

## Lightweight Electric Drives for New Energy Applications

### Innovative Drive Technologies Made by SciMo

As a result of the high demands of electric mobility, electric drive technologies have been under strong innovation pressure. What is needed are compact, lightweight, yet powerful electric motors. Especially in hybrid electric vehicles, the electric motor has to be installed in very small space. It should hardly influence vehicle weight, but still provide a large share of the propulsion power. Impacts on the environment, increasing scarcity of resources, and manufacturing costs are gaining importance in electric motor production. Since 2011, the Institute of Electrical Engineering of Karlsruhe Institute of Technology has been working on electric drives of considerably increased power density and reduced material expenditure. The newly developed motors are particularly compact, lightweight, and powerful. Apart from innovative mobility concepts, they might also be used in new energy production systems, such as airborne wind power plants. Development is based on the following strategies.

#### High-rev Concepts for Compact Design

By increasing the rotational speed level, electric motors of the same power can be designed in a more compact way. For this purpose, synchronous and asynchronous machines as well as switched reluctance machines with a maximum speed of 30,000 rpm were set up and studied at the Institute. In the studies, the rotational speed of the electric motor is reduced to the usually lower speed of the energy conversion system by a downstream gearbox. Based on this interaction of gearbox, electric motor, and power electronics, the optimum drivetrain can be computed for various application scenarios.

#### Innovative Cooling Concepts for Improved Heat Removal

In recent years, a wide range of cooling concepts was studied, from conventional water cooling jackets to oil

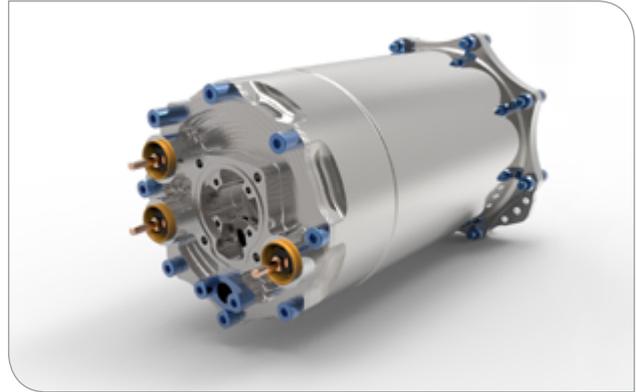


Compact generator unit, consisting of an electric motor with a flange-mounted planetary gearbox

coolers and integrated indirect cooling. With advanced cooling methods, continuous current densities of more than 40 A/mm<sup>2</sup> can be reached.

## Electric Drives in Application

The latest development is an electric motor with a continuous output of 32 kW at a weight of only 4 kg. This corresponds to a continuous power density of 8 kW/kg (cf. reference motor 5.2 kW/kg). KIT's startup "SciMo – Electric High-performance Motors" established in 2017 focuses on the design and setup of specialized drives for applications in the mobility and energy sectors.



High-speed synchronous generator: Maximum speed 30,000 rpm



Rotors of the high-speed synchronous generator with integrated permanent magnets

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