### Fuel Cell Technology a driving force



www.h-tec.com



### h-tec We're full of energy

Since our founding in 1997, we have established ourselves worldwide as a leading provider of education and demonstration models for conveying an understanding of fuel cell technology. In developing our models, we not only create experiments that are curriculum-compatible and ensure fast experiment setup, but also give particular emphasis to attractive, functional design. We firmly believe that learning has a lot to do with fun - and fun is essentially a given with our models. They give you a wide range of possibilities for letting people come into contact with and experience the fascinating concept of fuel cells.

In the area of industrial applications - another h-tec specialty - we have, since 1999, been developing lowcost fuel cells and electrolysis systems, designed primarily for mass production. Our applications are an alternative for portable, mobile and stationary power supply.

Renewable energy around the clock - solar hydrogen technology makes it possible. Using electrolysis, available solar or wind energy is used to produce hydrogen. This is temporarily stored and used for generating power via the fuel cell anytime it is needed. A clean solution indeed.

### Energy of the Future







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How a PEM fuel cell works: A fuel cell reaction is the exact reverse of the electrolysis of water. While the electrolysis process can be used to store electrical energy as chemical energy - here as hydrogen and oxygen - a fuel cell converts chemical energy stored as hydrogen and oxygen (e.g. out of air) directly, i.e. without a combustion process, into electrical energy. Hydrogen and oxygen are fed in and react to water, giving off electricity and heat in the process.





### ELECTROLYZER StaXX 2 & ELECTROLYZER StaXX 7

### Hydrogen production to your heart's content

High-performance PEM electrolyzers for a reliable and secure hydrogen supply for educational purposes. Power supplies, hydrogen storage and solar cells are available upon request.

04

Item 3011

Item 3017



### Electrolyzer StaXX 2

Double-cell PEM electrolyzer stack for production of hydrogen from distilled water.

#### **Specification**

Power: Hydrogen production: H x W x D: Weight: Item 3011 15 W 65 cm³/min 140 x 180 x 120 mm 460 g

### Electrolyzer StaXX 7

Seven-cell PEM electrolyzer stack for production of hydrogen from distilled water.

### Specification

Power: Hydrogen production: H x W x D: Weight: Item 3017 50 W 230 cm³/min 190 x 264 x 200 mm 1.5 kg

PowerSupply StaXX 2, PowerSupply StaXX 7, Solar Module StaXX 2 and Solar Module StaXX 7 as power supply for StaXX electrolyzers.

### h-tec FUEL CELL StaXX & FUEL CELL StaXX 3



More cells more power more possibilities

Item 3003-1

The powerful extension of our Education range. The individual airbreathing double-fuel cells Fuel Cell StaXX can be put together to form systems. You will add more power and even more fun to your experiments! These double-fuel cells are available individually or as

two, three or five Fuel Cell StaXX mounted on a base plate. DC/DC Converters to adjust the voltage are available as accessories.

### Fuel Cell StaXX

Double-cell PEM fuel cell stack for hydrogen/air operation.

1 W

260 g

90 x 100 x 65 mm

#### **Specification**

Power: H x W x D: Weight: Item 3001

### Fuel Cell StaXX 3 Pack1

Three double-cell PEM fuel cell stacks for hydrogen/air operation, mounted on a black base plate, DC/DC Converter StaXX 3 included.

3 W

1.7 kg

100 x 200 x 250 mm

#### **Specification**

Fuel Cell: DC/DC Converter: 4.5; 6; 7.5; 9; 12; 14 VDC H x W x D: Weight: Item 3003-1



StaXX Drive Model of an electric motor drive for vehicles. Designed for 5 StaXX Fuel Cells.

Item 3055

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### P R E M I U M<sup>h-tec</sup> E X H I B I T I O N

Item 1908-1

## We make hydrogen technology transparent

At trade fairs, exhibits or conventions, h-tec's Premium Exhibition lets you make state-of-the-art presentations featuring fuel cells and hydrogen technology. The demonstration model was designed specifically for extended, unsupervised operation. Its attractive appearance immediately mesmerizes visitors. A solar module provides the electricity used for the model's PEM electrolyzer. Viewers can watch the reactions taking place in the transparent cells, observe the creation of the gases and experience how the energy is stored in tall columns of water surrounded by acrylic glass. The split hydrogen and oxygen is initially stored, then used to power a fuel cell, which uses "cold combustion" to convert the two gases back into water, generating heat and electricity, which in turn powers an electric load. A fascinating show in and of itself.

07

### Premium Exhibition Pack1

### Specification

Electrolyzer: Fuel cell: H x W x D: Weight: Item 1908-1

Available without accessories (Fan, Cable, Solar Module Premium).

10 W

4.8 kg

650 x 800 x 300 mm





### Videolight

Halogen lamp for Solar Module Premium. Power: 300 W, H x W x D: 700 x 370 x 370 mm, Weight: 1.2 kg

Item 1931

Premium Exhibition, quite possibly the most dramatic and impressive presentation of hydrogen technology around.

### PREMIUM SOLAR HYDROGEN SET

### A sturdy case for future energy

A mobile solar hydrogen kit for events in universities or in industrial settings. Our Premium Solar Hydrogen Set comes in a handy case, to let you demonstrate the basic principles behind PEM electrolyzers and PEM fuel cells "on the fly". You can also do experiments to demonstrate the physical laws governing electrolysis and fuel cells. All components required for presenting solar hydrogen technology are included in the set, from the light source and solar cell, electrolyzer, gas reservoir, and fuel cell down to the electrical load. There is a special emphasis on safe and fast presentation, as well as on the option of carrying out individual qualitative experiments. Whether you're doing a demonstration or an experiment, the Solar Hydrogen Set leaves all your options open.

h-tec

Item 1909



In case solar cells are not used, this power supply is included in the Solar Hydrogen Set.

### Premium Solar Hydrogen Set Specification

Electrolyzer: Fuel cell: Gas storage: Solar module: Power supply: Electric load: Lamp: H x W x D: Weight: Item 1909 4 W 1.2 W 80 cm<sup>3</sup> H<sub>2</sub> / 80 cm<sup>3</sup> O<sub>2</sub> 2.0 V / 1.0 A 1.0 A 10 mW 300 W 425 x 530 x 210 mm 7.8 kg



Mobile Fuel Cell With the Solar Hydrogen Set, you can easily demonstrate hydrogen technology anywhere, anytime.

### PREMIUM XL A notch above the rest



It's the size of this model hydrogen system that makes it impressive. With separate electrolyzers, gas reservoirs and fuel cells, Premium XL impressively demonstrates the basic principles of hydrogen technology. This education and demonstration kit has one special advantage, thanks to its vertical generous construction, your experiments can be seen clearly even in the "back rows". This makes the Premium XL the favorite of many universities when choosing an education and demonstration model.

### Premium XL Pack1

10 W

1.2 W

4.1 kg

80 cm<sup>3</sup> H<sub>2</sub> / 80 cm<sup>3</sup> O<sub>2</sub>

560 x 670 x 250 mm

#### **Specification**

Electrolyzer: Fuel cell: Gas storage: H x W x D: Weight: Item 1800-1

Available without accessories (Fan, Cable, Solar Module Premium). Item 1800



A vertical construction against a black backdrop effectively showcases your experiments.







### PREMIUM DMFC



## Electricity from methanol

In addition to hydrogen, methanol is becoming increasingly important as a source of energy. The Premium DMFC helps training facilities and companies show how to make electrical energy with a Direct Methanol Fuel Cell, in a real-life setting. A highly interesting variation on hydrogen technology! In addition, the Premium DMFC offers you possibilities for experiments, e.g. measuring the current-voltage characteristic and the DMFC performance chart.







the standard in experimental metha-

### Premium DMFC Pack1

50 mW H x W x D: 115 x 200 x 200 mm

Available without accessories Item 1926

### New fuel for h-tec thought in your classroom

## $\frac{E\,C\,O}{H_2/A\,I\,R}$

Item 1936

ECO

 $H_2/O_2$ 

Item 1935

h-tec's two ECO models Eco H<sub>2</sub>/O<sub>2</sub> and Eco H<sub>2</sub>/Air give students insights into solar hydrogen technology. Numerous experiments can be carried out to teach lessons realistically. Solar cell, PEM electrolyzer, gas reservoirs, PEM fuel cell for hydrogen-oxygen operation, and electric load are all ready for use on the Eco H<sub>2</sub>/O<sub>2</sub> base plate. For those who wish to use the surrounding air rather than pure oxygen, h-tec offers the Eco H<sub>2</sub>/Air model. It contains a reservoir to hold hydrogen, and is otherwise identical to the Eco  $H_2/O_2$ . Both Eco systems offer students a variety of learning options. The currentvoltage characteristic and efficiencies can be determined through experimentation.



### Eco $H_2/O_2$

#### Specification Electrolyzer:

Fuel cell: Fuel cell: Gas storage: Solar module: Electric load: H x W x D: Weight:

Item 1936

2 W 600 mW 40 cm<sup>3</sup> H<sub>2</sub> / 40 cm<sup>3</sup> O<sub>2</sub> 2.0 V / 350 mA 10 mW 175 x 470 x 150 mm 1100 g

#### Specification Electrolyzer: Fuel cell: Gas storage:

Gas storage: Solar module: Electric load: H x W x D: Weight:

Eco H<sub>2</sub>/Air

2 W 300 mW 40 cm<sup>3</sup> H<sub>2</sub> 2.0 V / 350 mA 10 mW 140 x 470 x 150 mm 1000 q 11

Item 1935

Thanks to a wide range of possible experiments, the Eco series turns learning into an experience.

### ECO MULTI



### An all-rounder with a view

For successful learning, the vividness of your experiments plays an important role. h-tec developed the ECO Multi to make fuel cell technology even more transparent for students. Simply place it on the overhead projector and your students can observe hydrogen technology in action. The system's completely transparent construction makes it possible! But the ECO Multi is also a worthwhile investment because of its multi-functional cell, choose between using it as an electrolyzer, fuel cell, hydrogen-oxygen pump or methanol fuel cell.

Item 1940-1



### Eco Multi Pack1

2 W (electrolyzer mode); 600 mW (fuel cell/oxygenmode H2/O2); 270 mW (fuel cell/air mode H2/air) Gas storage: 20 cm<sup>3</sup> H<sub>2</sub> / 20 cm<sup>3</sup> O<sub>2</sub> Pumping rates: 35.0 cm<sup>3</sup>/min H<sub>2</sub> and 4.0 cm<sup>3</sup>/min O<sub>2</sub> Power as DMFC: 20 mW from methanol: 3.0 cm<sup>3</sup>/min H<sub>2</sub> and 1.0 cm<sup>3</sup>/min CO<sub>2</sub> H x W x D: 90 x 290 x 200 mm 680 g Weight: Fan, Cable, Solar Modul Eco included. Item 1940-1 Available without accessories (Fan. Cable, Solar Module Eco) Item 1940



#### Solar Module Eco

As electrical supply for Eco electrolyzers. Power: 2.0 V / 350 mA, H x W x D: 80 x 150 x 70 mm, Weight: 135 g

Item 1912

12

Conveys fuel cell technology compellingly, the ECO MULTI.

### DESKTOP MODELS Presentation models





### **DT** Rotating

**Specification** Power: 10 mW H x W x D: 100 x 100 x 100 mm Weight: 190 g

Item 2016

### DT Fan

Specification Power: 10 mW H x W x D: 93 x 100 x 40 mm Weight: 110 g

Item 2018



### DT Car

**Specification** Weight: 190 g

### that actually do something

High-quality presentation models equipped with advanced propulsion technology: the intricately designed DT Rotation, DT Car and DT Fan models are not only an attractive eye-catcher for your desk. Thanks to the integrated methanol fuel cell, they are also fully functional! Methanol is used in the PEM fuel cell for generating electricity, which operates a small electrical motor. Its elegant design makes the DT a striking present - not just for scientists!



Power: 10 mW H x W x D: 90 x 200 x 64 mm

Item 2017





at the same time: h-tec desktop models.



### **JuniorBasic**

### **Specification**

Electrolyzer: Fuel cell: Gas storage: Solar module: Electric load: H x W x D: Weight.

1.0 W 20 cm<sup>3</sup> H<sub>2</sub> / 20 cm<sup>3</sup> O<sub>2</sub> 2.0 V / 350 mA 10 mW 200 x 300 x 150 mm 600 g

#### Item 2010

Item 2010

Introduce young people to future technologies through experimentation! The Junior series offers a spectrum of possibilities that is both lowcost and diverse. High functionality, simple experiment set-ups and speedy results ensure rapid learning success. Thus, in the JuniorBasic basic experiment system, all the compo-

nents required in hydrogen technology - such as solar cells, electrolyzer, hydrogen/oxygen reservoirs, fuel cell and electric load - come fully assembled, ready to use in experiments. The JuniorSet experimentation kit allows students to carry out a number of dramatic experiments on their own. Included in both systems

Discovering the fascination of fuel cells, first-hand

is a comprehensive curriculum for your lessons. In addition to technical background information and instructions for experiments, it also gives you methodological ideas, worksheets and overhead transparencies to use with and for your students.

### **JuniorSet**

Specification Electrolyzer: Fuel cell: Gas storage: Solar module: Electric load: H x W x D: Weight:

10W 500 mW 20 cm<sup>3</sup> H<sub>2</sub> / 20 cm<sup>3</sup> O<sub>2</sub> 2.0 V / 350 mA 10 mW 140 x 450 x 380 mm 2.8 kg

Item 2011



Solar hydrogen technology in a convenient, sturdy carrying case.

Item 2011

h-tec introduces your students to all the basics of hydrogen technology

### HYRUNNER & H y S P E E D S T E R



Item 2050

Experience the future of automobiles

h-tec has already started the serial production of hydrogen fuel cell cars! At presentations and in schools, its two fuel cell model cars HyRunner and HySpeedster impressively get the futuristic propulsion concept across. Equipped with a reversible fuel cell, the two vehicle models can produce their own fuel - hydrogen - when electricity is supplied. This lets you give a dramatic presentation of the practical uses of hydrogen technology as well as carry out numerous experiments. The HySpeedster is extra fast thanks to a double fuel cell.





### Solar Module HySpeedster/ Solar Module Junior/ PowerSupply Junior

As electrical supply for HyRunner & HySpeedster

Item 2055/2021/2033

### HyRunner

#### Specification Power: 1.0 W (electrolyzer mode);

500 mW (fuel cell mode) Gas storage: 15 cm<sup>3</sup> H<sub>2</sub> / 15 cm<sup>3</sup> O<sub>2</sub> Number of cells: one cell Charging time: approx. 2 min approx. 8 min Running time: H x W x D: 75 x 90 x 200 mm Weight: 260 g

Item 2050

### HySpeedster

#### Specification Power:

2.0 W (electrolyzer mode); 1.0 W (fuel cell mode) 15 cm<sup>3</sup> H<sub>2</sub> / 15 cm<sup>3</sup> O<sub>2</sub> Gas storage: Number of cells: Stack with 2 cells Charging time: approx. 1 min Running time: approx. 4 min  $H \times W \times D$ : 75 x 90 x 200 mm Weight:

Item 2051

### FUEL CELL CONCEPT CAR



## From 0 to future in 30 seconds flat

h-tec's steerable Fuel Cell Concept Car demonstrates the effective use of hydrogen in the automotive sector. Combined with the Hydrogen Gas Station, the Fuel Cell Concept Car provides a perfect platform for presentations and driving demos. Because the two-cell fuel cell stack (no reversible cells) uses oxygen from the surrounding air, this model comes very close to real-life automotive applications. The Fuel Cell Concept Car is a frontrunner for promotional purposes as well with your design study or serially produced body as its chassis.



### Fuel Cell Concept Car

**Specification** Fuel Cell: Number of cells: Charging time: Running time: H x W x D: Weight:

t: 260

S: Stack with 2 cells approx. 30 sec approx. 7 min 45 x 240 x 100 mm 260 g

300 mW

Item 2053



Item 2053

Hydrogen Gas Station 2

The Fuel Cell Concept Car is refueled at the Hydrogen Gas Station 2. H x W x D: 230 x 360 x 150 mm, Weight: 1,2 kg



### FUEL CELL MINI Build your own Fuel Cell now

Fuel cell technology can be so simple: Assemble your own fully functional fuel cell in six steps without the use of tools. Fuel Cell Mini

**Specification** Power: H x W x D: Weight:

Item 1001

20 mW 30 x 20 x 2 mm 9 g

Item 1001





### Fuel Cell Systems Explained & Fuel Cell Mini

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Fuel Cell Systems Explained Hardcover - 384 pages 2nd Edtion (February 2003) Publisher: John Wiley & Sons ISBN: 047084857X

1 Fuel Cell Mini incl.

Item 1600-1

### Fuel Cell Systems Explained

By James Larminie and Andrew Dicks. Coverage of the complete fuel cell system incl. compressors, turbines, and the electrical and electronic sub-systems such as regulators, inverters, grid interties, electric motors, and hybrid fuel cell/battery systems.

### Fuel Cell Mini

Stamp-sized Fuel Cell Technology: Fuel Cell Mini, a fully functionable fuel cell, whitch can be self-assembled by folding.

Item 1001

### SUGGESTIONS FOR FURTHER READING



JAMES LARMINIE & ANDREW DICKS

"In summary, an altogether satisfying book that puts within its covers the academic tools necessary for explaining fuel cell systems on a multidisciplinary basis."

"An excellent book….well written and produced."

Power Engineering Journal

Journal of Power and Energy

### Fully revised and updated, the second edition:

• Provides an essential guide to the principles, design and application of fuel cell systems.

• Includes full and updated coverage of fuel processing and hydrogen generation and storage systems.

• Presents a full and clear explanation of the operation of all the major fuel cell types, and an introduction to possible future technology, such as biological fuel cells

- Features a new chapter on the direct methanol fuel cell.
- Now includes examples of the modelling, design and engineering of real fuel cell systems.
- A clear overview of fuel cell operation and thermodynamics.

### Fuel Cell Systems Explained

James Larminie and Andrew Dicks

h-tec

Hardcover - 384 pages 2nd Edition (February 2003) Publisher: John Wiley & Sons ISBN: 047084857X

Item 1600



### Handbook of Fuel Cells -

Fundamentals, Technology, Applications

Four Volume Set Edited by Wolf Vielstich, Hubert Gasteiger and Arnold Lamm

Hardcover - 2690 pages First Edition (March 2003) Publisher: John Wiley & Sons ISBN: 0471499269

### ACCESSORIES



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### PEMFC Kit

The original! PEM fuel cell that can be completely disassembled. The cell works in Hydrogen/Oxygen or in Hydrogen/Air mode.

#### Specification

Power: 600 mW (Oxygen) 200 mW (Air) H x W x D: 98 x 80 x 78 mm Weight: 225 g

#### Item 1919

#### Solar Module StaXX 2

13 W solar module as power source for Electrolyzer StaXX 2, can be positioned at 45°, 60° or 75°. Power: 4.0 V / 3.3 A, H x W x D 5 x 330 x 330 mm, Weight: 1.5 kg

Item 3031



Solar Module StaXX 7 53 W solar module as power source for Electrolyzer StaXX 7, can be positioned at 45°, 60° or 75°. Power: 13.8 V / 3.8 A, H x W x D 35 x 995 x 450 mm, Weight: 8.3 kg

Item 3037



#### Solar Module Premium

With three individual modules in parallel, this solar module (2.0 V / 1.0 A) serves as the perfect source of electricity for h-tec electrolyzers. H x W x D: 70 x 150 x 270 mm, Weight: 550 g

Item 1913









### Solar Module HySpeedster

Customized for the energy required by the HySpeedster fuel cell car, this double solar module delivers 4.0 V / 350 mA. H x W x D: 115 x 155 x 100 mm, Weight: 230 g

Item 2055

Solar Module Eco

This solar module delivers 2.0 V at 350 mA and may be used as a source of electricity for h-tec electrolyzers. H x W x D: 80 x 150 x 70 mm, Weight: 135 q

Item 1912

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### ACCESSORIES



### StaXX Drive

Model of an electric motor drive for vehicles. Two wheel hub motors as load, designed for 5 Fuel Cell StaXXs.

3.5 kg

2.7 W 140 x 450 x 350 mm

#### **Specification**

Power at 6 V: H x W x D: Weight:

Item 3055



# A

Videolight

Item 1931



#### Spotlight

With its 75 W halogen bulb, the Spotlight is the perfect source of light for Junior, Eco and HySpeedster solar modules. H x W x D: 490 x 170 x 200 mm, Weight: 1.4 kg

Item 2030



Premium Drive Model of an electric motor drive for vehicles. Wheel hub motor as load for Premium and Eco fuel cells. Power: 20 mW, H x W x D 110 x 225 x 225 mm,

Weight: 750 g



### Decade Resistor/Decade Resistor Junior

Decade resistor for individual test series and experiments. Maximum load 1 W. The Decade Resistor was developed specifically to take the characteristics of individual components. H x W x D: 40 x 160 x 130 mm, Jack diameter 4 mm (2 mm for Junior)

### Fan

This fan may be used as an electric load for fuel cells. Its engine has a load capacity of 10 mW. H x W x D: 130 x 60 x 95 mm, Weight: 65 g

Creates "sunshine" for h-tec solar modules. The halogen lamp has a power of 300 W and can be per-

H x W x D: 700 x 370 x 370 mm, Weight: 1.2 kg

fectly positioned thanks to a stable tripod.

Item 1914

#### Fan Junior

An electric load for Junior systems. The fan's 10 mW engine is easily driven by the Junior fuel cell.

H x W x D: 140 x 60 x 40 mm, Weight: 45 g

### ACCESSORIES

### Storage 1

Gas storage tank for 40 cm<sup>3</sup> hydrogen or oxygen and can easily be adapted.

#### **Specification** Volume:

40 cm<sup>3</sup> H x W x D: 140 x 100 x 100 mm Weight: 145 g

Item 1923

### Storage 80

Gas storage tank for 80 cm<sup>3</sup> hydrogen, can easily be connected by hoses.

#### **Specification** Volume:

80 cm<sup>3</sup> 265 x 100 x 100 mm H x W x D: 190 g

Item 1922

Weight:





### PowerSupply StaXX 2/PowerSupply StaXX 7

Power supply for Electrolyzer StaXX 2. Input: 100-240 V, 50-60 Hz, Output: 5.0 VDC / 3.0 A, Weight: 190 g Power Supply for Electrolyzer StaXX 7. Input: 100-240 V, 50-60 Hz, Output: 12.0 VDC / 5.0 A, Weight: 620 g





PowerSupply/PowerSupply Junior If you are not planning to use solar cells, this power supply provides all the energy that h-tec electrolyzers need. Plug diameter 4 mm, 2 mm for Junior. Input voltage: 100 - 240 V; 50 - 60 Hz Output voltage: 5.0 V DC 1.0 A

Item 1933/2033



### DC/DC Converter StaXX 2 *Voltage transformer; specially for Fuel Cell StaXX 2, can be switched to DC output voltages 4.5; 6; 7.5;* 9; 12; 14 V. H x W x D: 45 x 100 x 80 mm, Weight: 100 g Item 3042

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### DC/DC Converter StaXX 3

Voltage transformer; specially for Fuel Cell StaXX 3, can be switched to DC output voltages 4.5; 6; 7.5; 9; 12; 14 V. H x W x D: 45 x 100 x 80 mm, Weight: 100 g

Connection StaXX For electrical connection and gas supply of two Fuel Cell StaXX among each other. Weight: 7 g

Item 3020



### MediaPack

The MediaPack offers you extensive illustrative material for your classroom or your presentation, overhead transparencies on fuel cell technology and hydrogen technology as well as two posters that illustrate the principle of PEM fuel cells and solar hydrogen systems

Item 3043



Wasserstoff-Energie-Systeme GmbH Hydrogen Energy Systems Lindenstrasse 48a 23558 Luebeck Germany

 Phone:
 +49 (0) 451-49 89 5-0

 Fax:
 +49 (0) 451-49 89 5-15

 e-mail:
 info@h-tec.com

 website:
 www.h-tec.com