



**ENERGY**

# SOFC SYSTEM DEVELOPMENT AND FIELD TESTS FOR COMMERCIAL APPLICATIONS

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In addition to their use in residential buildings and micro-CHP applications, SOFC systems are especially suited for various industrial tasks and off-grid power supplies. In this context, the usability of different conventional fuels in SOFC systems, such as natural gas, LPG, biogas, ethanol, diesel and kerosene, provides crucial technological advantages for the development of application-specific and marketable power generators. At Fraunhofer IKTS, appropriate processes and methods for the development of customized, application-specific SOFC concepts and prototype systems were established within the framework of various past projects, funded by public bodies and industrial customers. During the implementation of these projects, professionals from different IKTS working groups are working together in interdisciplinary project teams.

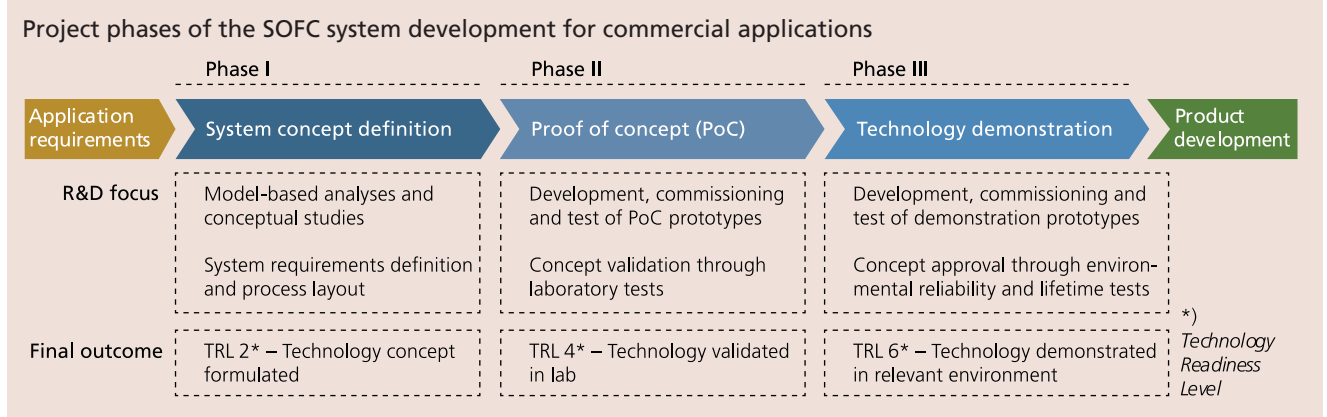
**Stack technology for the development of SOFC systems**

As an outcome of the cell and stack developments in the past years, two SOFC technology platforms for system integration are readily available at IKTS. The eneramic® technology can be utilized for SOFC devices in the power range between 50 and 300 W<sub>el</sub>. CFY stacks are available in standard sizes between 10 and 40 cells with a power output between 300 W<sub>el</sub> and

1.2 kW<sub>el</sub>. Higher power levels can be achieved by integrating multiple stacks in joint HotBox modules. The SOFC stacks, manufactured at IKTS, are based on electrolyte-supported cells (ESC), which are characterized by their durability and cyclization stability. The stack operation was demonstrated in various tests over more than 20,000 hours and 60 start/stop cycles, showing a power degradation rate below 1 % per 1000 hours and 1 % per 10 cycles, respectively. If required, SOFC stacks of external suppliers can be used for system development projects, as well.

**SOFC system development and prototype demonstration**

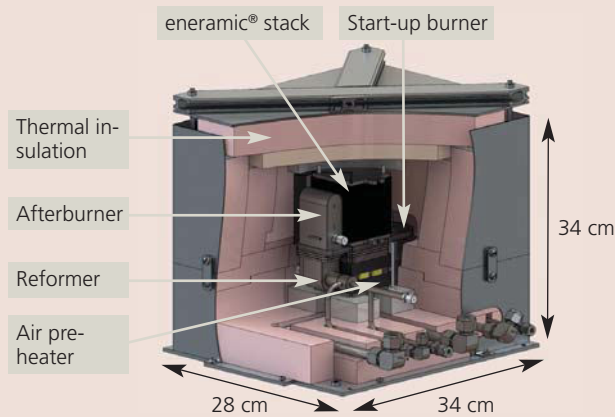
For the development of SOFC systems, a detailed plant specification and process design is prepared initially. Here, all application-specific requirements are considered and a system concept with special consideration of the proposed operating modes and fuel processing technology is derived. Afterwards, the proposed concept is validated by means of laboratory tests on component, HotBox and systems level. Further design iterations and model-based analyses are used for the creation of optimized solutions to be implemented in prototype and demonstration systems. During the complete system engineering



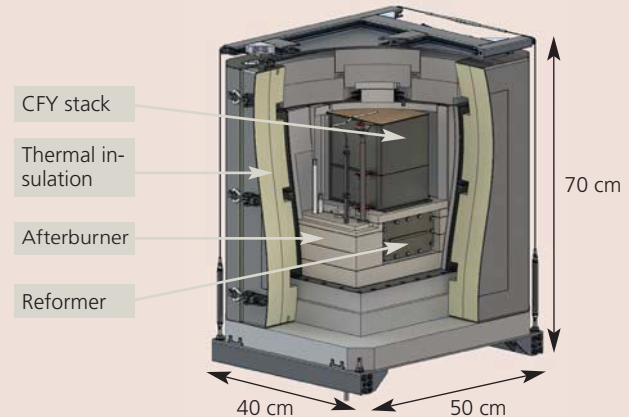


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Cross-sectional model of the HotBox used in a portable 100 W<sub>el</sub> SOFC power generator



Cross-sectional model of the stack module used in a stationary 1 kW<sub>el</sub> SOFC micro-CHP system



process, the project partners, customers or users are directly involved. The transfer of knowledge and technology for a subsequent product development and commercialization might be included in the project, if desired.

**Current development projects**

With financial support by the Fraunhofer Future Foundation, the LPG-fueled eneramic® system was developed for off-grid power supplies. The system is designed for industrial applications with small power consumption and very long lifetime. The latest prototype generation is currently demonstrated in field tests with traffic control systems and cathodic corrosion protection devices. For further development and commercialization of the eneramic® technology, the foundation of a spin-off company is prepared at present.

Contracted by the Indian company h2e Power Systems Pvt. Ltd., a stationary SOFC/battery-hybrid system for distributed power generation and micro-CHP has been developed since mid-2013. The h2e® system is intended for continuous power supplies in residential and commercial buildings in India. In addition to that, off-grid applications in rural areas are considered, e.g. for powering telecom towers or irrigation systems. The project includes a complete technology transfer for the later product development and local manufacturing in sole responsibility of the customer. During the first project phase, two proof-of-concept prototype systems were assembled and

commissioned by the end of 2014. The following prototype generation to be developed within a one-year time frame will be used for on-site demonstration projects and field tests in India.

**Services offered**

- Development of application-specific system concepts, based on the SOFC stack technology of IKTS or external suppliers
- Model-based system analyses and techno-economic assessment of power generator concepts
- Assembly and commissioning of pilot plants and prototype systems for concept validation and device engineering
- Pilot manufacturing of SOFC system components, modules and prototype units
- Implementation of test campaigns, demonstration projects, field tests and type examination for certification purposes

- 1 h2e® prototype system.
- 2 CFY stack.
- 3 eneramic® field test with cathodic corrosion protection devices.
- 4 eneramic® field test with remote traffic control system.