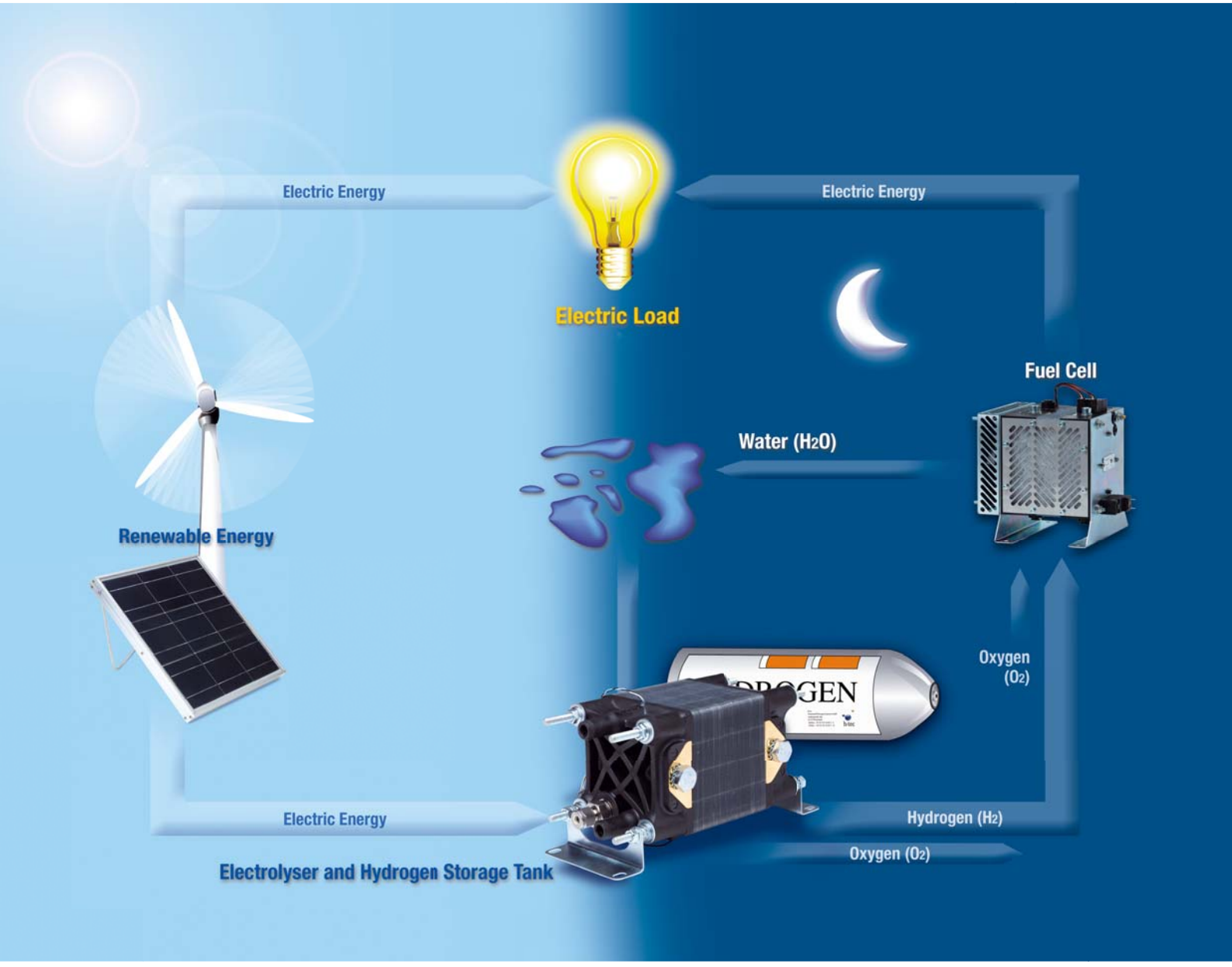
Hydrogen Technology for Energy Solutions

h-tec



Electrolysers and Fuel Cells

Commercial hydrogen technology is coming

- **It promises a future of clean, renewable energy produced using PEM electrolysers and PEM fuel cells, on-demand and off the grid.**
- **Electrolyser and fuel cell technology is ready for series production.**
- **Join with h-tec and help build the energy technologies of the future.**

A new market ready to emerge

There is currently a great demand for “green” energy sources, and existing hydrogen technologies like electrolysers, gas storage and fuel cells already make it feasible for hydrogen energy supply to become the new worldwide standard for green power generation. In other words, current technology can pave the way for the breakthrough of fuel cell technology into various markets.

h-tec has a leading position in the hydrogen technology field - since 1997 we have been building high-quality fuel cell and electrolyser products for use in research and classroom. At the same time, we have been working on industrial-grade products for commercial use.

Our proprietary PEM fuel cells and PEM electrolysers offer high-efficiency operation, and can be scaled up for low-cost serial production.

The time for the hydrogen energy revolution is now. h-tec is looking for strategic financial partners to make these exciting products a reality.

For more information visit **www.h-tec.com**

General market information

The market for green energy in general, and hydrogen energy in particular, will improve as fossil fuels run out. Many governments already provide incentives for fuel cell technology, because they see that this technology is economically friendly, efficient and flexible. Electrolysers and fuel cells can be used to generate electricity and heat for many applications, such as:

- Hydrogen infrastructure
- Industry/ laboratories
- Arts and crafts
- Off-grid energy production
- Decentralized energy supply
- In-home energy generation
- Mobile energy

PEM electrolysers

Operate at any load between 0% and 100%, therefore especially suited to use with renewable, intermittent energy supplies (e.g. solar, wind)

- High degree of gas purity
- High efficiency
- Less dangerous than other electrolyser designs (no caustic fluids needed)

PEM fuel cells

Highest possible efficiency

- Electrical efficiency : 40% at full load, up to 50% at partial load
- Overall efficiency: 90 %

Lowest possible emissions

- Produce only water, electricity and heat
- Free of harmful substances (SOx, particulate matter, NOx)
- Almost noiseless
- Vibration free

Most flexible application

- Supply electricity and heat at both base and peak loads
- Suitable to a large range of applications, from home energy supply to vehicle drive
- The required hydrogen can be supplied by a number of sources, from fossil fuels to electrolysers powered by renewable energy

h-tec at a glance

The company h-tec Wasserstoff-Energie-Systeme GmbH was founded in 1997 by Uwe Kueter and Stefan Hoeller.

h-tec currently has two divisions: h-tec Education, which produces products for educational and demonstration purposes, and h-tec Industrial, which is developing hydrogen technology for commercial use. Since 1997, the Education division has built a reputation for innovation and for meeting customers‘ demands with high quality products. As a leading educational supplier, h-tec sells about 10,000 units per year, about 85% of them outside of Germany. Our activities in the educational field have allowed us to amass fuel cell know-how, refine our PEM hydrogen technology and develop systems that can be scaled up for commercial use and serial production. This gives us great confidence in our future growth potential, since the potential industrial market is much larger than the total educational market.

With this much larger industrial market in mind, our Industrial division has been working since 1999 on market research, materials testing and prototypes, with the goal of producing a high-quality product range that delivers an industry-leading power to price ratio, and can be applied to a wide variety of applications.

This ambitious goal required a technological breakthrough, and we achieved it in 2003/4 during a research project funded by the WTSH (Promotion of Economy and Transfer of Technology Schleswig-Holstein GmbH). Our proprietary prototype designs for simple, efficient fuel cells and electrolysers are optimized for economical serial production.

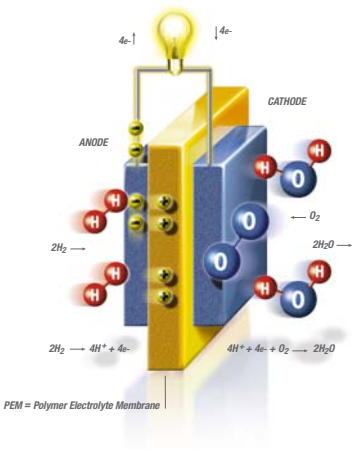
Expansion financing

Today, fuel cell technology has a reputation for being expensive and exclusive for much the same reason as automobile technology once did - at the moment such technology requires specialized knowledge, customized equipment and must be assembled in small batches, at least partially by hand.

h-tec is working to change that perception, and we have the experience necessary to do it. Our years of R&D and history of producing small, high-quality cells for the educational market means that we are uniquely suited to develop a serialized production method for the higher power cells necessary for commercial and industrial applications. With serial production of fuel cells and electrolysers, hydrogen energy technology can become economically competitive.

Of course, setting up a new serial production method for fuel cells will require considerable time and capital. This is why we are actively pursuing expansion financing and development partners.

Technology

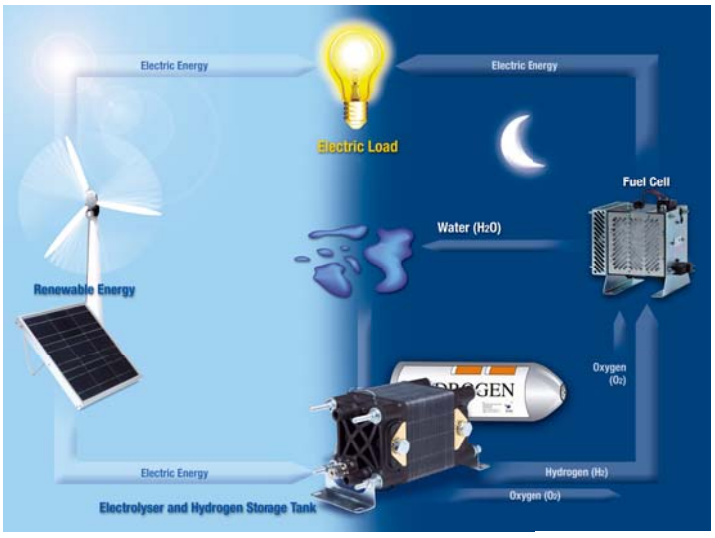


PEM Fuel Cells

The PEM fuel cell combines hydrogen and oxygen gas to form water, and also produces electrical energy efficiently, with low noise, and no harmful emissions. The heart of this type of fuel cell is a thin, proton-conducting membrane (Proton Electrolyte Membrane or PEM), which is coated with catalyst material on both sides. These two layers of catalyst form the cathode and the anode of the fuel cell. Individual cells can be connected together to form compact stacks in order to match the power requirements of a given application. Stackability, high efficiency, and the good cold-start behavior of the PEM fuel cell make it suitable for a wide range of applications, from battery replacement to electric drive.

PEM Electrolysers

Electrolysis is the reverse of the fuel cell reaction – instead of combining hydrogen and oxygen to create water and electricity, the PEM electrolyser uses electricity to split water into hydrogen and oxygen. Higher power electrolysers are built as stacks in which individual electrolysers are connected in series and higher voltages are added. PEM electrolysers have efficiencies of up to 85 %.



The Solar Hydrogen Energy Cycle

The solar-hydrogen cycle uses hydrogen energy technology to store energy for use at a convenient time. The power source runs an electrolyser to produce hydrogen gas, which is stored and used to power a fuel cell and produce electricity when needed. The hydrogen acts as an energy buffer, and makes this cycle particularly appropriate for producing steady electrical power from intermittent renewable supplies like solar or wind energy.

Sample h-tec Industrial Products

PEM Pressure Electrolysis System EL30

Uses electrical energy to split water into hydrogen and oxygen. Suitable for storing excess energy produced by, e.g. wind turbines or solar cells, or anywhere hydrogen is needed for fuel cells or industrial processes.

- Up to 2.4 Nm^3/h H_2
- Target up to 3.0 MPa (30 bar)
- 19" - rack (9 HU)
- Incl. control and data interface
- Designed for serial production

PEM Fuel Gas Generator Stack OxHy30

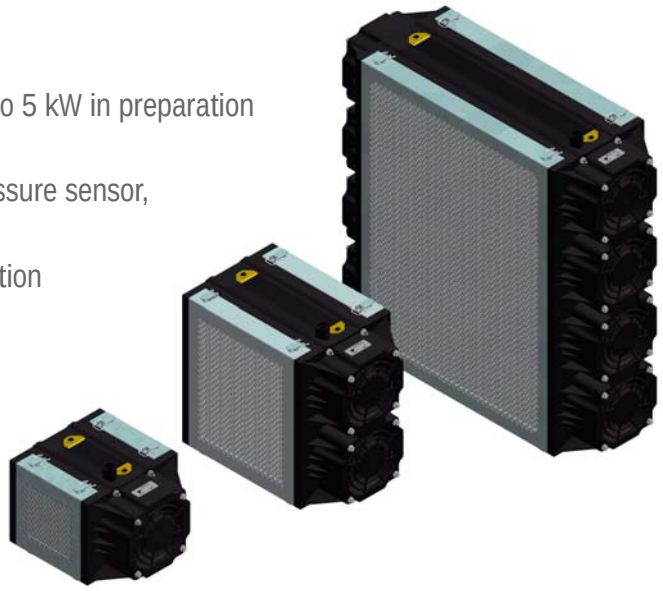
Special electrolyser. Produces hydrogen/oxygen in a mix. Useful for, e.g. craft welding or industrial production.

- Produces H_2/O_2 mixture of up to 500 l/h
- Designed for serial production
- Suitable coolers and pumps are available on request

PEM Fuel Cell Systems FCA45 / FCA90 / FCA180

Converts the chemical energy of hydrogen directly into electricity. The only byproduct is pure water.

- Air-cooled fuel cell system
- Currently up to 100 W power, more powerful systems up to 5 kW in preparation
- Self-humidifying, external humidification not necessary
- Integrated system consisting of temperature sensors, pressure sensor, valves, air supply, air filter, control and data interface
- High overall system efficiency due to low power consumption of the components
- Optional extra: single cell voltage evaluation
- Designed for serial production



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h-tec in brief

- Developer and producer of electrolyser and fuel cell technology
- Founders: Uwe Kueter and Stefan Hoeller
- Founded: 1997
- Team of 30 employees
- Based in Luebeck, Germany
- Two Business divisions

h-tec Industrial – PEM electrolysers (up to 2.4 Nm^3/h H_2) and PEM fuel cells (up to 5 kW) for portable and stationary industrial applications.

h-tec Education – Since 1997one of the world's leading supplier of solar hydrogen technology for schools, universities, vocational training and demonstrational PR-activities.

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