



# HYDROG(E)NICS

Advanced Hydrogen Solutions

HYSTAT<sup>®</sup> HYDROGEN FUELING STATIONS











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Carbon based fossil reserves, our primary energy supply today, are in decline and while in use are warming our planet. The decline in supply is not reversible, so the search for alternatives is becoming more important every day. Alternatives that are durable, fuel that is affordable, energy that is renewable. People long for a clean and affordable source of energy for transportation. Many energy experts believe that hydrogen is the energy carrier of choice to power and transport future generations.

Minimizing our footprint on our environment is the mission. Energy storage and zero-emission transportation is the vision. Hydrogen through electrolysis is the solution.

Durable - Affordable - Renewable Hydrogen

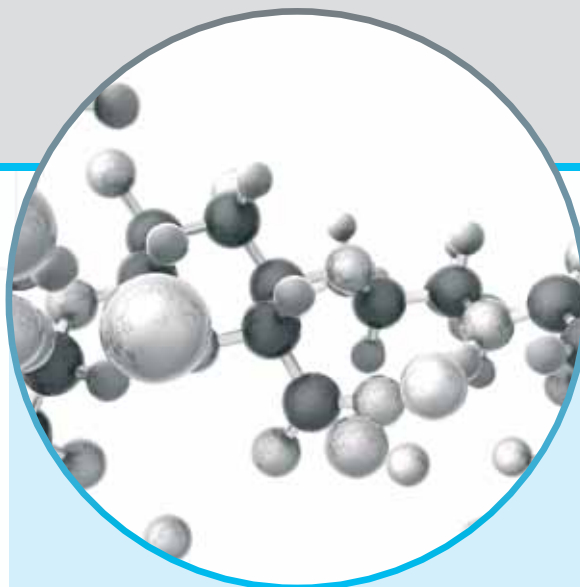
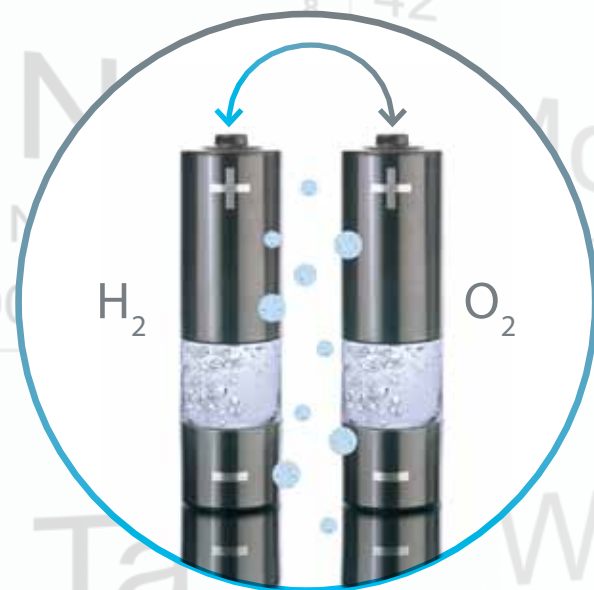
# HYDROGEN AS ENERGY CARRIER

## HYDROGEN MAKES UP 2/3 OF ALL MOLECULES ON OUR PLANET

The periodic table of elements starts with hydrogen. Although the oldest and most common element in our universe, pure hydrogen is not a natural resource. All hydrogen on earth is stored in a compound with other molecules. Water, essential for all life processes surrounding us, consists of 66% hydrogen. Water is a very stable element, from which hydrogen can be extracted using an electroly-

sis process.

Electrolysis requires the input of electrical energy, however because hydrogen is a very energetic fuel the resulting energy produced is almost equal to initial energy input. The only product of this combustion of hydrogen is water. Like any other fuel hydrogen can be stored and used for combustion at any given time.



### WATER + ELECTRICITY = HYDROGEN

Hydrogen's ability to combine with oxygen was first noted by Henry Cavendish in 1766. The first electrolyser subsequently appeared in 1800 when Nicholson and Carlisle induced a static charge into water. 300+ years later Hydrogenics continues to evolve and improve on these fundamental discoveries.

### RENEWABLE ENERGY

When a voltage is applied across 2 electrodes in an aqueous solution, a water splitting reaction occurs. Hydrogen will evolve at the cathode, while oxygen will evolve at the anode. Recombination of hydrogen and oxygen at this stage is avoided by means of an ion-exchange membrane between the electrodes. Hydrogenics has developed the IMET<sup>™</sup> membrane which offers a very high electrical conductivity with a close to perfect gas separation.



We're ready.

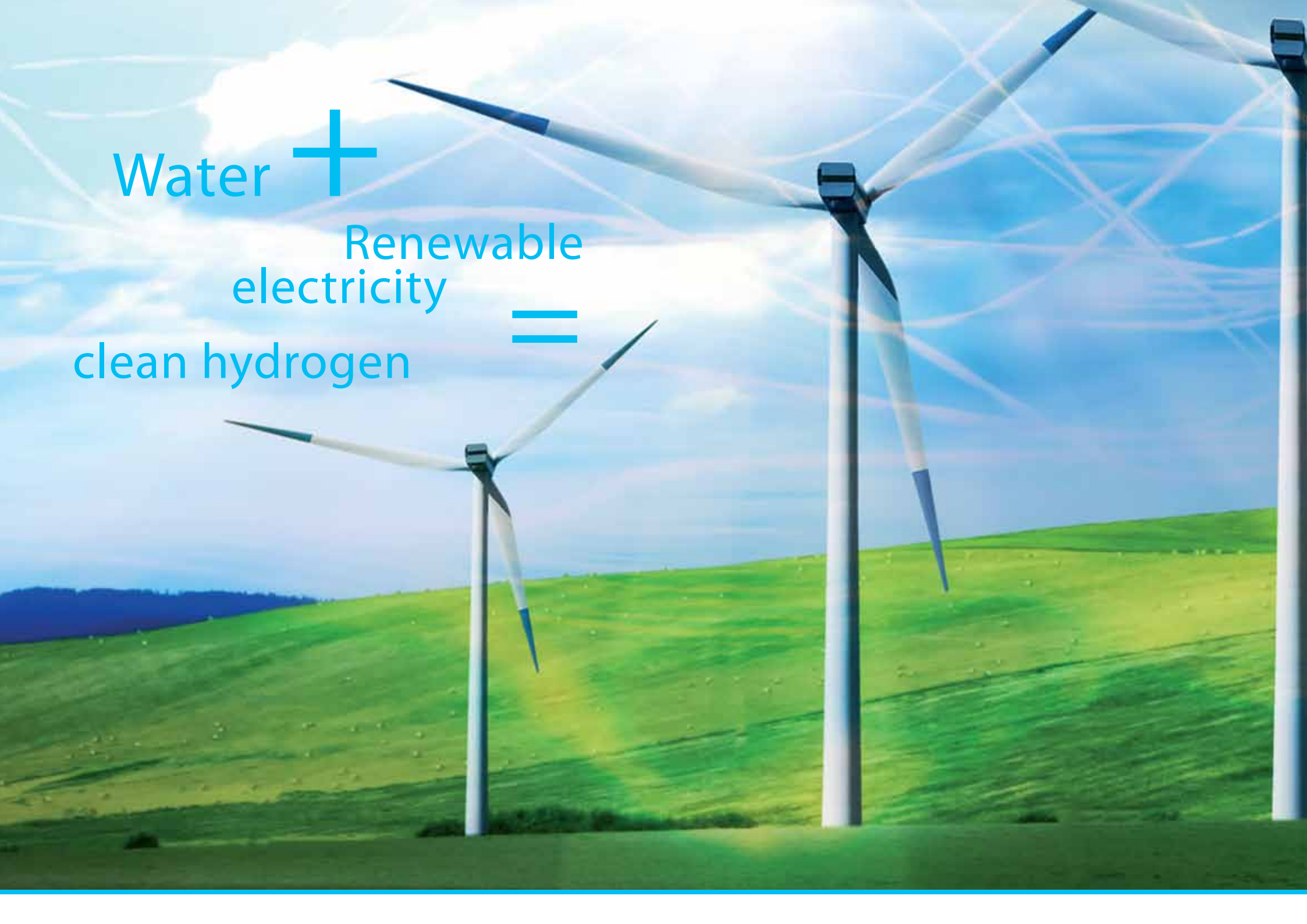
## Hydrogen data

- Lower heating value: 33,33 kWh/kg, 120 MJ/kg
- Higher heating value: 39,41 kWh/kg, 141,86 MJ/kg
- Density: 0,0899 kg/Nm<sup>3</sup>
- Boiling point: 20,390 K
- Specific heat capacity:  $C_p = 14,199 \text{ J/kg/K}$ ;  $c_v = 10,074 \text{ J/kg/K}$
- H<sub>2</sub> is the lightest element in the universe (14,5 x lighter than air).
- 1 kg of H<sub>2</sub> contains as much energy as 3,78 l gasoline.
- H<sub>2</sub> is colorless, tasteless and odorless.
- H<sub>2</sub> is non toxic.

1	<sup>2</sup> S <sub>1/2</sub>
H	
Hydrogen	
1.00794	
1s	
13.5984	
3	<sup>2</sup> S <sub>1/2</sub>
4	<sup>1</sup> S <sub>0</sub>

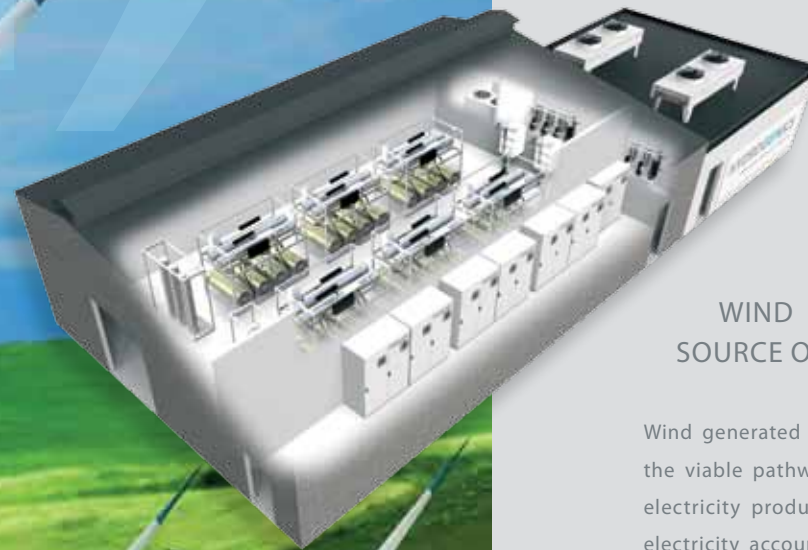


Water + Renewable  
electricity =  
clean hydrogen



# HYDROG(E)NICS

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WIND = A NEVER ENDING  
SOURCE OF CLEAN FUEL

Wind generated electricity is widely considered as the viable pathway to reduce CO2 emissions from electricity production. Every year wind generated electricity accounts for a larger share of the portfolio of applied generation technologies. However such an input of energy imposes extra measures on the grid to maintain stability. In times of excess energy (demand lower than supply) hydrogen can be produced and stored. The energy thus stored can be used at any given time later. The electricity generated by one large wind turbine is sufficient to power a fleet of 4.000 hydrogen fuelled cars.

Hydrogenics can offer you the adapted solution for fueling stations or MW energy storage installations.



# HYDROGENICS

Advanced Hydrogen Solutions

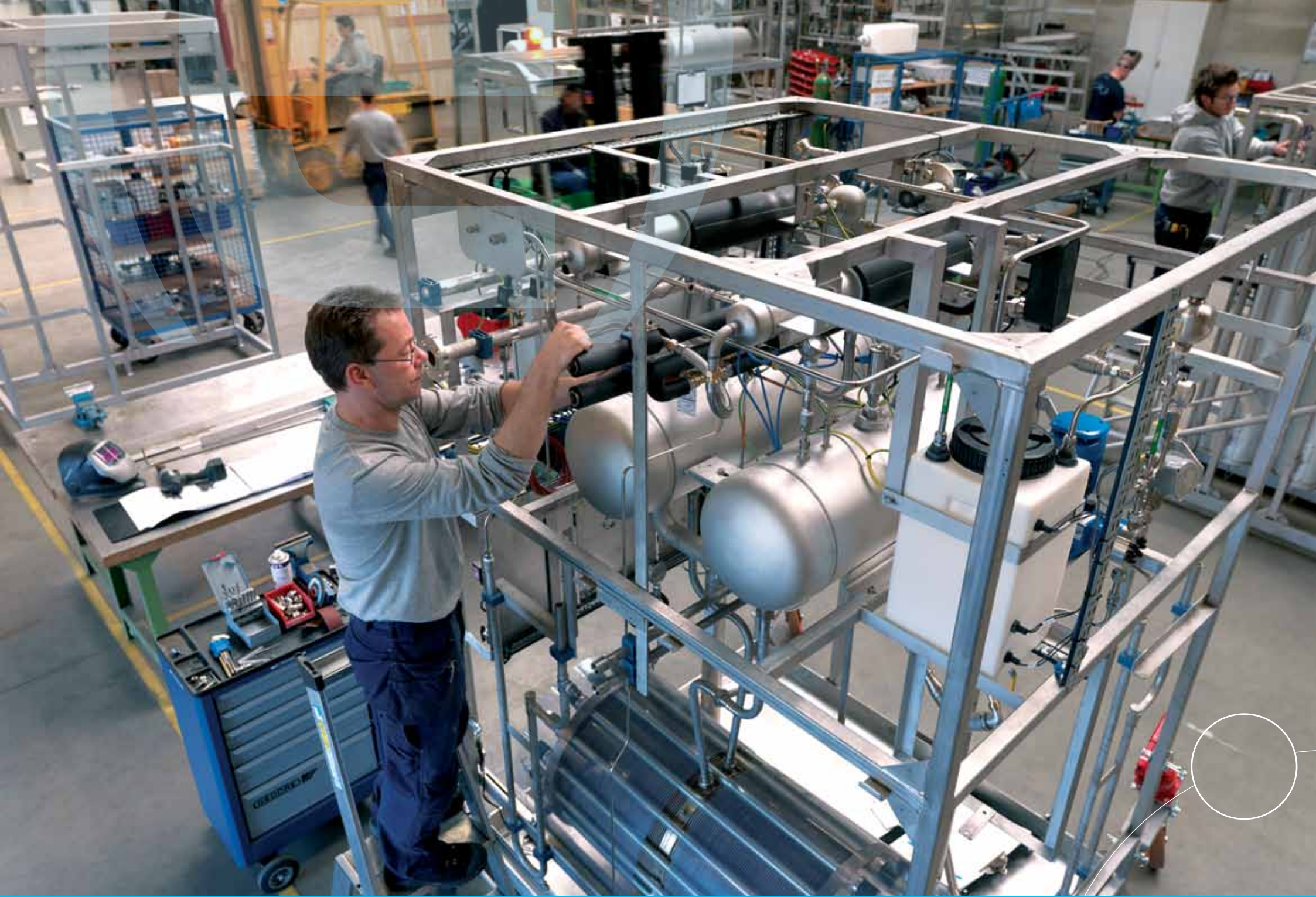
## THE POWER OF EXPERTISE

The combination of experience and a constant drive to improve, has made Hydrogenics the winning choice for a wide range of HySTAT® hydrogen fueling stations, renewable energy storage and conversion systems.

Today, all HySTAT® based products are designed and built in Hydrogenics manufacturing facility in Belgium. A dedicated staff of 60 skilled personnel bring a common ideal to work every day: to design and manufacture the world's best on-site hydrogen solutions.









# HySTAT<sup>®</sup> fueling station

## GREEN HYDROGEN FOR TRANSPORT

The HySTAT<sup>®</sup> fueling station uses our advanced electrolysis technology to split water into hydrogen and oxygen, using only electricity. Hydrogenics offers complete hydrogen fueling stations with modular capacities ranging from 20 kg

to 130 kg/day and beyond. The hydrogen is dispensed at 350 or 700 bar. The HySTAT<sup>®</sup> fueling station is a turnkey solution, which comes fully interconnected, automated and is easy to install. The process is quiet, reliable, safe and can

claim true zero emission fuel from production to consumption, eliminating the dependency on fossil fuels.

## Technical specifications

MODEL	HySTAT <sup>®</sup> 10	HySTAT <sup>®</sup> 15	HySTAT <sup>®</sup> 30	HySTAT <sup>®</sup> 45	HySTAT <sup>®</sup> 60
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### Module 1 (Electrolyser: H<sub>2</sub> production for 350 or 700bar)

Max. Nominal Hydrogen Flow	21 kg/day	32 kg/day	65 kg/day	97 kg/day	130 kg/day
Nr. of cell stacks	1	1	2	3	4
Hydrogen flow range	40 - 100% (25 - 100% as an option)				
Electrolyte	H <sub>2</sub> O + 30% wt. KOH				
Approx. Electrolyte Quantity	220 L	240 L	360 L	480 L	610 L
Tap water consumption	1,5 - 2 liters/Nm <sup>3</sup> H <sub>2</sub>				
Dimensions Module 1 (LxWxH)**	6,10m x 2,44m x 2,90m (+1,60m with dry cooler)				

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### Module 2 (for 350bar)

Compressor	450bar				
Storage vessels at 450bar	3 banks cascade system sized according to filling requirements				
Cooling for refueling	According to SAEJ2601 filling time requirements				
350bar Dispenser 2	1 (built according to SAEJ2601 standards)				
Dimensions Module 2 (LxWxH)**	6,10m x 2,44m x 2,90m				
Estimated AC power consumption (all included with module 1)	68 kWh/kg	68 kWh/kg	65 kWh/kg	65 kWh/kg	65 kWh/kg

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### Module 2 (for 700bar)

Compressor	450bar				
Booster Compressor	850bar, sized according to SAEJ2601 requirements				
Storage vessels at 450bar	3 banks cascade system sized according to filling requirements				
Storage vessels at 850bar	Sized according to filling requirements				
Cooling for refueling	According to SAEJ2601 filling time requirements				
700bar Dispenser 2	1 (built according to SAEJ2601 standards)				
Dimensions Module 2 (LxWxH)**	12,10m x 2,44m x 2,90m				
Estimated AC power consumption (all included with module 1)	70 kWh/kg	70 kWh/kg	68 kWh/kg	68 kWh/kg	68 kWh/kg

MODEL	HySTAT <sup>®</sup> 10	HySTAT <sup>®</sup> 15	HySTAT <sup>®</sup> 30	HySTAT <sup>®</sup> 45	HySTAT <sup>®</sup> 60
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### Overall for 350 and 700bar

Max. cooling water t° (electrolyte)	Closed loop cooling circuit installed				
Design flow cooling water (electrolyte)					
Max. cooling water t° (gas cooling)	Chiller gas colling circuit installed				
Design flow cooling water (gas cooling)					
Demineralized water consumption	Feed water purification system installed				
Hydrogen Purity (after HPS)	Fuel Cell grade hydrogen at 99,998% according to SAEJ 2719 and ISO 14687 (99,999% as an option)				
Voltage	3 x 400 VAC ± 3% (3 x 480 or 575 VAC ± 3% as an option)				
Frequency	50 Hz ± 3% (60 Hz ± 3% as an option)				
Installation Area	Outdoor, general purpose area (optional indoor)				
Ambient Temperature Range	-20°C to +40°C (-40°C or +50°C as an option)				

1: ISO high cube container

2: Additional dispenser and IR communication system with vehicle as an option





We're ready.



# Fuel from water

## SOME OF OUR HYSTAT® FUELING STATIONS

For more than a decade Hydrogenics has been delivering technology for hydrogen fueling stations around the world.



EON  
Malmö, Sweden

BP  
Barcelona, Spain

Shell, Santa Monica  
CA, USA





We're ready.

Toyota  
CA, USA

Powertech  
Bella Coola, Canada

CSULA, Los Angeles  
CA, USA

Gaz de France  
Dunkerque, France



## IMET<sup>®</sup> cell stack

At the 'heart' of the HySTAT<sup>®</sup> water electrolyser is our patented IMET<sup>®</sup> (Inorganic Membrane Electrolysis Technology) cell stack.

In this cell stack, water (mixed with 30% KOH) is broken down into its basic elements, hydrogen and oxygen, by means of a DC current. The cell stack consists of a series of interconnected, circular electrolysis cells, each containing two electrodes located on either side of an advanced patented inorganic ion-exchange membrane, which is manufactured in-house. The purpose of the membrane is 2-fold: to allow ion transfer with the minimum of resistance and to prevent recombination of the produced hydrogen and oxygen.

The IMET<sup>®</sup> cell stack combines an outstanding conversion efficiency with a long service life, of more than 50.000 hours.



Cell stack

## HySTAT<sup>®</sup> quality

Only the highest quality manufacturing standards result in a top quality product. Manufacturing of the HySTAT<sup>®</sup> is done in several stages, each of which ends in a quality monitor or "gate". No HySTAT<sup>®</sup> moves to its next stage without sign-off from our quality personnel and an assigned Project Manager. Every HySTAT<sup>®</sup> that leaves the factory is tested for more than 24 hours at its full operating rate. Testing can be attended by the customer.

Hydrogenics complies with ISO 9001 and 14001, OHSAS 18001 and all applicable world engineering codes and standard including CE, ATEX, Rostechndazor, PED and ASME / UL compliances.







After installation of the HySTAT<sup>®</sup>, our service team will come on-site for a final check and full commissioning of the plant. Many years of consolidated experience also makes our service team your best partner for longer term maintenance contracts.

## Global servicing



CONTACT US

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Hydrogenics On-site generation

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