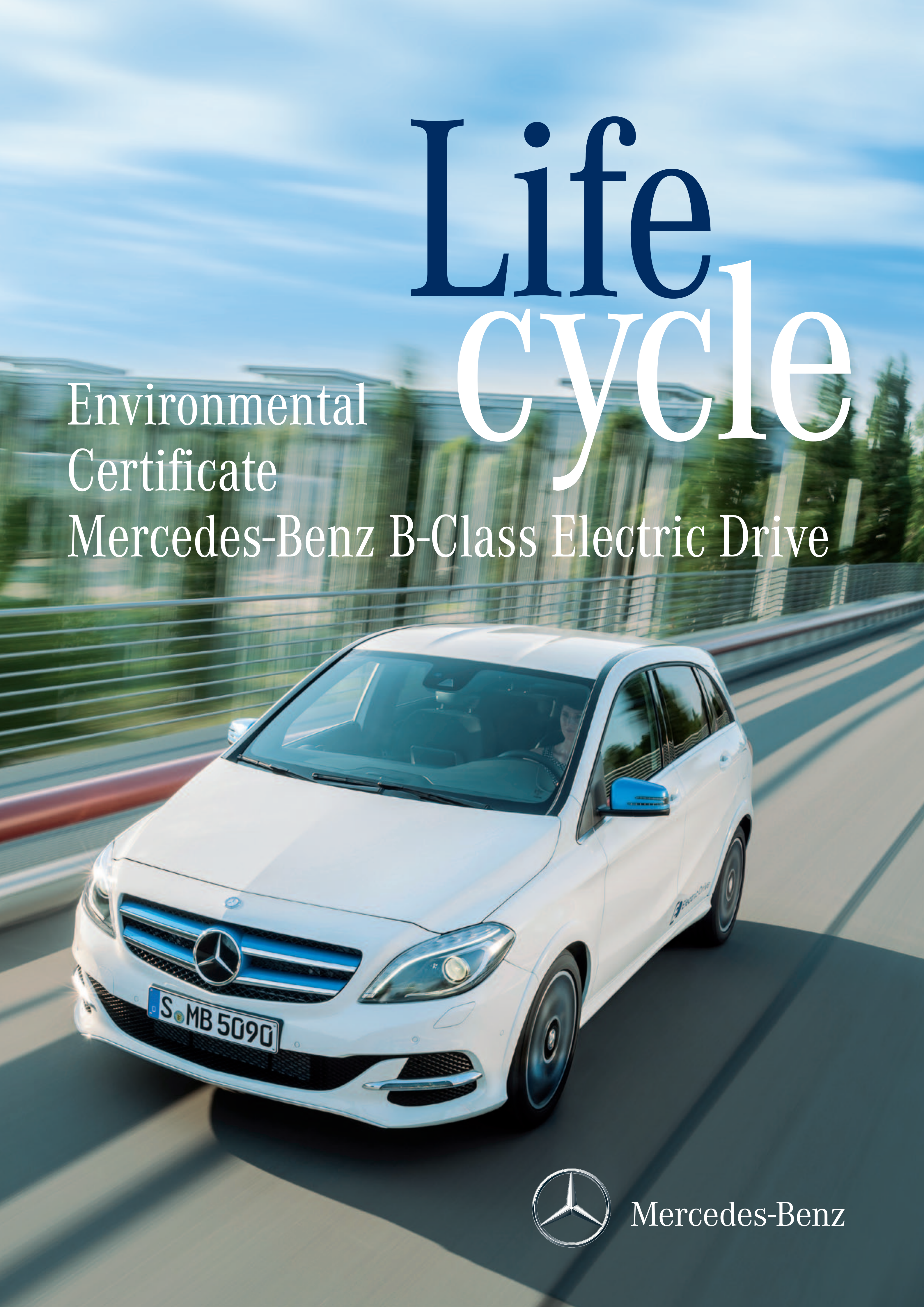
Life cycle

Environmental Certificate
Mercedes-Benz B-Class Electric Drive



Mercedes-Benz

Contents

As at: October 2014

Life cycle

Since the beginning of 2009, “Life Cycle” has been presenting the Environmental Certificates for Mercedes-Benz vehicles.

Above all the principal aim of this documentation series is to provide the best possible service to as many interested parties as possible: on the one hand, the wide-ranging and complex subject of the “car and the environment” needs to be communicated to the general public in a manner which is easy to understand. On the other hand, however, specialists also need to have access to detailed information. “Life Cycle” fulfils this requirement with a variable concept.

Those wanting a quick overview can concentrate on the short summaries at the beginning of the respective chapters. These summaries highlight the most important information in note form, while standardised diagrams also help to simplify orientation. If more detailed information on the environmental commitment of Daimler AG is required, clearly arranged tables, diagrams and informative text passages have also been provided. These elements describe the individual environmental aspects in meticulous detail.

With its service-oriented and attractive “Life Cycle” documentation series, Mercedes-Benz is once again demonstrating its pioneering role in this important area – just as in the past, when in 2005 the S-Class became the very first vehicle to receive the Environmental Certificate from TÜV Süd (South German Technical Inspection Authority). This issue of “Life Cycle” sees Mercedes-Benz breaking new ground once again, documenting all relevant environmental aspects of an electric vehicle in comprehensive form by reference to the example of the B-Class Electric Drive.

Interview

“Milestone
on the road to zero emissions”

Interview with Professor Dr Herbert Kohler, Chief Environmental Officer, Daimler AG

Professor Kohler, what is special about the B-Class Electric Drive?

The integration of an electric drive and batteries into a totally “normal” B-Class means that we are able to build the Electric Drive with the other B-Class vehicles on one and the same line, in addition to which our customers are not required to make any compromises in terms of spaciousness, safety or comfort. We have furthermore provided the B-Class Electric Drive with a sophisticated energy management system: radar sensors support optimum recuperation – that is, the feedback of braking energy into the battery, for example. This further enhances the efficiency of the drive system and enables even greater ranges.

How does the B-Class Electric Drive fit into Mercedes-Benz’s long-term drive strategy?

Our long-term goal is motoring with zero CO_2 emissions. Our road to emission-free driving is founded on three pillars: we are continually improving our high-tech combustion engines. At the same time, we are electrifying our product portfolio step by step – from systematic hybridisation through to electric drive systems with battery and fuel cell. The B-Class Electric Drive is an important milestone along this road.

And how is an electric vehicle such as the B-Class to be categorised when compared with hybrid vehicles?

While hybrid drive comes into its own in larger vehicles and with mixed route profiles, battery-powered cars are at their most impressive in an urban environment. Our smart – the quintessential city car – was conceived as an electric car from the outset. The smart fortwo electric drive has been on the roads in major European cities since 2007, when others still had no concept whatsoever of electric cars. Since 2012 it has been performing impressively in its third generation, leading the German market year after year. With the electric B-Class, we are now following up this success story with a five-door and five-seater model.

What hurdles still remain to be overcome in order to attain broad acceptance for electric vehicles?

The many smart fortwo electric drives which are available to everyone as part of the car2go programme show that people need to be able to see and experience electric mobility if we are to arouse the interest of potential customers. This is one reason why we are involved in numerous projects, such as the “LivingLab BWe mobil” research initiative, one of four showcase regions in Germany.
In one project we are getting our workforce electrically mobile in and around Stuttgart: with “charge@work”, Daimler is providing a total of 260 electric vehicles for business and private journeys. This project centres on developing the charging infrastructure. Over 170 charging points at five Daimler plants in Stuttgart provide an ideal basis for integrating emission-free mobility into everyday life. Charging is simpler than refuelling: users simply park up and hook up to the power – and charge up during their working hours.

Another example is “GuEST”, a joint project examining the use of electric taxis in Stuttgart. Four Mercedes-Benz B-Class Electric Drives and one Vito E-CELL are on the road in Stuttgart as electric taxis with the aim of developing a viable business model for the use of electric cars as taxis. At ten trips a day, the five electric taxis clock up at least 15,000 trips annually. This is also a means of bringing people into contact with the topic of electric mobility for the first time.

So electric mobility is actually well set up. The cars are available, the underlying conditions are gradually improving. In Germany in particular, business with electric cars is nevertheless proving slow to take off. Why is that?

It is going to be difficult to achieve the German government’s proclaimed target of a million electric cars in Germany by 2020. I would like to see an objective debate as soon as possible about other incentives - including financial options. Special rights for electric vehicles and plug-in hybrids, such as the use of bus lanes, preferred parking amenities or tax exemptions, are also good ideas. In my view that is not enough, however. It is worth looking abroad here, as some countries are putting together some highly attractive packages in this area. I am convinced that such measures are the only way of persuading substantially more customers to switch to electric cars in the short and medium term.

Product description

Electric motoring with no compromises

With its torquey electric motor, the B-Class Electric Drive offers lively and effortlessly superior fun at the wheel over a range of around 200 kilometres – all locally emission free.

The new B-Class Electric Drive surprises with an especially dynamic driving experience: it provides noticeably powerful acceleration and glides almost silently along country roads. The new electric Mercedes offers the driver and up to four passengers the familiar high standards of ride comfort in a high-class, spacious and precision-designed interior. The B-Class Electric Drive combines dynamism and driving pleasure with zero local emissions.

Quiet and local emission-free driving is ensured by a 132 kW electric motor which, as is typical of an electric drive, delivers its maximum torque of 340 Nm straight from idle state. This is approximately equivalent to the torque from a modern three-litre naturally aspirated petrol engine. The result is noticeably powerful acceleration from rest. For the standard sprint from zero to 100 km/h, the electrically powered B-Class requires only 7.9 seconds. Effortlessly superior driveability and exhilarating driving pleasure with a high level of dynamism are thus guaranteed in every situation.

The highlights of the new B-Class Electric Drive

- Powerful electric drive with output of 132 kW.
- Range of 200 km, RANGE PLUS as optional extra for an additional 30 km of range.
- Choice of three driving programmes (Economy+, Economy and Sport).
- Radar-based recuperative braking system (optional extra).
- ENERGY SPACE: Underfloor compartment to accommodate the batteries.
- Spacious body with five seats and large luggage compartment.
- Numerous driving assistance systems, including advanced COLLISION PREVENTION ASSIST PLUS.
- Convenient pre-heating and cooling as standard.

According to whether the driver wishes to drive economically or perhaps with more emphasis on comfort or sportiness, there is a choice of three driving programs.

Overview of the driving programmes

- E+ (Economy Plus):

This driving mode is configured for a defensive driving style and lends itself to driving at a constant, steady speed. The output here is reduced to around 65 kW, whereby the top speed falls to around 110 km/h on the flat. With kickdown, however, an output of 132 kW and a top speed of up to 160 km/h remain available.

- E (Economy):

The philosophy here is a comfortable driving experience. The output is restricted to 98 kW, although of course even in this driving program, kickdown will summon up as much as 132 kW.

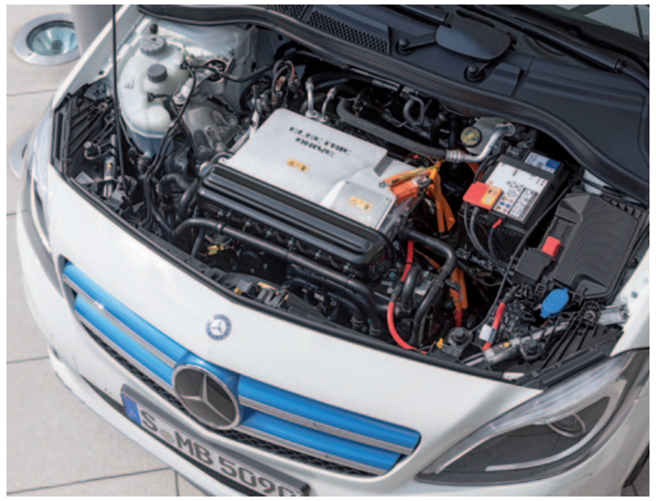
- S (Sport):

Maximum output for maximum acceleration is the motto behind this mode, configured for sporty driving. Accordingly, the engine can call upon 132 kW.

Range sufficient for everyday use, audible warning system

In the interests of optimising the range, the top speed is electronically limited to 160 km/h. Depending on the driving cycle, the vehicle has a range of around 200 kilometres.

This permits emission-free motoring not just in city traffic and on short journeys, but also over longer distances – such as those covered by many commuters on a daily basis.



The instrumentation of the B-Class Electric Drive is rounded off by functions that are specific to electric vehicles

One of the striking features is the power display in the right-hand circular instrument. When full power is demanded by the driver, the instrument pointer moves in a clockwise direction from the green zone towards the red zone, dropping back below the zero line when the vehicle is feeding energy into the battery through the recuperation feature.

As protection for pedestrians and cyclists, a specific Mercedes-Benz sound is generated (optional extra) at speeds of up to 30 km/h. Once over 30 km/h this is no longer necessary, as wind and tyre noise then begin to dominate.

Radar support provided as an option: intelligent recuperation

On the road, the electric drive makes its own contribution to a favourable energy balance by recovering energy under overrun conditions as well as by converting the kinetic energy produced during braking into electric power and feeding it to the battery. This process is controlled through the energy management system. The level of recuperation and thus of drag deceleration can be influenced by the

driver via the brake pedal (approx. 10 % of pedal travel). The potential recuperation performance depends, among other factors, on the state of charge and the temperature of the high-voltage battery.

Particularly effective energy recovery and thus an extension of the vehicle’s range are made possible with the optional extra of a radar-supported, recuperative braking system. The system also supports the driver in controlling proximity and speed.

The system uses the data from the radar sensors of COLLISION PREVENTION ASSIST PLUS to increase or reduce to zero, as appropriate, the level of recuperation and thus of deceleration.

If the system detects a slow-moving or slowing vehicle ahead, it triggers an increase in recuperation torque and thus a reduction in speed. If, on the other hand, any vehicle it detects is far in the distance or accelerating away, the vehicle will switch into energy-saving “sailing” mode, without recuperation.

This is particularly useful in town or on fast roads with a slight downhill incline. When driving downhill in “sailing” mode or on a steep slope, an increase in recuperation will restrict acceleration. The effect here is comparable to changing down a gear. In conjunction with COMAND, the

The “Charge&Pay for Mercedes-Benz” app enables B-Class drivers to locate available charging points and to control the charging and billing process.

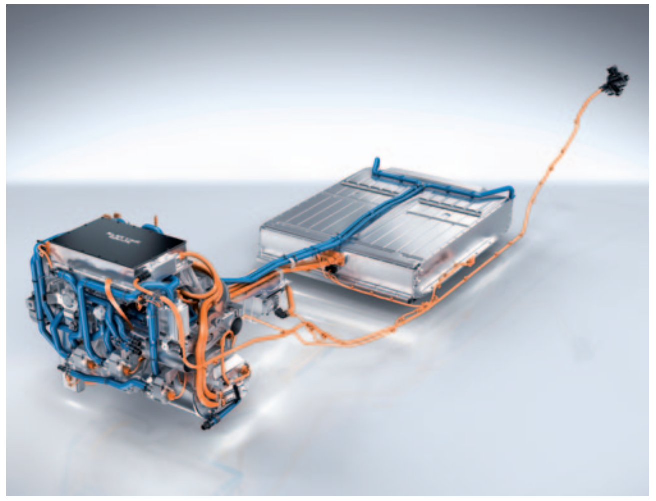
control functions are extended to take account of information supplied by the traffic sign recognition system as well as of speed limits stored in the navigation system. The steering-wheel gearshift paddles included with this optional equipment item also enable the driver to switch between four different stages of regeneration - from coasting to high regeneration.

Recuperation with a sporty accelerator pedal curve.
The following four recuperation stages are available:

- D+: “sailing” mode, no recuperation
- D: moderate recuperation
- D–: high recuperation
- DAuto: recuperation according to the traffic conditions

Quick charging; RANGE PLUS range extension optionally available

The power supply to the electric drive comes from a high-performance lithium-ion battery (capacity 28 kWh), which is compactly and securely fitted in the underfloor area between the front and rear axles, known as the ENERGY SPACE. The charger for the battery is located in the engine compartment. Charging is as straightforward as refuelling. Once the socket flap has been opened, the charging cable is connected to the vehicle and the power source, for example to a domestic socket, a public charging point or



a wallbox. With the latter, a full recharge of the battery is possible in just three hours or so (400 V, 3-phase, 16 A). Using a normal domestic socket (230 V, single-phase) it is normally possible to recharge the B-Class Electric Drive overnight. With 16 A circuit protection, this only takes about 9.1 hours.

The control light on the vehicle socket will remain illuminated throughout the charging process. The vehicle cannot be started or moved during this phase. Information about the current state of charge is shown in the multifunction display. Following completion of the charging process, the charging cable may be removed.

The optional RANGE PLUS extends the range of the vehicle by as much as 30 km. Pressing the RANGE PLUS button in the upper control panel extends the chargeable capacity of the battery the next time it is charged, i.e. more capacity is released. As over-frequent use of this function can reduce the lifespan of the battery more quickly, it should only be used when a long trip is planned or when there is only limited availability of charging points.

Each battery is certified by Mercedes-Benz as a guarantee of performance. This ensures that any technical malfunction within a period of eight years after initial delivery or registration, or up to a mileage of 100,000 kilometres, will be corrected by Mercedes-Benz.

The battery package is housed compactly in the Energy Space under the floor of the vehicle, while the electric drive unit is accommodated in the unmodified engine compartment. The 132 kW electric motor drives the front wheels.

Convenient pre-heating or cooling as standard

The thermal management system of the B-Class Electric Drive encompasses on the one hand the air conditioning for the vehicle interior and on the other hand the cooling of the electric drive. This ensures that all components perform to full efficiency even on long uphill inclines or in high outside temperatures. The high-voltage battery is cooled via a low-temperature circuit. At very high temperatures this can be boosted by the coolant circuit of the air-conditioning system. For low temperatures, a battery heater is available.

For heating and cooling of the interior, the B-Class Electric Drive is equipped as standard with THERMOTRONIC automatic climate control. This uses a high-voltage PTC heater and a high-voltage air conditioning compressor. Using “Mercedes connect me”, the driver can pre-heat or pre-cool the vehicle – depending on the temperature – in readiness for an individually defined departure time.

Body with “ENERGY SPACE”

Thanks to the “ENERGY SPACE” modular concept, the B-Class was designed from the start with the need to accommodate alternative drive systems in mind: various interface points in the bodyshell make it possible to modify the main floor for the versions with alternative drive and to exploit use of a partial double floor beneath the rear bench seat. The lithium-ion battery of the B-Class Electric Drive is accommodated in this underfloor. Due to this intelligent packaging method, the five-seater model has been able to retain the generously proportioned luggage compartment for which it is known.

Aesthetic and individual design

The exterior design of the B-Class Electric Drive combines refined sportiness and aesthetics with powerful, taut lines. When it comes to the finer details, it differs in design from the petrol and diesel models – particularly in the shaping of the front and rear aprons and the side skirts.

The interior of the B-Class is individual, exclusive and modern. This is demonstrated by the large free-standing head unit display, for example, which is optionally available with a screen diagonal of up to 20.3 cm, and in the elegant design of the dials in the instrument cluster. The chronograph look features a black dial, four illuminated red pointers and impressive typography.

The two equipment lines that the B-Class Electric Drive shares with its conventional siblings go by the name of Style and Urban. The Electric Art equipment line is an additional option.

On making its debut, the B-Class redefined the standard of safety in the compact class with its numerous new driver assistance systems, some of them included as standard equipment. These functions have now been enhanced and new assistance systems added to give the driver even more support.

The standard-specification COLLISION PREVENTION ASSIST PLUS extends the functionality of COLLISION PREVENTION ASSIST (radar-based distance warning and braking assistance in the form of Adaptive Brake Assist) with the addition of autonomous braking to reduce the risk of rear-end collisions.

The drowsiness detection system ATTENTION ASSIST (standard) has been similarly upgraded: operating within an extended speed range (60 - 200 km/h), it now uses a five-stage bar display to visualise the driver’s current attention level. The optional Intelligent Light System adapts automatically to the prevailing weather, light and driving conditions and, by improving visibility, also enhances safety.

“Mercedes connect me” connects the B-Class with the world around it. Basic Mercedes connect me services can be used with the standard communications module. Available services include, for example, Accident Recovery, Maintenance Management and Breakdown Management. Mercedes connect me services are even more extensive for the B-Class Electric Drive: for added convenience, for example, connect.mercedes.me can be used remotely to determine the current state of charge of the lithium-ion battery or the possible range of the vehicle.

Validation

TÜV SÜD
Management Service

Validation:

The **following report** gives a comprehensive, accurate and appropriate account on the basis of reliable and reproducible information.

Mandate and basis of verification:
The following environmental product information of Daimler AG, named as „Environmental-Certificate Mercedes-Benz B-Class Electric Drive“ was verified by TÜV SÜD Management Service GmbH. If applicable, the requirements outlined in the following directives and standards were taken into account:

- EN ISO 14040 and 14044 regarding life cycle assessment (principles and general requirements, definition of goal & scope, inventory analysis, life cycle impact assessment, interpretation, critical review)
- EN ISO 14020 (environmental labels and declarations – general principles) and EN ISO 14021 (criteria for self-declared environmental claims)
- ISO technical report ISO TR 14062 (integration of environmental aspects into product design and development

Independence and objectivity of verifier:
TÜV SÜD Group has not concluded any contracts regarding consultancy on product-related environmental aspects with Daimler AG either in the past or at present. TÜV SÜD Management Service GmbH is not economically dependent or otherwise involved in any way with the Daimler AG.

Process and depth of detail of verification:
Verification of the environmental report covered both document review and interviews with key functions and persons in charge of the design and development of the B-Class Electric Drive.
Key statements included in the environmental information, such as weight, emissions and fuel consumption were traced back to primary measuring results or data and confirmed.
The reliability of the LCA (life cycle assessment) method applied was verified and confirmed by means of an external critical review in line with the requirements of EN ISO 14040/44.

TÜV SÜD Management Service GmbH

Munich, 2014-10-13

Dipl.-Ing. Michael Brunk	Dipl.-Ing. Ulrich Wegner Head of Certification Body
Environmental Verifier	Environmental Verifier

Responsibilities:
Full responsibility for the contents of the following report rests with Daimler AG. TÜV SÜD Management Service GmbH had the task to review the available information for correctness and credibility and validate it provided the pertinent requirements were satisfied.

1 Product documentation

This section documents significant environmentally relevant specifications of the new B-Class Electric Drive referred to in the statements on general environmental topics (Chapter 2.1).

The detailed analysis of materials (Chapter 1.2), Life Cycle Assessment (Chapter 2.2), and the recycling concept (Chapter 2.3.1) refer to the B-Class Electric Drive with standard equipment.

1.1 Technical data

The following table documents key technical data of the new B-Class Electric Drive and the B 180 petrol variant with which it is compared in the Life Cycle Assessment. The relevant environmental aspects are explained in detail in the environmental profile in Chapter 2.

Characteristics	B-Class Electric Drive	B 180
Type of motor/engine	Electric motor	Petrol engine
Number of cylinders	–	4
Displacement (effective) [cc]	–	1595
Output [kW]	132	90
Emissions standard (met)	EU 6	EU 6
Weight (without driver and luggage) [kg]	1650	1320
		1350**
Exhaust gas emissions [g/km]		
CO_2	–	134 – 129
		129 – 125**
NO_X	–	0.013
		0.012**
CO		0.101
	–	0.177**
HC (for petrol engine)	–	0.044
		0.041**
Particulate matter	–	0.0001
	–	0.0003**
Particle number	– –	2.3 E 11
	–	4.4 E 11**
NEDC fuel consumption, combined	17.9 – 16.6*	5.8 – 5.6
[kWh resp. l/100 km]		5.5 – 5.4**
Electric operating range in acc. with NEDC [km]	200*	–
Driving noise [dB(A)]	68	74
		73**

* NEDC consumption, B-Class Electric Drive ECE base variant: 16.6 kWh/100 km

** Values with dual clutch transmission

1.2 Material composition

The weight and material data were determined on the basis of internal documentation of the components used in the vehicle (parts list, drawings). The “kerb weight according to DIN” (without driver and luggage) served as a basis for the recycling rate and Life Cycle Assessment. Figure 1-1 shows the material composition of the B-Class Electric Drive in accordance with VDA 231–106.

Steel/ferrous materials account for around half of the vehicle weight (51.4 percent) in the new B-Class Electric Drive, followed by polymer materials with around 17 percent and light alloys (12.8 percent) as the third largest group. The shares of other materials (primarily glass and graphite) and non-ferrous metals stand at 5.9 and 5 percent respectively. Precious metals make up around 4 percent. Service fluids comprise around 2.4 percent. The remaining materials – process polymers and electronics – contribute about 1.5 percent to the weight of the vehicle. In this study, the material class of process polymers largely comprises materials for the paint finish.

The polymers are divided into thermoplastics, elastomers, duromers and non-specific plastics, with thermoplastics accounting for the largest proportion, at 11 percent. Elastomers (predominantly tyres) are the second-largest group of polymers, at 3.6 percent.

The service fluids include oils, coolant, refrigerant, brake fluid and washer fluid. Only circuit boards with components are included in the electronics group. Cables and batteries are categorised according to their material composition.

A comparison of the B-Class Electric Drive with the petrol variant reveals marked differences in the materials mix. As a result of the alternative drive components, the proportion of steel in the B-Class Electric Drive is around 8 percent lower, for example, while the shares of light alloys and non-ferrous metals are each approx. 3 percent higher and the share of precious metals is approx. 4 percent higher than for the petrol variant. The share of service fluids is almost 2 percent lower, due to the absence of fuel.

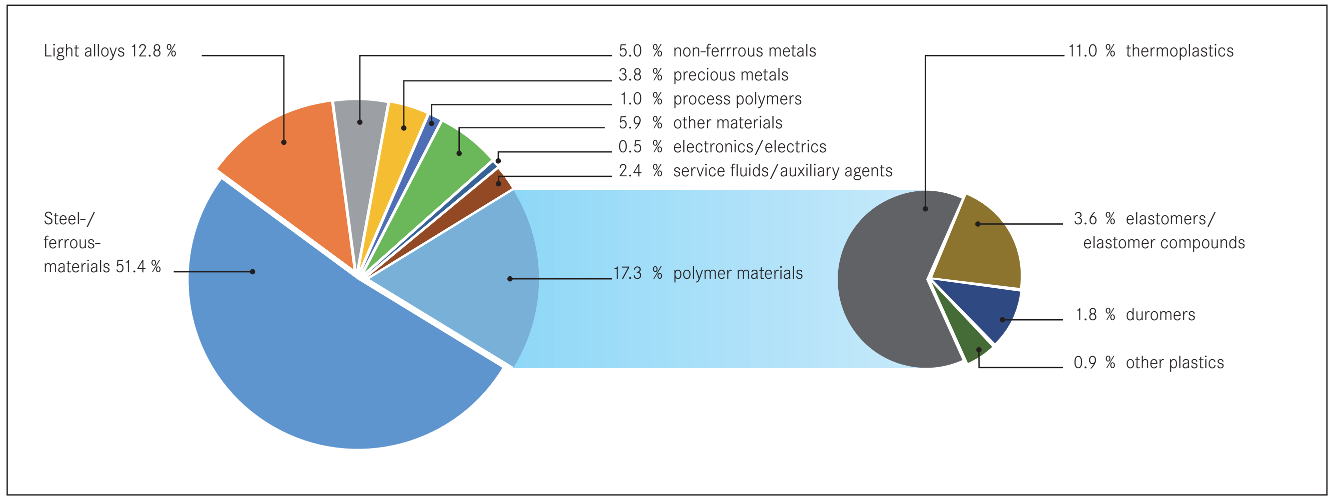


Figure 1-1: Material composition, B-Class Electric Drive

2 Environmental profile

The environmental profile documents general environmental features of the B-Class Electric Drive with regard to such matters as energy consumption and local emission-free driving. It also presents specific analyses of environmental performance, such as the Life Cycle Assessment, the recycling concept and the use of secondary and renewable raw materials.

2.1 General environmental issues

Local emission-free driving

- The B-Class Electric Drive produces no emissions while on the road.
- Total emissions are dependent on the mode of electricity generation.
- ENERGY SPACE means that there are no space restrictions.
- Production takes place together with the other vehicles of the B-Class family.
- Safety and comfort are on the same high level as its sister models.

Electric vehicles are a key element of the Mercedes-Benz strategy for sustainable mobility. In addition to high energy efficiency, the new B-Class Electric Drive now also offers the possibility of local emission-free driving. It is based on the B-Class with conventional engine.

Quiet, local emission-free motoring is ensured by an electric motor generating 132 kW. Typically for an electric drive system, this develops its maximum torque of more than 340 newton metres from the very first touch of the accelerator. The power supply to the electric drive is from a high-performance lithium-ion battery, which is compactly and safely housed in the so-called "ENERGY SPACE" in the underfloor of the vehicle. Such intelligent packaging allows the five-seater to retain the B-Class's familiar spaciousness in both its interior and its luggage compartment.

In the interests of optimising the range, the top speed is electronically limited to 160 km/h. Depending on the driving cycle, the vehicle has a range of around 200 kilometres. This permits emission-free motoring not just in city traffic and on short journeys, but also over longer distances - such as those covered by many commuters on a daily basis. The B-Class Electric Drive can be charged from any standard domestic power socket.

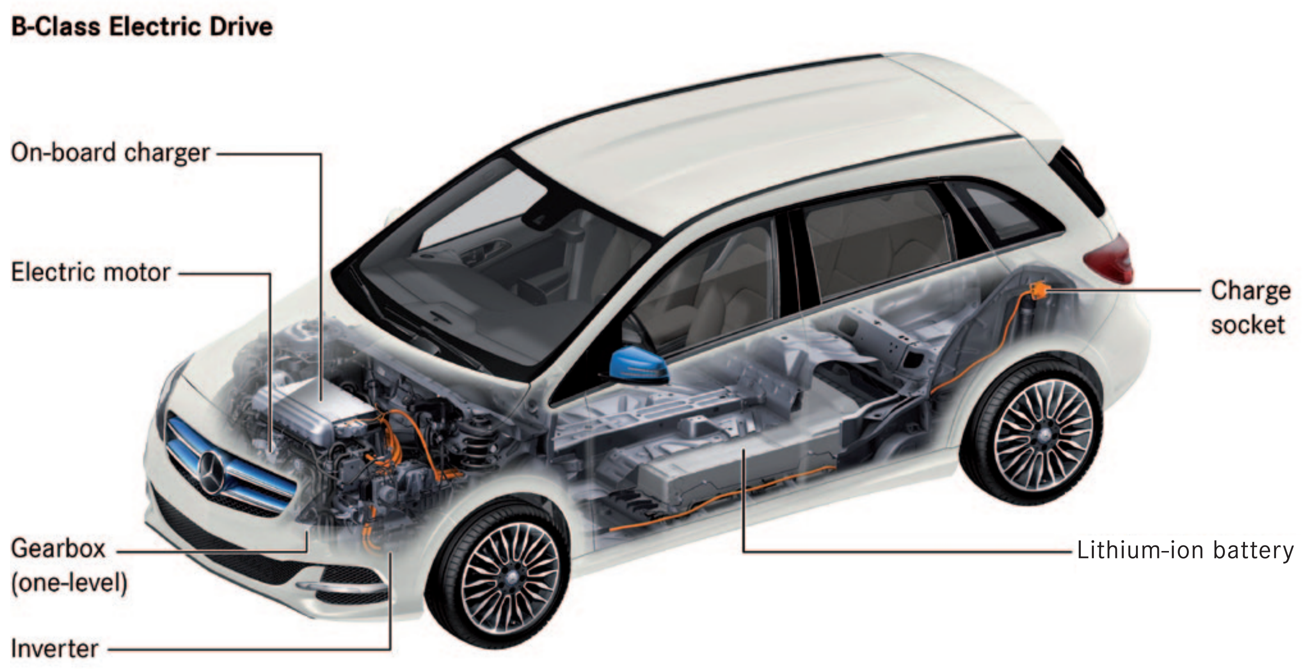


Figure 2-1: Electric drive components of the B-Class Electric Drive

For a range of 100 kilometres, the charging time at 400 V in Europe is 1.5 hours. On the road, the electric drive makes its own contribution to a favourable energy balance by recovering energy under overrun conditions as well as by converting the kinetic energy produced during braking into electric power and feeding it to the battery.

Figure 2-1 shows the primary electric drive components of the new B-Class Electric Drive.

"Mercedes connect me" connects the B-Class with the world around it. It enables convenient remote retrieval of the vehicle's status and remote configuration of the vehicle, for example. The driver can use their PC or smartphone to access the vehicle via the internet. In this way, the present state of charge can be checked or the current range can be marked on a map.

In addition to the improvements to the vehicle, the driver also has a decisive influence on energy consumption. For this reason, a display in the middle of the instrument cluster shows the current energy consumption level. The current B-Class Owner's Manual also includes additional tips for an economical and environmentally friendly driving style.

The B-Class Electric Drive is fully connected. "Mercedes connect me" enables convenient remote retrieval of the vehicle's status and remote configuration of the vehicle, for example. The driver can use their PC or smartphone to access the vehicle via the internet. It is possible, for instance, to ascertain the current state of charge of the lithium-ion battery or to show the vehicle's current range on a map.

The range of connected services is rounded off by a feature that allows individually timed pre-heating or cooling of the vehicle.

Furthermore, Mercedes-Benz offers its customers "Eco Driver Training". The results of this training course have shown that adopting an efficient and energy-conscious style of driving can help to further reduce a car's fuel consumption.

The B-Class Electric Drive is produced at the Mercedes plant in Rastatt on the same line as the models with combustion engines. For many years this production facility has had an environmental management system certified to EU eco-audit regulations and ISO Standard 14001. The paint technology used for the B-Class, for example, is not only state of the art but also stands out by virtue of its high levels of environmental friendliness, efficiency and quality, which are achieved thanks to consistent use of water-based paints with solvent levels of less than 10 percent. This painting process enables a low input of solvents, while electrostatic application reduces the amount of paint used by 20 percent.

The B-Class Electric Drive is produced at the Mercedes plant in Rastatt on the same line as the models with combustion engines. A host of innovative solutions reduce the environmental impact of the production process.

Substantial successes have also been achieved in Rastatt in the area of energy saving. The plant's combined heat and power unit uses clean natural gas to supply electricity and heating. Equally significant are what are known as the heat wheels. Such rotary heat exchangers are deployed wherever large volumes of air are exchanged – in ventilating the production shops and the painting booths, for example. This enables the heating energy in the in areas in which the heat wheels are used to be reduced by up to 50 percent. Additional reductions in CO_2 emissions are achieved through the use of a solar system to heat service water. A geothermal plant has been installed for the new body-in-white shop for the purposes of heating in the winter and cooling in the summer and to cool the welding equipment. For this purpose groundwater is sourced from five extraction wells and fed back via six infiltration wells. No fossil fuels are required.

High environmental standards are also firmly established in the environmental management systems in the sales and after-sales sectors at Mercedes-Benz. At dealer level, Mercedes-Benz meets its product responsibility with the MeRSy recycling system for workshop waste, used parts and warranty parts and packaging materials.

The take-back system introduced in 1993 also means that Mercedes-Benz is a model for the automotive industry where workshop waste disposal and recycling are concerned. This exemplary service by an automotive manufacturer is implemented right down to customer level. The waste materials produced in our outlets during servicing and repairs are collected, reprocessed and recycled via a network operating throughout Germany. Classic components include bumpers, side panels, electronic scrap, glass and tyres. The reuse of parts also has a long tradition at Mercedes-Benz. The Mercedes-Benz Used Parts Center (GTC) was established back in 1996. With its quality-tested used parts, the GTC is an integral part of the service and parts operations for the Mercedes-Benz brand.

Although the recycling of Mercedes passenger cars lies in the distant future in view of their long service life, Mercedes-Benz offers a new, innovative procedure for the rapid disposal of vehicles in an environmentally friendly manner and free of charge. For convenient disposal, a comprehensive network of collection points and dismantling facilities is available to Mercedes customers. Owners of used cars can find out all the important details relating to the return of their vehicles via the free phone number 00800 1 777 7777.

2.2 Life Cycle Assessment (LCA)

The environmental compatibility of a vehicle is determined by the environmental burden caused by emissions and the consumption of resources throughout the vehicle's lifecycle (cf. Figure 2-2). The standardised tool for evaluating a vehicle's environmental compatibility is the Life Cycle Assessment. It comprises the total environmental impact of a vehicle from the cradle to the grave, in other words from raw material extraction through production and use up to recycling.

Down to the smallest detail

- With the LCA, Mercedes-Benz registers all of the effects of a vehicle on the environment, from development through production to disposal.
- For a comprehensive assessment, all environmental inputs within each life cycle phase are taken into consideration.
- Many emissions result less from actual driving and rather from the production process - e.g. the non-methane volatile organic compounds (NMVOC-)* and sulphur dioxide emissions.
- The detailed investigations include an assessment of the consumption and processing of bauxite (aluminium production), iron ore and copper ore, for example.

* NMVOC = non-methane volatile organic compounds

The elements of a Life Cycle Assessment are:
1. Goal and scope definition
Defines the objective and scope of an LCA.
2. Inventory analysis
Encompasses the material and energy flows throughout all stages of a vehicle's life: how many kilograms of a raw material are used, how much energy is consumed, what waste and emissions are produced, etc.
3. Impact assessment
Gauges the potential effects of the product on the environment, such as global warming potential, summer smog potential, acidification potential, and eutrophication potential.
4. Interpretation
Draws conclusions and makes recommendations.

In the development of Mercedes-Benz passenger cars, Life Cycle Assessments are used in the evaluation and comparison of different vehicles, components and technologies. The DIN EN ISO 14040 and DIN EN ISO 14044 standards prescribe the procedure and the required elements.

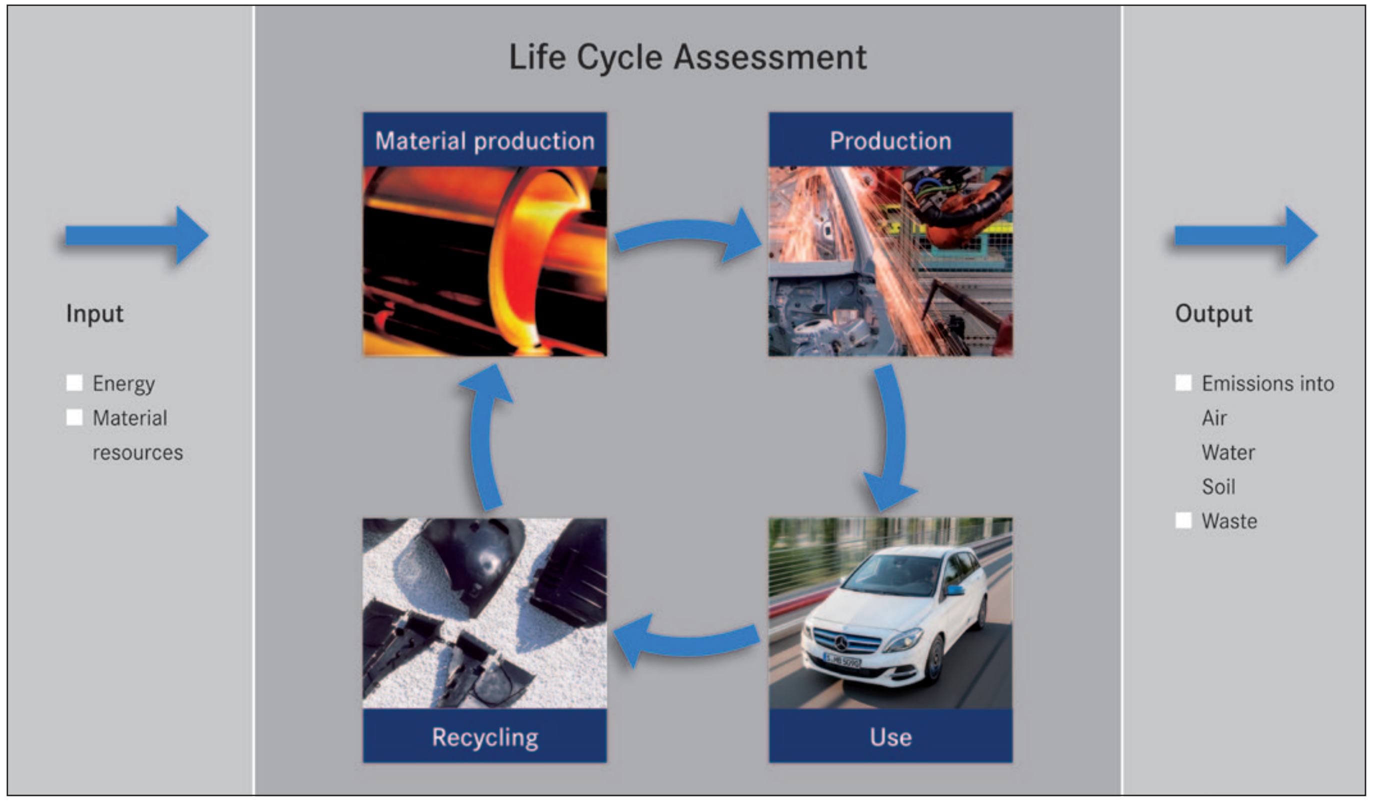


Figure 2-2: Overview of the Life Cycle Assessment

2.2.1 Data basis

To ensure the comparability of the examined vehicles, the ECE base variant is always examined. For the purposes of comparison, the B-Class Electric Drive was assessed alongside the current B 180 with petrol engine.
The main parameters on which the LCA was based are shown in the table below.

Project objective	
Project objectivel	• LCA over the life cycle of the new B-Class Electric Drive as ECE base variant compared with the current B-Class B 180 (revised LCA data status 2014). • Verification of attainment of the objective "environmental compatibility" and communication.
Project scope	
Functional equivalent	• B-Class passenger car (base variant; weight in acc. with DIN 70020).
Technology/ product comparability	• As two variants of the current B-Class with different drive systems, the products are essentially comparable. With the electric motor, the new B-Class Electric Drive supplies a higher level of torque than the B 180. Depending on the driving cycle, the electric range is around 200 kilometres. The maximum speed of the Electric Drive is limited to 160 km/h.
System boundaries	• Life Cycle Assessment for car production, use and recycling. The scope of assessment is only to be extended in the case of elementary flows (resources, emissions, non-recyclable materials).
Data basis	• Weight data of car: MB parts lists (B 180: as at 03/2011, Electric Drive: as at 08/2014). • Materials information for model-relevant, vehicle-specific parts: MB parts list, MB internal documentation systems, IMDS, technical literature. • Vehicle-specific model parameters (bodyshell, paintwork, catalytic converter, etc.): MB specialist departments. • Location-specific energy supply: MB database. • Materials information for standard components: MB database. • Use (fuel consumption, emissions): Type approval/certification figures for use phase (mileage): determined by MB. • Recycling model: state of the art (see also Chapter 2.3.1). • Material production, energy supply, manufacturing processes and transport: GaBi database, status: SP25 (http://documentation.gabi-software.com); MB database.
Allocations	• For material production, energy supply, manufacturing processes, and transport, reference is made to LCA databases and the allocation methods they employ. • No further specific allocations.

(Continues on page 27)

Project scope	(continued)
Cut-off criteria	• For material production, energy supply, manufacturing processes, and transport reference is made to GaBi databases and the cut-off criteria they employ. • No explicit cut-off criteria. All available weight information is processed. • Noise and land use are currently not available as life cycle inventory data and are therefore not taken into account. • "Fine dust" or particulate emissions are not analysed. Major sources of particulate matter (mainly tyre and brake abrasion) are not dependent on vehicle model and thus not relevant to the results of the comparison of the vehicles. • Vehicle maintenance and care are not relevant to the comparison.
Assessment	• Life cycle, in conformity with ISO 14040 and 14044 (LCA).
Analysis parameters	• Material composition according to VDA 231-106. • Life cycle inventory: consumption of resources as primary energy, emissions such as CO_2, CO, NO_x, SO_2, NMVOC, CH_4, etc. • Impact assessment: abiotic depletion potential (ADP), global warming potential (GWP), photochemical ozone creation potential (POCP), eutrophication potential (EP), acidification potential (AP). These impact assessment parameters are based on internationally accepted methods. They are modelled on categories selected by the European automotive industry, with the participation of numerous stakeholders, in an EU project under the name LIRECAR. The mapping of impact potentials for human toxicity and ecotoxicity does not yet have sufficient scientific backing today and therefore will not deliver useful results. • Interpretation: sensitivity analyses of car module structure; dominance analysis over life cycle.
Software support	• MB DfE-Tool. This tool models a car with its typical structure and typical components including their manufacture, and is adapted with vehicle-specific data on materials and weights. It is based on the LCA software GaBi 6 (http://www.pe-international.com/gabi).
Evaluation	• Analysis of life cycle results according to phases (dominance). The manufacturing phase is evaluated based on the underlying car module structure. Contributions of relevance to the results will be discussed.
Documentation	• Final report with all basic conditions.

Table 2-1: LCA basic conditions

Fuel production and electricity generation cover transport from the refinery to the filling station and from the power station to the charging point respectively. The fuel has a sulphur content taken to be 10 ppm. Combustion of one kilogram of fuel thus yields 0.02 grams of sulphur dioxide emissions. The use phase is calculated with a mileage of 160,000 kilometres. The LCA includes the environmental impact of the recovery phase on the basis of the standard processes of the removal of service fluids, shredding, and recovery of energy from the shredder light fraction (LSF). Environmental credits are not granted.

2.2.2 LCA results for B-Class Electric Drive

Over the entire life cycle of the B-Class Electric Drive, the life cycle inventory analysis reveals – depending on the mode of electricity generation for the use phase (EU electricity grid mix or hydro power) – a primary energy requirement of 449 or 299 gigajoules, for example (corresponding to the energy content of around 14,000 or 9300 litres of petrol), an environmental input of approx. 23 or 11 tonnes of carbon dioxide (CO_2), around 6 or 4 kilograms of non-methane volatile organic compounds (NMVOC), around 41 or 21 kilograms of nitrogen oxides (NO_X) and 83 or 45 kilograms of sulphur dioxide (SO_2). In addition to the analysis of the overall results, the distribution of individual environmental impacts over the various phases of the life cycle is investigated. The relevance of the respective life cycle phases depends on the particular environmental impact under consideration. For CO_2 emissions, and likewise for primary energy requirements, the use phase represents a share of 53 and 59 percent respectively (see Figure 2-4).

Figure 2-4 shows a breakdown of the environmental impact over the life cycle phases of the B-Class Electric Drive when using the EU electricity grid mix. In contrast to the conventional vehicle with combustion engine, operation of the vehicle is of relevance only with regard to the primary energy requirement. No other environmental impacts apply, owing to the local emission-free operation of electric vehicles. When electricity generated by hydroelectric means is used to power the electric vehicle, the other environmental impacts relating to electricity generation are also almost entirely avoided.

For a comprehensive and therefore sustainable improvement of the environmental effects associated with a vehicle the end-of-life phase must also be taken into account. In terms of energy, the use or initiation of recycling cycles is worthwhile. For a complete assessment, all environmental inputs within each life cycle phase are taken into consideration.

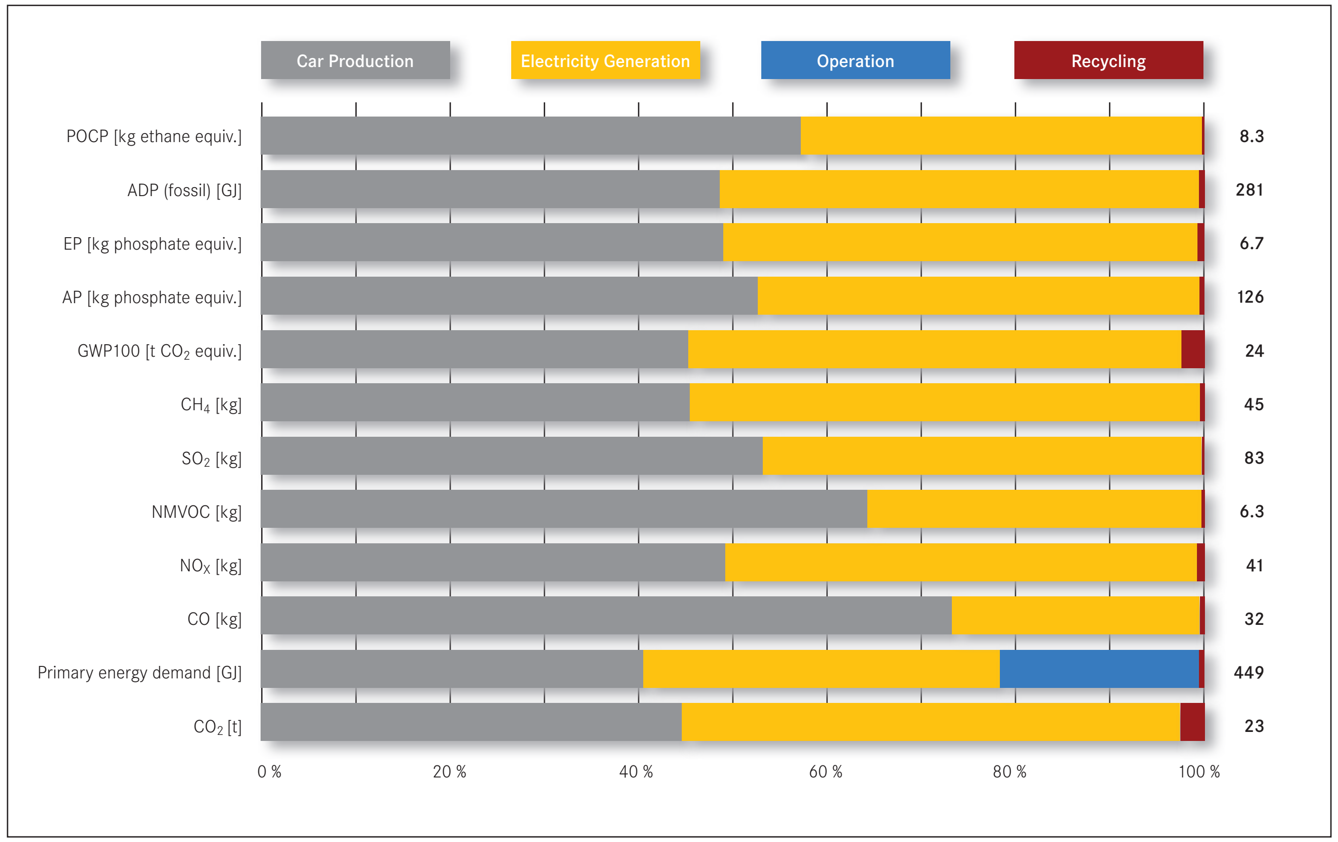


Figure 2-4: Share of life cycle phases for selected parameters, B-Class Electric Drive (EU electricity grid mix)

Environmental burdens in the form of emissions into water result from vehicle manufacturing, in particular owing to the output of inorganic substances (heavy metals, NO_3- and SO_4^{2-}-ions) as well as to organic substances, measured through the factors AOX, BOD and COD.

To enable an assessment of the relevance of the respective environmental impacts, the impact categories fossil abiotic depletion potential (ADP), eutrophication potential (EP), photochemical ozone creation potential (summer smog, POCP), global warming potential (GWP) and acidification potential (AP) are presented in normalised form for the life cycle of the B-Class Electric Drive in Figure 2-5.

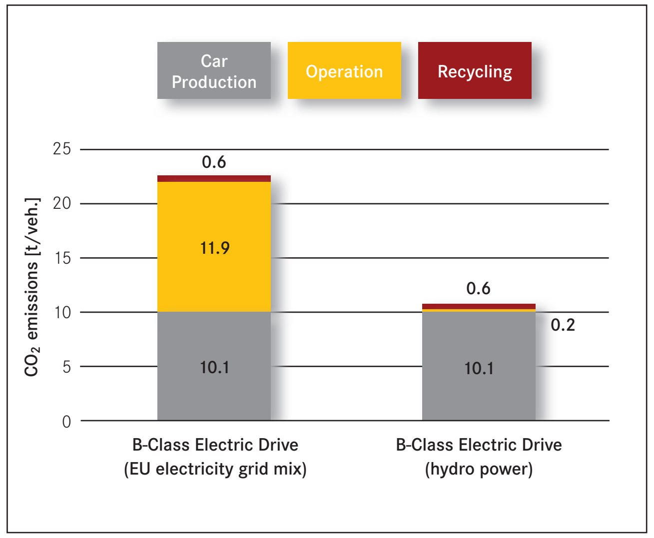


Figure 2-3: Overall carbon dioxide (CO_2) emissions in tonnes

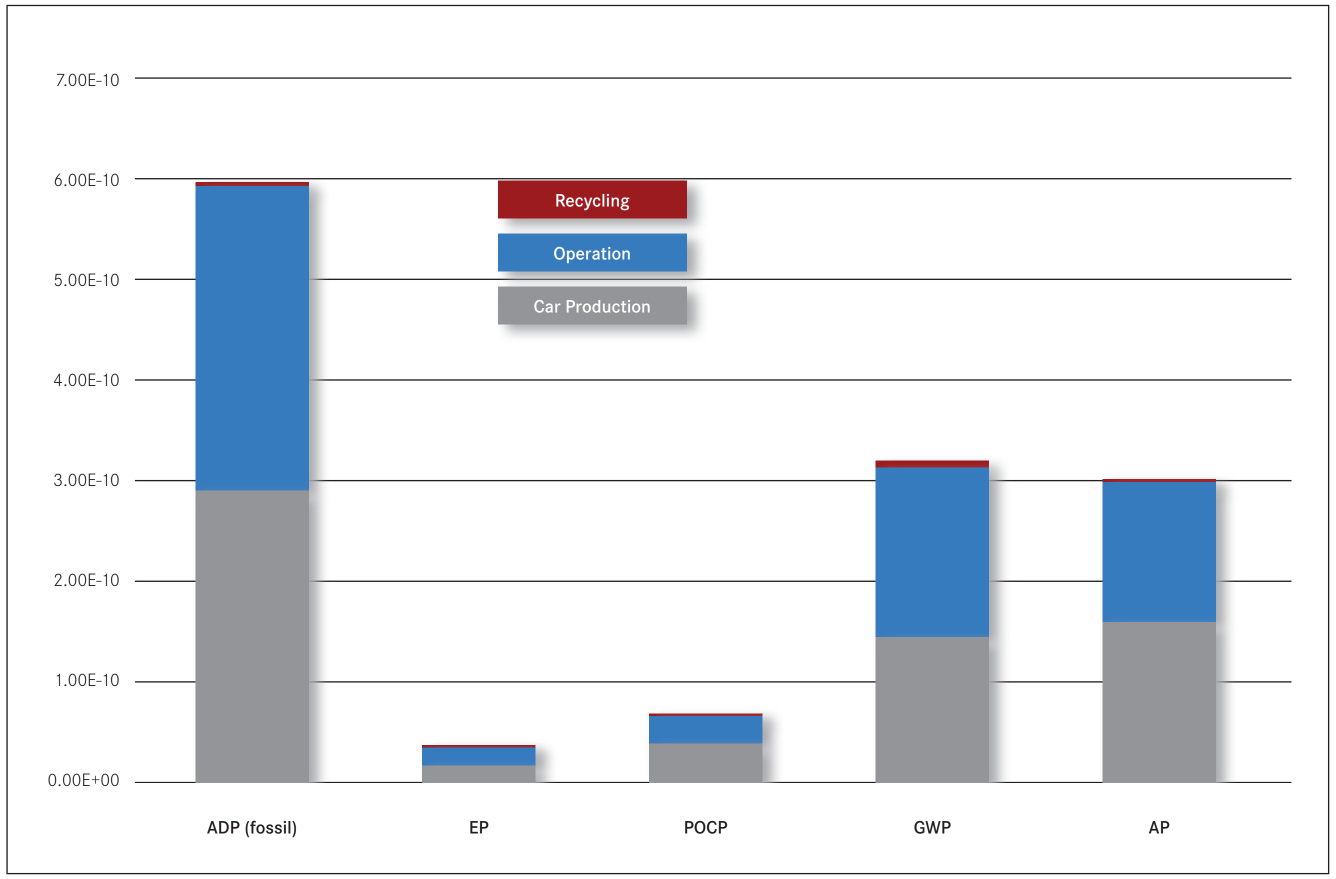


Figure 2-5: Normalised presentation of the life cycle of the B-Class Electric Drive (EU electricity grid mix) per annum [–/car]

Normalisation involves assessing the LCA results in relation to a higher-level reference system in order to obtain a better understanding of the significance of each indicator value. Europe served as the reference system here. The total annual values for Europe (EU 25+3) were employed for the purposes of standardisation, breaking down the life cycle over one year. In relation to the annual European values, the B-Class Electric Drive reveals the greatest proportion for fossil ADP, followed by GWP and AP (cf. Figure 2-5).

The relevance of these three impact categories on the basis of EU 25+3 is therefore greater than that of the remaining impact categories examined. The proportion is the lowest in eutrophication. When hydro power is used to power the B-Class Electric Drive, the columns relating to use are virtually eliminated, while the above-described relationship between the presented environmental impacts continues to apply.

2.2.3 Comparison with the B 180

Electric drive reduces total emissions

The following savings apply compared with a B 180 with petrol engine and dual clutch transmission:

- Reduction in CO_2 emissions over the entire life cycle by 64 percent (19 tonnes) when using hydro power.
- Reduction in CO_2 emissions over the entire life cycle by 24 percent (7.2 tonnes) when using EU electricity grid mix.
- This clearly overcompensates the higher CO_2 emissions which arise during production.
- Petroleum consumption is reduced very markedly, by 87 % (EU electricity grid mix) or 90 % (hydro power).
- Overall, the fossil abiotic depletion potential (fossil ADP) is reduced markedly compared with the petrol-engine variant, by 32 % (EU electricity grid mix) or 66 % (hydro power).

In parallel with the assessment of the B-Class Electric Drive an LCA of the petrol-engine variant B 180 with dual clutch transmission in the ECE base variant (1350 kilograms DIN weight) was drawn up. The parameters on which this was based are comparable to the modelling of the B-Class Electric Drive. The production process was represented on the basis of an excerpt from the current list of parts. Operation data were calculated on the basis of applicable certification values. The same state-of-the-art model was used for recovery and recycling.

As shown in Figure 2-6, production of the B-Class Electric Drive results in a higher quantity of carbon dioxide emissions than for the B 180. This is attributable to the alternative drive components, in particular the high-voltage battery. Due to the high efficiency of the electric drive, the new B-Class Electric Drive offers clear advantages over its entire life cycle, however. The extent of the reduction in emissions depends on the type of electricity used to charge the vehicle.

At the beginning of the life cycle, production of the new B-Class Electric Drive gives rise to a higher level of CO_2 emissions than the B 180. In the subsequent use, depending on the mode of electricity generation, the new B-Class Electric Drive emits 11.9 tonnes (EU electricity grid mix) or 0.2 tonnes of CO_2 (electricity from hydro power); this means total emissions for production, use and recycling of the car amount to around 23 tonnes (EU electricity grid mix) or 11 tonnes (hydro power) of CO_2.

Production of the B 180 petrol-engine variant gives rise to 5.5 tonnes of CO_2. During use, the B 180 emits around 24 tonnes of CO_2. Overall, CO_2 emissions for the B 180 thus total 30 tonnes.

Over the entire life cycle, comprising production, use over 160,000 kilometres and recycling, the B-Class Electric Drive gives rise to 24 percent (7.2 tonnes – EU electricity grid mix) or 64 percent (19 tonnes – hydro power) less CO_2 emissions than the B 180.

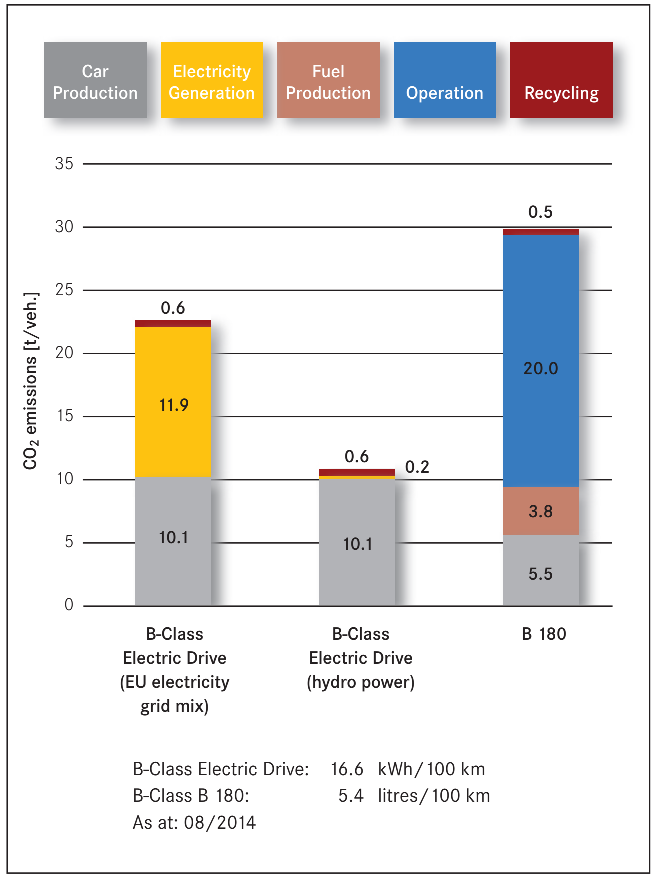


Figure 2-6: Carbon dioxide emission of the B-Class Electric Drive compared with the B 180 petrol-engine variant [t/car]

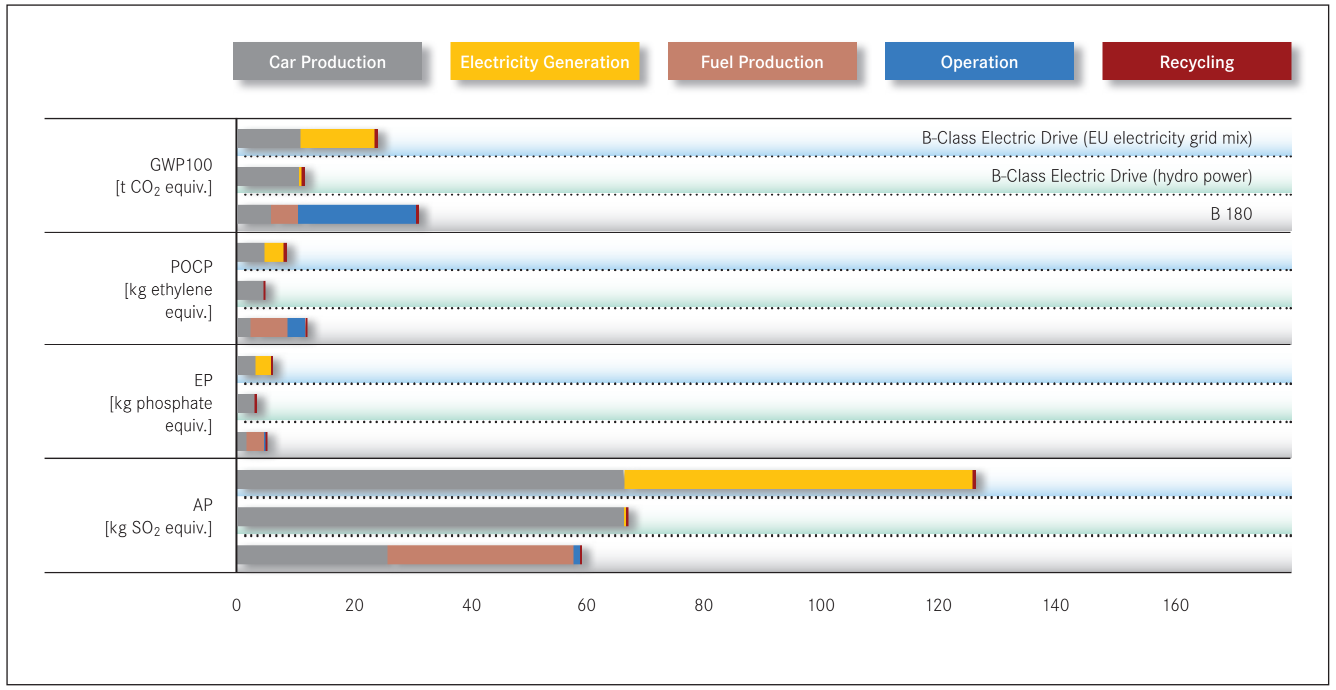


Figure 2-7: Selected LCA parameters for the new B-Class Electric Drive compared with the B 180 petrol-engine variant [unit/car]

Figure 2-7 shows a comparison of the examined environmental impacts over the individual life cycle phases. Over the entire life cycle, the B-Class Electric Drive shows significant advantages over the B 180 in regard to global warming potential (GWP) and photochemical ozone creation potential (POCP, summer smog).

In the impact category eutrophication potential (EP) the result depends on the electricity used: with the EU electricity grid mix the contribution of the Electric Drive is around 30 percent more than that of the B 180; if hydro power is used, then the contribution can be reduced by some 30 percent versus the B 180. Where acidification potential (AP) is concerned, with either electricity generation path the Electric Drive comes out worse than the B 180. This is attributable chiefly to the manufacture of the alternative drive components, especially the high-voltage battery.

Figure 2-8 shows the consumption of relevant material and energy resources. Because of the shifts in the materials mix described above (see also Chapter 1.2, page 17), the material resources requirements for car manufacture also change. For example, the iron ore consumption of the new B-Class Electric Drive is less because the share of steel is less, while the bauxite requirements increase significantly because of the larger use of primary aluminium.

In comparison with the conventional petrol-powered vehicle, significant changes in the use of energy resources can also be observed. Crude oil consumption can be reduced, very markedly, by 87 percent (EU electricity grid mix) or 90 percent (hydro power). If the EU electricity grid mix is used to charge the electric vehicle, the consumption of the fossil energy resources lignite, hard coal and natural gas as well as of uranium increases compared with the B 180. If hydro power is used for charging, resource consumption shifts mainly towards renewable energy resources.

All told, compared with the petrol-powered vehicle the consumption of fossil resources (ADP fossil) can be cut significantly by 32 percent (EU electricity grid mix) or 66 percent (hydro power).

Figure 2-8: Consumption of selected material and energy resources
new B-Class Electric Drive compared with the B 180 petrol-engine variant [unit/car]

Input parameters

Resources, ores	B-Class Electric Drive (EU electricity grid mix)	Delta B-Class Electric Drive (EU electricity grid mix) vs. B 180	B-Class Electric Drive (hydro power)	Delta B-Class Electric Drive (hydro power) vs. B 180	B 180	Comments
Bauxite [kg]	768	123 %	767	123 %	345	Aluminium production, higher primary component (mainly due to high-voltage battery).
Dolomite [kg]	104	6 %	104	5 %	98	Magnesium production, slightly higher magnesium mass.
Eisen [kg]**	834	- 6 %	844	- 5 %	891	Steel production, lower steel mass Delta above all for engine/transmission.
Non-ferrous metals (Cu, Pb, Zn) [kg]**	136	128 %	138	131 %	60	Delta above all for electric drive system, wiring harness and battery.

** as an elementary resource

Energy sources						Comments
Fossil ADP [GJ]	281	- 32 %	139	- 66 %	412	Electric Drive (electricity mix): approx. 50 % due to usage (electricity generation). Electric Drive (hydro power): limited almost exclusively to car production phase.
Primary energy [GJ]	449	0 %	299	- 33 %	448	Electric Drive (electricity mix): approx. 59 % due to usage (electricity generation). Electric Drive (hydro power): limited almost exclusively to car production phase.
Share of						
Lignite [GJ]	47	461 %	13	53 %	8	Electric Drive (electricity mix): approx. 73 % due to usage.
Natural gas [GJ]	104	69 %	50	- 20 %	62	Electric Drive (electricity mix): approx. 53 % due to usage.
Crude oil [GJ]	41	- 87 %	31	- 90 %	313	Electric Drive (electricity mix): approx. 74 % due to car production.
Hard coal [GJ]	89	206 %	46	57 %	29	Electric Drive (electricity mix): approx. 51 % due to car production.
Uranium [GJ]	106	754 %	25	101 %	12	Electric Drive (electricity mix): approx. 77 % due to usage.
Renewable energy resources [GJ]	61	160 %	135	473 %	24	Electric Drive (electricity mix): approx. 67 % due to usage. Electric Drive (hydro power): approx. 85 % due to usage.

* CML 2001, date of revision: April 2013

Table 2-2: Overview of LCA parameters (I)

Tables 2-2 and 2-3 present an overview of further LCA parameters. The lines with grey shading indicate superordinate impact categories. They group together emissions with the same effects and quantify their contribution to the respective impacts over a characterisation factor, e.g. contribution to global warming potential in kilograms of CO_2 equivalent.

Output parameters

Emissions into air	B-Class Electric Drive (EU electricity grid mix)	Delta B-Class Electric Drive (EU electricity grid mix) vs. B 180	B-Class Electric Drive (hydro power)	Delta B-Klasse Electric Drive (hydro power) vs. B 180	B 180	Comments
GWP* [t CO_2 equiv.]	24	– 22 %	12	– 63 %	31	primarily due to CO_2 emissions
AP* [kg SO_2 equiv.]	126	114 %	67	13 %	59	caused primarily by SO_2 emissions
EP* [kg phosphate equiv.]	7	33 %	3.3	– 33 %	5	caused primarily by NO_X emissions
POCP* [kg ethene equiv.]	8	– 29 %	4.8	– 59 %	12	caused primarily by NMVOC emissions
CO_2 [t]	23	– 24 %	11	– 64 %	30	Electric Drive (electricity mix): approx. 53 % due to usage. Electric Drive (hydro power): primarily due to car production.
CO [kg]	32	– 42 %	24	– 56 %	54	Electric Drive (electricity mix): approx. 26 % due to usage.
NMVOC [kg]	6	– 72 %	4.1	– 82 %	23	Electric Drive (electricity mix): approx. 36 % due to usage.
CH_4 [kg]	45	9 %	21	– 50 %	41	Electric Drive (electricity mix): approx. 54 % due to usage.
NO_X [kg]	41	67 %	21	– 15 %	25	Electric Drive (electricity mix): approx. 50 % due to usage.
SO_2 [kg]	83	125 %	45	20 %	37	Electric Drive (electricity mix): approx. 47 % due to usage.

Emissions into water						Comments
BSB [kg]	0.15	19 %	0.11	– 15 %	0.13	Electric Drive (electricity mix): approx. 29 % due to usage (electricity generation), remained primarily due to car production.
Hydrocarbons [kg]	0.49	– 51 %	0.44	– 56 %	1.00	–
NO_3^- [g]	2.8	– 62 %	0.67	– 91 %	7.37	Electric Drive (electricity mix): approx. 76 % due to usage. Electric Drive (hydro power): approx. 74 % due to car production.
PO_4^{3-} [g]	0.05	– 63 %	0.04	– 69 %	0.13	Electric Drive (electricity mix): approx. 83 % due to car production.
SO_4^{2-} [kg]	35	145 %	12	– 15 %	14.31	Electric Drive (electricity mix): approx. 66 % due to usage.

*CML 2001, date of revision: April 2013

Table 2-3: Overview of LCA parameters (II)

Overall, the aim of an improvement in environmental performance compared with the reference vehicle was attained with the B-Class Electric Drive. In addition to the major advantage of enabling local emission-free driving, the new B-Class Electric Drive also reveals marked advantages in the impact categories global warming potential (GWP) and photochemical ozone creation potential (POCP, summer smog) over the entire life cycle compared with the B 180. In the area of eutrophication (EP), the use of renewably generated electricity to charge the electric vehicle leads to an improvement in the order of 30 %. It is only with regard to acidification (AP) that the higher inputs from production of the electric vehicle (above all the high-voltage battery) are not fully offset; when hydro power is used, the Electric Drive is still 13 % above the level for the B 180.

2.3 Design for recovery

With the adoption of the European ELV Directive (2000/53/EC) on 18 September 2000, the conditions for recovery of end-of-life vehicles were revised.

The aims of this directive are to avoid vehicle-related waste and encourage the take-back, reuse and recycling of vehicles and their components. This results in the following requirements on the automotive industry:

- Establishment of systems for collection of end-of-life vehicles (ELVs) and used parts from repairs.
- Achievement of an overall recovery rate of 95 percent by weight by 01.01.2015 at the latest.
- Evidence of compliance with the recycling rate as part of type approval for new passenger cars as of December 2008.
- Take-back of all ELVs free of charge from January 2007.
- Provision of dismantling information to ELV recyclers within six months of market launch.
- Prohibition of lead, hexavalent chromium, mercury and cadmium, taking into account the exceptions in Annex II.

The recycling concept was conceived in parallel with the development of the B-Class.

- End-of-life vehicles have been taken back by Mercedes-Benz free of charge since January 2007.
- Heavy metals such as lead, hexavalent chromium, mercury or cadmium have been eliminated in accordance with the requirements of the ELV Directive.
- Mercedes-Benz already enjoys the benefit of an efficient take-back and recycling network.
- By reselling certified used parts, the Mercedes Used Parts Center makes an important contribution to the recycling concept.
- Even during development of the B-Class, attention was paid to segregation and ease of dismantling of relevant thermoplastic components.
- Detailed dismantling information is available in electronic form to all ELV recyclers via the International Dismantling Information System (IDIS).

2.3.1 Recycling concept for the B-Class Electric Drive

The calculation procedure is regulated in ISO standard 22628,
“Road vehicles – Recyclability and recoverability – Calculation method.”

The calculation model reflects the real ELV recycling process and is divided into four stages:

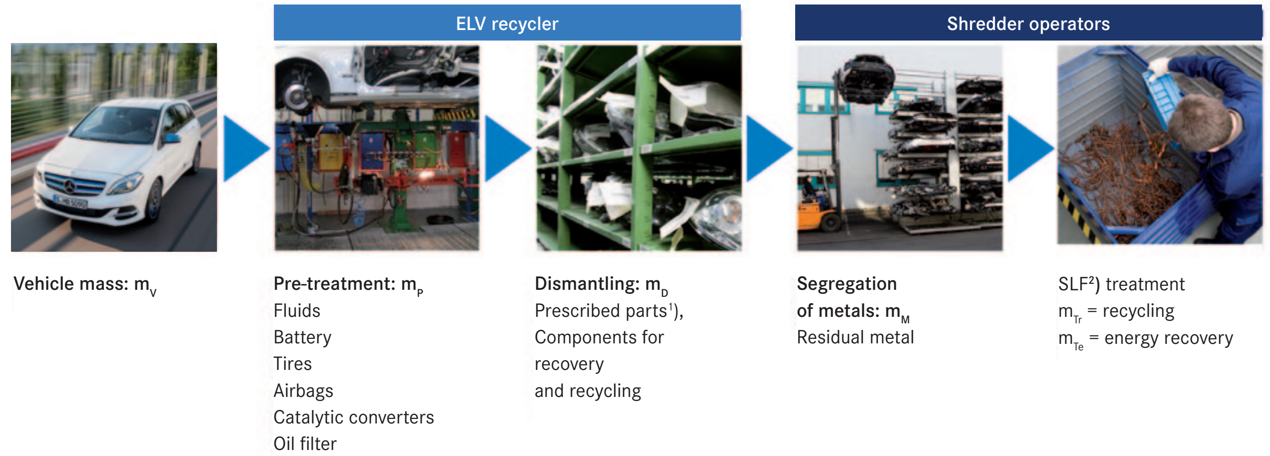
1. Pretreatment (removal of all service fluids, tyres, the battery and catalytic converters, ignition of airbags).
2. Dismantling (removal of replacement parts and/or components for material recycling).
3. Separation of metals in the shredder process.
4. Treatment of non-metallic residual fraction (shredder light fraction – SLF).

The recycling concept for the B-Class Electric Drive was devised in parallel with development of the vehicle; the individual components and materials were analysed for each stage of the process. The volume flow rates established for each stage together yield the recycling and recovery rates for the entire vehicle. With the process chain described below, overall a material recyclability rate of 85 percent and a recoverability rate of 95 percent were verified on the basis of the ISO 22628 calculation model as part of the vehicle type approval process (see Figure 2-9).

The fluids, battery and tyres are removed by recyclers in the course of the preliminary treatment process. The airbags are triggered with a device that is standardised amongst all European car manufacturers. During dismantling, the prescribed parts are first removed according to the European ELV Directive. To improve recycling, numerous components and assemblies are then removed and are sold directly as used spare parts or serve as a basis for the manufacturing of replacement parts.

In addition to used parts, materials that can be recycled using economically appropriate procedures are selectively removed in the vehicle dismantling process. These include components of aluminium and copper as well as selected large plastic components.

During the development of the B-Class, these components were specifically prepared for subsequent recycling. Along with the segregated separation of materials, attention was also paid to ease of dismantling of relevant thermoplastic components such as bumpers, wheel arch linings, outer sills, underfloor panelling and engine compartment coverings. In addition, all plastic parts are marked in accordance with international nomenclature.



$$R_{cyc} = (m_P+m_D+m_M+m_{Tr})/m_V \times 100 > 85 \text{ percent}$$

$$R_{cov} = R_{cyc} + m_{Te}/m_V \times 100 > 95 \text{ percent}$$

1) in acc. with 2000/53/EC
2) SLF = shredder light fraction

In the subsequent shredding of the residual body, the metals are first separated for recycling in the raw material production processes. The largely organic remaining portion is separated into different fractions for environment-friendly treatment in raw material or energy recovery processes. Recycling concepts have also been evolved together with the suppliers for the lithium-ion battery of the B-Class Electric Drive to enable recycling of the valuable substances contained in the batteries. In addition to compliance with the statutory requirements pertaining to recycling efficiency for the batteries, the focus here was also on optimising the recycling process in terms of safe and efficient dismantling and obtaining marketable products from the battery recycling process.

2.3.2 Dismantling information

Dismantling information plays an important role for ELV recyclers when it comes to implementing the recycling concept.

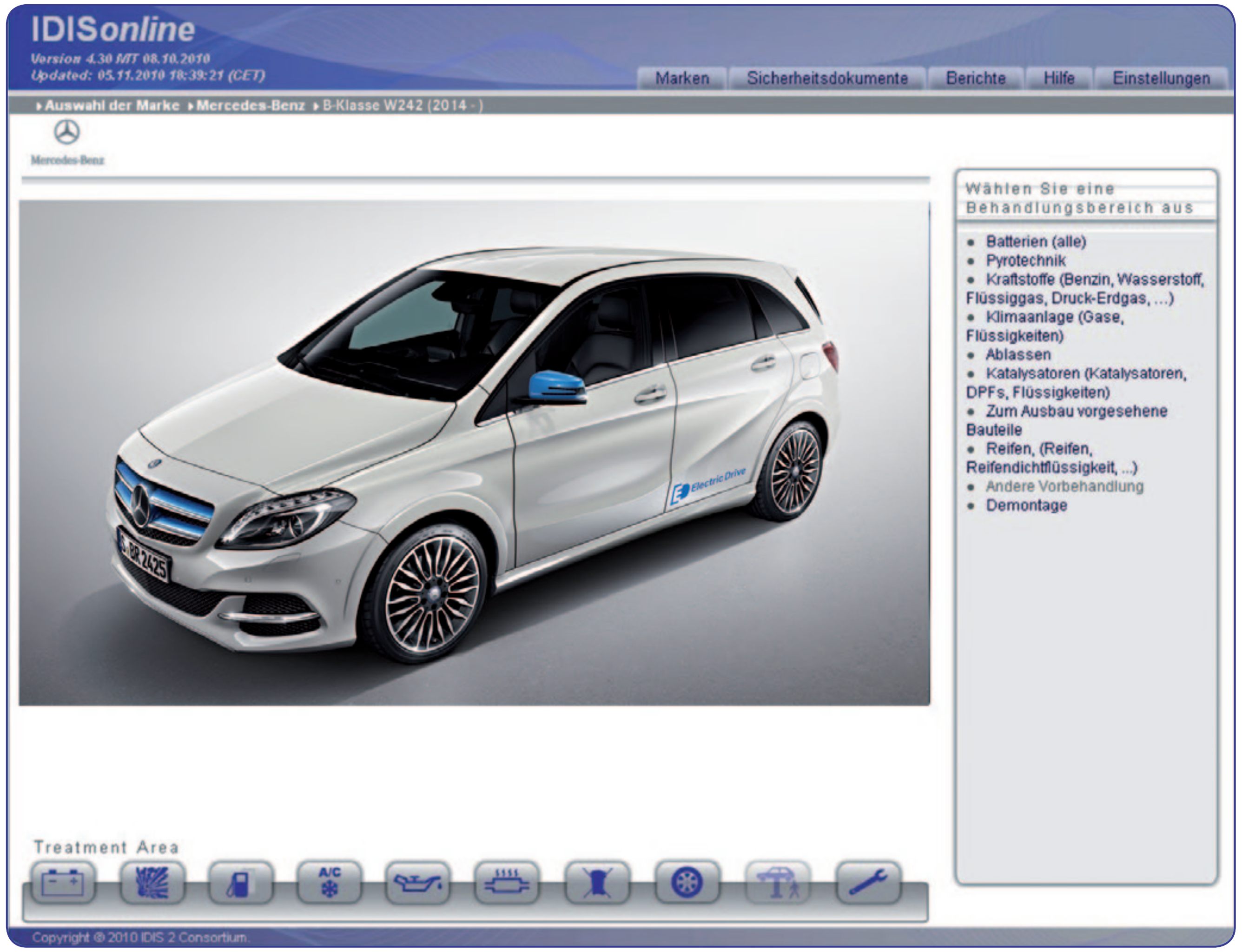


Figure 2-10: Screenshot of the IDIS software

For the new B-Class Electric Drive too, all necessary information is provided in electronic form via the International Dismantling Information System (IDIS).This IDIS software provides vehicle information for ELV recyclers, on the basis of which vehicles can be subjected to environmentally friendly pretreatment and recycling techniques at the end of their operating lives. The system presents model-specific data both graphically and in text form.

In pre-treatment, specific information is provided on service fluids and pyrotechnic components. In the other areas, material-specific information is provided for the identification of non-metallic components. The current version (July 2014) covers 1927 different models and variants from 69 car brands. The IDIS data are made available to ELV recyclers and incorporated into the software six months after the respective market launch.

2.3.3 Avoidance of potentially hazardous materials

The avoidance of hazardous substances is a matter of top priority in the development, manufacturing, use, and recycling of Mercedes-Benz vehicles. For the protection of humans and the environment, substances and substance classes whose presence is not permitted in materials or components of Mercedes-Benz passenger cars have been listed in our internal standard (DBL 8585) since 1996. This standard is already made available to the designers and materials experts at the advanced development stage for both the selection of materials and the definition of manufacturing processes.

Materials used for components in the passenger compartment and boot are also subject to emission limits that are likewise laid down in the DBL 8585 standard as well as in delivery conditions for the various components. The continual reduction of interior emissions is a key aspect of the development of components and materials for Mercedes-Benz vehicles. In the current B-Class, for example, the sum of organic compounds in the interior air (measured as the so-called FID value) has been reduced by 48 % compared with its predecessor.

Mercedes-Benz has also been awarded the Seal of Quality from the European Centre for Allergy Research Foundation (ECARF) for the current B-Class. The ECARF Seal of Quality is used by ECARF to designate products that have been scientifically tested and proven to be suitable for allergy sufferers.

The conditions involved are extensive: numerous components from each equipment variant of a vehicle have to be tested for inhaled allergens, for example. In addition, tests are undertaken with human “guinea pigs”. Driving tests, for example, were conducted in the B-Class with people suffering from severe asthma, with lung function tests providing information about the impact on the bronchial system.

In addition, all materials that might come in contact with the skin were dermatologically tested. So-called epicutaneous skin tests were undertaken with test subjects suffering from contact allergies in order to test the tolerance levels for known contact allergens. To this end, substances from the interior were adhered to the skin as potential allergens, using plasters. The air-conditioning filters also have to meet the stringent criteria of the ECARF Seal in both new and used condition: amongst other things the tests measure their retention efficiency with regard to dust and pollen.

2.4 Use of secondary raw materials

In the B-Class Electric Drive, 58 components with an overall weight of 31.9 kilograms can be manufactured party from high-quality recycled plastics.

- These include wheel arch linings, underbody panelling and cable ducts.
- Wherever possible, secondary raw materials are derived from vehicle-related waste streams: Wheel arch linings are made from reprocessed starter batteries, bumper coverings and cockpit production waste.
- The Electric Drive differs from the combustion-engine variants in that it does not have a (plastic) fuel tank, for example.

Figure 2-12: Use of secondary raw materials as illustrated by the example of wheel arch linings.

In addition to the requirements for attainment of recycling rates, manufacturers are obliged by Article 4, Paragraph 1 (c) of the European ELV Directive 2000/53/EC to make increased use of recycled materials in vehicle production and thereby to establish or extend the markets for recycled materials. To comply with these stipulations, the specifications book for the B-Class Electric Drive stipulated a target value for the percentage of secondary raw materials.

The main focus of the recyclate research accompanying vehicle development is on thermoplastics. In contrast to steel and ferrous materials, to which secondary materials are already added at the raw material stage, recycled plastics must be subjected to a separate testing and approval process for the relevant component. Accordingly, details of the use of secondary raw materials in passenger cars are only documented for thermoplastic components, as only this aspect can be influenced during development.

Figure 2-11: Use of secondary raw materials in the B-Class Electric Drive.

Component weight	B-Class Electric Drive
in kg	31.9

The quality and functionality requirements placed on a component must be met both with secondary raw materials and with comparable new materials. To ensure passenger car production is maintained even when shortages are encountered on the recycled materials market, new materials may also be used as an alternative.

In the B-Class Electric Drive, 58 components in all with an overall weight of 31.9 kilograms can be manufactured party from high-quality recycled plastics.Typical areas of use are wheel arch linings, cable ducts and underbody panels, which consist for the most part of polypropylene. Figure 2-11 shows the components for which the use of secondary raw materials is approved. Compared to the combustion-engine variants of the B-Class, the Electric Drive differs with regard to components which are directly related to the drive system, such as the plastic fuel tank.

A further objective is to obtain secondary raw materials wherever possible from vehicle-related waste flows, so as to achieve closed cycles. In the case of the wheel arch linings of the B-Class, for example, a secondary raw material comprising reprocessed vehicle components is used (see Figure 2-12): starter battery housings, bumper coverings from the Mercedes-Benz Recycling System (MeRSy), and production waste from cockpit units.

2.5 Use of renewable raw materials

In all, 13 components in the new B-Class Electric Drive with a total weight of 15.3 kilograms are made using natural materials.

- The use of renewable raw materials focuses on the interior.
- In addition, paper is used for diverse filters.

In automotive production, the use of renewable raw materials is concentrated primarily in the vehicle interior. Natural materials employed in series production of the B-Class Electric Drive consist primarily of wood fibres and honeycomb cardboard in combination with various polymer materials.The use of natural materials in automotive manufacturing has a number of advantages:

- Compared with glass fibres, the use of natural fibres usually results in a reduction in component weight.
- Renewable raw materials help to reduce the consumption of fossil resources such as coal, natural gas and crude oil.
- They can be processed by means of conventional technologies. The resulting products are generally readily recyclable.
- If recycled in the form of energy they have an almost neutral CO_2 balance, as only as much CO_2 is released as the plant absorbed during its growth.

Figure 2-13: Components produced using renewable raw materials in the B-Class Electric Drive

The types of renewable raw materials and their applications are listed in Table 2-4.

In all, 13 components in the new B-Class Electric Drive with a total weight of 15.3 kilograms are made using natural materials. Figure 2-13 shows the components in the B-Class Electric Drive which are produced using renewable raw materials.

Component weight, in kg	B-Class Electric Drive
	15.3

Raw material	Application
Paper	Diverse filters
Wood	Moulded wood fibre material, in door panelling carrier
Honeycomb cardboard	Luggage compartment floor

Table 2-4: Application fields for renewable raw materials

3 Process – Design for Environment

Reducing the environmental impact of a vehicle's emissions and resource consumption throughout its life cycle is crucial to improving its environmental performance. The environmental burden of a product is already largely determined in the early development phase; subsequent corrections to product design can only be implemented at great expense. The earlier environmentally compatible product development ("Design for Environment") is integrated into the development process, the greater the benefits in terms of minimised environmental impact and cost. Process and product-integrated environmental protection must be realised in the development phase of a product. The environmental burden can often only be reduced at a later date by means of downstream "end-of-pipe" measures.

We strive to develop products that are highly responsible to the environment in their respective market segments – this is the second Environmental Guideline of the Daimler Group. Its realisation requires incorporating environmental protection into products from the very start. Ensuring that this happens is the task of environmentally compatible product development. Comprehensive vehicle concepts are devised in accordance with the "Design for Environment" (DfE) principle. The aim is to improve environmental performance in objectively measurable terms and, at the same time, to meet the demands of the growing number of customers with an eye for environmental issues such as fuel economy and reduced emissions or the use of environmentally friendly materials.

Focus on "Design for Environment"

- Environmentally compatible product development ("Design for Environment", DfE), was integrated into the development process for the B-Class from the outset. This minimises environmental impact and costs.
- In development, a "DfE" team ensures compliance with the secured environmental objectives.
- The "DfE" team comprises specialists from a wide range of fields, e. g. life cycle assessment, dismantling and recycling planning, materials and process engineering, and design and production.
- Integration of "DfE" into the development process has ensured that environmental aspects were included in all stages of development.

In organisational terms, responsibility for improving environmental performance was an integral part of the development project for the B-Class Electric Drive. Under the overall level of project management, employees are appointed with responsibility for development, production, purchasing, sales, and further fields of activity. Development teams (e. g. body, drive system, interior, etc.) and cross-functional teams (e. g. quality management, project management, etc.) are appointed in accordance with the most important automotive components and functions).

One such cross-functional group is known as the DfE team. consisting of experts from the fields of life cycle assessment, dismantling and recycling planning, materials and process engineering, and design and production. Members of the DfE team are also incorporated in a development team, in which they are responsible for all environmental issues and tasks; this ensures complete integration of the DfE process into the vehicle development project. The members have the task of defining and monitoring the environmental objectives in the technical specifications for the various vehicle modules at an early stage, and of deriving improvement measures where necessary.

The integration of Design for Environment into the operational structure of the development project ensured that environmental aspects were not sought only at the time of launch, but were included in the earliest stages of development. The targets were coordinated in good time and reviewed in the development process in accordance with the quality gates. Requirements for further action up to the next quality gate are determined by the interim results, and the measures are implemented in the development team.

The process carried out for the B-Class Electric Drive meets all the criteria for the integration of environmental aspects into product development which are described in ISO standard TR 14062.

Over and above this, in order to implement environmentally compatible product development in a systematic and controllable manner, integration into the higher-level ISO 14001 and ISO 9001 environmental and quality management systems is also necessary. The international ISO 14006 standard published in 2011 describes the prerequisite processes and correlations.

Mercedes-Benz meets the requirements of the new ISO 14006 standard in full. This was confirmed for the first time by the independent appraisers from the South German Technical Inspection Authority (TÜV SÜD Management Service GmbH) in 2012.

Figure 3-1: “Design for Environment” activities at Mercedes-Benz

4

ZERTIFIKAT ◆ CERTIFICATE ◆ 認證證書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

TÜV SÜD Management Service

CERTIFICATE

The Certification Body
of TÜV SÜD Management Service GmbH
certifies that

Daimler AG
Group Research & Mercedes-Benz Cars Development
D-71059 Sindelfingen

for the scope

Development of Passenger Vehicles

has implemented and applies an Environmental Management System
with particular focus on ecodesign.
Evidence of compliance to

ISO 14001:2004
with ISO 14006:2011 and ISO/TR 14062:2002

was provided in an audit, report No. **70014947,** demonstrating that
the entire product life cycle is considered in a multidisciplinary approach when
integrating environmental aspects in product design and development.

Results are verified by means of Life Cycle Assessments.

The certificate is valid until **2015-12-06,** Registration-No. **12 770 13407 TMS**

with reference to the certificate ISO 14001:2004 of Daimler AG,
Mercedes-Benz Werk Sindelfingen (Registration-No. **12 104 13407 TMS).**

Munich, 2012-12-07

Design for Environment TÜV SÜD TÜV MS Standard

TÜV SÜD Management Service GmbH • Zertifizierungsstelle • Ridlerstraße 65 • 80339 München • Germany

5 Conclusion

The new B-Class Electric Drive meets many customers' demands for emission-free motoring without foregoing the hallmark attributes of a Mercedes-Benz: safety and comfort. And, let's not forget: exhilarating driving pleasure.

As proof of its vehicles' environmental compatibility, Mercedes-Benz is the world's first automotive manufacturer to have held Environmental Certificates in accordance with the ISO TR 14062 standard since 2005. Over and above this, since 2012 the requirements of the new ISO 14006 standard relating to the integration of environmentally compatible product development into the higher-level environmental and quality management systems have been met, as also confirmed by TÜV SÜD Management Service GmbH.

The Environmental Certificate for the B-Class Electric Drive documents the improvements achieved compared with the comparable model with combustion engine. Both the process of environmentally compatible product development and the product information contained herein have been certified by independent experts in accordance with internationally recognised standards.

With the B-Class Electric Drive, Mercedes customers benefit from an efficient drive module, local emission-free driving and a comprehensive recycling concept, for example. Furthermore, a high percentage of the materials used are high-quality recycled materials and renewable raw materials. The B-Class Electric Drive thus offers a very good environmental performance.

6 Glossary

Term	Explanation
ADP	Abiotic depletion potential (abiotic = non-living); impact category describing the reduction of the global stock of raw materials resulting from the extraction of non-renewable resources.
Allocation	Distribution of material and energy flows in processes with several inputs and outputs, and assignment of the input and output flows of a process to the investigated product system.
AOX	Adsorbable organically bound halogens; sum parameter used in chemical analysis mainly to assess water and sewage sludge. The sum of the organic halogens which can be adsorbed by activated charcoal is determined; these include chlorine, bromine and iodine compounds.
AP	Acidification potential; impact category expressing the potential for milieu changes in ecosystems due to the input of acids.
Base variant	Base vehicle model without optional extras, usually Classic line and with a small engine.
BOD	Biological oxygen demand; taken as measure of the pollution of waste water, waters with organic substances (to assess water quality).
COD	Chemical oxygen demand; used in the assessment of water quality as a measure of the pollution of waste water and waters with organic substances
DIN	German Institute for Standardisation (Deutsches Institut für Normung e.V.).
ECARF	European Centre for Allergy Research Foundation
ECE	Economic Commission for Europe; the UN organisation in which standardised technical regulations are developed
EP	Eutrophication potential (overfertilisation potential); impact category expressing the potential for oversaturation of a biological system with essential nutrients
FID value	A flame ionisation detector - FID for short - is a cumulative detector for organic compounds (= hydrocarbons). This measures the conductivity of an electrolytic gas flame (hydrogen) between two electrodes. It makes it possible to determine the total amount of organic materials in an air sample.
GWP100	Global warming potential, time horizon 100 years; impact category that describes potential contribution to the anthropogenic greenhouse effect (caused by mankind).
HC	Hydrocarbons
IDIS	International Dismantling Information System
IMDS	International Material Data System
Impact categories	Classes of effects on the environment in which resource consumptions and various emissions with the same environmental effect (such as global warming, acidification, etc.) are grouped together.
ISO	International Organisation for Standardisation
KBA	German Federal Office for Motor Vehicles (new car registration agency)
Life Cycle Assessment (LCA)	Compilation and assessment of the input and output flows and the potential environmental impacts of a product in the course of its life
MB	Mercedes-Benz
NEDC	New European Driving Cycle; cycle used to establish the emissions and consumption of motor vehicles since 1996 in Europe; prescribed by law
Non-ferrous metal	(aluminium, lead, copper, magnesium, brass, nickel, zinc, tin, etc.)
POCP	Photochemical ozone creation potential; impact category that describes, the formation of photo-oxidants (“summer smog”)
Primary energy	Energy not yet subjected to anthropogenic conversion
Process polymers	Term from the VDA materials data sheet 231-106; the material group “process polymers” comprises paints, adhesives, sealants, protective undercoats
SLF	Shredder Light Fraction; non-metallic substances remaining after shredding as part of a process of separation and cleaning.

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Descriptions and details quoted in this publication apply to the Mercedes-Benz international model range. Differences relating to standard and optional equipment, engine options, technical specifications and performance data are possible in other countries.

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