed.

Proof has been provided that the requirements of the international standards

- ISO 14040:2006 + A1:2020: Environmental management – life cycle assessment – principles and framework
- ISO 14044:2006 + A1:2018 + A2:2020: Environmental management – life cycle assessment – requirements and guidelines
- ISO/TS 14071:2014: Environmental management – life cycle assessment – critical review processes and reviewer competencies: additional requirements and guidelines to ISO 14044
- ISO/TR 14062:2022: Integration of environmental aspects into product design and development.
- ISO 14020: 2000: General principles of environmental labeling and declarations and ISO 14021: 2016: Environmental supplier declarations (Type II environmental labeling).

are considered.

Results:

- The LCA study for the variants E 300 e and E 200 (basis of the environmental brochure) was carried out according to the international standards ISO 14040:2006 + A1:2020 and ISO 14044:2006 + A1:2018 + A2:2020. The methods used and the modelling of the product system correspond to the state of the art. They are suitable to fulfill the goals stated in the study. The report and environmental brochure are comprehensive and provides a transparent description of the framework of the study.
- The assumptions used in the LCA study especially fuel and energy consumption based on the current WLTP (Worldwide harmonized Light vehicles Test Procedure) were verified and discussed.
- The assessed samples of data and environmental information included in the LCA study and environmental brochure are plausible.

Review process and level of detail:

Verification of input data and environmental information as well as the check of the LCA process was performed in course of a critical data review. The data review considered the following aspects:

- Check of the applied methods and the product model,
- Inspection of technical documents (e.g. type approval documents, parts lists, supplier information, measurement results, etc.) and
- Check of LCA input data (e.g. weights, materials, fuel and energy consumption, etc.).

27th November 2023

Laura Lang
Sustainability and Carbon Services

for Sustainability and Carbon Services

bility for the content of the LCA rests with Mercedes Benz AG. TÜV Rheinland Energy GmbH was commissioned to mpliance with the methodical requirements, and to verify and validate the correctness and credibility of the information

Mercedes-Benz has published product-related environmental information since 2005, reflecting the results of environmentally compatible product development and verified by independent experts.

The brochures are made available to the wider public as the „Lifecycle“ series. They can be downloaded at https://group.mercedes-benz.com/responsibility/sustainability/.

As of: August 2023

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