BMW GROUP

VEHICLE FOOTPRINT.

Life cycle assessment of the BMW M5 with a validation by TÜV Rheinland and further information on its environmental and social impact. Data at the time of the start of production of the vehicle in July 2024.

TABLE OF CONTENTS.

1. PRODUCT INFORMATION ON THE VEHICLE IN THE LIFE CYCLE ASSESSMENT.

Technical details of the vehicle in the life cycle assessment	BMW M5
Powertrain type	Petrol – Plug-in hybrid
Transmission	8-speed, steptronic
Drive type	Four-wheel drive
Power in kW (hp)	535 (727)
Maximum speed in km/h (electric)	250 (140)
Battery capacity (gross/net) in kWh	22.1 / 18.6
Electric range, WLTP in km (mls)[1, 2]	65 (40)
Vehicle weight in kg	2,431
Energy consumption, combined WLTP in l/100 km (mpg)[1, 2]	1.8 (155)
CO_2 emissions, combined WLTP in g/km[1, 2]	41
Energy consumption, combined WLTP in kWh/100 km (mls/kWh)[1, 2]	26.3
Fuel consumption with discharged battery, combined WLTP in l/100km (mpg)[1, 2]	10.5 (26.8)

[1]The stated fuel consumption and CO_2 figures were determined according to the prescribed measuring procedure of the WLTP (Worldwide harmonised Light vehicles Test Procedure) cycle in accordance with Regulation (EC) No. 715/2007 and Regulation (EU) 2017/1151. The specifications always refer to a vehicle with basic equipment. Any added optional equipment that is supplied by the manufacturer to replace parts of the basic equipment may increase these values and therefore differ depending on the model and motorisation. In addition, retrofitted optional equipment and accessories can change relevant vehicle parameters such as weight, rolling resistance and aerodynamics, resulting in deviating consumption values and CO_2 emissions. Values other than the values stated here may therefore apply for the assessment of taxes and other vehicle-related duties (also) based on CO_2 emissions. The figures therefore do not refer to the specific vehicle, and do not form an integral part of the offer, but are provided solely for comparison purposes between the different types of vehicle. Further information on the WLTP measurement procedure can be found at: https://www.bmw.com/en/innovation/wltp.html.
A battery electric vehicle requires mains electricity for charging. Whilst we recommend the battery for this vehicle is charged to 80% to help optimise the health and life of your battery, the electric range figure shown is the WLTP figure after the battery had been fully charged to 100%. WLTP figures are shown for comparability purposes. Only compare fuel consumption, CO_2 and electric range figures with other cars tested to the same technical procedures. These figures may not reflect real life driving results, which will depend upon a number of factors including the starting charge of the battery, accessories fitted (post registration), variations in weather, driving styles and vehicle load.

[2]Range and consumption depend on various factors, in particular: personal driving style, route conditions, outside temperature, heating/climate control, pre-temperature setting.

The 7th generation of the worlds fastest business sedan BMW M5 brings a lot of dualities regarding its drivetrain, it's everyday use and it's driving dynamics and makes it the perfect companion for your everyday life.

It is inspiring as a vehicle. The high-voltage battery cells, for example, consist of approx. 10 % secondary material (approx. 50 % secondary nickel). The front axle support is made of approx. 60 % secondary aluminium. Plastics in the floor trim contain approx. 25 % secondary material. Based on the overall vehicle the BMW M5 has a calculated secondary raw material content of approx. 22 %. These values have been calculated at the start of production of the new vehicle generation in 2024 based on specific supplier records as well as on average industry values and also include production residues.

The appearance combines pure elegance and a bold design.

2. LIFE CYCLE ASSESSMENT.

Think long term and act with the customer in mind. These are the fundamental objectives of the BMW Group and firmly anchored in our corporate strategy. Part of our product responsibility includes: evaluating the environmental, economic and social impact of the BMW Group. With the help of a lifecycle assessment, we can look at the entire life cycle of a vehicle and its components.

What is a Life Cycle assessment?
A Life Cycle assessment means looking at the three elements of the car:
– production of the vehicle
– the use phase, or driving phase
– the end of life, how the car can be recycled
This transparency means that in the development phase of a vehicle for example, potential measures to reduce the environmental impact can be identified and incorporated into product development decisions at an early stage.

What Criteria are we using?
The comparable presentation of results and process applications is particular challenging for complex products such as vehicles. We are using the WLTP (Worldwide harmonised Light Vehicles Test Procedure) which gives a representation of fuel consumption, electricity consumption and CO_2 figures for comparison purposes.

For the use phase of the vehicle WLTP consumption values are used over a total nominal distance covered of 200.000 km (approx. 125.000 mls).

Then, using LCA for experts 10 Software Programme and Database from Sphera, specific supplier records are added to quantify the environmental impact of the supply chain and vehicle production. Specific supplier records include the proportion of secondary raw materials and the use of renewable energies as at the start of production of the new vehicle generation. It's an industry standard system, and unless otherwise specified, all emission factors used are taken from the software.

Who verifies this data?
External experts, the TÜV Rheinland Energy & Environment GmbH, have verified compliance with the ISO 14040/44 standard.

The CML-2001 method is used for the life cycle assessment of the BMW M5, and this method was developed by the Institute of Environmental Sciences at Leiden University in the Netherlands in 2001. This method of impact assessment is used in many life cycle assessments in the automotive industry. It's aim is to quantitatively map as many material and energy flows as possible between the environment and the product system in the life cycle.

VALIDATION OF THE LIFE CYCLE ASSESSMENT.

TÜVRheinland®

Validation

TÜV Rheinland Energy & Environment GmbH confirms that a critical review of the life cycle assessment (LCA) study of **BMW AG, Petuelring 130, 80788 München** for the following passenger car:

BMW M5 – 2024 model year

was performed.

Proof has been provided that the requirements of the international standards

- ISO 14040:2006 + A1:2020: Environmental management – life cycle assessment – principles and framework
- ISO 14044:2006 + A1:2018 + A2:2020: Environmental management – life cycle assessment – requirements and guidelines
- ISO/TS 14071:2014: Environmental management – life cycle assessment – critical review processes and reviewer competencies: additional requirements and guidelines to ISO 14044

are fulfilled.

Results:

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

Review process and level of detail:

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

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

Cologne, 30th July 2024

N. Heidelmann J. Sobiech

Norbert Heidelmann
Department Manager for Carbon and Energy Services

Jocelyn Sobiech
Sustainability Expert

Responsibilities:
Sole liability for the content of the LCA rests with BMW AG. TÜV Rheinland Energy & Environment GmbH was commissioned to review said LCA study for compliance with the methodical requirements, and to verify and validate the correctness and credibility of the information included therein.

2. LIFE CYCLE ASSESSMENT.

The system boundary of the life cycle assessment (LCA) is shown in Figure 1 and ranges from the extraction of raw materials to the production of materials and components, logistics and the usage phase to recycling at the end of the vehicle's service life.

Recyclable production residues from manufacturing processes are kept in an internal cycle and are also taken into account. This includes, for example, the scrap from the production of steel and aluminium components. The impact of the manufacture of tools and the construction of production facilities are not included in this LCA.

For the usage phase, publicly available data records for EU-28 fuel and electricity mixes at the start of production of the new model generation are used for the energy supply. The scope of the study does not include the maintenance, high-voltage battery replacement or any service of the vehicles.

The recycling (end-of life) is mapped as part of the LCA using the standard ISO processes of drying and disassembly in accordance with the End-of-Life vehicles directive, as well as the separation of metal in the shredding process and the energy recovery of non-metallic components (shredder light fraction). No eco-credits are issued for secondary materials produced and energy recovery through thermal recycling. Only the efforts and emissions of the recycling processes are taken into account. The dismantling of the component was set as the system boundary for the recycling of the high-voltage battery and no further credit was issued.

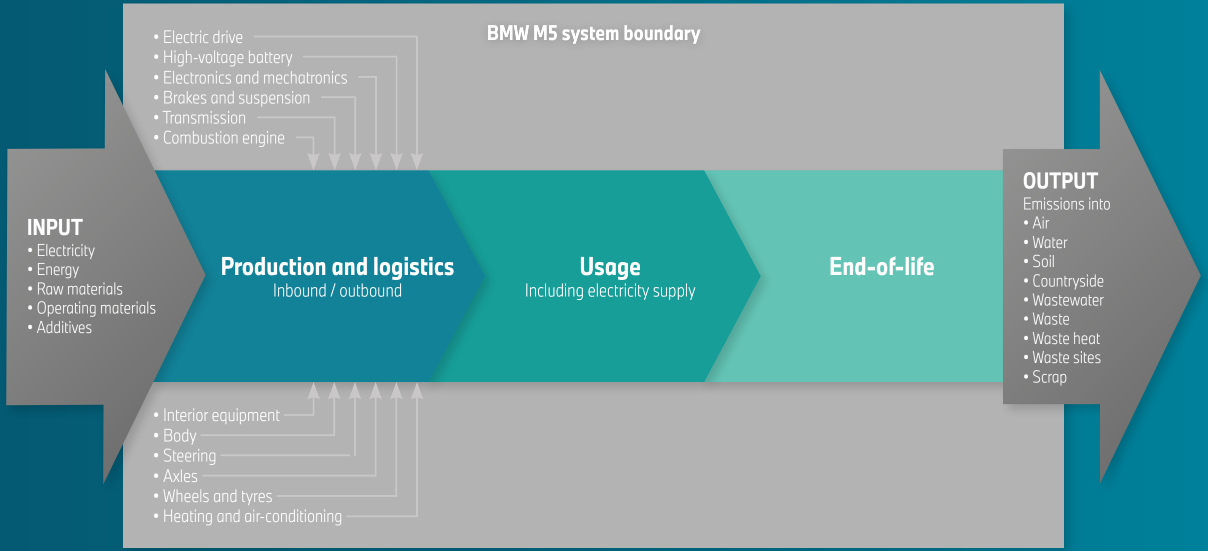


Fig. 1: BMW M5 life cycle assessment system boundary

2.1. MATERIALS USED IN THE VEHICLE.

Product-related data, such as component and material specifications, piece quantities, manufacturing and logistics efforts, etc., is primary data collected by the BMW Group.

For the LCA, the weight is taken as the "mass in a drive-ready state without a driver or luggage plus artificial leather upholstery". This weight is mapped through a derivation of the vehicle's components and their material composition from a vehicle-specific parts list.

Figure 2 shows the material composition of the BMW M5.

The weight of the BMW M5 is composed of 42.0 % steel and ferrous metals and 24.0 % light alloys, particularly aluminium. The material group of polymers also has a large share with 17.0 %. The cells, including the electrolyte of the high-voltage battery, make up 3.8 % of the weight. Their cell chemistry represents the latest generation of lithium-ion batteries. Other materials make up 3.7 %. Non-ferrous metals are 3.3 %. Process polymers account for 1.5 %. Operating materials are around 4.3 %. They are composed of oils, coolant and brake fluid, as well as refrigerant and washer water. Special metals such as tin have a share of well below 1 %.

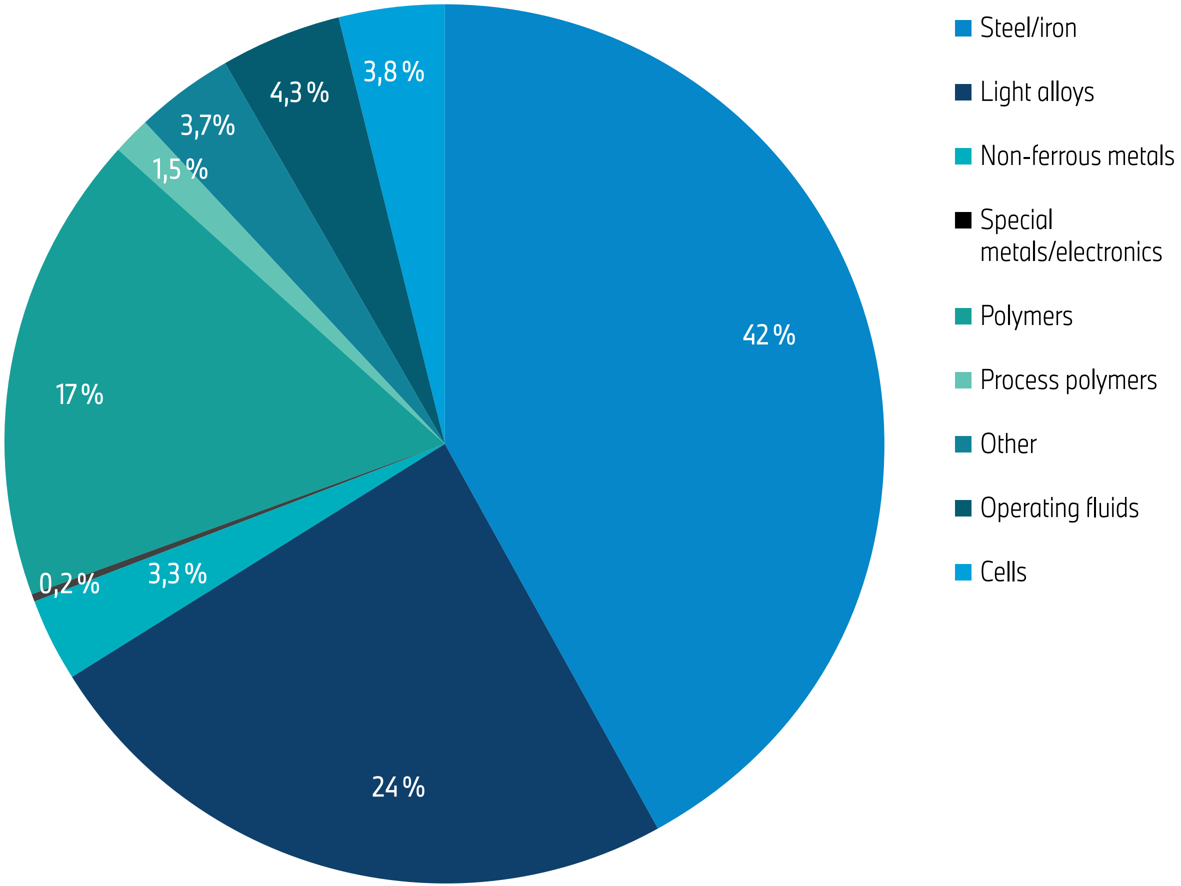


Fig. 2: Material composition of the BMW M5 at the start of production.
The specified values may contain rounding differences.

2.2. CO_2 EQUIVALENTS OVER THE LIFE CYCLE.

CO_2 equivalents [CO_2e] of the BMW M5 over its life cycle

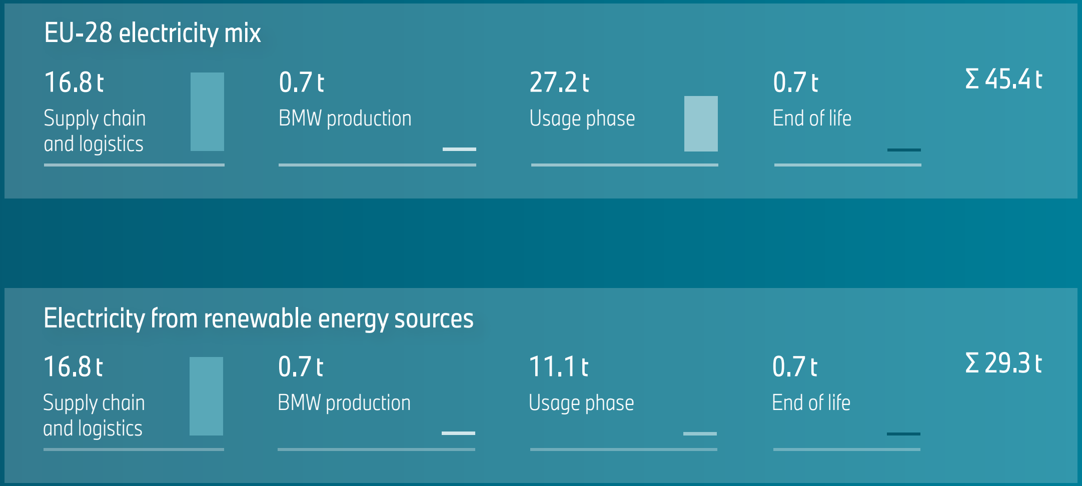


Fig. 3: The total amount of carbon dioxide (CO_2) and other greenhouse gas emissions such as methane or nitrogen oxide are taken into account. CO_2 equivalents (CO_2e) are a unit of measurement used to standardise the climate impact of different greenhouse gases. The crediting of electricity from renewable energy sources includes both electricity from renewable in-house-generation plants and direct supply contracts as well as certified guarantees of origin. Offsetting measures are not taken into account.

This life cycle assessment (LCA) considers the CO_2 equivalents of a product over its entire life cycle. In order to assess the climate impact, greenhouse gas emissions associated with the raw material supply chain, transport logistics and production, the usage and recycling or disposal of the product are included. The Global Warming Potential (GWP) evaluation is currently the main focus in the automotive sector.

Figure 3 shows the CO_2 equivalents of the BMW M5 over its life cycle and the impact of using 100% electricity from renewable sources in the usage phase.

The BMW M5 tested for this life cycle assessment is handed over to customers with 17.5 t CO_2e. Inbound and outbound logistics account for 0.4 t of this. Inbound logistics includes all transportation of goods from suppliers to the production sites and intra-plant transport. The outbound transport logistics from the factory to the global markets is determined on the basis of forecasted volume plans.

The calculation of the usage phase of the BMW M5 is based on WLTP consumption (mean value of the WLTP range) and a mileage of 200,000 km. The type-approved consumption for plug-in hybrid vehicles results from a mixed calculation specified in the WLTP cycle, a mainly electric driven share with a charged battery and very low CO_2 emissions and a proportion with an empty battery with the corresponding CO_2 emissions. According to current test regulations, the proportion of electrical operation is approximately 82 %, depending on the electric range. This proportion of the test specification will be reduced to around 52 % for the first time in 2025 and will then be adjusted every two years.

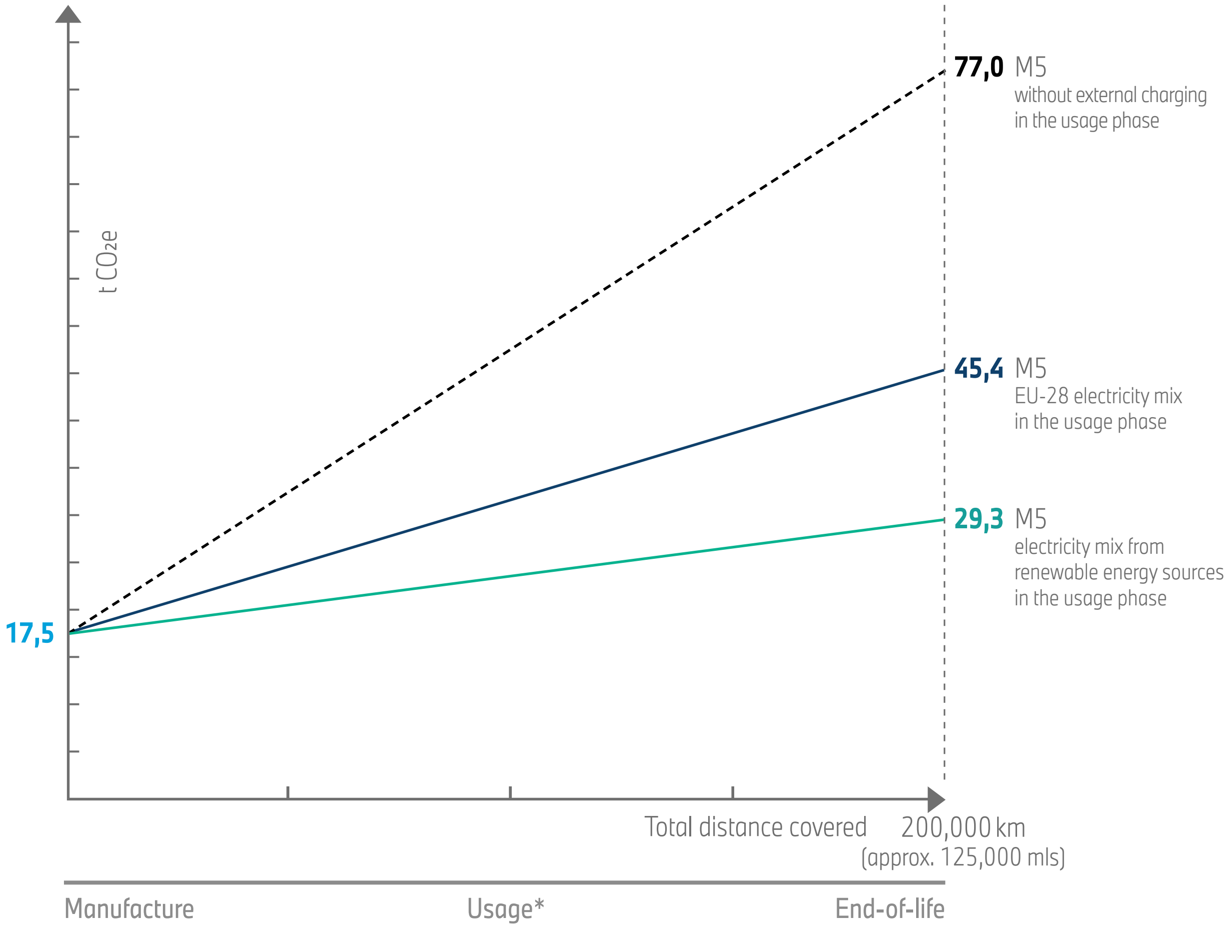
2.2. CO_2 EQUIVALENTS OVER THE LIFE CYCLE.

The production of the BMW M5 causes 17.5 t of CO_2e. The main reason is the energy-intensive production processes of the high-voltage battery.

However, besides production, fuel and electricity consumption in the usage phase are key to the environmental impact.

Figure 4 shows the influence of charging behavior as well as electricity generation on the vehicle's climate impact. Based on the generated Europan electricity (EU-28 mix, local or regional electricity mixes might differ), this amounts to 17.1 t of CO_2e plus 10.1 t due to the fuel consumed. When the customer charges the vehicle with electricity from renewable sources, electricity generation contributes only 1.0 t to the total life cycle emissions. Due to the inclusion of CO_2e emissions for the production of the energy-generating plants, this value is not equal to zero.

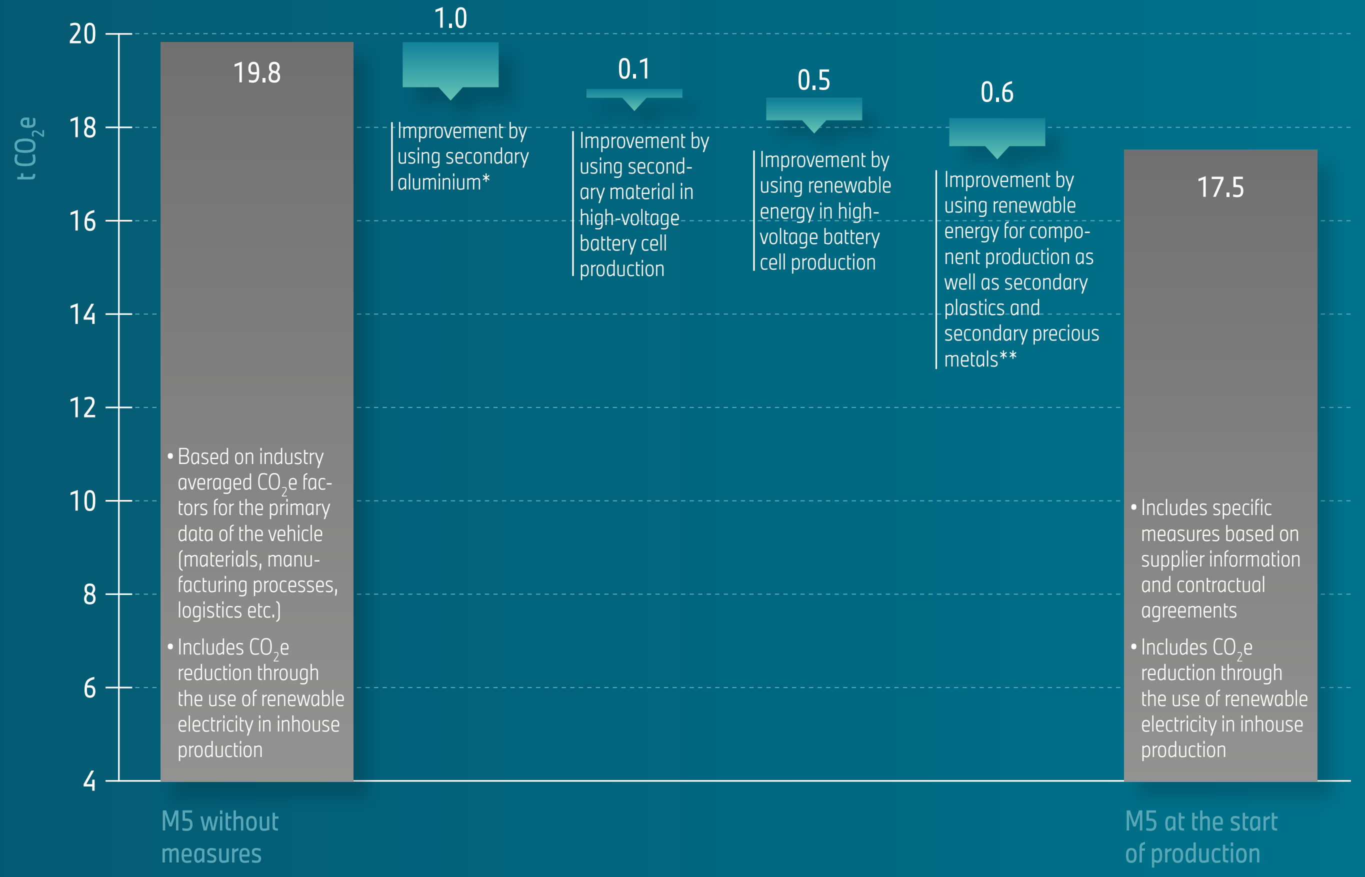
Not externally charging the Plug-in-Hybrid over the considered usage phase results in 77.0 t of total CO_2e emissions over the the life cycle.



*Consumption data according to type test (mean value of the WLTP range)

Fig. 4: Comparison of the CO_2 equivalents of the BMW M5 depending on charging behavior and energy mix.

2.3. MEASURES FOR REDUCING CO_2 EQUIVALENTS.



* Drive bearings, wheels, brake calipers, body, high-voltage battery housing, etc.

** Catalytic coating in the exhaust system

Fig. 5: Influence of development targets on the CO_2 equivalents in the manufacturing phase of the BMW M5

In order to achieve internal sustainability targets, various measures were implemented during the production phase of the BMW M5.

Figure 5 shows the measures that contribute to reducing CO_2 equivalents in the manufacturing phase by around 11 % compared to the industry averages according to LCA for Experts 10 Software and Database. The use of renewable energy sources in in-house production was not reported separately as a measure and is already included in the 19.8 t of CO_2e.

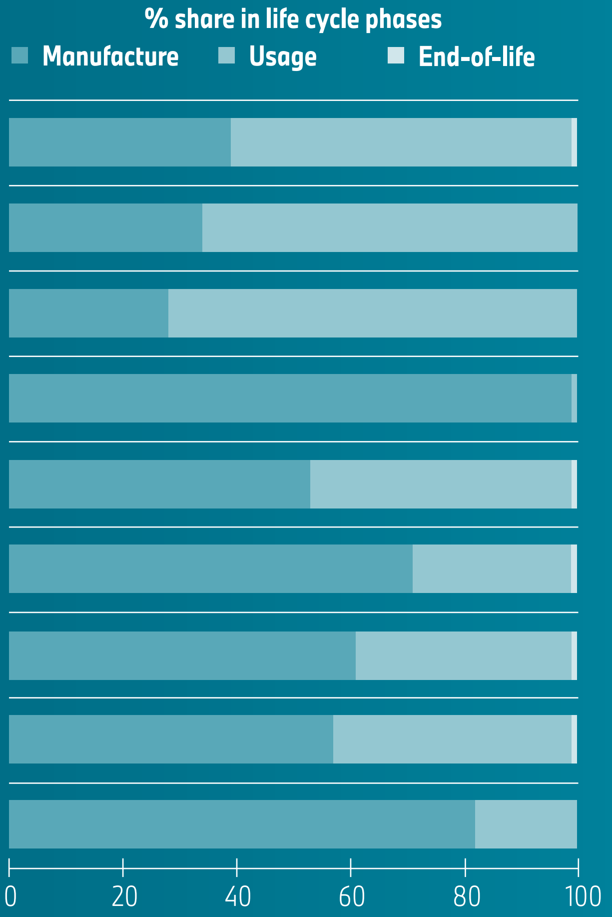
The inclusion of the measures result in a CO_2e value of 17.5 t when the vehicle is handed over to the customer. The specified values may contain rounding differences.

2.4. FURTHER ENVIRONMENTAL IMPACT CATEGORIES.

Table 1 shows the CO_2 equivalents of the BMW M5, which is expressed in CO_2e as well as other significant environmental impact categories with percentage contributions in the life cycle phases:

- The primary energy demand from renewable and non-renewable resources. In other words, the primary energy (e. g. coal, solar radiation) required to generate usable energy and to produce materials.
- Abiotic – i.e. non-living – resource consumption measures the scarcity of resources. The scarcer an element and the higher the consumption, the higher the contribution to Abiotic depletion potential (ADPelem.).
- The photochemical oxidant formation potential (POCP) measures ground-level ozone formation (e. g. summer smog) by emissions.
- The acidification potential (AP) quantifies and evaluates the acidifying effect of specific emissions.
- The eutrophication potential (EP) describes the undesirable introduction of nutrients into water bodies or soils (eutrophication).
- Nitrogen oxides (NO_x) contribute, among other things, to the formation of particulate matter and ozone. NO_2, for example, is an irritant gas.
- Emitted particles combine particles of different sizes.

Influencing variable	Unit	Value
Global warming potential (GWP)	t CO_2e	45.4
Primary energy demand from non-renewable resources	GJ	750.8
Primary energy demand from renewable resources	GJ	307.1
Abiotic depletion potential (ADPelem.)	kg Sbe	0.7
Photochemical oxidant formation potential (POCP)	kg C_2H_4e	11.7
Acidification potential (AP)	kg SO_2e	151.7
Eutrophication potential (EP)	kg PO_4e	14.8
Nitrogen oxide (NO_x)	kg	58.2
Particles	kg	13.2



Tab. 1: Environmental impact categories with percentage contributions in the life cycle phases of the BMW M5

3. PRODUCTION AND WATER DEMAND.

For the BMW M5, the relevant production sites are Dingolfing, Steyr, Landshut and Berlin. The assembly of the complete vehicle as well as the assembly of the electric drive components take place at the Dingolfing plant, while the petrol engine is manufactured at the Austrian plant in Steyr. Individual add-on parts of the body are delivered from the Landshut plant; the brake discs from the Berlin plant.

All four sites obtain their entire external electricity requirements from renewable energy sources, for example using guarantees of origin. The BMW Group only purchases certificates of renewable energy for which the production is not subsidised. This excludes the possibility of double counting. In addition, electricity is also generated from renewable energy sources on the factory premises. The heat demand is covered by natural gas, heating oil and heat from combined heat and power (CHP) plants.

Many production processes, such as painting the vehicles, require a lot of water. The average potable water consumption in 2023 across all global production sites was 1.78 m^3* per new vehicle.

*Source: https://www.bmwgroup.com/en/report/2023/index.html
The specifications regarding water demand do not form part of the LCA.

4. RECYCLING OPTIONS AT THE END OF THE LIFE CYCLE.

BMW considers the impact on the environment over the entire life cycle of a new vehicle. From production to usage, servicing and recycling. Efficient recycling is planned as early as in the development and production stages. "Designed for recycling" is applied and ensures efficient recycling of end-of-life vehicles. One example is the complete and simple removal of the operating fluids (e.g. refrigerant).

It goes without saying that BMW automobiles worldwide meet the legal requirements for the recycling of end-of-life vehicles, components and materials. In relation to the entire vehicle, at least 85% of materials are recycled and, including thermal utilisation, at least 95% as stipulated by legal requirements (European End-of-Life Vehicles Directive ELV 2000/53/EC).

End-of-life vehicles are recycled in recognised disassembly facilities. The BMW Group and its national sales companies have established a network recycling at more than 2,800 collection points in 30 countries worldwide. The four stages of recycling include controlled return, pre-treatment, disassembly and recycling of the remaining vehicle.

The statements and specifications on this page do not form part of the LCA.

5. SOCIAL SUSTAINABILITY IN THE SUPPLY CHAIN.

Compliance with environmental and social standards in the supplier network is a declared goal of the BMW Group. This includes respect for human rights and diligence in the extraction of raw materials.

We source components, materials and services from many manufacturing and delivery locations worldwide. We pass on social and environmental due diligence obligations as part of contractually binding sustainability standards. We counter identified risks in the network with prevention, enabling and remedial measures. They are systematically embedded in our processes.

In critical supply chains, corporate due diligence is a particular challenge. This is due to the complex tracing of raw material sources to ensure the necessary transparency. That is why we buy the lithium and cobalt for the BMW M5 directly from the producers. These are key components that we make available to suppliers. In this way, the origin and extraction methods of the raw materials are fully traced.

Further information on auditing and improving environmental and social standards in the extraction and processing of raw materials can be found here:
https://www.bmwgroup.com/en/sustainability/our-focus/environmental-and-social-standards/supply-chain.html

The statements and specifications on this page do not form part of the LCA.

6. EVALUATION AND CONCLUSION.

The 7th generation of the worlds fastest business sedan BMW M5 brings a lot of dualities regarding its drivetrain, it's everyday use and it's driving dynamics and makes it the perfect companion for your everyday life.

The independent TÜV Rheinland Energy & Environment GmbH validated a life cycle assessment of the BMW M5 showing the measures taken to reduce its environmental impact.