PRESS RELEASE

HV-MELA-BAT project develops XXL charging system for heavy-duty and passenger transport

Charging infrastructure for battery-powered heavy-duty and passenger transport is crucial for a successful transportation transition. The trend here is toward higher charging power and, consequently, higher charging currents and voltages. The collaborative project "HV-MELA-BAT" therefore developed the power electronic converters required for XXL charging, as well as a contact system for high currents and voltages. Thanks to a high switching frequency, the isolated DC/DC converter achieves a volumetric power density of 9 kW/l while maintaining a record-breaking efficiency of 99.26 percent. A buffer storage unit was integrated to ensure full charging power even at power-limited grid connection points.

"The project focused on upgrading existing fast-charging infrastructure based on the international Combined Charging System (CCS) standard to the new Megawatt Charging System (MCS). The higher charging power poses new challenges for power electronics, the contact system, and the available grid connection capacity," explains Dipl.-Ing. Stefan Reichert from the Fraunhofer Institute for Solar Energy Systems ISE, who coordinated the project. Other project partners in "HV MELA BAT" included Motion Control & Power Electronics GmbH, STS Spezial-Transformatoren Stockach GmbH, Mercedes-Benz Energy GmbH, and Fraunhofer IVI.

Charging system for a wide range of vehicles and grid connections

As part of the research project, the project team developed the core components required for XXL charging: power electronic converters such as the grid-side rectifier, an modular interconnection of DC/DC converters for galvanic isolation and DC/DC converters for adjusting the charging voltages, as well as the contact system for high voltages and currents. The charging system was supplemented by a buffer storage system made from second-life passenger car batteries. The storage system reduced the required grid connection capacity of the charging station to 500 kW; it also buffers high load peaks, thereby reducing the load on the grid.

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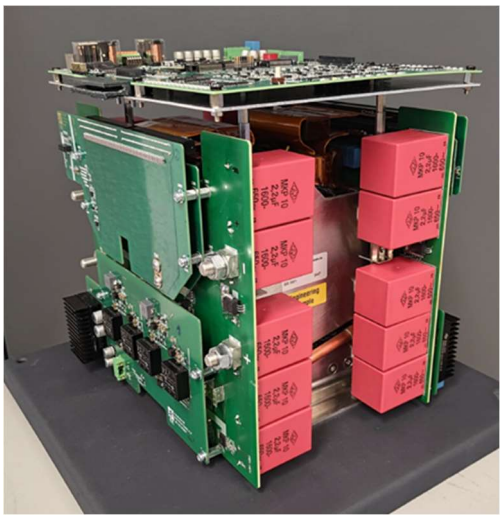
The MCS system developed in the project was designed to be flexible in order to cover the widest possible range of charging voltages and vehicle types. It is downward compatible with the existing CCS charging standard. The project team also investigated the modular configuration of up to four 250-kW charging points and the integration of renewable energy sources (e.g., photovoltaic systems) and loads within the system. The solar power can be used directly for the charging station or fed into the buffer storage.
The complete MCS charging system and the buffer storage were set up, commissioned, and tested at the Fraunhofer ISE Center for Power Electronics and Sustainable Networks in Freiburg. Using the modular and flexibly configurable DC/DC converters from Motion Control & Power Electronics, the battery, the AC grid, and the charging output were connected via a common DC bus. This enabled a charging power of more than one megawatt to be demonstrated with a limited grid connection capacity of 500 kW. The remaining 500 kW was supplied by the buffer storage system. The system was tested with charging processes of varying durations, and the size of the buffer storage system was also varied. In doing so, the system achieved above-average overall transmission efficiencies from the AC grid to the vehicle battery.

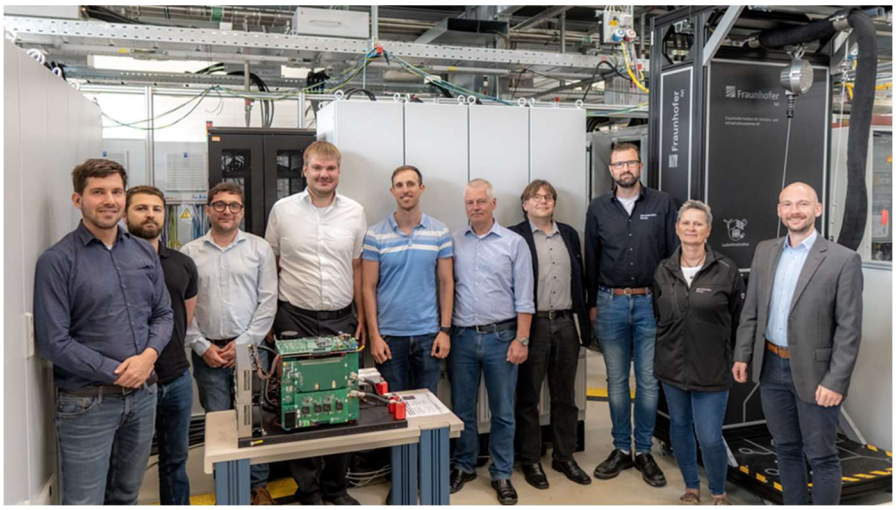
Innovative circuit topologies and high switching frequencies for record-breaking efficiency

An innovative component of the project is a new, ultra-compact, galvanically isolated DC/DC converter with a power transfer capacity of 250 kW. To provide a charging power of 1 MW, four of these modular converters are connected in parallel. The power converter is based on the fundamental topology of a series resonant converter. It operates at a very high switching frequency of up to 200 kHz, allowing inductive components such as the high-frequency transformer and the resonant circuit to be designed smaller. This reduces material usage and the size of the converter. Thanks to the high switching frequency, the converter achieves a volumetric power density of 9 kW/l, which, with a maximum efficiency of 99.26 percent in this power range, represents a world first.

The project was supported by the Federal Ministry for Economic Affairs and Energy.



Galvanically isolated DC/DC converter with a power output of 250 kW, 99.26% efficiency, and a volumetric power density of 9 kW/l (without recooler and auxiliary power supply). ©Fraunhofer ISE/Photo: Jörg Bornwasser



Demonstration of the megawatt charging system in Fraunhofer ISE's multi-megawatt laboratory during the final meeting in July 2025. ©Fraunhofer ISE/Photo: Jörg Bornwasser

The higher charging capacities for trucks pose new challenges for the power electronics and contact systems of charging stations, as well as for the available grid connection capacity.
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