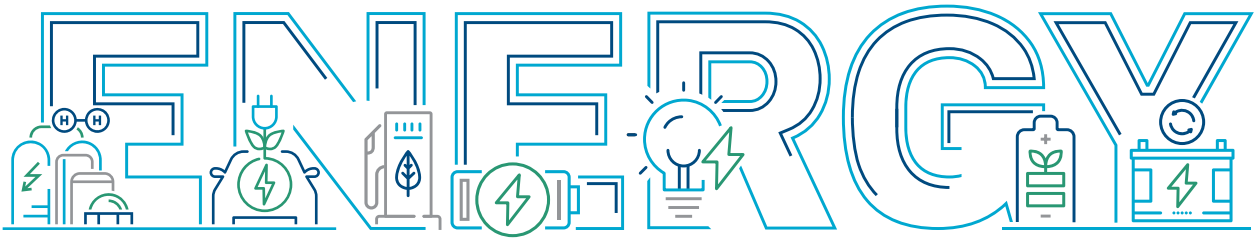
S-Fuelcell

FREE ENERGY PLANET



A New World of Clean and Infinite Energy with Hydrogen,
S-Fuelcell Will Make It Happen.

H2 PLUS 1000

S-Fuelcell

Hydrogen Fuel Cells Specialist
At the Forefront of Korean Technology

S-Fuelcell Co., Ltd. has been leading Korea's fuel cell research and development since 1989.
Starting in November 2001,
it became the first specialized fuel cell company in the country.

S-Fuelcell possesses
proprietary technology in core areas of fuel cells,
such as fuel cell stacks, hydrogen extractors, and integrated system design.
Additionally, the company holds **proprietary technology in core areas of fuel a diverse product range related to hydrogen energy, including fuel cell systems for buildings and hydrogen power generation systems.**

2018 - 2024
Challenge for Global No.1

- 2024 Launched Carbon-Capturing building fuel cell system(5kW) First in Korea
- 2023 Launched 200kW hydrogen power generation system First in Korea
  Launched 25kW single-module system First in Korea
- 2022 Acquired CE certification(5kW) First in Korea
- 2021 Selected as a hydrogen-specialized company
  Demonstrated fuel cell in Europe(5kW) First in Korea
- 2020 Exported fuel cells to China(5kW)
- 2019 Developed battery hybrid system(5kW) First in World
  Successfully conducted / IGFC trial run(50kW)
- 2018 Acquired PG10K 3-phase KS certification First in Korea
  Listed on KOSDAQ

2014 - 2017
Full-scale Commercialization of Fuel Cells

- 2017 Released modular 10kW system First in Korea
- 2016 Released modular 6kW system First in Korea
- 2015 Obtained 5kW LPG fuel cell certification(KGS,KS) First in Korea
- 2014 **Established S-Fuelcell Co., Ltd.**
  Acquired 5kW fuel cell facility certification(KS) First in Korea

2009 - 2013
Fuel Cell Product Commercialization and Market Penetration

- 2013 Received inspection approval for 5kW fuel cell system(KGS) First in Korea
  Started sales of 5kW fuel cell system
- 2011 Released 1kW fuel cell distribution model
- 2010 Conducted field tests for 5kW fuel cell system First in Korea
- 2009 Installed and operated fuel cells inside an apartment First in Korea
  Selected as the leading company for the development and verification of 5kW fuel cells

2001 - 2007
Beginning of Fuel Cells

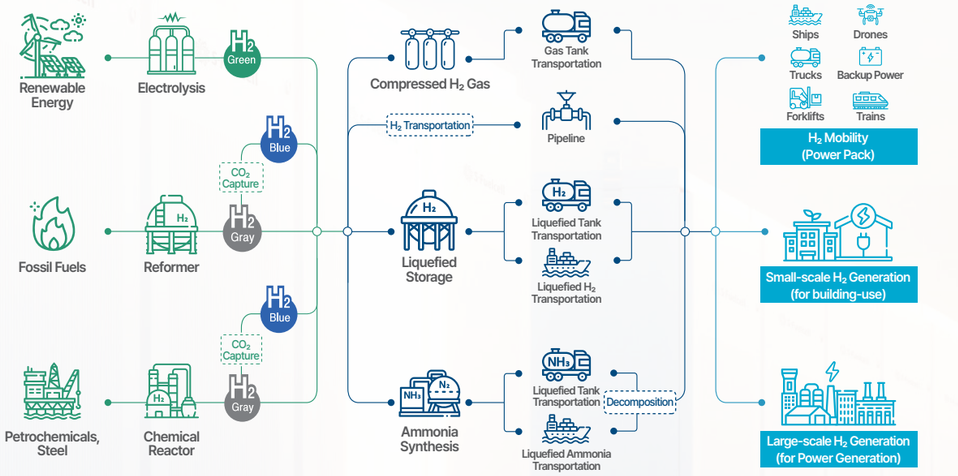
- 2007 Developed 5kW hydrogen power generation system(SPM) First in Korea
- 2005 Changed company name from CETI to GS Fuelcell
- 2003 Developed 1kW fuel cell system First in Korea
- 2002 Developed 1kW fuel cell stack First in Korea
- 2001 Established fuel cell-specialized company CETI First in Korea

01
Understanding Hydrogen Energy

Hydrogen energy is

- **a clean energy source** that doesn't emit pollutants
- It is easily accessible **anywhere on Earth**
- It offers **superior stability** compared to other fuels
- It is recyclable, preventing exhaustion and enabling **energy self-reliance**

Hydrogen Energy Value Chain



Production

Hydrogen is extracted from various energy sources, and its type (Gray, Blue, Green Hydrogen) is classified based on the amount of carbon dioxide emissions during hydrogen production.

Storage · Transportation

The extracted hydrogen is stored and transported using methods such as pipelines, ships, or cargo, in various forms depending on the application. These forms include physical states (compressed gas at 20-450 bar or liquid cooled to -253°C) and chemical compounds, notably methane and ammonia.

Application

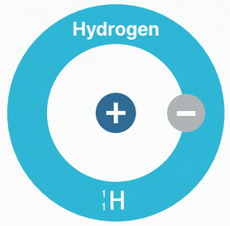
Hydrogen is applied in the wide range of industries such as the power sources for vehicles and construction equipment, power generation plants, and so on.

Is Hydrogen Energy Safe?

The hydrogen used in fuel cells poses no explosion risk.

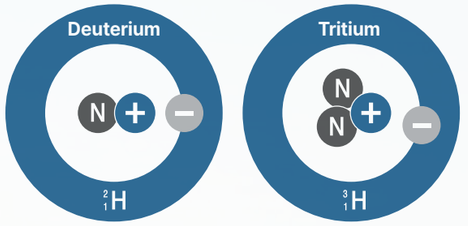
A hydrogen bomb uses nuclear fusion of hydrogen atoms and requires energy equivalent to an atomic bomb, so the hydrogen in fuel cells is not explosive.

Used as fuel in fuel cells



VS

Used in a hydrogen bomb
(possible at temperatures of 100 million°C)



© Isotopes of hydrogen: Hydrogen, Deuterium, Tritium

Proton Electron Neutron

Hydrogen is safer than city gas(LNG), LPG, and gasoline.

Since hydrogen is the lightest element on Earth, it disperses immediately into the atmosphere when released Therefore, it is much safer than commonly used LNG, LPG, and gasoline in our daily lives.

Relative Risk Evaluation by Fuel

Hydrogen		City Gas(LNG)		LPG		Gasoline	
Autoignition temperature	1	Autoignition temperature	2	Autoignition temperature	3	Autoignition temperature	4
Fuel characteristics	1	Fuel characteristics	2	Fuel characteristics	3	Fuel characteristics	4
Flame temperature	3	Flame temperature	1	Flame temperature	2	Flame temperature	4
Combustion velocity	4	Combustion velocity	3	Combustion velocity	2	Combustion velocity	1
⋮		⋮		⋮		⋮	
Total	32	Total	33	Total	39	Total	42
Relative risk	1	Relative risk	1.03	Relative risk	1.22	Relative risk	1.44

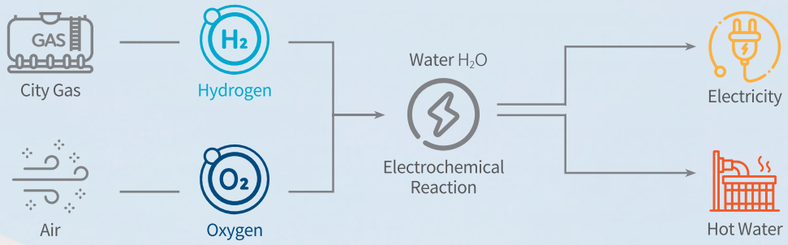
Safety order: 1>2>3>4, evaluated based on 15 criteria

02

Introduction to Fuel Cells

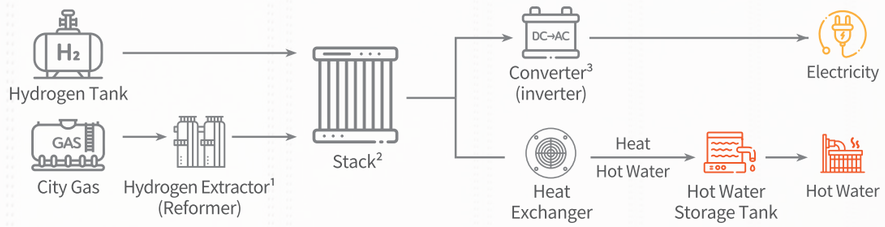
What is a fuel cell?

It **generates energy** through a chemical reaction
between hydrogen and oxygen (from the air), and it is **a clean energy source that doesn't emit harmful substances(such as SOx, NOx, etc.).**



Fuel Cell System Composition

Fuel cells can provide both electricity and heat simultaneously,
and they are high-efficiency generation systems with an overall efficiency exceeding 90%.



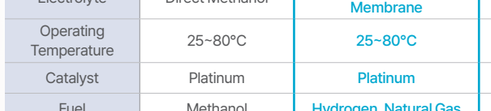
1. Hydrogen Extractor(Reformer): A device that converts fuels (such as LNG, LPG, etc.) into hydrogen
2. Stack: A device that uses hydrogen and (from the air) oxygen to generate electricity and heat
3. Power Converter (Inverter): A device that converts the direct current produced by the stack into alternating current

Effects of Introducing Fuel Cells

Fuel cells, a renewable energy source with the advantages of high efficiency and eco-friendliness, result in approximately a 31% primary energy reduction and about a 45% carbon dioxide reduction compared to other energy sources.

High Efficiency

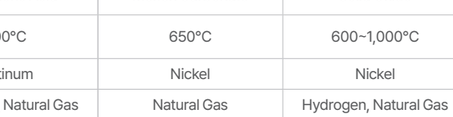
- Reduces primary energy consumption by 31%
- Compared to other renewable energies, it is the most efficient



* Primary Energy Consumption(MU)

Eco-Friendly

- Reduces carbon dioxide emissions by 45%
- 2 tons (annually) of CO_2 reduction per 1kWh



* CO_2 Emission(g-CO_2)

Types of Fuel Cells

Fuel cells are applied in various sectors including residential, commercial, transportation, and portable power.
In particular, the Polymer Electrolyte Membrane Fuel Cell (PEMFC) is the most commercialized fuel cell and is mainly used for homes, buildings, and vehicles.

	Portable	For Buildings	For Transportation	For Power Generation
Application	~50W	1~25kW	80~200kW	100~400kW
Applied Fuel Cell Type	DMFC	PEMFC	PEMFC	PEMFC, PAFC, MCFC, SOFC
				PAFC
				MCFC
		SOFC		SOFC

DMFC : Direct Methanol Fuel Cell / PEMFC : Polymer Electrolyte Membrane Fuel Cell
PAFC : Phosphoric Acid Fuel Cell / MCFC : Molten Carbonate Fuel Cell / SOFC : Solid Oxide Fuel Cell

	Low-Temperature Fuel Cells			High-Temperature Fuel Cells	
Type	DMFC	PEMFC	PAFC	MCFC	SOFC
Electrolyte	Direct Methanol	Polymer Electrolyte Membrane	Phosphoric Acid	Molten Carbonate	Solid Oxide
Operating Temperature	25~80°C	25~80°C	200°C	650°C	600~1,000°C
Catalyst	Platinum	Platinum	Platinum	Nickel	Nickel
Fuel	Methanol	Hydrogen, Natural Gas	Hydrogen, Natural Gas	Natural Gas	Hydrogen, Natural Gas
Efficiency (Natural gas/%LHV)	-	35~40%	40~45%	50~60%	50~60%
Efficiency (Hydrogen/%LHV)	-	50%	50%	52%	52%
Applications	Portable	Transportation, Residential, Buildings	Power Generation	Power Generation	Buildings, Power Generation

03
Fuel Cell System

ECOGENER

Eco-Friendly Hydrogen Fuel Cells

5kW / 6kW

10kW

Fuel Cell System Specifications

Product	1kW Fuel Cell System	5kW Fuel Cell System	6kW Fuel Cell System	10kW Fuel Cell System
Model	ECOGENER NG/PG 1K	ECOGENER NG/PG 5K	ECOGENER NG/PG 6K	ECOGENER NG/PG 10K
Rated Output (Electricity/Heat)	1kW/1.4kW	5kW/7.0kW	6kW/8.4kW	10kW/14kW
Size(WxDxH)	600 × 550 × 1,500 mm	650 × 1,300 × 1,550 mm		1,300 × 1,300 × 1,550 mm
Hot Water Temperature	Max 55°C(May vary depending on hot water usage conditions)			
Fuel	City Gas(LNG) or LPG			
Fuel Consumption	LNG : 0.25 $Nm^3/hr/kW$, LPG : 0.13 $Nm^3/hr/kW$			
Efficiency(LHV)	Electric Efficiency 35%, Overall Efficiency over 90%			
Features	Water-independent System, Automatic Operation, Web-based Operation, Load Operation(50%, 75%, 100%)			
Output Voltage	220V(Single Phase)	380V(Three Phase)		
Startup Time	Within 60 minutes			
Application	Apartments, Villas, Commercial Spaces, Buildings, Studio Apartments, and other buildings with city gas supply			

*Product image and size may vary from the actual products.

Largest Capacity Fuel Cell System for Buildings

Product	25kW Fuel Cell System
Model	ECOGENER NG 25K
Rated Output (Electricity/Heat)	25kW / 35kW
Size(WxDxH)	900 × 1,400 × 1,800 mm
Hot Water Temperature	Max 55°C (May vary depending on hot water usage conditions)
Fuel	City Gas(LNG)
Fuel Consumption	0.25 $Nm^3/hr/kW$
Efficiency(LHV)	Electric Efficiency 35%, Overall Efficiency over 90%
Features	Water-independent System, Automatic Operation, Web-based Operation, Load Operation(50%, 75%, 100%)
Output Voltage	380V(Three Phase)
Startup Time	Within 120 minutes
Application	Apartments, Villas, and other buildings with city gas supply

*Product image and size may vary from the actual products.

Hydrogen Power Generation System

Product	1~50kW Hydrogen Power Generation System
Model	ECOGENER HG 1~50K
Rated Output (Electricity/Heat)	1~50kW / 0.7~35kW
Size(WxDxH)	50K : 800 × 1,100 × 1,800 mm
Hot Water Temperature	Max 50°C (May vary depending on hot water usage conditions)
Fuel	Pure Hydrogen(H_2)
Fuel Consumption	0.75 $Nm^3/hr/kW$
Efficiency(LHV)	Maximum Efficiency 60% / Rated Electrical Efficiency 46%, Overall Efficiency over 85%
Features	Quick startup(witthin 3 minutes), Zero Emissions of SOx, NOx, CO, CO_2
Output Voltage	220V(Single Phase), 380V(Three Phase)
Startup Time	Wihtin 1~5 minutes
Application	Hydrogen Power Generation, Hydrogen Stations, Backup and Emergency Power Systems for Buildings

*Product image and size may vary from the actual products.

Battery Hybrid System

Product	Battery Hybrid System
Model	ECOGENER BH 5K
Rated Output (Electricity/Heat)	5kW / 7kW(Fuel Cell Output : 3.5kW / 5kW for Base Load)
Size(WxDxH)	Custom-Made
Hot Water Temperature	Max 55°C (May vary depending on hot water usage conditions)
Fuel	City Gas(LNG) or LPG
Fuel Consumption	LNG : 0.25 $Nm^3/hr/kW$, LPG : 0.13 $Nm^3/hr/kW$
Efficiency(LHV)	Electric Efficiency 35%, Overall Efficiency over 90%
Features	Grid-independent Operation, SOC(Battery Charge Level)Following Operation, Instant Peak Load 7kW(Electric) Response
Output Voltage	380V(Three Phase)
Startup Time	10msec
Application	Hydrogen Power Generation, Hydrogen Stations, Backup and Emergency Power Systems for Buildings

*Product image and size may vary from the actual products.

04
Installation Cases

Eulji Twin Tower 2019 / 48kW / NG6Km

G-Square 2020 / 180kW / NG6Km

Faculty and Staff Mutual Aid Association Bldg. 2017 / 35kW / NG5K

Corporate Training Center 2018 / 100kW / FP-100i

Private Power Generation Project 2017-2019 / 800kW / FP-100i

Gileum Centerpiece 2017 / 62kW / NG6Km, NG1K

KT Songpa Tower 2020 / 113kW / NG10Km, 6Km, 5Km

Centropolis 2017 / 70kW / NG10Km

Acro Seoul Forest 2020 / 132kW / NG6Km

05

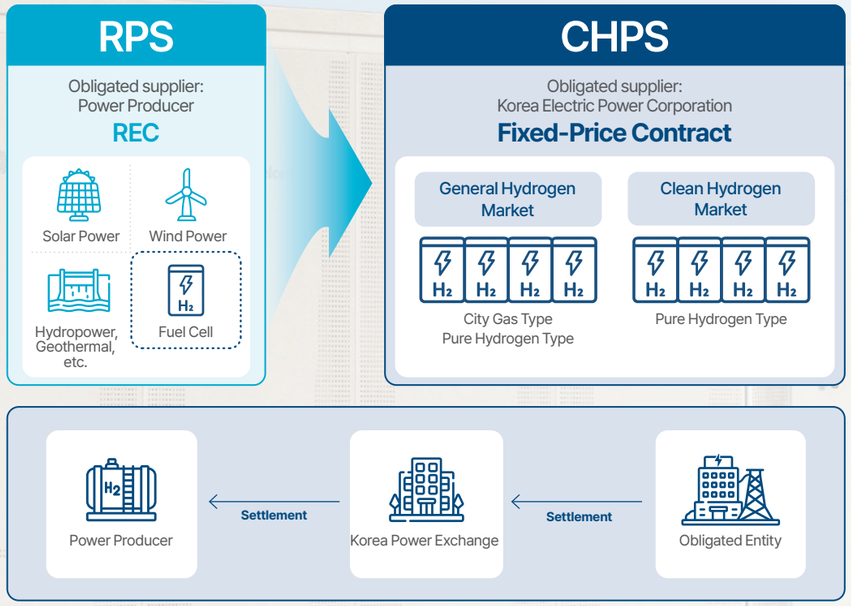
Clean Hydrogen Power Generation Fuel Cells

CHPS solution

CHPS : Clean Hydrogen Portfolio Standard

Clean Hydrogen Portfolio Standard (CHPS)

- Separation of hydrogen generation from RPS to establish a support system compatible with the characteristics of renewable energy and hydrogen generation, promoting the use of clean hydrogen in hydrogen generation
- Mandatory purchase of electricity by Korea Electric Power Corporation (KEPCO): Operation of a bidding market, signing of a differential contract linked to fuel costs with the successful bidder
- A certain percentage of mandatory use is planned for power producers considering the economic viability



Clean Hydrogen Power Generation Fuel Cell System

ECOGENER 200K

*Product image and size may vary from the actual products.

Large-Capacity Hydrogen Power System

Product	200kW Hydrogen Power System		
MODEL	ECOGENER HG 200K	Efficiency (LHV)	Maximum Efficiency 60% / Rated Electrical Efficiency 46%, Overall Efficiency over 85%
Rated Output (Electricity/Heat)	200kW/144kW	Output Voltage	380V(Three Phase)
Size(WxDxH)	4.5 × 1.7 × 1.8 m	Startup Time	Within 5 minutes
Hot Water Temperature	Max 50°C (May vary depending on hot water usage conditions)	Application	Hydrogen Power Generation, Hydrogen Stations, Backup and Emergency Power Systems for Buildings
Fuel Consumption	Pure Hydrogen(H_2), 0.75Nm³/hr/kW	Installation Area (Minimum)	200kW(1 unit) : approx. 24 square meters 1MW(5 units) : approx. 91 square meters 2MW(10 units) : approx. 157 square meters
Features	Quick Startup, High electrical efficiency, Zero emissions of SOx, NOx, CO, CO_2, Minimum Installation Area		

Hydrogen Generation Demonstration Cases

Ulsan Technopark(300kW)

- Completed the demonstration of PEMFC generation system using by-product hydrogen
  Cumulative Power generation of 510MWh
- Fuel cell system with verified stack durability
- Stack durability verified even with DSS (Daily Start & Stop) operation

[Ulsan Technopark HG 50K Demonstration - Using By-product Hydrogen]

Taean Thermal Power Complex Division, Korea Western Power Co., Ltd.(100kW)

- World's first successful demonstration operation of coal gasification fuel cell (IGFC)
  Continuous operation for more than 400 hours
- Enhanced system durability and accomplished 95% in-country production
- Korea Electric Power Corporation Research Institute in collaboration with Korea Western Power Co., Ltd. and Technology Development Service

[Taean Thermal Power Complex Division -Integrated Gasification]

06

Fuel Cell Power Packs

ECOHYNER

2.5kW　5kW　15kW

Customized fuel cell power packs
from design to system

Suitable for electric power sources requiring a lot of energy, supplied as a modular package system.

Product	2.5kW Fuel Cell Power Pack	5kW Fuel Cell Power Pack	15kW Fuel Cell Power Pack
Model	ECOHYNER 2.5K	ECOHYNER 5K	ECOHYNER 15K
Rated Output (Electricity)	2.5kW	5kW	15kW
Application	1.8ton Forklifts, Small Generators	3.5ton Forklifts, Small Generators	Construction Equipment, Generators
Size(WxDxH)	1,010 × 400 × 605 mm	1,085 × 990 × 525 mm	1,200 × 1,000 × 1,000 mm
Fuel	Hydrogen(H_2)		
Fuel Consumption	0.8 Nm^3/hr/kW		
Efficiency(LHV)	Rated Electrical Efficency over 44%		
Features	Quick Startup(within 10 seconds), Zero emissions of SOx, NOx, CO, CO_2		

*Product image and size may vary from the actual products

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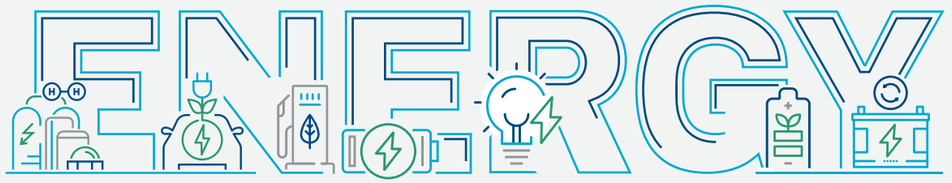

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