Galileo – decentralised energy and heat supply with fuel cells

Decentralised energy supply with fuel cells

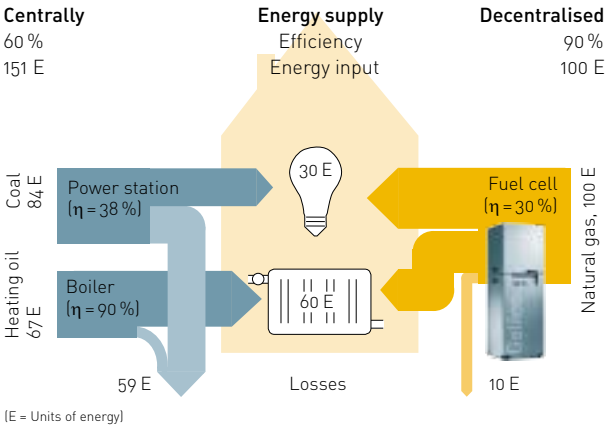
Decentralised power and heat generation

With the «Galileo 1000 N», Hexis is developing a fuel cell system which is to supersede the conventional gas boiler system in the single-family household. Compact, low emission and practically silent, it transforms natural gas directly into power and heat according to the tenants.

Efficient and environmentally friendly

Fossil fuel deposits are finite. In order to conserve resources and the environment, energy must be used even more efficiently in future. Relevant laws and innovative measures support research and development in this domain. One of the preferred technology options is heat and power supply using fuel cells.

With the combined heat and power (CHP) using fuel cells, power and heat are generated simultaneously – at the location where they are consumed, such as in a one-family house. This is how fossil fuel resources such as natural gas undergoes high-efficiency conversion. Where the supply of power (power station) and heat (boiler) is separate, overall efficiency amounts to approximately 60%. With decentralised combined heat and power using fuel cells, efficiency increases to approximately 90%.



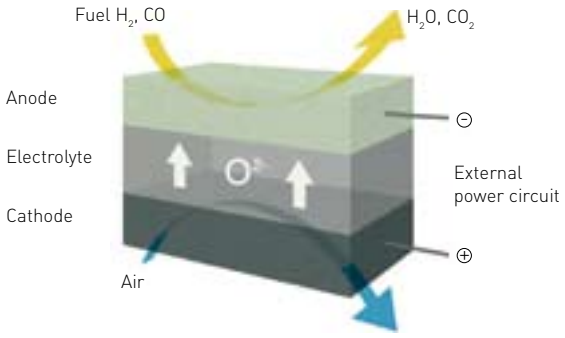
(E = Units of energy)

The Hexis fuel cell

Fuel cells differ according to the types of electrolyte and to the operating temperature. Hexis works with SOFC type (Solid Oxide Fuel Cells) high-temperature fuel cells. The electrolyte is ceramic and operates at temperatures of 800-950 °C.

The electrochemical process

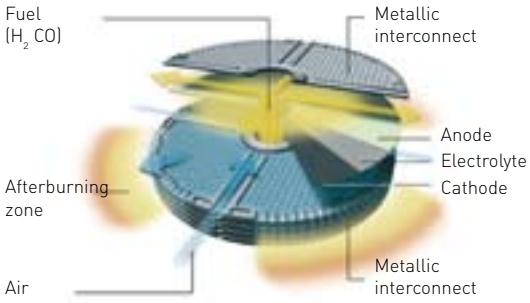
The reformed gas mixture of hydrogen and carbon monoxide oxidises at the anode. Water vapour and carbon monoxide are formed. This reaction liberates electrons which are led through an electrical conductor outside the fuel cell to the cathode. At the cathode, a part of the oxygen from the air is reduced with the liberated electrons, forming oxygen ions. These are conveyed through the electrolytes capable of conducting the ions. The electrons conducted from the anode to the cathode are used as electric current.



Principle of the Hexis SOFC

The solid oxide of the Hexis fuel cell module consists of a cell (ceramic electrolyte-/electrode unit) and the metallic interconnect (MIC). Both are of planar design, with a round aperture in the centre. The sixty or so layered cells and MIC form the cell stack, with the inner aperture serving

as a channel for the supply of fuel. The MIC has a number of functions. Its main task is to ensure electrical contact between the individual cells. In addition, it distributes the gases on the surface of the electrodes, seals the gas current against the air current and enables re-combustion at the stack circumference. Fuel flows outwards in a radial manner from inside the channel on the anode side of the cell. At the same time, preheated air flows from outside through four channels onto the MIC inside the cell stack, is diverted there and flows outwards in a radial manner over the cathode side of the cell. Fuel that has not been converted at the anode will be afterburned at the edge of the cell stack:



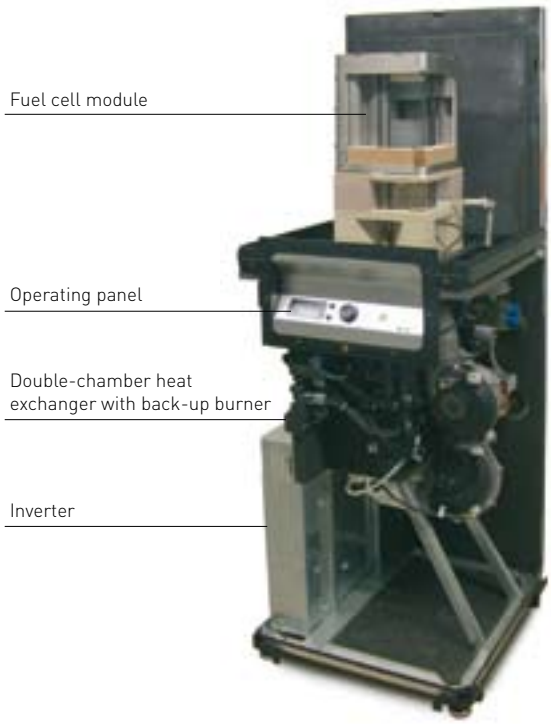
Fuel cell heating system

The «Galileo 1000 N» is being developed in order to meet the basic demand for power and the entire demand for heat of a single-family house. The fuel cell delivers approximately 1 kW and thermal power of approximately 2 kW.

If demand for heat in the building exceeds this value, an integrated gas burner provides an extra 4 - 20 kW of heat. The Hexis system is comparable with a modern gas condensing boiler. However, it also generates electric power over and above this.

System structure

The «Galileo 1000 N» essentially comprises two sections. In the upper section is the fuel cell module. The lower section contains the components for power conversion, heat coupling and supply of additional heat. In the double-chamber heat exchanger, the back-up burner with fan and gas-air ratio control is integrated as well as the heat-circuit pump. Via a heating-water circuit, the heat generated by the fuel cell and the back-up burner can be utilised to heat rooms and to provide hot water. An inherent safeguard against gas leaks is provided, as the fuel cell works at subatmospheric pressure. An inverter serves to convert the direct current to 230V alternating current.



All Hexis systems are inspected in accordance with standards and directives in force and are CE-certified for series production.

The «Galileo 1000 N» fuel cell heating system

- supersedes the gas heating boiler of a single-family household and in addition generates power according to the demand;
- works efficiently with low emissions and almost silently;
- uses the surplus heat of the fuel cell for space heat and hot water;
- is compact and light, as components have been consolidated and simplified;
- is easy to service and is capable of series production, as standard components of the heating appliance sector are used, and
- combines high-tech with user friendliness.

The «Galileo 1000 N» is still at the design stage. The focus of current work is on improving the fuel-cell stack in terms of efficiency and lifetime.

«Galileo 1000 N» – technical specifications

Design specifications

Electrical power of fuel cell:	1 kW
Thermal power of fuel cell:	2 kW
Thermal power of back-up burner:	4 - 20 kW
Electrical efficiency FC:	30% (goal: > 35%)
Overall efficiency:	90 - 105%
Type of fuel cell:	Hexis SOFC

Connection data

Fuel:	Natural gas, mains pressure
Electrical connection:	230V AC, 50 Hz

Dimensions/Weight

Width x Depth x Height:	55 x 55 x 160 cm
Space required:	3.0 m^2
Overall installed weight:	170 kg
Minimum room height:	2 .05 m

From laboratory to practice

In the laboratory, material tests and system trials are carried out. Field tests serve to verify laboratory results in a real-life setting. With the support of Hexis staff, the appliances are installed and run in items manufactured by partners. Not only are the fuel cells themselves tested but also the behaviour of the entire system as part of energy supply to a building. One important parameter for the success of the fuel cell is its life time. Extensive field tests are necessary to establish statistical proof of life time. The «Galileo 1000 N» is tested mainly in collaboration with development partners from the energy-supply sector.

Company

Hexis designs and produces fuel-cell heating systems for single-family houses and small blocks of flats. The company has many years' experience in high-temperature fuel cell technology (SOFC). What's more, the findings from field tests are passed on to ongoing development – with over 100 appliances of the forerunner model and others with the «Galileo 1000 N».

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