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Hydrogen Electrolysers

Sizes, Costs and

Manufacturers

2022 update



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Hydrogen Electrolyser

A hydrogen electrolyser uses electricity to split water (H_2O) into hydrogen (O_2) and oxygen (H_2).

After the process, oxygen is released back into the air while hydrogen is stored for later use.



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Green Hydrogen

If the electrical energy used in the process is sourced from renewable sources like solar or wind power, the resulting hydrogen has no carbon footprint and is categorised as “green hydrogen”.



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Load Balance

With electrolyzers, users can generate hydrogen and also balance the load on the grid. This is crucial for power and energy companies that require intermittent renewable energy to match consumer demand spikes.



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Market Share

In 2020, only 0.1% of global hydrogen production was green hydrogen. However, Goldman Sachs predicts that by 2050, green hydrogen will supply up to 25% of the world's energy needs, making it a EUR10 trillion global market.



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Main Electrolysers Types

Electrolysers come in different types, such as alkaline and PEM, which vary in cost, capacity, and application.



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ALKALINE

Alkaline electrolysers, commonly used in the industry, split water into its constituents using caustic electrolyte solution, such as potassium hydroxide (KOH).



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ALKALINE

When two electrodes (cathode and anode) are placed in a solution of water and caustic electrolyte, a reaction takes place. If enough voltage is applied, the water molecules will take electrons to create OH^- ions and a hydrogen molecule. The OH^- ions then move through the solution towards the anode, where they combine and release their extra electrons to produce water, hydrogen, and oxygen.

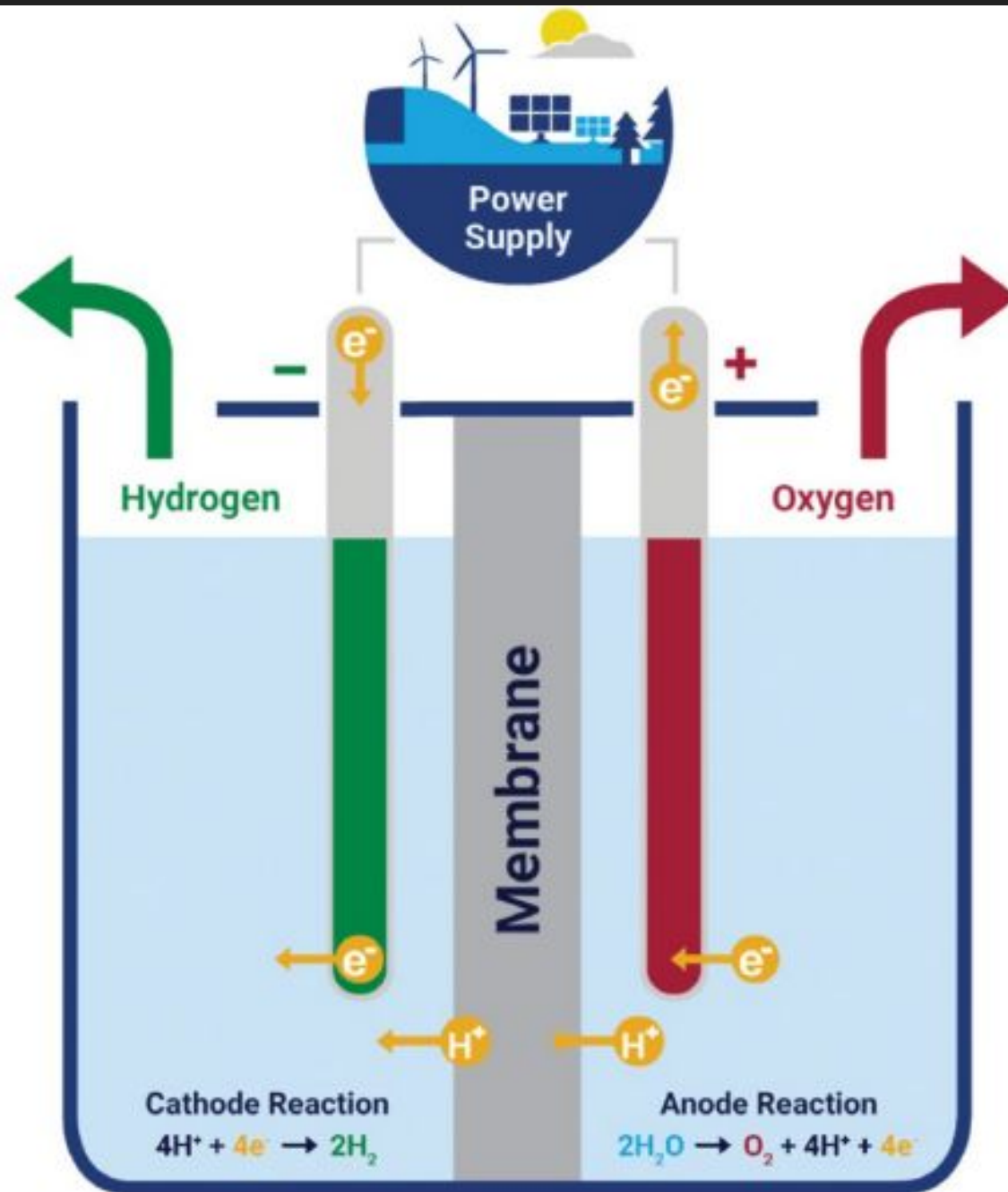


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ALKALINE



Alkaline electrolysis (Cummins.com)



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PEM

Polymer Electrolyte Membrane (PEM) technology separates hydrogen and oxygen through water electrolysis in a cell equipped with a solid polymer electrolyte (SPE).



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PEM

PEM electrolysis uses a solid polymer to create a reaction, not a liquid. When a voltage is applied between two electrodes, negatively charged oxygen in water molecules produces protons, electrons, and oxygen at the anode.

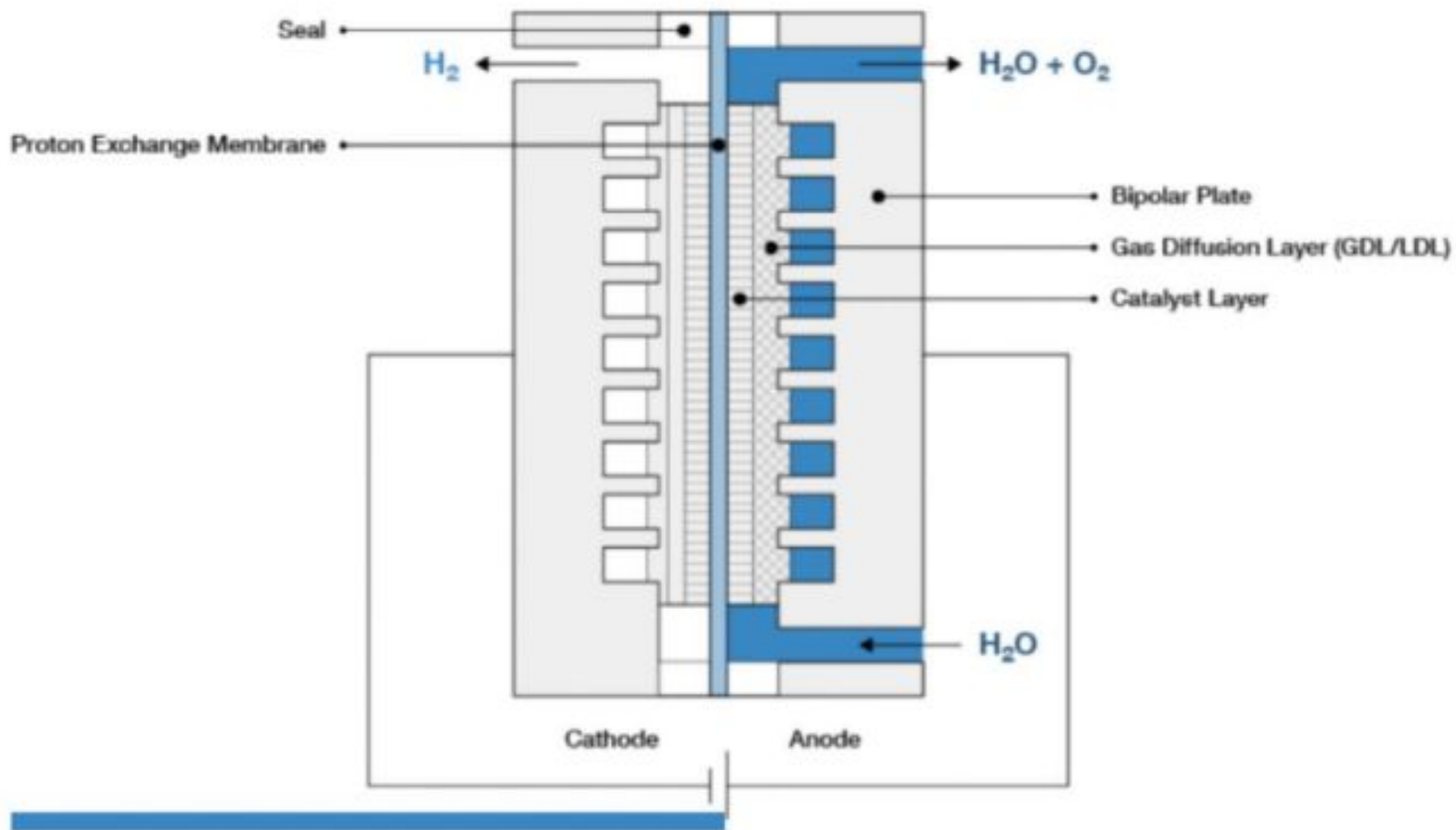


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PEM



PEM electrolysis (Cummins.com)



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Other Electrolysers

There are several emerging technologies for hydrogen electrolysis, including anion exchange membrane (AEM), solid-oxide electrolysis cell (SOEC), protonic ceramic electrochemical cell (PCEC), and photoelectrochemical (PEC) water splitting.



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COMPARISONS

1. Alkaline electrolysis is a more established and affordable technology compared to PEM electrolysers. PEM electrolysers require precious metals for the catalyst due to an acidic environment whereas alkaline electrolysis can use stainless steel and nickel.



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COMPARISONS

2. PEMs are often considered a safer option because the membrane acts as a barrier between the produced H₂ and O₂.



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COMPARISONS

3. PEM systems overcome limitations of traditional alkaline electrolysis as they are easier to pressurize and don't require extra compression steps.



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COMPARISONS

4. PEM electrolysers are more compact and efficient with varying loads of electricity from renewables, allowing operation when energy generation is cheapest.



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Sizes

H ₂ Production	Output Pressure	Water Consumption	H ₂ Purity	Power Requirement Per Hour	Input Voltage	Technology Used	Lifespan Hrs Continuous Use
1nm3/hr	30bar (437psi)	0.81/hr	99.940%	4kW	AC (240V) or DC	AES	10000
2nm3/hr	30bar (437psi)	1.61/hr	99.940%	8kW	AC (240V) or DC	AES	10000
1nm3/hr	0-7.9bar (0-115psi)	11/hr	99.998%	6.7kw	AC (240V) or DC	PEM	30000
2nm3/hr	0-7.9bar (0-115psi)	21/hr	99.998%	13.4kW	AC (240V) or DC	PEM	30000
10nm3/hr	4-10bar (58-146psi)	15-20l/hr	99.998%	54kW	3phase AC	IMET	60000
15nm3/hr	4-10bar (58-146psi)	22.5-30l/hr	99.998%	81kW	3phase AC	IMET	60000
30nm3/hr	4-10bar (58-146psi)	45-60l/hr	99.998%	156kW	3phase AC	IMET	60000
45nm3/hr	4-10bar (58-146psi)	67.5-90l/hr	99.998%	234kW	3phase AC	IMET	60000
60nm3/hr	4-10bar (58-146psi)	90-120l/hr	99.998%	312kW	3phase AC	IMET	60000
220nm3/hr	4-10bar (58-146psi)	200-220l/hr	99.998%	1MW	3phase AC	PEM	60000



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MAJOR MANUFACTURERS

Company <i>(non-exhaustive list)</i>	Country	ALKA- LINE	PEM	AEM
Cummins Inc (Hydrogenics)	Germany, Belgium, USA	X	X	
ITM Power PLC	UK		X	
Giner ELX Inc	USA		X	
NelHydrogen (Nel ASA)	USA, Norway	X	X	
Enapter srl	Italy			X
Areva H2Gen Gmbh Elogen	Germany, France		X	
Green H2 systems/A company of Fest Group (H-Tec Systems Gmbh iGas energy Gmbh)	Germany		X	
Green Hydrogen.dk	Denmark	X		
IPS-FEST Gmbh	Germany	X		
Kraftanlagen Munchen Gmbh	Germany	X	X	
Thyssenkrupp Uhde Chlorine Engineers Gmbh	Germany	X		
Hoeller Electrolyzer Gmbh	Germany		X	
Siemens	Germany		X	
HyGear	Netherlands	X		
McPhy	France			
PERIC	China	X		
Suzhou Jingli Hydrogen	China	X		
CETH2	France		X	



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COST OF ELECTRICITY

From 2010 to 2020, the initial costs of installing utility-scale solar PV decreased by 85%, while onshore wind generators saw a 56% decrease. These lower up-front expenses result in reduced average costs of electricity generation over time, and this trend is expected to continue as the world shifts towards renewable energy.



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COST OF ELECTRICITY

In 2020, the levelised cost of electricity (LCOE) for large-scale solar PV installations was between A\$41-77/MWh globally, while onshore wind ranged from A\$56-93/MWh. By 2030, both solar PV and onshore wind are projected to cost an average of A\$40/MWh, with the lowest estimate being A\$25/MWh.



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COST OF ELECTROLYSERS

According to the IEA, the cost of alkaline electrolysers today ranges from A\$714-2000/kW and is expected to drop to A\$571-1214/kW by 2030. PEM electrolysers, on the other hand, currently cost between A\$1571-2571/kW and are projected to cost A\$928-2143/kW by 2030



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COST OF ELECTROLYSERS

Chinese manufacturers of electrolyzers sell alkaline technology at approximately A\$262/kW, which is approximately 80% less expensive than European machines of the same type due to economies of scale.



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COST OF ELECTROLYSERS

Over the past four years, the electrolyser industry has reduced its capital costs by around 75% due to the demand for larger systems and advancements in system design and manufacturing. In the coming decade, costs of hydrogen electrolysis capex are expected to drop by an additional 30-50% as national targets and pilot projects increase production volume.



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COST OF ELECTROLYSERS

Currently, hydrogen production costs range from around A\$4.78-7.43/kg.

However, CSIRO projections, along with predicted electricity costs, estimate that hydrogen production could cost A\$1.89-3.71/kg for 2030.



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COST OF ELECTROLYSERS

Siemens Energy aims to produce green hydrogen at a cost of US\$1.50/kg (approximately A\$2/kg) by 2025 through large-scale commercial projects. These projects are based on wind energy, assuming an electricity cost of A\$16/MWh through a 100MW PEM electrolyser operating for an average of 16.4 hours per day.



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COST OF ELECTROLYSERS

Electrolyser providers aim to reach "fossil parity" by making green hydrogen production costs equal to those of steam methane reforming (SMR) with natural gas or coal (grey and brown hydrogen). Presently, green hydrogen is 2.5 times pricier than blue hydrogen's generation (SMR with carbon capture and storage). Nonetheless, with an increase in demand, the cost difference is diminishing.



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Disclaimer

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Reference

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Research Paper, John Hirjee, 2022



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Thank you

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