

Life cycle

Environmental
Certificate Mercedes-Benz C-Class
including Plug-In Hybrid C 350 e



Mercedes-Benz



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Life cycle

Ten years ago, the S-Class became the first-ever vehicle to be awarded the Environmental Certificate from TÜV Süd. The “Life Cycle” brochure has been presenting the environmental certificates since 2009. The “Lifecycle COMPACT” edition now also being released is brand new. This compact overview illustrates the high level of environmental compatibility of Mercedes-Benz vehicles during the entire lifecycle in an easy-to-understand way, and also gets right to the heart of Daimler’s environmental commitment.

This “Lifecycle” brochure not only presents the extensive and complex topic of “automobiles and the environment” for public consumption, but also allows specialists to obtain detailed information.

“Lifecycle” uses a variable concept to meet these requirements. 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 “Lifecycle” documentation series, Mercedes-Benz is once again demonstrating its pioneering role in this important area. This tradition is being successfully continued with the new 2014 C-Class. The neutral inspectors from the TÜV Süd technical inspection authority have also confirmed the high level of environmental compatibility of the C 350 e introduced in March 2015.

* Fuel consumption C 350 e with automatic transmission (combined): 2.4-2.1 l/100km, 11.7-11.0 kWh/100km; CO₂-emissions (combined): 54-48 g/km.



Interview

“Unique hybrid initiative”

Ms Kleinschmit, after holding several responsible positions within the Daimler group, including your previous one as head of the centre of competence for transmissions, you have been the group's Chief Environmental Officer since the beginning of this year. A dream job?

As far as I can judge at the present, it is certainly a very varied and multi-faceted job (laughs). And right now we are in a very interesting phase with respect to the environmental compatibility and efficiency of our cars. On the one hand we have already achieved a great deal: within two vehicle generations, Mercedes-Benz Cars has reduced the fleet CO₂ emissions in Europe by over 40 percent. In 2014 the fleet figure in Europe was 129 g/km. This corresponds to an average fuel consumption of 5.1 litres per 100 km. On the other hand we are now embarking on an unprecedented hybrid initiative.

Ten new plug-in hybrids are to be launched by 2017, so on average a model of this type every four months?

Yes, that's correct. For us plug-in hybrids are among the key technologies on the way towards the locally emission-free future of the automobile. As their strengths come to the fore in larger vehicles with mixed operating profiles, Mercedes-Benz is opting for this drive concept from the C-Class upwards.

Take the C-Class, for example: After the successful launch of the S 500 PLUG-IN HYBRID, the C 350 e made its way to the dealerships in March 2015 as the second model featuring this progressive drive concept. What are the particular strengths of the new C 350 e?

The pleasure of a hybrid is best experienced with a test drive: the new C 350 e has the performance of a sports car but only consumes a certified 2.4 – 2.1 litres of fuel per 100 kilometres. Thanks to an intelligent on-board charging system, the battery can be recharged in around 1 hour and 30 minutes at a wall-box or at a public charging point.

However, it is not just the snapshot figure at the filling station that is decisive for the environmental balance of an automobile. What about efficiency throughout the entire lifecycle, consisting of production, operation over 200,000 kilometres and eventual recycling?

The C 350 e is a good example of how only a comprehensive assessment best reflects the true environmental impact: As the environmental certificate shows, the inevitably more intensive use of resources in production is more than compensated for by the significantly better ecobalance during operation.



**Interview with
Anke Kleinschmit,
Chief Environmental Officer
of Daimler AG**

The new C 350 e is undoubtedly the efficiency champion in the C-Class – but by no means the only model in this series with an exemplary environmental balance?

That is correct, for thanks to an intelligent lightweight construction concept, excellent aerodynamics and new, economical engines, the entire model series scores top marks for efficiency in its class. By employing an intelligent lightweight design with a high proportion of aluminium, for example, it has been possible to make the new C-Class up to 100 kilograms lighter than its predecessor. This means that a lower mass needs to be accelerated and braked, which reduces fuel consumption and emissions. Or take aerodynamic drag as another example: with a Cd figure of 0.24 for the C 220 BlueTEC BlueEFFICIENCY Edition, the C-Class Saloon is the top aerodynamic performer in the medium class. And let's not forget this: there is another hybrid model in this series, in the form of the C 300 BlueTEC HYBRID. This diesel hybrid has an output of 150 + 20 kW (204 + 27 hp) and is happy with a combined NEDC fuel consumption of only 3.6 litres of diesel (corresponding to 94 grams of CO₂).

What are the facts and figures?

External charging with the European electricity mix can cut CO₂ emissions by around 14 percent (about 5 tonnes) compared with the C 250* petrol-engined model. The use of renewably generated hydroelectricity makes a 41 percent reduction (15.1 tonnes) possible.

The C-Class is by tradition the biggest-selling model series from Mercedes-Benz. Does this mean that the C 350 e will play a correspondingly important role in the company's hybrid initiative?

Absolutely. Plus there is this: we are offering the C 350 e as a Saloon and Estate model right from the start. That too should live up demand. And although the battery takes up space, both have a very large luggage capacity of 335 (Saloon) and 350 – 1370 litres (Estate). That is undoubtedly an important factor for buyers, apart from dynamic performance, efficiency and other attributes of the brand such as comfort and safety.

* Fuel consumption C 250 with automatic transmission (combined): 5.6-5.3 l/100km; CO₂-emissions (combined): 131-123 g/km.





Product description

The new Mercedes-Benz C-Class: Sheer attraction

Thanks to an intelligent lightweight design concept producing weight savings of up to 100 kilograms, excellent aerodynamics and new economical engines, the C-Class establishes new efficiency benchmarks in its segment. A wide range of new assistance systems also ensures safety at the highest level.

The new C-Class has a sensual and pure design and offers a host of technical innovations as well as a comprehensive level of standard equipment, together with exemplary emissions and fuel consumption figures. This all adds up to substantial added value and long-term savings on motor vehicle tax and at the filling station.

Rigid body – lightly done

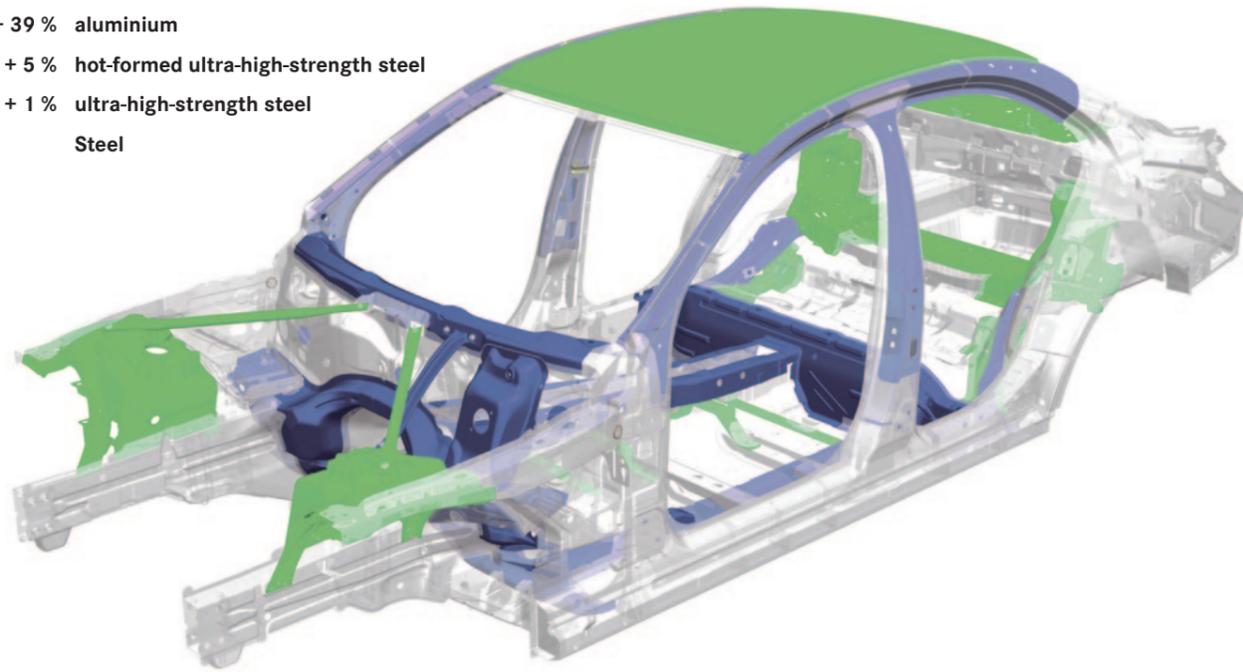
The bodyshell of the new C-Class provides an innovative basis for reduced weight and outstanding rigidity, including load introduction rigidity, so ensuring excellent handling, combined with optimum noise and vibration characteristics and a high level of crash safety. Thanks to the use of intelligent and innovative lightweight construction techniques, the aluminium hybrid body is around 70 kilograms lighter than a conventional steel body. The vehicle's overall weight has been reduced by as much as 100 kilograms. As such, the new C-Class is the "leader in the lightweight rankings" in its segment. This spawns numerous benefits: the lightweight construction of the new C-Class cuts fuel consumption by up to 20 percent without any loss of performance, while at the same time allowing a lower centre of gravity, which in turn gives rise to the vehicle's noticeably sporty and agile handling.

Highlights of the new C-Class

- Technological leap with intelligent lightweight design and high aluminium content. Up to 100 kilograms lighter. This makes the new C-Class the "leader in the lightweight rankings" in its segment.
- Sporty, agile suspension with new 4-link front axle.
- First-ever air suspension with continuous damper adjustment in this segment.
- Best-in-class aerodynamics: Cd figure 0.24.
- State-of-the-art operating convenience with rotary/push controller, touchpad, head-up display and internet-compatible navigation and entertainment system with large colour display above the centre console.
- High level of safety with virtually all new driver assistance systems from the E and S-Class.
- All engines already comply with EURO 6 emission standard.
- All engines with ECO start/stop function.
- High energy efficiency of ancillaries such as air conditioning system, clutch and refrigerant compressor.



- + 39 % aluminium
- + 5 % hot-formed ultra-high-strength steel
- + 1 % ultra-high-strength steel
- Steel



Mercedes-Benz achieves this feat of lightweight construction by various measures, including a completely new structural design and the use of an unusually high proportion of aluminium for a high-volume series. Compared with the successful predecessor, the aluminium content has increased from less than 10 percent to almost 50 percent.

Top aerodynamics figures

Low drag is crucial to achieving outstanding efficiency. From a speed of just under 70 km/h, aerodynamic drag exceeds the sum total of all other driving resistance factors. As such, drag is a major focus in the efforts to reduce fuel consumption and CO₂ emissions. With a Cd value of 0.24 for the C 220^[1] BlueTEC BlueEFFICIENCY Edition, the new C-Class Saloon sets a new benchmark in the medium-size category. The wind noise level, which was already very low in the preceding generation of the C-Class, has been lowered further still.

Lively engines with excellent CO₂ levels

Powerful and efficient petrol and diesel engines, all equipped with the ECO start/stop function and complying with Euro 6 emission standard, provide lively performance and driving enjoyment. They also cut fuel consumption by up to 20 percent compared with the preceding model.

Three engine variants are available at the market launch – a diesel in the form of the C 220 BlueTEC and the two petrol models, C 180^[2] and C 200^[3]. The further developed four-cylinder diesel with a displacement of 2.2 litres features tried-and-tested SCR technology (Selective Catalytic Reduction) for particularly environmentally responsible driving.

The BlueDIRECT petrol engines combine spontaneous response and exemplary power delivery with high efficiency and best-in-class emissions. To this end,



Mercedes-Benz has transferred the BlueDIRECT technology from the V6 and V8 engines to the four-cylinder engine. The direct injection system with spray-guided combustion, first introduced into passenger car series production by Mercedes-Benz, employs an electronically controlled precision multiple injection process.

Optimised powertrain

Depending on the installed output ratings, Mercedes-Benz offers a new 6-speed manual transmission for the four-cylinder engines in the new C-Class, which primarily excels with its enhanced ease of shifting, coupled with increased shifting precision and a harmonious gear change sequence. Smooth automatic gear shifting is provided by the automatic transmission 7G-TRONIC PLUS, which has undergone further development by Mercedes-Benz to further improve environmental friendliness and driving pleasure.

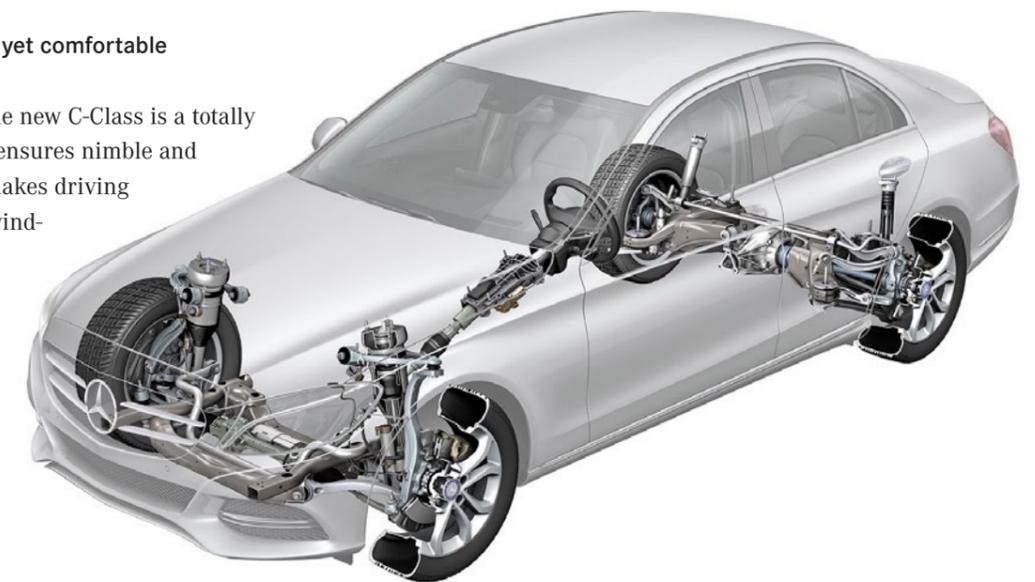
Suspension – sporty yet comfortable

The suspension on the new C-Class is a totally new development. It ensures nimble and agile handling that makes driving a great pleasure on winding roads, while also offering the highest standard of ride comfort in the segment.

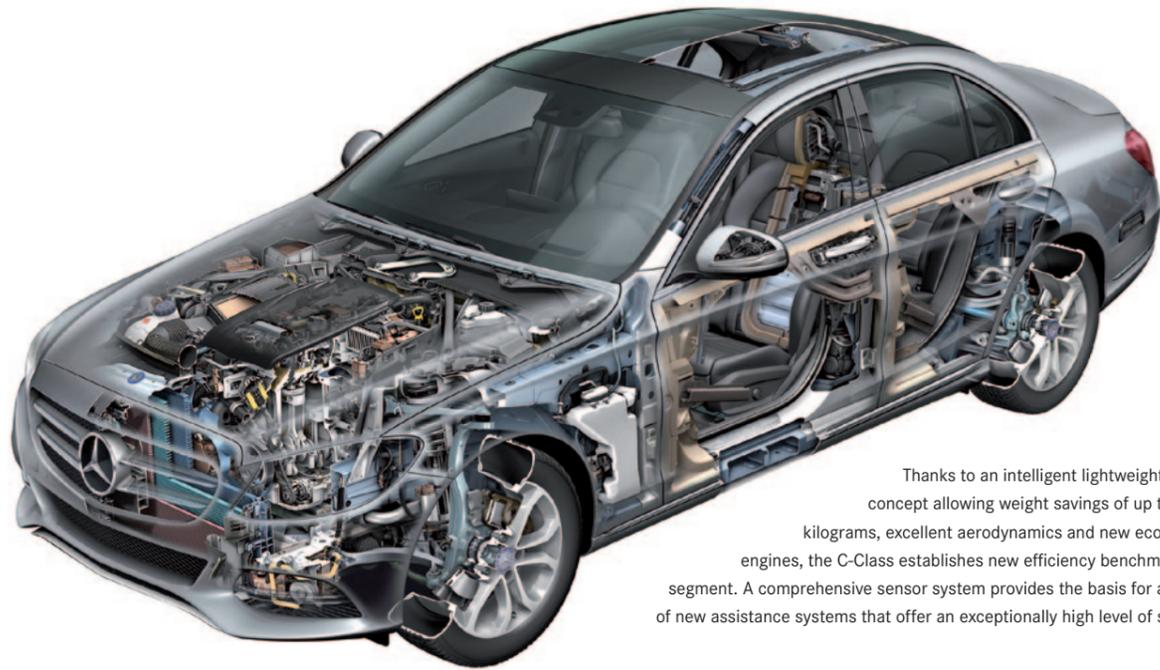


The suspension offers exemplary springing and road roar and tyre vibration characteristics, combined at the same time with outstanding dynamic handling. In addition, the new C-Class is the first vehicle in its segment that can be fitted with air suspension (AIRMATIC) at the front and rear axles.

A newly designed 4-link front axle plays a major part in the agile handling characteristics. Thanks to the 4-link principle, the wheel suspension is fully decoupled from the spring strut. The resultant favourable axle kinematics allow more grip and higher cornering forces. As a result, the suspension responds more sensitively to steering movements and allows a sporty, agile driving style. An optimised multi-link independent rear suspension with 5 links ensures unsurpassed wheel location qualities and supreme straight-line stability.



[1] Fuel consumption C 220 d with manual transmission (combined): 4.2-4.0 l/100km; CO₂-emissions (combined): 110-103 g/km.
 [2] Fuel consumption C 180 with manual transmission (combined): 5.5-5.0 l/100km; CO₂-emissions (combined): 126-116 g/km.
 [3] Fuel consumption C 200 with manual transmission (combined): 5.9-5.3 l/100km; CO₂-emissions (combined): 136-123 g/km.



Thanks to an intelligent lightweight design concept allowing weight savings of up to 100 kilograms, excellent aerodynamics and new economical engines, the C-Class establishes new efficiency benchmarks in its segment. A comprehensive sensor system provides the basis for a wide range of new assistance systems that offer an exceptionally high level of safety.

The new C-Class Saloon is fitted with a steel suspension as standard. Three DIRECT CONTROL suspensions with selective damping system are available in conjunction with this suspension:

- a comfort suspension
- a comfortable Avantgarde suspension lowered by 15 millimetres
- a sports suspension lowered by 15 millimetres

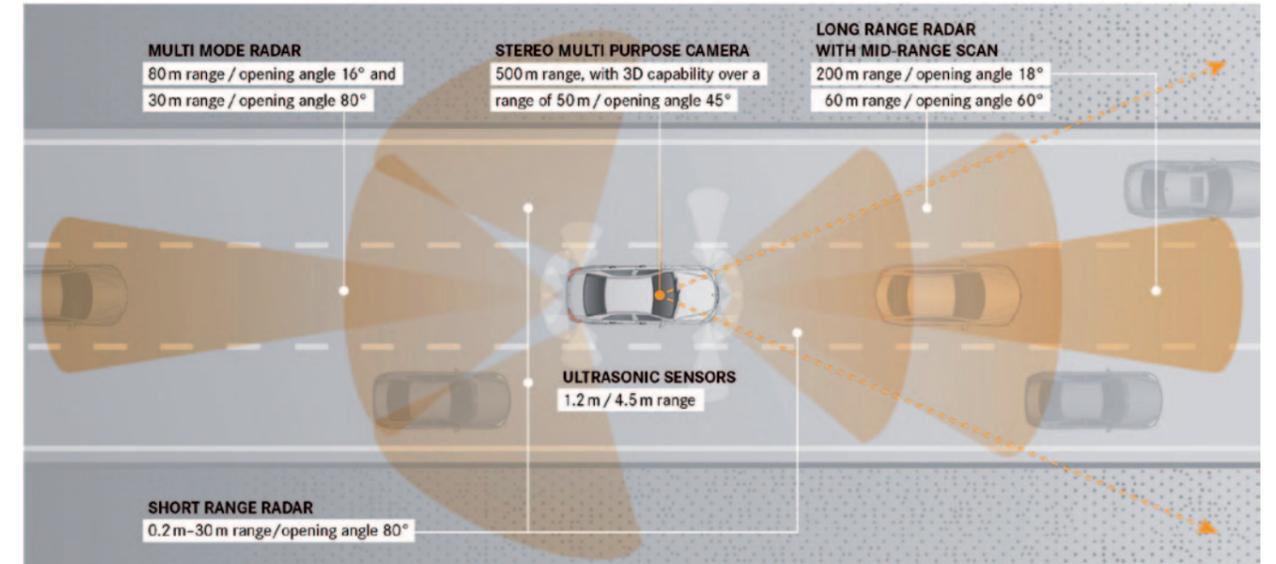
First air suspension in this category

Alternatively, the new C-Class is the first vehicle in its segment that can be fitted with an air suspension (AIRMATIC) at the front and rear axles. Thanks to electronically controlled, continuous variable damping at the front and rear, it offers outstanding road roar and tyre vibration characteristics even with the vehicle loaded. The driver can use the AGILITY SELECT switch to choose between the various characteristics: "Comfort", "ECO", "Sport" and "Sport+". The additional "Individual" option enables drivers to configure their vehicle to suit their own preferences. AIRMATIC also features all-round self-levelling for optimum ride comfort even with the vehicle loaded.



Steering with a sporty character

All models of the C-Class family will in future feature the electromechanical Direct-Steer system as standard. This combines speed-sensitive servo assistance from the speed-sensitive steering with a steering ratio that varies according to the given steering angle. The power assistance provided by the rack-and-pinion steering gear is controlled on demand, thereby contributing to efficiency.



Mercedes-Benz Intelligent Drive: the intelligent car

It is the declared aim of Mercedes-Benz to make the highest standard of safety available to everyone. To this end, the new C-Class incorporates almost all the new assistance systems, with a host of enhanced functions, that previously celebrated their world premiere in the S-Class and E-Class. The assistance systems increase both comfort and safety. Mercedes-Benz calls this Intelligent Drive.

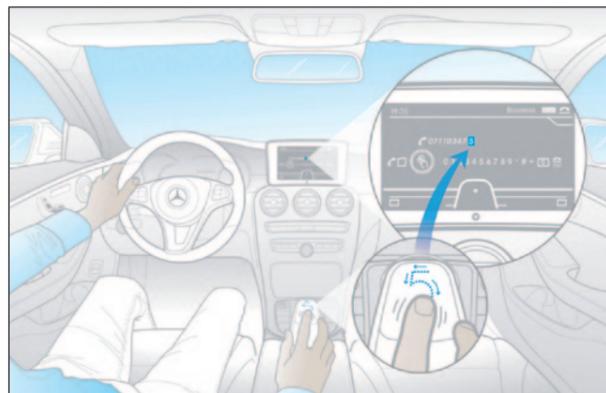
The new C-Class offers numerous innovative safety and assistance systems. It is fitted as standard with ATTENTION ASSIST, which can warn the driver of inattentiveness and drowsiness. On motorways the COMAND Online navigation function offers nearby break options as stopovers, providing the system has been specified in the vehicle. The ATTENTION ASSIST function offers an adjustable level of sensitivity and can inform drivers in a separate view in the instrument cluster about their level of drowsiness and how long they have been driving since their last break.

In addition to Adaptive Brake Assist, which offers protection from collisions from speeds as low as 7 km/h, standard-fit COLLISION PREVENTION ASSIST PLUS also features an additional function: when a danger of collision persists and the driver fails to respond, the system

is able to carry out autonomous braking at speeds of up to 200 km/h, thereby reducing the severity of collisions with slower or stopping vehicles. At speeds of up to 50 km/h the system also brakes in response to stationary vehicles, and is able to prevent rear-end collisions at up to 40 km/h.

New assistance systems from the new S-Class and E-Class, with a host of enhanced functions, are also optionally available, combining data from various sensor technologies as part of the Intelligent Drive concept to enhance comfort and safety substantially:

- DISTRONIC PLUS with Steering Assist and integrated Stop&Go Pilot is a semi-autonomous tailback driving system which in addition to using the lane markings, is able to follow the vehicle ahead at speeds below 60 km/h, thus providing a safe and convenient means of following the flow of traffic.
- BAS PLUS Brake Assist can now also detect crossing traffic and boost the braking force if the driver fails to apply the brakes sufficiently; the PRE-SAFE® Brake can detect stationary vehicles and even pedestrians, brake autonomously if the driver fails to react and thus prevent accidents at speeds of up to 50 km/h and mitigate the severity of collisions at speeds of up to 72 km/h. In flowing traffic the PRE-SAFE® Brake provides assistance according to the same mode of operation throughout the speed range from 7 to 200 km/h.

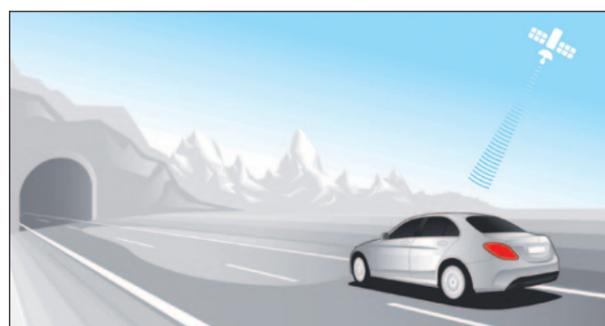


All the functions of the head unit can be controlled simply and intuitively from the touchpad, using fingertip gestures. The air-conditioning system of the new C-Class offers tunnel recognition using the satellite navigation system, whereby the air recirculation flap is automatically closed when the vehicle enters a tunnel and re-opened when it emerges.

- The enhanced Active Lane Keeping Assist system can now also prevent the vehicle from unintentionally drifting out of lane by applying the brakes on one side when the lane markings are interrupted and there is a risk of collision, e.g. as a result of vehicles overtaking at high speed, parallel traffic or even oncoming traffic.

The numerous assistance systems also include:

- Active Parking Assist, which allows automated parking with active steering and brake intervention in both parallel and end-on parking spaces,
- a 360° camera which is able to show the vehicle and its surroundings from various perspectives, including a virtual bird's-eye view,
- Traffic Sign Assist with wrong-way warning function, which warns of speed limits and also alerts the driver to no-overtaking zones and no-entry signs, as well as
- Adaptive Highbeam Assist Plus, which allows the high-beam headlamps to be kept on permanently without dazzling others by masking out other vehicles in the light cone of the high-beam headlamps.



Climate control: signals from space

Mercedes-Benz has undertaken systematic further development and substantial improvement of the air conditioning in the new C-Class. This applies in particular to the control quality, performance, efficiency and air quality. The new C-Class is the only vehicle in the segment also to offer tunnel detection via satellite navigation. It uses the map information from the navigation system and the GPS location data to close the air recirculation flap automatically when the vehicle enters a tunnel, subsequently re-opening it when the vehicle emerges from the tunnel.

Vibrant infotainment experience

A completely new multimedia generation offers intuitive operation in the new C-Class, featuring elaborate animations and visual effects which present all the functions in a clear and highly attractive manner. The new C-Class is also equipped with the unique Frontbass system. This avant-garde acoustic system uses the space within the



cross member and side member in the body structure as a resonance chamber for the woofers. The result is a listening experience almost on a par with that enjoyed in a concert hall. A Burmester® surround sound system is optionally available.

The navigation system presents its contents in interactive mode. Its features include an animated compass, a "Drive Show" with information for passengers similar to the on-screen presentations on board airliners and Google Maps displayed on the head unit. COMAND Online is now also able to provide more accurate real-time information about the situation on the roads when it receives its traffic data via the internet by means of the "Live Traffic Information" service.

Internet and diverse data sources already available in the basic version

A Bluetooth-compatible mobile phone with data option is all it takes to make the Audio 20 system internet-capable.



Loudspeaker covers with intricately photo-etched surfaces set into a surround made out of real stainless steel are just one example of the fine detailing that has gone into the new C-Class. A completely new multimedia generation offers intuitive operation, with elaborate animations and visual effects that present all the functions in a clear and highly attractive manner. Internet and diverse data sources are available even in the entry-level model.

This enables the internet to be surfed without restrictions when the vehicle is stationary. Mercedes-Benz Apps such as Weather, Google™ Local Search with StreetView and Panoramio, destination/route download and Facebook can be used while on the move, in conjunction with COMAND Online. Audio and video playback is possible from various sources. e.g. via Bluetooth, from the Apple iPod and iPhone, from SD card, USB stick or CD/DVD (with Audio 20 CD or higher and with COMAND Online).

COMAND Online with hotspot functionality

COMAND Online not only offers a larger display with a resolution of 960 x 540 pixels and a special bonded glass cover such as is familiar from consumer devices like the iPhone or iPad. It also allows digital TV/radio reception, for example, and offers a host of other features including fast hard-disc navigation, automatic tailback avoidance via up-to-date and accurate "Live Traffic Information", an integrated WLAN hotspot functionality and the LINGUATRONIC voice-operated control system.



C 350 e product description

Efficiency, dynamism and comfort – the best of three worlds

Following its premiere in the S-Class, Mercedes-Benz is now offering its most advanced hybrid technology yet in the C-Class and, for the first time, also in an estate model.

The dynamism and efficiency of the C 350 e make it a convincing proposition in both its saloon and estate variants. With an all-electric range of up to 31 kilometres, local emission-free driving is now a reality. Its four-cylinder petrol engine, in conjunction with a powerful electric motor, gives it a total system output of 205 kW (279 hp) with a system torque of 600 Nm.

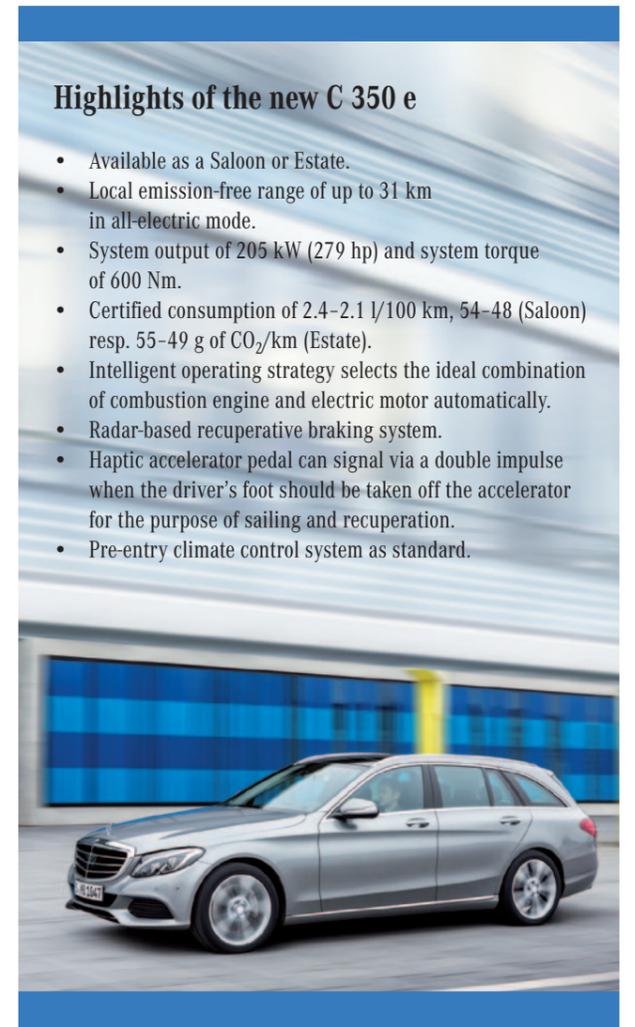
The new C 350 e thus delivers the performance of a sports car while offering a certified consumption of just 2.4–2.1 litres of fuel per 100 kilometres in both its Saloon and Estate variants. This corresponds to CO₂-emissions of 54–48 grams (Estate 55–49 grams) per kilometre. Both models are also equipped as standard with AIRMATIC air suspension plus a pre-entry climate control system that can be controlled via the internet, adding up to a truly exceptional level of driving and climatic comfort.

Following the C 300 BlueTEC HYBRID, the C 350 e is the second hybrid model in the new C-Class and the second Mercedes-Benz model to feature plug-in hybrid technology. Thanks to their combination of internal combustion engine and electric motor, hybrid drives stand out with their low consumption and high performance. The electric motor can replace or support the combustion engine and makes use of energy generated while braking by converting it into useful electric energy, which is stored and reused.

* Fuel consumption C 300 h with automatic transmission (combined): 3.9-3.6 l/100km; CO₂-emissions (combined): 103-94 g/km.

Highlights of the new C 350 e

- Available as a Saloon or Estate.
- Local emission-free range of up to 31 km in all-electric mode.
- System output of 205 kW (279 hp) and system torque of 600 Nm.
- Certified consumption of 2.4–2.1 l/100 km, 54–48 (Saloon) resp. 55–49 g of CO₂/km (Estate).
- Intelligent operating strategy selects the ideal combination of combustion engine and electric motor automatically.
- Radar-based recuperative braking system.
- Haptic accelerator pedal can signal via a double impulse when the driver's foot should be taken off the accelerator for the purpose of sailing and recuperation.
- Pre-entry climate control system as standard.





The plug-in hybrid technology can be integrated into the structure of the C-Class without any modifications, as the second-generation hybrid transmission is based on the 7G-TRONIC PLUS automatic transmission. Despite the space taken up by the battery, the C 350 e Saloon has a boot capacity of 335 litres.

The C 350 e employs the currently most advanced hybrid technology. Its electrical energy storage unit is a high-voltage lithium-ion battery with a total capacity of 6.38 kWh, which can be charged from an external power source to make an effective contribution to the low consumption and emission figures. The battery is water-cooled, weighs around 100 kilograms and is mounted in a sheet steel housing on top of the rear axle in order to maximise crash safety, driving dynamics and boot space.

Thanks to an intelligent on-board charging system, the battery can be recharged in around 1 hour 30 minutes at a wallbox or at one of the growing number of public charging points (230 V, 16 A, 3.7 kW single-phase), which in some cases offer privileged parking. Alternatively, charging via a domestic power socket is, of course, also possible. Depending on the connection, a charge time of around two hours is achievable (with 230 V and 13 A, 3.0 kW, single-phase).

Despite the space taken up by the battery, the C 350 e still has a boot capacity of 335 litres in its Saloon format and 350 litres in the Estate model or, in the latter case, 1370 litres with the rear seat backrests folded down and, as ever, a level load compartment floor.

Plug-in hybrid for the first time now with four-cylinder petrol engine

In the new Mercedes-Benz C 350 e, this hybrid drive concept is combined for the first time with an efficient four-cylinder petrol engine. From a displacement of just under two litres, it produces 155 kW (211 hp) with a maximum torque of 350 Newton metres. Its direct injection system with spray-guided combustion uses electronically precision-controlled multiple injection and fast multi-spark ignition. The electric motor in the C 350 e has an output of up to 60 kW and delivers a torque of 340 newton metres, A total system output of 205 kW (279 hp), as well as torque of 600 newton metres, are thus available.

7-speed automatic with additional clutch

The hybrid module of the standard 7-speed automatic transmission 7G-TRONIC PLUS incorporates both the electric motor and an additional clutch between the combustion engine and the electric motor. When driving in all-electric mode, this decouples the combustion engine from the drive train. It also, however, offers the possibility of moving off using the combustion engine but with the performance of a wet start-up clutch. The clutch here is a substitute for the torque converter.

A hybrid is efficient and dynamic to drive

The C 350 e offers all the characteristics of a state-of-the-art hybrid vehicle. These include first and foremost:



- Silent Start: the vehicle starts virtually silently and runs in electric mode. At this point the combustion engine is generally kept switched off. An electric output of up to 60 kW is available for driving in all-electric mode.
- Boost (additional output): the electric motor kicks in to boost the output of the combustion engine by a further 60 kW – for example for rapid acceleration.
- Energy recuperation: during braking and coasting, energy is recovered and stored in the battery. This energy is then available later for electric driving or as a power boost.

Impulses for the driver

An innovation in the C 350 e is the so-called haptic accelerator pedal, which helps to reduce fuel consumption and therefore also exhaust emissions. It provides two types of information:

- If the driver's foot meets a point of resistance on the accelerator pedal when driving in electric mode, this is an indication that maximum electric performance is being delivered. If the driver continues to depress the accelerator beyond this resistance point, the combustion engine will kick in.
- A double impulse from the ECO Assist function signals that the driver's foot should be removed from the acce-



Working in the background, the intelligent engine management system in the C 350 e selects the ideal combination of combustion engine and electric motor automatically. Then there are innovative functions such as the route-based operating strategy or the haptic accelerator pedal which can help the driver to drive economically.

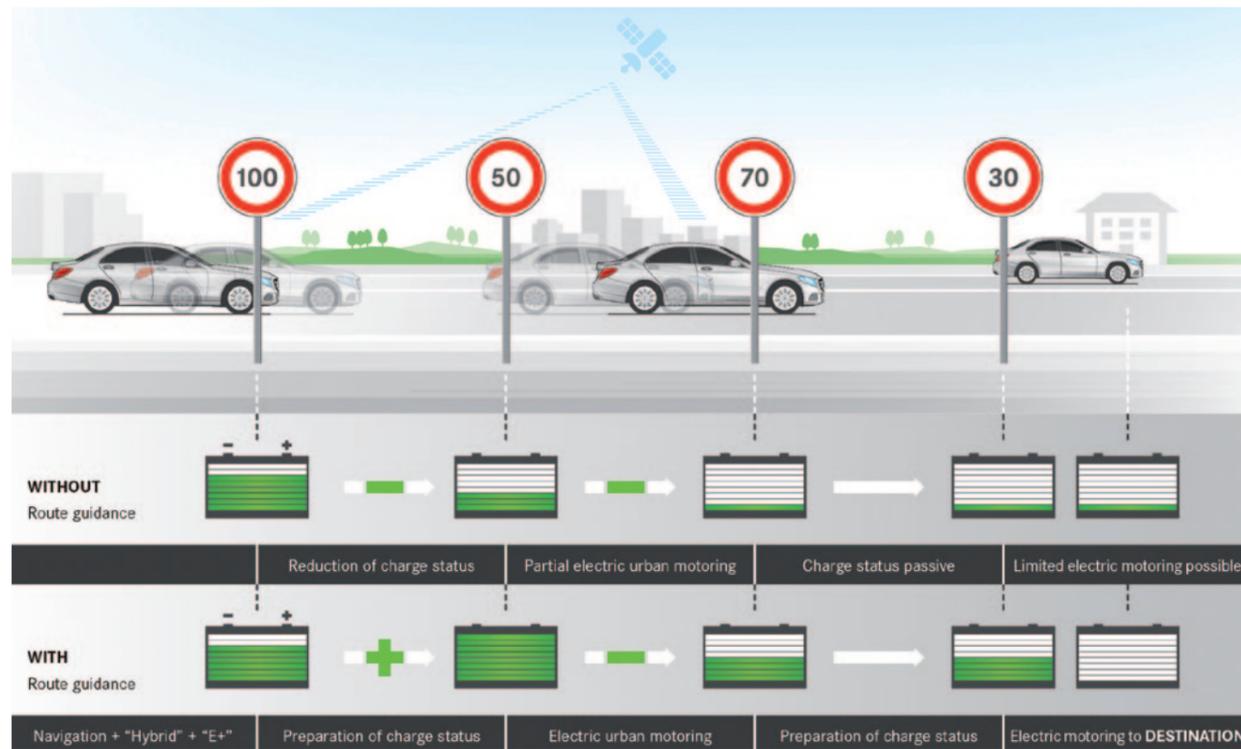
erator pedal in order to switch off the combustion engine and decouple it from the drive train. Assuming that the driver does what the double impulse suggests, the intelligent drive management system in the C 350 e varies how the vehicle behaves on the overrun between unpowered (coasting) and energy recovery, using data from the car's radar systems as a basis.

Individual transmission mode

The complex technology of the C 350 e makes it no more difficult to drive than a conventional vehicle with automatic transmission. But anyone wanting to can also intervene manually and regulate the hybrid interplay themselves, with the help of four operating modes and five transmission modes. This is done via an operating mode switch and a transmission mode switch located in the centre console. A display in the middle of the instrument cluster shows the current setting. Selecting a specific transmission mode enables the driver to define certain functions that influence the driving experience.

The following transmission modes are available:

- **I Individual:** individual definition of the characteristics of the transmission mode, including: drive, suspension, steering, ECO Assist, air conditioning
- **S + Sport+:** maximum boost power, very sporty gear



changes, the combustion engine is always active, particularly stiff suspension and damping settings.

- **S Sport:** enhanced boost power, sporty gear changes, the combustion engine is always active, stiff suspension and damping settings.
- **C Comfort:** boost power and energy recovery optimised for comfort and consumption, electric drive/engine shut-off possible up to 130 km/h, comfort-oriented standard settings.
- **E Economy:** boost power is consumption-optimised, energy recovery minimised in favour of the coasting distance. All-electric mode and engine shut-off are possible. If the navigation system's route guidance function is switched on and the Hybrid operating mode selected, the system will control the charge status of the high-voltage battery according to the route, ensuring that the electric operating mode is used as far as possible in built-up areas. The ECO Assist is also active.

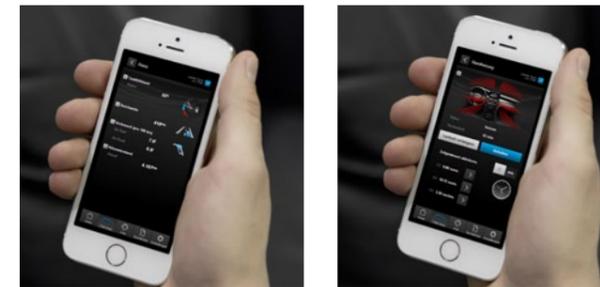
ECO Assist activates an additional function, using the radar technology behind the standard proximity warning system in order to do so. If the radar system identifies a slower-moving vehicle ahead, it sends a double impulse through the "haptic accelerator pedal" to signal to the driver to take their foot off the accelerator. The vehicle will then adjust its deceleration automatically, using the electric motor to do so. In this way frequent braking, particularly in stop-and-go traffic, can be avoided.

Choice of four operating modes

In addition to selecting a transmission mode, the driver of the C 350 e can also use the operating mode switch to influence the regulation between electric mode and use of the engine for driving. In the Eco and Comfort transmission modes, the following operating modes are available:

- **Hybrid:** all hybrid functions such as electric operating mode, boost and recuperation are available and are applied according to the driving situation and route in the most fuel-efficient manner.
- **E-Mode:** Used for all-electric driving – for inner-city areas or because the battery holds sufficient charge for the remainder of the journey.
- **E-Save:** the charge status of the battery is maintained – for example to allow all-electric driving in an environmental zone at a later stage in the journey. Electric driving and the boost function are therefore only available to a limited extent.
- **Charge:** allows the battery to be recharged while driving using the combustion engine – for example in order to ensure a higher state of battery charge for later parts of the journey. The combustion engine remains switched on and fuel consumption may increase. Electric operation is not possible.

In transmission modes **S+** and **S** the "Hybrid" operating mode is activated. In the **"Individual"** mode, the



The charging process or pre-entry climatisation can be conveniently controlled remotely via connect me: this is possible thanks to the electrically powered refrigerant compressor and electric heating elements for warm air circulation.

choice of available operating modes depends upon the drive system setting.

Route-based operating strategy

The best strategy for efficient operation is anticipatory driving. If the exact destination is known because the relevant data has been entered into the navigation system, charging and discharging of the high-voltage battery in the C 350 e are controlled to ensure the optimal use of energy on the overall route. Another key point is the requirement that urban areas should be reached with a fully charged battery if possible, so that the vehicle can be driven efficiently in stop-and-go traffic – and frequently in electric mode.

Air suspension and pre-entry climate control as standard

The new C 350 e offers the familiar range of equipment and appointment options that are available for the C-Class and, in addition, includes the enhanced comfort feature AIRMATIC air suspension as part of its standard specification, along with a further comprehensive range of pre-entry climate control options. Pre-entry climate control, a further standard feature, makes it possible to set the



The C 350 e is available in two body versions (Saloon and Estate), and with two different faces: the AVANTGARDE line has the Mercedes star in the radiator grille, and the EXCLUSIVE line on the bonnet in classic style.

desired temperature for the interior of the vehicle before setting off – cooling it in the summer, warming it up in the winter. This can be activated by pre-setting the departure time (can be set in the vehicle or from home via the internet at <http://connect.mercedes.me>) or directly by pressing a button. This is possible due to the electrically powered refrigerant compressor and electric heating elements for the warm air circulation. In vehicles with the appropriate specification, the seat ventilation or heating will also be activated. As well as the pre-entry climate control function, the charging of the vehicle can also be controlled via <http://connect.mercedes.me>. It is also possible to check the charge status of the high-voltage battery or the vehicle's potential range in electric mode.

Two different faces for the plug-in hybrid as well

The C 350 e is available in the AVANTGARDE exterior equipment line, which emphasises its sporty, premium-vehicle character. As an alternative and at no extra cost, both the saloon and estate versions are also available in the EXCLUSIVE exterior equipment line. With its classic radiator grille and three-pointed star on the bonnet, the C-Class conveys a prestige status and sense of modern luxury.

Validation



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 C-Class including Plug-In Hybrid C 350 e“ with statements for the passenger vehicle types C 180, C 200, C 250, C 350 e, C 400 4MATIC, C 63 AMG, C 63 S AMG, C 180 d, C 200 d, C 220 d, C 250 d, C 250 d 4MATIC and C 300 h 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 of the C 180, C 250 and C 350 e (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 C-Class. 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, 2015-08-18

Dipl.-Ing. Michael Brunk
Environmental Verifier

Dipl.-Ing. Ulrich Wegner
Head of Certification Body
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 different variants of the C-Class 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) each refer to the new C 180 with standard equipment. The LCA results for the C 350 e plug-in hybrid are also shown in comparison with the C 250 (Chapter 2.2.4).



1.1 Technical data

The table below shows key technical data for the variants of the new C-Class Saloon. The relevant environmental aspects are explained in detail in the environmental profile in Chapter 2.

Technical data	C 180	C 200	C 250	C 350 e	C 400 4MATIC	C 63 AMG	C 63 S AMG
Engine type	Petrol engine	Petrol engine	Petrol engine	Petrol engine/ Electric motor	Petrol engine	Petrol engine	Petrol engine
Number of cylinders	4	4	4	4	6	8	8
Displacement (effective) [cc]	1595	1991	1991	1991	2996	3982	3982
Output [kW]	115	135	155	155+60***	245	350	375
Emission standard (fulfilled)	EU 6	EU 6	EU 6	EU 6	EU 6	EU 6	EU 6
Weight (without driver and luggage) [kg]	1320**/ 1350	1375**/ 1390	1405	1705	1570	1640	1655
Exhaust emissions [g/km]							
CO ₂ *	126-116**/ 135-126	136-123**/ 131-123	131-123	54-48	181-170	195-192	195-192
NO _x	0.0139**/ 0.013	0.0572**/ 0.0299	0.0299	0.0099	0.0314	0.0348	0.0348
CO	0.2379**/ 0.1311	0.3741**/ 0.2711	0.2711	0.1080	0.1272	0.1452	0.1452
HC (petrol models)	0.049**/ 0.0511	0.0364**/ 0.0388	0.0388	0.0187	0.0417	0.0526	0.0526
NMHC (petrol models)	0.0439**/ 0.0471	0.024**/ 0.0274	0.0274	0.0166	0.0338	0.0405	0.0405
HC+NO _x (diesel models)	-	-	-	-	-	-	-
Particulate matter	0.00044**/ 0.00035	0.00018**/ 0.00062	0.00062	0.00016	0.00022	0.00056	0.00056
Particulate count [1/km]	4.77E11**/ 2.33E11	1.04E12**/ 1.95E12	1.95E12	5.14E11	3.00E11	4.86E11	4.86E11
Fuel consumption NEDC combined [l/100 km]*	5.5-5.0**/ 5.9-5.4	5.9-5.3**/ 5.6-5.3	5.6-5.3	2.4-2.1	7.8-7.3	8.4-8.2	8.4-8.2
Driving noise [dB(A)]	70**/71	71**/72	74	69	69	74	74

As of: 01/2015

NEDC consumption for base variant C 180 with manual transmission and standard tyres: 5.0 l/100km

* Figures depend on tyres

** Figures for vehicle with manual transmission.

*** Electric motor

Technical data	C 180 d	C 200 d	C 220 d	C 250 d	C 250 d 4MATIC	C 300 h
Engine type	Diesel engine	Diesel engine	Diesel engine	Diesel engine	Diesel engine	Diesel engine
Number of cylinders	4	4	4	4	4	4
Displacement (effective) [cc]	1598	1598	2143	2143	2143	2143
Output [kW]	85	100	125	150	150	150+20***
Emission standard (met)	EU 6	EU 6	EU 6	EU 6	EU 6	EU 6
Weight (without driver and luggage) [kg]	1410**/ 1430	1410**/ 1430	1475**/ 1495	1520	1585	1640
Exhaust emissions [g/km]						
CO ₂ *	110-99**/ 119-109	110-99**/ 119-109	110-103**/ 121-109	121-109	134-127	103-94
NO _x	0.0679**/ 0.0536	0.0679**/ 0.0536	0.0621**/ 0.0558	0.0558	0.0498	0.0707
CO	0.4459**/ 0.2731	0.4459**/ 0.2731	0.2779**/ 0.1824	0.1824	0.1788	0.2827
HC (petrol models)	-	-	-	-	-	-
NMHC (petrol models)	-	-	-	-	-	-
HC+NO _x (diesel models)	0.1099**/ 0.0767	0.1099**/ 0.0767	0.0811**/ 0.069	0.069	0.063	0.092
Particulate matter	0.00044**/ 0.00000	0.00044**/ 0.00000	0.00032**/ 0.00112	0.00112	0.00063	0.00074
Particulate count [1/km]	7.29E8**/ 9.53E8	7.29E8**/ 9.53E8	8.11E8**/ 2.56E9	2.56E9	8.43E10	5.42E8
Fuel consumption NEDC combined [l/100 km]*	4.2-3.9**/ 4.6-4.2	4.2-3.9**/ 4.6-4.2	4.2-4.0**/ 4.6-4.3	4.6-4.3	5.0-4.8	3.9-3.6
Driving noise [dB(A)]	71**/67	71**/67	73**/69	69	69	72

As of: 01/2015

1.2 Material composition

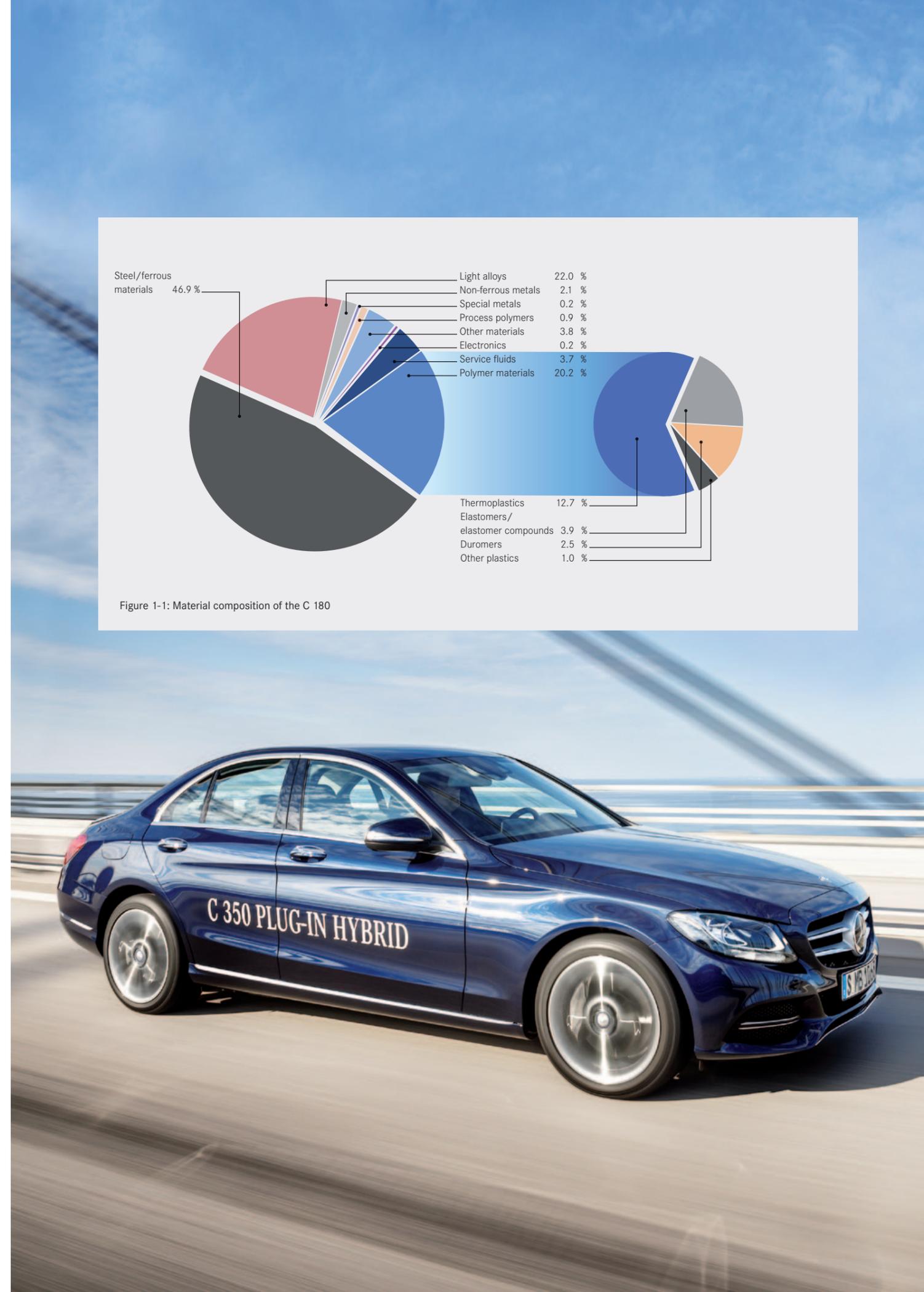
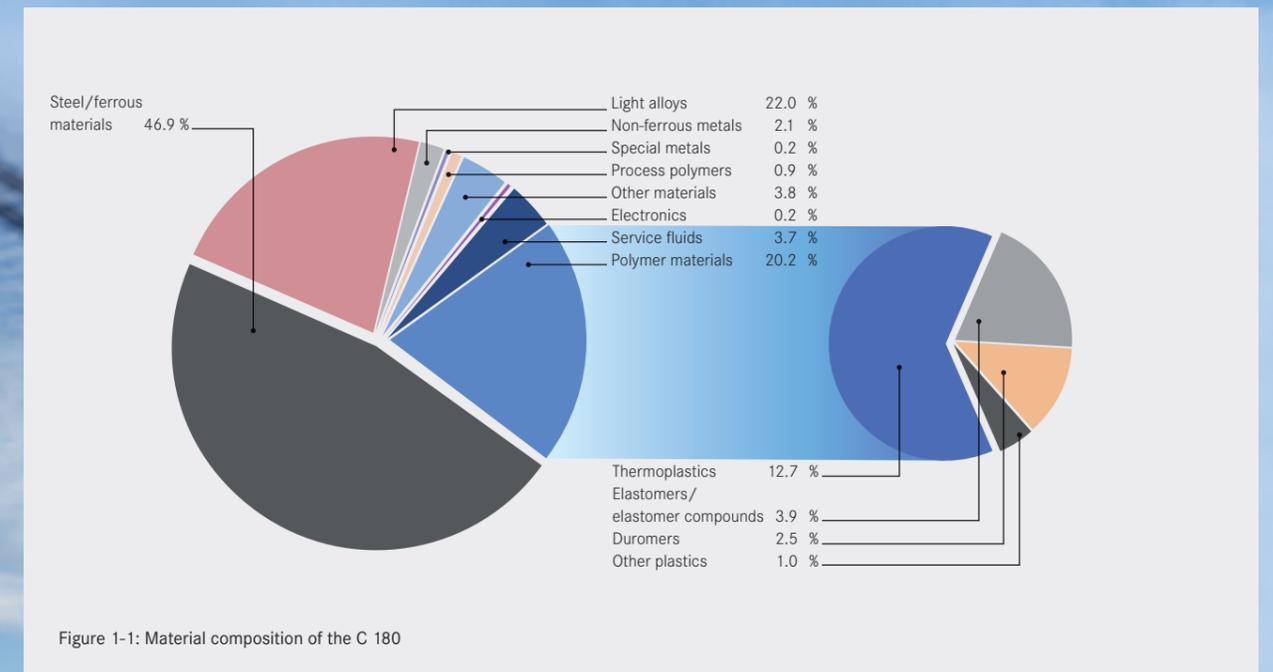
The weight and material data for the C 180 were determined on the basis of internal documentation of the components used in the vehicle (parts list, drawings). The “kerb weight according to DIN” (without driver and luggage, fuel tank 90 percent full) served as a basis for the recycling rate and LCA. Figure 1-1 shows the material composition of the C 180 in accordance with VDA 231-106.

Steel/ferrous materials account for slightly less than half the vehicle weight (46.9 percent) in the new C-Class. These are followed by light alloys at 22 percent and polymer materials as the third-largest group (20.2 percent). Service fluids comprise around 3.7 percent. The proportions of other materials (first and foremost glass) and non-ferrous metals are somewhat lower, at about 3.8 percent and 2.1 percent respectively. The remaining materials – process polymers, electronics, and special metals – contribute about 1.3 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 the thermoplastics accounting for the largest proportion at 12.7 percent. Elastomers (predominantly tyres) are the second-largest group of polymers with 3.9 percent.

The service fluids include all oils, fuel, 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 with the previous model reveals differences in particular with regard to steel and light alloys. The new C-Class has an approximately 10 percent lower steel content at 46.9 percent, while the proportion of light alloys is around 9 percent higher and the proportion of polymers 1 percent higher than in the preceding model. These changes can be attributed above all to the light-weight construction techniques used for the bodyshell and axles.



2 Environmental profile



The environmental profile documents general environmental features of the new C-Class with regard to such matters as fuel consumption and exhaust emissions. 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

The new C-Class achieves substantial reductions in fuel consumption. The C 180 with manual transmission shows a drop in fuel consumption in comparison to its predecessor from between 7.6 and 7.4 l/100 km (at the time of the market launch in 2007) or from between 6.4 and 5.8 l/100 km (at the time of discontinuation in 2013) to between 5.5 and 5.0 l/100 km – depending on the tyres fitted. This corresponds to a reduction in fuel consumption of up to 32 percent. The diesel variant also ensures a very high level of efficiency. The fuel consumption of the C 180 d* with manual transmission stands at a very favourable 4.2 to 3.9 l/100 km – depending on the tyres. The best consumption figure is achieved by the C 350 e. It has a certified fuel consumption of 2.4 – 2.1 l/100 km, corresponding to CO₂ emissions of 54 – 48 grams per kilometre.

The fuel efficiency benefits of the new C-Class are ensured by an intelligent package of measures. These extend to optimisation measures in the powertrain, energy management, aerodynamics, tyres with optimised rolling resistance, weight reduction using lightweight construction techniques and driver information to encourage an energy-saving driving style. The most important measures include:

- For all petrol and diesel drive systems: Friction-optimised downsizing engines with turbocharging, direct injection and thermal management; petrol engine with Camtronic (C 180).
- ECO start/stop function as a standard feature of all engines.
- Regulated fuel pump and oil pump that adjust their output according to the required load.

* Fuel consumption C 180 d with manual transmission (combined): 4.2-3.9 l/100km; CO₂-emissions (combined): 110-99 g/km.

Contributory factors to improved environmental performance

- Efficient powertrain with ECO start/stop system for all engine variants.
- Consumption-optimised ancillaries.
- Intelligent lightweight construction.
- Outstanding aerodynamics.
- Mercedes-Benz second-generation hybrid technology.
- ECO driver information.
- Certified environmental management system at production locations.



- Electric water pump which makes on-demand operation possible (C 180 and C 200).
- Use of tyres with optimised rolling resistance.
- Friction-optimised 6-speed manual transmission and 7-speed automatic transmission 7G-TRONIC PLUS.
- Fuel-economy rear axle differential with tapered roller bearings for reduced losses and low-friction oil.
- Aerodynamic optimisation courtesy of an optimised underfloor panelling concept comprising extensive panelling of both the engine compartment and the main underfloor, radiator shutter and wheels.
- Wheel bearings with substantially reduced friction.
- Weight optimisation through the use of lightweight materials.



Figure 2-1: Fuel economy measures for the new C-Class

- The intelligent alternator management in conjunction with an efficient alternator ensures that consumers are powered from the battery during acceleration, while during braking part of the resulting energy is recuperated and fed back into the battery.
- Highly efficient refrigerant compressor with magnetic clutch which avoids losses caused by the drag power.
- Optimised belt drive with decoupler.
- Innovative hybrid technology in the C 300 h and in the externally chargeable C 350 e plug-in hybrid.

The 2nd-generation hybrid module used in the diesel hybrid variant C 300 h consists of the 2.2-litre 4-cylinder diesel engine, the 20 kW electric motor, the 7G-TRONIC PLUS transmission, combined power electronics with a DC/DC converter and the lithium-ion high-voltage battery.

The C 300 h has the following attributes:

- Purely electric operation.
- Silent Start (purely electric operation after turning key).



- Automatic combustion engine start/stop function.
- Recuperation (recovery of braking energy and feed-in to high-voltage battery).
- Sailing (the combustion engine is switched off and decoupled from the drive train; the electric motor generates pulling power equivalent to that of a conventional vehicle).
- Sailing Plus (in electric operating mode, the energy recuperated during sailing is reduced to a minimum – the recuperation process is used purely to keep the vehicle’s 12 V electrical system supplied).
- Boost effect (the electric motor assists the combustion engine with additional drive torque when the accelerator pedal is rapidly depressed).
- Intelligent powertrain management (predictive operating strategy).

The C 300 h can cover a limited distance under electric power at speeds up to about 35 km/h, such as occur during manoeuvring and in stop-and-go traffic. After the combustion engine has been switched off, it is restarted as required by the situation. During electric driving, the combustion engine is started when a critical speed is reached, during the acceleration phase or when high power is required. While on the move, overrun recuperation begins as soon as the driver’s foot leaves the accelerator. This converts the vehicle’s kinetic energy into electrical energy and stores it in the high-voltage battery. This is also the case when the wheel brakes are used in addition for stronger deceleration. The electric motor of the hybrid

model assists the combustion engine with additional torque to improve drive system efficiency – especially when travelling in rural areas or on motorways.

Following the C 300 h, the C 350 e plug-in hybrid is the second hybrid model in the C-Class, and the second Mercedes-Benz model to feature plug-in hybrid technology. The C 350 e likewise uses the architecture of the Mercedes-Benz modular hybrid system. With this drive system, this model makes additional functions possible which result in great driving enjoyment and comfort combined with the lowest possible consumption and emissions, with local emission-free driving. The functions include purely electrically powered motoring up to a speed of 130 km/h, a range of up to 31 km in electric mode, and external charging of the high-voltage traction battery.

The C 350 e is powered by the 155 kW four-cylinder petrol engine in combination with an electric motor developing up to 60 kW. The hybrid module is integrated in the housing of the 7G-TRONIC PLUS 7-speed automatic transmission. The electrical energy is stored in a lithium-ion battery that can also be charged externally by connecting a charging cable to a domestic power socket or a wallbox.

In “HYBRID” operating mode, the innovative energy management system automatically selects the ideal combination of internal combustion engine and electric motor in the background, thereby not only adapting its strategy to the charge status of the battery but also anticipating the



traffic situation or the route. But anyone wanting to can also intervene manually and regulate the hybrid interplay themselves, with the help of four operating modes and three transmission modes.

These four hybrid operating modes can be selected at the push of a button:

- HYBRID: combined operation of electric motor and combustion engine
- E-MODE: maximum possible use of all-electric mode
- E-SAVE: fully charged battery is reserved to be able to drive on electric power alone later
- CHARGE: battery is charged while driving

The haptic accelerator pedal, as it is known, supplies the driver with feedback on the switch-on point of the combustion engine in E-MODE or signals via a double impulse when they should take their foot off the accelerator for the purpose of sailing and recuperation in E+ transmission mode.

Under the current terms of the European certification directive, the C 350 e achieves emissions of 54 - 48 g of CO₂ per kilometre depending on tyres. And with a fuel consumption equating to 2.4 - 2.1 litres per 100 kilometres, this model sets a top value in its class.

In addition to the improvements to the vehicle, the driver also has a decisive influence on fuel consumption. The predictive energy management system of the C 350 e includes an innovative display concept with an energy flow diagram in the instrument cluster. In the other models,

three bar graphs in the instrument cluster provide drivers with feedback about the economy of their driving style. The ECO display responds positively if the driver accelerates moderately, drives smoothly in an anticipatory manner and avoids unnecessary braking. The new C-Class owner's manual also includes additional tips for an economical and environmentally friendly driving style. 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 new C-Class is also fit for the future when it comes to its fuels. The EU's plans make provision for an increasing proportion of biofuels to be used. It goes without saying that the C-Class meets these requirements: in the case of petrol engines, a bioethanol content of 10% (E 10) is permitted. A 10% biofuel component is also permitted for diesel engines in the form of 7% biodiesel (B 7 FAME) and 3% high-quality, hydrogenated vegetable oil.

A high degree of environmental compatibility is achieved in terms of exhaust gas emissions, too. The petrol engines even undercut the much more stringent diesel particulate limit in the Euro 6 standard with no additional exhaust aftertreatment.

The C-Class is built in Germany, at the Mercedes plant in Bremen. An environmental management system certified in accordance with EU eco-audit regulations and ISO standard 14001 has been in place at this plant for many

years. The painting technology used, for example, is of a very high standard not only in technological terms but also with regard to environmental protection and workplace safety. Service life and value retention are further increased through the use of a newly developed clear coat which, thanks to state-of-the-art nanotechnology, ensures much greater scratch-resistance than conventional paint.

Considerable successes have also been achieved in Bremen in terms of energy savings. 2012 saw the successful completion of a five-year energy optimisation project (EOP) encompassing all aspects of the plant. The targeted 20 % reduction in specific energy consumption, based on the 2007 figures, was met in full. Energy savings of 110 GWh/a and thus a reduction in CO₂ of 25,000 tonnes per annum were achieved. The key measures undertaken involved the optimisation of the plant control system and process engineering changes in the paint shop, the implementation of demand and quality-controlled ventilation systems in the production areas, and the optimisation of compressed air generation.

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

The new C-Class is built at the Bremen plant, amongst other locations. Further production locations are East London (South Africa), Beijing (China) and for the first time also Tuscaloosa (Alabama/USA).

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 used 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 and makes an important contribution to the appropriately priced repair of Mercedes-Benz vehicles.

Although the reuse 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 LCA. 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 Life Cycle Assessment, Mercedes-Benz registers all the effects of a vehicle on the environment - from development via production and operation through to disposal.
- For a comprehensive assessment, all environmental inputs are accounted for within each phase of the life cycle.
- Many emissions arise not so much during the operation of the vehicle, but in the course of fuel production - for example the nitrogen oxide and sulphur dioxide emissions.
- The detailed analyses also include the consumption and processing of bauxite (aluminium production), iron and copper ore.



Life Cycle Assessments are used by the Mercedes-Benz passenger car development division for 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.

The elements of a Life Cycle Assessment are:

1. Goal and scope definition

define 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 raw material are used, how much energy is consumed, what wastes 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.

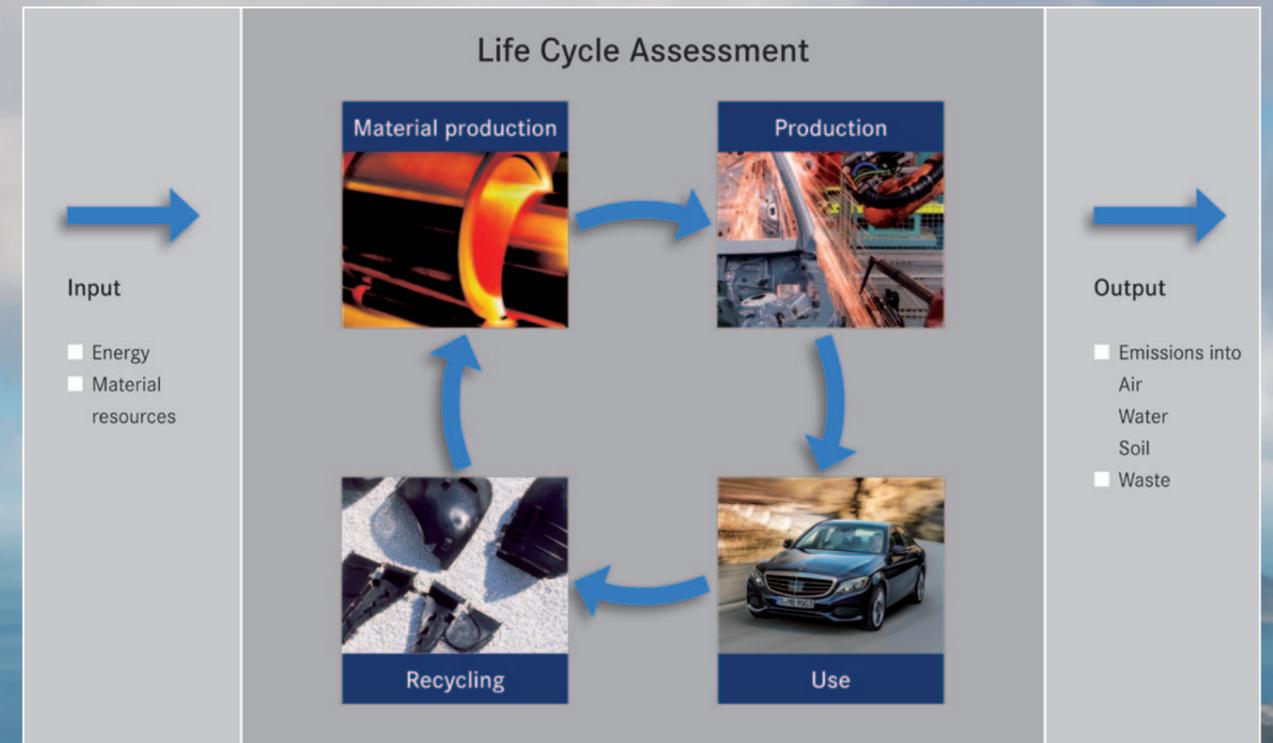


Figure 2-2: Overview of the Life Cycle Assessment



2.2.1 Data basis

To ensure the comparability of the examined vehicles, the ECE base variant is always examined. The C 180 (115 kW) with manual transmission was taken as the base variant of the new C-Class at market launch; it was compared with the corresponding preceding model.

The models C 250 and C 350 e were also examined. The main parameters on which the LCA was based are shown in the table below.

Project objective	
Project objective	<ul style="list-style-type: none"> LCA over the lifecycle of the new C-Class as the ECE base variant C 180 compared to its predecessor, and in model variants C 350 e and C 250. Verification of attainment of the objective “environmental compatibility” and communication.
Project scope	
Functional equivalent Technology/ product comparability	<ul style="list-style-type: none"> C-Class passenger car (base variant, weight in acc. with DIN 70020). With two generations of one vehicle model, the products are fundamentally comparable. Owing to progressive development and changing market requirements, the new C-Class provides additional features, above all in the area of active and passive safety. In cases where these additional features have an influence on the LCA, a comment is provided in the course of evaluation.
System boundaries	<ul style="list-style-type: none"> LCA for car production, use and recycling. The LCA limits must only be exceeded in the case of elementary flows (resources, emissions, non-recyclable materials).
Data basis	<ul style="list-style-type: none"> Weight data of car: MB C 180 parts list (as of: 06/2013); MB parts lists C 250 and C 350 e (as of: 01/2015). 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 data. Use (mileage): MB specification. C 350 e operating type acc. to certification directive ECE-R 101. Recycling model: state of the art (see also Chapter 2.3.1). Material production, energy supply, manufacturing processes and transport: LCA database as of SP22 (http://documentation.gabi-software.com); MB database.
Allocations	<ul style="list-style-type: none"> For material production, energy supply, manufacturing processes and transport, reference is made to GaBi databases and the allocation methods which they employ. No further specific allocations.

Table 2-1: LCA basic conditions

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 on the basis of a mileage of 200,000 kilometres.

The LCA includes the environmental impact of the recovery phase on the basis of the standard processes of drying, shredding and recovery of energy from the shredder light fraction (SLF). Environmental credits are not granted.

Project scope	(continued)
Cut-off criteria	<ul style="list-style-type: none"> 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 lifecycle 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 type and consequently of no relevance to the result of the vehicle comparison. Vehicle maintenance and care are not relevant to the result.
Assessment	<ul style="list-style-type: none"> Lifecycle, in conformity with ISO 14040 and 14044 (LCA).
Analysis parameters	<ul style="list-style-type: none"> Material composition according to VDA 231-106. Life cycle inventory: consumption of resources as primary energy, emissions such as CO₂, CO, NO_x, SO₂, NMVOC, CH₄, 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 meaningful results. Interpretation: sensitivity analyses of car module structure; dominance analysis over lifecycle.
Software support	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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 are discussed.
Documentation	<ul style="list-style-type: none"> Final report with all basic conditions.

2.2.2 LCA results for the C 180

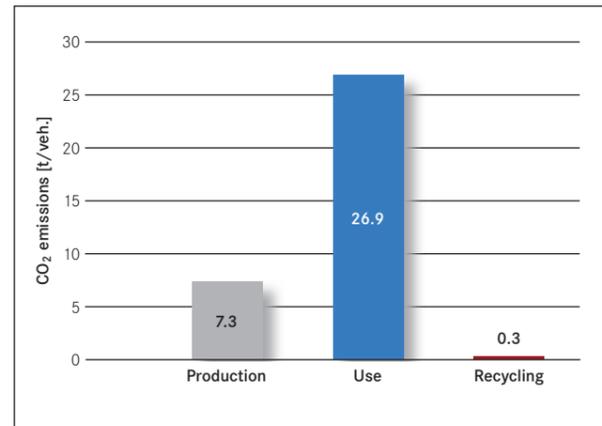


Figure 2-3: Overall carbon dioxide emissions (CO₂) in tonnes



Over the entire lifecycle of the C 180, the lifecycle inventory analysis yields e.g. a primary energy consumption of 521 gigajoules (corresponding to the energy content of around 16,000 litres of petrol), an environmental input of approx. 35 tonnes of carbon dioxide (CO₂), around 19 kilograms of non-methane volatile organic compounds (NMVOC), around 25 kilograms of nitrogen oxides (NO_x) and 37 kilograms of sulphur dioxide (SO₂). 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 CO₂ emissions, and likewise for primary energy requirements, the operating phase dominates with a share of 78 and 74 percent respectively (see Figure 2-3/2-4).

However, it is not the use of the vehicle alone which determines its environmental compatibility. Some environmentally relevant emissions are caused principally by manufacturing, for example SO₂ and NO_x emissions (see Figure 2-4). The production phase must therefore be included in the analysis of ecological compatibility. During the use phase of the vehicle, many of the emissions these days are dominated less by the actual operation of the vehicle and far more by the production of fuel, as for example in the case of the NO_x and SO₂ emissions and the inherently associated environmental impacts such as the eutrophication potential (EP) and acidification potential (AP).

For comprehensive and thus sustainable improvement of the environmental impacts associated with a vehicle, it is essential that the end-of-life phase is also considered.

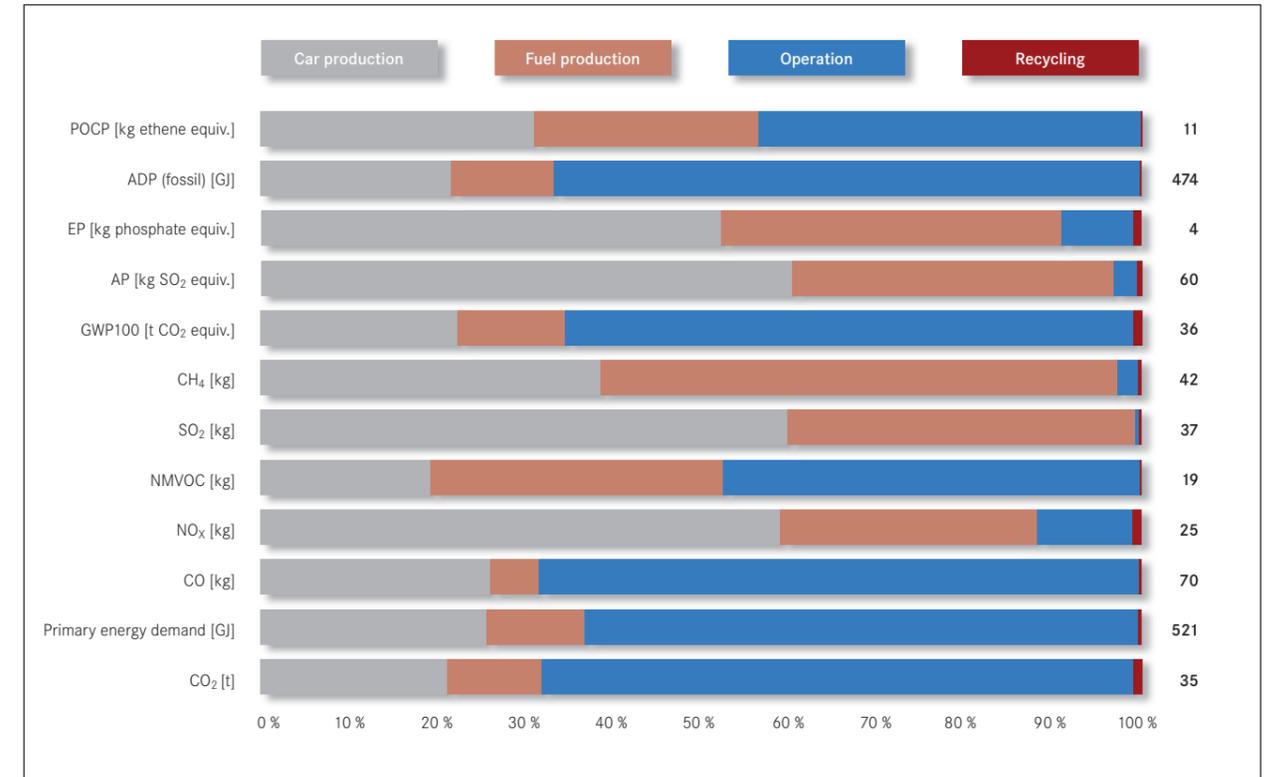


Figure 2-4: Share of life cycle phases for selected parameters

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. In addition to the results presented above it has also been determined, for example, that municipal waste and tailings (first and foremost ore processing residues and overburden) arise primarily from the production phase, while special and hazardous waste is caused for the most part by fuel production during the use phase.

Environmental burdens in the form of emissions into water result from vehicle manufacturing, in particular owing to the output of inorganic substances (heavy metals, NO₃⁻ and SO₄²⁻ ions) as well as organic substances, measured according to the factors AOX, BOD and COD.

To allow 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 standardised form for the lifecycle of the C 180 (see Fig. 2-5).

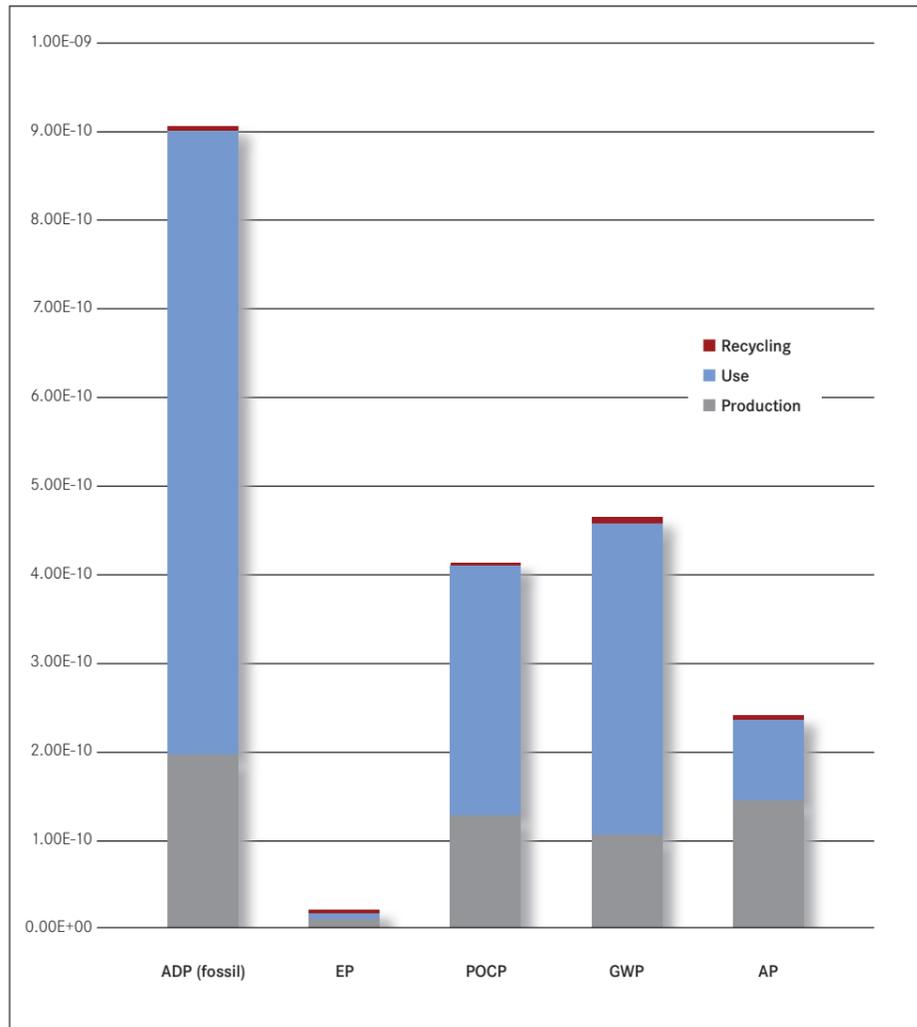


Figure 2-5: Normalised lifecycle of the C 180 [-/passenger car]

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 lifecycle of the C 180 HYBRID over one year. In relation to the annual European values, the C 180 reveals the greatest proportion for fossil ADP, followed by GWP and POCP. The relevance of these two impact categories on the basis of EU 25 +3 is therefore greater than that of acidification and eutrophication.

In addition to the analysis of overall results, the distribution of selected environmental impacts on the production of individual modules is investigated. Figure 2-6 shows by way of example the percentage distribution of carbon dioxide and sulphur dioxide emissions for different modules. While bodyshell manufacturing features predominantly in terms of carbon dioxide emissions, owing to its share of overall mass, when it comes to sulphur dioxide it is modules with precious and non-ferrous metals and glass that are of greater relevance, since these give rise to high emissions of sulphur dioxide in material production.

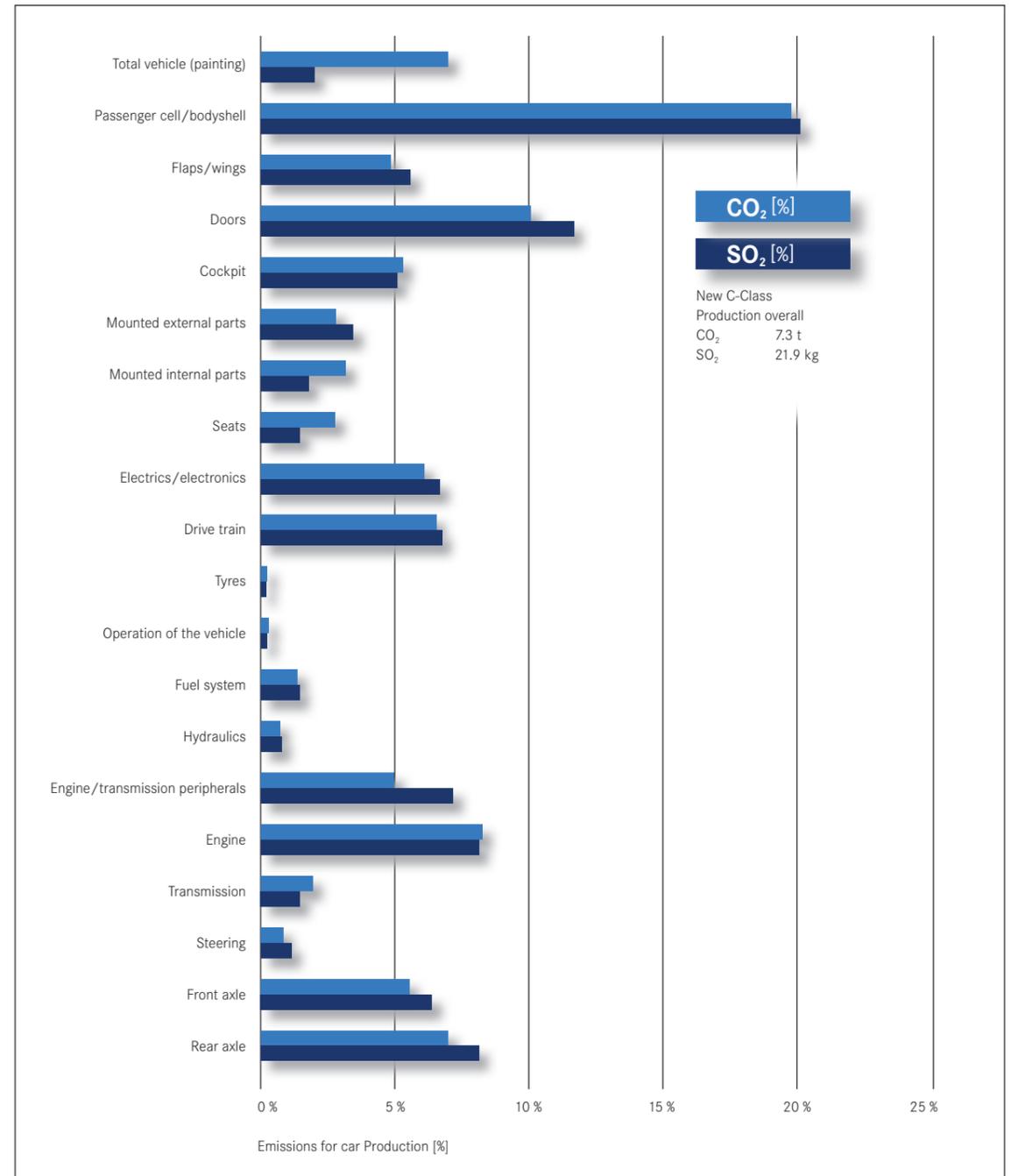


Figure 2-6: Distribution of selected parameters (CO₂ and SO₂) to modules

2.2.3 Comparison with the preceding model



The new C-Class shows the classic saloon proportions that are so characteristic of its predecessor.

High potential for reductions exploited

The following reductions apply in comparison to the preceding model at the time of its market exit:

- Reduction in CO₂ emissions over the entire lifecycle by 10 percent (3.8 tonnes).
- Reduction of the primary energy demand of 8 percent over the entire lifecycle, corresponding to the energy content of approx. 1400 litres of petrol.
- Over its entire lifecycle, the new C-Class shows significant advantages in regard to CO₂, NO_x, NMVOC and CH₄ as well as in regard to the impact categories global warming potential, acidification, eutrophication and summer smog.



In parallel with the analysis of the new C-Class, an assessment of the ECE base version of the preceding model was made (1395 kilograms DIN weight on market exit and 1410 kilograms on market launch respectively). The parameters on which this was based are comparable to the modelling of the new C-Class. The production process was represented on the basis of extracts from the current list of parts. Operating data for the preceding model with the same engine displacement were calculated using the valid certification values. The same state-of-the-art model was used for recovery and recycling.

As Figure 2-7 shows, production of the new C-Class results in a higher quantity of carbon dioxide emissions than in the case of the predecessor. CO₂ emissions over the entire lifecycle are however clearly lower for the new C-Class.

At the beginning of the lifecycle, production of the new C-Class gives rise to a higher quantity of CO₂ emissions than was the case with its predecessor (7.3 tonnes of CO₂ overall). In the subsequent operating phase, the new C-Class emits around 27 tonnes of CO₂; the total emissions during production, use, and recycling thus amount to 34.5 tonnes of CO₂.

Production of the previous model at the time of market exit (= predecessor from 2013) gives rise to 6.5 tonnes of CO₂. The figure for the predecessor from 2007 is at much the same level, at 6.6 tonnes. Owing to the higher fuel consumption, the preceding models emit 31.5 tonnes (2013) and 40.9 tonnes (2007) of CO₂ during use. The recycling process contributes around 0.3 tonnes of CO₂. The overall figures for the preceding models are 38.3 tonnes and 47.8 tonnes of CO₂ emissions respectively.

Taking the entire life cycle into consideration, namely production, operation over 200,000 kilometres and recycling/disposal, the new C-Class produces CO₂ emissions that are 10 percent (3.8 tonnes) lower than those of its predecessor at the time of market exit. Compared with the preceding model at the time of market entry, the new C-Class is around 28 percent (13.3 tonnes) better.

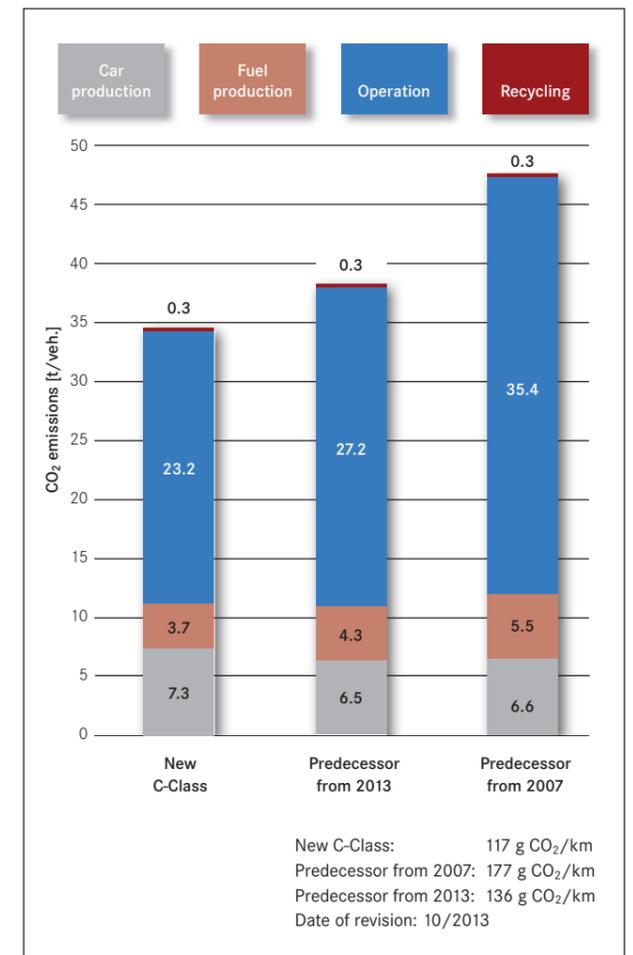


Figure 2-7: Carbon dioxide emissions of the C 180 in comparison to its predecessor [t/car].

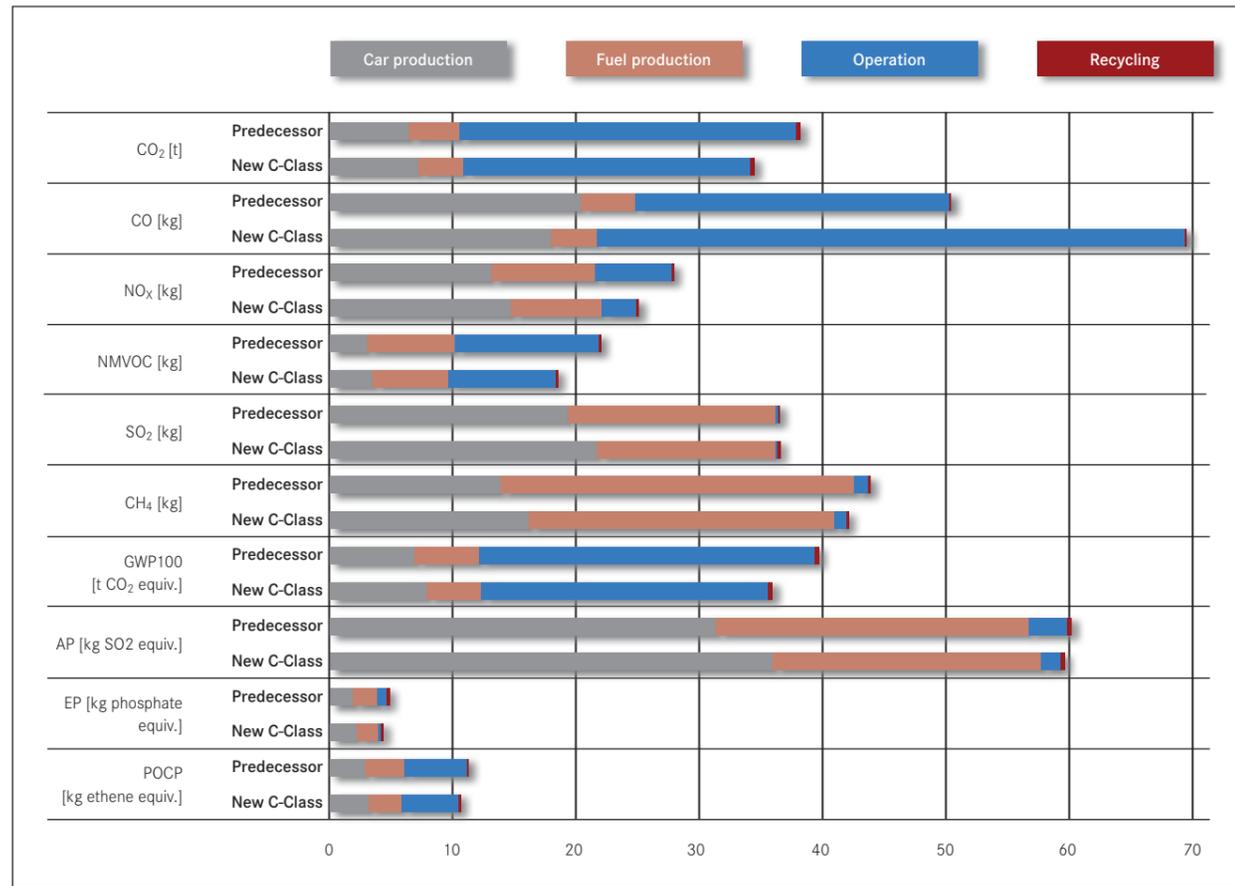


Figure 2-8: Selected result parameters for the C 180 compared with its predecessor from 2013 [unit/car]

Figure 2-8 shows further emissions into the atmosphere and the corresponding impact categories in comparison over the various lifecycle phases. Over the entire lifecycle, the new C-Class shows clear advantages in terms of CO₂, NO_x, NMVOC and CH₄ emissions, as well as in the impact categories of global warming potential, acidification, eutrophication and summer smog. Emissions of sulphur dioxide are on a par with those of the preceding model.

In terms of carbon monoxide (CO) emissions during the operation of the vehicle, a significant improvement was achieved over the 2007 predecessor. It was not possible, however, to achieve the very good figure shown by the preceding model at the time of market exit. The CO emissions of the new C-Class during operation are 76 % below the level stipulated by the Euro 6 standard that comes into effect in 2015.

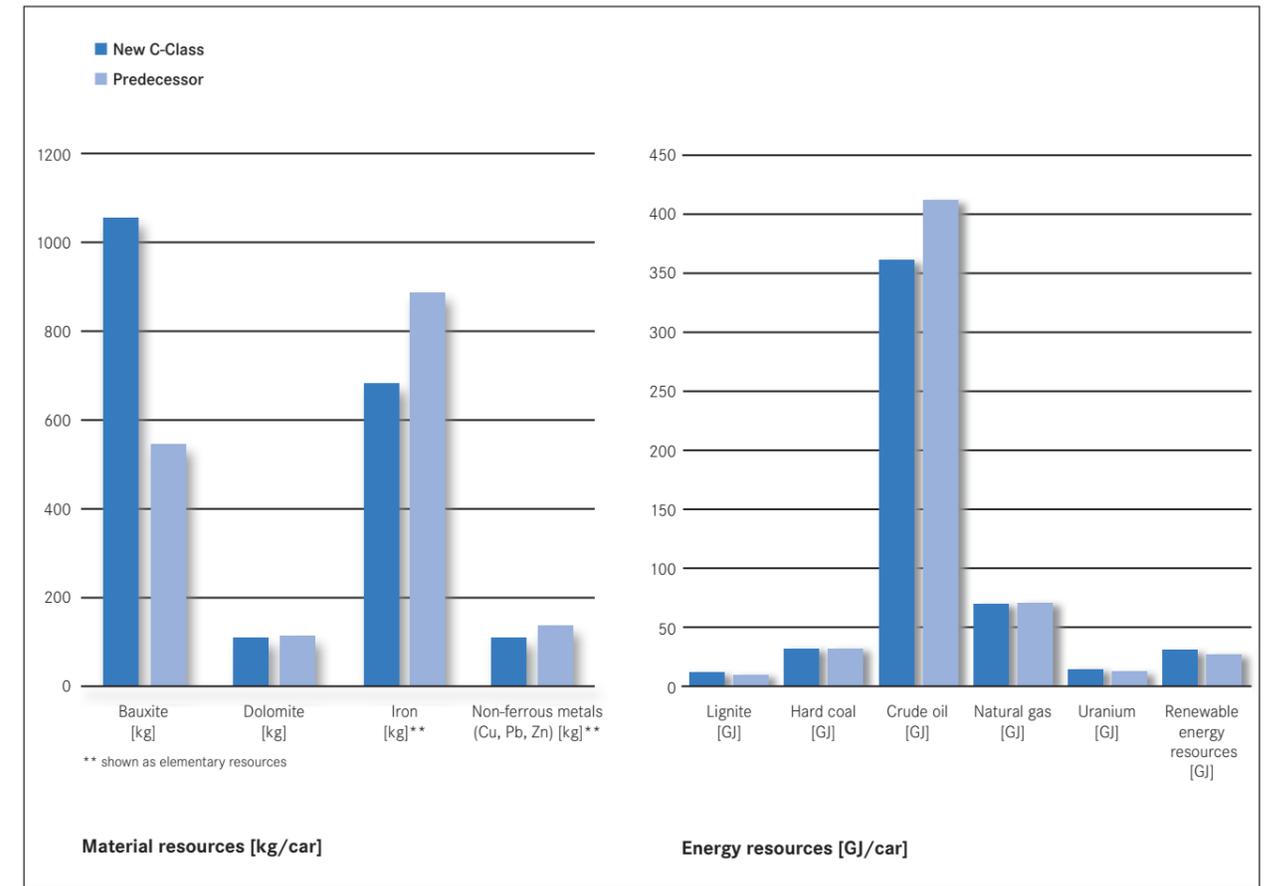


Figure 2-9: Consumption of selected material and energy resources by the new C 180 compared with the predecessor from 2013 [unit/car]

Figure 2-9 shows the consumption of relevant material and energy resources. Because of the shifts in the materials mix, the material resources requirements for car manufacture also change.

For example, the iron requirements are less because the share of steel is less, while the bauxite requirement increases because of the higher light alloy share. Where energy resources are concerned, lignite, hard coal and uranium figure principally in car production. The new C-Class shows a slightly higher level in this respect than its predecessor. Natural gas and above all crude oil are

strongly influenced by fuel consumption during the use phase. In total, including production and operation, considerable savings are realised by the new C-Class thanks to the greatly reduced fuel consumption.

Compared with the predecessor, primary energy savings of 8 percent (2013) and 25 percent (2007) are achieved over the entire lifecycle. The fall in energy demand by 45 GJ (2013) and 170 GJ (2007) corresponds to the energy content of about 1400 and 5300 litres of petrol respectively.

Input parameters

Material resources	New C-Class	Predecessor from 2013	Delta to Predecessor from 2013	Predecessor from 2007	Delta to Predecessor from 2007	Comments
Bauxite [kg]	1060	546	94 %	555	91 %	Aluminium production, higher primary content.
Dolomite [kg]	107	116	-8 %	120	-11 %	Magnesium production, smaller mass of magnesium.
Iron [kg]**	683	886	-23 %	894	-24 %	Steel production, smaller mass of steel.
Non-ferrous metals (Cu, Pb, Zn) [kg]**	112	139	-19 %	140	-20 %	Esp. electrics (cable harnesses, battery) and zinc.

**as elementary resources

Energy resources	New C-Class	Predecessor from 2013	Delta to Predecessor from 2013	Predecessor from 2007	Delta to Predecessor from 2007	Comments
ADP fossil* [GJ]	474	525	-10 %	644	-26 %	Mainly fuel consumption.
Primary energy [GJ]	521	566	-8 %	691	-25 %	Consumption of energy resources. Much lower compared with the predecessor, due to consumption advantage of new C-Class.
Proportionately						
Lignite [GJ]	12	11	12	11	5 %	Approx. 84 % from car production.
Natural gas [GJ]	70	72	-2 %	82	-15 %	Approx. 47 % from use.
Crude oil [GJ]	360	410	-12 %	518	-30 %	Significant reduction on account of lower fuel consumption.
Hard coal [GJ]	33	33	0 %	34	-3 %	Approx. 94 % from car production.
Uranium [GJ]	15	13	16 %	14	10 %	Approx. 88 % from car production.
Renewable energy resources [GJ]	31	27	12 %	32	-4 %	Approx. 56 % from car production.

CML 2001, date of revision: November 2010

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 using a characterisation factor, for example the contribution to global warming potential in kilograms of CO₂ equivalent.

In Table 2-3 the superordinate impact categories are also indicated first. In the impact categories GWP, AP, EP and POCP, the new C-Class has clear advantages over the predecessor. The goal of bringing about improved environmental performance in the new model over its predecessor was achieved overall.

Output parameters

Emissions in air	New C-Class	Predecessor from 2013	Delta to Predecessor from 2013	Predecessor from 2007	Delta to Predecessor from 2007	Comments
GWP* [t CO ₂ equiv.]	36.0	39.8	-9%	49.5	-27 %	Mainly due to CO ₂ emissions.
AP* [kg SO ₂ equiv.]	59.7	60.3	-1%	65.8	-9 %	Mainly due to SO ₂ emissions.
EP* [kg phosphate equiv.]	4.4	4.8	-8%	4.9	-10 %	Mainly due to NO _x emissions.
POCP* [kg ethene equiv.]	10.6	11.3	-7%	10.9	-3 %	Mainly due to NMVOC emissions.
CO ₂ [t]	35	38	-10%	48	-28 %	Mainly from driving operation. CO ₂ Reduction is a direct result of the lower fuel consumption.
CO [kg]	70	50	38 %	104	-33 %	Around 74 % owing to use, of which approx. 93 % driving operation.
NMVOC [kg]	19	22	-16 %	17	9 %	Around 81 % owing to use of which approx. 59 % driving operation.
CH ₄ [kg]	42	44	-4 %	53	-21 %	Around 39% from car production. The rest mainly from fuel production. Driving operation accounts for only around 2 %.
NO _x [kg]	25	28	-10 %	27	-6 %	Around 59 % from car production. The remainder owing to car use. Driving operation accounts for only around 11 % of the total nitrogen oxide emissions.
SO ₂ [kg]	37	37	0 %	41	-12 %	Around 60 % from car production. Rest from fuel production.

Emissions in water	New C-Class	Predecessor from 2013	Delta to Predecessor from 2013	Predecessor from 2007	Delta to Predecessor from 2007	Comments
BOD [kg]	0.3	0.1	75 %	0.2	57 %	Approx. 80 % from car production.
Hydrocarbons [kg]	0.5	0.5	0 %	0.5	-13 %	Approx. 45 % from use.
NO ₃ ⁻ [g]	3988	4414	-10 %	5514	-28 %	Approx. 86 % from use.
PO ₄ ³⁻ [g]	78	80	-3 %	97	-20 %	Approx. 66 % from use.
SO ₄ ²⁻ [kg]	14,5	14,1	3 %	16	-7 %	Approx. 67 % from car production.

* CML 2001, date of revision: November 2010

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

2.2.4 LCA results for C 350 e compared to C 250



The plug-in hybrid model in the current C-Class, the C 350 e, combines a 60 kW electric motor and an externally rechargeable battery with a four-cylinder petrol engine displacing just under two litres.

While the battery of the C 300 h hybrid is charged during braking, on the overrun or by the internal combustion engine, the new high-voltage lithium-ion battery of the C 350 e with an energy content of 6.38 kWh can also be externally charged from a charging socket. With the aid of the synchronous electric motor, the C-Class thus has an all-electric range of 31 kilometres. The quantities of electricity and petrol consumed during use of the vehicle were calculated on the basis of the shares pertaining to the respective operating modes as determined in accordance with the certification rules and the certified consumption figures. The electric energy consumption (NEDC) stands at 11.0 kWh/100 km in accordance with ECE-R101. With regard to generation of the externally charged electric power, the two EU variants “electricity grid mix” and electricity from “hydro power” were examined.

Fig. 2-10 compares the carbon dioxide emissions of the C 350 e with those of the C 250 on which it is based. Production of the C 350 e entails a visibly higher level of carbon dioxide emissions, on account of the additional hybrid-specific components. Over the entire lifecycle comprising manufacture, operation over 200,000 kilometres and recycling, however, the plug-in hybrid has clear advantages. External charging with the European electricity grid mix can cut CO₂ emissions by around 14 % (approx. 5 tonnes) compared to the C 250 petrol model. A 41 % reduction (approx. 15 tonnes) is possible through the use of renewably generated electricity from hydro power.

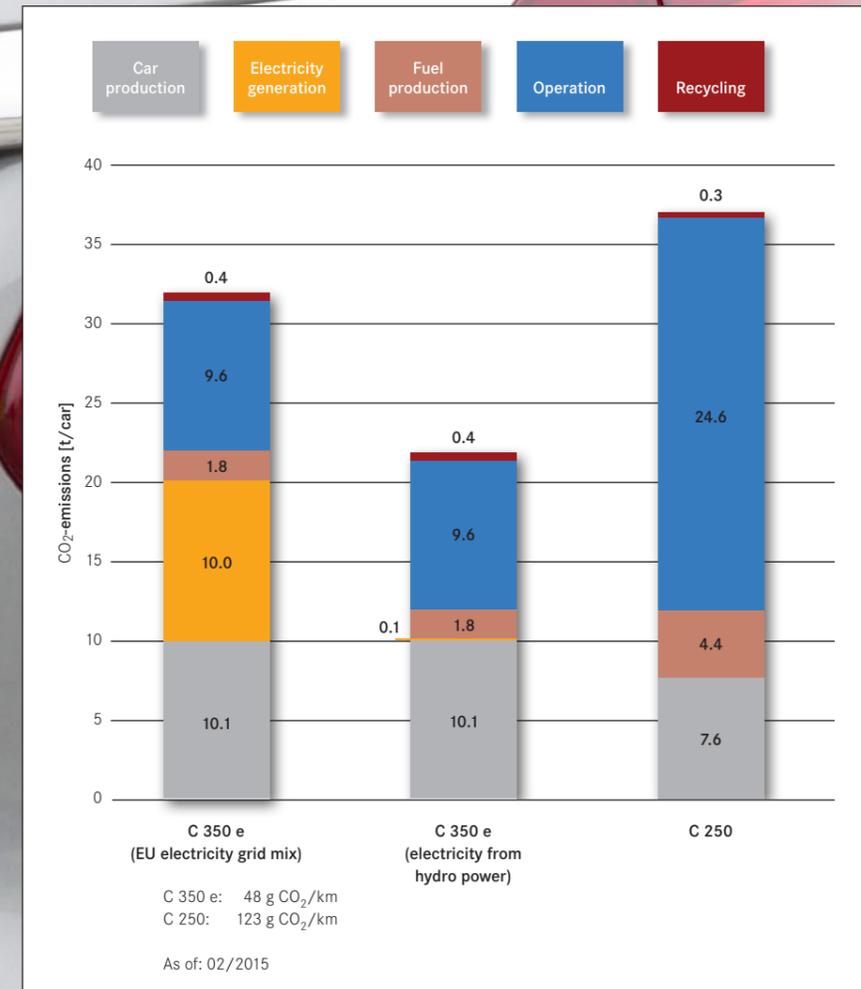


Figure 2-10: Comparison between the carbon dioxide emissions of the C 350 e and the C 250 [t/car]

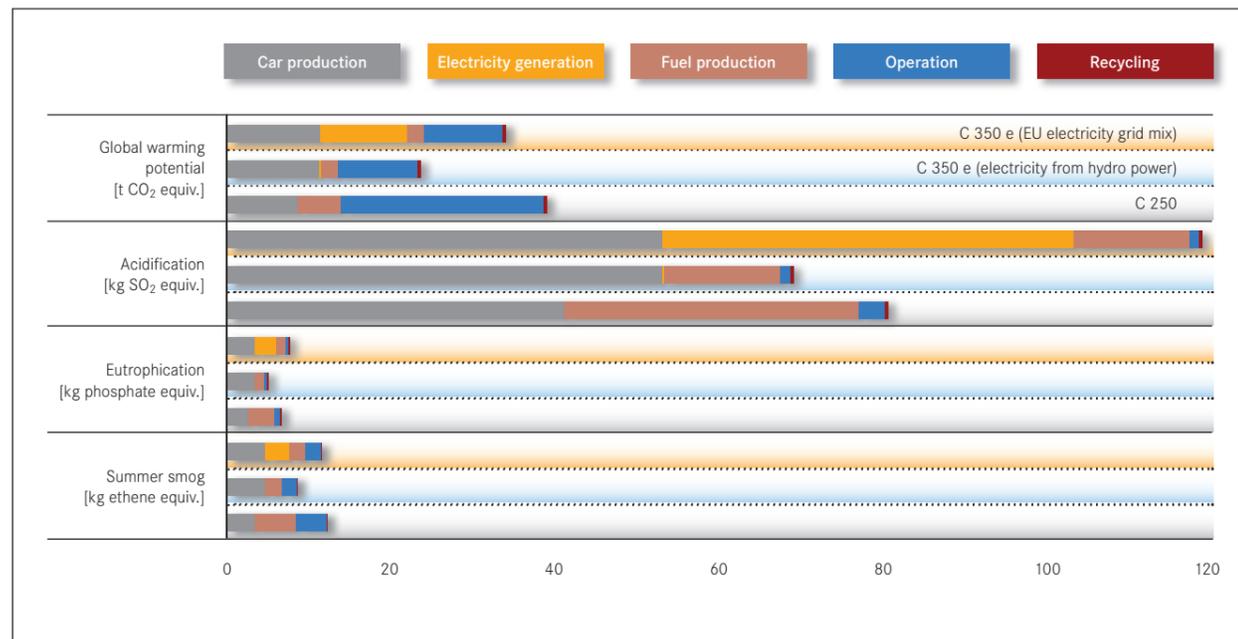


Figure 2-11: Selected result parameters for the C 350 e compared to the C 250 [unit/car]

Fig. 2-11 shows a comparison of the examined environmental impacts over the individual life cycle phases. Over the entire lifecycle, the C 350 e charged using electricity from hydro power has clear advantages in terms of all the result parameters shown. If the European electricity grid mix is used for charging, there are still advantages with respect to global warming potential and summer smog. For eutrophication the C 350 e lies around 15 % and for acidification around 48 % above the C 250.

Fig. 2-12 shows the consumption of relevant material and energy resources. The C 350 e with electricity from water-power has a significantly lower consumption of energy resources. Over the entire life cycle, primary energy savings of 20 percent are possible in comparison to the C 250. The decrease in required primary energy by 113 GJ corresponds to the energy content of approx. 3,500 litres of petrol respectively. "With the European electricity grid mix the C 350 e is at the same level as the C 250.

While the consumption of lignite, natural gas, hard coal and uranium rises for the C 350 e with the European electricity grid mix (due to additional hybrid-specific components in car manufacture and generation of electricity during operational phase), the particularly relevant factor of crude oil consumption can be reduced by over 50 % thanks to the high efficiency of the plug-in hybrid. When the vehicle is charged with renewably generated electricity, the consumption of natural gas, petroleum, coal and uranium can be further reduced. As a result of the additional hybrid-specific components, the plug-in hybrid exceeds the C 250 in terms of the consumption of material resources.



Figure 2-12: Consumption of selected material and energy resources compared to the predecessor C 250 [unit/car]

Tables 2-4 and 2-5 show further LCA result parameters for the C 350 e and C 250 as an overview. 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 CO₂ equivalent.

Input result parameters						
Material resources	C 350 e (EU electricity grid mix)	C 350 e (electricity from hydro power)	C 250	Delta C 350 e (EU electricity grid mix to C 250)	Delta C 350 e (electricity from hydro power to C 250)	Comment
Bauxite [kg]	1,480	1,480	1,162	27 %	27 %	Aluminium production higher primary content.
Dolomite [kg]	227	227	224	1 %	1 %	Magnesium production.
Iron [kg]*	892	896	543	64 %	65 %	Steel production, higher mas of steel (delta esp. for engine/transmission).
Non-ferrous metals (Cu, Pb, Zn) [kg]*	158	160	88	79 %	81 %	Delta esp. with electric traction drive, wiring harness and battery.
*as an elementary resource						
Energy resources						
ADP fossil** [GJ]	420	301	510	-18 %	-41 %	C 350 e (electr. mix) approx. 66 % from operation. C 350 e (hydro power) approx. 53 % from operation.
Primary energy [GJ]	570	448	561	2 %	-20 %	C 350 e (electr. mix) approx. 67 % from operation. C 350 e (hydro power) approx. 59 % from operation.
Proportionately						
Lignite [GJ]	41	14	12	261 %	19 %	C 350 e (electr. mix) approx. 68 % from operation. C 350 e (hydro power) approx. 93 % from production.
Natural gas [GJ]	110	65	79	39 %	-18 %	C 350 e (electr. mix) approx. 44 % from production. C 350 e (hydro power) approx. 74 % from production.
Crude oil [GJ]	185	175	385	-52 %	-54 %	C 350 e (electr. mix) approx. 82 % from operation. C 350 e (hydro power) approx. 81 % from operation.
Hard coal [GJ]	84	47	35	143 %	35 %	C 350 e (electr. mix) approx. 54 % from production. C 350 e (hydro power) approx. 97 % from production.
Uranium [GJ]	87	21	16	452 %	31 %	C 350 e (electr. mix) approx. 77 % from operation. C 350 e (hydro power) approx 94 % from production.
Renewable energy resources [GJ]	62	126	35	76 %	259 %	C 350 e (electr. mix) approx. 39 % from operation. C 350 e (hydro power) approx. 81 % from operation.

**CML 2001, date of revision: November 2010

Table 2-4: Overview of LCA result parameters (I)

Output result parameters						
Emissions in air	C 350 e (EU electricity grid mix)	C 350 e (electricity from hydro power)	C 250	Delta C 350 e (EU electricity grid mix to C 250)	Delta C 350 e (electricity from hydro power to C 250)	Comment
GWP** [t CO ₂ equiv.].	34	24	39	-13 %	-40 %	primarily due to CO ₂ emissions.
AP** [kg SO ₂ equiv.]	119	69	81	48 %	-14 %	primarily due to SO ₂ emissions.
EP** [kg phosphate equiv.]	8	5	7	15 %	-25 %	primarily due to NO _x emissions.
POCP** [kg ethen-equiv.]	11	9	12	-5 %	-29 %	primarily due to NMVOC and CO emissions).
CO ₂ [t]	32	22	37	-14 %	-41 %	C 350 e (electr. mix) approx. 67 % from operation. C 350 e (hydro power) approx. 52 % from operation.
CO [kg]	54	48	76	-28 %	-37 %	C 350 e (electr. mix) approx. 57 % from operation. C 350 e (hydro power) approx. 51 % from operation.
NMVOC [kg]	15	13	20	-28 %	-37 %	C 350 e (electr. mix) approx. 65 % from operation. C 350 e (hydro power) approx. 60 % from operation.
CH ₄ [kg]	56	36	53	6 %	-31 %	C 350 e (electr. mix) approx. 59 % from operation. C 350 e (hydro power) approx. 63 % from production.
NO _x [kg]	46	29	35	32 %	-18 %	C 350 e (electr. mix) approx. 47 % from production. C 350 e (hydro power) approx. 75 % from production.
SO ₂ [kg]	75	42	50	51 %	-15 %	C 350 e (electr. mix) approx. 43 % from production. C 350 e (hydro power) approx. 76 % from production.
Emissions in water						
BSB [kg]	0.28	0.25	0.26	9 %	-3 %	C 350 e (electr. mix) approx. 81 % from production. C 350 e (hydro power) approx. 91 % from production.
Hydrocarbons [kg]	0.4	0.38	0.41	0 %	-6 %	C 350 e (electr. mix) approx. 74 % from production. C 350 e (hydro power) approx. 78 % from production.
NO ₃ ⁻ [g]	5,758	4,164	9,096	-37 %	-54 %	C 350 e (electr. mix) approx. 86 % from operation. C 350 e (hydro power) approx. 81 % from operation
PO ₄ ³⁻ [g]	63	57	100	-37 %	-43 %	C 350 e (electr. mix) approx. 57 % from operation. C 350 e (hydro power) approx. 53 % from operation.
SO ₄ ²⁻ [kg]	34.5	14.6	14.4	140 %	2 %	C 350 e (electr. mix) approx. 64 % from operation. C 350 e (hydro power) approx. 84 % from production.

Table 2-5: Overview of LCA result parameters (II)



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. The resulting requirements for the automotive industry are as follows:

- 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 C-Class meets the recoverability rate of 95 percent by weight, effective as of 01.01.2015

- 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 C-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 new C-Class

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 new C-Class 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, an overall material recyclability rate of 85 percent and a recoverability rate of 95 percent were verified on the basis of the ISO 22628 calculation model for the new C-Class as part of the vehicle type approval process (see Fig. 2-13).

At the ELV recycler’s premises, the fluids, battery, oil filter, tyres, and catalytic converters are removed as part of the pretreatment 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 new C-Class, these components were specifically prepared with a view to their 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.

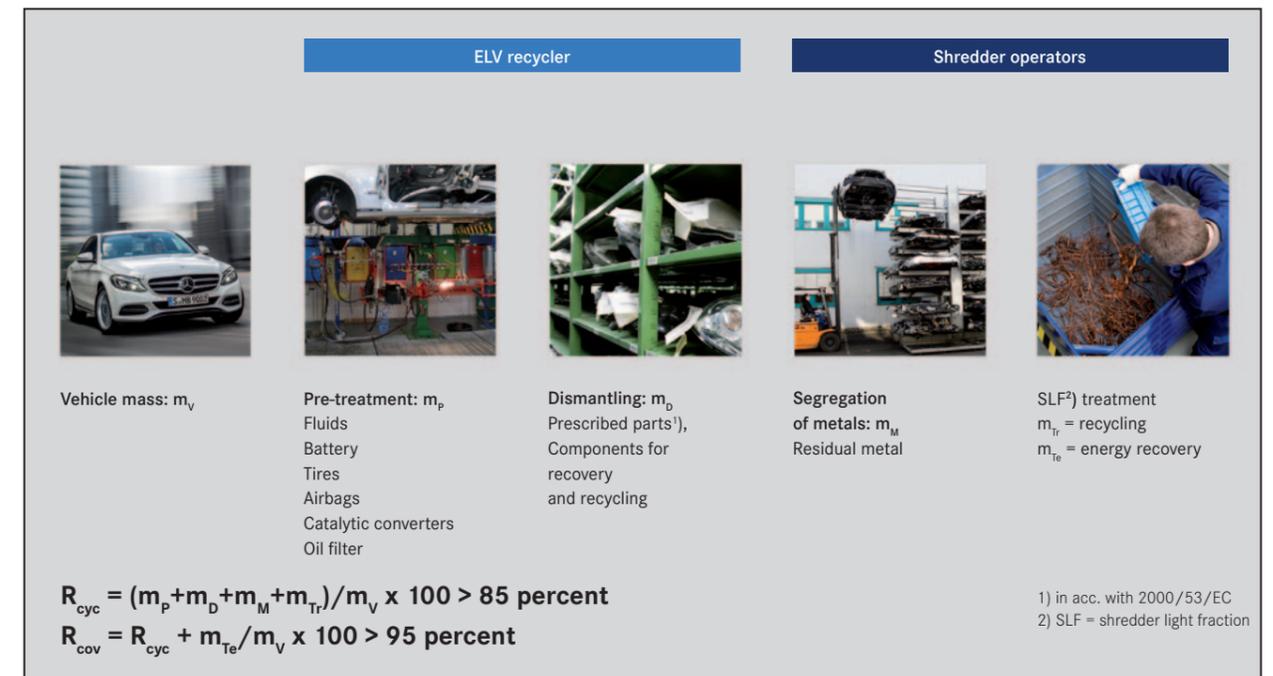


Figure 2-10: Material flows in the C-Class recycling concept.

In addition, all plastic parts are marked in accordance with international nomenclature. In the subsequent shredding of the residual body, the metals are first separated for reuse in the raw material production processes. The largely organic remaining portion is separated into different fractions for environment-friendly reuse in raw material or energy recovery processes.

Innovative recycling concepts and technologies were developed for the lithium-ion battery of the C 350 e together with the supplier and waste recycling partners, enabling the valuable battery materials to be reused. In addition to compliance with the statutory requirements pertaining to recycling efficiency for the battery, 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.

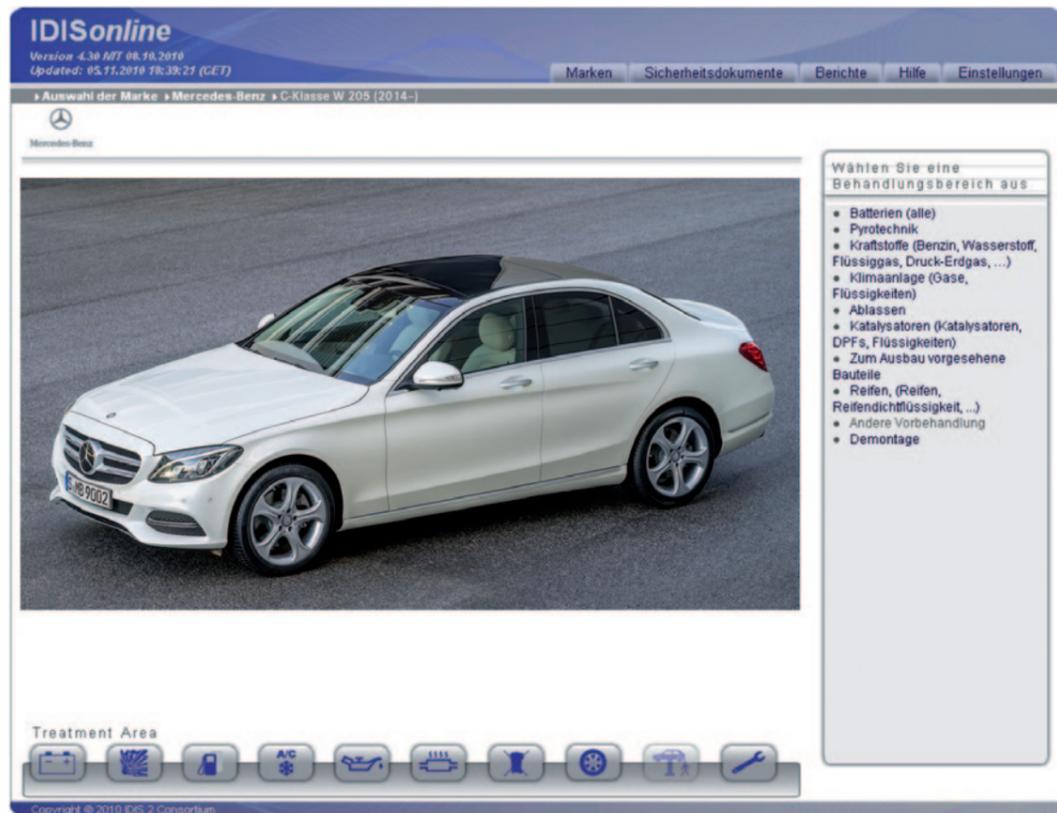


Figure 2-14: Screenshot of the IDIS software

For the new C-Class 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 (March 2015) covers 1970 different models and variants from 70 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



Elegant interior of the C-Class: the reduction of interior emissions is a key aspect of the development of components and materials for Mercedes-Benz vehicles.

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 the 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 in the development of components and materials for Mercedes-Benz vehicles.

The current C-Class has also been awarded the Seal of Quality from the European Centre for Allergy Research Foundation (ECARF). 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. Furthermore, the function of the pollen filter must be tested in both new and used condition. In addition, tests are undertaken with



human “guinea pigs”. Driving tests were conducted in the C-Class with people suffering from severe asthma, for example, 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

More secondary raw materials

- In the C-Class, 52 components with an overall weight of 49.3 kilograms can be manufactured partly from high-quality recycled plastics.
- These include wheel arch linings and underbody panelling.
- The mass of secondary raw material components has increased by almost a quarter compared with the preceding model.
- Wherever possible, secondary raw materials are derived from vehicle-related waste streams: the front wheel arch linings are made from recovered vehicle components.



Component	New C-Class	Predecessor	
weight in kg	49.3	40.1	+ 23 %

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 books for new Mercedes models prescribe continuous increases in the share of the secondary raw materials used in car models.

The studies relating to the use of recycled material which accompany the development process focus 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.

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.



Figure 2-15: Use of secondary raw materials in the new C-Class.

In the new C-Class, 52 components with an overall weight of 49.3 kilograms can be manufactured partly from high-quality recycled plastics. The weight of secondary raw material components could thus be increased by 23 percent compared with the preceding model. Typical areas of use are wheel arch linings and underbody panels, which consist for the most part of polypropylene. Fig. 2-15 shows the components for which the use of secondary raw materials is approved.

A further objective is to obtain secondary raw materials wherever possible from vehicle-related waste flows, so as to achieve closed cycles. To this end, established processes are also applied for the C-Class: a secondary raw material comprised of reprocessed starter batteries and bumper panelling is used for the wheel arch linings, for example.



Use of secondary raw materials, taking the wheel arch lining as an example (as here in the current B-Class).

2.5 Use of renewable raw materials

Component	New C-Class	Predecessor	
weight in kg	26.3	17.0	+ 55 %

In automotive production, the use of renewable raw materials is concentrated primarily in the vehicle interior. Established natural materials such as cellulose and wood fibres, wool, cotton and natural rubber are also used, of course, in series production of the C-Class. The use of these natural materials gives rise to a whole range of advantages in automotive production:

- Compared with glass fibre, natural fibres normally result in a reduced 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 CO₂ balance, as only as much CO₂ is released as the plant absorbed during its growth.

Raw material	Use
Wood	Trim, fascias
Natural fibres	Door panelling
Wool	Textiles for upholstery fabrics
Cotton, wool,	Insulating materials
Paper	Boot floor
Natural rubber	Vibration dampers and bearing parts

Table 2-4: Areas of use for renewable raw materials.

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



In the new C-Class, a total of 76 components with an overall weight of 26.3 kilograms are made using natural materials. The total weight of components manufactured with the use of renewable raw materials has thus increased by 55 percent compared with the preceding model. Fig. 2-16 shows the components in the new C-Class which are produced using renewable raw materials.

Figure 2-16: Components produced using renewable raw materials in the new C-Class.



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. It follows the principle "Design for Environment" (DfE) to develop comprehensive vehicle concepts. 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"

- Sustainable product development ("Design for Environment", DfE), was integrated into the development process for the C-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 new C-Class. 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. It consists 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 represented 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.

Integration of Design for Environment into the operational structure of the development project for the new C-Class ensured that environmental aspects were not sought only at the time of launch, but were given consideration from 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 new C-Class 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 already meets the requirements of the new ISO 14006 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



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**).

M. Wegner

Munich, 2012-12-07



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5 Conclusion

The new Mercedes-Benz C-Class not only meets the highest demands in terms of safety, comfort, agility, and design, but also fulfils all current requirements regarding 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 new C-Class documents the significant improvements that have been achieved compared with the previous model. 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.

In the new C-Class, Mercedes customers benefit for example from significantly enhanced fuel economy, low emissions and a comprehensive recycling concept. In addition, it employs a greater proportion of high-quality secondary and renewable raw materials. The life-cycle assessment for the new C-Class has thus been significantly improved compared with that of its predecessor.



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 organic halogens; sum parameter used in chemical analysis mainly to assess water and sewage sludge. Used to determine the sum of the organic halogens which can be adsorbed by activated charcoal; 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.).
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.
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 (internationales Demontage-Informationssystem)
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 are grouped together (e.g. global warming, acidification etc.).
ISO	International Organisation for Standardisation (internationale Organisation für Standardisierung)
KBA	Federal Motor Transport Authority
LCA	Life Cycle Assessment Compilation and assessment of the input and outputflows 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.
NF metal	Non-ferrous metal (aluminium, lead, copper, magnesium, nickel, zinc etc.)
NMVOC	Non-methane volatile organic compounds (NMHC Non-methane hydrocarbons)
POCP	Photochemical ozone creation potential, (summer smog); 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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