



Hydrogen Solutions

Your partner for sustainable hydrogen generation

Renewable energy



Growth

Renewable energy is playing an increasingly important role worldwide. It's the backbone of a sustainable, CO₂-free energy sector, and this a key technology for achieving decarbonization by the year 2100. Its share in global power generation is growing daily. But how can fluctuating energy sources such as sun and wind be integrated in existing grids, ongoing industrial processes, and flexible, individual mobility?

Electrochemistry

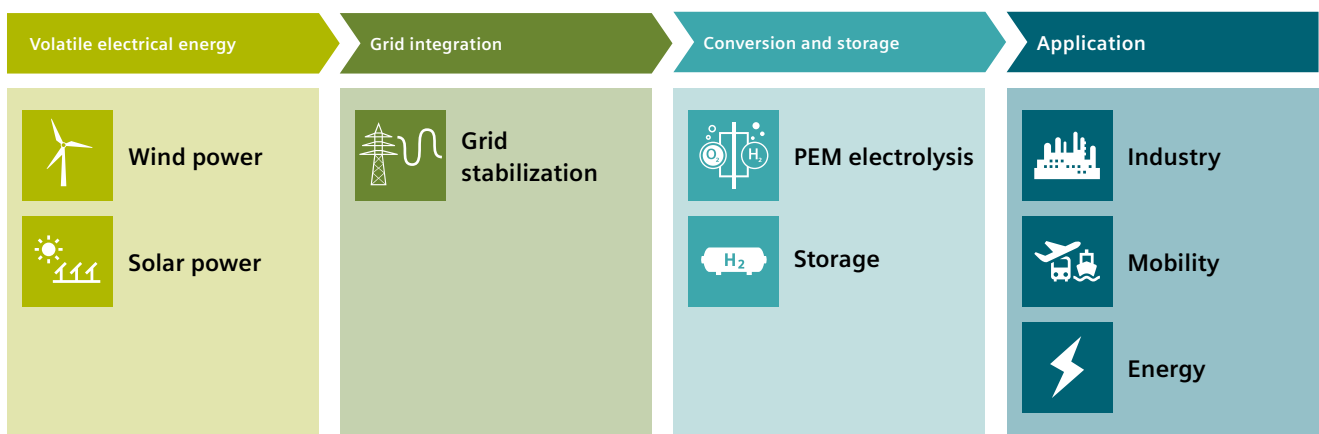
Using electrochemical processes, electrical energy is converted directly to a chemical energy source – and vice versa! The advantage is that this eliminates the intermediate step of thermal power generation, resulting in a very high level of efficiency.

Probably the most well-known electrochemical process is the battery, which can store electrical energy with almost no loss. But storing electrical energy over a longer period of time and making it available across sectors requires alternative energy carrier.

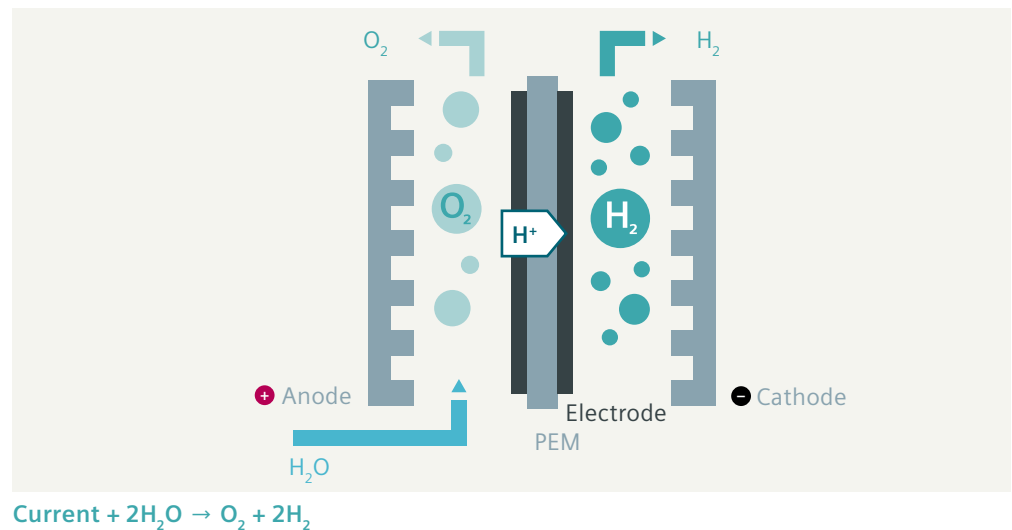
Hydrogen – fuel of the future?

Hydrogen isn't just the fuel of the future – it's the fuel of the present!

Hydrogen is the most common element in the universe. Almost all of our chemical fuels are based on hydrogen, although in a bound form as hydrocarbons or other hydrogen compounds. To limit climate change caused by the global increase in CO₂ emissions, solutions must be found for generating carbon-neutral and, therefore, sustainable fuels. This requires, among other things, that hydrogen be produced using renewable energy sources.



Conversion and storage

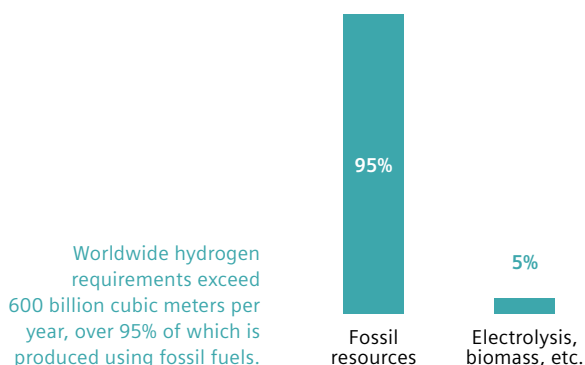


Electrolysis

As early as 1800, two Englishmen named William Nicholson and Anthony Carlisle discovered electrolysis, a process for splitting water into hydrogen and oxygen. Direct current was used. The two men thus founded a new field of chemistry, electrochemistry.

“Water will be the coal of the future.”

For many decades, the electrolysis of water was the standard method for producing hydrogen and led the French author Jules Verne, in his 1874 novel “The Mysterious Island” to state: “Water will be the coal of the future.” Over the years, gas reformation and coal gasification have prevailed as a major source of hydrogen, thanks to the development of the natural gas infrastructure.



Proton Exchange Membrane (PEM) electrolysis

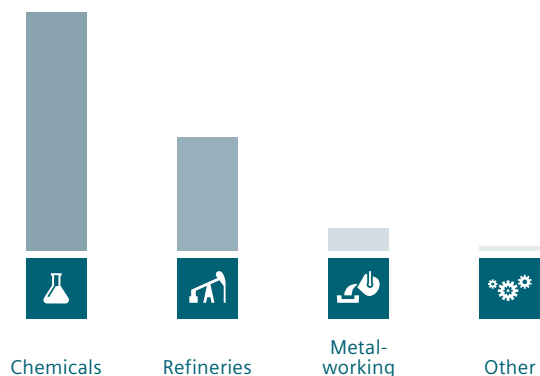
J. H. Russell and his colleagues first recognized the enormous potential of PEM electrolysis for the energy industry in 1973.

PEM takes its name from the proton exchange membrane. PEM's special property is that it is permeable to protons but not to gases such as hydrogen or oxygen. As a result, in an electrolytic process the membrane takes on, among other things, the function of a separator that prevents the product gases from mixing.

On the front and back of the membrane are electrodes that are connected to the positive and negative poles of the voltage source. This is where water molecules are split. In contrast to traditional alkaline electrolysis, PEM technology is ideally suited to harvesting energy generated from wind and solar power – which are irregularly generated – because it can be quickly switched on and off without any need for preheating. PEM electrolysis also has the following characteristics:

- High efficiency at high power density
- High product gas quality, even at partial load
- Low maintenance and reliable operation
- No chemicals or impurities

Use cases



Industry

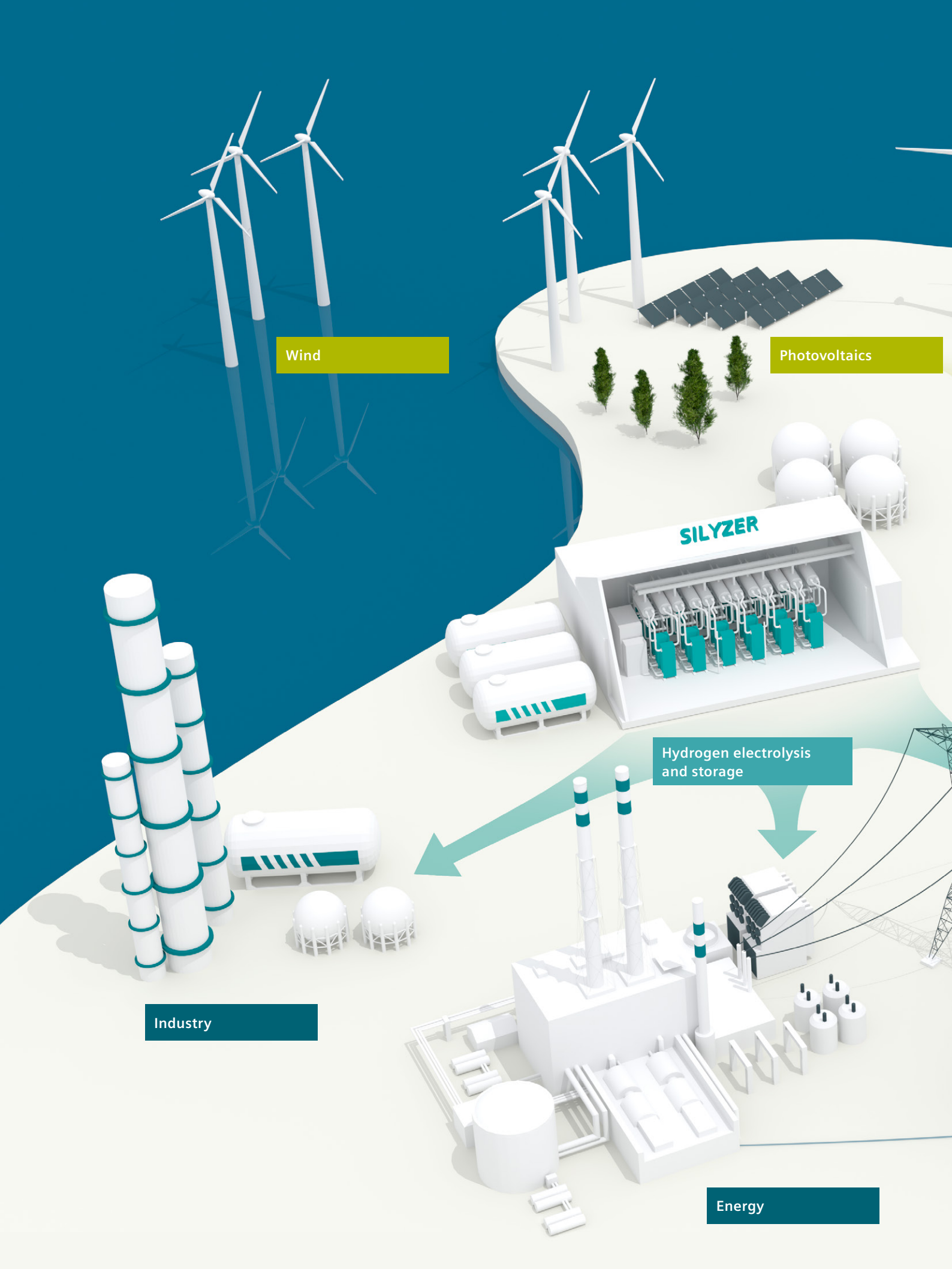
About 90 percent of the more than 600 billion cubic meters of hydrogen produced annually worldwide is used by industry. Hydrogen is an essential chemical in industry that serves as fuel, additive, or reduction agent. Hydrogen is primarily used as a basic chemical in the synthesis of ammonia and other fertilizers such as urea, and for the synthesis of methanol, various polymers, and resins. Other major consumers in today's hydrogen industry include refineries and the metalworking industry, as well as the semiconductor, glass, and food and beverage industries.



Energy

Only a small percentage of hydrogen is currently used in the energy sector, even though hydrogen is considered one of the most promising technologies in the large-scale integration of renewable energy. The more that electricity is generated from fluctuating renewable sources such as sun and wind and the less reliance there is on conventional power utilities, the more important it is that energy systems change. Ultimately, renewably generated power must also be available at times when sun and wind are scarce. This requires storing energy, including over extended periods of time. Hydrogen plays a key role as an energy source and storage medium. One example of a suitable infrastructure would be gas grids with their tremendous storage potential.

"Island solutions" can also be implemented using a hydrogen infrastructure. The highly dynamic behavior of a PEM electrolysis system is ideally suitable for direct connection to renewable power sources. Load peaks can thus be intercepted in the island grid and the energy can be fed back into gas turbines or fuel cells as needed.







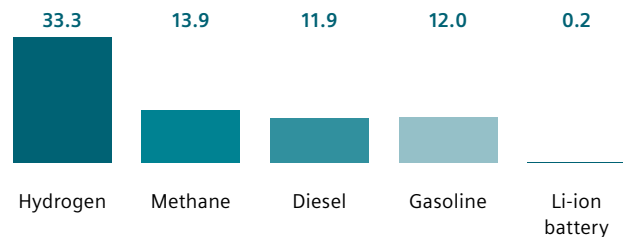
Mobility

The electrification of mobility is one of the greatest challenges in global decarbonization. Hydrogen can help to decarbonize this in two ways. Fuel cell vehicles can use hydrogen directly. Instead of CO₂ and NO_x, they produce only water. Together with battery-powered vehicles, they not only reduce emissions from local urban traffic but also from interurban traffic and light and heavy-duty transport, because these vehicles have a significantly higher range than that of exclusively battery-powered vehicles – plus it takes only three minutes to refuel.

The second way hydrogen can help is through the synthesis of hydrocarbons from sustainable hydrogen and carbon from agriculture and forestry. In this way, even sectors with high fuel requirements, such as the aeronautics and shipping industries, can be decarbonized.

“Hydrogen is impressively versatile.”

Gravimetric power density in kWh/kg



It serves as an energy carrier that can store electrical power from just a few kilowatt hours to gigawatt hours, and over a period of several weeks. It can then be used in industry as a process gas and in mobility as a fuel for emissions-free fuel cell vehicles.”

Gabriele Schmiedel, CEO of Hydrogen Solutions

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