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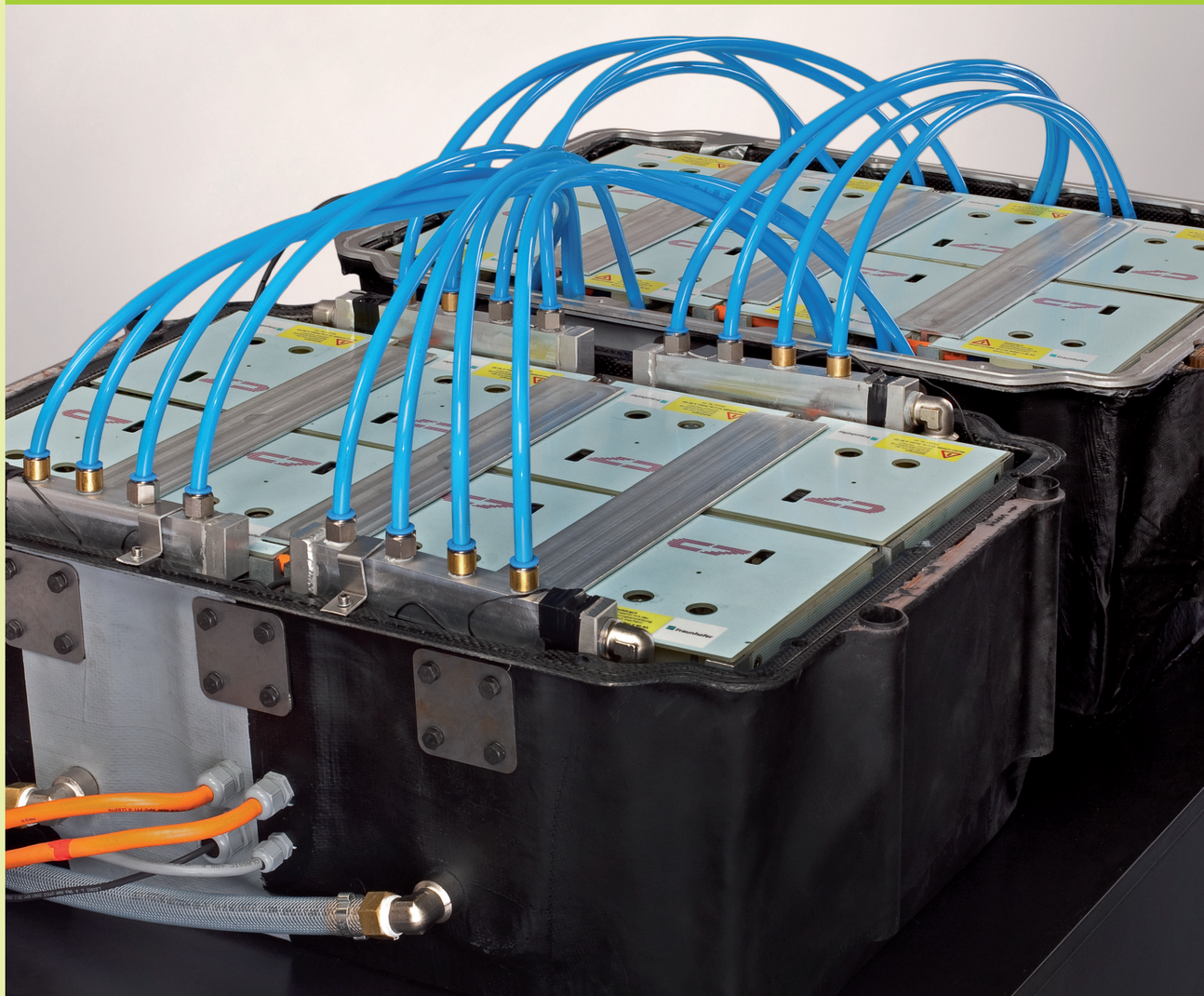
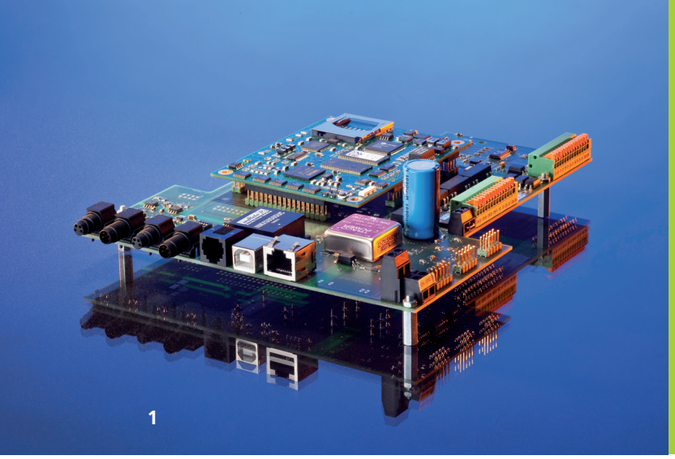
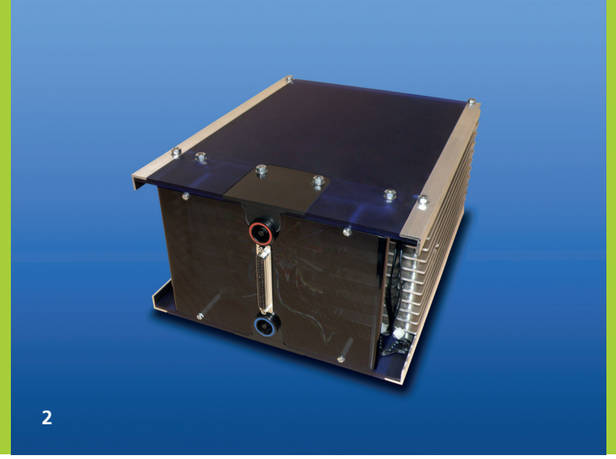
BATTERY SYSTEM TECHNOLOGY R&D SERVICES



Cover picture: battery pack for an electric vehicle.





1 *Energy management system.*
2 *Lithium ion battery module with high energy density for stationary applications.*
3 *Testing equipment for pouch cells.*
4 *Vanadium redox flow stack.*
5 *Lithium ion phosphate battery for hybrid light vehicles.*

Battery System Technology – From Cell to System

For all autonomous power supplies electrical storage is necessary to meet a continuous energy demand. This applies to a wide range of applications: mobile devices such as mobile phones and laptops, stationary technical devices like signaling systems and timetable illumination, autonomous power supply of households e. g. solar homes systems and Alpine huts, renewable power supplies for villages and increasingly for grid-connected applications. Due to their modular concept and high energy efficiency, battery systems play a decisive role in the use of fluctuating renewable energy sources like photovoltaic or wind power.

With the ongoing advances of new technologies, the energy and power density of batteries are increasing. New areas of application are constantly opening up. An example in the automobile industry is the development of the electrification of power trains in cars. A prerequisite for the success of this future vision of sustainable mobility, particularly in this context, is a reliable, safe, efficient and durable storage system.

Depending on the application and its use, the requirements for future battery systems are enormous: they must be safe, be able to work under heavily fluctuating ambient temperatures, achieve high calendar and cycle life times, they should be charged very quickly and, of course, be cost-effective.

The ultimate ambitions of the activities at Fraunhofer ISE are therefore the optimization of the overall system, to achieve higher reliability while simultaneously minimizing the costs of storage systems.

With its combination of expertise, experience, innovative thinking and a state-of-the-art laboratory, Fraunhofer ISE supports the development of competitive products.

R&D Services

Battery Laboratory – Equipment and Testing Procedures

- over 140 test cycles ranging from the smallest coin cell to big battery systems
- freely programmable testers up to 1000 V, 600 A and 250 kW with CAN bus emulation
- 9 climate chambers and different water quenches
- impedance spectroscopy
- test equipment for battery management systems
- capacity measurements and ageing tests
- electrical and thermal characterization

Modeling and Simulation

- battery cells, modules and systems
- analysis of components and systems
- ageing behavior and life time analyses

Battery and Energy Management Systems

- algorithms for intelligent state of charge and state of health determination as well as operation control strategies
- regulation of the energy flows
- error diagnostics and lifetime forecasts

Development of Battery Modules and Systems

- model-based development processes
- build-up and connection techniques
- cooling systems and thermal management
- system integration

Battery Laboratory – Equipment and Testing Procedures

With up-to-date EDP-supported battery testers, Fraunhofer ISE tests cells ranging from the smallest coin cell to complete battery systems for stationary (e. g. solar) and mobile (e. g. electric vehicles) applications in three different laboratory facilities. We have a test facility, which is able to provide voltages up to 1000 V, currents up to 600 A and power up to 250 kW, enabling the simulation of realistic driving cycles, for example. In three laboratory facilities with nine temperature chambers Fraunhofer ISE tests lithium cells and battery packs in an inert secure environment. Classical water quenches are also offered for the testing of lead-acid batteries.

We carry out battery tests according to established standards and codes (e. g. IEC, DIN, PVGAP) as well as freely programmable testing procedures. Ageing tests lasting months and comprising huge numbers of batteries are possible. These tests include calendar and cycle life times, taking into consideration different temperature levels, application purposes and load profiles.

Modeling and Simulation

Fraunhofer ISE develops models from the cell to the whole battery system. According to the accuracy and calculation times required, we are able to reproduce both highly dynamic processes and steady-state operations by employing different modeling approaches. The development of models by Fraunhofer ISE also comprises ageing models for different battery technologies. They are used for technical questions of life times in certain applications and life cycle cost analysis within simulation studies. Currently, we have models for lead-acid batteries, different kinds of lithium ion technologies, redox flow and high temperature batteries frequently being deployed in projects, e. g. for simulation based development.

Battery and Energy Management Systems

The control of devices and facilities requires continuous information about the states of the storage. Even the most modern battery technologies do not provide the user with information about the internal condition of the battery: what is the current state of charge (SOC)? What is the current state of health (SOH)? Does the battery need to be changed? Fraunhofer ISE employs model-based approaches on the state of charge and state of health of the battery in real time and informs the user. We develop intelligent charging and operation control strategies which can be easily implemented in microcontrollers of charge controllers, device controls as well as battery and energy management systems. For example, it is possible to control the cooling system, to diagnose errors, and to control connected chargers.

Development of Battery Modules and Systems

Fraunhofer ISE develops stacks, modules and systems with the necessary safety concepts for different technologies, with its main focus on lead-acid, lithium and redox flow batteries. The modules are adapted to the specific requirements of the cells and the application, thus ensuring the required mechanic stability and reliability regardless of whether they are being cooled by liquid or by air. We construct systems up to the range of MW/MWh. To support such activities, thermal, electrical and electrochemical models from cell to system are developed and deployed. Typical applications are PV off-grid systems, local home storage systems as well as storage devices in electricity grids and electric vehicles.