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Zero Emission Strategy Daimler Buses

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Abstract

In its *Zero Emission Strategy Daimler Buses* focuses on real emission free drivetrains in order to bring *real zero emission solutions* to the market. Today's available battery buses do not fulfill all requirements for a battery bus in series production. Further on *opportunity charging* is more seen as a bridging strategy until a more powerful battery technology is available. To help operators switching from a Diesel vehicle based fleet to an electric bus fleet Daimler has come up with a new business model. Daimler will not only provide electric vehicles, but also *consult operators* in finding the best configuration of an electric bus and the needed charging infrastructure in order to keep investments on the operator's side for electric buses and charging infrastructure in an optimum range. But the challenge is not only to provide a real zero emission bus with sufficient range in order to meet customer demands, also the grid integration of charging stations and energy supply needs to be managed. This is something that is often neglected and needs to be taken into account from manufacturers, operators, energy supply companies and politics.

1 Daimler Buses Zero Emission Strategy

The trend of urbanization is pushing the need for emission free driving dramatically. Today about half of the world population is living in cities and this trend will continue in the next years. By 2050 about two third of the world population will live in 37 megacities around the world [1]. This also means that the need for intelligent and clean mobility solutions will further increase in future. Estimations show that the three megacities of New York, Delhi and Tokyo will need more than 40,000 additional buses to be able to transport their citizens. Growing passenger number in public transportation throughout the last years also confirm this development.

How can these demands regarding public transportation in cities be satisfied in the future? For sure, clean mobility solutions with electric drive systems will play an essential role. Looking at the Daimler Buses city bus portfolio the drivetrain strategy is based on two pillars:

- The Mercedes-Benz Citaro Euro VI with a nearly emission free drivetrain
- The Mercedes-Benz full electric bus with an emission free drivetrain

1.1 Nearly Emission Free Driving

The first pillar is the nearly emission free Euro VI Mercedes-Benz Citaro as it is on the market today. By 2018 Daimler will further reduce CO₂ emissions of these already very clean vehicles by another significant portion in the higher one-digit-percentage range using conventional measures and mild hybrid technology.

1.2 Emission Free Driving

The second pillar is the new Mercedes-Benz full electric bus, the emission free city bus which will be brought into series production by the end of 2018. This new product will bring real emission free driving in series application to the streets using battery technology as the base technology.

Daimler Buses is looking back on a history of electro mobility for more than 40 years. The CHIC project successfully demonstrated that the fuel cell technology is a solid solution for future zero emission public transport. However, one needs to keep in mind that technology maturity is currently not 100 percent in line with Daimler's requirements of a true Mercedes-Benz. All these findings will be incorporated in the new electric bus Citaro to be brought into series production in 2018.

The goal is to bring the very challenging requirements operation range, capacity, reliability and product costs and price into a very competitive and attractive balance.

Analyzing the energy flow in the electric vehicle, it is noticeable that about 1kWh is consumed by the drivetrain for propulsion of the vehicle in city bus operation. In addition to that, the energy consumption of auxiliaries, infotainment systems and climatization/heating sums up to another 2kWh in cold winter and about 1kWh in transition period. This clearly indicates the demand for an intelligent energy management and innovative and economical auxiliaries.

2 Daimler Buses eMobility Consulting

Besides the vehicle itself an efficient mobility infrastructure will be key for a city worth living in. Therefore Daimler Buses is aiming for a holistic approach offering complete mobility solutions to their customers in order to make public transportation more attractive than it is today by offering more services.

Today, driver costs are the main costs for operators, they account for about 2/3 of the total operation costs. To keep the total cost of operation as low as possible one major part is to ensure the optimal usage of driver capacities. Assuming that today's schedules are optimized with regard to driver costs it is mandatory to keep this schedule when switching to zero emission vehicles. If an operator needs to deploy additional drivers and buy additional vehicles in order to manage the demand of public transportation with zero emission vehicles, the additional costs for zero emission mobility will be too high and operators will not be willing to switch to this new technology. This is exactly where the Daimler Buses eMobility Consulting comes into action. Together with operators Daimler Buses will analyze schedules and routes in order to find the perfect vehicle configuration for customers. This analysis will also take into account the topography of routes. As the cost for batteries is very high, the perfect balance of battery size and opportunity charging needs to be worked out. Not every city might have the infrastructure to install charging stations for opportunity charging and different solutions have to be realized.

For this analysis Daimler Buses has developed a special app to find the perfect vehicle configuration for each customer. This app will show the progress of state of charge of the battery bus taking into account:

- Operator specific routes
- Weather conditions
- Number of passengers
- Available stations for opportunity charging on the route
- Battery size installed in the vehicle

The methodical approach as shown in Figure 1 is a 4-phase process starting with a specific customer data acquisition, eg. fleet structure, vehicle scheduling, route characteristics, workshop characteristics and energy supply. Based on that data, a detailed analysis focusing on energy consumption and energy needs is conducted, with a special focus on operational integration. The third phase is driven by a customer-centric design and optimization of operation and charging scenarios as well as vehicle configurations. Potential effects of additional measures in energy management are being considered in that phase as well. Finally, in phase 4 detailed transformation and rollout scenarios are being designed and accompanying measures synchronized to reach a fully operational system for e-mobility.

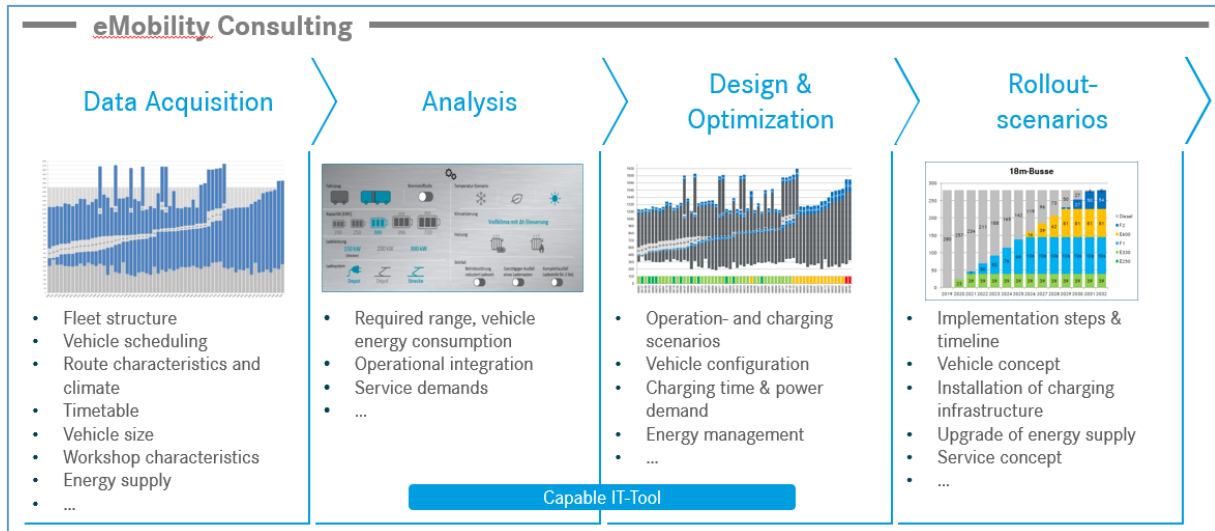


Figure 1: Methodical approach of eMobility consulting @DaimlerBuses

With this holistic approach Daimler Buses will not only deliver zero emission vehicles to their customers. Daimler Buses will work out the best way to switch from a conventional driven fleet to a zero emission fleet together with their customers. This consulting approach also considers energy supply as well as grid integration, two very important factors that are often neglected when talking about zero emission and charging strategies.

References

[1] United Nations, *Worldwide Urbanization Prospects, The 2007 Revision*, February, 26th 2008

Authors



Andreas Mink holds the position as Head of Daimler Buses Engineering Electric/Electronics & Chassis systems. After various positions in electrics and electronics engineering for passenger cars and commercial vehicles within the Daimler group, he is now responsible in Daimler Buses for development and validation of the EE-architecture including mechatronics for axles and brake systems, active driver assistance systems and connectivity solutions as well as the development and validation of high voltage and energy management systems for electric drive buses and fuel cell buses.