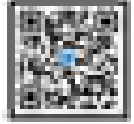


# PEM-Electrolysers

PROTON EXCHANGE MEMBRANE

[www.sbunitech.co.kr](http://www.sbunitech.co.kr)



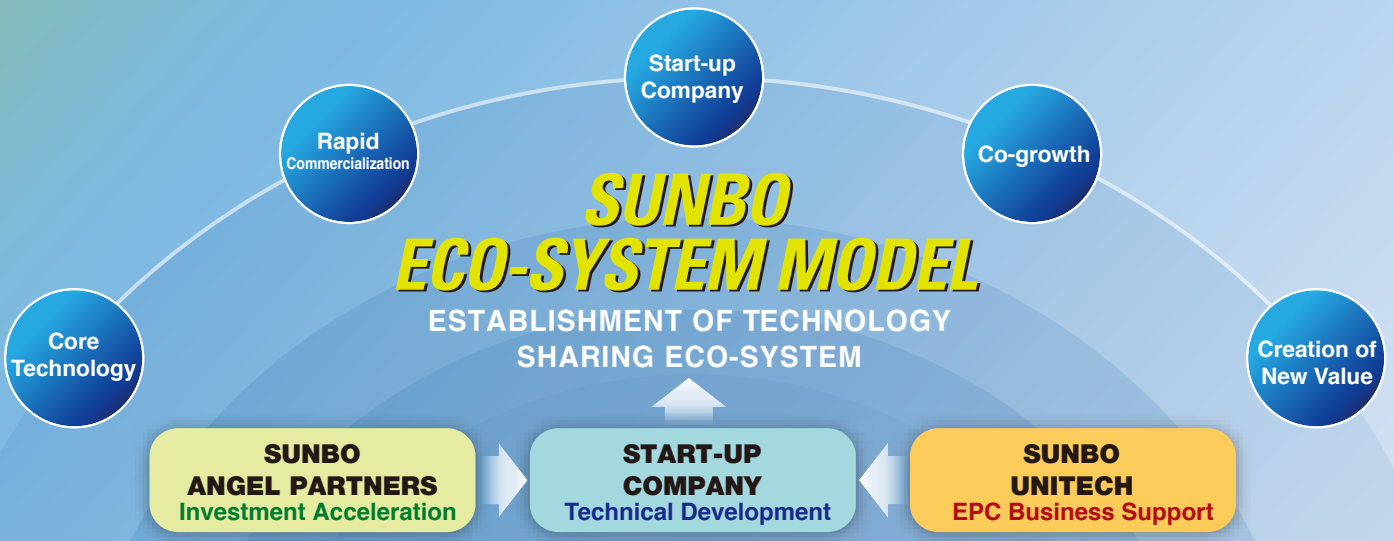
**SUNBO UNITECH**

Creative thinking to Energy Solution



# ABOUT SUNBO UNITECH

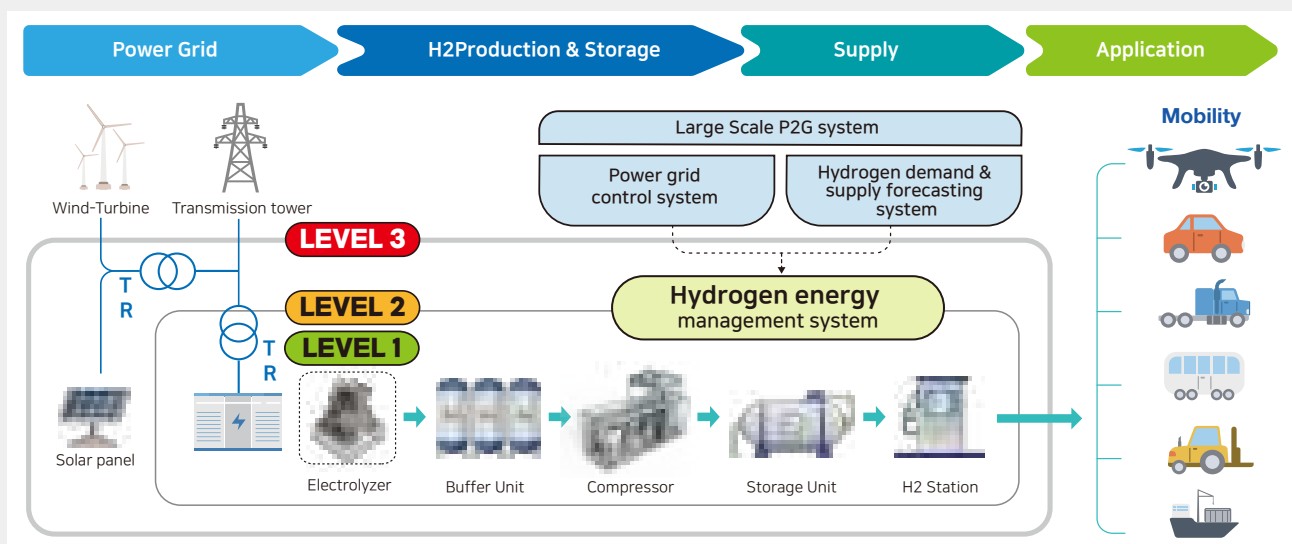
**Sunbo** is committed to leading the way to build the innovative & creative solutions that raise the quality of life. To provide the better service and production which meet the customer requirement, Sunbo has continuously developed and improved the new technology with cooperation of relevant company.



## SUNBO FAMILY

SUNBO INDUSTRY SUNBO HITECH	SUNBO UNITECH	SUNBO ANGEL PARTNERS	Carbon Value	FES
<b>Founded in 1986</b> Shipbuilding / LNG · System Package · Fuel Gas Supply System	<b>Founded in 2002</b> LNG / Energy Solution · H2 Production Package · Compressor PKG	<b>Founded in 2016</b> · Start up investment · Venture Capital · Joint venture / M&As	<b>Founded in 2021</b> · Modular Carbon Capture · Rotating Packed Bed System · Ultrasonic-assited Reboiler System	<b>Founded in 2016</b> Frontier Energy Solution · Pevroskite Solar Cells · Solar Cell Modularization Technology

## Total Solution for Green Energy



# INTRODUCTION OF H2 GEN.

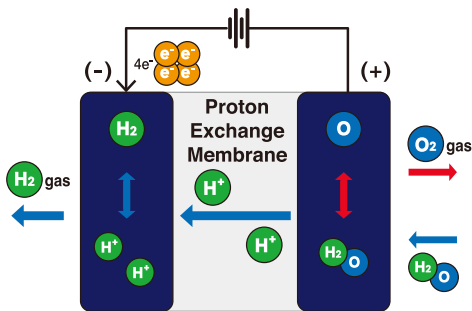


## A Suitable Hydrogen Production Method for the Era of Renewable Energy

**H2Gen<sup>®</sup>** is a hydrogen generator based on PEM (Proton Exchange Membrane) technology.

Unlike conventional hydrogen production methods, it produces hydrogen using only water (H<sub>2</sub>O) and electricity. H<sub>2</sub> and O<sub>2</sub> are the only by products generated through electrolyzer, and harmful gases like CO<sub>2</sub> are not produced, making it an environmentally friendly hydrogen generator. It is the ultimate hydrogen generation device capable of handling 100% of the load fluctuations characteristic of renewable energy sources.

## H2Gen<sup>®</sup> Operational Principle

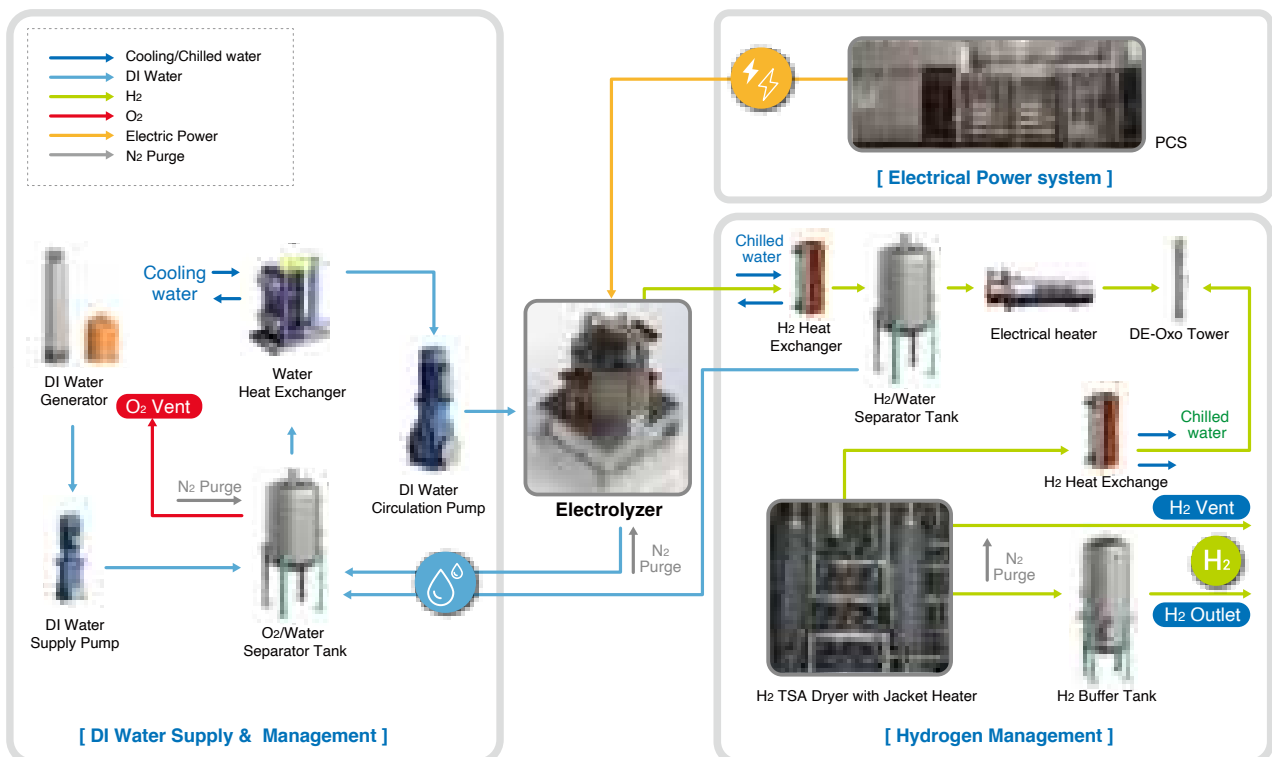


### PEM = Proton Exchange Membrane

1. When water is supplied to the anode and electricity is applied, the generation reaction (oxidation reaction) of oxygen, hydrogen ions, and electrons occur.
2. The hydrogen ions generated at the anode move to the cathode through PEM.
3. At the cathode, the hydrogen ions that moved from the anode react with electrons that have moved through the external circuit from the Anode, resulting in the generation of hydrogen.



## Conceptual Process for Hydrogen production (PEM)



# TECHNICAL SPECIFICATION



## Gas Production

- Maximum pressure : **Up to 30barg**
- Operating temperature : **60±10°C**
- H2 quality (Purity) : **99.999%**  
(O2 : ≤5ppm / H2O (humidity) : ≤ 5ppm)
- Stack Power Consumption : **4.6(BOL) ~ 5.5(EOL) kWh/Nm3**
- System Power Consumption : **4.8(BOL) ~ 5.7(EOL) kWh/Nm3**

## Utility

- Purging gas (N2)-Pressure : **Over 2barg**
- Instrument Air-Pressure : **5~7barg**

## Power Conditioning System Specification

- P h a s e : **3ph 3W(Y)/4W(D)**
- V o l t a g e : **22.9/11/6.6/2kV to 380/440Vac (Rectifier TR)**
- Frequency : **60Hz or 50Hz**
- Topology : **IGBT (THDi < 3%) or Thyristor (THDi < 5%)**
- Power Factor : **0.98~1.00(IGBT) or 0.90~0.95(Thyristor)**
- Air or Water-cooled (Containerized Solution with HVAC)
- BOP System efficiency : **Below 7.5 %, (Max. 150kW based on 2MW)**

## Technical Specification as per capacity

Division	Specification	H2 Generator Model No. (PEM Electrolyzer System)					
		H2 Gen 100	H2 Gen 200	H2 Gen 600	H2 Gen 1000	H2 Gen 2000	H2 Gen XMW
PEM Stack	Rated Power	<b>50kW</b>	<b>100kW</b>	<b>300kW</b>	<b>500kW</b>	<b>1MW</b>	<b>2MW</b>
Hydrogen Production	<b>Volume (Nm<sup>3</sup>/hr) @ system outlet</b>	<b>10</b>	<b>20</b>	<b>60</b>	<b>100</b>	<b>200</b>	<b>400</b>
Water Consumption (Liter/hr)	Tap Water for DI Water	25	50	140	240	480	1,000
	DI Water	11	22	66	110	220	440
Utility (Option)	DI Water (Conductivity)	0.05 ~ 0.1 μS/cm (Up to 6barg)					
	Cooling Water (kg/h) [based on closed loop]	6,400	12,800	38,000	64,000	128,000	256,000
	Chilled Water (kg/h) [based on closed loop]	90	180	530	880	1,750	3,500
Installation Footprint	Installation Footprint (m <sup>2</sup> )	28	28	31	31	62	62
	Containerized Size	30ft x 1ea	30ft x 1ea	40ft x 1ea	40ft x 1ea	40ft x 2ea	40ft x 2ea

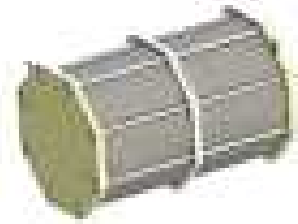


# COMPARISON - PEM VS ALKALINE

## PEM Electrolyzer system (Advantage)

- **Easy to operation & maintenance** / simple process (Only water / Power)
- Real time response to **100% Load Fluctuations** of renewable energy
- **Minimization of System footprint**

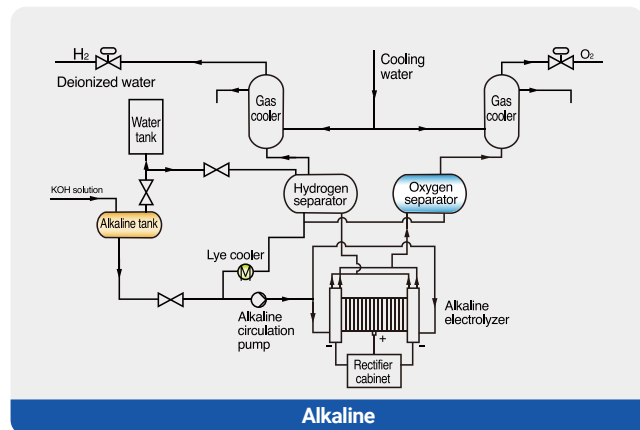
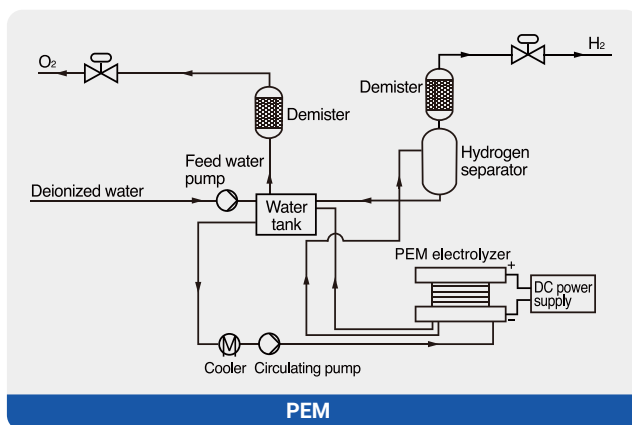
## Stack Specification



Division	PEM
Electrolyte	Solid polymer
Current Density	1.5~2.5 A/cm <sup>2</sup>
Pressure	High Pressure (Up to 30barg)
Operating Temperature	50~70
Raw materials	Deionized water
Corrosion	N/A
Volume and Weight	Small Size about 1/3 of the alkaline electrolyzer

Division	Alkaline
Electrolyte	KOH
Current Density	0.2~0.8 A/cm <sup>2</sup>
Pressure	Low Pressure (Up to 10 barg)
Operating Temperature	80 ~ 90
Raw materials	Pure water with Potassium hydroxide
Corrosion	Alkaline corrosion
Volume and Weight	Big Size

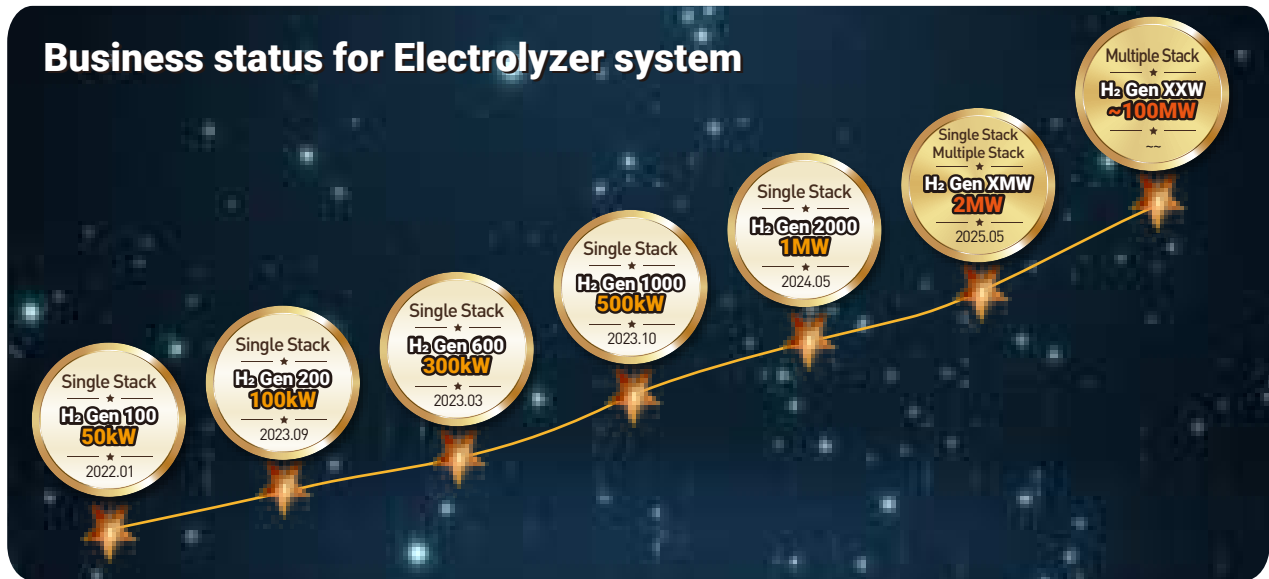
## System process



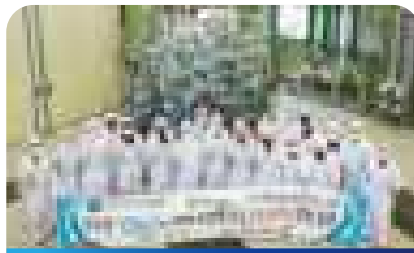
## Operation for renewal energy

Division		PEM	ALKALINE
Load range	Min Load	10 % nominal load	15 % nominal load
	Max Load	100 % nominal load	100 % nominal load
Start-up	warm	1 second	1 minute
	cold	5 minutes	10 minutes
Ramp-up / Ramp-down		10 %/second	0.2~20 %/second
Shutdown		Seconds	1~10 minutes

# BUSINESS MODEL FOR H2 GEN. SYSTEM



## Reference list



**50kW**

10Nm<sup>3</sup> per hour  
Delivery : 2022  
H<sub>2</sub> Purity : 99.999%



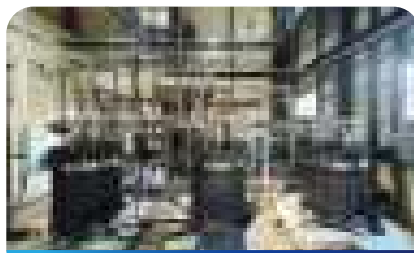
**100kW**

20Nm<sup>3</sup> per hour  
Delivery : 2023  
H<sub>2</sub> Purity : 99.999%



**300kW**

60Nm<sup>3</sup> per hour  
Delivery : 2023  
H<sub>2</sub> Purity : 99.999%



**500kW**

100Nm<sup>3</sup> per hour  
Delivery : 2023  
H<sub>2</sub> Purity : 99.999%



**1MW**

200Nm<sup>3</sup> per hour  
Delivery : 2024  
H<sub>2</sub> Purity : 99.999%



**2MW**

400Nm<sup>3</sup> per hour  
Delivery : 2025  
H<sub>2</sub> Purity : 99.999%

Capacity	Customer	Hydrogen		Delivery	Remark
		Flow	Purity		
50kW	KHNP	10Nm <sup>3</sup> /hr	99.999%	2022.01	
100kW	IAE	20Nm <sup>3</sup> /hr	99.999%	2023.09	
300kW	Doosan	60Nm <sup>3</sup> /hr	99.999%	2023.03	
500kW	ULSAN Technopark	100Nm <sup>3</sup> /hr	99.999%	2023.10	
1MW	J.N Technopark	200Nm <sup>3</sup> /hr	99.999%	2024.05	
2MW	KOSPO	400Nm <sup>3</sup> /hr	99.999%	2025.05	