HOW MUCH ENERGY DOES IT CONSUME?

The Mercedes eCitaro was used for a demonstration test in order to explain the criteria that have to be adopted to measure overall electric bus consumption

A test drive to measure the consumption of electric buses took place in Mannheim. In early May, at the New Vehicle Center of Mercedes-Benz Bus & Coach, the international press dealt with the problems related to the use of electric buses and, in more detail, to the measuring of energy consumption during regular service.

The protagonist of the demonstration test was obviously the 12-meter Mercedes eCitaro equipped with three doors. We have already underlined its various qualities (see BusToCoach Magazine of April 2018) starting from the energy efficiency of the equipment that enables a range of about 170 km.

In order to make a correct comparison of the consumption, it is necessary first of all to establish homogeneous starting conditions as far as battery charge level (maximum), vehicle weight (ballasted at 2/3 of the payload), test route and climatic conditions.

In our test, of which we underline the purely demonstrative nature of the procedures and therefore of the results obtained, the weight of the eCitaro was 16,560 kilos and it accommodated about 30 journalists and 10 battery modules (243 kWh of total capacity). As a guide, we would like to remind you that the two-door version with twelve battery modules (maximum supply) weighs 14.1 tons with a permissible maximum mass of 19.5 tons.

The test drive was developed on 23 kilometers on the suburban streets of Mannheim with 14 intermediate stops; the external temperature was 12-15° and, before the start of the test, the temperature of the vehicle was set up to 22° and compressed air supply was filled to the maximum.

It should be remembered that the eCitaro has a thermal management system for heating, ventilation and climate control specifically designed to reduce energy consumption by about 40% compared to the normal consumption of the Citaro with an internal combustion engine. This was achieved by powering thermo convectors at the bottom of the internal walls with a low-consumption heat pump, completed if necessary by the heating function of the roof-mounted air-conditioning system that uses CO2 as a coolant. Moreover, thanks to the axle load sensors, the output of the heating and climate control varies according to the number of passengers on board. Finally, all components that give off heat are linked together to reduce energy consumption to a minimum and to increase battery life, which

are cooled by means of a separate cooling device, boosted when necessary by the passenger-compartment climate control system.

In order to keep the operating parameters under control, the driver has at his disposal a dashboard similar to the one of the Citaro diesel but with an immediate indicator of energy absorption or recovery positioned on the right, in place of the usual rev counter. Furthermore, the central display shows the range, the available power and the charge level. The driver can also increase energy recovery by acting on the electric brake lever located on the steering column, as for the classic retarder.

During the demonstration test, the central eCitaro energy management system was connected to a computer in order to display a screen with all consumption data, from moment to moment (see image on the side). Next to the speed indicator (on the left) is displayed the immediate percentage of power consumed (in red) or recovered (in green), while on the right is displayed the

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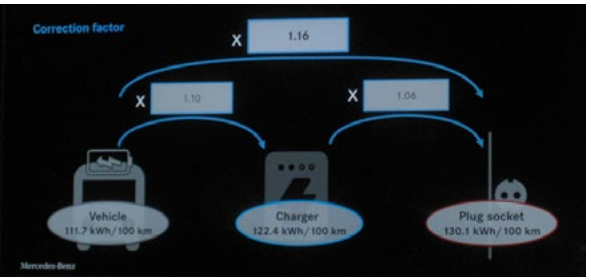


percentage of battery charge, the external and internal temperature, and the odometer. Underneath the first two indicators, three coloured bars respectively show the total power (in kW) that is being absorbed from the batteries (red), and the corresponding power sharing absorbed by the engine (blue) and by the utilities (green), i.e. climate control, door opening, and so on. In this case, it should be underlined that on the eCitaro the energy management system automatically redirects the energy recovered to the heating system when the batteries are at their full charge.

On the right side of the battery charge indicator there are two columns showing the consumed kWh (highlighted in blue) and the average consumption in kWh/100km, both total and absorbed by engine and utilities.

Thanks to this instrumentation, the total consumption data recorded at the end of the test was 25.67 kWh, corresponding to an average consumption of 1.117 kWh/km, split into 0.862 kWh/km absorbed by the engine and 0.255 absorbed by the utilities. It should be underlined that these data should not be taken as distinctive tout court of the eCitaro but in relation to the particular conditions in which the demonstration test took place, starting from the fairly critical weather conditions.

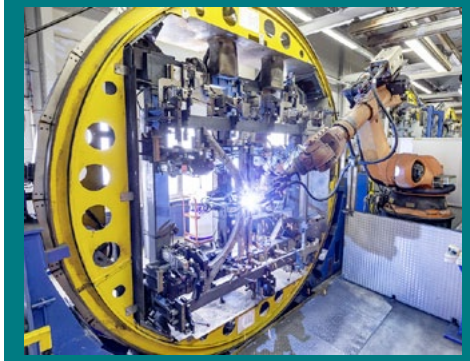
Furthermore, when measuring the consumption of an electric bus, it is not enough to refer only to consumption in operation, but it is necessary to refer to the overall consumption during the charging phase which includes both losses between the electric socket and the charger and between the charger and the vehicle, both depending on the efficiency of the charging device.

Using an 80 kW charger with a Combo-2 interface branded Eko Energetyka, it took about 20 minutes to recharge the 25.67 kWh batteries installed on the eCitaro and 29,892 kWh have been consumed. This means that during charging, 14.12% of the energy supplied was lost in the transfer from the network to the vehicle. In more detail, 5.92% was lost in the transfer from the network to the charger and 8.2% from the charger to the batteries.

In conclusion, in order to measure the overall average consumption in kWh/km a multiplicative factor must be introduced. In this case the factor was 1.16, which increases the initial 1,117 kWh/km to 1.302 kWh/km. The use of electric buses raises therefore completely new issues, starting from the evaluations of the energy costs of operation. Mercedes decided to share its criteria for a correct calculation methodology. ●

IN THE PLANT IN MANNHEIM

Since the autumn of last year, the historic plant in Mannheim (founded in 1908) has been set up for the manufacturing of the eCitaro. The assembly lines are the same as those used for the Citaro equipped with thermal engine. They share many intermediate workstations. The first step is the manufacturing of self-supporting bodies using laser cutting machines, bending robots, rotary positioners and ergonomic workstations for the welding phases.



It's then the phase of the cathodic dip-paint coating (KTL), with subsequent drying at 90° and 220° and sealing to prevent corrosion. The bodywork is then sent to the Neu-Ulm plant for paneling and painting.

When it is sent back to Mannheim, the assembly phase begins. Components are placed on the roof and the high voltage cables (orange) are laid from a raised position. Then the windows are glued, the platform is assembled, the air tanks and air conditioning pipes are installed. Then it's the turn of the electrical system with the related laying of the cables and the assembly of the rear axle with its electric motors on the wheel hubs.

From workstation to workstation the eCitaro is completed until the pre-assembled battery modules are put together. It should be underlined that quality controls are constant throughout the assembly process. After this, in an area that can be accessed only by operators, the high-voltage system is checked. Lastly, the final test of the entire Citaro range take place. In addition to this, the eCitaro is also tested on the road, both inside and outside the plant. ●

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