AST Gruppe
Angewandte System Technik

SOFC Demonstration Units

EBZ

SOFC SYSTEM RESEARCH & DEMONSTRATION

Fuel cells are expected to become a key technology of future decentralised energy supply. The EBZ Demonstration Units provide a flexible platform for a large variety of research and application targets. Due to our consistent modular design and the in-house developed system components, numerous parameters can be adapted to customers specification.
EBZs SOFC Demonstration Units are applied to residential µCHP, large-scale CHP for industry or stand-alone power generators for stationary and mobile applications. The units can be operated with different fuels and fuel processing technologies. EBZ offers the possibility to integrate the customers stack or module into the system. The EBZ Research & Demonstration system is a fully functional SOFC demonstration system based on natural gas. The fuel reforming can be realised with steam reforming, ATR- or CPOx.

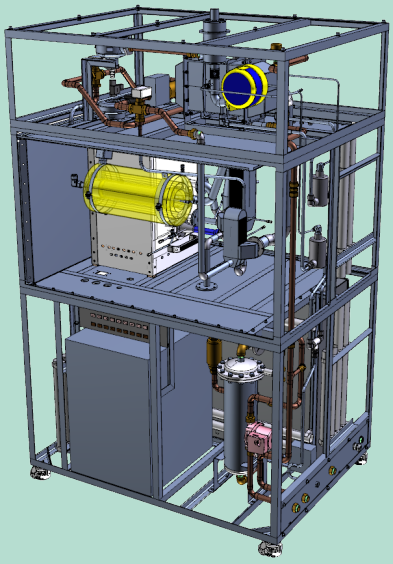
FOR SOFC STACK MANUFACTURERS

- Demonstrate the capabilities of your stack in a real system environment with generation of electricity and heat
- Investigate the stack and system behaviour under long-term steady state conditions or load-cycles and start / stop operation
- Benefit from EBZs experiences of integration and operation of SOFC stacks and hotbox modules from different European suppliers
- We design the system according to your needs: as full self-sustained module or with a high flexibility in testing your stack performance

2,8 kW_{el} SOFC Demonstrator

FOR FUEL CELL SYSTEM RESEARCH

- Demonstrate the SOFC excellence of highest electrical efficiencies
- Investigate and optimise control strategies
- Couple a SOFC system with auxiliary boilers, sorption cooling systems, steam generators, ...
- Show the suitability of the SOFC to work with different hydrocarbon fuels and fuel processing technologies



1,5 kW_{el} SOFC µCHP System

Fuel Cells

MAIN SYSTEM COMPONENTS

- Reforming unit
- Heat exchangers (air preheater, gas preheater)
- Start-up and afterburner
- Evaporator for steam and autothermal reforming
- Exhaust gas cooler
- Electronic load or inverter
- Blowers
- Water pump
- Shut-off and flow control valves

FUELS AND FUEL PROCESSING

- Hydrogen, natural gas, LPG, biogas, ethanol, methanol, synthetic gas mixtures, …
- Steam reforming (SR), autothermal reforming (ATR) or catalytic partial oxidation (CPOX)
- Desulphurisation in liquid or gaseous phase

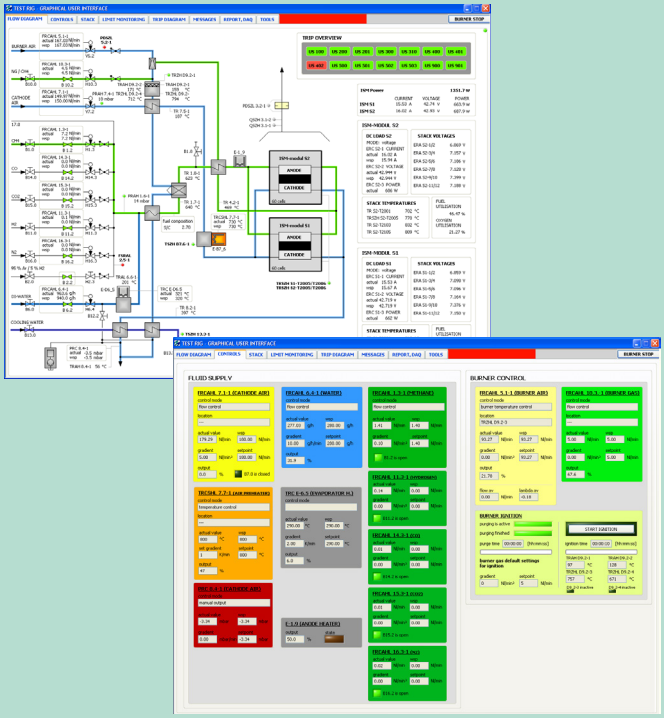
CONTROL AND SAFETY SYSTEM

- Operation in a manual or semi-automated mode to provide full access to all operational states

→ **Programmable process control: EBZ ProControl**

- Remote control system access
- Modular measurement and control (ICA) system
- Extended set of sensor equipment
- Safeguarding of temperatures, pressures, and flow rates
- Multi-stage safety management system
- Independent Safety PLC according to EN 954-1
- system ventilation with safeguard, sensors for toxic and burnable gases

SOFC DEMONSTRATION UNITS	
Electrical power	500 W … 20 kW
Electrical efficiency (with steam reforming)	Up to 45 % based on lower heating value; depending on stack performance
Fuel supply	Natural gas, LPG, biogas, methanol, ethanol, synthetic gas mixtures
Air supply	Blower
Dimensions (H×W×D)	2000 × 1000 × 1000 mm^3 (< 5 kWel systems)



display of actual process values as flow scheme

FIRST MARKET APPLICATIONS

EBZs Demonstration Units can form a development platform to explore first niche markets for fuel cell applications. We offer you our support to evaluate your product ideas and design a suitable system for your requirements.

Application Examples of Fuel Cell Based µCHP Systems

SOFC TECHNOLOGY FOR COMBINED HEAT & POWER

Small-scale combined heat and power µCHP systems provide reductions in CO_2 emissions and costs by generating heat and electricity locally with efficient fuel use and by decreasing the electricity grid load and capacity demands.

The major benefits of decentralised power generation are heat usage, low electricity transmission losses, lower installation costs and ability to cover peak load conditions locally with small scale units. SOFC technology has the potential of very high electrical efficiencies and lowest costs compared to alternative fuel cell types. The high efficiencies of the SOFC based µCHPs will lead to direct reduction of fuel consumption.

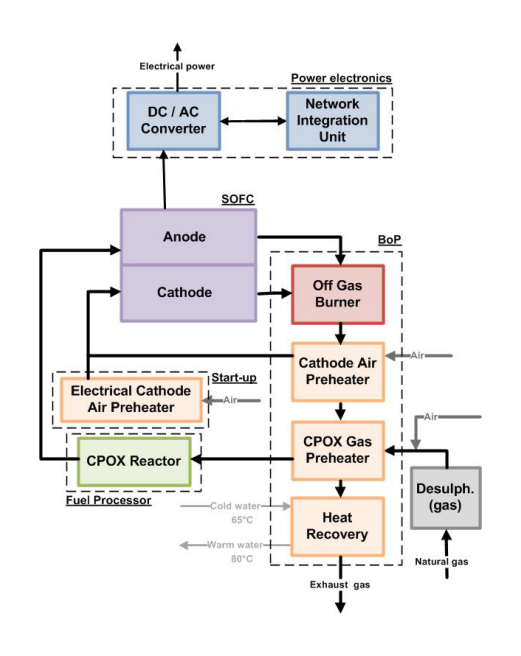
SYSTEM CHARACTERISTICS

The system will operate with natural gas that is processed via catalytic partial oxidation (CPOx) to a hydrogen-rich gas. The advantage of a CPOx based system is the simple layout with lowest initial and operational costs.

The SOFC based µCHP units are designed to deliver up to 2 kW electrical power and 6 - 8 kW thermal power. The electrical efficiency of up to 35 % and an overall efficiency of 90% allowing trigenerative use (power/heating/cooling) at building level, inter-connection with a district heat distribution system and the connection to an electrical micro-grid.

The system was developed in the framework of the FP7 project FC-DISTRICT. Main partners were the Energy research Centre of the Netherlands, TU Bergakademie Freiberg in Germany, Fagor Electrodomesticos and IKERLAN from Spain as well as the SOFC system integrator EBZ from Germany.

SPECIFICATION OF SOFC BASED µCHP SYSTEM	
General	Gas appliance for single-family houses and district heating environments for providing demand-flexible electricity and heat
Fuel input	Natural gas (H-gas and L-gas), biogas
Nominal power	1.5 kW_{el} / 2.75 kW_{th} at 30% net electrical efficiency
Modulation	1:2
Emissions	NO_x < 60 mg/kWh, CO < 50 mg/kWh at 0% O_2 (Blue Angel)
Dimensions	H × W × D: 1800 × 800 × 1000 mm^3



system layout

SUMMARY & OBJECTIVES

FC-DISTRICT targets at an innovative energy production and distribution concept for sustainable and energy efficient districts, exploiting decentralized co-generation. The concept is based on dynamic heat exchange between the buildings equipped with Solid Oxide Fuel Cell based µCHP units for energy production collaborating with improved thermal storage and insulation building systems, the distribution system for electricity as well as heat and the consumer, aiming to achieve energy balance at district level.

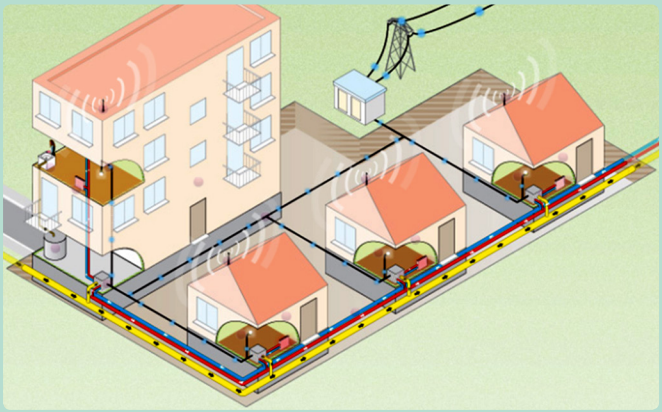
The project team has investigated innovative co-generation concepts, where fuel flexibility is one main objective. Small-scale biogas production and utilization in a fuel cell is used to reach a CO_2 neutral power and heat production at district level.

µCHP BASED ON HIGH TEMPERATURE FUEL CELLS

Distributed generation systems offer a considerable CO_2 saving capability, where the SOFC technology is most promising due to its high electrical efficiency. A coupling of smaller-scale units in a local network coupled with central heat storage capabilities is expected to be the most economic energy distribution system.

DISTRICT WIDE DISTRIBUTION NETWORKS

Electrical integration at district level can be met using the Virtual Power Plant (VPP), a collection of smaller electricity generating units able to replace a conventional power plant in terms of power output. The concept of thermal integration at district level with a dynamic load exchange between neighboring buildings and/or with a central hub is an extension of the VPP concept. This totally innovative approach was investigated in the framework of the project "FC-DISTRICT".



FC-DISTRICT integration concept

PROJECT PARTNERS	
Large industrial	Mostostal (PL) – project coordinator, Acciona (ES), Knauf (DE/GR), Fagor (ES), Powerpipe (SE), D'Appolonia (IT)
Technological specialized SMEs	EBZ (DE), Rinicom (UK), Solintel (ES), Ecofast (IT)
Research organisations	NTUA (GR) – scientific coordinator, IEN (PL), ECN (NL), TU-BAF (DE), IKERLAN (ES), OvM (RO), SP (SE), Vito (BE), Chalmers (SE), IST (PT)
Financial sector	IntesaSanpaolo
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