Karlsruhe Institute of Technology

KIT Mobility Systems Center

Institute of Vehicle System Technology (FAST)

E-City Bus Demonstrator

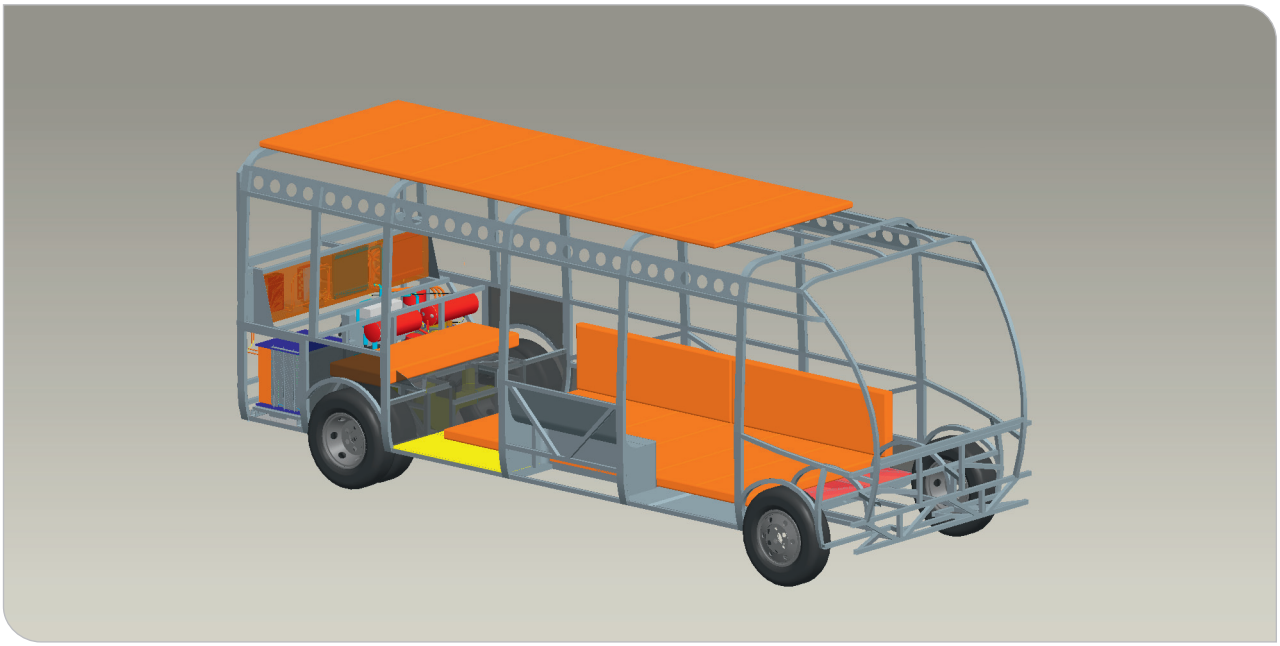
Motivation

Battery electric vehicles (BEV) being "refueled" by renewable energies reduce the traffic caused emission of the climate-damaging CO_2. Low operating and maintenance costs are one of the main advantages of electric vehicles over conventional vehicles with combustion engines. The low driving range and high purchase costs of electric vehicles are the main disadvantages leading to a low consumer acceptance. For this reason, the research in the field of electric mobility has increased within the last years to reduce the disadvantages and improve the cost-benefit ratio. This is necessary to reach the target of 1 million electric vehicles on the street in the year 2020, a goal set by the Federal Government of Germany.

A total cost of ownership analysis (TCO analysis) of Competence E shows, that BEVs become profitable if they are used frequently for short to medium trips (urban/suburban areas) with stops for fast recharging inbetween. Therefore car-sharing fleets, delivery vans and city busses are an ideal application for BEVs. Furthermore the TCO analysis shows, that the costs of city busses with a battery electric drive amortize during their usual period of usage due to a high utilization in local traffic.

Technical Information

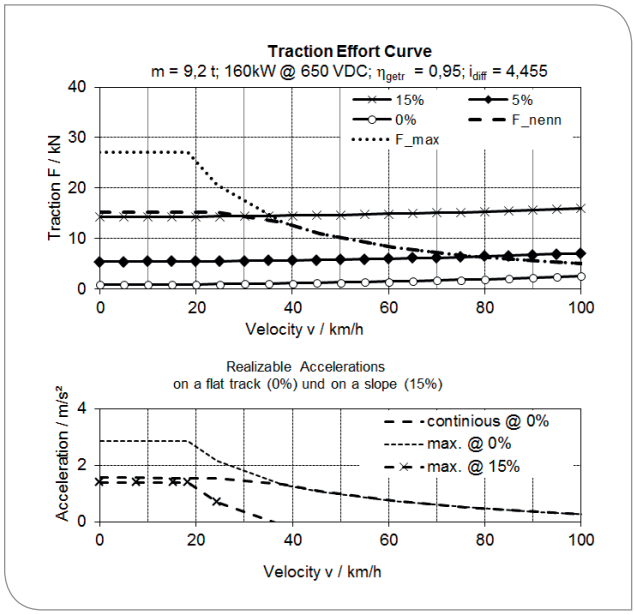
At the Karlsruhe Institute of Technology (KIT) the e-city bus demonstrator was built up in cooperation of several faculties and enables the test of new components, systems and operation strategies under real operating conditions. For that purpose, the main components (electric drive system, battery, battery management system and control unit) for battery electric drive were installed on a functional bus frame.



E-city bus concept for an economic city use

The energy for driving the e-city bus demonstrator is stored in Li-Ion pouch cells which are implemented in a modular battery system developed by KIT. The new concept of the modular battery system consists of flat battery modules that can be connected and assembled to the desired size and to the desired capacity. The condition of the modular battery system is controlled by the attached battery management system (BMS) and can be disconnected using contactors.

The bus is driven by a permanently synchronous motor. The motor transmits the driving torque through a differential with a fixed gear ratio directly to the wheels of the rear axle. The transmitted power can be up to 160 kW at 650 VDC. The installed power allows the bus to drive 107 km/h on a flat track. The high continuous torque at low engine speed allows a bus with a weight of 9 tons to climb hills with a gradient of 15 % at speeds up to 25 km/h. While the final bus will be operating at 750 VDC, the voltage level is 450 VDC at the first expansion stage. It should be mentioned that the voltage level in operation influences the max. power output, since the occurring current within the components has to be limited.



Engine compartment of the demonstrator

For the operation of the permanently synchronous motor, the constant current of the battery is changed in 3 phases of alternating current by the inverter. Besides the electric drive system, additional high voltage auxiliary consumers are connected to the battery using a power distribution unit (PDU). One consumer is a DC-DC converter to supply low voltage to the electronics, the compressor for the braking system, the cooling pumps, the fan and the control units.

The vehicle control unit (VCU) communicates with the other control units (BMS, Motor Control Unit) and transforms the driver's input – given by the gas and braking pedal position – into a torque request for the electric drive system. The torque request is determined and reduced based on the limits of the components.

The development of the e-city bus demonstrator was carried out within the scope of the project Competence E and funded by the Federal Ministry of Economics and Technology.

Karlsruhe Institute of Technology
Rintheimer Querallee 2
76131 Karlsruhe, Germany

Dr.-Ing. Martin Gießler
Institute of Vehicle System Technology (FAST)
Phone: +49 721 608-44149
E-mail: martin.giessler@kit.edu

FAST Institut für Fahrzeugsystemtechnik

COMPETENCE E