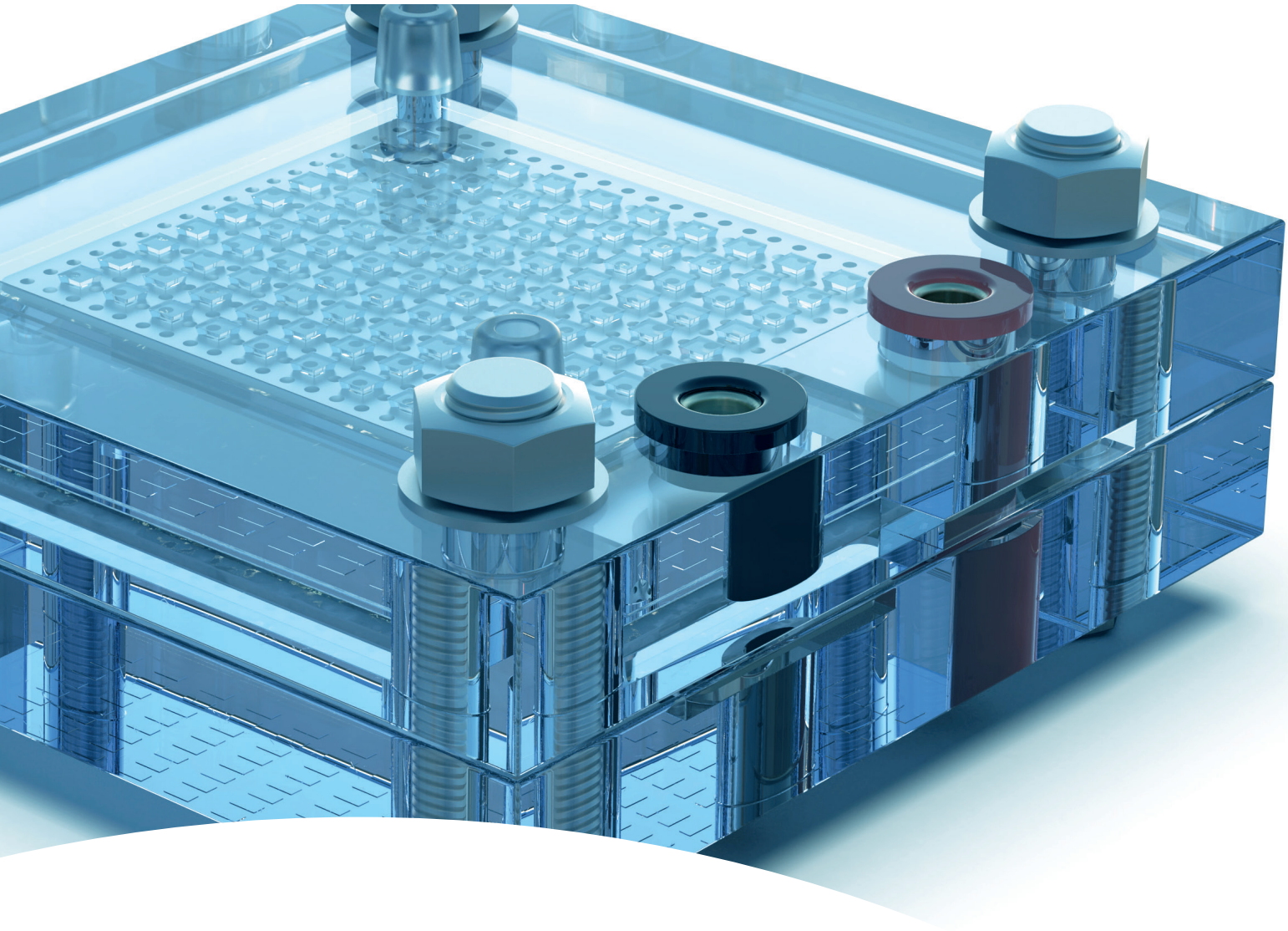
Usage/application:

Fuel cell systems



TÜV®

TÜV NORD GROUP

H_2 competence @ TÜV NORD

1. Energy generation

Wind energy ■ ■ ■

2. H_2 generation

Electrolysis ■ ■ ■

Seawater desalination plants ■ ■ ■

3. Distribution/transport

Electrical grid ■ ■ ■

Pipelines ■ ■ ■

District heating ■ ■ ■

Intelligent networks ■ ■ ■

Pipelines ■ ■

Refuelling stations/ filling systems ■

Tankers (lorry, train, ship) ■

4. Storage

Battery storage ■ ■ ■

Gas tanks ■ ■ ■

Cavern storage (H_2 and CO_2) ■ ■ ■

Pressure vessels ■ ■ ■

H_2 hybrid storage ■

5. Consumption/use

Fuel cell systems ■ ■ ■

Methanol synthesis units ■ ■ ■

Refinery ■ ■ ■

Mobility ■ ■

In every field of services, we support you in the following phases:

■ Concept/planning ■ Production ■ Operation

Concept/planning

We support you in the concept phase with comprehensive services that will give your project the security it needs in technical and legal aspects from the very start. From product design through the assessment of requirements and technical specifications to plant development and process optimisation, our specialists have the details and the desired goal in view and are equipped and prepared for your tasks with ultra-modern IT and AI instruments as well as a broad spectrum of risk analysis, certification, test and evaluation services.

Production

With specific testing,auditing and approval services, we provide neutral and technically competent support as a notified and accredited body for manufacturers. This includes assessment and certification as a material manufacturer, obligatory for the production of certain products. Our range of services also includes the assessment of manufacturing processes, material assessments, stress tests, damage appraisal and product certifications. In addition, on top of monitoring production, we also support commissioning, assembly works and personnel instruction in production processes.

Operation

After setup and commissioning, we help you when operations are up and running to avoid shutdowns, eliminate technical sources of danger and reduce costs with the use of software-supported maintenance systems. We take on the task of carrying out all recurring inspections and specific tests of electrical and mechanical plants and systems. We can also create risk-based maintenance plans and provide you with tailor-made strategies to reduce operational risks and increase plant safety over the long term.

Fuel cells: the motors of the hydrogen economy

Fuel cells are required to generate electricity from hydrogen. By converting chemical energy directly into electrical energy and heat, they have a significantly higher level of efficiency than conventional power plants. In combination with a fuel storage tank and water recycling facility, fuel cell systems can achieve energy generation that is fully free from pollutants. The range of power in fuel cells runs from the sub-kW range for individual cells to the MW range in the form of virtual power plants. They are used, among other things, to generate heat and electricity in buildings, provide remote solutions outside the grid and to drive vehicles, aeroplanes and ships.

We are your partner for the research, development and market deployment of fuel cell technologies – giving special attention to municipal and industrial actors aiming to make use of hydrogen. With the most modern analytical methods and competent specialists, we are at your side to carry out your project safely and successfully, and to help you benefit from subsidies as available. Do get in touch.

Fuel cell technologies

Currently, 6 types of fuel cell are used. They run on various gases, use different electrolytes and are classified depending on their operating temperature as either low, medium or high-temperature fuel cells.

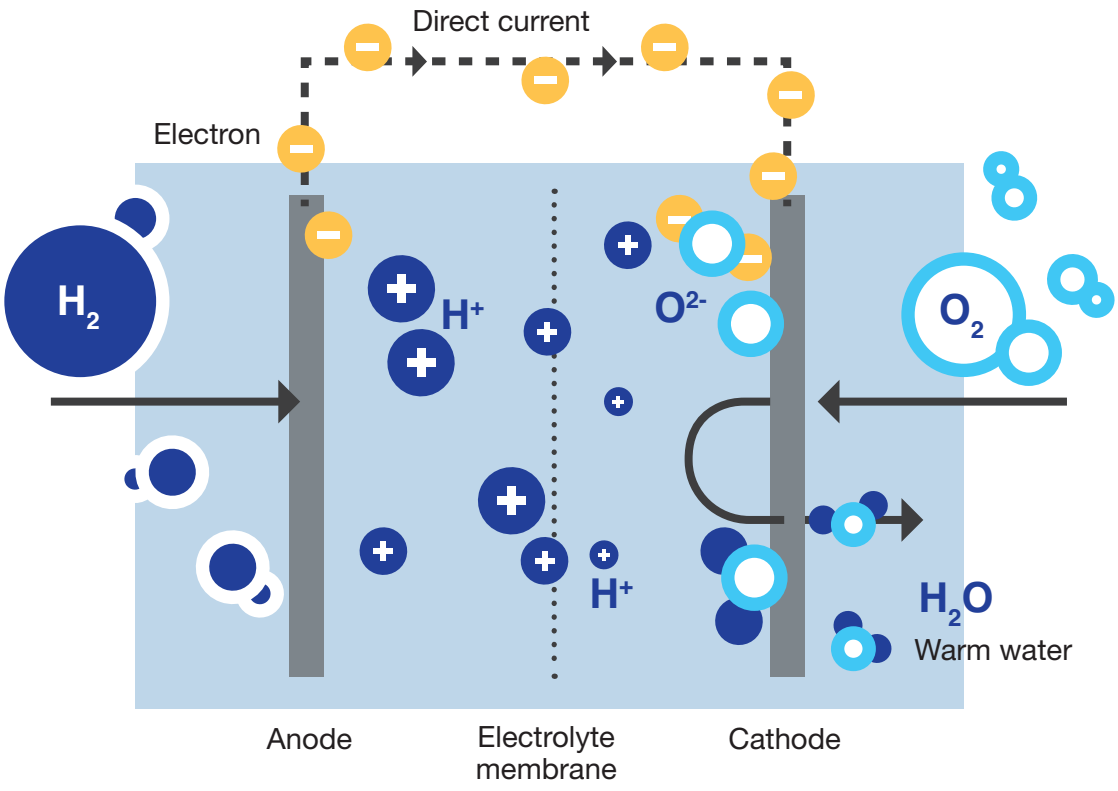
Type	Anode gas	Cathode gas	Electrolyte	Working temperature	Power range	Cell efficiency
Alkaline fuel cell AFC	Hydrogen	Oxygen	Aqueous potash	20 °C-90 °C	up to 100 kW	60 %–70 %
Proton exchange membrane fuel cell PEMFC	Hydrogen	Atmospheric oxygen	Polymer membrane	20 °C-80 °C	up to 500 kW	50 %–70 %
Direct methanol fuel cell DMFC	Methanol	Atmospheric oxygen	Polymer membrane	20 °C-130 °C	up to 100 kW	20 %–30 %
Phosphoric acid fuel cell PAFC	Hydrogen, natural or biogas	Atmospheric oxygen	Phosphoric acid	160 °C-220 °C	up to 10 MW	55 %
Molten carbonate fuel cell MCFC	Natural, coal, biogas	Atmospheric oxygen	Molten carbonate salts	620 °C-660 °C	up to 100 MW	65 %
Solid oxide fuel cell SOFC	Natural, coal, biogas	Atmospheric oxygen	Yttrium-stabilised zirconium oxide	800 °C-1000 °C	up to 100 MW	60 %–65 %

Principle of construction and mode of functioning

A fuel cell consists of an array of several cells divided by separators and arranged into a stack. They are set up in planar layers or, in the case of solid oxide cells, as tubular systems.

The core of an individual cell is a liquid or solid electrolyte, surrounded on two sides by bipolar electrode plates (anode and cathode). The plates have a porous GDL (gas diffusion layer) that transports the reactive gases past a noble-metal-coated catalyst (low and medium-temperature range) or a nickel, ceramic or steel catalyst (high-temperature range).

In this way, in most fuel cell types, the hydrogen is split at the anode and the electrons diverted to the electrical load. The hydrogen protons migrate through the electrolyte to the cathode side and combine with the oxygen provided there to form water.



Areas of use and usage

The range of uses for fuel cells is large and constantly growing as they are reliable to use, low-maintenance and environmentally friendly. While all fuel cell types are suitable for stationary applications, portable and mobile uses largely rely on membrane fuel cells and direct methanol fuel cells.

Low-temperature fuel cells

- Alkaline fuel cells (AFC)

This fuel cell type is setting benchmarks in the development of the technology, above all in space and submarine travel. The first fuel cell passenger boat in the world was also driven by alkaline fuel cells.

Despite its robust system, this type of fuel cell nevertheless has a low service life and does not achieve the high power density of today's widespread membrane fuel cells.

- Proton exchange membrane fuel cells (PEMFC)

No other fuel cell type is so versatile. Because of the high dynamism of their power output, membrane fuel cells are often deployed in mobile use, e.g. in cars, small vans and buses, alongside aerospace and nautical applications. A further use is in emergency power supplies, say, for railway transport and in telecommunications and to secure critical industrial infrastructures or data centres. Smaller fuel cell systems are used e.g. in portable generators or, in stationary use, for domestic energy supply from cogeneration plants. Larger systems are found e.g. in hospitals, swimming pools and other communal utilities.

- Direct methanol fuel cell (DMFC)

Thanks to its uncomplicated handling, this fuel cell technology finds widespread use. Stationary uses include remote electricity supply for metering stations, monitoring systems or communications facilities. They can be portable e.g. for leisure use (while camping, say) and mobile, where they are often used as range extenders for electric vehicles, for which they provide excellent, environmentally friendly mobility thanks to their high storage density.

Through the reaction of methanol with oxygen, a small amount of CO_2 alongside water vapour is generated in direct methanol technology.

Medium- and high-temperature fuel cells

- Phosphoric acid fuel cells (PAFC)

As medium-temperature fuel cells, this cell type not only has a higher working temperature than the low-temperature fuel cells, but also has a certain CO and CO_2 tolerance, meaning they can largely be operated with reformed natural gas. Because of their aggressive, acidic electrolytes, however, they have a comparatively low service life. They are used in the field of cogeneration, e.g. in stationary energy supply for industrial plants, shopping centres, hospitals and residential estates.

- Molten carbonate fuel cells (MCFC)

As high-temperature fuel cells, molten carbonate fuel cells have the advantage of being insensitive to CO and able to use natural, coal, bio- and synthetic gas directly, without reforming. However, their internal CO_2 cycle requires additional electrolyte and CO_2 management. As with the medium-temperature fuel cell, heat production is the focus here rather than electricity production. As they have a longer start-up phase and their service life is decisively influenced by the number of start-stop cycles, they are ideally used in power plants and cogeneration plants ideally in base-load operation.

- Solid oxide fuel cells (SOFC)

In comparison with molten carbonate fuel cells, solid oxide fuel cells have a comparatively simple system, high service life and high efficiency. Their working temperature of up to 1,000 °C predetermines these powerful high-temperature fuel cells for the decoupling of process heat and thus for stationary use in power plants, cogeneration plants, and also heating facilities in detached and semi-detached houses. In combination with gas turbines, solid oxide fuel cells are also used in smaller communal cogeneration plants and larger facilities for electricity generation.

Our services

Fuel cells and fuel cell systems have great market potential in nearly all areas of emissions-free energy supply. With comprehensive services in the fields of testing, inspection and certification, we support manufacturers and operators in the following phases:

	Concept / planning	Production	Operation
Inspection of concepts to current legal requirements, standards and regulations	■		
Inspection of requirements specifications	■		
Inspection of technical specifications	■		
Inspection of component designs on the basis of standards, third-party requirement catalogues or customer demands	■		
Certification of protective devices	■		
Inspection of staggered power system protection plans, protection tests	■		
Analysis of electrical grids	■		
Certification of the grid connection	■		
Certification of protective devices, inspection, safety design	■		
Conformity assessments of electronic components/systems	■		
Inspection of the design, construction, functioning and reliability of hoists, cranes and load handling equipment	■		
Inspection of risk analyses to determine the potential risk of intervention by unauthorised persons	■		
Inspection of safeguarding concepts	■		
Inspection on determination of intervention measures by guarding/security company or police	■		

Services along the hydrogen value chain: Consumption/use

	Concept / planning	Production	Operation
Inspection on determination of administrative security measures	■		
Inspection commissioning and periodic inspection concepts	■		
Technical due diligence	■		
Technical, financial, legal due diligence (with external partners)	■		
Testing electromagnetic compatibility	■		■
Inspection on installation and operation of alarm receiving stations		■	
Production monitoring and auditing		■	
Inspection and support for commissioning and assembly works		■	
Acceptance and functional tests		■	
Acceptance tests (commissioning, periodic inspection) of isolated grids with involvement of e.g. decentralised generator units, electrolysers and any necessary storage systems (on and offshore)		■	
Inspection of switchgears/control cabinets to EN 61439-1			■
Inspection of electrical and mechanical safeguarding systems			■
Recurring inspections			■

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