Karlsruhe Institute of Technology

Division III – Mechanical and Electrical Engineering

Institute of Electrical Engineering (ETI)

Li-ion Large-scale Storage Solution in the Energy Lab 2.0

Energy-efficient System Design with Innovative Cooling

The expansion of renewable energies is an essential component of the energy transition which requires the use of stationary large-scale storage systems. In addition to the investment costs, the low operating costs resulting from the energy-saving system design are an important factor for economic operation. For the latter, the costs of cooling, and efficient operation, i.e. the efficiency of the entire system, are decisive.

Developments at Battery Technical Center

Since 2013, the Battery Technical Center at Karlsruhe Institute of Technology (KIT) has been running several storage systems from 30 kWh to 75 kWh. These storage systems are used for the development of battery storage control systems as well as for implementation and design of various operating strategies. On this basis, a near-series prototype of a lithium-ion storage system was developed and installed at the photovoltaic facility of KIT as part of the Energy Lab 2.0. The thermal component activation of the concrete building as well as the use of the groundwater for temperature control of the batteries allow minimization of the operating and maintenance costs of the system and ensure a long lifespan. The required space for storage systems is reduced by the proportionate sinking of the building into the ground. The acceptance of the building as a storage facility in residential areas is enhanced by the attractive design. The robust building also makes the system suitable for installation under unfavorable weather and adverse environmental conditions. The hardware, if equipped with the appropriate software packages, is suitable for variable applications. This includes the primary operating reserve to compensate volatile-generated (i. e., time-, location- and weather-dependent) electrical energy or industrial applications (compensation of peak loads). The storage system is scalable in its rated power and storage capacity. Therefore, various requirements can be met.

Large-scale storage system at KIT's solar power storage park

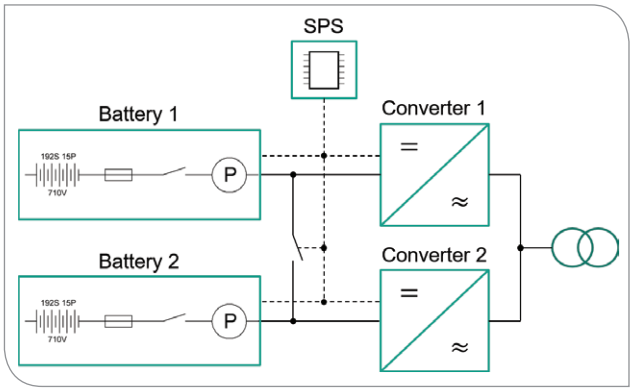
Cooling Concept

The idea of the cooling concept is the indirect water cooling of the battery modules. The battery modules are positioned directly on the tubes of the cooling circuit. The heat loss of the Li-ion cells and the battery management system is transferred directly to the coolant. Boreholes for transferring the heat to the groundwater are part of the cooling circuit. Compared to conventional systems, this system significantly reduces the required energy for cooling the battery storage.

Technical Data and Operating Concept

The storage system supplies 1.5 MWh of energy and consists of 608 battery modules. With a nominal DC voltage of 710 V, up to 800 kW of electrical power can be achieved. The interconnection of two independent battery and converter systems offers important advantages. The storage system continues if a component fails: a special partial-load operating mode increases the service life and overall efficiency.

View into the battery room



Block diagram of the wiring scheme

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