

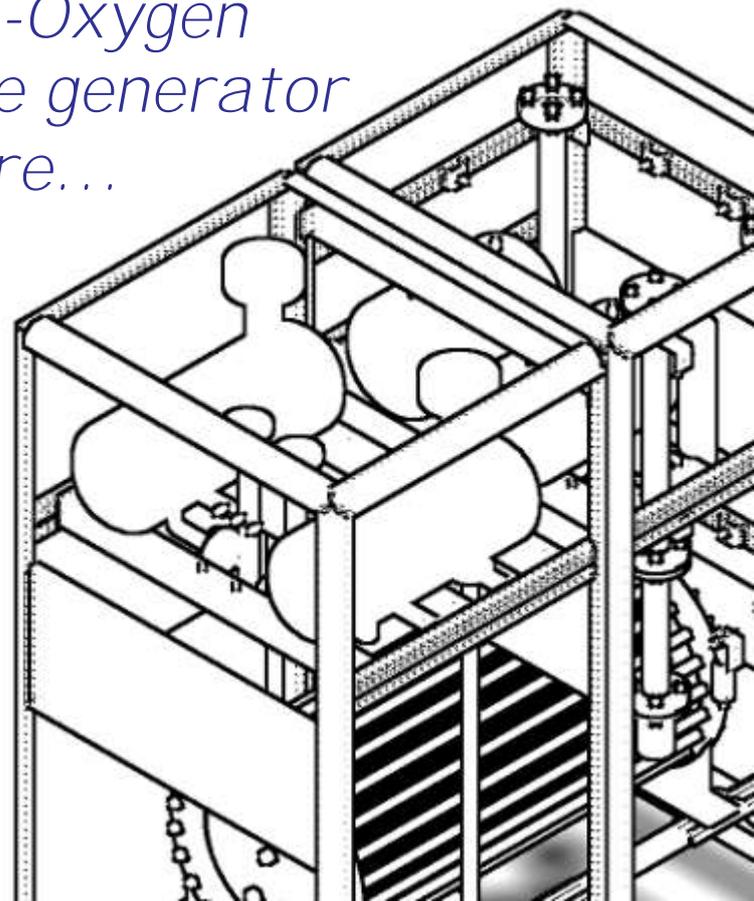


**Autodesk**  
Clean Tech Partner

# **H<sub>2</sub> Nitidor**

HIGH PRESSURE GENERATOR

*Hydrogen-Oxygen  
high-pressure generator  
& more...*



*Custom machines*

# What is hydrogen?

*Hydrogen* is the simplest element known to exist, the first element of the periodic table and its symbol is H.

An atom of hydrogen has one proton and one electron around it.

Hydrogen as a gas is found only in compound form ( $H_2$ ), and it has the highest energy content of any common fuel by weight.

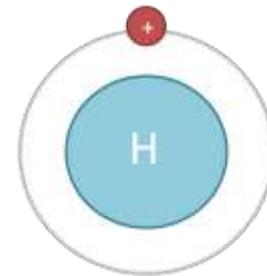
Hydrogen with a ratio of 80% is the main ingredient of the visible universe and is quite abundant on Earth too; many stars, including the Sun, generate energy by fusing hydrogen to helium. In fact the sun is basically a giant ball formed by these two elements.

In a process called fusion, four hydrogen atoms combine to form one helium atom, releasing energy as radiation.

This radiant energy is our most abundant energy source. It gives us light, heat, makes some plants grow, and causes wind to blow and rain to fall.

On earth the most familiar hydrogen compound is water where two atoms of Hydrogen combine with one atom of oxygen ( $H_2O$ ). All the complex molecules of life contain hydrogen too.

*Hydrogen atomic model*



*Hydrogen technical data*

molecular weight [g/mol]	2,016
boiling point [° C]	-252,8
critical temperature [° C]	-239
critical pressure [bar]	12,79
low calorific value [MJ / kg]	119,9
low calorific value [kWh/Nm <sup>3</sup> ]	2,93
high calorific value [MJ / kg]	141,8
high calorific value [kWh/Nm <sup>3</sup> ]	3,45
Specific heat [kJ/kgK]	14,89
heat vaporization [kJ / kg]	446
lower flammability limit [%]	4
upper flammability limit [%]	75
ignition energy [mJ]	0.02
ignition temperature [° C]	585

## Why Hydrogen is the future energy source?

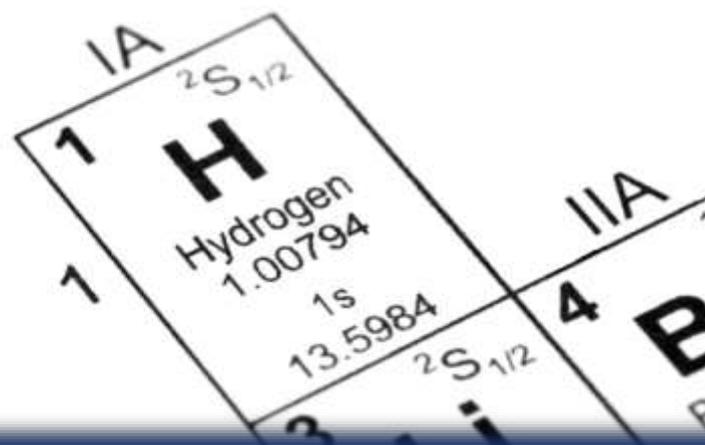
**Because** hydrogen is a high efficiency and low polluting fuel that can be used for transportation, heating and power generation in places where it is difficult to obtain electricity.

For this reason, hydrogen is the most promising energy carrier for the future.



**IMPORTANT:** The volume of hydrogen is measured in Nm<sup>3</sup> (normal cubic meter).

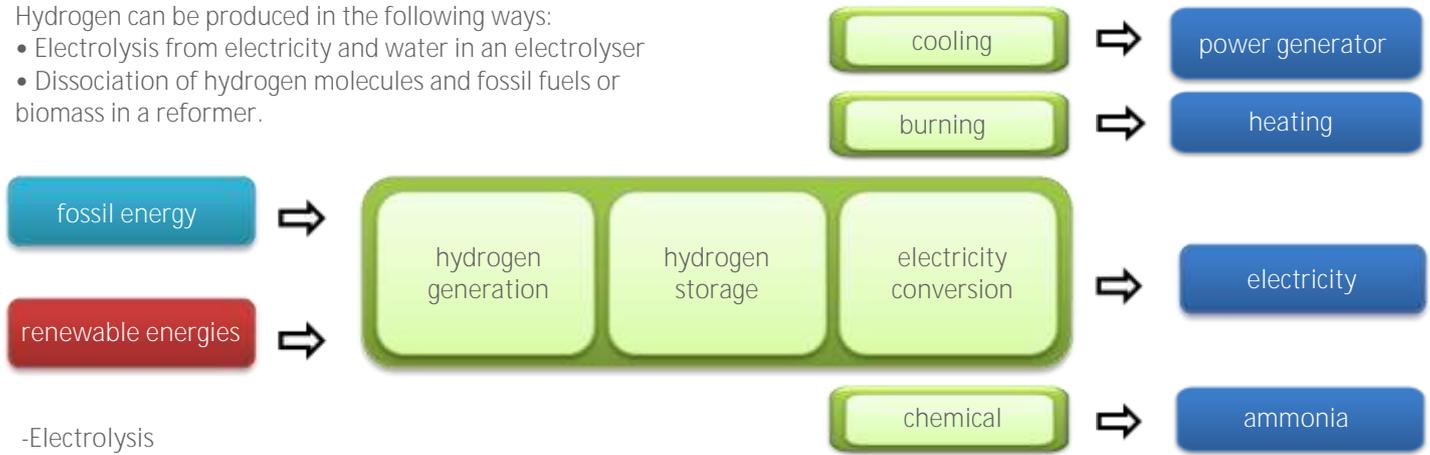
1 Nm<sup>3</sup> represents a volume of 1 m<sup>3</sup> of hydrogen at a pressure of 1 atmosphere (1013 hPa is 1.013 bar) at a temperature of 0 ° C. 1Nm<sup>3</sup> hydrogen weighs 0,089 kg.



# What is electrolysis?

Hydrogen can be produced in the following ways:

- Electrolysis from electricity and water in an electrolyser
- Dissociation of hydrogen molecules and fossil fuels or biomass in a reformer.



## -Electrolysis

Hydrogen is present in water (H<sub>2</sub>O) with 2 grams of hydrogen to 18 grams of water. It can be extracted by a process of electrolysis using electricity and water. The only source of pollution may be the electric power feeding the electrolyser.

With the use of renewable electricity such as hydro, wind turbines or solar cells, electrolysis of water can produce pure hydrogen without pollution and a fuel efficiency of almost 80 %.

Electrolysers generally produce hydrogen at high pressure (H<sub>2</sub>Nitidor electrolysers up to 30bar) which can be stored in hydrides or compressed to be stored under higher pressure.

## -Reforming

Hydrogen can be extracted through a direct chemical process (reformed), but the chemical industry always leads to locally produced CO<sub>2</sub> or impurities remaining in the hydrogen (sulfur compounds ...)

## -Pressurized storage

Hydrogen which is the output of electrolysis can be stored under pressure without using compressor, about <30 bar. However, at this pressure, the energy stored per unit volume is low (15 Wh per liter to 10 bar). The industrial hydrogen is stored at a pressure of 200 bar in bottles of a few tens of liters. The industry standard is to store 50 liters, at 200 bar, 10 Nm<sup>3</sup> (900 grams) of hydrogen, an energy of 15 kWh. Storage tanks can increase the storage capacity if necessary. Pressure for hydrogen storage on board vehicles (car - public transportation) is 200 - 350 - 700 bar (depends on Country). Storage tanks are made of metal or composite materials for lightness.

## -Liquefied hydrogen

Another way to store hydrogen is to produce liquid hydrogen systems, which contain the gas at very low temperatures. This method allows decreasing even further the volume occupied by hydrogen, compared to an increase in weight and cost.



6Nm<sup>3</sup>/h Hydrogen electrolyser unit



Metal hydrides tank

## -Metal Hydrides (MH) storage

It is also possible to store hydrogen at low pressure (about <30 bar) directly at the output of electrolytic in bottles of metal hydrides. Hydrides offer a storage volume capacity greater than that obtained under pressure at 700 bar with an efficiency of about 97% during the storage and restitution.

# About Us...

H2Nitidor is a company with years of experience in designing and manufacturing high pressure electrolyzers. We are a team of experts, committed to the excellence and innovation on hydrogen technologies

With an active department of R&D, H2Nitidor is focused on the development of reliable, high efficiency, high purity and high pressure alkaline electrolyzers

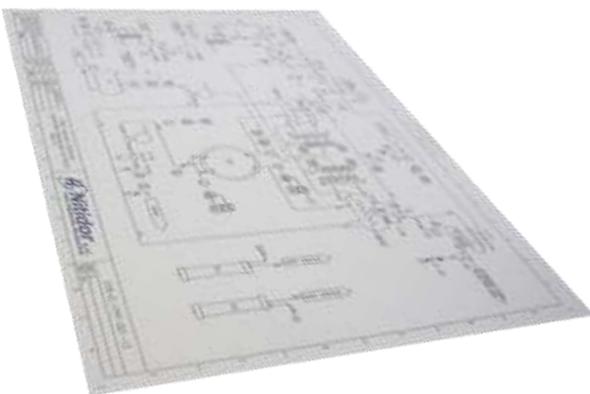
Field proven and state-of-the-art hydrogen-electrolyser system suitable for advanced transportation, aviation and renewable energies, such as Photovoltaic and Wind energies. The development department of H2Nitidor researches and studies about advanced industrial applications in partnership with the main research institutes in the world.

Our electrolyzers offer operational advantages:

- on site, on demand and reliable hydrogen source
- High purity hydrogen gas
- Up to 30 bar pressure (without a compressor)
- Automated, reliable and low maintenance system
- Possibility of use with either grid electrical power or renewable electrical power
- High quality safety system

H2N offers gas Compressor Unit (Booster), realized with an original design. The H2NITIDOR compressors are able to

H2Nitidor engineers work on the schematic P&I and electrical schematic.



In partnership with **Autodesk**, H2Nitidor's team works with the best software and hardware available in the market today.

3D CAD modeling, stress analysis, simulation of flows and piping are only part of software that Autodesk gives to H2Nitidor designers.



### VOLTIANA® Electrochemical Cell

The engineering basis of VOLTIANA® cells have been established from 1982, and patents have been filed consequently.

The cells have been designed to be available for a variety of electrochemical applications, it allows the design from the possibility of setting up series cell configurations, and then carrying out electrochemical processes having different requirements.

VOLTIANA® cells are characterized by standard frames in electrically non-conductive material, accommodating in this frame the components performing the electrochemical process, such as the electrodes, the diaphragms or the membranes, as well as the necessary devices for leading the electric current, for distributing the electrolyte and collecting the electrolysis products.

Recently it has been recognized that the VOLTIANA® cells' structure may be also used for setting up fuel cells and flow battery systems having the advantage of a reduced weight of the manufacturing.

The cell frames are not metallic, but are realized in "composite" materials (combination of a reinforcement material, such as particles or fibres, in a matrix of binder material). Fibre-reinforced plastics (FRP) are the most family of composite used for VOLTIANA® cell frame manufacturing.

The composite materials frames have many intrinsic advantages, so for instance:

- they are produced by injection-moulding techniques, allowing the mass production of the cells;
- the wide spectrum of available moulding plastic materials, which can withstand the chemical attack of almost all possible electrolytes;



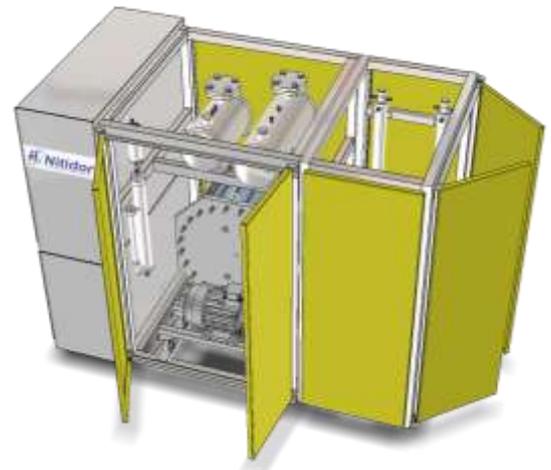
Typical VOLTIANA® cell frame structure in composite material



VOLTIANA® cell frame of series cell set up



The structure of a typical VOLTIANA fuel cell



H2Nitidor is Supporter of NEW IG



Committed to excellence and innovation since its creation, H2Nitidor offers high efficiency Pressurized Alkaline Water Electrolysers up to 30bar, based on VOLTIANA® technology by CASALE Chemicals (CH).

H2Nitidor offers a wide range of electrolyser technical specifications and special constructions will be provided on request for integration into energy handling systems based, for instance, on renewable energy resources powering.

-The cell stack is the heart of the process. It is made by stacking in series a certain number of bipolar electrolytic cells of patented design, trade mark VOLTIANA®. Hydrogen and oxygen are generated inside the cells by the action of a direct current (DC) flow

Water splitting requires power (theoretically about 3.55 kWh/Nmc of generated hydrogen), which is supplied by the DC power flow. Thanks to the particular design of VOLTIANA® electrolysers the low inherent heat power losses allow cells reach up to 80% energy efficiencies. Potassium Hydroxide (KOH) is added for forming the electrolyte.

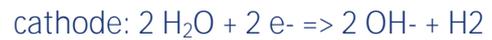
-Programmable logic controller (Plc) for managing all the processes and safety. Optionally, remote operation is also possible from a PC using proprietary software.

-Power Supply 1 or 3-Ph AC power input from the grid could be converted to DC power by a controlled transformer/ converter system, or renewable energy (PV, wind, etc) can be used.

Control panel with PLC



*Water shift reaction*



80 cells 30 bar stack  
With 500 cm<sup>2</sup>  
active surface



40 cells 30 bar stack  
with 100cm<sup>2</sup>  
active surface



The electrolyte and gases inventory in the system are very limited.

No manual operation may bring the operator into contact with the electrolyte.

The system is enclosed in a cabinet subdivided, double wall, into two separate chambers, one encloses the process unit, the second one encloses the power supply unit.

The process chamber is subject to forced ventilation, aiming to remove any possible traces of hydrogen. The ventilation is guaranteed by supervision. A H<sub>2</sub> sensor could also be installed inside.

Optionally in the smaller units, and systematically in the larger H2Nitidor units, hydrogen and oxygen purity is monitored by gas analyzers

All H2Nitidor products comply with the requirements of ISO **TC 197, No 228 “Basic considerations for the safety of hydrogen systems”**, and consequently also comply with the Directive PED 97/23/CE concerning pressure vessels, and the Directive ATEX 94/9/EC, relating to the electric and control installations in possible presence of flammable gas.

# Applications

*Hydrogen is an important resource for industry and it's possible to find it in many applications*

## -Cutting & welding metals

Hydrogen has been extremely successful as a replacement for common industrial gases for most soldering, brazing, cutting, fusing (it makes possible to melt and cut most materials in record time), and specialty welding applications.

## -Hydrogen in the Fertilizer Industry

The mixture of hydrogen and nitrogen is the key to make ammonia. Natural gas is often used to cause the electrolysis that separates hydrogen from water, but researchers are trying to make the process work with hydrogen generated through wind power. Ammonia is a key ingredient in fertilizer production.

## -Cleaning Semiconductors

The presence of hydrogen in semiconductors allows them to work more efficiently. However, hydrogen does have negative impacts on some kinds of semiconductors as well.

## -Hydrogen in Rockets

Hydrogen has become the default fuel for space travel. It is favored because it is the lightest known substance and has a high energy capacity. Many space agencies such as NASA use hydrogen in their rockets.

## -Hydrogen Cooking & Heating

Hydrogen burns differently than either propane or natural gas. In particular, hydrogen's rate of diffusion and flame velocity are roughly ten times greater than the propane or natural gas ones. The great advantage of burning hydrogen is that, Hydrogen doesn't produce pollution, but only NOx.

Another applications are: cooling of power generators, hydrogenation of oils, special steel and float glass production



*Hydrogen is closely connected with renewable energy applications like photovoltaic panel and wind generator.*



*With zero emissions and zero pollution, hydrogen is the future for mobility and transports.*

-Hydrogen mixed with Natural gas

The combination of natural gas and Hydrogen gas provides an impressive compliment of clean fuels. The addition of Hydrogen to natural gas combustion environments has been shown to greatly reduce fuel consumption and improve emissions, especially carbon monoxide (CO).



-Fuel cell

Fuel cell is a device that converts the chemical energy from a fuel, in this case hydrogen, into electricity through a chemical reaction with oxygen or another oxidizing agent.



-Mobility

H2N.mobility is the answer of H2N to the increasing request of mobility at zero emission.

H2Nitidor studies innovative solutions to introduce hydrogen in mobility market.

Turnkey plant for small and medium quantity of hydrogen production for light vehicles:

- mini Cars
- bicycle
- motorcycle

Turnkey plant for high quantity of hydrogen production for heavy vehicles:

- cars
- bus
- school bus
- boats
- airplane



# Electrolysers



## Standard electrolyser line

...High pressure, High purity, High efficiency  
..Everything ON DEMANDE!

Controllable range [%]
Operation pressure [bar]
Hydrogen Purity (ref. dry gas) [%]
Hydrogen Purity (with pury-unit) [%]
Hydrogen humidity
Hydrogen humidity (with dryer) D.P. [°C]
Electrolyte KOH [%]
Power supply grid
Cooling by
Min/max room temperature [°C]
Installation
Managing Process

20-100
Up to 30
99,8
99,995
Saturated
-65°C
25
1-3 Ph 230-400V 50/60Hz
air/liquid
5-35
Outdoor/indoor
PLC



Hydrogen capacity (ref.dry gas) [Nm <sup>3</sup> /h]
Power consumption (at full load) [kW]
Demineralsed water consumption [l/h]
Active cell surface [cm <sup>2</sup> ] *

0,25	0,5	1	1,5	2
1,8	3,5	5,5	8	11
0,23	0,45	0,9	1,35	1,8
100	100	100	100	100

Hydrogen capacity (ref.dry gas) [Nm <sup>3</sup> /h]
Power consumption (at full load) [kW]
Demineralsed water consumption [l/h]
Active cell surface [cm <sup>2</sup> ] *

2,5	5	6
14	27	33
2,25	4,5	5,4
500	500	500

Hydrogen capacity (ref.dry gas) [Nm <sup>3</sup> /h]
Power consumption (at full load) [kW]
Demineralsed water consumption [l/h]
Active cell surface [cm <sup>2</sup> ] *

10	15	20
55	82	110
9	13,5	18
1000	1000	1000

Hydrogen capacity (ref.dry gas) [Nm <sup>3</sup> /h]
Power consumption (at full load) [kW]
Demineralsed water consumption [l/h]
Active cell surface [cm <sup>2</sup> ] *

30	50	100
160	260	500
27	45	90
5000	5000	10000

\***IMPORTANT:** use a cell with different active surface to lower the voltage. In this way you can connect the electrolyser directly to DC Bus of a renewable source (for example photovoltaic panel, wind generator and more...)





# Mini booster

## Standard Mini booster/Compressor line

**..up to 200 or 350 bar...**  
*The best way to storage hydrogen at high pressure!*

H2N.b high pressure boosters by H2NITIDOR are suitable for oil free compression of gases and air. Industrial gases like **Hydrogen, Methane, Nitrogen ...** can be compressed to operating pressures up to 350bar(5,075 psi).

H2N.b boosters are an efficient alternative instead of Electrically and Air driven products, They can be used in explosion proof areas.

One, two stage boosters or more stages can be used to achieve different operating pressures and flow capacities. H2N.b booster can be supplied assembled in the electrolyser; this is a compact and easy solution to use.

Special Customer Flow Capability available on demand; CE, PED, ATEX standards are respected.



Model	Capacity	In Pressure (min)	Out Pressure (max)
H2Nb 3-200	3Nmc/h	5bar	200bar
H2Nb 3-350	3Nmc/h	5bar	350bar
H2Nb 10-200	10Nmc/h	5bar	200bar
H2Nb 10-350	10Nmc/h	5bar	350bar
H2Nb 20-200	20Nmc/h	5bar	200bar
H2Nb 20-350	20Nmc/h	5bar	350bar

H2N.b booster can be used alone to increase the hydrogen pressure up to 350 bar for storage, and also integrated in the electrolyser, so that a compact and sure system that can produce and furnish hydrogen to high pressure is available.

High Pressure storage hydrogen gas can be used for Power generator cooling

With our electrolyser system and mini booster you can produce hydrogen at pressure up to 350bar, and this can be used in Hydrogen Refueling Station



# Exhaust gas analyser



## Standard exhaust gas analyzer line

...simple to use, with touch screen interface... **The best way to analyze exhaust gases...**

H2N.ega (Exhaust Gas Analyzer) by H2NITIDOR is used extensively in emissions checking stations in continuous sampling system.

H2N.ega exhaust gas analyzer wraps a robust, continuous sampling, conditioning and calibration system. The analyzer is highly repeatable, utilizing Electro-Chemical, Zirconium Oxygen Sensor and NDIR sampling methods, making it an excellent diagnostic tool when packaged and integrated in a solid system. A heated filter and with temperature controls are offered for sample gas conditioning.

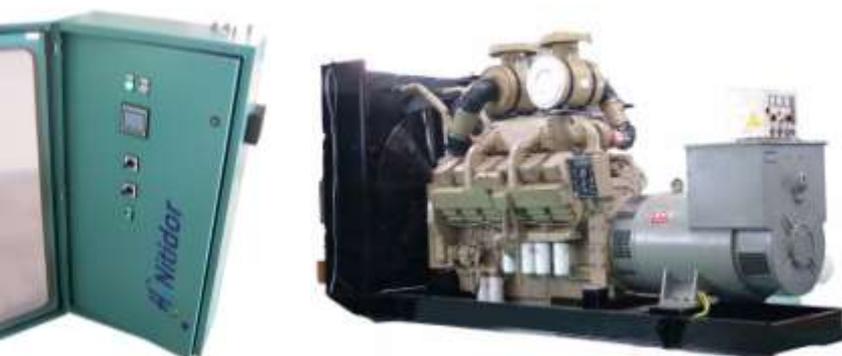
Touch-screen interface is available for manual operation, calibration and operator data viewing, and offers a computer Mod bus port for communications and data acquisition.

Gas	Sensor	Range
O <sub>2</sub>	Zirconia Sensor or Electro-chemical	0,1/20,9 % 0,1/20,9 %
CO	Electro-chemical	0/4000ppm
CO <sub>2</sub>	Calculated or NDIR	0/ CO2max 0/20%
NO	Electro-chemical	0/2000ppm
NO <sub>2</sub>	Electro-chemical	0/200ppm
SO <sub>2</sub>	Electro-chemical	0/2000ppm
T	Pt100 0/+500°C	+ 1 °C



H2N.ega analyzers are used in industrial processing to verify the emissions of polluting gas.

Also the H2N.ega analyzers are used for testing the emissions from GEN-SET fueled by Methane, Singas, etc., and then mixing these gases with hydrogen (HNG)





CasaleChemicals is based on the founder's fundamental values of innovations, geniality, high quality, entrepreneurial sense, customer care and endurance. Casale chemicals operates in the field of hydrogen production processes and construct and commercializes pressured water electrolyzers of an advanced design powered by renewable energies .

## accadue s.l.

accadue s.l. Is a Spanish company that is developing hydrogen customized solutions.



Ador Green Energy Pvt. Ltd.(AGEPL) is a member of the Ador Group of Companies. Situated in Mumbai, India, Ador Green proposes innovative solution for renewable energy .



## ENESSERE

Building on decades of experience in technology & engineering, ENESSERE is ready to deliver the next-generation of practical, reliable, and scalable energy systems. ENESSERE proposes a business model focused on delivering commercially desirable products which incorporate practical innovation, solve real-worlds problem, and fulfill important needs.



Hytron, Brazilian company developing small on site hydrogen generators for industrial and energy applications. Hytron offers its clients customized water electrolyzers and ethanol and natural gas reformers with high reliability and low environmental impacts.



*...See our website: [www.h2nitidor.com](http://www.h2nitidor.com)...*

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