BMW GROUP

VEHICLE FOOTPRINT.

Life cycle assessment of the BMW i5 with a validation by TÜV Rheinland and further information on its ecological and social impact. Data at the time of the start of production of the vehicle in July 2023.

TABLE OF CONTENTS.

VALIDATION OF THE LIFE CYCLE ASSESSMENT.

TÜVRheinland®

Validation

TÜV Rheinland Energy 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 i5 eDrive40 – 2023 model year

was performed.

Proof has been provided that the requirements of the international standards

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

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, measurement results, etc.) and
- Check of LCA input data (e.g. weights, materials, energy consumption, emissions, etc.).

Cologne, 02nd August 2023

N. Heidelmann

Norbert Heidelmann
Department Manager for Carbon and Energy Services

Responsibilities:
Sole liability for the content of the LCA rests with BMW AG. TÜV Rheinland Energy 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.

1. PRODUCT INFORMATION AND TECHNICAL DATA.

Technical details	BMW i5 eDrive40
Propulsion system	Electrical
Transmission	1-speed automatic
Power in kW (hp)	250 (340)
Drive type	Rear-wheel drive
Maximum speed in km/h	193
Power consumption, combined WLTP in kWh/100 km	18.9–15.9
Electric range, WLTP in km[1, 2]	497–582
Battery capacity (gross/net) in kWh[3]	83.9/81.2
Empty weight in kg[4]	2,205

[1]The stated fuel consumption and CO_2 figures were determined according to the prescribed measuring procedure of the WLTP cycle (Worldwide harmonised Light vehicles Test Procedure) 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 varying consumption values and CO_2 emissions. For the assessment of taxes and other vehicle-related levies that are (also) based on CO_2 emissions, values other than those given here may therefore apply. The information therefore does not relate to the specific vehicle and is not part of the offer, but serves solely for the purpose of comparison between the different vehicle types. Further information on the WLTP measuring procedure can be found at: https://www.bmw.co.uk/en/topics/discover/efficientdynamics/bmw-emissions.html. The CO_2 efficiency figures are derived from Directive 1999/94/EC and Passenger Car Consumer Information Act (PKW-VIG) and use the consumption and CO_2 values determined in the course of the approval procedure for classification. A guide to fuel consumption, power consumption and CO_2 emissions, containing data for all new passenger car models, is available free of charge at all points of sale. The fuel consumption or power consumption and CO_2 emissions of a vehicle depend not only on the efficient use of fuel by the vehicle, but also on driving style and other non-technical factors. CO_2 is the main greenhouse gas responsible for global warming. In addition, further details on the specific vehicle can be found in the type approval available at the dealer.
[2]Range depends on various factors, in particular: personal driving style, route conditions, outside temperature, heating/climate control, pre-temperature setting.
[3]Charging performance depends on the state of charge, ambient temperature, individual driving profile and use of auxiliary consumers. The ranges shown are based on the WLTP best case. The charging times apply to ambient temperatures of 23°C with the car having just been driven and may vary according to usage behaviour.
[4]The EC unladen weight refers to a vehicle with standard equipment and does not include optional equipment. This unladen weight refers to a tank that is 90% full with a driver weighing 75 kg. Optional equipment can change the weight of the vehicle, the payload and, if it affects the aerodynamics, the top speed.

The new BMW i5 signals a new era. BMW's first fully electric business saloon. The business card for people who drive change. Mobility that is fun and inspiring.

Inspiring as a vehicle and as a role model. The plastic in the floor trim, for example, consists of up to 50% recycled polyamide. It is derived from fishing nets, among other things. The aluminium components, such as wheel carriers and cross and side members, contain up to 50% recycled material. Up to 45% secondary aluminium is used for the wheels. Furthermore, the BMW i5 is the first BMW model to feature a completely leather-free interior as standard.

It is therefore setting new standards for the business class. The all-electric model for locally emission-free mobility. In production and on the road.

2. LIFE CYCLE ASSESSMENT.

Think long term and act responsibly. These are the fundamental objectives of the BMW Group that are firmly anchored in our corporate strategy. This requires the simultaneous and equal implementation of ecological, economic and social specifications. Evaluating the ecological impact of a BMW is part of our product responsibility. With the help of a life cycle assessment, we look at the entire life cycle of a vehicle and its components.

Environmentally relevant effects are made transparent as early as in the development phase of a vehicle and potential for improvement is identified. Environmental aspects are incorporated into product development decisions at an early stage.

The life cycle assessment of the BMW i5 eDrive40 will be prepared for the start of production in July 2023.

A total distance covered of 200,000 km in the WLTP (Worldwide harmonised Light vehicles Test Procedure) is considered. The cells in a high-voltage battery are designed for a long service life. A partial or complete change within the total distance covered under consideration is not envisaged.

The comparable presentation of results and process applications is particularly challenging for complex products such as vehicles. External experts verify compliance with the ISO 14040/44 standard. This test is carried out by the independent TÜV Rheinland Energy.

The CML-2001 method is used for the life cycle assessment of the BMW i5. The Institute of Environmental Sciences at Leiden University in the Netherlands developed it in 2001. This method of impact assessment is used in many life cycle assessments in the automotive industry. Its aim is to quantitatively map as many material and energy flows as possible between the environment and the product system in the life cycle.

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 punching offcuts from the production of steel or aluminium components. Expenses for 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 electricity mixes are used in the electricity supply. The cells in a high-voltage battery are designed for the service life of the vehicle. The scope of the study does not include the maintenance and servicing of the vehicles.

The recycling phase is mapped according to standard processes of drying and disassembly in accordance with the End-of-Life Vehicles directive, as well as the separation of metals in the shredding process and the energy recovery of the non-metallic components. The cost and emissions of the recycling processes are taken into account without credits. In contrast, only the cost of processing secondary materials used in production is calculated.

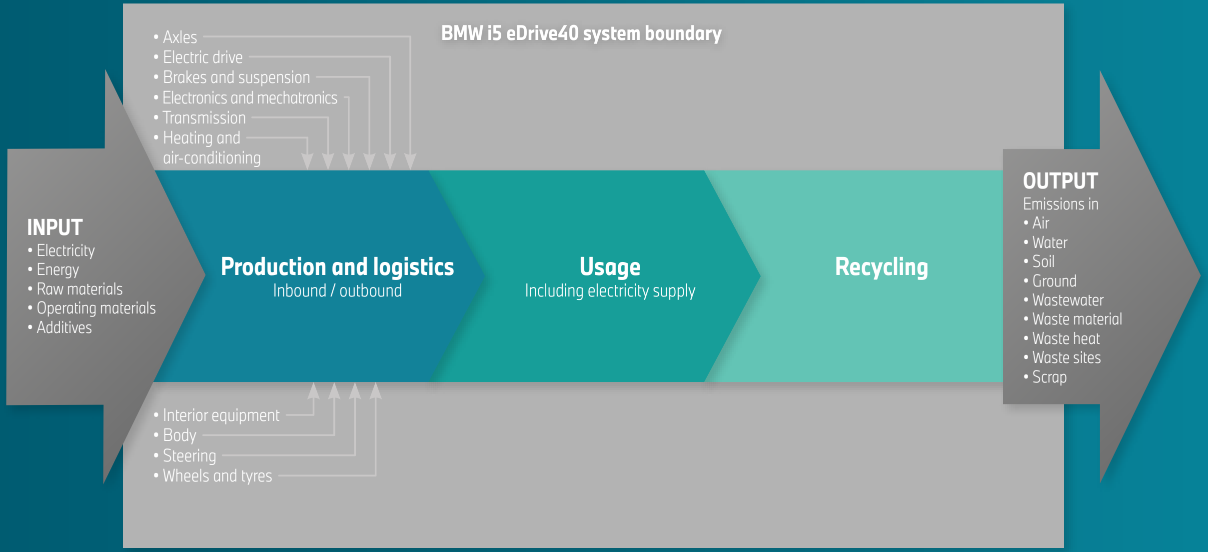


Fig. 1: BMW i5 eDrive40 life cycle assessment system boundary

3. MATERIALS USED IN THE VEHICLE.

Product-related data, such as component and material specifications, piece quantities, manufacturing and logistics costs, 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 i5.

The weight of the BMW i5 is composed of 32.0% steel and ferrous materials and 24.0% light alloys, particularly aluminium. The material group of polymers also has a large share with 19.0%. The cells, including the electrolyte of the high-voltage battery, make up 15.0% of the weight. Their cell chemistry represents the latest generation of lithium-ion batteries. Other materials make up 2.5%. Non-ferrous metals are 3.7%. Process polymers account for 1.6%. Operating fluids about 1.7%. 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%.

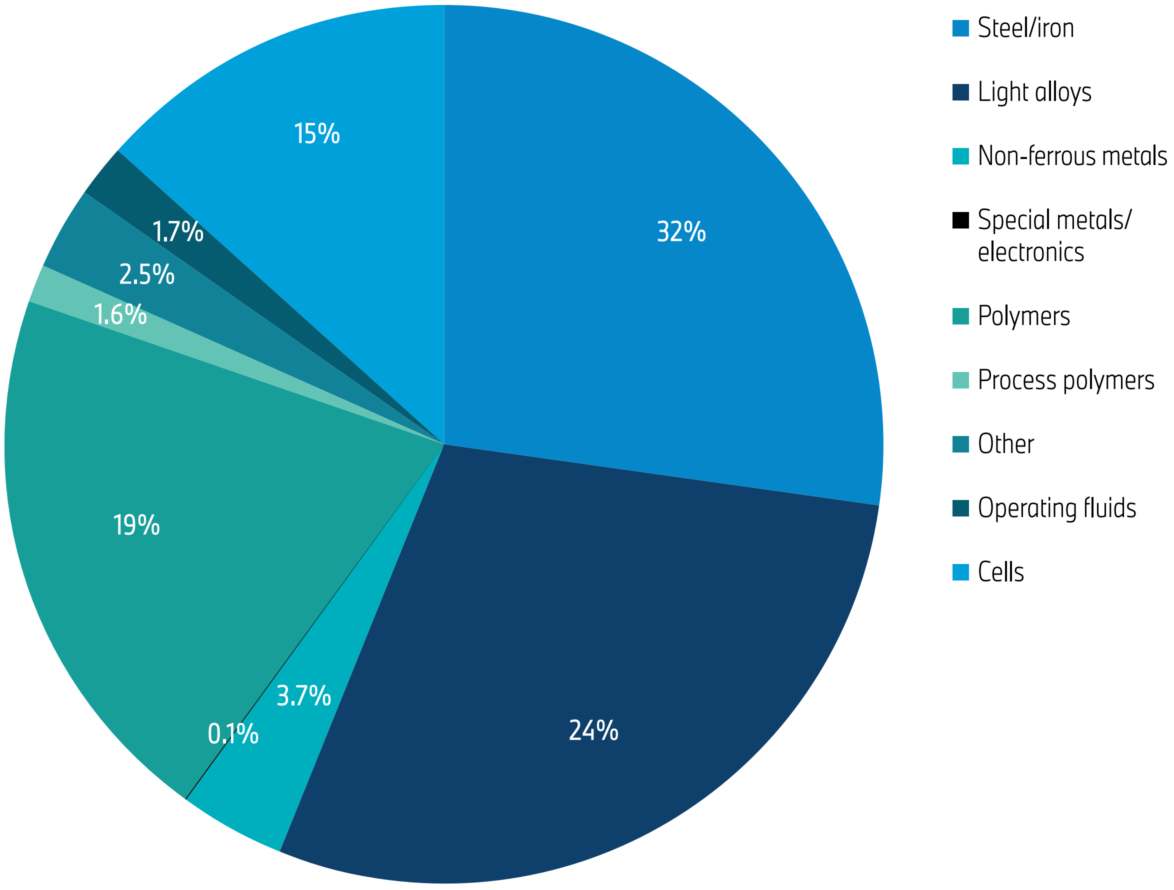


Fig. 2: Material composition of the BMW i5 eDrive40 at the start of production (SoP)

4. PRODUCTION AND WATER DEMAND.

For the BMW i5 eDrive40, the relevant production sites are Dingolfing, Landshut and Berlin. The assembly of the complete vehicle as well as the assembly of the electric drive components takes place at the Dingolfing site. This is where the union of electric machine, power electronics and electric machine transmission is formed and the vehicle is assembled. Individual add-on parts of the body are delivered from the Landshut plant; the brake discs from the Berlin plant.

Parts of the electricity consumed at all three locations come from renewable sources. It comes from the location's own sources or is based on 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. These locations obtain their external electricity entirely from renewable sources. 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 water consumption in 2022 across all global production sites was 1.90 m^3* per new vehicle. This value refers to water purchased from an external supplier.

*Source: https://www.bmwgroup.com/en/report/2022/index.html.

The specifications regarding water demand do not form part of the LCA.

5. GLOBAL WARMING POTENTIAL OVER THE LIFE CYCLE.

Global warming potential [CO_2e] of the BMW i5 eDrive40 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 green electricity 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 global warming potential (GWP) of the BMW i5 over its entire life cycle. In order to fully assess the climate impact, all greenhouse gas emissions associated with the raw material supply chain, transport logistics and production at BMW locations, the usage and recycling or disposal of the product are included. The GWP evaluation is currently the main focus in the automotive sector.

Figure 3 shows the global warming potential of the BMW i5 over its life cycle and the impact of using 100% renewable energy in the usage phase.

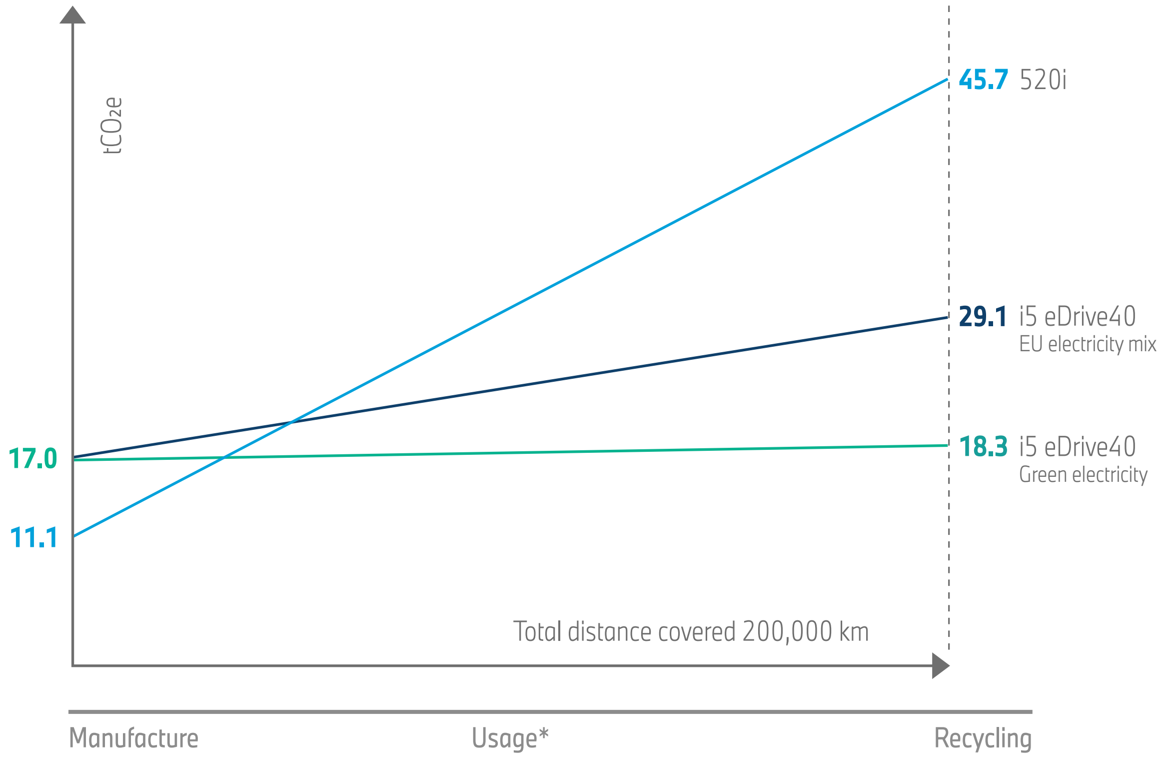
The BMW i5 tested for this life cycle assessment is handed over to customers with 17t CO_2e. Inbound and outbound logistics account for 1t of this. Inbound logistics includes all transportation of goods from suppliers to the production sites and intra-plant transport. The outbound transport logistics from the factory to the global markets is determined on the basis of forecasted volume plans for one year. The usage phase for the BMW i5 is based on WLTP consumption and a total distance covered of 200,000 km.
How the electricity used is generated significantly influences the climate impact of the vehicle. Based on the European electricity mix, this amounts to 11.5t of CO_2e. When using electricity from renewable sources, electricity generation contributes only 0.7t 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.

6. GLOBAL WARMING POTENTIAL COMPARED.

The production of the BMW i5 causes 17.0t of CO_2e. That is more than the BMW 520i with a combustion engine causes during production. The main reason is the energy-intensive production processes of the high-voltage battery.

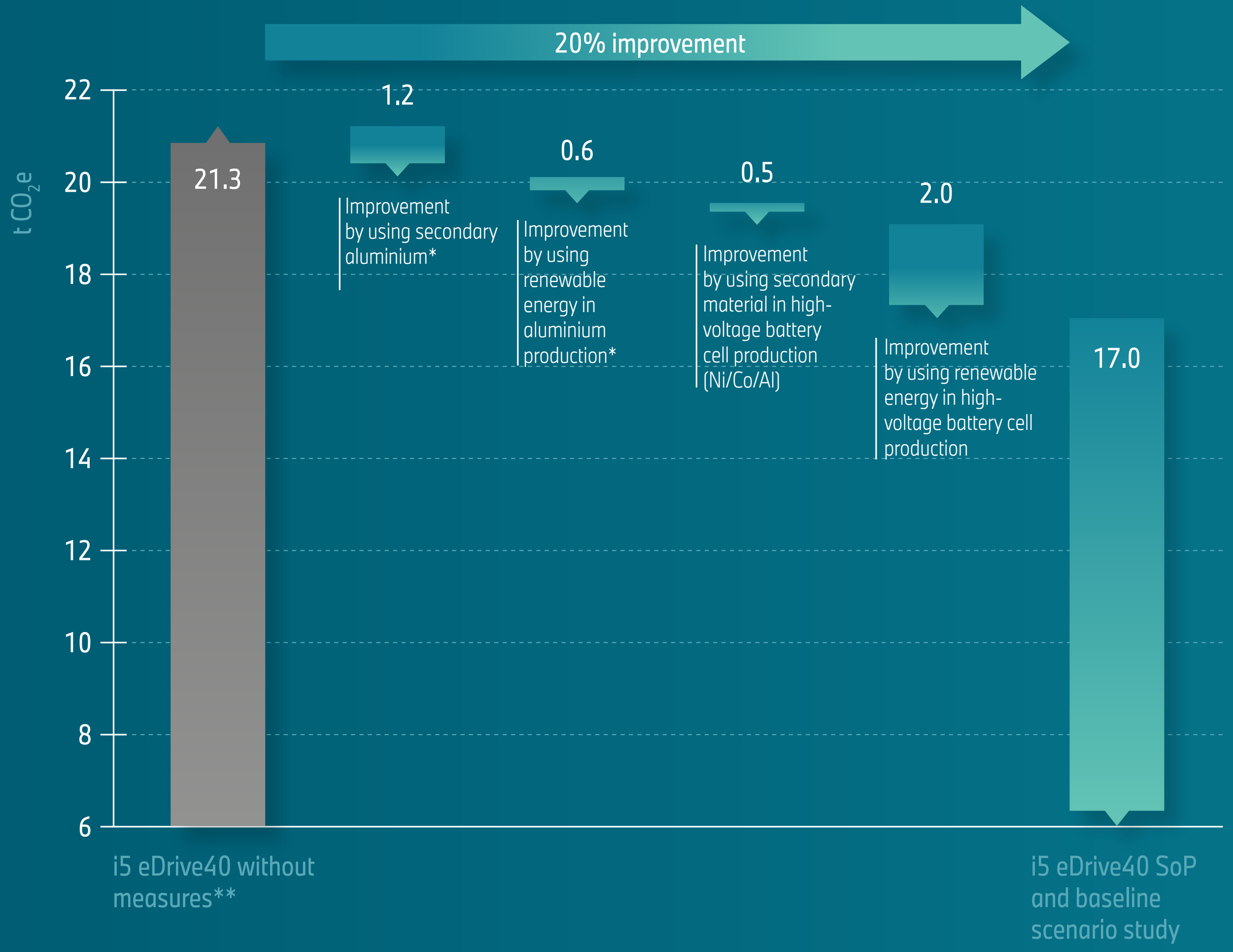
However, besides production, consumption in the usage phase of both vehicles is key to their environmental impact. At 200,000 km total distance covered, charged with EU electricity mix in the usage phase, the BMW i5's total emissions of 29.1t of CO_2e are significantly lower than the 45.7t of CO_2e emitted by the BMW 520i.

Charging with green electricity can reduce CO_2 emissions in the usage phase of an electric vehicle to 0.7t.



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

7. MEASURES FOR REDUCING GLOBAL WARMING POTENTIAL.



In order to achieve sustainability targets, various measures were implemented during the production phase of the BMW i5 eDrive40.

Figure 5 shows the measures that contribute to improving the global warming potential in the manufacturing phase by around 20%. The use of renewable energy sources in in-house production was not reported separately.

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

** With renewable energy in in-house production

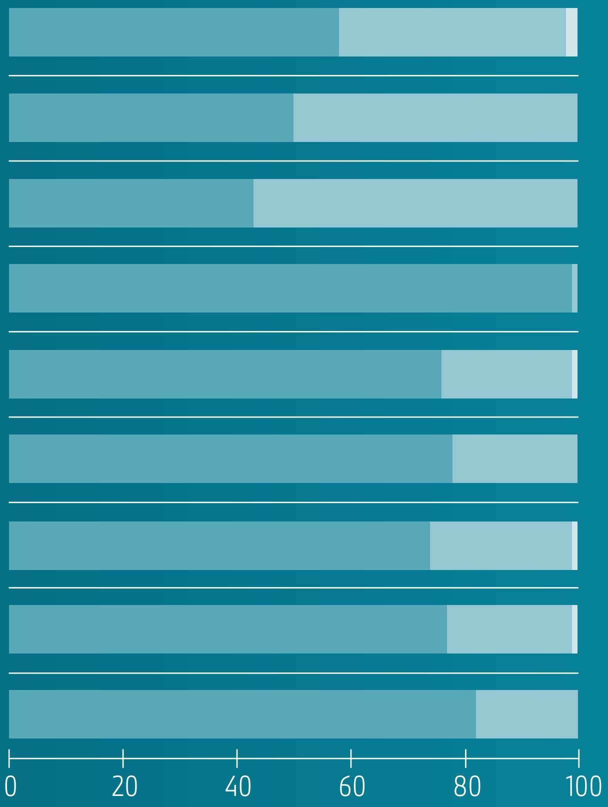
8. FURTHER ENVIRONMENTAL IMPACT CATEGORIES.

Table 2 shows the global warming potential of the BMW i5, which is expressed in CO_2e. In addition, other significant environmental impact categories are shown 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.
- The photochemical oxidant formation potential (POCP) measures ground-level ozone formation (e.g. summer smog) by emissions.
- 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 resource consumption (ADPe).
- 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.
- The particles group together particles of different sizes.

Influencing variable	Unit	Value
Global warming potential	t CO_2e	29
Primary energy demand from non-renewable resources	GJ	486
Primary energy demand from renewable resources	GJ	253
Abiotic resource consumption (ADPe)	kg Sbe	0.5
Photochemical oxidant formation potential (POCP)	kg C_2H_4e	7
Acidification potential (AP)	kg SO_2e	109
Eutrophication potential (EP)	kg PO_4e	11
Nitrogen oxide (NO_x)	kg	59
Particles	kg	11

% share in life cycle phases: Manufacture – usage – recycling



9. 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. Environmentally friendly recycling is planned in as early as in the development and production stages. "Designed for recycling" is consistently 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).

BMW cars built worldwide have met the legal requirements for recycling end-of-life vehicles, components and materials since 2008. Since 2015, vehicles registered in the European Union must be at least 95% recyclable.

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

10. SOCIAL SUSTAINABILITY IN THE SUPPLY CHAIN.

Compliance with environmental and social standards in the supplier network is the 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 i5 directly from the manufacturers. Both are key components for the production of battery cells, which we make available to suppliers. In this way, the origin and extraction methods of the raw materials are fully traced. Environmental and social standards become more transparent.

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

11. EVALUATION AND CONCLUSION.

To choose a BMW i5 is to choose an all-electric businesssaloon. To choose a sporty look and mobile office. To choose mobility that's fun and inspiring.

The independent TÜV Rheinland Energy performed a life cycle assessment of the BMW i5. The assessment shows that the BMW Group is taking measures to reduce its environmental impact.