



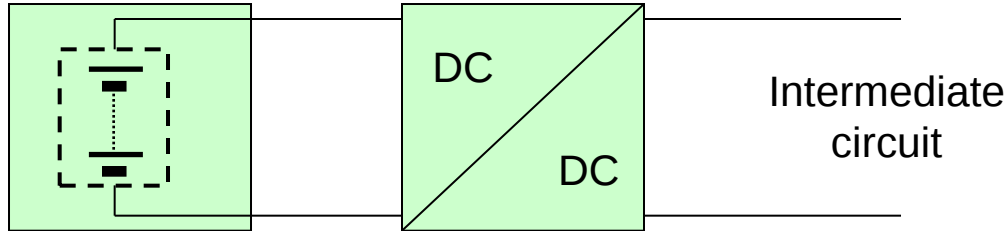
**On-board Li-Ion energy storage systems
for trolleybus Zurich**



Traditional auxiliary propulsion units for trolleybuses

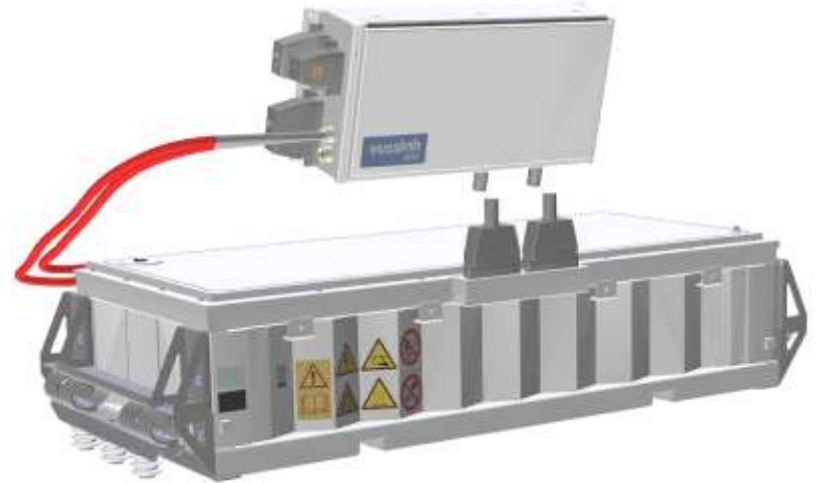
- ▶ For the use of trolleybuses independent of the overhead line, auxiliary propulsion units based on diesel-generator-sets are used:
 - line gaps, crossings and switches (e.g. downtown stop-and-go)
 - driving around road works
 - operating the bus in the workshop area
 - grid expansions without overhead wired
- ▶ Electrical power: 50 kW to 175 kW
- ▶ More and more strict diesel limits lead to complex and expensive solutions
- ▶ Large number of starting sequences (> 1000 / year) und low runtime (< 50 h / year) produce high maintenance costs

Auxiliary power unit based on Li-Ion technology



- ▶ Energy storage system made of Lithium-Iron-Phosphate (LiFePO_4) batteries
- ▶ Compact, enclosed design
- ▶ Installation on the roof or in the rear of the vehicle
- ▶ Active Balancing of battery cells
- ▶ Step-up/step-down-converter for optimal power control of battery system and interfacing to the 600V system of the vehicle
- ▶ Complete double insulation according to CLC/TS 50502 and EBV (CH)

Design of the energy storage system



- ▶ Enclosed container
- ▶ Forced air cooling with internal cooling circuit
- ▶ Fully integrated system including:
 - Main relays, main fuse
 - Battery management system
 - Heating and cooling
- ▶ Scalable system
- ▶ Easy connection to the vehicle by means of power connectors



Technical Data



- ▶ Variants system for double-articulated and articulated bus
- ▶ Discharge power: 80 kW / 100 kW
- ▶ Charging power from OHL: 25 / 30 kW
- ▶ Usable energy: max. 30 / 38 kWh
- ▶ Number of cycles: > 3000 full charge/discharge cycles
- ▶ Charge time: typ. 5-8 minutes per driven km
- ▶ Voltage: 200 – 400 V
- ▶ Mass: approx. 740 kg / 800 kg

Practical experience

- ▶ Contract: 12 double articulated and 21 articulated trolleybuses for VBZ (Zurich, Switzerland)
- ▶ First vehicle in passenger operation since 06.09.12
- ▶ Currently 7 buses in operation



- ▶ Scheduled use of battery system: up to 1,5 km
- ▶ Operating range: > 10 km
- ▶ Gradability: > 12% at 38,1 t gross vehicle weight

Advantages for the customer



- ▶ 100% emission free trolleybus with option for “hybrid trolley” functionality
- ▶ Operation possible without waiting time for preheating or start of engine
- ▶ Flexible charging strategies for batteries possible, e.g. with brake energy or during the night, short charge time.
- ▶ Significantly reduced maintenance costs:
batteries are maintenance-free, yearly visual inspection is sufficient
- ▶ Grid expansions or wireless operation of neuralgic areas are easy and economically possible in conjunction with automatic current collector system

Thank you for your attention



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