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Paper "Zero emission operation for urban distribution with HD Trucks"

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Summary

With regard to expected access limitations to inner cities electro mobility gets more and more important for urban distribution. Therefore a holistic approach must be observed. With the Urban eTruck we have presented a study at IAA how a realization for electro mobility for heavy duty urban distribution could be and which technologies are necessary. Not only is the capacity of the batteries with regard to the range furthermore the decision of the right powertrain crucial to reach a reasonable packaging. Also important is the electrification of the auxiliaries.

Keywords: BEV, heavy-duty, sustainability, freight transport

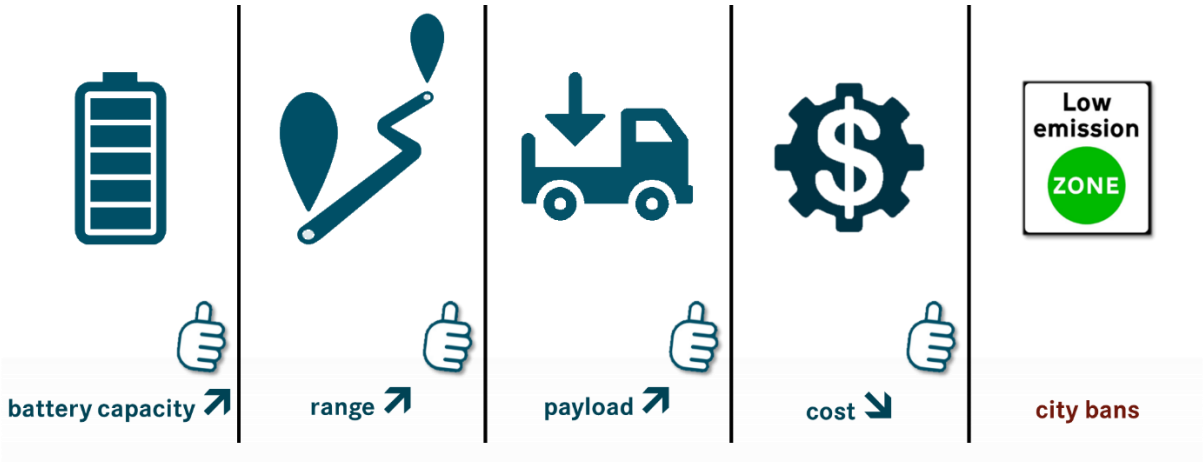
1 Shaping future transportation

Delivering food and products to people, disposing of waste, supplying goods to industry, trade and commerce, taking away the finished products and growing sensitivity to exhaust and noise emissions.

As an alternative to the consistent gradual reduction of emissions through ever tighter regulations, the ideal solution is local emission-free mobility – in future also for trucks up to a permissible gross vehicle weight of 26 tones. Not only the emissions will be locally zero, also the noise will go down to prevent too much noise in urban areas and the grade of efficiency will rise.

In urban logistics, heavy-duty vehicles are needed with a sufficient payload and volume. Moreover, cooled goods make a large share of heavy-duty distribution in urban areas – most prominently food. It adds up to 55 percent of this segment. Cooled goods are sensitive and, of course, our customers need to guarantee a perfect cold chain. In addition to that, urban logistics needs to be reliable and on time. The truck needs a sufficient driving range while at the same time having sufficient performance. Our customers also directly feel the trend that urban areas increasingly aim at reducing both local emissions and noise – especially at night. The eActros is our answer to these challenges our customers are facing.

Four factors make e-mobility for trucks possible. First of all, battery capacity has increased substantially. For the period from 1997 until 2025 we expect a growth by the factor 2.5. With this and the additional support of other technical solutions, range has increased as well. We can now offer trucks that deliver the range needed for real use cases. Third, we are able to offer electrically powered trucks with a suitable payload. And while all these factors have improved, costs have decreased. This is especially the case for batteries. From 1997 until 2025, the price will be reduced by the factor 2.5. If you then take into account the urgent need especially in urban areas for emission-free transport solutions, it becomes more than obvious: the time for electrically powered trucks in urban distribution has come.



1.1 Mercedes-Benz eActros: electric drive, modular battery concept and right weight balance

The three-axle rigid eActros from Mercedes Benz features a tailor-made concept for highly efficient and clean short-radius distribution. Its outstanding attributes include an electrically powered rear axle with electric motors directly adjacent to the wheel hubs. Technical starting position is a Mercedes-Benz rigid platform truck for heavy-duty urban distribution use.

Compared to a Diesel truck an electric truck has a significantly higher degree of efficiency. A diesel truck has a degree of efficiency about 50%, an electric truck over 90%.

The power is supplied by modular packs of lithium-ion batteries. Thanks to the well-thought out concept with motors adjacent to the wheel hubs, the batteries are housed in a crash-proof location inside and underneath the frame.

1.1.1 Battery

As already mentioned the batteries are placed inside and underneath the frame rails. This place is very good defined because the batteries have a good protection against a side collision. Also the weight balance is an advantage of this packaging due to a low centre of gravity and a high stability against vehicle roll. Another advantage is the significant lower torsional moment for the frame rails.

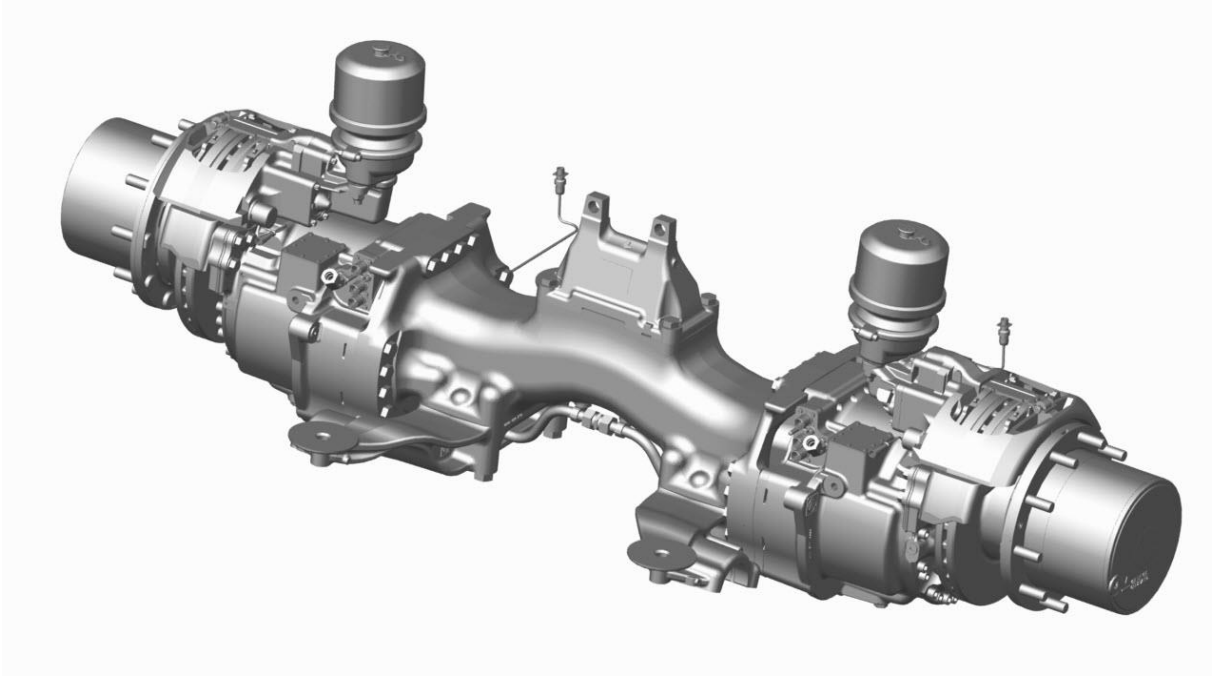
The battery itself is based on proven lithium-ion battery technology and with the connection of the trays a supply of approx. 750V can be reached. The configuration of the eActros consists out of three trays with a capacity in total of 212 kWh. Other voltage levels are supplied via DC/DC converter like 400V or 24V. Batteries will be charged with connection to the infrastructure with the normed CCS Combo2 plug.

1.1.2 E-Axle

A completely new drivetrain concept is used for the eActros. No centralised electric motor is installed (e.g. in the position of former combustion engine). No typical transmission box, differential gear and drive shaft are installed. Therefore electric motors are installed close to the wheel hubs integrated in a new electrical axle.

Only with the integration of the electric motors in the axle it was possible to place the batteries inside the frame rails. Like with the conventional drivetrain 11.5 tons are the permissible axle load. Peak power of the electric motors is 2 x 125 kW with a nominal voltage of 400V. The electrical engines have also the additional function to recuperate during braking times.

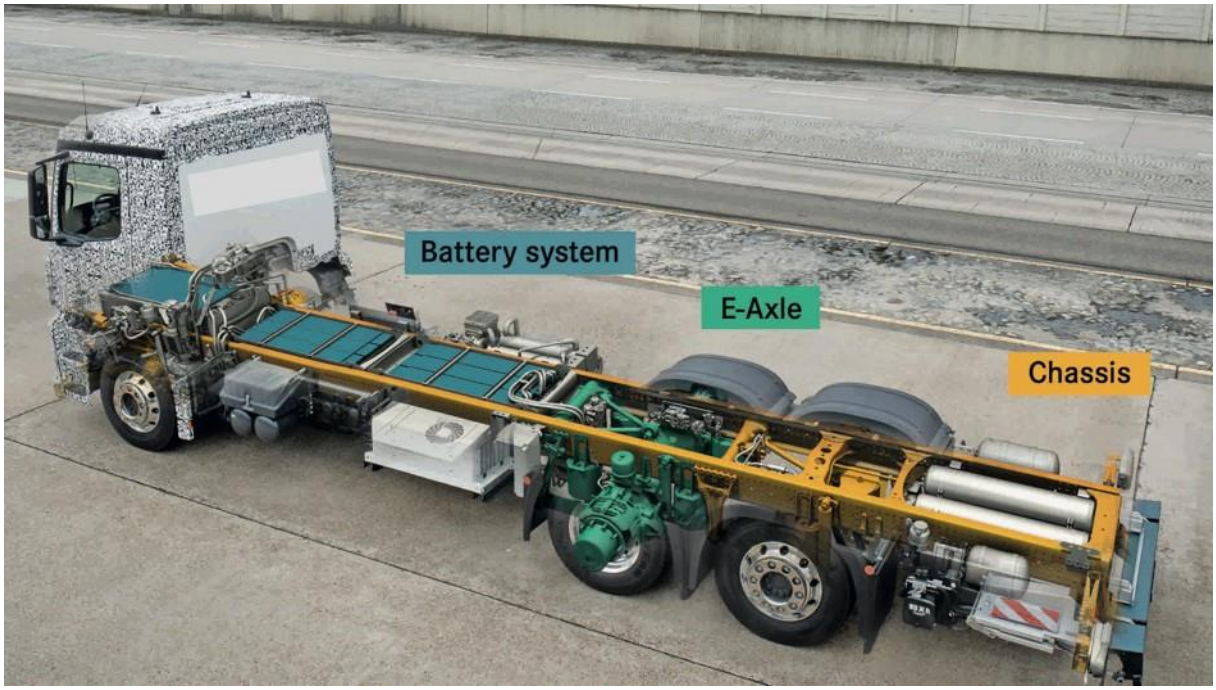
eActros is consequently designed for battery electric drive. Due to the substitution of the conventional drivetrain a completely new packaging and architecture is possible.



1.1.3 Chassis

The Chassis is a so called 6 x 2 NLA that means a three-axle rigid truck with a wheelbase of 4.900 mm and a steered trailing axle. With the substitution of further more components that were only needed for a conventional drivetrain the free space on both sides of the frame rails are used for the installation of all needed electrified auxiliaries. For separation of high-voltage and low-voltage one side is only equipped with high-voltage auxiliaries and the other side only with low-voltage auxiliaries. Furthermore all cooling modules are placed close to the auxiliaries that needs the cooling.

Not only on the mechanical site are many changes, also on the electrical site. A completely new electronic architecture based on the conventional architecture was developed. A new concept with substitution of conventional technologies and integration of new components for electric drivetrain were implemented.



1.2 The Vision of Urban Transport in the Not-too-distant Future

In near future the first city bans for conventional vehicle will come up in cities with problems of air pollution like Paris, Beijing or Stuttgart. The delivery of the urban area has to be secured because the demand of the population of big cities can only be covered with the usage of heavy-duty urban distribution trucks. To satisfy the demand of the people and simultaneously conform the future regulations (esp. city bans) a new solution for the substitution of trucks with conventional drivetrain must be found. Therefore Mercedes-Benz invented the Mercedes-Benz eActros as first fully integrated electrical 26 tons in the world. With an ongoing development the demand in near future can be satisfied with a series production of zero emission heavy-duty trucks for urban distribution.

By looking a bit further in the future e.g. 2050 about 70 percent of the world's population will live in urban areas. Long-haul trucks will bring goods to logistic centers on the outskirts of a large urban area. The goods will be stored there and loaded on electric trucks for local delivery. Thanks to electric drive the delivery will be done with local free emissions and quiet. Also the long-haul trucks then can be electrified for a zero emission transportation. To achieve the needed daily range for long-haul trucks another zero emission solution than pure battery electric trucks must be installed because the size and weight of batteries for a daily range of long-haul trucks is too big to be installed in a truck.

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Authors

Martin Zeilinger, born on May 07th 1960 in Stuttgart, is Director of Advanced Engineering Truck. He studied air and space technology at the university in Stuttgart.

Mr. Zeilinger joined what was in that time Mercedes-Benz AG in 1987, gaining his first experience at Truck testing in Stuttgart, Germany, working on engine controls.

In 1998, he assumed the position as a Senior Manager in motor peripheral systems. A few years later in 2004 he changed to EvoBus GmbH in Neu-Ulm as the director of testing and powertrain technology.

Since March, 2014, Martin Zeilinger has been Director of Advanced Engineering Truck in Stuttgart, Germany.