Every generation has its figurehead. The new eCitaro.

The benchmark. The new eCitaro is Mercedes-Benz’s answer to current and upcoming challenges of the e-mobility era. Ready to electrify the future, the eCitaro expands the global bestseller’s portfolio to include a mature, fully electric vehicle. Its future-proof concept and comprehensive e-mobility system mean the eCitaro is showing the way forward for electric mobility in the city.

For more information go to www.mercedes-benz.co.uk/bus
Electromobility is the latest hot topic. Yet it is not simply a case of replacing combustion with electric engines in city buses. The complex conversion to electromobility represents a real challenge. We want to actively support you in taking this big step and have therefore developed the complete eMobility system around the new eCitaro. We present its many facets to you in this special edition of our magazine.

The experts from Mercedes-Benz and OMNiplus are on hand to help your company, from the first considerations about electromobility to putting them into practice. What needs to be considered when taking these steps – starting with the power supply and how the eCitaro stands scheduled services – can be found in this edition, supported by numerous practical examples. As you will see, with the eMobility system, Mercedes-Benz offers much more than just a bus.

With the new eCitaro, we are pressing firmly ahead with electromobility for buses and taking it to a new level. So that the eCitaro meets the high demands of transport operations, we have equipped it with sophisticated components for maximum energy efficiency. We have not only developed it very diligently but also tested it intensively under extreme conditions – like any Mercedes-Benz. We present it in detail and can tell you already where it is heading technically speaking in the years to come.

One aspect that is neglected among others on an electric bus is that of safety – consider the high-voltage technology alone. Mercedes-Benz has therefore developed a comprehensive service and training concept, from educating the workers to equipping the garage. Operational reliability also comes under focus. Transport operators rightly expect the same reliability from a fully electrically powered bus as they do from a conventional vehicle. That is why we provide the eCitaro with the eMobility service concept and tailor-made eService Contracts from OMNiplus.

We wish you an electrifying read.

Yours, Ulrich Bastert
Head of Marketing, Sales and Customer Services
Daimler Buses
The way towards electromobility

From the eCitaro to the overall system

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“The eCitaro has everything an electric bus needs”
“With our eMobility system, together with the customer, we are developing a tailored solution for electromobility – from intensive advice beforehand through to support with a comprehensive aftersales service.”

What part does battery technology play?
The new eCitaro is our first step towards electrifying the public transport network with buses. Our batteries contain lithium nickel manganese cobalt oxide (NMC) cells. These batteries allow the eCitaro to run up to 280 kilometres under ideal conditions. In high summer with the air conditioning working, it is around 150 kilometres according to SORT2. With two battery packs, it is more than 170 kilometres. We are talking about a system-relevant range here - in other words, about a reliable figure that gives transport companies planning security, 365 days a year. Already from the end of 2020, we will start equipping the eCitaro with the next generation of NMC batteries. They provide around 35 per cent more energy with the same installation space. The construction and connections are identical, which means we can switch over without the need for modifications. We will then reach a system-relevant range of around 200 kilometres under difficult conditions – without recharging on route.

You were talking about a first step. Will others follow?
At the same time, we will be the first series manufacturer to also offer the eCitaro with lithium polymer batteries, which are also called solid-state batteries. Their advantages are durability and high energy density, although, they are not suitable for high-speed charging. We will then cover a system-relevant range of about 280 kilometres. These batteries are a second path that we are pursuing alongside NMC batteries. Every transport operator should also get the technology for modifications. We will then reach a system-relevant range of around 300 kilometres per year. We will also offer the eCitaro with a choice of NMC or solid-state batteries.

First the autonomous Future Bus, now the fully electric Mercedes-Benz eCitaro – where is Daimler Buses heading?
Our headline for the mobility of tomorrow is CASE – Connected, Autonomous, Shared, Electric. The public transport network with buses in cities is a prime example for turning this strategy into reality. To shape the future of mobility, Daimler Buses will invest around 200 million euros into the implementation of the CASE strategy by 2020 alone. A significant share of this will go into enhancing expertise, the development of and the production of electric buses.

Let’s start with the present. Where does the Mercedes-Benz eCitaro stand?
The eCitaro has everything an electric bus needs. Underneath its elegant garb is a concentrated technology package for maximum performance and ultimate energy efficiency. Take the electric intelligent eco-steering. A front axle with a load-bearing capacity of eight tonnes in support of optimal weight distribution and a high passenger capacity. At the rear, we have the electric drive axle with the two electric motors on the wheel hubs. Also at the back, we accommodate four battery modules, components for the cooling system and the brake resistor. On the roof at the front is the installation space for an optional pantograph or for charging rails. Then come modular battery packs, the air-conditioning unit with heat pump and, finally, the cooling system. The HVAC system and battery-cooling system are linked to each other, which forms the basis of our unique thermal management for ultimate energy efficiency.

What does that mean precisely?
We look at the whole process chain here. To be able to deploy entire electric bus fleets highly efficiently, the current charging status is transmitted to the transport operator via telematics and connectivity solutions. Here, we look at the interface to the transport operator’s IT system. We test the charging infrastructure and give our customers recommendations accordingly. We also offer solutions for well-thought-out charging management for whole vehicle fleets. This prevents unnecessary power peaks whilst charging the buses and hence reduces investment and electricity costs.

And when the eCitaro goes to the garage for a service? We have put together unique service packages for this. That starts with stocking spare parts. It continues with a fully equipped prototype garage and an elaborate training system - be it for drivers, fitters or cleaners. It ends with special eService Contracts through to bus depot management with servicing by our employees in the customer’s garage. You can see why we talk about an eMobility system. We support our customers in all aspects of electromobility and do not leave them on their own with the new technology.

New by 2020: the eCitaro G with NMC or solid-state batteries.

The Mercedes-Benz eCitaro: It has everything an electric bus needs.
The fully electrically powered Mercedes-Benz eCitaro at the heart of the eMobility system

The intention is quite simple: combustion engine out, plug-and-play electric drive in. Yet it does not work as easy as that, since electromobility means rethinking urban mobility with buses. That is why electromobility from Mercedes-Benz is more than the fully electric eCitaro; it is an overall system.

Conversion according to plan:
Mercedes-Benz eMobility Consulting helps

For a transport operator, converting to electromobility is about more than just energy consumption and range. The key issues are depot management, routing and circulations, topography and weather, bus stop intervals and timetables. The experts at Mercedes-Benz are at home here. They use simulation software to work out which routes are suitable for electromobility and develop proposals for electric bus rotations on request.

Top performance:
the tailor-made charging infrastructure

As standard, Mercedes-Benz opts for charging via sockets in the depot. Opportunity charging is also possible on request, either by pantograph on the roof or by using the combination of charging rails and a fixed pantograph. The Mercedes-Benz experts have tested various charging infrastructures so they can provide advice and make recommendations. And, on request, the eCitaro can be also delivered as a complete package including charging infrastructure.

Electricity:
how the bus gets its power

The power supply for the buses is the centrepiece of electromobility in the city. Mercedes-Benz eMobility Consulting provides support when planning infrastructure, calculates the necessary power supply, knows the ways to grid operators and power suppliers, and recommends the right charging technology – through to organising the depot with spaces and feeding the bus with power.

Steps towards the future:
the eCitaro’s batteries

The lithium ion batteries in the eCitaro are selected to make them suitable for high-speed charging and to ensure a long range. The next, even more efficient battery generations have already been announced for 2020. These include very-long-lasting solid-state batteries for longer ranges. They are particularly suitable for rotations with a depot charging strategy.

Always connected: integration in telematics systems exploits potential

The eCitaro communicates by being networked with the charging infrastructure via the ISO 15118 protocol. Mercedes-Benz provides solutions for integrating vehicle-specific data with management systems. The OMNiplus ON portal gives companies insights into their fleet’s operating data. Together with the ITS software provider IVU Traffic Technologies, Mercedes-Benz offers integrated system solutions for maximum transparency – from rotation planning to depot management.

Well looked after: the OMNiplus eMobility service concept

Electromobility demands specific services. The eMobility service concept starts with looking after the customer’s garage, covers the tailored eBasic and ePremium Service Contracts and ends with bus depot management. Here, OMNiplus employees look after the vehicles in the customer’s garage. The OMNiplus Training Centre in Dortmund advises on how to equip an electric bus garage, for example, and offers a complete training concept for electromobility.
Mercedes-Benz eCitaro

Design with its own characteristic trait

A new electric bus is fundamentally different to its precursors with a combustion engine. You have to see that both at the first as well as the second glance. Stefan S. Handt, the Daimler Buses Head of Design, is convinced you do.
Stefan S. Handt, Daimler Buses Head of Design

His design motto is: "You must not aestheticise things; you have to let them talk." Stefan S. Handt has been the Head of Design at Daimler Buses since March 2018. The 52-year-old Berliner took on overall responsibility for the interior and exterior design of all buses under the Mercedes-Benz and Setra brands on 1 March. Handt, who gained his degree at the Berlin School of Arts, worked in different roles in the exterior and interior at automotive manufacturers and is also a familiar figure in the Daimler group. The father of two daughters, he was the Daimler Head of Corporate Design, among other things, and responsible for many years for exterior detailing in the Mercedes-Benz Car Group. Before his move to the international bus division, he was recently responsible for interior design in the truck and vans sector.

With the new eCitaro, Mercedes-Benz is entering a whole new era of urban transport – and not only as far as the drive technology is concerned: the vehicle’s exterior is also changing noticeably. Even the previous successful model, of which over 50,000 have been sold around the world, was known for its independent and dynamic design. Nevertheless, the brand, which stands for reliable urban buses like no other in Europe, has not been content with freshening up the previous design shell. Clearly borrowing from the Mercedes-Benz “Future Bus” study, the Daimler Buses Head of Design, Stefan S. Handt, has created a new appearance for the city that is full of character.

The native Berliner, who earned his professional spurs both in the car as well as the truck and van sectors, says on this matter: “The design of the new eCitaro signals the future and electromobility as such.” Yet Handt not only set out to mark a new era, but also had the intention of visibly strengthening the Mercedes-Benz brand: “When I decide as a customer to invest in new capital goods, then this product must possess an individual character trait. A Mercedes-Benz, for example, should always exude quality, solidity, reliability and, last but not least, modernity.” The underlying “creative gesture” here may only be evident to many onlookers at the second, more intensive look, yet has a longer lasting effect.

The new front design in a black fascia look with a body-like frame, which is adorned by completely new design elements, for instance the round headlights with LED technology or the optically low-slung bow area, ought to catch the eye of any onlooker at first glance. Handt: “The classic Mercedes-Benz radiator grille is now invoked in a very modern way. The front of the bus thus displays an extreme sense of power, which looks impressive to oncoming traffic.” At the same time, the front is characterised by its horizontal severity, without “looking boring”, however. The three-dimensional decorative elements are made of shaped, smoke-grey glass elements with a chrome-plated surface on the back. “Depending on the perspective, it takes on a different effect and thus reveals a particular charm,” says the designer explaining the innovative effect.

In terms of the design, special attention was naturally paid to the roof structure of the buses, which are 3.40 metres high – that is around 50 centimetres more than the conventional model. From a construction point of view, it is prepared for all further evolutionary steps up to 2022 and for Handi the roof is the bus’s “fifth face” – alongside the front/ rear and side views. In addition to the solid aluminium extruded profiles fitted on the sides for the first time, the transitions from the front and rear section to the roof are characterised by painted “islands”, which are surrounded by a black strip and thus run across the whole vehicle. “We thereby pulled off an optical trick that reduces the severity of the roof and makes it look lighter.”

The designer also makes it easier for the garage in the event of a repair, as the framework, rear and side walls have many parts in common with the previous model. Thus, the interior has also only been gently modernised: what is striking here above all is the new ceiling, which now offers more headroom and takes some of the weight off the top. The roof looks almost like it is hovering because the window bars are now clad in black. Wide LED strip lights diffuse a pleasant light and provide safety on board. New air ducts made of textile material ensure low noise in turn – after all, the drive unit is now barely audible when setting off.

In the cockpit, however, the Daimler design department largely reframed from making changes, as Handt explains: “The drivers of electric buses should get a sense of familiarity and safety as soon as they get on – be able to easily find their way.” A good idea, as even in the new, exciting electromobility era, it is sometimes simply a matter of steering the most widely sold urban bus in Europe through the traffic with authority and ease.
Ice and heat

Minus 30 degrees Celsius in the Arctic Circle, plus 40 degrees in the Sierra Nevada, extreme urban traffic in Istanbul and Izmir: before the new eCitaro was ready for the start of serial production, it had to pass extreme endurance tests.
The little town of Rovaniemi in Finland is considered to be the home of Father Christmas. And in winter, it is the second home of the Daimler Buses test engineers. The eCitaro has completed two winter tests here. Once it even drove to the far north under its own steam to endure almost minus 30 degrees Celsius there.

Winter tests in the Arctic Circle lead to valuable findings. For example, that despite the icy outdoor temperatures, it takes days until a battery is fully cooled down. And that an electric bus with the three-pointed star can start no problem even then. It only gets difficult at icy temperatures when charging outdoors. In this case, the electric bus fares like an athlete who is expected to put in top performances with cold muscles. Driving in the winter, on the other hand, is a pleasure. Andreas Dingler, Head of Testing at Daimler Buses: “The eCitaro, thanks to its individually controllable electric motors on the hubs, has an outstanding starting ability in ice and snow.” The test engineers have also discovered fine details, such as preconditioning and even over-conditioning for starting purposes, which can be used to optimise the range. Such findings cannot be acquired in a cold chamber. Instead, you have to go to the endless ice in the Arctic Circle.

Or to a hot summer in Spain. The destination is Granada where the thermometer creeps towards 40 degrees Celsius. Anyone who then loads up the interior and also uses room heaters and humidifiers to generate conditions like those in a fully occupied urban bus will make an e-bus face the highest demands. More so than ever in tough urban traffic with wide-open doors at the bus stops. As if that was not enough, the test engineers took the eCitaro up the nearby Pico del Veleta mountain pass in the Sierra Nevada. The ascent here is non-stop for almost 35 kilometres climbing to 2,550 metres. Among cyclists, the route is considered to be the queen of mountain roads. Also among testers: uphill, the cooling system is tested at full capacity. Downhill, then the deceleration, including the braking resistance of the electric brake.

2,800 kilometres east in Istanbul, another endurance run awaited. An eCitaro with 35,000 kilometres on the clock travelled from the urban traffic in Mannheim in order to then launch itself into the hustle and bustle of the city on the Bosphorus for another 60,000 kilometres. Around the clock, interrupted only by the charging times. It carried on to Izmir, a city of over a million inhabitants on the Mediterranean coast: 400 metres of altitude difference, partly more than 70 per cent humidity and hot temperatures. Another 60,000 kilometres. “It is constantly uphill and downhill, always alternating between a full and empty battery, which is pure stress,” explains Andreas Dingler.

Whether it is a winter or summer test, there must be two test periods in each case. Dingler elucidates: “The first time, we gain insights, then develop the concept further and verify the result the second time.” That is why an eCitaro takes a bit longer than other buses to be ready – but the results speak for themselves. The bad surface trial alone on the group’s own test route in Wörth near Karlsruhe allows the test engineers to ultimately assume a certain relentless character. A few thousand kilometres there equate to a vehicle’s entire life. An acid test in fast-forward mode.

Finally, the eCitaro and a Citaro with a diesel engine even drove on a racetrack for an acceleration duel. It was not about getting the fastest time, but about reducing the starting torque of the eCitaro to the level of the diesel drive – the passengers will be grateful.

All in all, the Daimler Buses test engineers grilled a dozen eCitarios. Added to this were numerous individual tests on components. Andreas Dingler therefore stresses once more: “We tested the eCitaro according to just equally strict criteria as the Citaro with a combustion engine. It reached Citaro level.” And hence, the road is open to serial production and operation at transport companies. Everywhere between Rovaniemi in the Arctic Circle and Granada in Spain. The eCitaro was not spared because of its drive unit. The tests are at the same level as for the Citaro with a diesel engine.”

Andreas Dingler, Head of Testing at Daimler Buses

The endurance tests on video: http://www.youtube.com/MercedesBenzOmnibus

Loaded and wired up, in the Arctic Circle and in the heat of summer in the Sierra Nevada mountains: Mercedes-Benz tested the eCitaro relentlessly. Anything that survives this will also survive in practice.
Mercedes-Benz eCitaro: the unique technology

Electrically into the future

With its innovative technology, the new eCitaro raises electromobility for urban buses to a new level. It reduces energy consumption and thus increases the range, improves the weight distribution and hence secures the large number of passenger seats – the eCitaro is precisely the Citaro among electric buses.

Space for an optional pantograph or contact rails for Opportunity Charging.

Modular battery packs: two as standard, up to eight packs on request.

The battery cooler keeps the rechargeable batteries at the ideal temperature, important for endurance and charging capability.

Eight-tonne front axle for maximum passenger capacity.

Electric drive axle with motors near the wheel hubs.

Four battery packs as standard in the rear, above them the cooling system components.
In full flow

On the road in the new Mercedes-Benz eCitaro - a different kind of bus journey for drivers, passengers and the environment.
The city bus glides quietly along the road, coasts, stops silently in the bus bay. Those who prick up their ears despite the noise of the traffic will at most perceive a quiet humming sound. The electrically operated doors open up – welcome to the Mercedes-Benz eCitaro. Anyone wanting to find out about the future of urban bus transport should plan a trip to Mannheim, Heidelberg, Hamburg or Berlin in the near future. Their transport operators are the first to use the new, fully electric powered Mercedes-Benz eCitaro. Today there is the opportunity to take a spin on a test site.

The classic pre-departure check thus has the nature of an optical examination. The designers have not promised too much: this bus is a special Citaro. Connoisseurs will notice the discreet blue letter “e” in the logo of the eCitaro model. No idling engine can be heard, the urban bus stands there quietly not disturbing the environment and yet is ready to set off.

Inside, the cockpit looks like normal and the quick change-over behind the wheel is no problem. After switching on the ignition, the blue instrument lighting catches the eye. A power meter replaces the rev counter, superfluous here, showing the current performance requirement when stepping on the accelerator and the status of recuperation when the eCitaro turns braking energy into electricity and tops up its batteries.

Adjust the seat and mirror, set the gearbox button to “D”, release the brake and put your foot on the gas – sorry: electricity – the eCitaro accelerates dynamically whilst remaining quiet. It appears almost effortless when the 13 tonnes plus start moving. Noise from the tyres on the road is louder than the drive unit. A challenge for the production department: there is no engine and no transmission here to drown out any creaking or rattling. It is a good thing it is a Citaro. It is also good that the eCitaro is produced alongside the combustion engine version – quality does not tolerate experiments.

Due to its eight-tonne front axle, the eCitaro sits firmly but not stiffly on the road. Thanks to a pitch-and-roll control system, it remains stable on bends despite the battery load on the roof. The eCitaro is well balanced. The centre of gravity and weight distribution benefit from the fact that some battery packs are housed in the rear in the place of the engine and transmission. Traffic light ahead: throttling in the eCitaro means sailing weightlessly towards it. Braking is done either by means of a brake pedal or a switch on the steering column. In both cases, deceleration takes place purely electrically and the energy recuperated charges the battery. This is particularly fascinating on longer downhill sections, when the eCitaro glides along and the range indicator shows a rising figure. Only in the case of very abrupt deceleration using the brake pedal does the classic friction brake intervene.

And the passengers? They too benefit from the lack of noise. A normal Citaro is quiet; the eCitaro is silent. You can hear that you cannot hear anything. The CO2 air-conditioning unit saves electricity and also works effectively. The heating system with a highly efficient heat pump remains switched off in view of the temperatures today.

The eCitaro rolls along silently, almost inaudible for the environment, does not give off any emissions and there is no longer an exhaust pipe. The trip is much too short, yet one thing is clear: regardless of what the destination says, it is driving towards tomorrow. The future of the city bus – in the Mercedes-Benz eCitaro, it is already the present. Another circuit? There is not enough time. How about a trip to Mannheim, Heidelberg, Hamburg when the new eCitaro is whispering along its lines there.

Benefits

For the operator:
- Attractive design based on a tried-and-tested vehicle concept
- High number of passenger seats
- Reduced energy consumption thanks to energy-efficient design
- Future-proof investment

For the driver:
- Cockpit and operation almost unchanged
- Superior acceleration loaded and unloaded
- Safe handling despite high load on roof

For the passengers:
- Low noise levels and even acceleration
Since the end of January, the first Mercedes-Benz eCitaro buses have been running on a new bus line in Heidelberg; Mannheim will follow. The transport company Rhein-Neckar-Verkehr GmbH (rnv) has painstakingly prepared for the electric buses.
Operating plan

The Management, but now in Proposal Preparation and Product Development, is working on the electric bus project at rnv. That is why rnv appointed a project engineer for alternative drives, Yunus Keskin, who supported the steps for the introduction of the eCitaro.

At the same time, rnv worked closely with the Mercedes-Benz electromobility experts. Dr Robert Schimke from Development at the Mannheim site has helped rnv with requirement calculations, planning tools and technical expertise. “Without the sound advice of the experts and the back-up in our own ranks, six months would have been far from adequate for the preparations,” says Stefan Prüfer with conviction.

In addition, rnv and EvoBus have agreed to share their findings from operations at an intensive level. “The issue of electromobility is new to us all, so we can learn a lot from each other,” says Stefan Prüfer. He recommends that all transport operators both keep an adequate number of their own personnel available and take advantage of the advice offered by Mercedes-Benz eMobility Consulting.

Last but not least, Prüfer values the benefit that Daimler Buses supplies the vehicles and charging infrastructure from a single source. One of the most difficult issues was the charging strategy. Charge at the depot or on the road? “There is no patent remedy for this … every operation is different,” explains Stefan Prüfer. For instance, in Mannheim and Heidelberg, it turned out that the planned terminal stations would not be accessible for months due to pending roadworks; hence, installing charging stations was out of the question. “That was one of the reasons why we decided to charge in the depot.” With around 200–300 kilometres being covered every day and a range of 120 kilometres for the eCitaro under the rnv operating conditions, the electric buses must be fully charged during the day, during which a third bus is put into service. Sebastian Menges explains: “Our charging stations have a maximum charging capacity of 150 kilowatts and need around 100 minutes to fully charge the batteries.” After that, the eCitaro goes back on route with full power. “The quick charging comes at a cost to the battery service life, however,” Menges explains. The charging stations therefore supply the power with a reduced and hence gentler capacity during the six-hour charging phase at night.

The project start in January was a good choice, Sebastian Menges believes: “With winter on our doorstep, we had the harshest test conditions right at the beginning.” After the successful start phase, Stefan Prüfer is already looking forward: “The two lines are just the beginning. We want to develop electromobility further.”
Service report: eCitaro

On the road in the whisper-quiet bus

The new eCitaro has been operating scheduled services through Hamburg since December. Drivers and passengers are making new discoveries. On the road on the 1871.
Joachim Will is testing new city buses on Route 24 operated by Hamburger Hochbahn AG. “The route has the ideal conditions for the first services. Lots of passengers, plenty of traffic, tight timing and a length of 30 kilometres,” says Will, describing the conditions. The Hochbahn test driver performs three full service runs there with every bus type. After that, no questions about the vehicle remain unanswered. At the end of November last year, the Hamburg operator took delivery of the first eCitaro buses. Immediately after that, Joachim Will completed his first runs. When Will is not testing buses, he is putting operating instructions together for his colleagues and delivering training sessions. He is one of those indispensable all-rounders. Above all, he is passionate about driving city buses, having done so now for 33 years for Hochbahn.

Today, in February, Will is driving the eCitaro 1871 on a scheduled service on Route 174. He accelerates briefly, and then takes his foot off the pedal; the bus rolls along. The engine near the rear axle also sings quietly. The loudest noise on board is the heater blower, which soon heats up the passenger compartment at the outset; then, there is silence. At the Fuhlsbüttel bus stop, a dozen passengers get on. All dutifully show their bus pass. As a three-door bus with pivot-and-slide door in the middle, a large standing platform and 25 seats, the 1871 is set up for a fast flow of passengers. The double monitor at the top on the cross-channel shows the next destination on the right whilst a film explains electromobility on the left.

The bus thrusts itself into the road from the bus stop. “The linear acceleration and braking is pleasant for driver and passengers,” says Joachim Will. It saves time, because on the smoothly running eCitaro the passengers move towards the door earlier before getting off. That adds up to important seconds at every stop. Will is pleased about the chassis: “The bus doesn’t sway despite having batteries on the roof. The developers did a great job.”

In the meantime, the streets get narrower, and turning manoeuvres become more frequent. No problem: Will knows around 30 Hamburg bus routes by heart. Route 174 turns round at the Tegelsbarg stop. Before and after it, green islands with trees in the road force the bus to do a slalom – a prime discipline for the eCitaro. “They made an excellent chassis,” the driver enthuses once again. The passengers also like it: “The bus is so quiet; you feel like you’re flying,” an older lady says with delight. And when she finds out she is riding in an electric bus: “So you are even doing something for the environment by buying a ticket.”

Some young people get on at the Wesselstraat stop. Joachim Will gives an everyday report from the quiet eCitaro: “If a mobile phone rings, you can hear it throughout the bus.” No diesel engine drones. Conversations are muted: “They only whisper.” A passenger tells a similar story: “You don’t feel any vibration at the back, and it is quiet.” At the Mussenredder stop, a young woman with a pram brandishes her bus pass whilst flagging down the bus. Joachim Will gives a friendly wave and lets her get on in the middle. After the Alte Landstrasse stop, the road goes downhill slightly – a splendid rolling stretch. With no foot on the pedal the eCitaro glides almost weightlessly for hundreds of metres, rolling across the next crossroads with the lights green to the next stop.

Shortly afterwards, the test run comes to an end at the Poppenbüttel stop – a hub with a transfer station covered by a futuristic roof. It’s a piece of art, just like the eCitaro. Joachim Will greets colleague drivers who are taking a break in the sunshine. “They all want to drive the eCitaro,” the bus driver grins with passion, before adding, “the best place in a bus is still up front on the left.”

In the depot, Joachim Will hooks the eCitaro up to a quick charging station, where electricity races into the batteries at 150 kilowatts. The display on the dashboard shows how the current level of the batteries rises quickly. “It will go back out at midday,” announces Joachim Will. The eCitaro 1871 has not yet finished for the day.
The target has been set: according to the Berlin Mobility Act, the BVG – Berlin’s transport service – may only use climate-neutral buses with non-fossil drives from 2030 onwards. This means diesel power is out, and electromobility is in. “The aim is a more liveable city,” explains Torsten Mareck, Bus Division Manager at the BVG. It’s a Herculean task for Germany’s largest transport service, with around 1,400 buses. Luckily, electromobility is nothing new for Berliners thanks to the underground and tram system.

The initial challenge is the pure size: the cities of Hamburg, Munich and Frankfurt would fit into the capital’s city limits with around 200 bus lines. Added to that are tough operations: the buses are in use seven days a week around the clock. “Berlin is a challenging patch,” stresses Mareck. Traffic jams, building sites, diversions and lanes full of parked cars demand everything of the buses. In the city’s central area, the BVG buses only reach average speeds of 11 to 12 km/h. Nevertheless, they cover over 70,000 kilometres a year. “All that takes it out of the buses. Anything that survives here can make it anywhere,” says Mareck.

Sophisticated charging strategy

Driving by day and charging by night does not work in Berlin, as the electric buses are deployed in a rolling system. As charging takes several hours, the fleet will grow. What three diesel buses manage today will be taken on by four electric buses in the future. What three diesel buses manage today will be taken on by four electric buses in the future. And the depots? “With electromobility, every bus needs its own fuelling station,” says Mareck. This takes up extra space. The number of depots will therefore increase.

The BVG is starting with the Indira-Gandhi-Strasse depot in the east of the city. It is close to a substation, which makes the power supply easier. One cable with 10 kV will suffice at first. The next step is more of these cables or a power supply with 110 kV. The buses will run on “green electricity.” The first electric buses will be parked in three lanes and supplied with power via charging poles. A carport solution, whereby the buses are supplied by cable from the roof, is also conceivable. The BVG is starting with the Indira-Gandhi-Strasse depot in the east of the city. It is close to a substation, which makes the power supply easier. One cable with 10 kV will suffice at first. The next step is more of these cables or a power supply with 110 kV. The buses will run on “green electricity.” The first electric buses will be parked in three lanes and supplied with power via charging poles. A carport solution, whereby the buses are supplied by cable from the roof, is also conceivable.

For a more liveable city

Germany’s biggest transport service is converting its bus operations to electromobility. From the start, 15 Mercedes-Benz eCitaro buses will be included as of this spring.

“We are driving by sight, starting now, gathering experience,” says Mareck. The selection of the routes is based on the capacity of the solo buses, their range of 150 kilometres and the location near the depot. The first five routes go through the particularly polluted ring road around the central area of the city – Mareck talks about NOx hotspots.

The BVG is starting with the Indira-Gandhi-Strasse depot in the east of the city. It is close to a substation, which makes the power supply easier. One cable with 10 kV will suffice at first. The next step is more of these cables or a power supply with 110 kV. The buses will run on “green electricity.” The first electric buses will be parked in three lanes and supplied with power via charging poles. A carport solution, whereby the buses are supplied by cable from the roof, is also conceivable.

OMNiplus on board

The equipment of the eCitaro buses corresponds exactly to the current major contract for up to 950 Mercedes-Benz Citaro buses with low-emission diesel engines. Alongside these, the BVG is pushing electric buses. At least 120 solo and 15 articulated buses are planned for 2021. Besides price and consequential costs, the emphasis is also on reliability and, above all, their range. In this respect, the BVG is relying on an increase provided by future battery technology, as announced by Mercedes-Benz. The Berlin operator, faced with around 1.2 million bus passengers a day, is also equally considering articulated buses with electric drive. A separate lane is being installed in the garage for the electric buses. The BVG will take care of servicing the eCitaro itself according to manufacturer’s specifications, with repairs being done by OMNiplus.

“We must get the electric drive to the stability of the combustion drive, as the transportation must work in a reliable and stable manner at all times,” explains Mareck. He is even aiming for a further increase in the availability of electric buses and “the durability scenario of a tram”. The former divisional manager of BVG trams is bursting with ideas. For certain operations, the trained heavy-current electrician believes a combination of a battery electric drive with trolley wire is possible. Alternatively, fast charging systems on the routes with a capacity of 450 kW plus a mobile cleaning service would mean that the buses no longer have to enter the depot and can also operate round the clock.

There are many ideas, one clear objective and an enormous challenge. Buses and infrastructure together will require investments of around two billion euros by 2030, the BVG has calculated. All for a more liveable city.
“We must test here in Tübingen whatever,” stresses Hans Zeutschel, Divisional Head of Public Transport at Stadtwerke Tübingen (swt). He is responsible for the TüBus department and the public utility’s own transport service. Tübingen, south of Stuttgart, is one of the oldest university towns in Germany. Out of some 90,000 residents, around 26,000 are students. Tübingen also has a demanding topography with many inclines of more than 10 per cent on its bus routes. The Königsetappe even reaches 17.5 per cent. Added to that is a high workload. Not every vehicle can manage that, especially not every electrically powered bus.

“We’ve had nearly all the manufacturers here,” reports Hans Zeutschel, describing the start-up problems, for example. For this reason, the electric buses drive with sandbags in test mode. The eCitaro was also loaded with these on a test run in October 2018. “It got up the hill,” though, says Zeutschel, who was at the wheel himself. As a consequence, from autumn this year, a first eCitaro will complete the fleet of 67 buses.

swt’s own transport service was only founded in 2011. There are two neighbouring depots, but it does not have its own garage. The buses with the three-pointed star come with an OMNIplus Premium Service Contract from emission level Euro VI. Autohaus Seeger looks after maintenance and repairs during the buses’ entire holding period. It operates BusWorld Tübingen in the immediate vicinity and is set up for electromobility.

TüBus has also worked towards electromobility. Three Citaro G Bluetec hybrid models have been driving through the university town for two years – two of them previously operating in Hamburg. “They are a start for us,” says Zeutschel. For the fully electric eCitaro, Zeutschel has opted for depot charging. The charging station is not yet defined, but the energy is “green electricity in any case”. TüBus benefits from the expertise at swt, whose main business is supplying energy and operating the mains grid in Tübingen and the region. The technology is supplied and installed by the Stadtwerke colleagues, which you could call a home advantage. swt produces around half of the electricity needed in Tübingen regeneratively from sun and wind at its own facilities, with the share of green power in the Tübingen energy mix already at around 70 per cent.

TüBus will adjust the rotation of the eCitaro to its range. Driver training is necessary, as the drivers often switch between both routes and buses. “The drivers must be able to do everything,” says Zeutschel. Because the eCitaro runs so quietly, the Tübingen utility company is also considering using it on the daily-running night bus routes. Working closely with the Mercedes-Benz experts, each route is carefully examined from bus stop to bus stop.

What persuaded the company about the eCitaro? Zeutschel mentions “the performance on the hill” as well as drive comfort, the sophisticated vehicle plus maintenance and repairs, documentation and, last but not least, trusted contact persons. Ultimately, electromobility is all about the basics: “We have to transport our passenger safely and reliably.” The transport service is under the public gaze, “the people and politicians expect TüBus buses to also fulfil the highest environmental standards.”
Overall e-mobility system: battery technology

The strategy for the battery

At the heart of an electric vehicle is the battery. With the eCitaro, Mercedes-Benz is already presenting the near future of battery technology – good prospects for the future of electromobility.

The complicated term is lithium nickel manganese cobalt oxide cells, or NMC for short among experts. Which explains why everyone prefers to simply talk about lithium-ion batteries. Yet just as no two city buses are the same, no two lithium-ion batteries are identical. The composition of those in the new eCitaro is selected so that they are suitable for high-charging currents for high-power charging and, thanks to their energy density, are also good for long ranges.

Every single battery cell has a capacity of 37 Ah. The prismatic cells are roughly the shape and size of a paperback. Twelve battery cells make up one cell module. 15 cell modules plus a control unit for monitoring and balancing the charge between cells make up one battery module. The number of battery modules is variable. The eCitaro starts with a total capacity of 292 kWh maximum. For maximum performance, charging capability and lifespan, the batteries in the eCitaro are treated carefully. A liquid cooling system keeps them at their ideal temperature of around 25 degrees Celsius.

Thus equipped, the eCitaro can drive up to 280 kilometres without recharging in ideal conditions. In summer with air conditioning running, this is reduced to 170 kilometres according to SORT 2. With this system-relevant range, it already covers around a third of all routes typically served by transport companies.

The battery starter pack for the eCitaro is just the beginning, as battery technology is developing rapidly. The eCitaro is prepared: the next generation of batteries is expected sometime next year. Also NMC batteries, but with around 50 Ah per cell. That means a total capacity of around 396 kWh with twelve battery packs, with the range increasing accordingly. The space and connections are identical, and the higher weight is considered in the vehicle concept – the eCitaro will remain, its “electricity tank” will grow. Customers can even undergo bus tuning and replace the first batteries for the new, more efficient powerful generation after a few years.

The step towards a second technology path is expected at the same time: as an alternative to NMC batteries, the eCitaro will have solid-state batteries. Here the electrolyte is in a solid form. The advantage of solid-state batteries: they are particularly long-lasting, have a very high energy density and do not require cooling either. For the eCitaro this means around 400 kWh total capacity, 280 kilometres system-relevant range, route coverage of 70 per cent. Solid-state batteries are not suitable for high-power charging, however, so quick intermediate charging en route is not possible. This means a choice of two battery technologies, with every transport company getting the right eCitaro for its operating strategy.

Shortly thereafter, the eCitaro will finally move to the fast lane: we will then see the eCitaro with a fuel cell as a range extender. It will be designed so that the eCitaro will achieve a system-relevant range of 400 kilometres without recharging according to SORT 2. It will thus cover practically 100 per cent of city bus routes and turn into an all-rounder like the eCitaro with a combustion engine. The timetable is set. The journey into the electric future is beginning.

For the operator:

- Temperature control ensures maximum charging capability and performance, as well as long battery service life.
- Subsequent replacement with more powerful batteries possible
- Different technology paths enable individual configuration

Benefits

Battery capacity made to measure

How much battery capacity, and thus range, would you like? The eCitaro is a bus made to measure. It comes as standard with four battery packs in the rear and two more on the roof. Thanks to the modular battery cluster, the roof also offers space for four, six and – new – even eight battery packs. Using the maximum capacity of 292 kWh, the eCitaro has enough power for more than 170 kilometres under difficult conditions and nearly 300 kilometres under ideal conditions.
Anyone switching their bus fleet to electromobility cannot just think about electric buses. Among other things, the power supply comes into consideration. Daimler Buses eMobility Consulting helps.

Diesel buses out, electric buses in – that would be nice. Yet the company filling station cannot be turned into a charging station at the press of a button. The eMobility Consulting experts know that only too well. This is where the team comes in with its consulting approach.

Anyone hooking up their electric car to the socket in the garage can charge the battery of a Smart EQ Fortwo in eight hours. In comparison, a Mercedes-Benz eCitaro with a battery capacity of 243 kWh would have to be connected to a household socket for about 100 hours, because it only charges at 2.3 kW. For a fleet of 20 electric buses, up to 3,000 kW (three megawatts) would be needed, because an eCitaro can be charged at up to 150 kW.

The first step on the way to electromobility leads to the grid operator. Transport companies’ depots are often on industrial estates. They have a power supply of around 10 to 20 kV with power lines as thick as a person’s thigh. Yet woe if a large consumer, such as a big bakery with a high electricity demand at night, is connected to it. Then a thicker cable is necessary.

But how is it at the depot? Where should the charging stations and the electric buses go? Should the power be supplied from above to make the installation easier and prevent damage from manoeuvring? Are extra lanes for quick interim charging needed to avoid a power supply for charging on public roads?

Then it comes to the power supplier. If all the buses dock at the same time in the evening, they will consume a lot of electricity – peak power at peak tariffs. This means capping power peaks because not every bus sets off at the same time. Not every bus enters the depot with completely empty batteries. And continuous, maximum charging capacity strains batteries. For planning and implementing charging infrastructure, you need to think from the end. It is crucial that every bus sets off on its route with a full battery and is charged as carefully as possible beforehand. Intelligent charging systems are aware of departure times and routes. They weigh all buses, minimising the maximum electricity demand. Preconditioning is even taken into account when the passenger compartment and battery are cooled in summer and heated in winter just before setting off. EvoBus is providing the transport operators and their IT systems with the basic vehicle data for this via a backend system. eMobility Consulting is offering support in this respect in the run-up to procurement measures.

Not every charging device is perfectly compatible with every electric bus either. Does the charging process start as required? Will the necessary capacity be reached? Are all safety functions guaranteed? The developers of the eCitaro have tested marketable charging devices and can give information regarding their compatibility. Over and above this, on request Mercedes-Benz can supply the eCitaro together with the necessary charging infrastructure specially matched to the bus. The portfolio for charging infrastructure solutions is being further developed together with cooperation partners.

This all takes time for the transport operators, up to four years depending on the necessary preliminary work and the extent of the conversion. On the way to converting to electromobility, the experts from eMobility Consulting provide support. They analyse the operational feasibility and help design the charging infrastructure. Until the first eCitaro hums quietly and emission-free along the roads. That will not happen at the press of a button either but rather like clockwork.
The OMNIplus eMobility service concept

Changing battery module instead of oil

The eCitaro is running scheduled routes for the first operators – the service is already there. Alongside support and a spare parts service, the eMobility service concept includes a prototype garage and a qualification programme for high-voltage technology. One of the main points is maximum safety.
Electromobility means rethinking local public transport, that relates to servicing too. It faces completely new challenges with electromobility. To put it briefly: high-voltage technology instead of changing oil. Traditional jobs surrounding the combustion engine, exhaust gas treatment and the automatic gearbox are omitted, and new ones are added. The job description of the employees in the garage, their technical equipment and operational procedures are changing. At the same time, the vehicle technology is new. It is reassuring therefore that the Mercedes-Benz eCitaro comes with a five-year guarantee for the high-voltage components as standard. The overall package also includes maintenance and repairs as well as any necessary replacements for components in the high-voltage system.

The OMNiplus service brand meets the challenges with its specially developed eMobility service concept. It is composed of single, coordinated modules. Transport operators can individually match modules from it. That starts with classic support for the customer’s garage, continues with garage activities in conjunction with Service Contracts in competence centres and ends with bus depot management. Here, OMNiplus employees take on defined jobs through to the all-round service of the vehicles directly at the customer’s garage.

**Tailored eService Contracts**

OMNiplus has developed tailor-made eService Contracts for the eCitaro. The eBasic contract covers repairs to the high-voltage system and battery, working materials apart from the battery charge and all necessary maintenance work on the overall vehicle according to the manufacturer’s specifications. Over and above this, the ePremium Service Contract covers repairs to the overall vehicle including maintenance and wear as well as vehicle-related costs in case of a breakdown. ePremium thus offers a convenient, all-round package for switching to an electric bus fleet. The benefit of the Service Contracts are maximum availability, calculable costs and the highest value retention. Operators of the eCitaro can take out one of the two Service Contracts at any time, with the duration and scope being individually defined – for instance, by add-on packages such as statutory inspections.

Alongside all this, the spare parts warehouse is already stocked. Because – as is the case with all Mercedes-Benz buses – when the eCitaro comes, the OMNiplus service is already there.

**Training in the prototype garage**

OMNiplus supports companies with the excellently fitted OMNiplus prototype garage in the Dortmund training centre. There, they can find out how a garage for electric buses is equipped to start with. Dortmund, meanwhile, is much more than an exhibition garage: intensive training takes place there, as only well-prepared employees are allowed to enter a garage with electric vehicles due to statutory regulations, never mind work with high-voltage technology.

A look behind the scenes opens up a new perspective on the world of electromobility – away from common discussions about range or battery sizes.

Dortmund Training Centre, Gate 31a: behind an inconspicuous roller shutter hides the unique OMNiplus prototype garage. There, fitters learn to handle the high-voltage technology on the eCitaro. After all, the electric power involved goes up to a substantial 750 volts. That is more than three times the voltage of a household socket.

Kay Volmer is a trained electrical engineer and motor vehicle electrician, an experienced technical trainer and responsible for high-voltage safety at OMNiplus. He knows the components on the eCitaro and its safety concept down to the last detail. He points to the emergency off-switch in the cockpit and in the compartment for the charging socket: “This is used to disconnect the bus from the power in an emergency in less than a second.” Volmer explains the emergency function that ensures that the eCitaro can still roll away from a crossroads or rail crossing in the event of a problem in the high-voltage system; he also mentions the batteries and cables fitted to withstand a crash. He points out the rescue card with QR code on board the Citaro. It leads to the rescue guide for buses with the three-pointed star, to which a chapter has been added especially for the eCitaro.
Kay Volmer is a walking e-lexicon. He also knows about the ECE R100 regulation for electric road vehicles – according to which, battery casings must withstand a fire for 15 minutes. “The battery in the eCitaro was still working in the fire after a longer time than required,” stresses Volmer not without pride. The batteries are tested and certified under hazardous materials regulations. With tests on the cell, cell module, battery pack and the battery groups in the vehicle, the battery systems are tested fourfold and extremely safe.

The prototype garage is the training site for OMNIplus fitters and transport operators. The basis is a modular training system, in each case tailored to the regulations in the individual European countries. Trained high-voltage country coordinators help to pass on the information to the markets. This involves tools, processes and procedures – all aspects surrounding high-voltage safety.

Strict safety regulations
OMNIplus Euro trainers lead the training courses. The regulations for high-voltage safety are strict. A list of operating instructions in the garage defines who is allowed to do which jobs and advises about dangers. Nobody can simply walk into a hangar with an electric bus, unless they have first been given precise instructions. The training content for the fitters is much more extensive. In the basic module, they qualify as an expert for high-voltage systems. Anyone then passing the eCitaro module can completely repair the electric bus. After a further module, specialists are even allowed to assess damaged batteries and repair them.

Meanwhile, transport companies can also leave these jobs to the OMNIplus specialists. They take care of maintenance and repairs on request, even in the customer’s garage. Kay Volmer demonstrates the equipment – something like a storage box for battery modules with integrated fire extinguisher. “Although a lithium-ion battery does not burn in the conventional sense, the insurance companies call for protective measures,” explains Volmer. “This box spares the operators from needing a sprinkler system in the hangar.” Just one of many pragmatic ideas from Dortmund.

After being trained, engineers can even replace worn-out cell modules in the batteries. Thermal imaging cameras are used to detect faulty modules from the outside. For safety, the employees wear insulated gloves, protective clothing and a helmet with visor – that protects them from the risk of an arc flash in the event of a short circuit. When working on live batteries, the station is screened off with a barrier tape.

Diligent documentation
New modules are brought exactly to their voltage in a charging box using a CAN bus link with the battery. From the serial number to the position of the cell module, everything is diligently documented. Volmer also gives recommendations for mobile charging devices for the eCitaro in the garage. For this, he presents a suitable crane cross-beam and a trolley for transporting batteries – after all, a battery like this weighs around 220 kilograms.

The mobile roof work platform is outstanding in every respect. Fitters use it to climb on the roof of the eCitaro, secured all round by railings and sliding cassettes as a positive connection to the bus. Jetties take on tool trolleys or a mobile testing device. Even an eCitaro goes in for a service once a year. Although there is no need to change the engine oil, the equipotential bonding and insulation of the electric bus are measured at defined places, for example.

On leaving from Gate 31a, Kay Volmer says confidently: “Others only supply buses.” At Mercedes-Benz and OMNIplus, you also get a comprehensive service for the eCitaro.
The eCitaro has won the International busplaner Sustainability Prize (IBNP), which was awarded for the fourth time since 2013. The new Mercedes-Benz city bus was given first place by the jury of experts in the electric bus category.

The prize is awarded by the German trade magazine busplaner, owned by the publisher HUSS from Munich. The aim of the biennial competition is to support manufacturing firms and service providers within the bus industry, as well as bus operators, with regard to developing sustainable products and acting in a sustainable manner.

Another success for the Mercedes-Benz eCitaro was announced in Spain. The new fully electrically powered bus from Mannheim was voted City Bus of the Year 2019 in the southern European country. The jury was composed of 46 experts from transport companies and associations from Spain. The vote is organised by Editec, the Madrid publishing house that specialises in commercial vehicles and public transport.

Presented for the first time worldwide at the IAA Commercial Vehicles last autumn, serial production of the Mercedes-Benz eCitaro has now started, and the first buses have been operating on scheduled services in Germany since spring 2019.

Electric winner: Juan Antonio Maldonado (left), Managing Director of EvoBus Ibérica, S.A.U., collects the prize from Miguel Ruíz (right), CEO of the Urban Public Transport Association (ATUC).
Every generation has its figurehead. The new eCitaro.

The benchmark. The new eCitaro is Mercedes-Benz’s answer to current and upcoming challenges of the e-mobility era. Ready to electrify the future, the eCitaro expands the global bestseller’s portfolio to include a mature, fully electric vehicle. Its future-proof concept and comprehensive e-mobility system mean the eCitaro is showing the way forward for electric mobility in the city. For more information go to www.mercedes-benz.co.uk/bus

Ready for the city of tomorrow
The fully electric Mercedes-Benz eCitaro

Provider: EvoBus GmbH, Mercedesstraße 127/1, 70327 Stuttgart (Germany)