Focus on electric energy storage

Generation, storage and use of electric energy on a sustainable and cost-efficient basis for stationary and mobile applications are among the biggest global challenges for the next decades. In the long run, only those institutions will be successful, which pursue a comprehensive, interdisciplinary approach along the complete value chain. In Project “Competence E”, the competencies of KIT along the value chain are pooled and an open technology platform for future electric energy storage systems is being set-up.

With a so far unique focus on the entire system, Competence E develops industrially applicable, cost-efficient solutions for energy storage of the next generations. Simultaneously to the development and prototypical construction of new kinds of cells and batteries and the integration to an overall system, new manufacturing processes for the cost-efficient production of those components are being developed and demonstrated. The objective is to develop battery systems that feature a gravimetric density of 250 Wh/kg, producible on an industrial scale at the costs of 250€/kWh.

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Solar energy at night and wind energy in calms – this is feasible with the use of energy storage. Thus efficient and economic energy storage technologies contribute to the German “Energiewende” and allow a sustainable energy supply based on renewable energies. Considering the economic use of electric vehicles, such storage technologies also take over a key function. Special challenges lie in the fields of battery development, software development and design of the entire system.

Electric energy storage is a topic that meets with unique prerequisites at KIT.

- KIT is one of the largest energy research centers in Europe.
- KIT has been working on improved battery materials for more than 10 years.
- KIT has modern production technologies for small series production of Li-ion cells up to 20 Ah.
- KIT accepts the challenge of designing holistic solution concepts for energy storage systems.
- KIT advises politics and society in establishing adequate framework conditions for stationary energy storage and e-mobility.

KIT aims at a worldwide leading role in the field of electric energy storage.

KIT research consistently covers the entire energy storage system along with its components:

- Electrochemical battery with battery management system
- Control and regulation units for energy storage systems (storage control)
- Central control of the storage system with combined photovoltaic or wind power system (central control system)

For profitability calculations of stationary storage systems, KIT has a simulation tool for the design of the single components and hence, the total system dimensioning.

Competence E's objectives are in line with the market requirements for modern storage technologies.

- Cost optimization (reduction of target manufacturing and operational costs)
- Efficiency optimization
- Improvement of intrinsic safety
- Increase of calendar life and cycle stability
- Increase of operation tolerance in terms of environmental impacts and operation conditions (e.g. temperature, air humidity)
- Improvement of installation and maintainability
- Increase of reliability

Research for energy storage of tomorrow

Materials development (cathode, anode, electrolyte)

- Low-cost resources and manufacturing processes
- Long durability and high cycle stability
- Low power loss and high peak power stability
- High onset temperature for thermal runaways and intrinsic safety
- Wide operation temperature range
- Energy density above 250 Wh/kg on battery system level

Cell development

- High quality and high performance Lithium-ion pouch cells in lab and large-format size (up to 20 Ah)
- Examination of failure mechanisms with intentional cell failures
- Cell performance tests (electrical cell characterization) and post-mortem analysis (e.g. electron microscopy, X-ray analysis)

Battery system development

- Optimization of assembly and disassembly
- Highly-conductive reversible or irreversible cell connections
- Reliable control of thermal loading
- Optimized BMS algorithms including prognosis software

Overall system integration

- Coupling of stationary energy storage solutions with photovoltaic and wind power systems
- Control of power to grid and isolated operation
- Central compilation of all subsystems data
- Central intelligent control of the overall system
- Development of prototypes and small series

Test and validation infrastructure

- Functional validation of storage systems in modern hardware-in-the-loop test facilities
- More than 100 photovoltaic test plants, different converter types and load simulations available