

## Executive Summary Project Competence E

Efficient electrochemical energy stores are the key component for a large number of future stationary and mobile applications, in particular in the field of fully-electric cars and utility vehicles.

In producing these components the process and manufacturing costs amount to 70% of the manufacturing cost, whereas only the remaining 30% amount to the raw materials.

In order to reach a significant reduction of the manufacturing costs to about a third of today's costs, an entire system development of the battery and the electric drive train as well as the development of reliable and cost-efficient manufacturing processes are an essential prerequisite. Besides the electric motor, the motor control via the inverter and the control/conditioning of the drive train and the battery, the energy storage is of high importance for the costs and efficiency of the entire system in the electric vehicle.

The project "Competence E" targets the implementation of a required systemic development concept relating to the product design and the manufacturing processes. To pursue such a concept in the frame of one research and development project is so far unique in Europe. Therefore, the Karlsruhe Institute of Technology (KIT) bundles all work in the field of electric energy stores and electric drive trains in the project Competence E since 01 January 2011.

The cooperation of 26 institutes in the fields of chemistry, materials research, production and process engineering, electrical engineering, product development, vehicle systems, informatics and technological impact assessment will enable the development of industrially applicable, cost-efficient solutions for storage and driving systems of the next generations. Thereby Competence E pursues an integrated approach from molecule, battery and electromotor with power electronics to the entire working electric power train within the respective application.

Simultaneously to the development and prototypical construction of new kinds of cells, batteries and drive trains, new manufacturing processes for the cost-efficient production of those components are being researched and demonstrated. Competence E focuses thereby on the advancement of high-energy cells; high-performance cells are not part of the project.

The objective of Competence E is to develop battery systems within seven years that feature a **gravimetric density of 250 Wh/kg**, producible on an **industrial scale at the costs of 250€/kWh**.

Within this context an infrastructure, the „System Engineering Center“, is to be constructed in all relevant development, manufacturing and integration processes.

The required machine and plant technology for the validation of the different concept studies is to be developed and built up together with German suppliers along the entire value chain.

In the course of this, new cost-optimized manufacturing and integration processes will especially be developed and tested. The selection of resources for energy stores and electric motors

focuses on the use of low-cost and sustainable resources (e.g. substitution of rare earth materials, cobalt and nickel).

Within the frame of the product and technology development, a continuous correlation of the process and machinery parameters with the semi-finished product features and the product features along the entire value chain will take place. At the same time, the effects of modified semi-finished product and product features on the entire system are analyzed.

The developed product designs and manufacturing processes will be validated prototypically within the scope of the construction of various stationary and mobile systems.

The project Competence E will not only enhance today's state of production technology and product performance significantly, but it also includes the development of completely new kinds of Li-ion cells (material and structure) with the corresponding manufacturing technology.

In doing so a multilevel innovation strategy is pursued:

- Description of the state-of-the-art in all fields (until 2012)
- Significant improvements of the state-of-the-art (from 2012)
- Entirely new developments (from 2014)

The manufacturing infrastructure of the System Engineering Center will be available to all interested industrial users for the advancement of their own products and technologies. Whereas the process engineering will be developed by its users in separate projects, the manufacturing processes and synthesis methods will constantly be developed on the basis of fundamental research.

Thus Competence E pursues a so far unique focusing on the entire system with the emphases:

- Construction of manufacturing and pilot assembly lines in the System Engineering Center
- Complete integration along the value chain
- Complete integration of the process engineering development with the development of the entire system

The concept of Competence E is not that of a typical project cluster, whose results can primarily be used by its members. On the contrary, different kinds of cooperation are to be set up being open for all interested companies and research institutions located in Germany.

By this, the products and technologies created in the frame of the project shall be comprehensively available to all potential users (established and new market players from different levels of the value chain).

The economic utilization strategy aims to transfer all results along the value chain to the German economy as soon as possible.

Therefore, different instruments will be used:

- **Access to manufacturing plants:**

The manufacturing plants include state-of-the-art technology for material conditioning, the production of Li-ion cells, electric motors and the required power electronics. Furthermore KIT's institutes of production research are continually improving the plants and validate the additional value on the basis of appropriate reference material. As a publicly funded institution, KIT will allow interested companies and research institutions access to this infrastructure on condition of respective confidentiality agreements.

- **Development on demand using background IP:**

Both KIT's already existing IP and the IP added by the project are available to all companies along the value chain as it can be used in the execution of customized research orders. In this case, KIT charges the companies operating in Germany only the additional costs for the customized advancement.

- **Licensing**

Licensable results (expertise and patents) are actively offered to interested companies. This approach has already proved successful in the commercialization of former results from Competence E.

- **Spin-Offs/Joint Ventures**

Next to the above mentioned utilization strategies it is intended to expedite the economic utilization of the products and technologies by spin-offs and/or joint ventures with established market players. Concerning these utilization concepts KIT has a longstanding and highly successful history and can therefore give many successful examples (ten spin-offs and joint ventures within the last three years).

Next to scientific and industrial interests that are focus of the proposal of Competence E, the extra-occupational training of the project partners in terms of a life-long learning approach represents an important additional value to the economy.

Therefore Competence E seeks cooperation with the HECTOR School of Engineering and Management, a KIT business school, to train engineers particularly in the field of electro mobility. A master program, industrial internships as well as extra-occupational language courses shall be offered to about 50 new potential professionals per year.

The scheduled project volume of Competence E for 7 years amounts to 180-200 million €.

These funds are to be used for the construction of the infrastructure as well as the implementation of integrated development projects. After the construction of the infrastructure, the implementing of the System Engineering Center and the successful completion of the sub-projects, a continuation of the established structures is intended.