Life cycle

Environmental Certificate for the Mercedes-Benz SL-Class

Mercedes-Benz

Contents

As at: January 2012

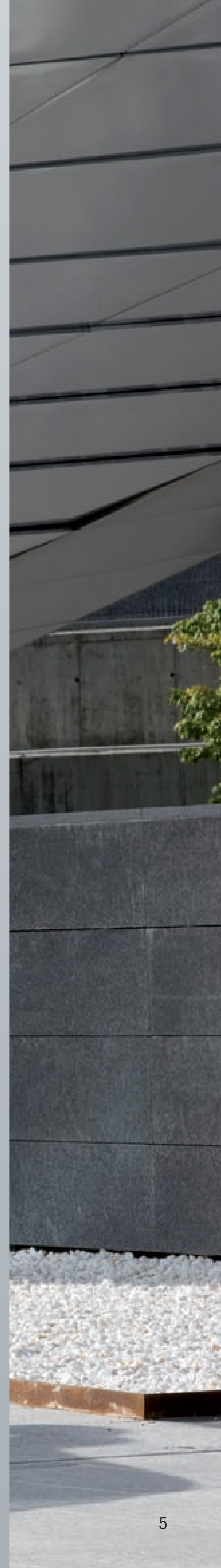
Life cycle

Since the beginning of 2009, "Life Cycle" has been presenting the Environmental Certificates for vehicles from Mercedes-Benz. With this documentation series the focus is above all on optimum service for the most diverse of interest groups: on the one hand the aim is to explain the extensive and complex subject of "the car and the environment" to the general public in an easily understandable way. On the other hand, however, specialists also have to be able to call up detailed information. "Life Cycle" meets this requirement with a variable concept.

Those wanting a quick overview can concentrate on the short summaries at the start of the respective chapters. This is where the fundamental facts are summarised in key words, and a uniform diagram aids orientation.

If the aim is to glean more precise information on Daimler AG's commitment to the environment, clearly arranged tables, diagrams and informative text passages are available. Here the individual environmental aspects are described in depth, right down to the last detail.

With the service-oriented and attractive documentation series "Life Cycle", Mercedes-Benz is once again demonstrating its pioneering role where this crucial topic is concerned – just as it did in the past, when the S-Class became the very first vehicle to receive the Environmental Certificate from the TÜV Süd (South German Technical Inspection Authority) in 2005. Since then it has been customary at Mercedes-Benz to document the environmental compatibility of new models through the Environmental Certificate. So far the following ten model series have received the certificate: S-Class, A-Class, B-Class, C-Class, E-Class, CLS, SLK, SL, GLK- and M-Class. Further models will follow.



Interview

Sports cars have also developed ecologically

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

Professor Kohler, is a sports car like the SL still in keeping with the times nowadays?

Prof. Kohler: at the end of the day this is decided by our customers all over the world. And the good sales figures of our two-seater roadsters, the SL and SLK, are proof positive that they are indeed in keeping with the times. This is certainly also down to the fact that their technology is at a very high level and makes it possible to achieve an extremely high degree of environmental compatibility which one would never have deemed a sports car to be capable of – even just a few years ago. Take, for example, the consumption figures for the SL: they are impressive. In the SL 350[1], for instance, an output of 225 kW/306 hp goes hand in hand with a consumption of 6.9 litres over 100 kilometres. Some compact cars consume more than that.

What lies behind such figures?

Prof. Kohler: our engineers have successfully tweaked a lot of parameters. For example, they have managed not only to stem the spiralling weight – they have done so to a significant extent. The bodyshell and body of the SL consist almost entirely of aluminium. This brings with it a weight reduction of some 110 kilos. We are losing further kilos through other aspects of its intelligent lightweight construction. This is why the SL 350 is even 140 kilos lighter than its predecessor, even though it is even more comfortable and has more safety devices on board. Both the environment and motoring pleasure profit from this.

Will a reduction of weight also have a role to play in future Mercedes-Benz models?

Prof. Kohler: of course. Every kilogram which the engine does not have to move improves the LCA of a vehicle. As far as the weight is concerned we set ourselves a savings target of at least ten percent, which we have far exceeded with the SL. But our ecological ambition extends across all areas which are connected with a car – from production right through to recovery after the vehicle has been taken out of use.

So it is all about comprehensive detailed work?

Prof. Kohler: exactly right. In the case of the SL, for example, even the windscreen wipers and the roof have a positive effect with regard to ecology. Our new wiper system MAGIC VISION CONTROL directs the washer fluid directly in front of the wiper lip and automatically controls the water consumption in accordance with the prevailing exterior conditions. This means up to 50 percent less washer fluid coupled with an improved cleaning effect, and facilitates a reduced supply of water – a small contribution towards a reduction in weight and towards higher efficiency. Our optionally available transparent panoramic vario-roof with MAGIC SKY CONTROL can be switched to dark, preventing the interior from heating up too much in intense sunlight. Not only do the occupants find this pleasant; the strain on the air conditioning system is also relieved in this way, and this saves CO_2. Both represent just small contributions towards the overall ecological picture, but lots of such small measures do add up

Does the combustion engine still have a future?

Prof. Kohler: for the next decades to come – certainly. There is still a huge potential here, which will shall be continuing to exploit, above all through innovative technology and sophisticated electronic control of all the components required for the drive system. The results are plain for all to see: the new V8 in the SL 500[2], for instance, has almost one litre less displacement than its predecessor, but it makes around twelve percent more hp available –not to mention a torque that has been increased by approximately one third. This is made possible, for example, by 3rd-generation direct injection with piezo injectors and multi-spark ignition. And the standard-specification ECO start/stop function also plays its part in the SL.

Will this technology be reserved only for the high-priced top models from Mercedes-Benz?

Prof. Kohler: not at all. Our new four-cylinder engine generation is also profiting from it. In the new B-Class it is already proving in everyday operation that an astonishing amount of progress can still be achieved with the internal combustion engine.

The production of aluminium is much more energy-intensive than is the case with steel, for instance. The new SL consists of aluminium to a large extent. Does this not worsen the LCA?

Prof. Kohler: during manufacturing it is true that more CO_2 is released. Having said that, through the reduced consumption we have a considerable advantage on the bottom line. This is why we have been using flaps and doors made of aluminium in our saloons for a long time now. In addition to this, we also use recycled aluminium in order to keep the burden on the environment during the manufacturing process as low as possible. The boot recess in the SL, for example, is made of recycled sheet metal.

Will aluminium also have a role to play in future Mercedes-Benz models?

Certainly, wherever it makes sense and is ecologically compatible. We shall be using the positive experience gained with aluminium structures during production of the SL. But we generally place an emphasis on an intelligent material mix. The best for the purpose in question, in line with our company’s motto.

[1] Fuel consumption SL 350 BlueEFFICIENCY (combined): 7.5-6.8 l/100km; CO_2-emissions (combined): 176-159 g/km.
[2] Fuel consumption SL 500 BlueEFFICIENCY (combined): 9.2-9.1 l/100km; CO_2-emissions (combined): 214-212 g/km.

Product description

Light, athletic, luxurious – the new Mercedes-Benz SL

With the completely redeveloped SL, Mercedes-Benz is continuing a tradition which began 60 years ago. Since that time the letters "SL" have stood for a symbiosis of sportiness, style and comfort – not to mention for ground-breaking innovations. The new SL from Mercedes-Benz offers considerably more sportiness and comfort than its successful predecessor, setting new benchmarks in the luxury roadster segment. Add to this absolute suitability for everyday use – making it an unparalleled all-rounder amongst sports cars. In short: anyone who talks about the new SL is talking about passionate, refined motoring of the highest calibre.

For the first time, the new SL is produced almost entirely from aluminium and weighs up to 140 kilograms less than the predecessor. The aluminium structure is not only lighter – it also demonstrates that it is superior to the steel design of its predecessor where rigidity, safety and comfort are concerned. This is ensured by the intelligent lightweight construction with components optimised for the respective conditions of use.

Appearance:
Sporty and refined motoring at the highest level.

Drive system:
Powerful and economical BlueDIRECT engines.

Efficiency:
Up to 30 percent lower fuel consumption
ECO start/stop function fitted as standard.

World premiere:
The intelligent wiper/washer system
MAGIC VISION CONTROL and the unique
Frontbass sytem for a concert-hall atmosphere.

Driving dynamics:
Fully automatically controlled damping or
active suspension system.

Safety:
ATTENTION ASSIST as part of the standard specification,
PRE-SAFE® Brake as an option.

Interior:
High-quality materials, immaculate handcraftsmanship.

Design:
Classic SL proportions and
sensual design idiom.

Design with classic SL proportions

The designers have brought the latest generation of the SL unmistakably to life on the basis of tradition but added new perspectives and visions. The result is a stylishly sporty and elegant luxury sports car with the classic hallmark SL balanced proportions: the long bonnet gives way to a compact passenger compartment that is set well back. A wide, muscular tail end giving the impression of raciness provides the finishing touch. A handful of elaborately styled lines define the powerfully sculpted and yet calm surfaces of the flanks. Finely worked details from the dynamic traditional Mercedes-Benz design heritage visually emphasise the SL legend.

An upright classic sports car radiator grille clearly marks out the new SL visually as a prestigious member of the current Mercedes-Benz sports car family. The centrally positioned star is a contemporary reinterpretation of the famous trademark, which now extends into the centre section with its organically flowing contours.

Dynamically slanting headlamps set well to the outside flank the striking front end and give the new roadster its own unmistakable face. The headlamps come as standard with the Intelligent Light System (ILS). With five different lighting functions that are tailored to typical driving and weather conditions, and are activated depending on the driving situation, they offer the driver a much better illuminated field of vision.

Interior: aesthetic, stylish, sporty

Following the Mercedes-Benz tradition, the new SL blends its athleticism with a luxurious ambience. Fine materials, painstakingly processed with great attention to detail, shape the style and character of the harmoniously sculpted interior. In keeping with the roadster's character, it marries the pristine atmosphere of a high-performance sports car with the comfortable and stylish ambience that motorists are looking for in a luxurious vehicle that takes them on long journeys.

Infotainment with internet access

Even in its base version the new Mercedes-Benz SL is equipped with the “Cockpit Management and Data System” COMAND. As an option COMAND Online is also available as an option (whilst it comes as standard with the SL 500). The latter features internet access and a DVD changer. When the vehicle is at a standstill it facilitates free browsing on the internet and fast access to a Mercedes-Benz online service.

MAGIC SKY CONTROL as an option

The sixth generation of the SL also offers a vario-roof that can be retracted into the boot using an electrohydraulic mechanism to save space, converting the SL into a roadster or a coupé in just a few seconds, depending on the driver's wishes and the weather. Unlike its predecessor, three versions are available for the new SL: painted, with a glass roof or with the unique panoramic vario-roof featuring MAGIC SKY CONTROL. The transparent roof switches to light or dark at the push of a button. When light it is virtually transparent, offering an open-air experience even in cold weather. In its dark state the roof provides welcome shade and prevents the interior from heating up in bright sunlight.

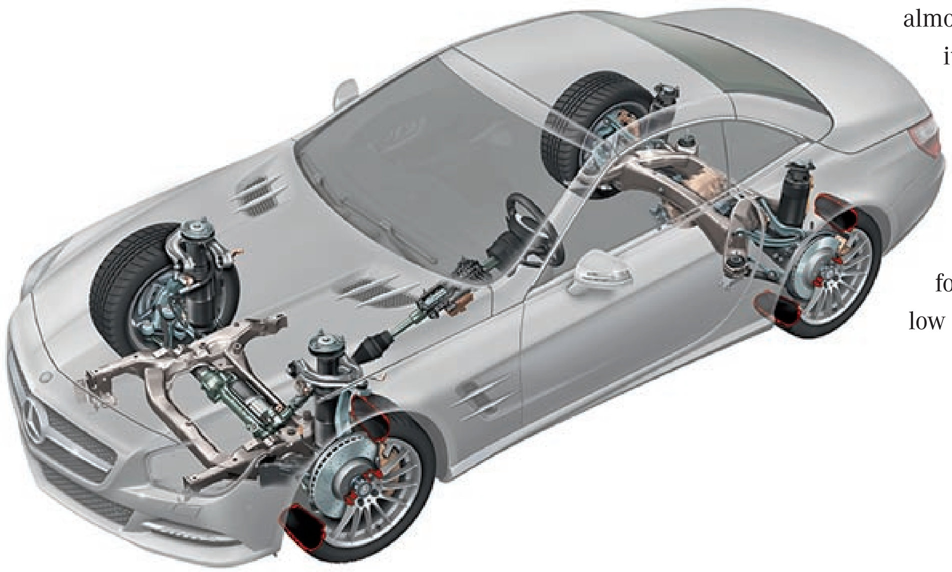
Top marks for aerodynamics

The design of the new SL not only meets high aesthetic demands – it also boasts exemplary aerodynamic qualities. As such, the roadster merits best marks in its segment in four important disciplines:

- With the lowest drag coefficient (cd = 0.27 in the SL 350);
- With the lowest wind noise that is virtually on a par with a closed saloon;
- With the best comfort for open-top motoring so that you can still have the roof down even at high speed;
- With virtually no accumulation of dirt on the side windows

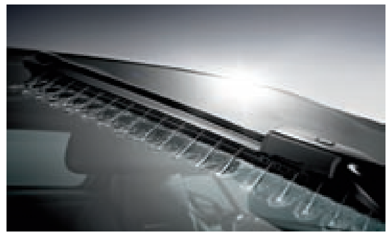
Agile suspension

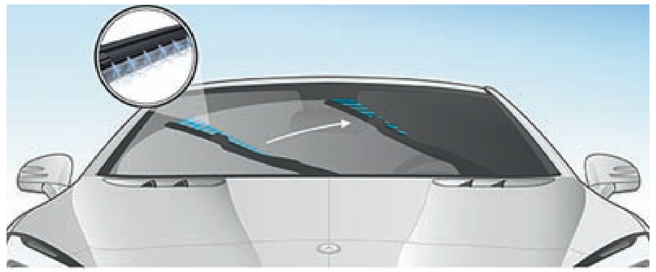
The new highly rigid all-aluminium bodyshell forms the basis for agile handling whose sporty nature has been considerable heightened – matched with exemplary road roar and tyre vibration characteristics and ride comfort. The two suspension systems offered for the SL both contribute to this: as part of its standard spacification the SL comes with semi-active adjustable damping. As an alternative the active suspension system ABC (Active Body Control) is available. Both suspension variants are combined with a new electromechanical Direct-Steer system with speed-dependent steering power assistance and a transmission ratio which can be adjusted via the steering wheel angle.

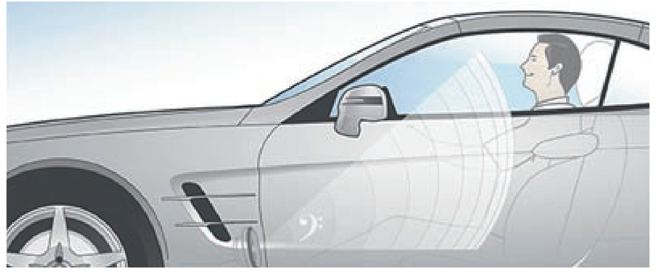


Powerful and economical engines

New BlueDIRECT engines ensure superb driving dynamics; they are more powerful, yet at the same tme they are considerably more economical than the engines in the predecessor generation. The new V8 in the SL 500 develops 320 kW (435 hp) from its displacement of 4663 cc and thus around 12 percent more than its predecessor despite some 0.8 litres less displacement. The fuel consumption has been reduced by up to 22 percent. At the same time, the torque has increased from 530 Nm to 700 Nm – a gain of 32 percent. Although the displacement remains the same at 3499 cc, the new V6 engine in the new SL 350 develops 225 kW (306 hp) and delivers 370 Nm of torque. It uses just 6.8 litres of fuel per 100 kilometres, making it almost 30 percent more economical than its predecessor. Both engine variants come with a standard-fit ECO start/stop function. The 7G-TRONIC PLUS automatic transmission, which has been optimised in relation to fuel consumption and comfort, also contributes to the exemplary, low fuel consumption.







Two world premieres: Frontbass and MAGIC VISION CONTROL

With two standard-specification innovations, the new SL remains true to its tradition as a technological trendsetter:

MAGIC VISION CONTROL is a new, intelligent and highly efficient wipe/wash system. The innovative wiper blade concept always applies the washer fluid just in front of the wiper blade lip via the channels integrated into the blade – in both directions of wipe. As a result, no water is splashed onto the windscreen during spraying to disrupt the driver's visibility, while at the same time cleaning the windscreen perfectly. The water also remains on the windscreen, thus ensuring it is cleaned without troubling the occupants, even with the roof down. For the first time an optional fully heated wiper blade which prevents snow or ice from forming on the blade in winter is available. This heating function also allows warm water to be applied directly onto the windscreen for the first time, even in cold temperatures.

Also unique, the Frontbass system intelligently uses the free spaces in the aluminium structures in front of the footwell as resonance spaces for the bass loudspeakers. As a result the new SL features clear, crisp bass sounds that facilitate a concert hall ambience even with the top down, and frees up space in the doors.

The safest roadster

Thanks to the crash-optimised aluminium structure, standard-fit PRE-SAFE® and assistance systems on the same high level as the S-Class, the SL is the world's safest roadster. Other standard features on board include the drowsiness detection system ATTENTION ASSIST and the ADAPTIVE BRAKE.

As an option DISTRONIC PLUS proximity control and PRE-SAFE® Brake, which is already well proven in other Mercedes-Benz models, are available. Once a serious risk of a rear-end collision is detected, the PRE-SAFE® Brake warns the driver initially and can initiate autonomous braking if the driver fails to react, and so either prevent the accident or at least mitigate its severity. PRE-SAFE® can also activate occupant protection measures.

Validation

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 SL-Class" with statements for the passenger vehicle types SL 350 und SL 500 was verified by TÜV SÜD Management Service GmbH. If applicable, the requirements outlined in the following directives and standards were taken into account:

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

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

Process and depth of detail of verification:
Verification of the environmental report covered both document review and interviews with key functions and persons in charge of the design and development of the new SL-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, 2012-01-30

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 new SL-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) refer to the new SL 350 with standard equipment.

1.1 Technical data

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

Characteristic	SL 350 BlueEFFICIENCY	SL 500 BlueEFFICIENCY
Engine type	Petrol engine	Petrol engine
Number of cylinders	6	8
Displacement (effective) [cc]	3498	4663
Power output [kW]	225	320
Emissions standard (fulfilled)	EU 5	EU 5
Weight (w/o driver and luggage) [kg]	1610	1710
Exhaust emissions [g/km]		
CO_2	159* – 176	212 – 214
NO_X	0.005	0.032
CO	0.079	0.314
HC	0.055	0.073
PM	0.0030	0.0006
Fuel consumption NEDC combined [l/100km]	6.8* – 7.5	9.1 – 9.2
Driving noise [dB(A)]	72	72

*NEDC consumption for base variant SL 350 with standard tyres: 6.8 l/100 km

1.2 Material composition

The weight and material data for the SL 350 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, 90 percent fuel tank filling) served as a basis for the recycling rate and life cycle assessment. Figure 1-1 shows the material composition of the SL 350 in accordance with VDA 231-106.

The new SL-Class sees the very first use of an all-aluminium bodyshell in volume production. Accordingly the light metals form the largest material group – at 35.3 percent. They are followed by the steel/ferrous materials at 32.6 percent and the polymer materials as the third-largest group at 20 percent. Service fluids comprise about 4.9 percent. The proportions of non-ferrous metals and of other materials are somewhat lower, at about 3.0 percent and about 2.7 percent, respectively. The remaining materials – process polymers, electronics, and special metals – contribute about one percent to the weight of the vehicle. In this study, the material class of process polymers largely comprises materials for painting.

The polymers are divided into thermoplastics, elastomers, duromers and non-specific plastics, with the thermoplastics accounting for the largest proportion with 13.7 percent. Elastomers (predominantly tyres) are the second-largest group with 4.5 percent.

The service fluids include 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 materials composition.

A comparison with the previous model reveals differences with particular regard to steel, light metals and polymers. The new SL-Class has an approximately 19.2 percent lower steel content at 32.6 percent, while the proportion of light metals, at 35.3 percent, is around 15.7 percent higher than the predecessor model. The main constructional differences compared with the predecessor model are as follows:

- Body of aluminium
- Rear wall and structure of the vario-roof of magnesium
- Boot lid with a plastic hybrid design.

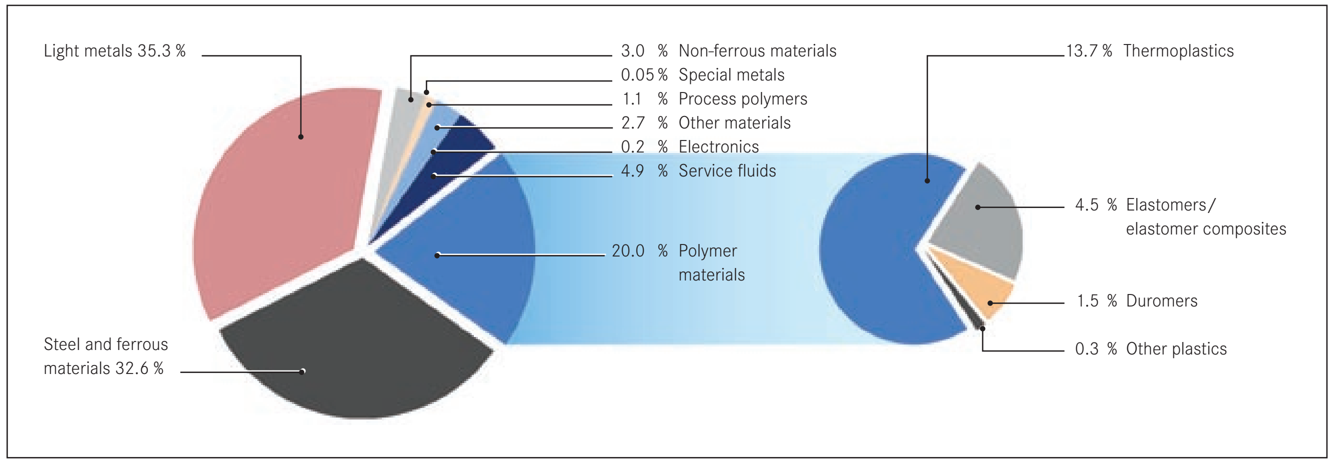


Figure 1-1: Materials used in the SL 350

2 Environmental profile

The environmental profile documents the general environmental features of the new SL-Class with regard to such matters as fuel efficiency, emissions, and environmental management systems, as well as providing specific analyses of the environmental performance, such as life cycle assessment, the recycling concept, and the use of secondary and renewable raw materials.

2.1 General environmental topics

The new SL-Class makes for significantly improved fuel efficiency. In the case of the SL 350, consumption has decreased from the previous levels of 11.7 l/100km (at the time of market launch in 2001) and 9.7 l/100km (at the time of market exit in 2012) respectively down to 6.8 to 7.5 l/100 km – depending on the tyres. Compared with the time of launch of its predecessor, this represents a reduction in fuel consumption of up to 42 percent; and compared with the market exit of the predecessor model, the reductions amount to as much as 30 percent.

The fuel efficiency benefits are ensured by an intelligent package of measures. These extend to optimisation measures in the drive system, energy management, and aerodynamics, and to tyres with optimised rolling resistance and weight reduction through a lightweight construction.

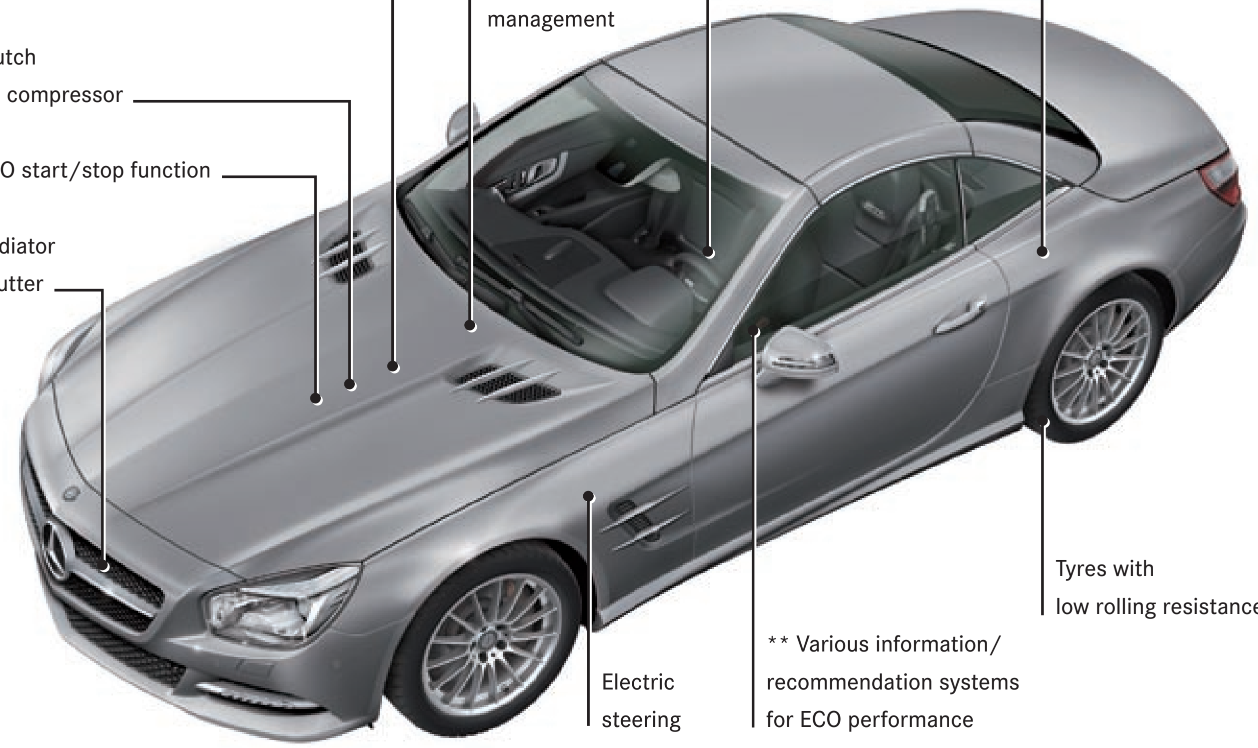
The most important measures include:

- The ECO start/stop function fitted as standard on all available engines
- Aerodynamic optimisation measures such as radiator shutter, design of the wheels, spoiler lip on the boot lid, wheel spoilers in front of the front and rear wheels and complete engine compartment and underbody panelling concept. As a result it was possible to reduce the cd figure to a value of 0.27 (SL 350)
- The use of tyres with optimised rolling resistance as part of the standard specification
- The electric power steering ensures energy-efficient steering angle and speed-dependent steering power assistance
- Weight optimisation with lightweight materials
- Regulated fuel pump can adjust pump performance depending on the required load
- Intelligent generator management in conjunction with an efficient generator ensures that consumers are powered from the battery during acceleration, while during braking part of the resulting energy is recuperated and stored back in the battery
- The AC compressor clutch, which avoids losses caused by braking power
- Friction-optimised powertrain through wheel bearing and fuel-economy new-generation rear axle transmission (FE HAG+)
- The wheel slip reduction on the torque converter was minimised (controlled zero wheel slip) and further components optimised for reduction of converter losses

In addition to improvements to the vehicle, the driver also has a decisive influence on fuel efficiency. For this reason, a display in the middle of the speedometer shows the current fuel consumption level. This easily readable bar indicator reacts immediately when the driver takes his or her foot off the accelerator, for example, and makes use of the fuel cut-off on the overrun.

The owner's manual of the new SL-Class also includes tips on an economical and environment-friendly driving style.

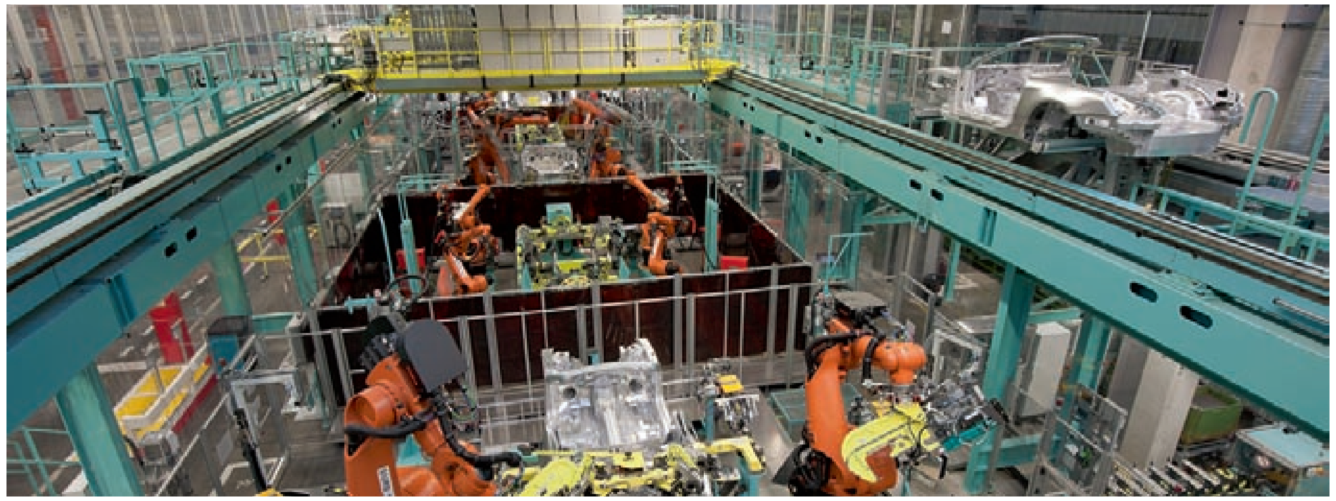
Furthermore, Mercedes-Benz offers its customers "Eco Driver Training"; the findings from this training course show that a car's fuel efficiency can be increased by up to 15 percent by means of economical and energy-conscious driving.



* Design of the wheels, spoiler lip on the boot lid, radiator shutter in the SL 350, wheel spoilers in front of the front and rear wheels, complete engine compartment and underbody panelling concept, exterior mirror on the door panelling, A-pillar trim

** Current consumption indicator in the instrument cluster, consumption histogram in the head unit

Figure 2-1: Measures designed to reduce consumption in the new SL-Class



The new SL-Class is also fit for the future when it comes to its fuels. The EU plans include an increasing proportion of biofuels. It goes without saying that the SL-Class will meet these requirements: in the case of petrol engines, a bioethanol content of 10 % (E 10) is permitted.

A considerable improvement has been achieved in terms of exhaust gas emissions, too. For example, when it comes to the nitrogen oxide emissions (NO_X) the SL 350 remains at 91 percent below the EU 5 limit values, in the case of the hydrocarbon emissions (THC) 45 percent below and for the carbon monoxide emissions (CO) 92 percent below.

The SL is built at the Mercedes production plant in Bremen. This plant has implemented an environmental management system certificated according to the EU eco-audit regulations and ISO standard 14001 for many years. For example, the coating techniques boast a high level not only in technological terms, but also with respect to environmental protection and safety. Longevity and value retention are further enhanced by a newly developed clearcoat, whose state-of-the-art nano-technology ensures much greater scratch-resistance than conventional paint, while the use of water-soluble paints and fillers drastically reduces solvent emissions.

High environmental standards are also firmly established in the environmental management system in the sales and after-sales sectors at Mercedes-Benz. At dealer level, Mercedes-Benz meets its product responsibility with the MeRSy recycling system for workshop waste, used parts and warranty parts and packaging materials. The take back system introduced in 1993 also means that Mercedes-Benz is a model for the automotive industry where workshop waste disposal and recycling are concerned. This exemplary service by a 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 parts, the GTC is an integral element of service and parts operations for the Mercedes-Benz brand. 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 environment-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.

At the birthplace of the new SL in Bremen, Mercedes-Benz is manufacturing the first volume-production vehicle whose bodyshell and body consist almost completely of aluminium. Lots of new joining methods are employed, and only tolerances up to 0.5 millimetres are allowedk. Around 350 specially trained employees take care of assembly, interior equipment and appointments and finishing

2.2 Life Cycle Assessment (LCA)

Decisive for the environmental compatibility of a vehicle is the environmental impact of its emissions and consumption of resources throughout its life cycle (see Figure 2-2). The standardised tool for assessing a vehicle‘s environmental impact is life cycle assessment (LCA). This shows the total environmental impact of a vehicle from the cradle to the grave, in other words from raw material extraction through production and usage up to recycling.

Down to the smallest detail

- With life cycle assessment, Mercedes-Benz registers all of the effects of a vehicle on the environment – from development via production and operation through to disposal.
- For a complete assessment, within each life cycle phase all environmental inputs are accounted for.
- Many emissions arise not so much during driving, but in the course of fuel production – for example non-methane hydrocarbon (NMVOC) and sulphur dioxide emissions.*
- The detailed analysis also includes the consumption and processing of bauxite (aluminium production), iron and copper ore.

* NMVOC (non-methane volatile organic compounds)

In the development of Mercedes-Benz passenger cars, life cycle assessments are used in the evaluation and comparison of different vehicles, components, and technologies.

The DIN EN ISO 14040 and DIN EN ISO 14044 standards prescribe the procedure and the required elements.

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 humans and the environment, such as global warming potential, summer smog potential, acidification potential, and eutrophication potential.
4. Interpretation
Draws conclusions and makes recommendations.

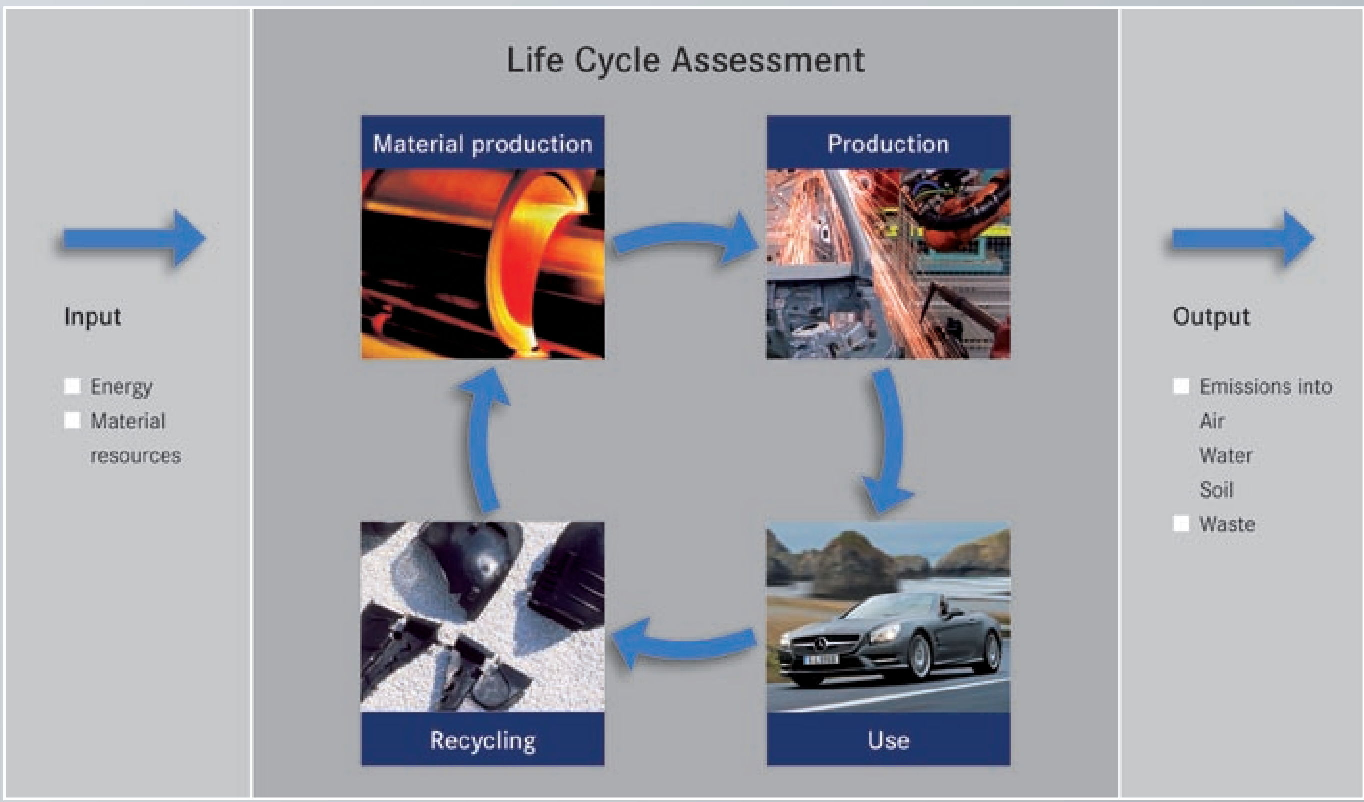


Figure 2-2: Overview of life cycle assessment

2.2.1 Data basis

To be able to ensure the comparability of the vehicles, as a rule the ECE base variant was investigated. The SL 350 at the time of launch served as the basis for the new SL-Class; the corresponding predecessor (at the time of market exit and market entry) served as a basis of comparison.

Project objective	
Project objective	• LCA for the new SL-Class, ECE base variant with the SL 350 engine and automatic transmission compared with its predecessor (SL 350 at market exit and market launch, respectively). • Verification of attainment of objective "environmental compatibility" and communication.
Project scope	
Functional equivalent	• SL-Class passenger car (base variant; weight in accordance with DIN 70020).
Technology/ product comparability	• With two generations of one vehicle model, the products are fundamentally comparable. Due to developments and changing market requirements, the new SL-Class provides additional features, above all in passive and active safety and in terms of a higher output. In cases where these additional features have an influence on the analysis, a comment is provided in the course of evaluation.
System boundaries	• Life cycle assessment for car manufacturing, usage, and recycling. The scope of assessment is only to be extended in the case of elementary flows (resources, emissions, non-recyclable materials).
Data basis	• Weight data of car: MB parts lists (date of revision 07/2011). • Materials information on model-relevant vehicle-specific parts: MB parts list, MB internal documentation systems, IMDS, technical literature. • Vehicle-specific model parameters (bodyshell, paint, catalytic converter etc.): MB specialist departments. • Location-specific energy provision: MB database. • Materials information for standard components: MB database. • Usage (fuel efficiency, emissions): type approval/certification data; usage (mileage): determined by MB. • Model used: state of the art (see also Chapter 2.3.1). • Material production, energy supply, manufacturing processes, and transport: GaBi database, as at: SP18 (http://documentation.gabi-software.com); MB database.
Allocations	• For material production, energy supply, manufacturing processes, and transport, reference is made to GaBi databases and the allocation methods they employ. • No further specific allocations.
Project scope	(Continued)
Cut-off criteria	• For material production, energy supply, manufacturing processes, and transport, reference is made to GaBi databases and the cut-off criteria they employ. • No explicit cut-off criteria. All available weight information is processed. • Noise and land use are not available as LCA data today and are therefore not taken into account. • Particulate matter and 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 vehicle comparison. • Vehicle care and maintenance are not relevant to the comparison.
Assessment	• Life cycle, in conformity with ISO 14040 and 14044 (life cycle assessment).
Assessment parameters	• Material composition according to VDA 231-106. • Life cycle inventory: consumption of resources as primary energy; emissions, e.g. CO_2, CO, NO_x, SO_2, NMVOC, CH_4, etc. • Impact assessment: abiotic depletion potential (ADP), global warming potential (GWP), photochemical ozone creation potential (POCP), eutrophication potential (EP), acidification potential (AP). These impact assessment parameters are based on internationally accepted methods. They are modelled on categories selected by the European automotive industry, with the participation of numerous stakeholders, in an EU project, LIRECAR. The mapping of impact potentials for human toxicity and ecotoxicity does not yet have sufficient scientific backing today and therefore will not deliver useful results. • Interpretation: sensitivity analyses of car module structure; dominance analysis over life cycle.
Software support	• MB DfE tool. This tool models a car with its typical structure and typical components, including their manufacture, and is adapted with vehicle-specific data on materials and weights. It is based on the LCA software GaBi 4.4 (http://www.pe-international.com/gabi).
Evaluation	• Analysis of life cycle results according to phases (dominance). The manufacturing phase is evaluated based on the underlying car module structure. Contributions of relevance to the results will be discussed.
Documentation	• Final report with all parameters.

(Continues on page 27)

Table 2-1: Parameters of the LCA

A comparison with these two versions reveals the development steps already realised by the time the predecessor was replaced. These document the continuous improvement in environmental performance during the lifetime of a model generation. The main parameters on which the LCA was based are shown in the table below.

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 usage phase is calculated on the basis of a mileage of 300,000 kilometres.

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

2.2.2 LCA results for the SL 350

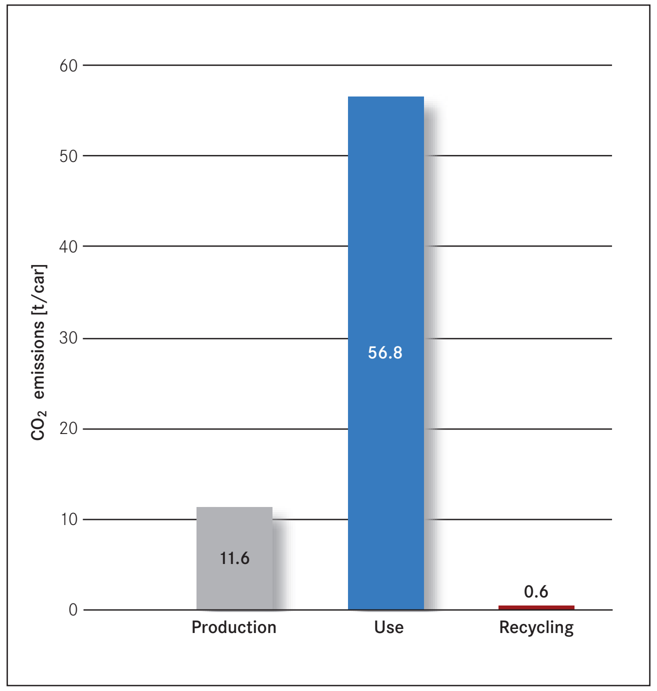


Figure 2-3: Overall carbon dioxide emissions (CO_2) in tonnes

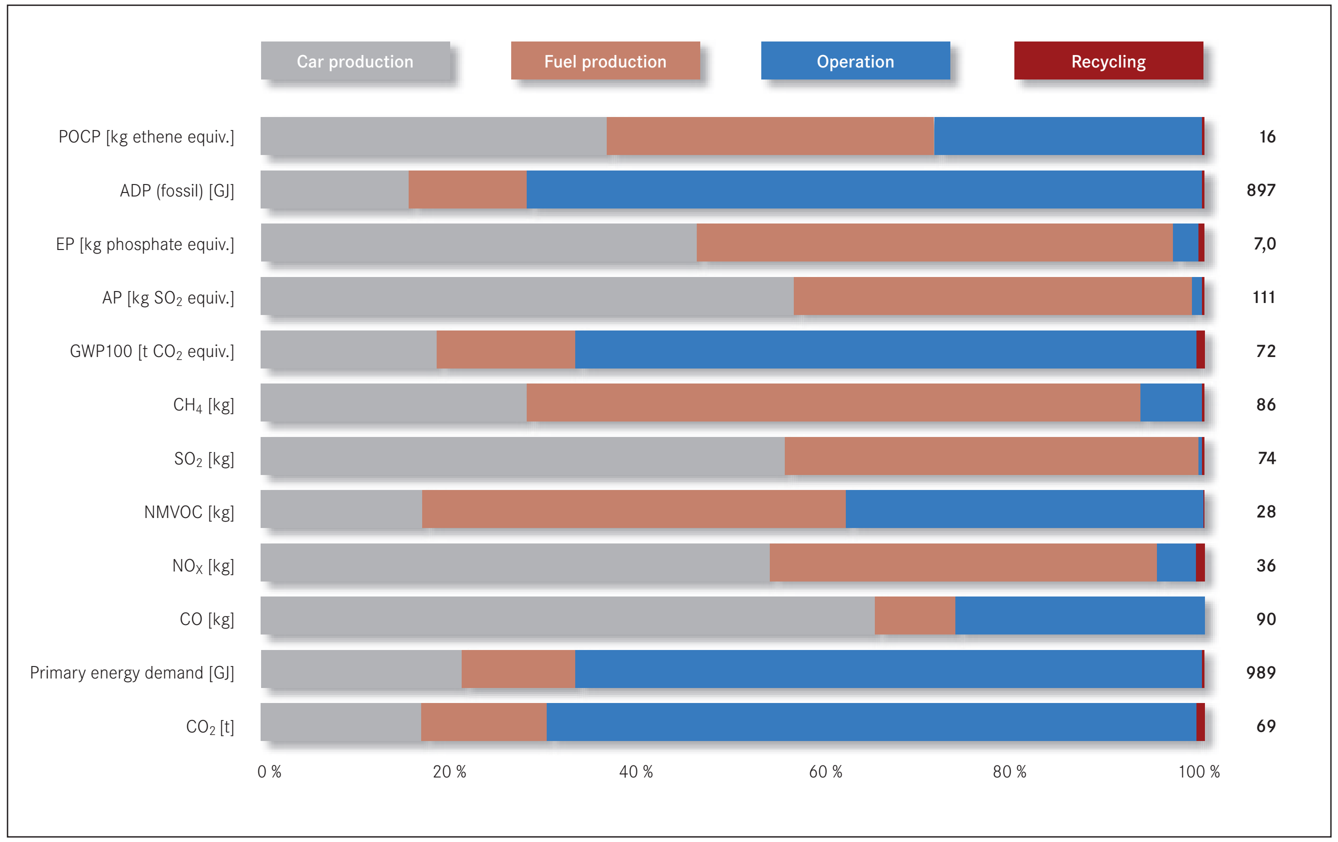


Figure 2-4: Share of life cycle stages for selected parameters

Over the entire life cycle of the SL 350, the life cycle inventory analysis yields for example a primary energy consumption of 989 gigajoules (corresponding to the energy content of around 30,000 litres of petrol), an environmental input of approx. 69 tonnes of carbon dioxide (CO_2), around 28 kilograms of non-methane volatile organic compounds (NMVOC), around 36 kilograms of nitrogen oxides (NO_x) and 74 kilograms of sulphur dioxide (SO_2). In addition to an analysis of the overall results, the distribution of individual environmental factors on the various phases of the life cycle is investigated. The relevance of the respective life cycle phases depends on the particular environmental impact under consideration. For CO_2 emissions, and likewise for primary energy consumption, the use phase dominates with a share of 82 and 79 percent respectively (see Figure 2-3).

However, the use of a vehicle is not alone decisive for its environmental impact. A number of environmental emissions arise to a significant extent in manufacturing, e.g. SO_2- and NO_x emissions (see Figure 2-4). The production phase must therefore be included in the analysis of ecological compatibility.

It is not the actual operation, but rather fuel production which is now the dominant factor for a variety of emissions, such as hydrocarbon (NMVOC) and NO_x emissions, and for closely associated environmental effects such as photochemical ozone creation potential (POCP: summer smog, ozone) and acidification potential (AP).

For comprehensive and thus sustainable improvement of the environmental impacts associated with a vehicle, the end-of-life phase must also be considered. For a comprehensive assessment, all environmental inputs are taken into consideration within each phase of the life cycle. In addition to the results shown above, it was determined for example that municipal waste and stockpile goods (especially ore processing residues and overburden) largely arise in the manufacturing phase, while special waste is created mainly through the production of petrol in the usage phase.

Environmental burden in the form of emissions into water is a result of vehicle manufacturing; this especially applies to heavy metals, NO_3- and SO_4^{2-}-ions, and the factors AOX, BOD and COD.

In order to assess the relevance of environmental factors, the impact categories abiotic depletion potential (ADP), eutrophication potential (EP), photochemical ozone creation potential (POCP, summer smog), global warming potential (GWP), and acidification potential (AP) are shown in normalised form for the life cycle of the SL 350. In normalisation the life cycle is evaluated against a superordinate reference system for improved understanding of the significance of each indicator value. The frame of reference chosen was Europe (EU 25 +3). Normalisation was based on the overall European yearly values, and the life cycle of the SL 350 was itemised for one year. In terms of European yearly values, fossil ADP accounts for the largest share in the SL 350, followed by GWP (see Figure 2-5).

The relevance of these two impact categories on the basis of EU 25 +3 is therefore greater than that of the remaining impact categories examined. The proportion is the lowest in eutrophication.

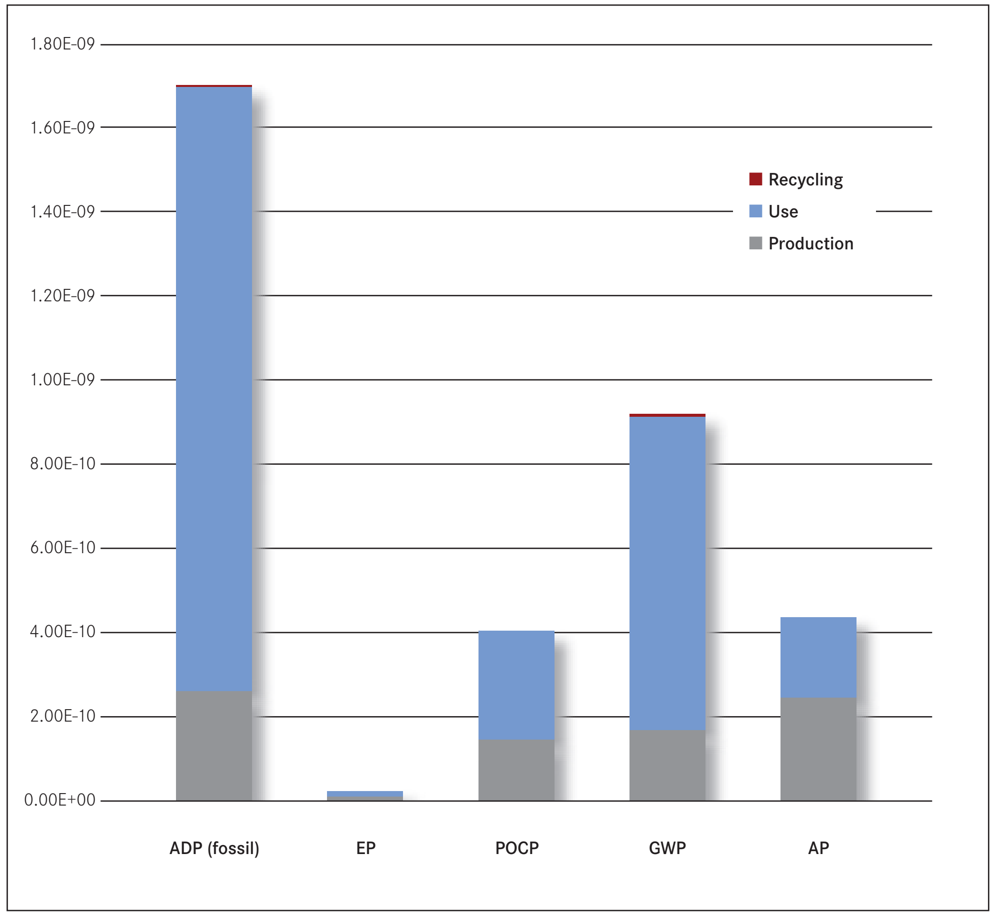
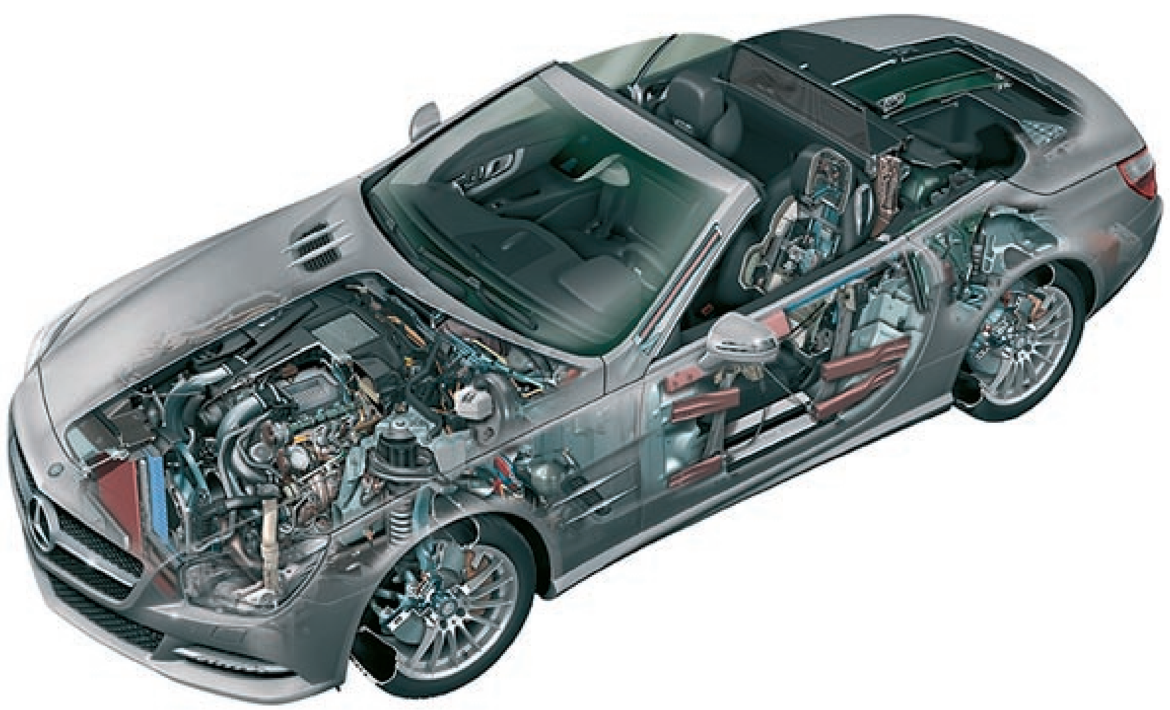


Figure 2-5: Normalised life cycle for the SL 350 [-/car]



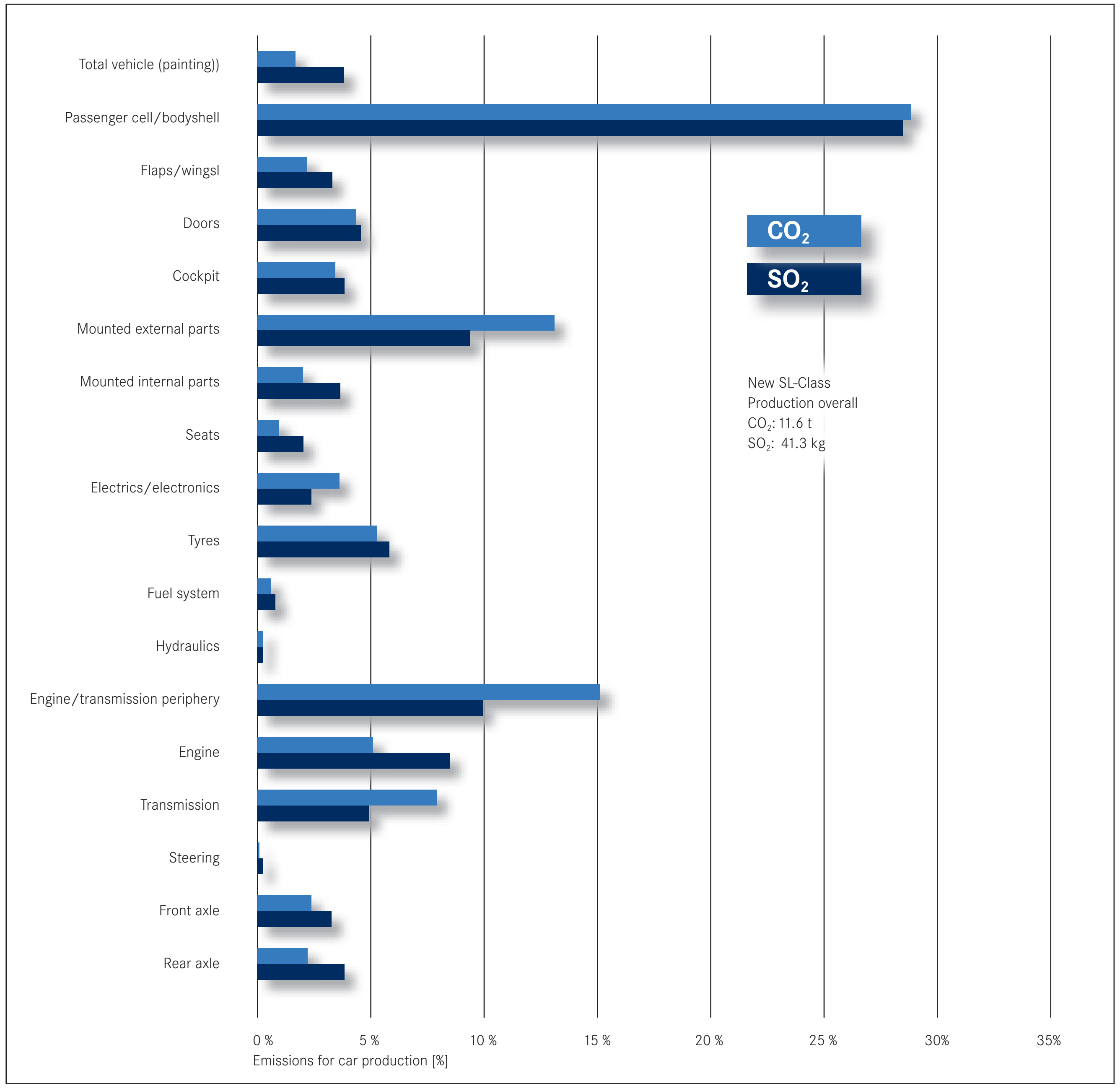


Figure 2-6: Distribution of selected parameters (CO2 and SO2) to modules

In addition to the analysis of overall results, the distribution of selected environmental effects 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, due to the mass share, 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.

2.2.3 Comparison with the predecessor model

The new SL also boasts the classic proportions which characterise the SL.

CO_2 Advantage for the new SL

- The carbon dioxide emissions during manufacturing do increase compared with the predecessor due to the aluminium lightweight construction.
- But as the fuel consumption has been significantly reduced, the new model causes approximately 25 percent fewer CO_2 emissions over the entire life cycle.

In parallel with the analysis of the new SL-Class, an assessment of the ECE base version of the predecessor model was made (1695 kg DIN weight on market launch and 1750 kg on market exit, respectively). The underlying conditions were similar to those for the new SL-Class. The production process was represented on the basis of an excerpt from the current list of parts. Use of the predecessor vehicle with a comparable engine was calculated on the basis of applicable certification values. The same state-of-the-art model was used for recovery and recycling.

As Figure 2-7 shows, production of the new SL-Class results in a quantity of carbon dioxide emissions which is greater than that of the predecessor. However, assessment of the entire life cycle yields clear advantages for the new SL-Class through the significantly reduced fuel consumption.

At the beginning of the life cycle, production of the new SL-Class gives rise to a quantity of CO_2 emissions which is greater than that of the predecessor (11.6 tonnes of CO_2 overall). In the subsequent usage phase, the new SL-Class emits around 56.8 tonnes of CO_2; the total emissions during production, use, and recycling thus amount to 69 tonnes of CO_2.

Production of the previous model at the time of market exit (= predecessor from 2012) gives rise to 10.2 tonnes of CO_2. The figure for the predecessor from 2001 is somewhat lower at 9 tonnes. Due to the higher fuel consumption, the predecessor models emit 80.8 tonnes (2012) and 100 tonnes (2001) of CO_2 during use. The overall life cycle figures for both predecessor models are therefore around 92 tonnes and 109 tonnes respectively of CO_2 emissions.

Over its entire life cycle, comprising production, use over 300,000 kilometres, and recovery, the new model gives rise to 25 percent (22.5 tonnes) less CO_2 emissions than its predecessor at the time of market exit and 37 percent (40 tonnes) than its predecessor at the time of market launch.

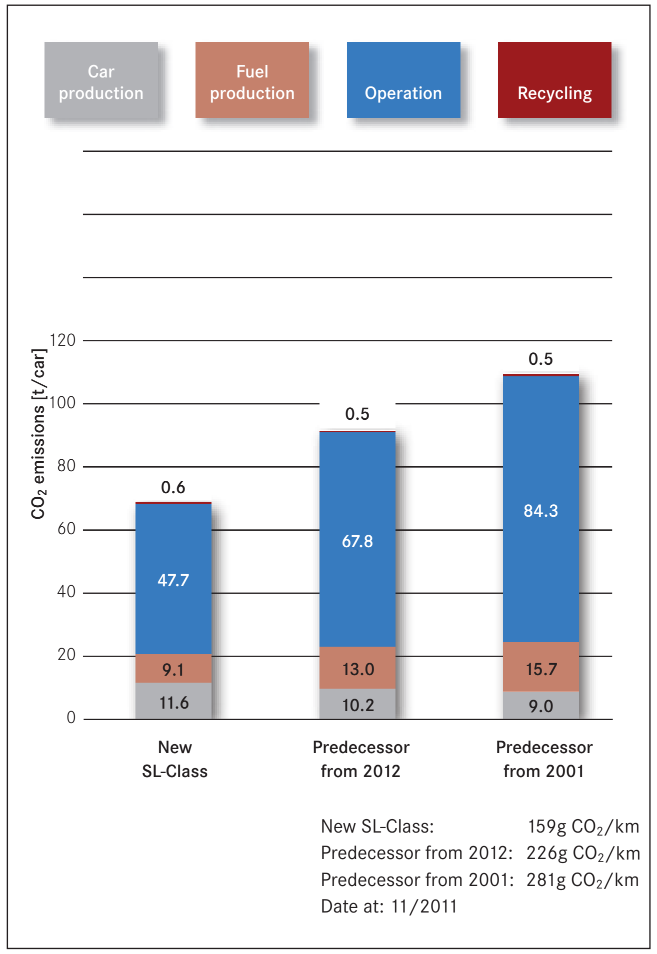


Figure 2-7: Carbon dioxide emissions of the SL 350 compared with the predecessor [t/car]

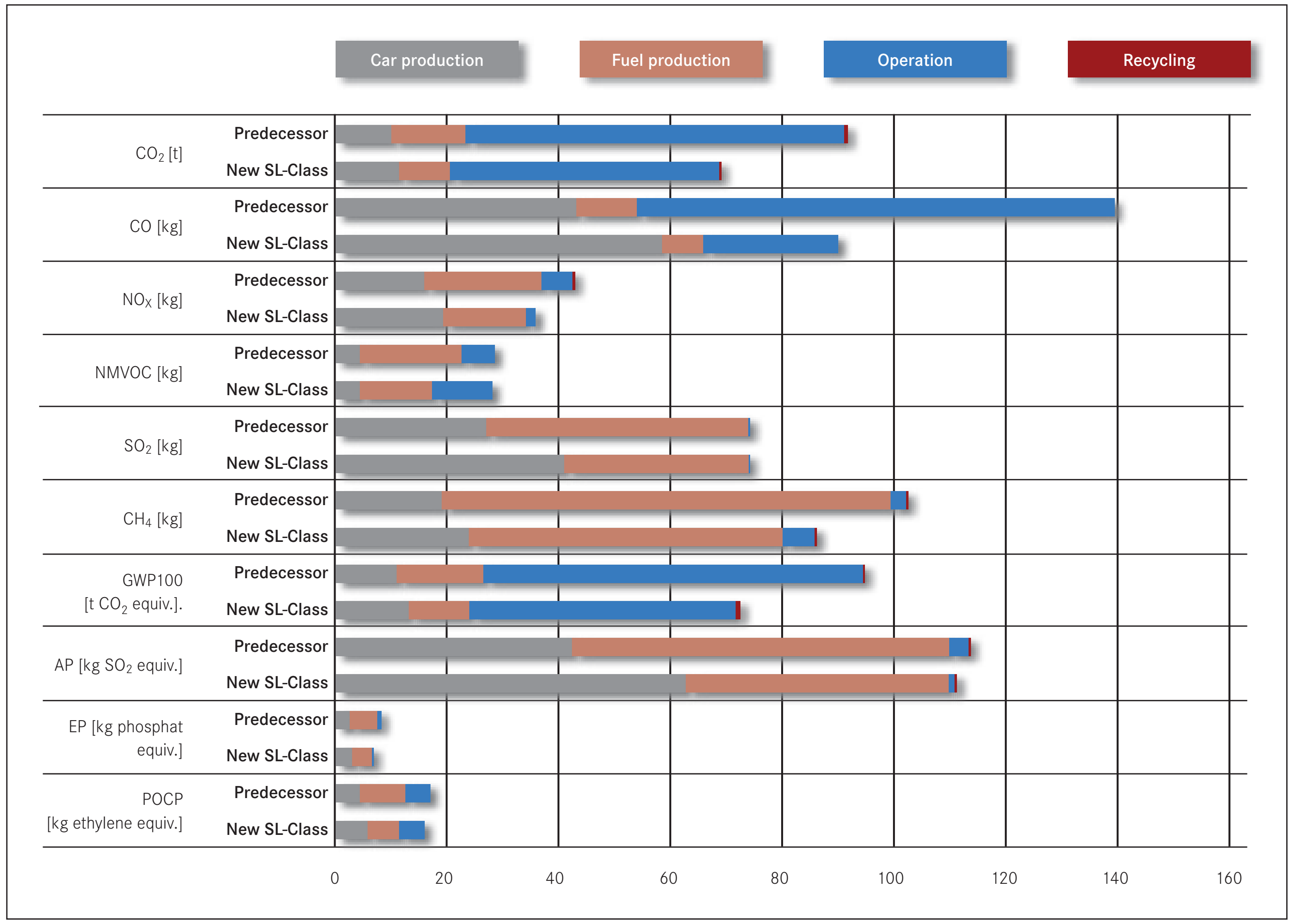


Figure 2-8: Selected parameters of the new SL-Class compared with the 2012 predecessor [units/car]

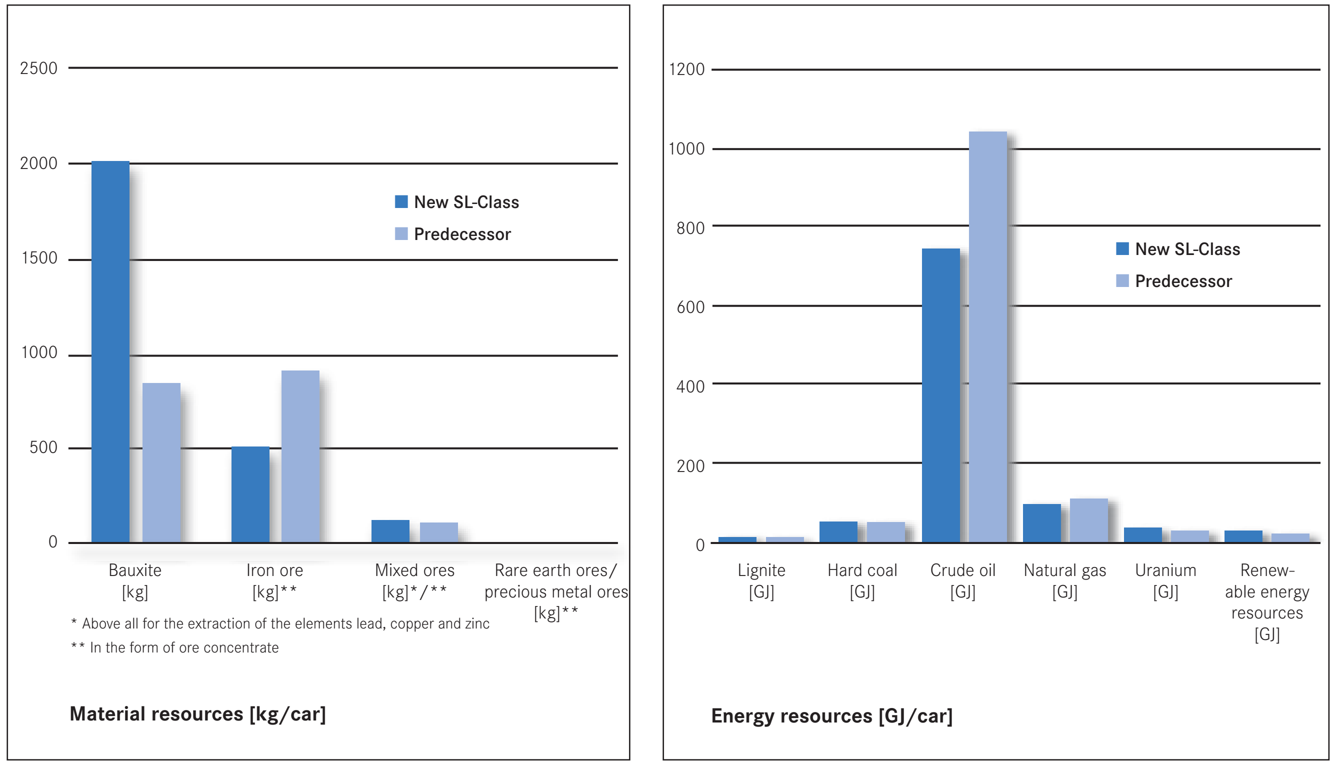


Figure 2-9: Consumption of selected material and energy resources by the new SL-Class compared with the 2012 predecessor [units/car]

Figure 2-8 shows further emissions into the atmosphere and the corresponding impact categories in comparison over the various phases. Over the entire life cycle, the new SL-Class shows clear advantages in terms of CO_2, CO, NO_X and CH_4 as well as in the impact categories of global warming potential and eutrophication. In terms of NMVOC and SO_2 emissions and, as a consequence, also in terms of the acidification potential and the photo-oxidant formation potential (POCP), the new SL is at the level of the predecessor.

Figure 2-9 shows consumption of relevant material and energy resources. The shifts in the material mix also lead to changes in demand for material resources in production. For example, iron ore consumption in the new SL-Class is lower due to the lower amount of steel used, while bauxite requirements, on the other hand, are higher due to the increased use of primary aluminium. The significant fall in requirements for energy resources (natural gas and oil) is mainly due to the significantly enhanced fuel economy during the usage phase.

Compared with the predecessor, primary energy savings of 23 percent (2012) and 34 percent (2001) are achieved over the entire life cycle. The fall in primary energy demand by 301 GJ (2012) and 510 GJ (2001) corresponds to the energy content of about 9200 and 15600 litres of petrol respectively.

Input parameters

Resources, ores	New SL	Predecessor from 2012	Delta vs Predecessor from 2012	Predecessor from 2001	Delta vs Predecessor from 2001	Comments
Bauxite [kg]	2015	851	137 %	628	221 %	Aluminium production, higher primary share.
Dolomite [kg]	278	127	118 %	29	874 %	Magnesium production, higher magnesium mass.
Iron ore [kg]**	504	905	–44 %	933	–46 %	Steel production, lower steel mass.
Mixed ores (esp. Cu, Pb, Zn) [kg]**	113	103	10 %	108	5 %	Primarily electrics (cable harnesses, battery).
Rare earth ore/ precious metal ores [kg]**	8.5	2.9	191 %	3.2	166 %	Engine/transmission periphery (exhaust system).

** In the form of ore concentrate

Energy sources	New SL	Predecessor from 2012	Delta vs. Predecessor from 2012	Predecessor from 2001	Delta vs. Predecessor from 2001	Comments
Fossil ADP* [GJ]	897	1206	–26 %	1416	–37 %	Primarily fuel consumption.
Primary energy [GJ]	989	1290	–23 %	1499	–34 %	Consumption of energy resources Significantly lower than for the predecessor, due to the increased fuel efficiency of the new SL-Class.
Share from						
Lignite [GJ]	20.1	20.1	0 %	19.5	3 %	approx. 83 % from car manufacturing
Natural gas [GJ]	100	117	–15 %	130	–23 %	approx. 55 % from usage
Crude oil [GJ]	747	1042	–28 %	1247	–40 %	Significant reduction to due lower fuel consumption.
Hard coal [GJ]	52.0	52.6	-1 %	48.3	8 %	approx. 93 % from car manufacturing
Uranium [GJ]	37	35	6 %	34	10 %	approx. 86 % from car manufacturing
Renewable energy Resources [GJ]	32.6	22.3	46 %	21.2	53 %	Primarily from car manufacturing (aluminium bodyshell)

* CML 2001, date of revision: November 2009

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

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

In Table 2-3 the superordinate impact categories are also indicated first. The new SL-Class shows advantages over its predecessor in all the impact categories. The goal of bringing about improved environmental performance in the new model over its predecessor was achieved overall.

Output parameters

Emissions in air	New SL	Predecessor from 2012	Delta vs. Predecessor from 2012	Predecessor from 2001	Delta vs. Predecessor from 2001	Comments
GWP* [t CO_2 equiv.]	72	95	–24 %	113	–36 %	Primarily due to CO_2 emissions.
AP* [kg SO_2 equiv.]	111	113	–2 %	124	–10 %	Primarily due to SO_2 emissions.
EP* [kg phosphate equiv.]	7	9	–18 %	10	–32 %	Primarily due to NO_X emissions.
POCP* [kg ethylene equiv.]	16	17	–7 %	21	–23 %	Primarily due to NMVOC emissions.
CO_2 [t]	69	92	–25 %	109	–37 %	Primarily due to driving operation. CO_2 reduction is a direct consequence of lower fuel consumption.
CO [kg]	90	139	–35 %	129	–30 %	Approx. 65 % due to car manufacturing.
NMVOC [kg]	28	29	–2 %	39	–28 %	Approx. 83 % due to usage, of which approx. 45 % is due to driving operation.
CH_4 [kg]	86	102	–16 %	120	–28 %	Approx. 28 % due to car manufacturing. The remainder from fuel production. Driving operation accounts for only approx. 5 %.
NO_X [kg]	36	43	–16 %	53	–32 %	Approx. 54 % due to car manufacturing, the remainder to usage. Driving operation accounts for approx. 4 % of total nitrogen oxide emissions.
SO_2 [kg]	74	74	0 %	79	–6 %	Due to car manufacturing and usage in equal amounts

Emissions in water	New SL	Predecessor from 2012	Delta vs. Predecessor from 2012	Predecessor from 2001	Delta vs. Predecessor from 2001	Comments
BSB [kg]	0.4	0.6	–43 %	0.7	–43 %	Approx. 65 % due to car manufacturing.
Hydrocarbons [kg]	0.5	0.9	–43 %	1.0	–49 %	Approx. 80 % due to usage.
NO_3^- [g]	2034	2534	–20 %	2924	–30 %	Approx. 71 % due to car manufacturing.
PO_4^{3-} [g]	44	57	–24 %	66	–34 %	Approx. 28 % due to car manufacturing.
SO_4^{2-} [kg]	30	35	–14 %	38	–22 %	Approx. 52 % due to usage.

* CML 2001, date of revision: November 2009

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

2.2.4 Component life cycle assessments

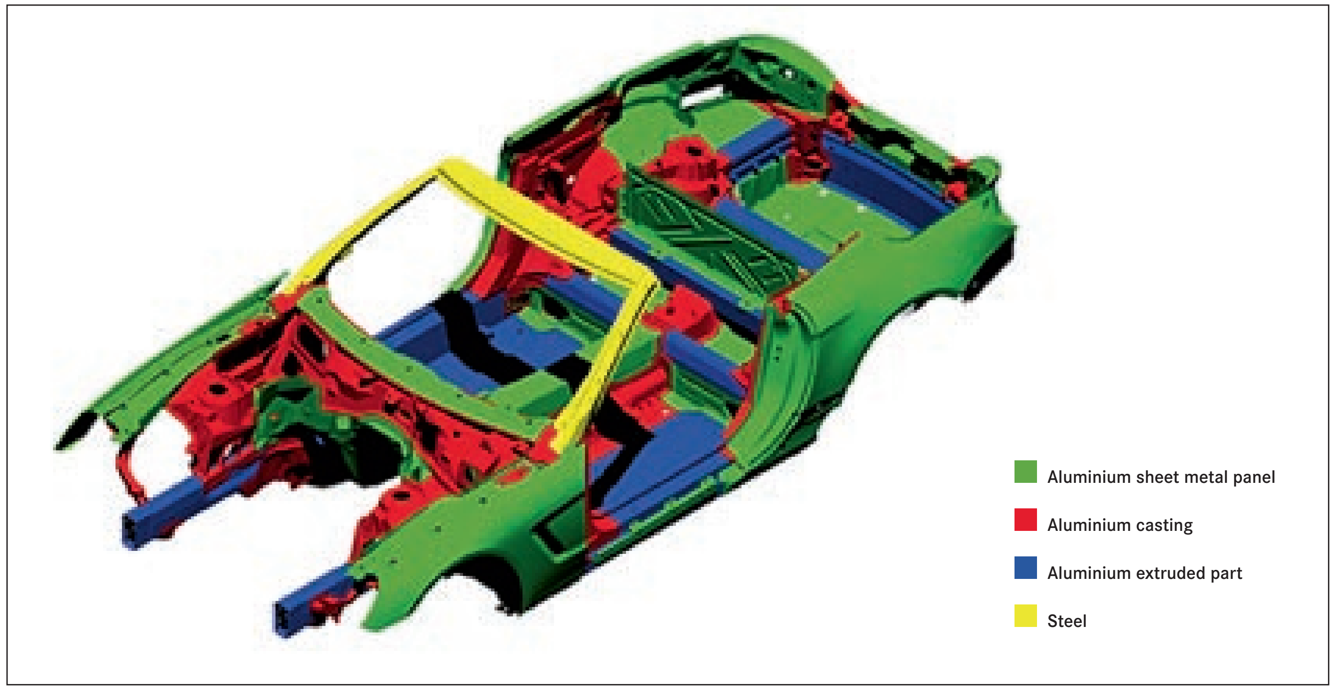


Figure 2-10: Break-even component concept (schematic)

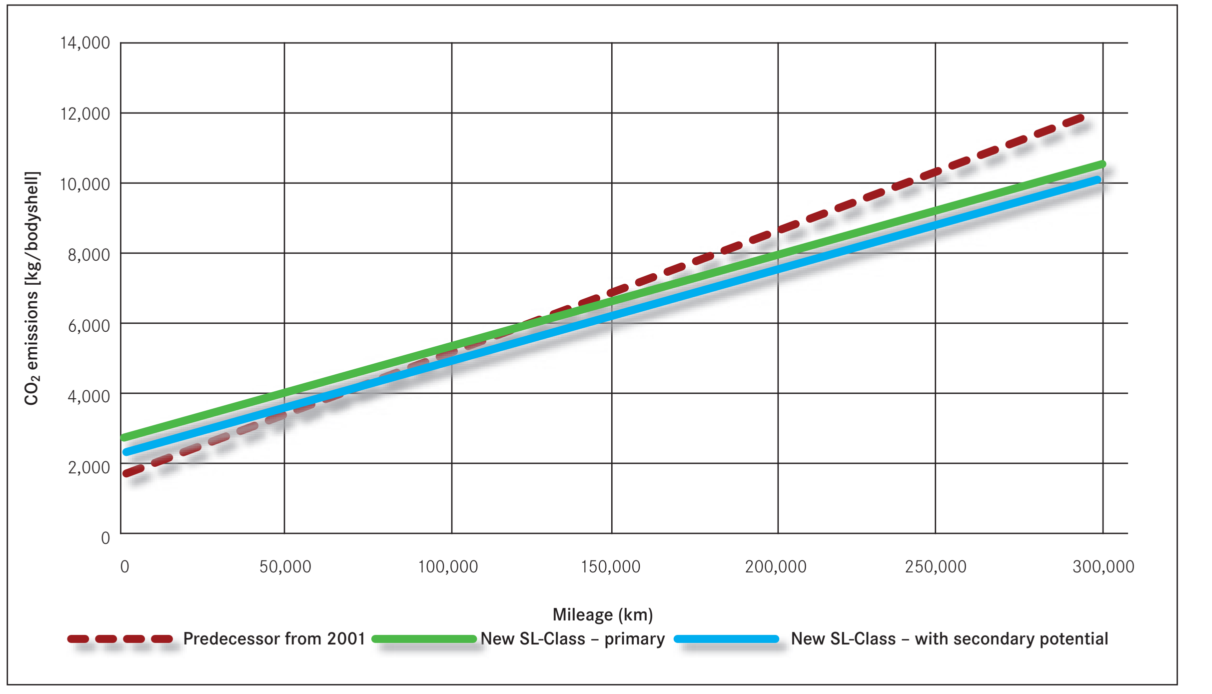


Figure 2-11: Break-even component concept (schematic)

The enhancement of environmental compatibility at an overall vehicle level is an integral part of the Daimler passenger car development process. The necessary basis for this is created at component level. Similar to the overall vehicle life cycle assessment, the component life cycle assessment is determined via the environmental profile of the materials and processing methods used. As part of the development of the bodyshell structures for the new SL, life cycle assessments were carried out at an early stage on the basis of the defined material concepts. Figure 2-10 shows the material use in the bodyshell of the new SL.

The objective was to assess the effects of the new lightweight materials and at the same to time to indicate ways of improving thee CO_2 emissions.

Figure 2-11 shows the CO_2 emissions of the bodyshell compared with the predecessor concept for the component production and use. The steel-intensive bodyshell concept of the predecessor is more favourable than the aluminium bodyshell of the current SL in terms of production. This is fundamentally due to the less energy-intensive production of steel. Representation of the usage phase is based on fuel consumption, which in the case of component comparisons is calculated by means of what is known as the fuel reduction value. This takes into account the fact that the fuel consumption of a passenger car changes with an increase or reduction in weight. Due to the significantly lower weight of the new all-aluminium bodyshell concept, less fuel is consumed during the usage phase. Over the entire life cycle, the new bodyshell concept results in 15 % fewer CO_2 emissions. A decisive factor for the environmental profile of aluminium components is where primary (i.e. used for the first time) or secondary (i.e. gained through recycling) aluminium is used for production. Primary material requires more energy (electrolysis) than secondary material. For this reason, during the development phase of the new SL a great deal of attention was paid to the amount of secondary material used during manufacture of semi-finished products. In particular in the case of the castings alone up to 50 % of the materials are secondary.

In the case of sheet metal panel parts, up until now only the production scraps are recirculated and taken into account in the environmental assessment. In order to go beyond this, new alloys must be qualified from end-of-life material. The potential of such a secondary variant of the SL bodyshell concept is shown in Figure 2-11.
During the assessment it was shown that in the case of the technically feasible use of secondary aluminium for interior sheet metal panels the CO_2 emissions during production can be cut by 10 %.

In order to implement the potential, during development of the new SL what is known as a 6000 alloy was qualified for automotive construction for the first time, consisting of at least 90 % secondary aluminium. The alloy is in pilot use in the boot tub of the new SL, thus underlining the efforts of Daimler AG in working towards “green technology leadership”.

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 objective of this directive is the prevention of vehicle waste and the promotion of the return, reuse, and recycling of vehicles and their components. This results in the following requirements on the automotive industry:

- Establishment of systems for collection of end-of-life vehicles (ELVs) and used parts from repairs.
- Achievement of an overall recovery rate of of 95 percent by weight by 1 January 2015 at the latest.
- Evidence of compliance with the recycling rate in type approval for new passenger cars as of December 2008.
- Take-back of all ELVs free of chargefrom January 2007.
- Provision of dismantling information from the manufacturer to the ELV recyclers within six months of market launch.
- Prohibition of the heavy metals lead, hexavalent chromium, mercury, and cadmium, taking into account the exceptions in Annex II.

The SL-Class already meets the recoverability rate of 95 percent by weight, effective 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 requirementsof the ELV Directive.
- Mercedes-Benz already currently has a highly 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 SL, attention was paid to separation and ease of dismantling of relevant thermoplastic components.
- Detailed information is provided in electronic form for all ELV recyclers: the International Dismantling Information System (IDIS).

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2.3.1 Recycling concept for the new SL-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:

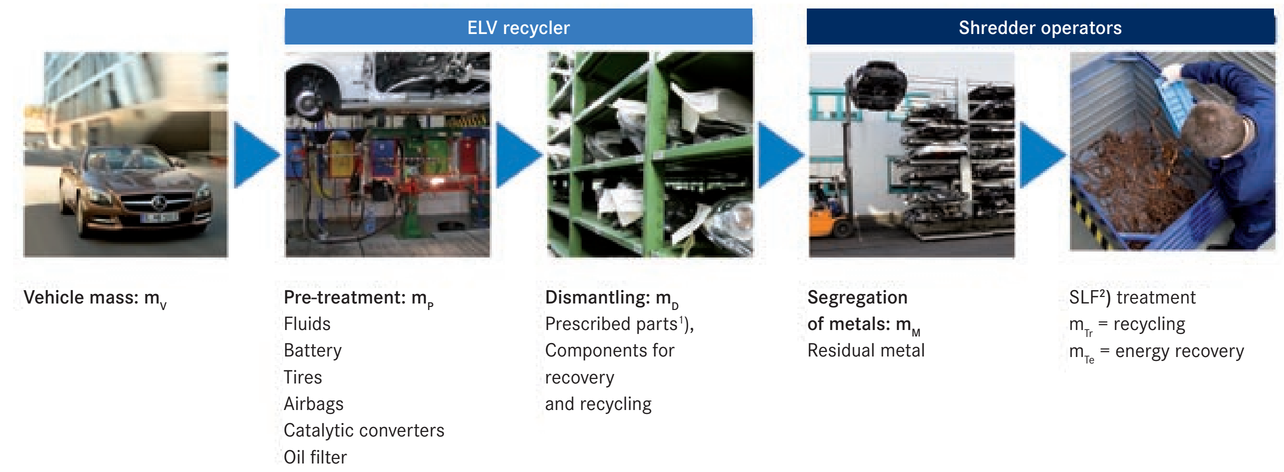
1. Pre-treatment (extraction of all service fluids, removal of tyres, battery, and catalytic converter, triggering of airbags).
2. Dismantling (removal of replacement parts and/or components for material recycling).
3. Segregation of metals in the shredder process.
4. Treatment of non-metallic residue fraction (shredder light fraction, SLF).

The recycling concept for the new SL-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.

At the ELV recycler's premises, the fluids, battery, oil filter, tyres, and catalytic converters are removed as part of the pre-treatment process. The airbags are triggered with a device that is standardised among 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.

The reuse of parts 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 Mercedes-Benz brand's service and parts business and makes an important contribution to the appropriately priced repair of vehicles. 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 SL-Class, these components were specifically prepared for subsequent recycling. Along with the segregated separation of materials, attention was also given to ease of dismantling of relevant thermoplastic components such as bumpers, wheel arch linings, outer sills, underfloor panelling and engine compartment coverings. In addition, all plastic parts are marked in accordance with international nomenclature.



$$R_{cyc} = (m_P+m_D+m_M+m_{Tr})/m_V \times 100 > 85 \text{ percent}$$
$$R_{cov} = R_{cyc} + m_{Te}/m_V \times 100 > 95 \text{ percent}$$

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

Figure 2-12: Material flows in the SL-Class recycling concept

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. With the described process chain, a material recyclability rate of 85 percent and a recoverability rate of 95 percent overall were verified on the basis of the ISO 22628 calculation model for the new SL-Class as part of the vehicle type approval process (see Figure 2-12).

2.3.2 Dismantling information

Dismantling information for ELV recyclers plays an important role in the implementation of the recycling concept.

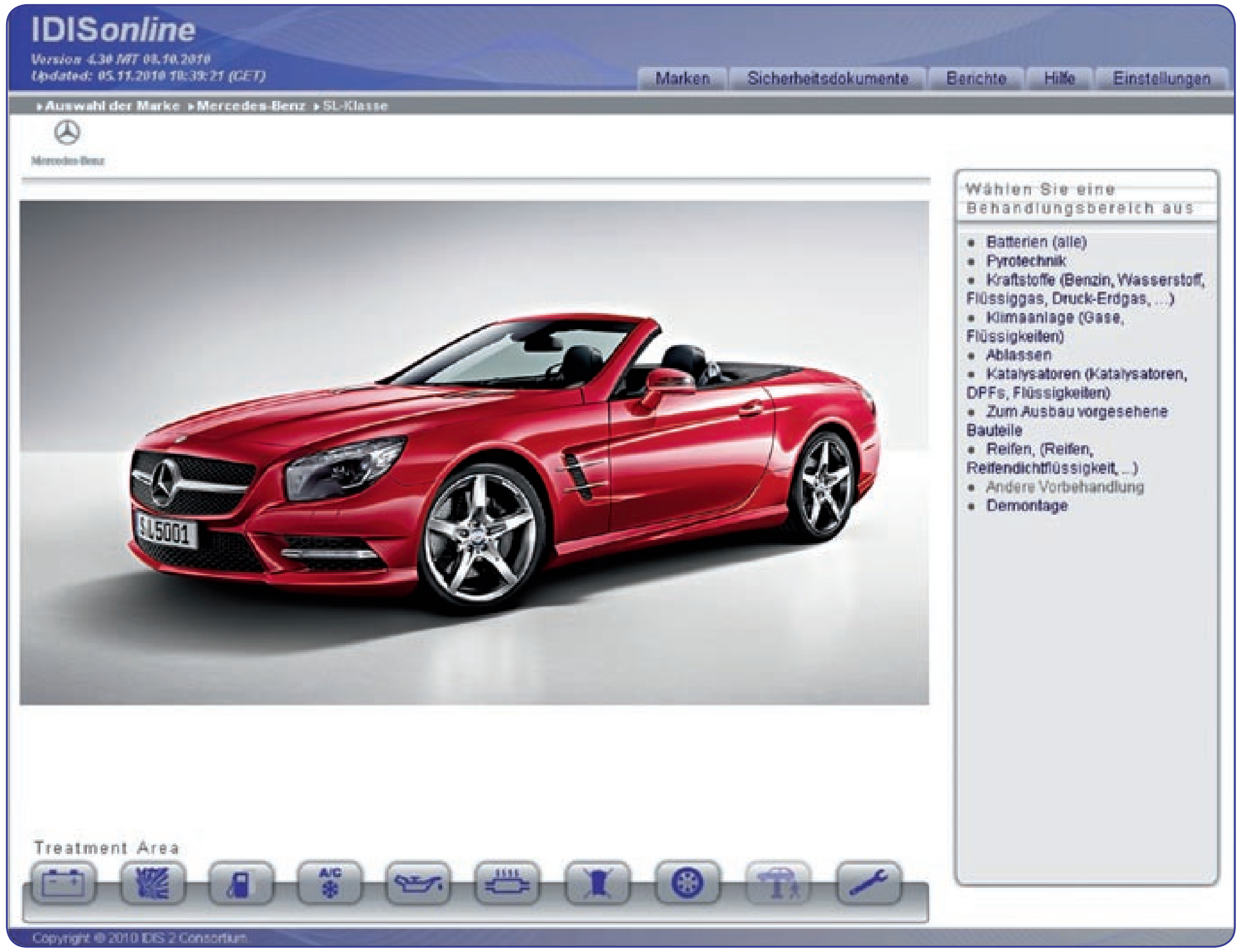


Figure 2-13: Screenshot of the IDIS software

For the new SL-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 (June 2011) covers 1758 different models and variants from 61 car brands. The IDIS data are made available to ELV recyclers and incorporated into the software half a year after the respective market launch.

2.3.3 Avoidance of potentially hazardous materials

The avoidance of hazardous substances is a matter of top priority in the development, manufacturing, use, and recycling of Mercedes-Benz vehicles. For the protection of humans and the environment, substances and substance classes that may be present in materials or components of Mercedes-Benz passenger cars have been listed in an 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.

The heavy metals lead, cadmium, mercury, and hexavalent chromium, which are prohibited by the ELV Directive of the EU, are also taken into consideration. To ensure compliance with the ban on heavy metals in accordance with the legal requirements, Mercedes-Benz has modified and adapted numerous processes and requirements both internally and with suppliers.

The new SL-Class complies with valid regulations. For example, lead-free elastomers are used in the drive system, along with lead-free pyrotechnic initiators, cadmium-free thick film pastes, and surfaces free of hexavalent chromium in the interior, exterior, and assemblies

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 major aspect of component and material development for Mercedes-Benz vehicles.

The elegant SL interior: environmentally friendly materials are also a crucial element in the case of the interior appointments.

2.4 Use of secondary raw materials

In addition to the requirements for attainment of recycling rates, the 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.

Component-	New SL-Class	Predecessor	
weight in kg	32.6	15.4	**+ 112 %**

In the new SL-Class, 78 components with an overall weight of 32.6 kilograms can be manufactured party from high-quality recycled plastics.

- These include wheel arch linings, cable ducts, and underbody panelling.
- The mass of secondary raw materials components has doubled compared with the predecessor model.
- Wherever possible, secondary raw materials are derived from vehicle-related waste streams; the front wheel arch linings are made from recovered vehicle components.

To meet these requirements, the technical specifications for new Mercedes models prescribe a constant increase in the recycled content of passenger cars.

The studies relating to the use of recycled material, which accompany the development process, focus on thermoplastics. Unlike steel and ferrous materials, which already include a proportion of secondary materials from the outset, the use of plastics requires a separate procedure for the testing and release of the recycled material for each component. For this reason, the data on the use of recycled material in passenger cars are documented only for thermoplastic components, as this is the only factor that can be influenced in the course of development. The quality and functionality requirements placed on a component must be met both with secondary raw materials and with comparable new materials. To secure passenger car production even when shortages are encountered on the recycled materials market, new materials may also be used as an option. In the new SL-Class, a total of 78 components with an overall weight of 32.6 kg can be manufactured partly from high-quality recycled plastics. The mass of the approved components made from recycled material has thus been doubled compared with the predecessor model. Typical applications include wheel arch linings, cable ducts and underbody panelling, which are largely made from polypropylene. Figure 2-14 shows the components approved for the use of recycled materials. A further objective is to derive the recycled materials as far as possible from automotive waste streams, thereby closing process loops. To this end, established processes are also applied to the SL-Class: for example in the case of the wheel arch linings a secondary raw material comprising reprocessed starter batteries and bumper covers is used (see Figure 2-15).

Figure 2-14: Use of secondary raw materials in the new SL-Class

The process for manufacturing battery holders for the SL-Class is new. Waste products from the production of dashboards for the E-Class are reprocessed so that the high-quality plastic can be recuperated. This is then processed further in the MuCell® (Micro Cellular Foam Injection Moulding) procedure, which is where the finest of gas bubbles are worked into the plastic, causing its density and consequently the weight of the components produced from it to be reduced. As a result the advantages for the environment are two-fold through the use of the recycled plastic and through the reduction of weight.

Figure 2-15: Use of secondary raw materials, taking the wheel arch lining as an example.

2.5 Use of renewable raw materials

In the new SL-Class, a total of 28 components with a combined weight of 17.6 kg are produced using natural materials.

- This is 41.7 percent more than for the predecessor.
- The floor of the luggage compartment consists of a card board honeycomb structure.
- Charcoal coke serves as an activated charcoal filter for fuel tank ventilation.
- The mountings for the door panelling make use of a moulded wood-fibre material.

Component-	New SL-Class	Predecessor	
weight in kg	17.6	12.4	**+ 41.7 %**

In automotive production, the use of renewable resources concentrates on the vehicle interior. In the new SL-Class, the natural fibres used in series production largely comprise woods, coconut and cellulose fibres, leather, virgin wool and cotton. The use of natural products in automotive manufacturing has a number of advantages:

- Compared with glass fibre, natural fibres normally result in a reduced component weight.
- Renewable resources help 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.
- In energy recovery they exhibit an almost neutral CO_2 balance, since only the same amount of CO_2 is released as was absorbed by the plant during growth.

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

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

In the new SL-Class, a total of 28 components with a combined weight of 17.6 kg are produced using natural materials. The total weight of components manufactured with the use of renewable raw materials has thus increased by 41.7 percent compared with the predecessor. Figure 2-16 shows the components in the new SL-Class produced using renewable raw materials.

For the tank ventilation the Mercedes engineers have also drawn on a raw material from nature: wood-based coke is used in the activated charcoal filter. This porous material adsorbs the hydrocarbon emissions, and the filter is constantly regenerated during operation.

Raw material	Application
Wood	Moulded wood-fibre material in the mountings for the door panelling, trim parts, activated charcoal filter
Virgin wool,, Leather	Seat covers
Coconut/natural rubber	Rubberised backrest padding
Paper	Luggage compartment floor
Cotton	Damping components

Table 2-4: Application of renewable raw material

3 Process documentation

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 realised at great expense. The earlier sustainable 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. Environmental burden can often only be reduced at a later date by means of downstream „end-of-pipe“ measures.

“We strive to develop products which 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 this is the task of environment-friendly product development. Comprehensive vehicle concepts are devised in accordance with the „Design for Environment“ (DfE) principle. The aim is to improve environmental performance in objectively measurable terms, while at the same time meeting 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 environment-friendly materials.

Focus on “Design for Environment”

Sustainable product development (“Design for Environment”, DfE), was integrated into the development process for the SL-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 toward improving environmental performance was an integral part of the development project for the SL-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) and cross-functional teams (e.g. quality management, project management) are appointed in accordance with the most important automotive components and functions.

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

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

The process carried out for the SL-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 managment 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 GmbH in 2012.

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

4

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

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. **70097150/70014947,** 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 **2012-12-03**

Certificate Registration-No. **12 770 13407 TMS**

Munich, 2012-01-30

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

5 Conclusion

The new Mercedes-Benz SL-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 the Environmental Certificate in accordance with the ISO TR 14062 standard since 2005.

Over and above this, since 2012 the requirements of the new ISO 14006 standard on the integration of environmentally acceptable product development into the higher-level environmental and quality management systems have been confirmed by the South German Technical Inspection Authority Management GmbH.

The Environmental Certificate for the new SL-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 SL-Class, Mercedes customers benefit for example from significantly enhanced fuel economy, lower emissions and a comprehensive recycling concept. In addition, it employs a greater proportion of high-quality secondary and renewable raw materials. The new SL-Class is thus characterised by environmental performance that has been significantly improved compared with 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 organically bound halogens; sum parameter used in chemical analysis mainly to assess water and sewage sludge. The sum of the organic halogens which can be adsorbed by activated charcoal is determined; these include chlorine, bromine and iodine compounds.
AP	Acidification potential; impact category expressing the potential for milieu changes in ecosystems due to the input of acids.
Base variant	Base vehicle model without optional extras, usually Classic line and with a small engine.
BOD	Biological oxygen demand; taken as measure of the pollution of waste water, waters with organic substances (to assess water quality).
COD	Chemical oxygen demand; used in the assessment of water quality as a measure of the pollution of waste water and waters with organic substances.
DIN	German Institute for Standardisation (Deutsches Institut für Normung e.V.)
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
ISO	International Organization for Standardization
IMDS	International Material Data System
Impact categories	Classes of effects on the environment in which resource consumptions and various emissions with the same environmental effect (such as global warming, acidification, etc.) are grouped together.
KBA	Federal Motor Transport Authority (Kraftfahrtbundesamt)
Life Cycle Assessment (LCA)	Compilation and evaluation of input and output flows and the potential environmental impacts of a product system throughout its life.
MB	Mercedes-Benz
NEDC	New European Driving Cycle; cycle used to establish the emissions and consumption of motor vehicles since 1996 in Europe; prescribed by law.
Non-ferrous metal	Aluminium, lead, copper, magnesium, brass, nickel, zinc, tin, etc.
POCP	Photochemical ozone creation potential; impact category that describes the formation of photo-oxidants („summer smog“).
Primary energy	Energy not yet subjected to anthropogenic conversion.
Process polymers	Term from the VDA materials data sheet 231-106; the material group “process polymers” comprises paints, adhesives, sealants, protective undercoats.
SLF	Shredder Light Fraction; non-metallic substances remaining after shredding as part of a process of separation and cleaning.

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Mercedes-Benz Technology Center, D-71059 Sindelfingen
Department: Design for Environment (GR/PZU) in collaboration with Global Product Communications Mercedes-Benz Cars (COM/MBC)

Tel.: +49 711 17-76422

www.mercedes-benz.com

Descriptions and data in this brochure apply to the international model range of the Mercedes-Benz brand. Statements relating to standard and optional equipment, engine variants, technical data, and performance figures are subject to variation between individual countries.

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