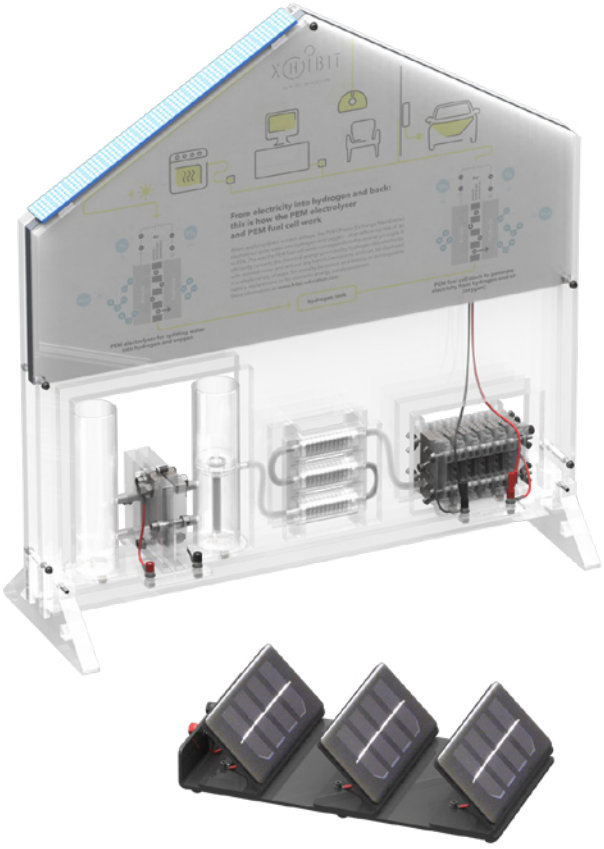
H-TEC EDUCATION

Operating Instructions



D111 DEMO House

H-TEC EDUCATION

Table of contents

Introduction

The realistic model of a residential building “DEMO House” shows the domestic energy supply of the future. It contains a 5-cell PEM fuel cell stack combined with a PEM electrolyzer and an implied hydrogen storage tank. The electrolyzer produces hydrogen which is supplied to the fuel cell. In combination with the oxygen of the ambient air, the fuel cell converts the hydrogen into heat and into electricity for the LEDs which illuminate the graphic in the upper part of the model.

We hope you gain interesting insights into hydrogen technology.

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About these instructions

These operating instructions are intended for the supervisor in charge.

- These operating instructions must be read and observed before use.
- These operating instructions must be available for reference and must be stored in a safe place.
- All safety instructions must be observed.
- This product may only be put into operation and operated under the direction of the supervisor in charge.

Safety instructions

Read and observe the **general safety instructions** included separately with this product and keep them in a safe place together with the operating instructions!

Product-specific safety instructions

The product may only be used:

- According to its intended use
- In compliance with all safety instructions
- In perfect working order

The components of this product feature freely accessible, live electric contact surfaces. Connecting to an impermissible operating voltage may result in a fire hazard, a risk of electric shock and damage to the components.

The product may only be operated under the constant supervision of an adult trained in the handling of this product.

The product may only be operated in a display cabinet or similar if adequate ventilation with an air velocity of 0.5 m/s at the product is ensured. The operator must provide proof of this through appropriate measurements.

The water bottle included with the product is to be filled with distilled water ($\sigma < 2$ µS/cm) only.

Product contents

Demonstration model "DEMO House"

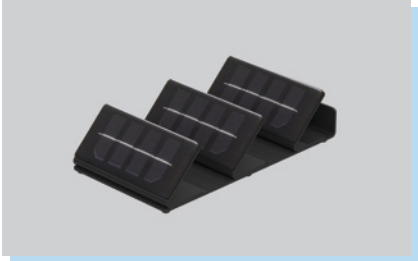
Graphic, front side (pre-installed)

Graphic, rear side (pre-installed)

Electrolyzer with water reservoirs, mounted on base plate

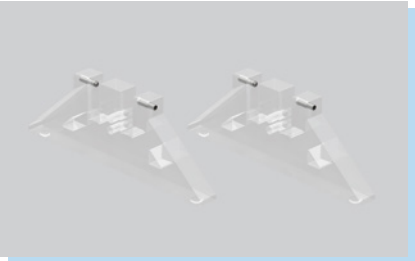
Overflow (pre-installed)

Fuel cell stack, mounted on base plate

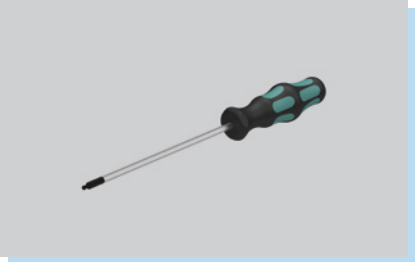


Solar module

Implied solar module



Supporting feet (possibly pre-installed)



Allen key
2.0 mm

Set of cables
consisting of:
Connecting cable, 2 mm, length 50 cm, red
Connecting cable, 2 mm, length 50 cm, black
Adapter, 4 mm multilam plug
to 2 mm female connector, red
Adapter, 4 mm multilam plug
to 2 mm female connector, black

Water bottle
250 ml
with separate tube attachment

Case with insert (optional)

Companion book

Operating instructions

General safety instructions

Overview

The "DEMO House" demonstration model at a glance

The “DEMO House” demonstration model consists of an electrolyzer, two water reservoirs, a 5-cell fuel cell stack and an illuminated graphic. When the electrolyzer is supplied with electrical energy, it produces hydrogen and oxygen from distilled water. The hydrogen, combined with the atmospheric oxygen, is converted into electrical energy in the fuel cell stack, creating water and heat. The electrical energy is fed to the LEDs for illuminating the graphic. The demonstration model is equipped with two 2 mm female connectors for connecting banana plugs. The individual components are shown in the following figure.

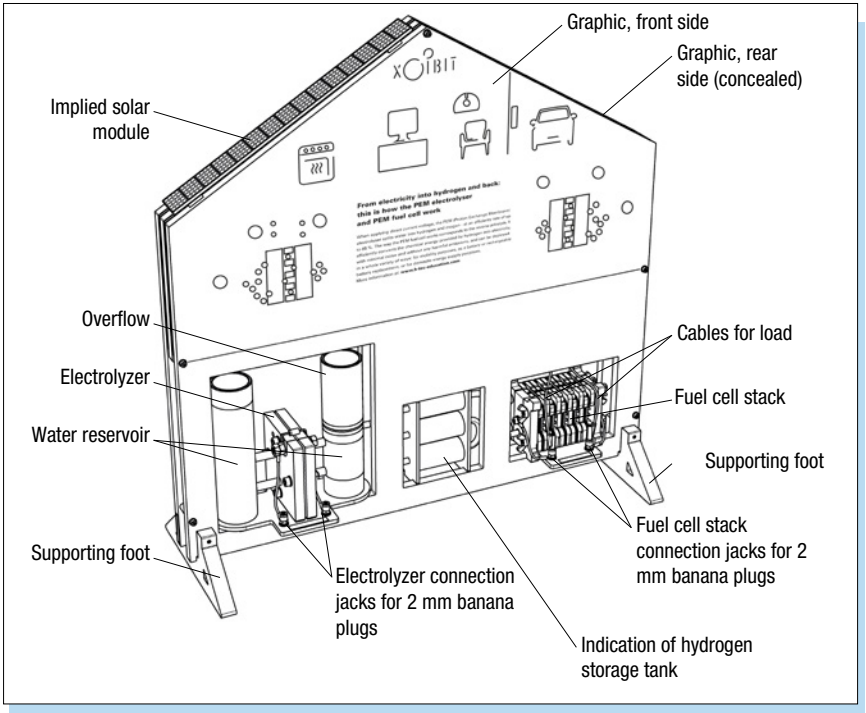


Fig. 1: The "DEMO House" demonstration model at a glance

Starting up

⚠ WARNING

Magnets may affect the function of cardiac pacemakers and defibrillators

A cardiac pacemaker may be switched into test mode and may cause uneasiness.
A defibrillator may stop working.

Bearers or users of such devices must maintain a minimum distance of 10 cm to magnets.
Bearers or users of such devices must be warned against approaching magnets.

⚠ CAUTION

Bruising

Careless handling may lead to fingers or skin being caught between two magnets. This can lead to bruises and haematoma.

The components with must be handled with caution.

CAUTION

Effect of magnets on objects

The strong magnetic field may damage TVs, laptop computers, computer hard drives, credit or debit cards, storage media, mechanical watches, hearing aids, speakers, etc.

Magnets must be kept away from all devices and objects which may be damaged by strong magnetic fields.

Installation of supporting feet

The following process steps are not required for demonstration models with the aluminium case with insert. In this case, the supporting feet are already pre-installed.

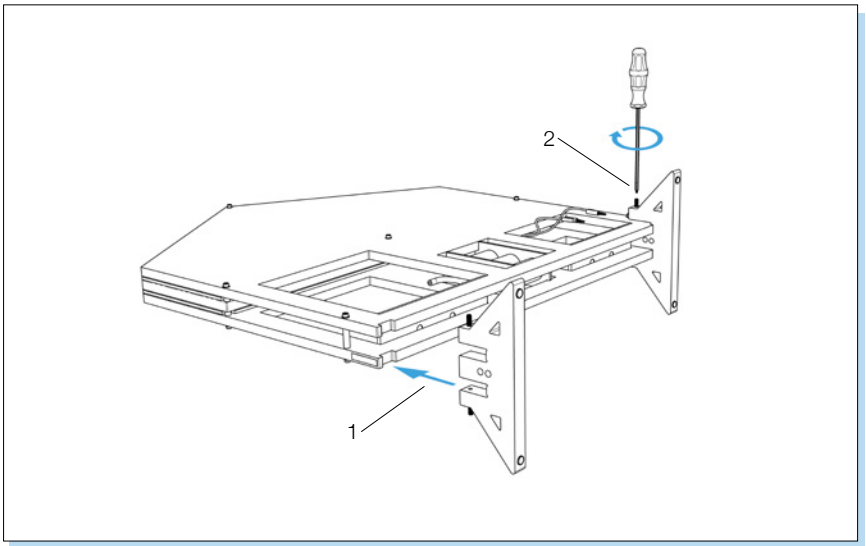


Fig. 2: Installation 1

- 1. Place the demonstration model on a firm and clean base. Bring the supporting feet in position. The supporting feet must be centred in the recesses of the demonstration model.
- 2. Screw in the Allen screws of the supporting feet until they come in contact with the surface of the demonstration model. Then fix the supporting feet on the demonstration model with another **half** turn of the Allen screws.

NOTICE

Tightening the screws

Excessive tightening of the screws may cause damage to the product.

Filling

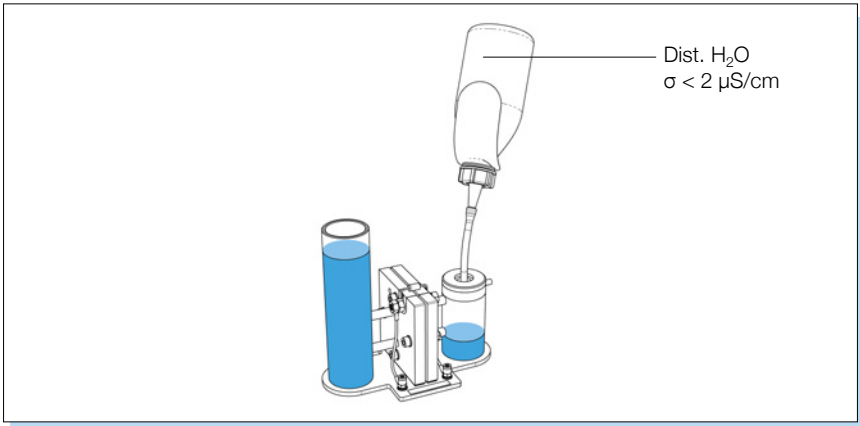


Fig. 3: Filling 1

- Fill both water reservoirs with distilled water (σ < 2 µS/cm) up to the lower mark.

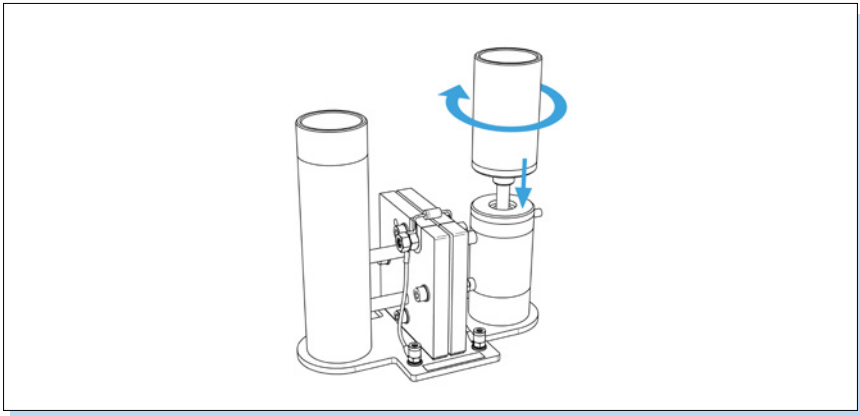


Fig. 4: Filling 2

- Attach the overflow to the hydrogen storage tank using a clockwise motion.

Assembly

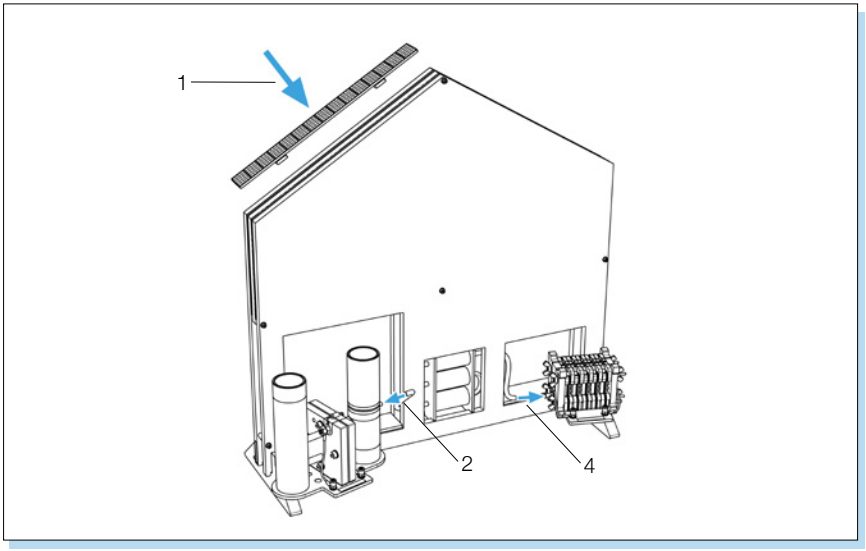


Fig. 5: Installation 2

- 1. Put on the implied solar module. It is fixed by magnets.
- 2. Attach the lower connecting tube of the implied gas storage tank on the connecting pipe of the electrolyzer. Ensure that the connecting tube is not kinked.
- 3. Put the electrolyzer into the demonstration model. It is fixed by magnets. The connection jacks must be located in the front (see fig. 6).
- 4. Attach the upper connecting tube of the implied gas storage tank on the connecting pipe of the fuel cell stack.

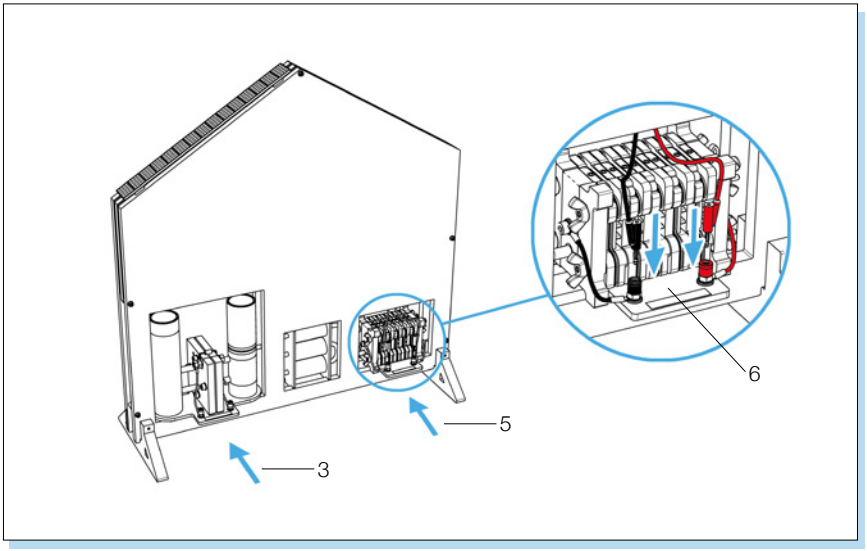


Fig. 6: Installation 3

■ 5. Put the fuel cell stack into the demonstration model. It is fixed by magnets. The connection jacks must be located in the front (see fig. 6). Ensure that the connecting tube is not kinked.

■ 6. Connect the cables of the graphic to the respective connections of the fuel cell stack. While ensuring correct polarity (red = “+”, black = “-”).

Do not yet connect the power source to the electrolyzer.

Replacing the graphics

The graphics of the demonstration model “DEMO House” are available in different language versions and can also be designed individually. This is why they are replaceable.

The graphics are replaced as follows.

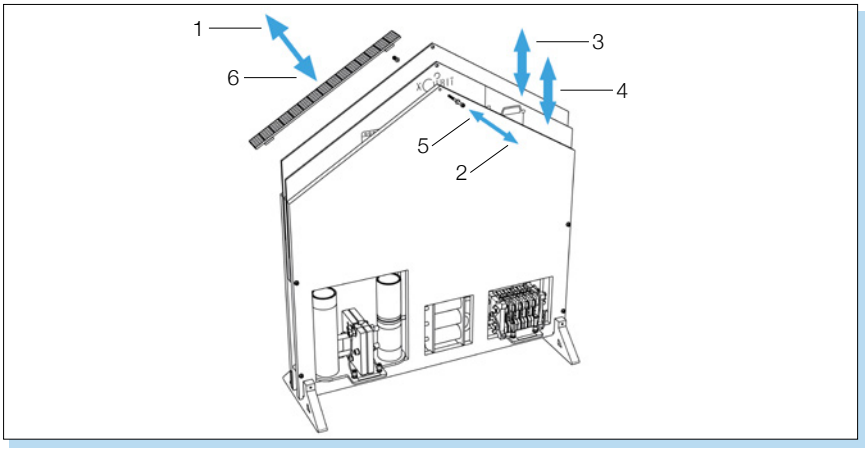


Fig. 7: Replacing the graphics

- 1. Remove the implied solar module.
- 2. Loosen the upper screw at the gable end of the demonstration model and remove it. Screw, nut and washers must be stored safely.
- 3. Carefully pull the graphic front side and the graphic rear side out from above one after another.
- 4. Carefully insert the new graphics and make sure not to damage the surfaces.
- 5. Insert the screw with a washer again and fix it with a second washer and the nut.

NOTICE	**Tightening the screws** Excessive tightening of the screws may cause damage to the product.

- 6. Put on the implied solar module again.

Operation

⚠ CAUTION

Risk of injury from hydrogen ignition

During operation, small amounts of hydrogen are continuously released into the atmosphere. Escaping hydrogen may ignite when in proximity to an ignition source.

Keep product away from ignition sources. Ensure ventilation in accordance with the general safety instructions.

⚠ CAUTION

Risk of injury from hydrogen ignition

Damaged tubes or leaking connections may cause hydrogen to escape. Hydrogen and hydrogen-air mixtures may ignite when in proximity to an ignition source.

Check tubes and connections for damage before each setup and before each use.

⚠ CAUTION

Risk of injury from hot surfaces

The protection diode on the electrolyzer becomes very hot in case of incorrect polarity. Touching the protection diode may cause injuries.

Before starting up, ensure correct polarity of the connecting cables and the electrical connections (red = “+”, black = “-”).

Do not touch the protection diode.

⚠ CAUTION

Risk of injury from hot surfaces

The surface of solar modules may become very hot during operation. Touching the surface of solar modules may cause injuries.

Do not touch the surface of solar modules during operation.

Do not touch the surface of solar modules even after operation until they have cooled down to below 60 °C.

⚠ CAUTION

Risk of fire due to electrical overload

Any operation beyond the electrical specifications will lead to excessive overheating of the electrolyzer. This may cause a fire.

Never operate the electrolyzer beyond the electrical specifications stated in the technical data.

CAUTION

Risk of damage due to electrical overload

Any operation beyond the electrical specifications will lead to irreparable damage to the electrolyzer.

Never operate the electrolyzer beyond the electrical specifications stated in the technical data.

CAUTION

Risk of damage due to voltage

Applying voltage to a fuel cell or a solar module leads to irreparable damage to the components.

Do not apply voltage to fuel cells and solar modules.

CAUTION

Risk of damage due to insufficient distance to lamps

The solar module may become excessively hot or sustain irreparable damage if it is too close to the lamp.

Observe the minimum distance defined by the manufacturer when operating solar modules with lamps.

CAUTION

Risk of damage due to improper handling

Operating the electrolyzer using water with an electrical conductivity of $\sigma \geq 2$ µS/cm will cause irreparable damage to the electrolyzer. Only fill the electrolyzer using distilled water with an electrical conductivity of $\sigma < 2$ µS/cm.

NOTICE	**Water in the fuel cell** Ensure that no water enters the fuel cell. A film of water on the electrode surface may suppress the reaction of hydrogen and oxygen in the fuel cell. In such cases, the output of the fuel cell will be inadequate.

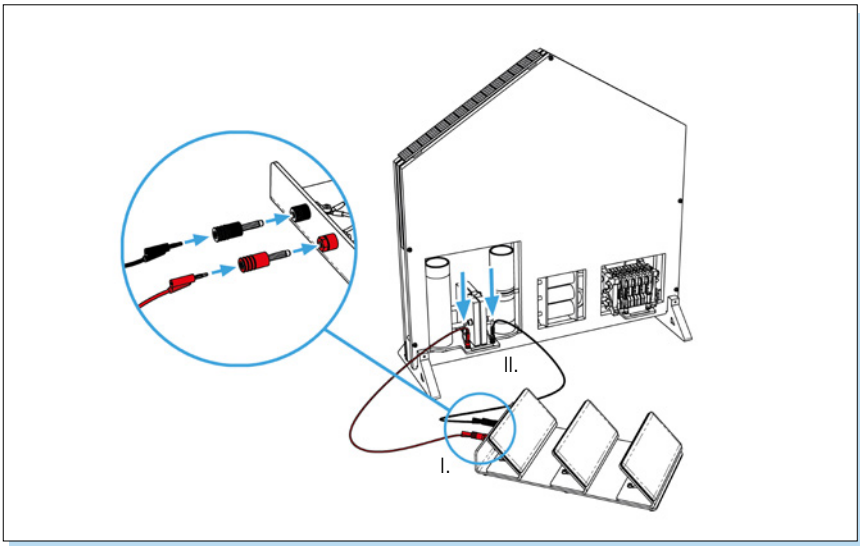


Fig. 8: Operation „DEMO House“

- Read and observe the general safety instructions.
- Connect the connections of the solar module (I.) to the connections of the electrolyzer (II.) (see fig. 8) using connecting cables and adapter
- While ensuring correct polarity (red = “+”, black = “-”).
- If using an alternative power source, make sure to comply with the electrical specifications as defined in the technical data.

■ Provide the solar module with adequate direct sunlight or with light from a powerful, concentrated electrical light source. The shadow of an individual module created by the light must not be projected onto another module. The water is split into hydrogen and oxygen at a ratio of 2:1. Oxygen escapes into the room via the water reservoir. Gas production can be recognized by gas bubbles rising inside the water reservoirs.

■ The “DEMO House” is now in operation. The graphic lights up as soon as the hydrogen reaches the fuel cell stack. Warm-up takes approximately 5 to 10 minutes. If the model is operated by solar module, and if lighting conditions are extremely poor, warm-up may take longer.

■ Hydrogen production has to be stopped if the graphic does not light up after maximum 20 minutes.

■ During operation, small amounts of water pass through the electrolyser’s polymer electrolyte membrane (PEM) from the oxygen side to the hydrogen side. This may cause the water level to rise on the hydrogen side and fall on the oxygen side. In addition, distilled water is being consumed during operation. Therefore, the water levels in the water reservoirs must be checked during operation and, if necessary, adjusted.
If the water level needs to be adjusted, gas production must be stopped. For this purpose, remove the connecting cables on the power source from the respective connections on the electrolyzer.

The water levels in the water reservoirs must always be kept between the marks or at the fill level mark (see chapter “Starting up/Filling”).

Before adjusting the water level, any hydrogen present has to be consumed.

To remove water, suck a little water from the respective water reservoir using the water bottle with installed tube attachment. To this end, the overflow on the hydrogen side must be unscrewed from the water reservoir in counter-clockwise direction.

Distilled water ($\sigma < 2$ µS/cm) can be added with the overflow in place.

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Technical data

Item name: ..... DEMO House
Item no: D111

Solar module:

H x W x D: ..... 70 mm x 150 mm x 280 mm
Weight: ..... approx. 500 g
Number of individual modules: 3
Active solar area: ..... approx. 180 cm²
Open-circuit voltage: ..... approx. 2000 mV DC
Operating current: ..... approx. 1050 mA*

DEMO House

H x W x D: ..... 525 mm x 500 mm x 175 mm
Weight: ..... approx. 7000 g
Permissible operating pressure: ..... 0 - 20 mbar

Electrolyzer:

Number of cells: 1
Active surface per cell: ..... 40 mm x 40 mm
Operating medium: ..... distilled water (σ < 2 µS/cm)
Permissible operating voltage: ..... 0 - 2000 mV DC
Permissible operating current: ..... 0 - 3000 mA
Rated power consumption: ..... approx. 2000 mW
Gas production H_2 at rated power output:...approx. 9 ml/min
Gas production O_2 at rated power output:...approx. 4.5 ml/min

Fuel cell:

Number of cells: 5
Active surface per cell: ..... 15 mm x 15 mm
Operating media: ..... H2 and atmospheric O_2
Open-circuit voltage: ..... approx. 5000 mV DC
Short-circuit current: ..... approx. 1500 mA
Rated power output: ..... approx. 1000 mW
H_2 consumption : ..... approx. 26 ml/min
O_2 consumption : ..... approx. 13 ml/min**

Load:

Type: ..... Lighting

Gas storage tank and water reserve:

Fill volume H_2O, H_2-side: ..... approx. 60 ml
Fill volume H_2O, O_2-side: ..... approx. 110 ml
Gas storage volume H_2: ..... -
Gas storage volume O_2:..... -

Troubleshooting

Despite hydrogen production, the load (illuminated graphic) connected to the fuel cell is not working.

Possible cause 1:

- The overflow is not secured firmly in place.

Solution:

- Secure the overflow firmly in place.

Possible cause 2:

- The connecting cables of the illuminated graphic are not properly connected.

Solution:

- Check the connecting cables and the power source.

Possible cause 3:

- The product requires a brief warm-up period before the hydrogen produced by the electrolyzer reaches the fuel cell stack, where it is converted to electrical energy. Warm-up takes approximately 5 to10 minutes. If the model is operated by solar module, and if lighting conditions are poor, warm-up may also take longer.

Solution:

- Wait an appropriate amount of time (maximum 20 minutes).

The fuel cell has only a low output.

Possible cause 1:

- The fuel cell was stored too dry or for too long. A fuel cell with a dry polymer electrolyte membrane (PEM) will lose power.

Solution:

- Continue operation. The fuel cell automatically moistens itself during operation, which will slowly let it reach its full capacity again.

Possible cause 2:

- Water has entered the fuel cell during operation. This may cause a rapid decline in performance.

Solution:

- Continue operation. Excess water will be expelled from the fuel cell during operation. Consequently, the fuel cell will slowly return to full capacity.

With the solar module connected, no gas production takes place in the electrolyzer.

Possible cause:

- The light intensity is insufficient.

Solution:

- Operate the solar module using either adequate direct sunlight or concentrated light from a powerful electrical light source. Energy-saving light bulbs, fluorescent tubes etc. are unsuitable for the operation of solar modules.

If the above-mentioned solutions do not eliminate the cause of the error, please contact H-TEC EDUCATION.

Shutting down

After disconnecting the power source from the electrolyzer, continue operating the fuel cell stack until the connected lighting turns off. This procedure prevents that hydrogen is released unnecessarily.

⚠ CAUTION

Risk of injury from hydrogen ignition

Escaping hydrogen may ignite when in proximity to an ignition source.

Prevent hydrogen from being released into the atmosphere. Completely use up all hydrogen before dismantling.

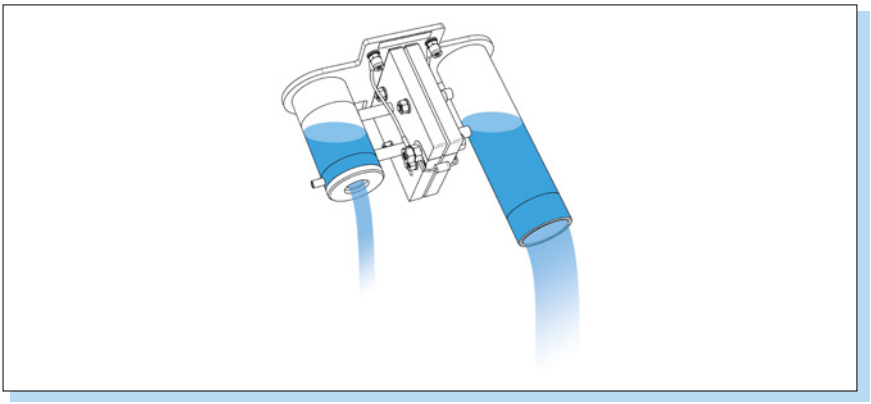


Fig. 9: Emptying the water reservoir

- Disconnect the power source from the connections on the electrolyzer.
- Any hydrogen present has to be consumed before draining the storage tanks.
- Remove the electrolyzer from the demonstration model (see chapter “Starting up”, fig. 5 and fig. 6).
- Disconnect the lower connecting tube of the implied gas storage tank from the connecting pipe of the electrolyzer.
- Unscrew the overflow from the water reservoir in counter-clockwise direction (see chapter “Starting up”, fig. 4).

- Drain both water reservoirs, as shown in fig. 9.
- The water must be disposed of correctly (e.g. drain).
- Disconnect the cables of the graphic from the connections of the fuel cell stack.
- Disconnect the upper connecting tube of the implied gas storage tank from the connecting pipe of the fuel cell stack (see chapter “Starting up”, fig. 5 and fig. 6).
- Remove the fuel cell stack from the demonstration model.
- Remove the implied solar module.

Before putting the product into storage, observe the following points:

- You must ensure that the power source is disconnected from the connections on the electrolyzer.
- Carefully remove any water droplets from the product using a soft, lint-free cloth. This prevents the formation of water stains. No cleaning agents must be used.

⚠ CAUTION

Risk of fire due to catalytic substances

The catalysts for the electrodes of fuel cells and electrolysers promote burning when they come into contact with flammable substances.

Avoid contact with flammable substances.

Maintenance

The components of this product do not require maintenance. The following points should be observed, however:

- Use fresh, distilled water ($\sigma < 2$ µS/cm) for each new start-up.
- After operation, remove the water from the water reservoirs.

Transport and storage

With regard to transport and storage of the product, the following points should be observed to ensure a long service life. Transport and storage only:

- in the original packaging
- dry and dust-free
- at temperatures from 4 °C to 50 °C
- protected from shock and vibrations

Disposal

Do not dispose of fuel cells and electrolysers as general household waste.

⚠ WARNING

Risk of fire due to catalytic substances

The catalysts for the electrodes of fuel cells and electrolysers promote burning when they come into contact with flammable substances.

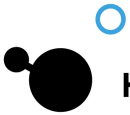
Avoid contact with hydrogen, alcohol fumes or other organic fumes. Ensure correct disposal.

According to European regulations, used electric and electronic devices may not be disposed of as unsorted household waste. The symbol of the crossed-out wheelie bin indicates the requirement for separate disposal.

Your local waste management company can provide you with additional information about disposal options.

Notes:

Notes:



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