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The next level of efficiency becomes reality

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Descriptions and data in this press kit apply to the international Mercedes-Benz model programme. Country-specific deviations are possible. Further information on the vehicles offered, including the WLTP values, can be found on a country-specific basis at <https://www.mercedesbenz.com>.

Key facts in brief

Insight Mercedes-Benz – Drivetrains & Efficiency: the next step towards the electric future

#Electric drive: The new drivetrain incorporates many years of Mercedes-Benz engineering excellence. The electric drive unit (Electric Drive Unit - EDU 2.0) of the upcoming all-electric MMA (Mercedes-Benz modular architecture) models represents the first manifestation of a new generation of electric drive units from Mercedes-Benz. At the same time, it brings the drive technology of the VISION EQXX with 800-volt system and silicon carbide (SiC) inverter to the compact class. The compact, 200 kW electric drive unit with a permanently excited synchronous motor (PSM) on the rear axle was developed entirely in-house by Mercedes-Benz engineers. The high-performance power electronics are equipped with a SiC inverter for particularly efficient energy utilization. In addition, the 4MATIC models have an 80 kW drive unit on the front axle, also equipped with an SiC inverter.

#Efficiency: The bottom line is that the electric drive, as demonstrated in the Concept CLA Class, aims for a WLTP range of over 750 kilometres. With battery-to-wheel efficiency of 93% on long journeys, it also offers outstanding ranges in real-world operation. The two-speed gearbox on the main drive at the rear axle not only boosts efficiency, but also enables highly dynamic driving performance.

#Charging: Mercedes-Benz is using an 800-volt electric architecture for the first time. In conjunction with the premium version of the battery, this configuration enables high-power DC charging at up to 320 kW. In the Concept CLA Class, this would correspond to a range of up to 300 kilometres.¹

#Battery: Customers can choose between batteries with two different cell chemistries for the MMA models. The cells of the premium version with a usable energy content of 85 kWh have anodes in which silicon oxide is added to the graphite. Compared to the predecessor battery with conventional graphite anodes, the gravimetric energy density is up to 20 % higher. At cell level, the volumetric energy density of the cell chemistry is 680 Wh/l. The use of raw materials has been further optimised.

#Battery safety: The battery housing is part of the vehicle structure and is integrated into the crash concept. The battery, high-voltage (HV) cables and other HV components are designed and protected to meet the stringent safety requirements of Mercedes-Benz in the event of an accident. Mercedes-Benz has taken comprehensive precautions against thermal runaway with technical solutions for the new battery generation.

#Endurance: Its focus on time efficiency has already earned a close-to-production prototype of the CLA a successful record drive: a pre-series model covered exactly 3,717 kilometres in 24 hours at Nardò in southern Italy.

#Electric Software Hub (ESH): The Electric Software Hub (ESH), which opened in 2022, has played a key role in the development of the new generation of compact electric cars from Mercedes-Benz. This building at the Mercedes-Benz Technology Centre (MTC) in Sindelfingen brings together numerous software, hardware, system integration and testing functions under one roof.

#48-volt hybrid: Shortly after the launch of the all-electric models, the CLA will be available as a hybrid with 48-volt technology and an electric motor with up to 20 kW¹ drive power. Thanks to energy recuperation and all-electric driving capability at urban speeds, this drivetrain is particularly efficient. This is enhanced by electric coasting at speeds of up to around 100 km/h. The electric motor and inverter are integrated into a new electrified eight-speed dual-clutch transmission (8F-eDCT). The combustion engine is a new

¹ The figures are provisional. There are currently no confirmed figures from an officially recognised testing organisation, nor is there an EC-type approval or a certificate of conformity with official figures. There may be discrepancies between the figures and the official figures.

FAME (Family of Modular Engines) four-cylinder petrol engine. The hybrid is initially available in three power levels at 100, 120 or 140 kW.

Efficiency is the key to everything

Insight Mercedes-Benz Drivetrains & Efficiency: the short version

- Mercedes-Benz underlines its claim to leadership in drive systems – whether electric or hybrid
- The technology offensive is being launched on the basis of a versatile and flexible vehicle architecture
- The new CLA is the first example of intelligent modularity in the upper compact segment
- The MMA architecture brings VISION EQXX technologies to the compact class

Stuttgart. Mercedes-Benz is emphasising its claim to leadership in drive systems, including those planned for the future. Customers will be able to choose between two innovative powertrains in the upcoming vehicle architecture. The forthcoming CLA will be available as a highly efficient electric car and as an economical hybrid.

Mercedes-Benz has set new standards in terms of efficiency with the VISION EQXX technology platform. The company is now incorporating the findings from this project into its series-production vehicles. Leading the way is the new all-electric CLA, as the first model to be based on the Mercedes-Benz Modular Architecture (MMA). The centrepiece of this versatile and flexible vehicle architecture is the so-called skateboard chassis, a floor assembly designed primarily for electric cars, including the corresponding drive and chassis components. The body design varies, however: in the newly defined entry-level segment, Mercedes-Benz is planning a family of four models in total. In addition to the CLA as a four-door saloon, these include a shooting brake and two SUVs.

“As the inventor of the automobile, Mercedes-Benz has always been a pioneer of ground-breaking drive systems. We recently proved this with the record-breaking VISION EQXX technology programme. With the upcoming MMA vehicles, we are now making this visionary technology available to our customers and getting ever closer to the idea of the one-litre vehicle of the electric age. Our new hybrid drive with electric transmission is also setting new standards in terms of efficiency. With the new CLA and the other vehicles based on the MMA architecture, all customers will benefit from efficient technology at the highest level.”

Markus Schäfer, Member of the Board of Management of Mercedes-Benz Group AG. Chief Technology Officer,
Development & Procurement

The company will also rely on intelligent modularity with a scalable skateboard design for future model families in other segments. Because Mercedes-Benz is striving for a leading role in both electric driving and vehicle software, the company has massively increased its development activities in these areas. This includes the recent opening of the eCampus in Stuttgart-Untertürkheim as a competence centre for the development of cells and batteries for the future electric vehicles of the brand with the three-pointed star. The aim is to develop innovative chemical combinations and optimised production processes for high-performance cells with "Mercedes-Benz DNA" and thus reduce battery costs by more than 30 percent in the coming years.

Parts of the development and testing of the new MMA models have taken place in the Electric Software Hub (ESH). This building in the Mercedes-Benz Technology Centre (MTC) in Sindelfingen brings together numerous software, hardware, system integration and testing functions under one roof. The entire electrical/electronic integration process of vehicle development is reflected within the ESH. This ensures that all new hardware and software components interact smoothly.

The first MMA model

With its outstanding energy efficiency, the highly flexible MMA architecture marks the next step into the electric future of Mercedes-Benz. The new powertrain incorporates the many years of engineering excellence

of the brand with the three-pointed star. This applies equally to the high-voltage components and to mechanical components such as transmissions. The Electric Drive Unit (EDU 2.0) is the first of a new generation of electric drive units from Mercedes-Benz. The highly integrated units form an intelligent modular system.

With the main drive on the rear axle for optimum traction and driving characteristics, Mercedes-Benz is now introducing a drive layout familiar from the mid-size and luxury classes to the entry-level segment. The 200-kW electric drive unit with a permanently excited synchronous machine (PSM) on the rear axle was developed entirely in-house by Mercedes-Benz engineers. The high-performance power electronics are equipped with a silicon carbide (SiC) inverter for particularly efficient energy utilisation. Transmission control and inverter are highly integrated in a single component. The drive unit is built in Untertürkheim, where Mercedes-Benz has developed many innovative drives over the years.

The EDU 2.0 reconciles the conflicting goals of maximum torque, top speed and exemplary efficiency, especially in real driving conditions. This is because the high torque ensures dynamic driving performance. It is also helpful when negotiating mountain passes or towing trailers. Another strength is the extraordinary compactness of the EDU 2.0, which benefits the interior dimensions and the volume of the rear boot.

The 4MATIC models also have an 80-kW drive unit on the front axle. In the interests of efficiency, this is also equipped with a next-generation inverter with silicon carbide (SiC) and designed as a permanently excited synchronous machine (PSM). The front electric motor acts as a “boost” drive. Depending on the driving situation or driving programme, it is only switched on when the corresponding power or traction is required. This task is performed by the Disconnect Unit (DCU), which Mercedes-Benz is now using for the first time in the entry-level segment.

For greater efficiency, the DCU can decouple the electric motor on the front axle at lightning speed when the load is low, so that the electric motor and parts of the transmission are at a standstill. This reduces front axle losses by 90 % and increases the range. In the case of the Concept CLA Class, this would correspond to a range of more than 750 kilometres (WLTP)². With an energy consumption of just 12 kWh/100 km, the Concept CLA Class would be the ‘one-litre car’ of the electric age.

Mercedes-Benz is using 800-volt electrical architecture for the first time. The system maximises efficiency and performance and, in conjunction with the new battery generation, can significantly reduce charging time. Within 10 minutes, a range of up to 300 kilometres¹ can be added to the Concept CLA Class using DC fast charging. Thanks to its focus on time efficiency, the CLA has already done better than other close-to-production electric vehicles in a record attempt: In a 24-hour test drive at Nardò in southern Italy, a pre-series model covered exactly 3,717 kilometres in 24 hours. The two-speed transmission on the main drive on the rear axle not only contributes to efficiency, but also enables extremely dynamic driving performance.

Customers will be able to choose between batteries with two different cell chemistries. The cells of the premium version with a usable energy content totalling 85 kWh have anodes in which silicon oxide is added to the graphite. Compared to the predecessor battery with conventional graphite anodes, the gravimetric energy density is up to 20 % higher. At cell level, the volumetric energy density of the cell chemistry is 680 Wh/l. The use of raw materials has been further optimised and reduced. In particular, the proportion of cobalt has been further reduced.

This is followed by an all-electric entry-level variant with a lithium iron phosphate (LFP) cathode battery. Its usable energy content is 58 kWh and the volumetric energy density of the cell chemistry is 450 Wh/l.

² The information is provisional. There are currently no confirmed values from an officially recognised testing organisation, nor an EC-type approval, nor a certificate of conformity with official values. There may be discrepancies between the information and the official values.

The new hybrid is capable of all-electric driving

Mercedes-Benz is emphasising its claim to leadership in drive systems – whether electric or hybrid. Efficiency is also the key to the development of modern hybrid drive systems. The MMA architecture vehicles will also be available as a hybrid with 48-volt technology. The electric motor with 20 kW drive power³ has been integrated into a new electrified eight-speed dual-clutch transmission (8F-eDCT) together with an inverter. The electrical energy of up to 1.3 kWh is provided by a new 48-volt battery with lithium-ion technology and a flat-pack design.

Thanks to energy recuperation and all-electric driving capability at urban speeds, this drivetrain is particularly efficient. This is enhanced by electric coasting at a speed of up to around 100 km/h¹. The combustion engine is a new FAME (Family of Modular Engines) four-cylinder petrol engine. The hybrid drivetrain is initially available in three power levels with 100, 120 or 140 kW¹.

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Press information and digital services for journalists and multipliers can also be found on our **Mercedes-Benz Media online platform** at <http://media.mercedes-benz.com>.

Mercedes-Benz AG at a glance

Mercedes-Benz AG is part of Mercedes-Benz Group AG with a total of around 166,000 employees worldwide and is responsible for the global business of Mercedes-Benz -Cars and Mercedes-Benz -Vans. Ola Källenius is Chairman of the Board of Management of Mercedes-Benz -AG. The company's focus is on the development, production and sale of passenger cars and vans as well as vehicle-related services. In addition, the company aims to be the leader in electromobility and vehicle software. The product portfolio comprises the Mercedes-Benz brand -with MercedesAMG-, MercedesMaybach -and G-Class -with their all-electric models as well as products from the smart brand. Mercedes-Benz -AG is one of the world's largest manufacturers of luxury passenger cars. In 2023, around two million passenger cars and 447,800 vans were sold. In these two business areas, Mercedes-Benz -AG is continuously developing its global production network with more than 30 production sites on four continents and is orienting itself towards the requirements of electromobility. At the same time, the global battery production network is being established and expanded on three continents. Sustainability is the guiding principle of the Mercedes-Benz -strategy and for the company means creating lasting value for all stakeholders: for customers, employees, investors, business partners and society as a whole. The basis for this is the sustainable corporate strategy of the Mercedes-Benz -Group. The company thus assumes responsibility for the economic, ecological and social impact of its business activities and has the entire value chain in mind. As an internationally active company, equal opportunities, diversity, openness and respect are among the fundamental beliefs of Mercedes-Benz-. We demonstrate this in the way we think, act and communicate. As a matter of course, all terms chosen include all genders and identities.

³ The information is provisional. There are currently no confirmed values from an officially recognised testing organisation, nor an EC-type approval, nor a certificate of conformity with official values. There may be discrepancies between the information and the official values.

The one-litre car of the electric age

Insight Mercedes-Benz Drivetrains & Efficiency: the efficient electric drive

- 800-volt system and two-speed gearbox in the entry-level segment for the first time
- Main drive developed and produced by Mercedes-Benz
- Long-range efficiency of 93 % underscores extremely high overall efficiency
- New drivetrain has potential for consumption of around 12 kWh/100 km and a WLTP range of over 750 km
- Navigation with Electric Intelligence offers realistic real-time energy forecasts

The new CLA is the forerunner of a new portfolio of innovative Mercedes-Benz electric vehicles that will soon go into series production. Its highlights include the 800-volt electric architecture and the advanced drive units including a two-speed gearbox on the main drive at the rear axle. Mercedes-Benz has derived the new Electric Drive Unit (EDU 2.0) directly from the ground-breaking technology of the VISION EQXX and developed it entirely in-house. The 4MATIC models have a Disconnect Unit (DCU) on the front axle. The 800-volt system maximises efficiency and performance and can significantly reduce charging times. In the Concept CLA Class, this would mean that a range of up to 300 kilometres could be recharged within 10 minutes.⁴

Drive system based on the VISION EQXX technology platform

The new drive system has the potential for a range of more than 750 kilometres (WLTP).¹ In the Concept CLA Class, this figure represents energy consumption of just around 12 kWh/100 km¹ – earning it the title of the one-litre car of the electric age. The battery-to-wheel efficiency over long distances is 93 %¹.

The compact, up to 200 kW electric drive unit with a permanently excited synchronous machine (PSM) on the rear axle was developed by Mercedes-Benz engineers. The drive unit is built in Untertürkheim, where Mercedes-Benz has developed many innovative drives over the years. The magnets in the rotor are arranged in a double-V shape. Another feature is the winding of the stator with so-called stretched coils. Together, these measures contribute to a remarkably quiet drive. The PSM also has a significantly lower proportion of heavy rare earths than previous motor generations - almost down to zero per cent -. The high-performance power electronics feature a silicon carbide inverter for particularly efficient energy utilisation.

The drive architecture includes a two-speed gearbox on the rear axle. It combines dynamics with efficiency. This is because the first gear, with a short ratio of 11:1, offers excellent acceleration right from the start, enables a high towing capacity and also delivers outstanding efficiency in urban traffic. The second gear (gear ratio: 5:1), on the other hand, is designed for power delivery at high speeds and for high efficiency on the motorway. The top speed of up to 210 km/h¹ is also reached in second gear. The shift points depend on the driving situation and the selected driving programme. The online optimiser continually adapts them to current parameters such as battery SoC, performance and driver requirements. Traction is achieved via claws (1st gear) or discs (2nd gear). The transmission has special thermal insulation.

The 4MATIC models also have an 80-kW drive unit on the front axle. In the interests of efficiency, this is equipped with a next-generation inverter with silicon carbide (SiC) and designed as a permanently synchronised machine (PSM). The front electric motor acts as a “boost” drive. Depending on the driving programme, it is only switched on when the corresponding power or traction is required. This task is performed by the so-called disconnect unit (DCU), which Mercedes-Benz is now using for the first time in the compact class. For greater efficiency, the DCU can decouple the electric motor on the front axle at lightning

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speed when the load is low, so that the electric motor and parts of the transmission are at a standstill. This reduces front axle losses by 90 % and increases the range.

Further strengths of this unit are its compact dimensions, which allow for a front boot (frunk), and the high level of crash safety. One factor behind this is a predetermined bending point on the frame. The EDU is connected to the body via two elastomer bearing levels and an additional support frame. This elaborate double structure-borne noise decoupling, among other things, results in excellent NVH (noise, vibration and harshness) behaviour.

Charging stops with a Mercedes-Benz have never been so short: up to 320 kW charging power

In conjunction with the premium version of the battery, the 800-volt configuration enables high-power DC charging at up to 320 kW. Thanks to the optimised battery design, the high charging power is maintained over a wide SoC field, enabling short stops. The Concept CLA Class has already demonstrated that 10 minutes of charging can add up to 300 kilometres in range. ⁵

If Electric Intelligence navigation is activated, the battery is preheated during the journey if necessary. This preconditioning allows it to reach the optimum temperature for fast DC charging at the charging point.

For AC charging, the architecture offers the option of an 11 kW or 22 kW charger. Mercedes-Benz relies on a highly integrated "one-box" system in a lightweight design for the charging technology - a technology transfer from Formula 1.

In the future, new entry-level models will be capable of bidirectional charging⁶. When connected to a compatible bidirectional DC wallbox, the vehicle then becomes an energy storage system that can store solar power for later use, for example. Above all, however, it can also serve as an electricity supplier, either vehicle-to-home (V2H) or vehicle-to-grid (V2G).

Simultaneous use of three energy sources: new multi-source heat pump

The MMA models are the first Mercedes-Benz vehicles to feature an air-to-air heat pump as standard. It no longer takes the indirect route via a water circuit. As a multi-source model, it can also utilise three energy sources in parallel: the EDU 2.0 waste heat, the waste heat from the battery and the ambient air.

Maximum recuperation and minimum energy consumption

Intelligent recuperation contributes to the high efficiency. The recuperation power can presumably reach 200 kW. Almost all braking operations in everyday life are carried out with the aid of recuperation and not mechanically via the wheel brakes. In principle, the models can even brake electrically until the vehicle comes to a standstill and thus recover kinetic energy. The strong deceleration (up to 3 m/s² per axle) means more recovered energy and therefore a longer range at the end of the day. Recuperation is even possible in ABS mode or on icy roads.

The selector lever behind the steering wheel can be used not only to select the gear, but also to adjust the recuperation power. Pulling the lever towards the steering wheel causes the recuperation level to increase to a deceleration of up to 3 m/s². Pushing the lever away towards the driver's display, on the other hand, reduces the energy recuperation level. By pressing the selector lever again, the driver switches between the recuperation levels D + and D Auto. The lower area of the display indicates which lever is selected.

The four recuperation levels:

- D Car: intelligent recuperation
- D+: no recuperation (sailing)

⁵ Data for the future range champion at an outside temperature of 23° C and a remaining range of between 15 and 60 km.

⁶ The use of bidirectional charging may be subject to market-specific conditions in terms of legislation and the requirements of energy suppliers.

- D: standard recuperation up to 1 m/s²
- D-: increased recuperation up to 3 m/s²

All four recuperation levels are possible as “Last Mode”. ECO Assist is automatically active in recuperation level D Auto. Depending on the features, the ECO Assistant can use the data stored in the navigation map as well as information from sensors and cameras to determine the vehicle's expected route. In this way, the system can help to optimise the driving style to the situation ahead, minimise energy consumption and maximise recuperation. The following route events can be recognised: roundabout, sharp bend, junction, T-junction, downhill gradient and speed limit. The ECO Assistant can also react to other junctions or turn-offs if the indicator is set in good time.

If the system detects an incident or vehicle ahead and your own vehicle is approaching it, the ECO Assistant calculates the optimised speed profile based on distance, current speed and the available route information.

The “Foot Off Accelerator” indicator appears in the display. It is placed even more centrally in the new generation of electric cars. If the driver responds, intelligent recuperation is activated in overrun mode. If the ECO Assistant has recognised a vehicle in front or a stationary vehicle, it can even bring the vehicle to a standstill. This is possible at the end of a traffic jam or at traffic lights, for example.

Continuous development makes predictive energy management even more realistic

When it comes to navigation with Electric Intelligence⁷, the name says it all. This is because it plans the fastest and most convenient route, including charging stops, based on numerous factors and reacts dynamically to traffic jams or a change in driving style, for example. This convenient system, familiar from the EQS and EQE, has been expanded for the new generation of electric cars. Mercedes-Benz is also continuously developing energy forecasting for navigation with Electric Intelligence. In future, the predicted wind conditions along the carriageway will be taken into account even more precisely based on the vehicle's height.

While conventional range calculators have relied on past data, navigation with Electric Intelligence looks to the future. Energy requirements are computed when planning the journey. Topography, route, ambient temperature, speed, heating and cooling requirements are all considered. Other factors include the traffic situation on the planned route as well as the available charging stations, their capacity and the payment functions. The calculation takes place in the cloud and is combined with onboard data.

Customers do not necessarily have to fully charge at every charging stop but receive a specific recommendation for the optimum charging time at the station. The stops are scheduled to optimise the overall journey time: in some circumstances, two short charging stops with a higher charging capacity can be preferable to a single long charge. In addition, the vehicle's charging settings are automatically adjusted by the Electric Intelligence navigation system and optimised for fast charging along the route.

The MBUX system visualises the current battery capacity, enabling drivers to see if they can return to the starting point without charging. Manually added charging stations along the way are prioritised in the route calculation. Suggested charging stations can be excluded. The system also calculates the estimated costs per charging stop.

If there is a risk of not reaching the destination or the charging station with the current settings, the range monitoring system supports the driver by displaying a maximum driving speed. It also provides energy-saving tips. Under the “Range” menu item, the driver can switch off various energy consumers to increase the range and activate the ECO driving functions to support a more efficient driving style.

⁷ An active Mercedes me connect user account is a prerequisite for use.

New cell chemistries: high energy density, fast charging and excellent performance

Insight Mercedes-Benz Drivetrains & Efficiency: battery expertise

- Modular high-integration concept with compact battery design
- Premium battery version with up to 85 kWh usable energy capacity and silicon oxide anode
- Basic battery version with up to 58 kWh usable energy capacity and lithium iron phosphate cathode
- The most stringent Mercedes-Benz safety standards are met

Because cell chemistry essentially determines the performance of the battery, it is also ultimately the defining factor for the characteristics of the entire drivetrain. The VISION EQXX technology programme has demonstrated the importance of mastering cell chemistry for the development of future products. With its high-performance battery based on pioneering cell chemistry, it has set several EV track records. With its high energy density and fast-charging capability, the new battery generation is taking these successes to the next level. At the same time, the battery costs have been reduced by up to 30 %.

By developing the battery software in-house, Mercedes-Benz defined the brand's characteristic driving experience. Quality benefits from complete data transparency throughout the development phase. At the same time, the in-house approach underscores Mercedes-Benz's claim to be a leader in vehicle software.

Modular architecture and two battery types with different cell chemistries

The innovative battery system of the new Mercedes-Benz EV generation is based on a modular, high-integration concept. The repairable batteries comprise four large cell modules with hardcase cells and are characterised by a compact and flat design.

Customers will be able to choose between batteries with two different cell chemistries. The cells of the premium version with a usable energy content totalling 85 kWh have anodes in which silicon oxide is added to the graphite. Compared to the predecessor battery with conventional graphite anodes, the gravimetric energy density is up to 20 % higher. The volumetric energy density of the cell chemistry is 680 Wh/l. The proportion of cobalt has been further reduced.

This is followed by an all-electric entry-level variant with a lithium iron phosphate (LFP) cathode battery. The usable energy content there is 58 kWh and the volumetric energy density of the cell chemistry is 450 Wh/l.

Intelligent thermal management and comprehensive battery certificate

The high-voltage battery is integrated into the intelligent thermal management system of the all-electric MMA models to ensure that it always operates within an optimal temperature range, even in freezing cold or extreme heat. The system is equipped with a liquid cooling system, with an auxiliary heater integrated into the water circuit. At low temperatures, this heats up the cooling water, which then flows through the high-voltage battery, heating it and optimising its performance and efficiency range.

If Electric Intelligence navigation is activated, the battery is preheated during the journey if necessary. This preconditioning allows it to reach the optimum temperature at the fast DC charging point, which can charge the premium battery type at an output of 320 kW. This allows the battery to take on up to 36 kWh of energy within 10 minutes.

Despite a significant increase in charging capacity, the full scope of the battery certificate for the EQA and EQB model series still applies to the new all-electric entry-level models. Mercedes-Benz guarantees that the maximum battery capacity of the high-voltage battery will not fall below 70 % for a total of eight years or up to a total mileage of 160,000 km (whichever comes first).

Extensive safety measures

The battery housing is part of the vehicle structure and integrated into the collision safety concept. The battery, high-voltage (HV) cables and other HV components are designed and protected to meet the stringent safety standards of Mercedes-Benz in the event of an accident. In addition to the legal requirements, both the entire vehicle and the batteries must pass internal testing standards that are sometimes stricter.

In the pole impact test, one of the Group's own crash tests, electric vehicles are not only tested to ensure that the side structure offers maximum protection to occupants. It also examines the deformation behaviour of the battery. In this crash test configuration, the test vehicle on a sled crashes sideways against a steel pole. Mercedes-Benz uses another special test bench procedure to test the so-called touchdown management. This refers to the design precautions taken to prevent damage to the underbody caused by touching down, for example when driving over kerbs. During the test, a ram is pressed into the vehicle floor with a force of several tonnes. This also tests whether there is a risk of intrusion from foreign objects lying on the road, such as lost towbars.

Mercedes-Benz has further improved the already very high safety standard of the batteries with technical solutions for the new battery generation used in the MMA models. Comprehensive precautions have been taken against a potential thermal reaction of the battery through appropriate spacing between the battery cells and the structure of the cells and cell modules. In addition to alerting the occupants, the advanced early warning system in this model family includes other vehicle-side protective measures - for example, side windows and ventilation flaps close automatically. A new sensor positioned centrally in the battery monitors the batteries of Mercedes-Benz vehicles even when they are switched off.

Every battery is subjected to a pressure test at the end of production. The battery housings must also pass further tests. To verify comprehensive anti-corrosion measures, they are exposed to salt water, among other things.

The multi-stage protection concept of the HV system has already proven itself in other all-electric models from Mercedes-Benz. Analyses of real accidents by Mercedes-Benz Accident Research have also confirmed that safety in models with the three-pointed star is not a question of the drive concept. In the event of danger, the HV system can be automatically switched off and disconnected from the battery. A distinction is made between reversible and irreversible disconnection. Reversible disconnection takes place in the event of minor accidents. The high-voltage system can then be reconnected if an insulation measurement carried out by the vehicle beforehand does not detect a fault. This means that vehicles that are still roadworthy can continue to be driven. The high-voltage system is only irreversibly switched off in the event of serious accidents, in which the vehicle is usually no longer drivable anyway. It cannot be reactivated without repair in a specialised workshop. When the system is switched off, it ensures that no residual electrical voltage is present in the high-voltage system outside the battery within a few seconds. Disconnection points are also provided for the emergency services to deactivate the high-voltage system manually.

New centre of excellence for the development of high-performance cells, global production network

Mercedes-Benz recently strengthened its development activities in battery technology with the eCampus in Stuttgart-Untertürkheim. At this new centre of excellence, innovative chemical combinations and optimised production processes for high-performance battery cells with "Mercedes-Benz DNA" are being developed. The knowledge gained at the eCampus will flow into the technology development and series production of battery cells at the partner companies for use in future Mercedes-Benz battery generations.

The batteries for the all-electric Mercedes-Benz vehicles are manufactured in the global battery production network. The Kamenz battery factory will be the first factory in this network to produce batteries for the new MMA platform models. The cooperation with different cell suppliers worldwide follows the "local-for-local" approach.

MMA hybrid models capable of energy recuperation and all-electric driving

Insight Mercedes-Benz Drivetrains & Efficiency: new self-developed combustion engine drivetrain developed

- Efficient hybrids with 48-volt technology can also drive electrically at inner-city speeds
- New four-cylinder FAME engine family with Miller combustion process
- Newly developed electrified eight-speed dual-clutch transmission with integrated electric motor
- New 48-volt flat pack with 1.3 kWh of energy content

Fully electric models play a key role in implementing the Mercedes-Benz sustainable business strategy. However, the wishes and mobility needs of customers in different regions of the world determine the pace of this transformation. The new model family will therefore also be available as a hybrid with 48-volt technology and an electric motor with 20 kW drive power integrated into the transmission. The highly efficient drivetrain was developed by Mercedes-Benz engineers in Germany according to proven quality standards.

The impressive compactness of the motor and gearbox design can be attributed to the small distance between cylinders and side-by-side arrangement of the integrated electric motor: the motor, inverter and transmission form a highly integrated unit. A newly developed 48-volt battery with lithium-ion technology offers an energy content of up to 1.3 kWh. Once again, the design is particularly compact: the battery cells and the DC/DC converter are integrated in what is known as a flat pack.

The electric motor provides intelligent support in the low speed range. The constant speed profiles are covered electrically, meaning that this operating mode will eliminate inefficient operation. Thanks to recuperation and the ability to drive purely electrically at urban speeds, this drivetrain is particularly efficient. This is enhanced by electric coasting at a speed of up to around 100 km/h. A special feature: the engine can recuperate in all eight gears, in this way recovering up to 25 kW of energy.

Because the torques of the combustion engine and electric motor are additive, the maximum torque is realised over a wide speed range. In addition, the combustion engine can be started entirely via the electric motor and separating clutch. This means that a conventional pinion starter is no longer required. Particularly convenient: with the start-stop function, the start is almost imperceptible for the driver.

The electric motor and inverter are integrated into a new, highly compact eight-speed dual-clutch transmission (8F-eDCT). This development is called "eDCT" because the electric motor is integrated into the transmission and the mechanical system is controlled electrohydraulically. An electric motor operates both dual clutch lines. Power is connected and disconnected with the aid of two drive clutches and a separating clutch. The ratios of the eight gearshift stages are widely spread, which also benefits efficiency, as this allows the engine operating points to be optimised.

The combustion engine is a newly developed Mercedes-Benz four-cylinder petrol engine with a displacement of 1.5 litres. The unit with the type designation M 252 belongs to the FAME (Family of Modular Engines) modular engine family and is suitable for a wide range of vehicle applications. Common features of the FAME units include an all-aluminium crankcase with NANOSLIDE® technology, cylinder head with partially integrated manifold and turbocharger with segment turbine with switchable scroll connection. Further highlights are the compact charge air duct and the exhaust system close to the engine in one-box design, which is prepared for future exhaust emission standards.

The concept of the electric refrigerant compressor with 48-volt technology adopted from the M 256 reduces frictional power and enables the vehicle to be air-conditioned even when stationary and in all-electric operation.

Three power levels with 100, 120 or 140 kW will initially be available. In addition, there will be 20 kW of electric drive power in each case.⁸ In view of the displacement of 1,496 cm³, this represents a considerable output per litre. Buyers will have the choice between front-wheel drive and 4MATIC.

For reasons of efficiency, the petrol engine uses a combustion process based on the Miller cycle. This keeps fuel consumption low, especially in the partial load range, a very common driving style in everyday life. The comparatively early closing of the intake valves reduces throttle losses and allows a high compression ratio of 12:1.

The new engine-transmission unit has compact dimensions and is installed transversely in the vehicle between the steering knuckles. Another plus point is the exemplary NVH behaviour. Conceptually, the M 252 has an advantage here anyway, because Mercedes-Benz uses four cylinders instead of three. In addition, the engine has a comprehensive NVH package consisting of foams and covers to reduce noise emission.

Added to this is the double bulkhead concept familiar from higher vehicle classes. The bulkhead insulation has also been extended to the side area of the A-pillar and the floor area.

⁸ Peak power for 20 seconds at 3,000 rpm.

New 24-hour world record in Nardò: impressive endurance test

Insight Mercedes-Benz Drivetrains & Efficiency: behind the scenes

- A distance of 3,717 km was travelled on the high-speed track
- This corresponds to the distance from Trondheim (Norway) to Istanbul (Turkey)
- A total of 40 charging stops, each around 10 minutes long, were completed
- Extensive digital simulation in advance and live telemetry made this impressive figure possible
- Electric Software Hub as the epicentre of digital research and development

How many kilometres can an all-electric CLA cover in 24 hours, including charging stops and driver changes? That was the question faced by the development team working to optimise the efficiency of the new all-electric compact class models. The impressive answer was provided by “Project N”, the internal code name for a project that is as secret as it is ambitious. N for Nardò: two close-to-production prototypes of the CLA set off on this high-speed route in southern Italy at the beginning of April 2024.

A CLA covered exactly 3,717 kilometres within 24 hours – and got further than other near-production electric vehicles. The distance of the endurance run is equivalent to a trip from Trondheim (Norway) to Istanbul (Turkey). Air temperatures ranged from 13 °C at night to 29 °C during the day. The tarmac was even hotter.

The vehicle's battery was charged exactly 40 times at a standard charging station during the 24-hour test. The charging breaks only lasted around 10 minutes each time. If these are taken into account, the average speed was a remarkable 154.9 km/h. In the run-up to the drive, the experts at Mercedes determined the ideal charging strategy to maximise the average speed. On a real long-distance journey, this optimisation takes place via navigation with Electric Intelligence.

As with the three road trips of the VISION EQXX technology carrier, this 24-hour drive also relied on live telemetry: the CLA transmitted sensor data from the circuit to the nearby mission control room in real time. The live signals were compared directly with the simulation data and then used for further optimisation. In this way, the team reacted to environmental influences and temperatures and adapted the strategy via simulation and optimisation. This process ran continuously over the entire 24 hours. In addition, the drivers received appropriate instructions via radio to enable them to implement the strategy. The dashboard and the data from the live telemetry could be used by colleagues worldwide and were also analysed in Stuttgart and Sindelfingen.

Digital simulations were also helpful in the preparation phase. The data from several test drives were utilised. This was followed by extensive test bench runs. In the week before the actual endurance test, the car covered over 7,000 kilometres on a vehicle drive test stand in different climatic conditions. The “lessons learnt” strategy also included conversations with former Nardò record holders who drove for Mercedes-Benz. Among them was Robert Schäfer, who set three world records in 1983 with a Mercedes 190 E 2.3 16V over distances of 25,000 kilometres, 25,000 miles and 50,000 kilometres and set nine international class records.

“Our 24-hour drive in Nardò demonstrated the high time efficiency of our new, compact generation of electric cars on long journeys. The vehicles have also proven their maturity a good year before market launch. At the same time, the successful test is of course very encouraging for the entire company.”

Markus Schäfer, Member of the Board of Management of Mercedes-Benz Group AG. Chief Technology Officer,
Development & Procurement

The interdisciplinary composition of the “Project N” team, with specialists from series development and complete vehicle development as well as data experts, also contributed to the success. And even if there was

only a small core team on site in Nardò, they always knew that the large team in Sindelfingen and Untertürkheim was there in the background and ready to support them.

Bundled electronics development under one roof: the Electric Software Hub (ESH)

The Electric Software Hub (ESH), which opened in 2022, played a key role in the development of the new generation of compact electric cars from Mercedes-Benz. This building at the Mercedes-Benz Technology Centre (MTC) in Sindelfingen brings together numerous software, hardware, system integration and testing functions under one roof. The entire electrical/electronic integration process of vehicle development is reflected inside the ESH. This ensures that all new hardware and software components interact smoothly.

From top to bottom - from code to product - software and hardware continue to flow into the vehicle until they are integrated into vehicle prototypes on the lower floors. Software code creation and pre-integration laboratories are located on the upper floors. Here, the experts first use virtual technologies and simulation to test whether the various software components interact correctly with each other and whether the vehicle functions are implemented without errors. This is known as integration. State-of-the-art methods of safeguarding electrics/electronics are used here. For example, components and control units in a virtual vehicle are tested fully automatically ("hardware-in-the-loop"). In principle, only the electronics with the software to be tested are actually present; the rest of the vehicle and the environment are simulated.

With the "digital test drive", a test in the vehicle can be fully simulated in the ESH. In a fully simulated environment, a virtual vehicle is moved and tested in the same way as it would be in a real test drive - only this "test drive" takes place in a laboratory on the sixth floor of the Electric Software Hub.

Vehicle-related testing without a vehicle: the innovative test benches

The ground floor of the ESH in Sindelfingen is home to many high-tech test facilities such as roller and climate test benches. The so-called full vehicle system test bench (FVS) stands out with its innovative concept. It combines a high-voltage drivetrain with a functional mock-up of the 12-volt vehicle electrical system. Both superstructures are located in neighbouring rooms and are connected to each other via a cable harness - an umbilical cord, so to speak. Built in a framework of metal profiles, all vehicle components can be assembled, connected and tested in the overall system in this open structure without a body.

The battery, charging sockets and e-drive units form the high-voltage drivetrain. Components that are operated with low voltage, from the headlights and screens to the trailer coupling, are part of the functional mock-up. Driving robot "James" is in the driver's seat of the 12-volt mock-up, while "Erica", the interface to the test bench, sits in the rear. "James" offers the experts the opportunity to drive predefined test sequences fully automatically. Route profiles taken from reality can also be run on the test bench.

In particular, the wiring harness and control units can be tested in interaction with real sensors, actuators and other subsystems and power users and checked for efficiency. All parts of the test setup are easily accessible so that pre-series components can be replaced with series parts during the development process. This means that hardware and software components can be put into operation at a very early stage. The full vehicle system test bench can also be used to demonstrate new software versions, which experts refer to as release strokes.

In addition to the FVS, the vehicle powertrain test bench (F-ATS) complements the test portfolio at the ESH. Controlled by James, specific manoeuvres can be carried out automatically in all conceivable climate zones. Testing in the entire vehicle network eliminates the need to simulate missing vehicle components. The so-called R2R control (Road to Rig) enables the vehicle behaviour to be precisely reproduced from the road. This means that the maturity level of the vehicles can be further advanced in the development phases with test vehicles. Preliminary runs of the 24-hour drive in Nardò took place on the F-ATS.

From E for eDCT to W for heat pump: key technical terms

Insight Mercedes-Benz Drivetrains & Efficiency: glossary

Electric dual clutchless transmission (eDCT): the eDCT hybrid technology with a 20 kW electric motor and eight gears enables purely electric driving and recuperation. Mercedes-Benz uses an electric motor integrated into the transmission to switch seamlessly between electric and hybrid mode.

Electric Drive Unit (EDU): a highly efficient electric drive unit consisting of motor, transmission and power electronics. Based on a modular concept, the EDU2.0 is the first member of a family of drive units developed for a wide range of performance requirements in a variety of model series.

Hardcase cells: battery cells with a stable aluminium housing. Also known as: prismatic cells

Inverter: converts the direct current (DC) from the battery into three-phase current (AC) for the electric motor. During recuperation, the electric motor generates a three-phase current, which is rectified into a direct current by the inverter.

Mercedes-Benz Operating System (MB.OS): a new operating system developed in-house by Mercedes-Benz, which is making its debut in the MMA models. It comprises four areas: Infotainment, Automated Driving, Body & Comfort and Driving & Charging. There is also the connectivity module for connection to the Mercedes-Benz Intelligent Cloud. The chip-to-cloud architecture ensures deep integration into the vehicle and full control over all sensors and actuators. In addition, by decoupling the innovation cycles of software and hardware, the company can ensure that its vehicles are always up to date.

Permanently excited synchronous machines (PSM): in PSMs, the rotor of the AC motor is fitted with permanent magnets and therefore does not need to be supplied with power. The magnets - and therefore the rotor - follow the circulating alternating current field in the windings of the stator. The motor is called synchronous because the rotor rotates with the frequency of the stator magnetic field. The frequency is adapted to the rider's speed requirements in the power electronics inverters. The advantages of this design include high power density, high efficiency and high power consistency.

Recuperation: in this energy recovery process, the high-voltage battery is charged by converting the mechanical rotation of the wheels in the drive units into electrical energy during overrun or braking.

Heat pump: the air-side heat pump in the new model family can utilise the heat generated by the drive system and the heat present in the outside air in parallel to heat the interior. Thanks to its outstanding efficiency, it can significantly increase the range of the battery in colder regions of the world, for example. In this process, the multi-source heat pump draws heat from the ambient air via an external heat exchanger.