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 system transformation which also necessitates the use of stationary large-scale storage systems. In addition to investment costs, the low operating costs resulting from the energy-saving system design is an important factor for economical operation. For this the costs for cooling and efficient operation, i.e. the efficiency of the whole system, are decisive.

Developments at the Battery Technology Center

The Battery Technology Center at KIT runs several storage systems from 30 kWh to 75 kWh since 2013. Those storage systems are used for the development of control systems for battery storage as well as the 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 building as well as the use of the groundwater for temperature control of the batteries allow the minimization of the operating and maintenance costs of the system and ensure a long life span. The required space for storage systems is reduced by the proportionate sinking of the building into the ground. Its acceptance as a storage facility in residential areas is enhanced by the attractive design. The robust building also makes the system suitable for installation under unfavourable weather and adverse environment conditions. The hardware, if equipped with the appropriate software packages, is suitable for variable applications. These include the primary operating reserve to compensate volatile generated (time-, location- and weather-dependent) electrical energy or industrial applications (compensation of peak loads).

Large-scale storage at the KIT PV storage park

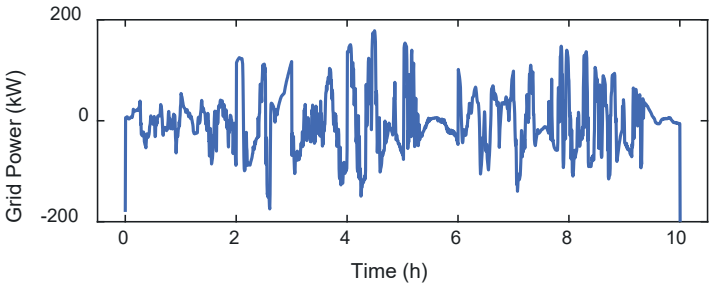
Cooling concept

The idea of cooling concept is the indirect water cooling of the battery modules. The battery modules lie 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 are part of the cooling circuit to transfer the heat to the groundwater. This system significantly reduces the required energy for cooling the battery storage compared to conventionally systems.

View into the battery compartment

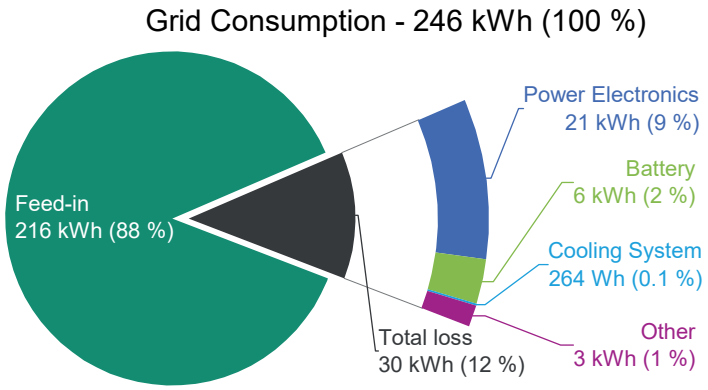
Example from real operation

To evaluate the efficiency of the cooling system and other components, a 10-hour peak-shaving profile was run by the system.



Ten-hour peak shaving profile for evaluating the system efficiency

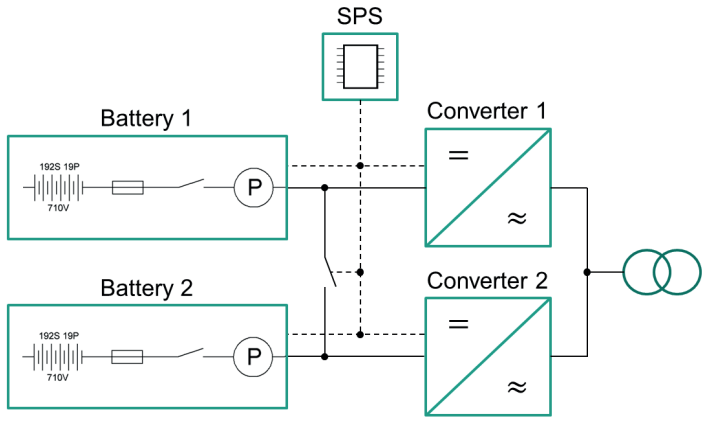
At the beginning and at the end, a state of charge of 50 % is approached in each case in order to calculate the battery losses. In the example presented here, the system achieved an overall efficiency of 88 %, with the cooling system accounting for only 0.1 % of the losses. In other scenarios, efficiencies of > 90 % have already been achieved. The cooling system only requires 120 W on average, even during heat waves in summer.



Losses in categories during the run of the reference profile

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 operating mode in partial load operation increases service life and overall efficiency.



Electrotechnical topology

Karlsruhe Institute of Technology (KIT)
Institute of Electrical Engineering (ETI)

Hermann-von-Helmholtz-Platz 1
76344 Eggenstein-Leopoldshafen, Germany

E-Mail: office@batterietechnikum.kit.edu
Web: www.batterietechnikum.kit.edu

Karlsruhe Institute of Technology (KIT) · President Professor Dr.-Ing. Holger Hanselka · Kaiserstraße 12 · 76131 Karlsruhe