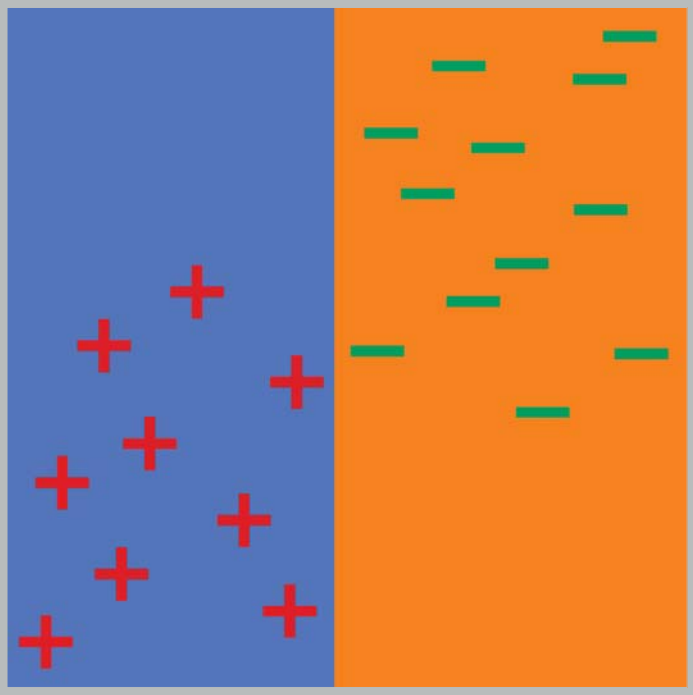
Domestic fuel cell energy centre

VIESMANN



The fuel cell: Innovative technology for generating power and heat

The Viessmann fuel cell R&D project

Fossil fuels are finite

There are two prime motivators behind the search for ever more efficient processes in the generation of thermal energy, DHW and electric power. The first is the fact that fossil fuels, such as oil and gas, are finite, and the second is that the environment must be protected against further damage. So, world-wide efforts are being directed at the development and introduction to the market of fuel cells, which are now recognised as the way forward for the rational and clean generation of power and thermal energy.

Fuel cell prospects

Generally, fuel cells are suitable for deployment in stationary systems providing a decentralised energy supply (electric power plus heat), as well as in mobile applications, even, for instance, to power a laptop or camcorder. Its principal function, i.e. the controlled electro-chemical reaction of hydrogen and oxygen, enables the generation of power and heat from hydrogen, without emissions. However, hydrogen, as free agent, does not occur naturally and economic production of sufficient quantities from renewable energy sources is an unlikely prospect for the foreseeable future.

Until then hydrogen must be produced in a prior process (reformer), where natural gas is mainly used as primary energy transfer medium.

Fuel cells promise a high level of electrical efficiency at full and partial loads, and therefore a favourable ratio between power and heat generation. In addition, its modular design enables the system to be perfectly matched to the demand figures of the relevant building. Fuel cells comprise very few moving components; consequently noise emissions and maintenance effort are kept to a minimum.

Production-ready by 2010

The manifold of benefits offered by these systems cannot overcome the fact that this technology is still in its infancy. Fuel cell technology is, as yet, quite some way off before they can compete with other, environmentally responsible and affordable heating technologies, such as condensing boilers. Fuel cells can only become an attractive alternative when investment outlay is reduced to below 1500 € per kW_{el}.

One must assume that fuel cell heating equipment with a small output is unlikely to replace conventional heating technology or existing power supply systems, in the short term. However, over time, it its likely to supplement conventional technologies.

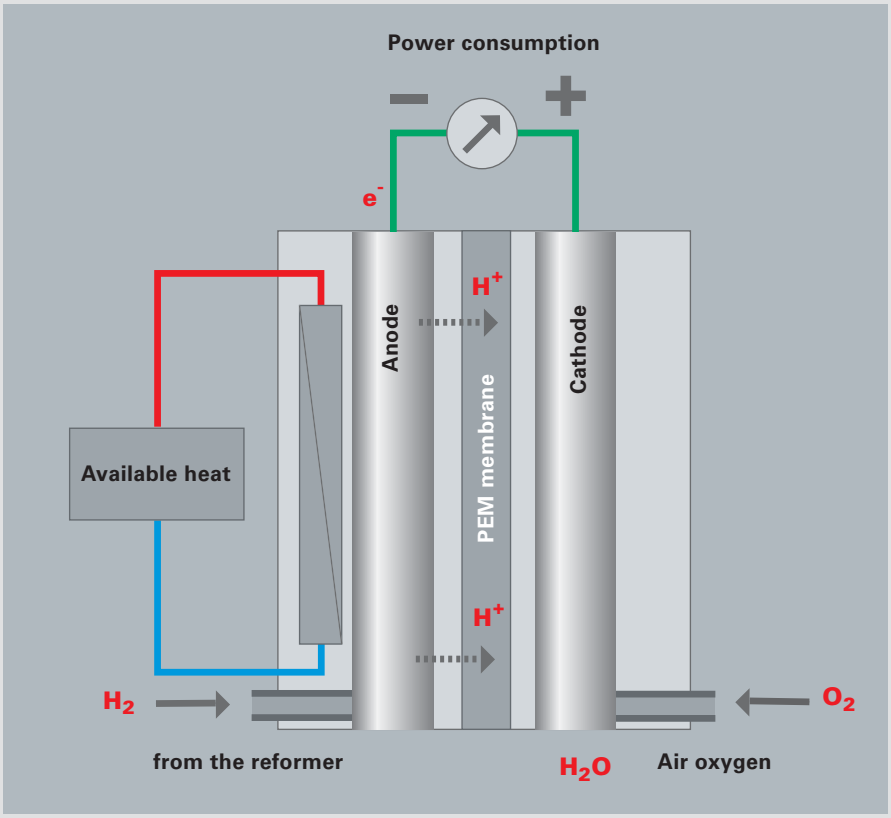
The fuel cell principle

Electro-chemical cells

Like batteries or accumulators, fuel cells are "electro-chemical cells", each has a positive (anode) and a negative (cathode) pole. Power flows between both poles and chemical reaction generates electrical energy inside the cell. For continuous transfer of electrical power and reaction heat, the chemical reaction must be maintained with a constant supply of hydrogen and oxygen.

Water electrolysis

What chemical reaction occurs inside the fuel cell?
In principle, it is the oxyhydrogen gas reaction well-known from chemistry lessons, with one important difference: The reaction inside the fuel cell is controlled and "cold", i.e. there is neither detonation nor flame. On the anode side, a catalyst splits positively charged hydrogen protons (H^+) and negative electrons (e^-). Each hydrogen atom releases an electron, which migrates through a conductor to the cathode: In other words, a current flows. Meanwhile, the hydrogen ion diffuses through the separating electrolyte and combines with oxygen in the air on the cathode side to form pure water.



Processes inside the fuel cell

This basic pattern is common for all fuel cell types. Its most significant variation is the electrolyte separating both gases inside the cell and simultaneously enabling the ion exchange. Fuel cells are identified according to electrolyte type and character.

The PEM fuel cell

The domestic fuel cell energy centre from Viessmann contains a PEM fuel cell (Polymer Electrolyte Membrane). This type of cell is suitable for stationary and mobile applications. The high power density of the PEM fuel cell enables a compact design to be achieved allowing a reduction in volume and weight, compared with alternatives. The PEM fuel cell is operated with hydrogen and air, where the hydrogen is derived from natural gas in a process upstream of the cell (reformer). As in a gas fired boiler – fuel cell heating equipment requires a gas supply pipe, a combustion ventilation and a flue pipe.

PEM cells reach a constant operating temperature of approx. 90 °C in only a few minutes and the generated heat can be utilised for central heating and DHW, via a heat exchanger.

The domestic fuel cell energy centre from Viessmann

Component overview

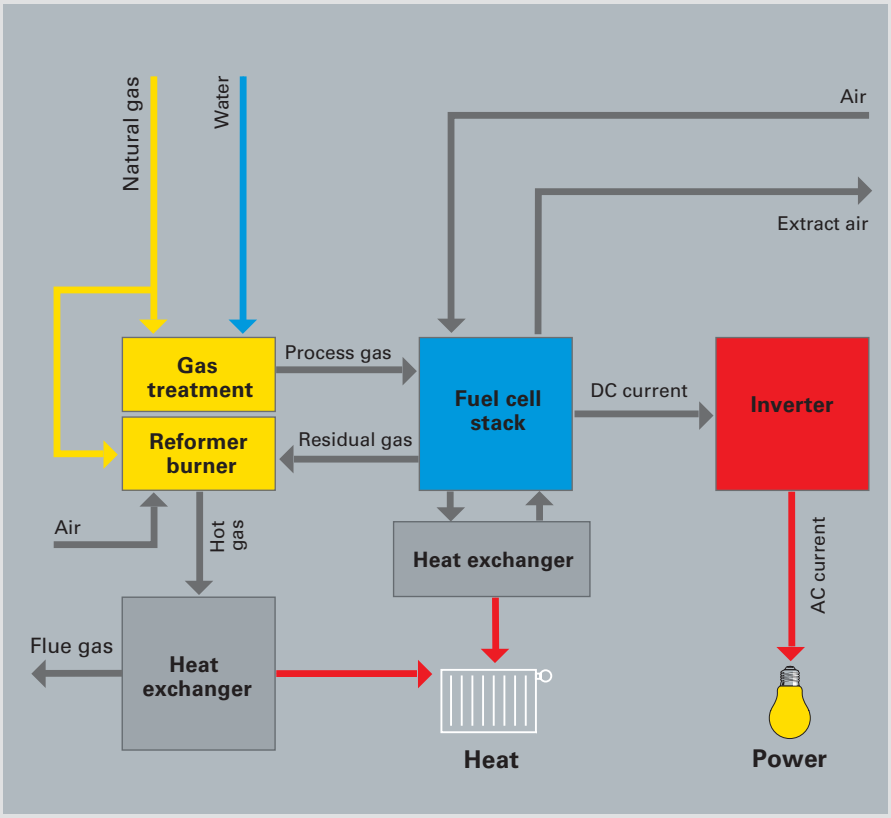
The Viessmann fuel cell, as decentralised energy supply system using natural gas as primary fuel, comprises: Gas treatment, fuel cell stack, inverter as the electrical component and a heat exchanger. In addition, it requires a fuel, heat and power management system as a control unit.

Gas treatment

Initially, a mixture of natural gas and water vapour enters the energy centre's gas treatment plant, where the natural gas is converted into hydrogen-rich process gas, with the necessary energy supplied by the reformer burner. There, the flue gas energy is used as a preheating medium via a heat exchanger. A second heat exchanger transfers any residual energy from the hot gas to the heating circuit.

Fuel cell stack

A catalyst scrubs the process gas, which is then supplied to the anode side of the stack; outside air is supplied to the cathode side of the stack. The reaction process described above creates thermal energy and DC power inside the fuel cell.



Simplified system diagram

Heating circuit

The energy released is transferred to the cooling system of the fuel cell stack and, via the stack, to the heating circuit. Any process gas not converted inside the fuel cell returns as residual gas into the reformer burner where it is burned with the air supplied. Cathode flue gas is also formed inside the stack and this is extracted as humid air.

Inverter

The inverter transforms the generated DC power into AC power (230 V / 50 Hz).

The compact domestic fuel cell energy centre from Viessmann

Fuel cells for domestic energy supply

The Viessmann research project

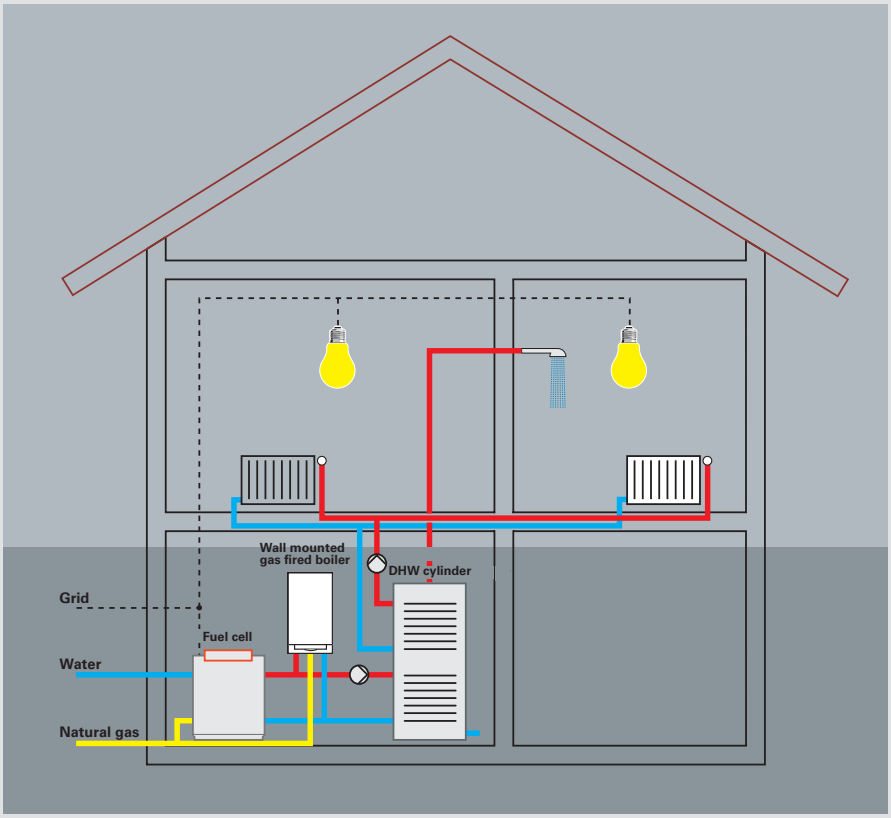
In July 2000, Viessmann, backed by the BMWA, and in conjunction with SolviCore, Gore, Freudenberg, Schunk Süd-Chemie, ZSW and Dortmund University, began work on developing a domestic fuel cell energy centre as part of a research and development project (research reference: 0327089A, 0326875A and 0327751A). The resultant energy centre, made by Viessmann, has an electrical rating of 2 kW and a thermal output of 3.5 kW.

Our intention is to bring the energy centre to its first field trials during 2007, and the first systems are scheduled to be available in small numbers, for demonstration purposes, during 2008.

Fuel cells for domestic energy supply

Fuel cells simultaneously generate electrical power and heat in your own home. The benefits are obvious: Energy is generated where it is required. This cuts down transmission losses, which are common in large-scale power distribution networks. Any surplus power not required by your household can be fed into the mains – for some remuneration, naturally.

The system is modulated over a wide range so that the fuel cell is used as efficiently as possible. Excess heat can be stored in a DHW cylinder and an additional condensing boiler can be deployed to cover peak heat demands.



Hydraulic integration of a domestic fuel cell energy centre

Contributing to environmental protection

Low emissions will enable fuel cells to make an important contribution to environmental and climate protection. Domestic fuel cell energy centres will produce approximately 20 to 25 % less carbon dioxide than current, state of the art, systems.

Utilising the current infrastructure

Domestic fuel cell energy centres can be connected to the existing natural gas and domestic heating pipework, as would a conventional central heating system. So this new technology can be worked into existing infrastructures, giving it an excellent introduction into the market.

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For three generations, the Viessmann family business has been committed to generating heat conveniently, economically, with environmental responsibility and in accordance with the prevailing demand. With a number of outstanding product developments and problem-solving solutions, Viessmann has created many milestones which have frequently made them the technical pacemaker and trendsetter for their entire industry.

With the current comprehensive range, Viessmann offers its customers a stepped range of products with output from 1.5 kW to 20 000 kW: Freestanding and wall mounted boilers for oil and gas, either employing conventional or condensing technology, plus systems using renewable energy, such as heat pumps, solar heating systems and boilers for sustainable fuel supplies. The product range further includes control technology and data communication components, as well as the entire system periphery, including radiators and underfloor heating systems.

Viessmann's orientation is decidedly international – it maintains 11 factories in Germany, Austria, France, Canada, Poland and China, sales organisations in Germany and 35 other countries plus 112 sales offices around the world.

Responsibility for the environment and society at large, fairness in dealing with business partners and employees as well as striving for perfection and the highest efficiency in all business processes are core values for Viessmann. This applies to every individual employee and therefore to the whole company. It offers its customers, with the multitude of its products and associated services, the particular benefit and added value of a strong brand.

Our comprehensive product range sets new standards

E

Energy sources:
Oil, gas, solar, wood and environmental heat

kW

Output range:
From 1.5 to 20 000 kW

1·2·3

Program steps:
100: Plus
200: Comfort
300: Excellence

SYS

System solutions:
Perfectly matching products

Viessmann Group

VIESMANN climate of innovation

weso Das Plus beim Guss

SATAG Wärme aus der Natur

MAWERA ...aus Holz wird Energie

Subject to technical modifications
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