



EN Ver.01 2022



FREE ENERGY PLANET

A new world of infinite clean energy – Hydrogen
S-Fuelcell makes it happen

We Make
Free Energy Planet



S-Fuelcell Co., Ltd. www.s-fuelcell.com

Headquarters | 20 Pangyoyeok-ro 241Beongil, Bundang-gu, Seongnam-si, Gyeonggi-do, Republic of Korea (3F MiraeAsset Tower)

Q1 Center | (16648) 66, Saneop-ro 156beon-gil, Gwonseon-gu, Suwon-si, Gyeonggi-do, Republic of Korea

Tel. +82-70-4613-4900 Fax. +82-70-4613-4999 E-mail. sales@s-fuelcell.com



INNOBIZ

KOSDAQ¹

ISO 9001 • 14001 • 45001

S-Fuelcell **S-Energy** **S-Power** **S-Mobility Solution**

H₂

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Hydrogen fuel cell company with the best technology in Korea

S-Fuelcell has been leading fuel cell research and development since 1989. Starting in November 2001, the first fuel cell company in Korea, CETI, was founded and later became the origin of **S-Fuelcell**.

S-Fuelcell have variety of product lines related to hydrogen energy which include fuel cell systems for buildings and hydrogen-used power generating system. The fuel cell systems have been developed by specialized technologies in fuel cell stacks, fuel processors and system integration.

2001~2007

Beginning the fuel cell business

- 2001 **The first in Korea** Established CETI (specialized in fuel cells)
- 2002 **The first in Korea** Developed PEMFC stack (1kW class)
- 2003 **The first in Korea** Developed PEMFC system (1kW-class)
- 2005 Changed company name to GS Fuelcell
- 2007 **The first in Korea** Developed the stack power module (5kW-class)

2009~2013

Commercializing the fuel cell systems

- 2009 **The first in Korea** Installed and operated 5kW-class fuel cell systems in apartment
Selected as the managing department of the national project for developing and demonstrating the 5kW-class fuel cell system
- 2010 **The first in Korea** Developed and field-tested the 5kW-class fuel cell system
- 2011 Launched the fuel cell systems for residence (1kW-class)
- 2013 **The first in Korea** Launched the fuel cell systems for buildings (approved by *KGS, 5kW-class)

2014~2017

Expanding the fuel cell business

- 2014 Established **S-Fuelcell** (spin-off company of GS-Caltex)
- 2014 **The first in Korea** Acquired **KS certification of the fuel cell system for buildings (approved by ***KEA, 5kW-class)
- 2015 **The first in Korea** Launched the LPG fuel cell systems for buildings (approved by *KGS & ***KEA, 5kW-class)
- 2016 **The first in Korea** Launched the modular fuel cell system for buildings (6kW-class)
- 2017 **The first in Korea** Launched the modular fuel cell system for buildings (10kW-class)

2018~2021

Towards Global NO.1


- 2018 **The first in Korea** Acquired certification of LPG fuel cell system (approved by *KGS & ***KEA, 10kW-class)
- The first in the industry** Listed on **KOSDAQ**
- 2019 **The first in the world** Developed battery-hybrid fuel cell systems (1kW & 5kW-class)
Demonstrated IGFC with ****KEPCO (100kW-class fuel cell)
- 2020 **The first in Korea** Exported fuel cell systems to China
- 2021 **The first in Korea** Selected as one of "Hydrogen Specialized Company"
Demonstrated fuel cell systems in Europe (the Czech Republic)

*KGS(Korea Gas Safety Corporation), **KS(Korean Industrial Standards), ***KEA(Korea Energy Agency), ****KEPCO(Korea Electric Power Corporation)


What is hydrogen energy?

H₂


It is “**clean energy**” that does not release pollutants.




It is highly accessible “**anywhere on earth**”




It is more “**stable**” than other fuels.

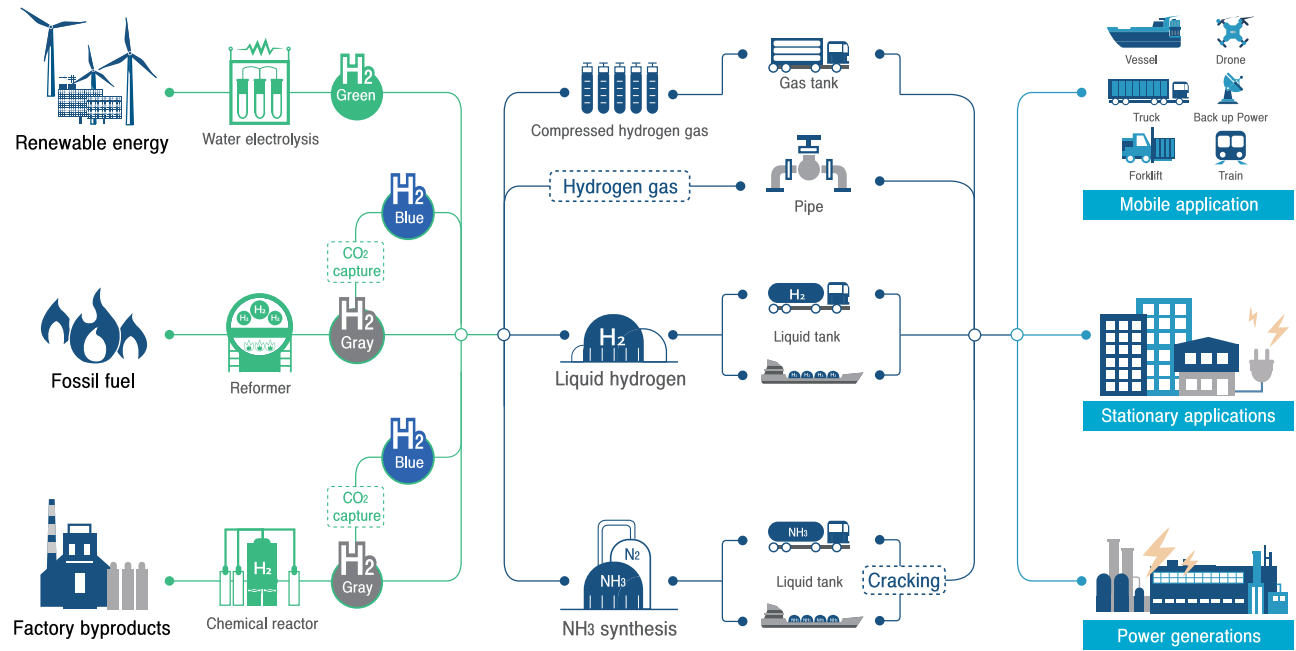


It enables “**energy independent**” for its recyclability and inexhaustibility.





Value chain of hydrogen energy



Hydrogen is extracted from various energy sources, and classified by amount of carbon dioxide emitted during hydrogen production (Gray, Blue, Green Hydrogen)

Hydrogen is stored in the forms of compressed gas, liquid, and hydrogen-compound (such as methane, ammonia, etc.), and transported by using tanks or pipelines.

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.

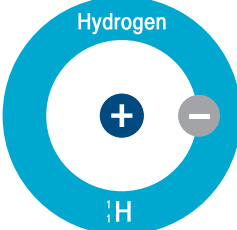
Is hydrogen safe?

Hydrogen is a safe energy source.

Hydrogen in fuel cell has no risk of explosion.

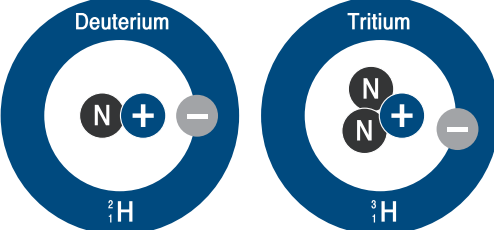
The hydrogen bomb entails nuclear fusion of hydrogen atoms, and the nuclear fusion requires energy as great as the atomic bomb. Hydrogen in fuel cells has no risk of explosion.

Fuel cells




VS

Hydrogen bomb (with 100 million℃)



● Proton ● Electron ● Neutron



Source: Hydrogen Isotopes : Hydrogen, Deuterium, Tritium

Hydrogen is safer than LNG(City Gas), LPG and gasoline.

As hydrogen is the lightest of all the elements existing on Earth, it disperses in the air immediately upon release. Therefore, it is much safer than LNG, LPG and gasoline that you use every day.

Hydrogen	LNG	LPG	Gasoline
Spontaneous ignition temperature 1	Spontaneous ignition temperature 2	Spontaneous ignition temperature 3	Spontaneous ignition 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
Burn rate 4	Burn rate 3	Burn rate 2	Burn rate 1
Total 32	Total 33	Total 39	Total 42
Relative risks 1	Relative risks 1.03	Relative risks 1.22	Relative risks 1.44

Order of stability 1)2)3)4, Total of 15 items assessed

Source - KOSHA MSDS, DIPPR

Hydrogen Economy Policy of Korea

Introduction of Fuel Cell



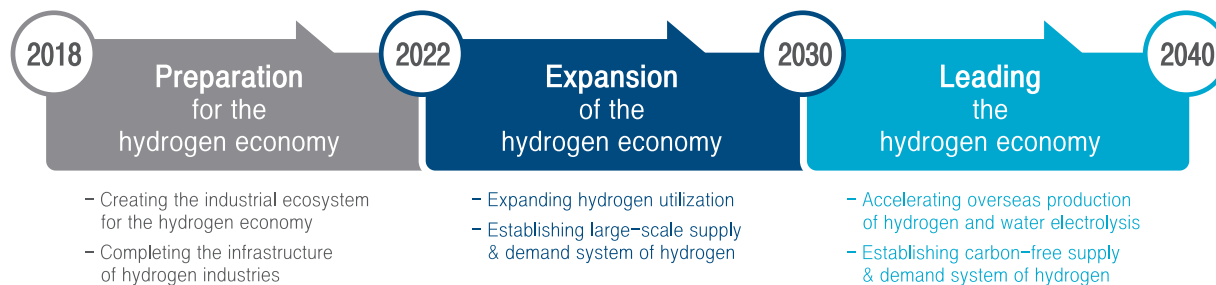
Master plan for realizing hydrogen economy

The government announced and promoted the 'Hydrogen Activation Roadmap' which set the goals for value chain of the hydrogen industry from 2019 to 2040. In February 2020, the 'Act on Promotion of the Hydrogen Economy and Safety Management' (Hydrogen Act), was enacted for the first time in the world



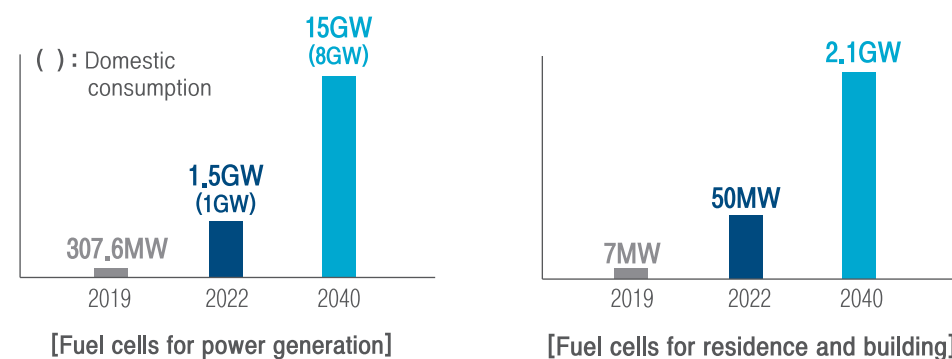
Hydrogen economy activation roadmap

The goals of Korean government are 1) to become a leader of the hydrogen economy by 2040, 2) to create the industrial ecosystem for the hydrogen economy, and 3) to secure future growth engines and reduces greenhouse gas emissions by switching to the hydrogen economy.



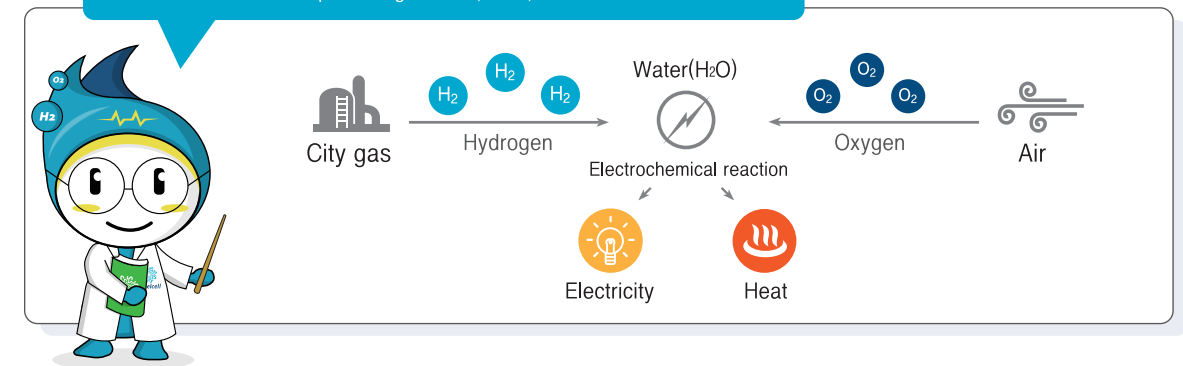
Dissemination goal of fuel cells for power generation, residence and building

The government plans to disseminate 15GW of fuel cells for power generation (8GW in domestic) and 2.1GW of fuel cells for residence and building (940,000 households) by 2040.



What is a fuel cell?

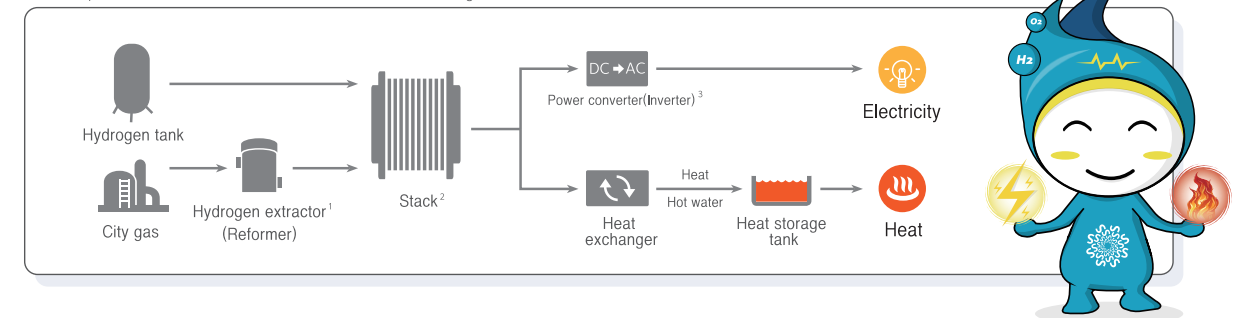
A fuel cell is a clean energy source that generates energy through the chemical reaction between hydrogen and oxygen (in the air), and does not release polluted gas (SOx, NOx, etc.)



Fuel cell system configuration

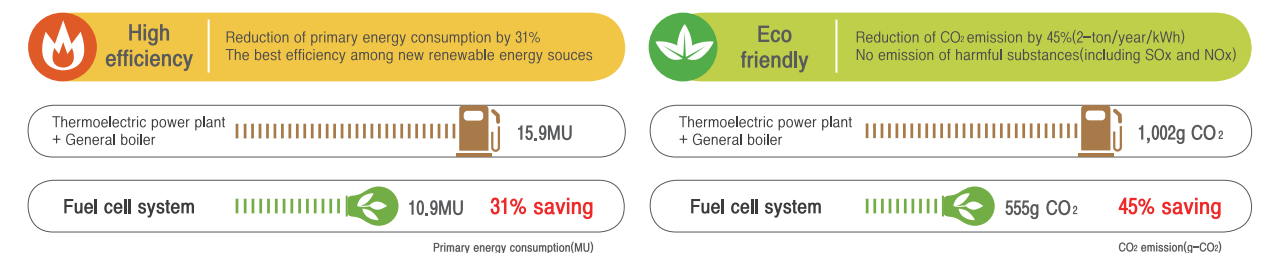
A fuel cell can supply electricity and heat at the same time, and is a highly efficient power generation system with its overall efficiency of 90%.

1. The hydrogen extractor (Reformer) is a reactor that converts the fuel (LNG, LPG, etc.) into hydrogen.
2. The stack uses hydrogen and oxygen (in the air) to generate electricity and heat.
3. The power converter (Inverter) converts the direct currents generated in the stack to alternate currents.



Fuel cell advantages

A fuel cell is a new and renewable energy source with high efficiency and eco-friendly advantages, which can reduce primary energy consumption by 31% and CO₂ emission by 45% to compare with other energy sources.



Hydrogen fuel cell system
ECOGENER



Hydrogen PEMFC system

*Actual product can be changed due to the performance enhancement.		
Power generation (Electricity/Heat)	HG1K~50K	1~50kW / 0.7~35kW (Hot water around 60℃)
Size (W x D x H)	HG50K	1,000 X 1,800 X 1,700 mm
Fuel	H2	
Fuel consumption	0.75m ³ /hr/kW	
Efficiency(LHV)	Approx. 50%(Electricity) / Over 90%(Total)	
Features	Quick start up time, low level noise(Less than 60dB), zero emissions of SOx, NOx and CO	
Output voltage	220V(Single phase) / 380V(Three phase)	
Start-up time	Within 3 minutes	
Applications	Hydrogen power plant, hydrogen station, auxiliary power sources	



Battery-hybrid PEMFC system

*Actual product can be changed due to the performance enhancement.		
Power generation (Electricity/Heat)	Rated power 5kW / 7.0kW (Hot water around 60℃) (Battery capacity) 9kWh	
Size (W x D x H)	Custom Order	
Fuel	LNG , LPG	
Fuel consumption	0.25m ³ /hr/kW (LNG) , 0.13m ³ /hr/kW (LPG)	
Efficiency(LHV)	Over 35%(Electricity) / Over 90%(Total)	
Features	Off-grid operation, SOC(State-Of-Charge) follow-up operation automatic operation, web-based monitoring, Up to 7kW(electricity) peak demand	
Output voltage	220V(Single phase) / 380V(Three phase)	
Start-up time	10msec	
Applications	Emergency power generator for buildings	

Specifications

MODEL	5kW-class modular PEMFC system		10kW-class modular PEMFC system	
Power generation (Electricity/Heat)	NG/PG 5Km	5kW / 7.0kW (Hot water around 60℃)	NG/PG10K	10kW / 14kW (Hot water around 60℃)
	NG/PG 6Km	6kW / 8.4kW (Hot water around 60℃)		
Size (W x D x H)	NG/PG 5Km, 6Km	650 X 1,300 X 1,550 mm	NG/PG10K	1,300 X 1,300 X 1,550 mm
Fuel	LNG , LPG			
Fuel consumption	0.25m ³ /hr/kW (LNG) , 0.13m ³ /hr/kW (LPG)			
Efficiency(LHV)	Over 37%(Electricity) / Over 90%(Total)			
Features	No water supply for chemical reactions, automatic operation, web-based operation, load operation (50%, 75%, 100%)			
Output voltage	220V (single phase) / 380V (three phase)			
Start-up time	Within 1 hour			
Applications	Offices, small buildings, apartment complex			



Compact PEMFC system

*Actual product can be changed due to the performance enhancement.		
Power generation (Electricity/Heat)	NG/PG1K	1kW / 1.4kW (Hot water around 60℃)
Size (W x D x H)	NG/PG1K	600 X 550 X 1,500 mm
Fuel	LNG , LPG	
Fuel consumption	0.25m ³ /hr/kW (LNG) , 0.13m ³ /hr/kW (LPG)	
Efficiency(LHV)	Over 35%(Electricity) / Over 90%(Total)	
Features	No water supply for chemical reactions, automatic operation, web-based operation, load operation (50%, 75%, 100%)	
Output voltage	220V(Single phase)	
Start-up time	Within 1 hour	
Applications	Residence, small buildings, apartment complex	



1



4



5



6



2



3



7



8

Installation Cases

1. KT Songpa / 113kW / NG10Km, 6Km, 5Km / 2020
 4. Centerpiece / 62kW / NG6Km, NG1K / 2017
 7. Centropolis / 70kW / NG10Km / 2017

2. Eulji Twin Towers / 48kW / NG6Km / 2019
 5. Teacher's Credit Union / 35kW / NG5K / 2017
 8. G Square / 180kW / NG6Km / 2020

Fuel Cell System for Power Generation

100kW PAFC System

	FP-100i	FP-100iH	FP-100iB
Power generation (Electricity/Heat)	100kW / 123kW (Hot water around 60℃)	100kW / 99kW (Hot water around 60℃)	100kW / 116kW (Hot water around 60℃)
Fuel	LNG	Hydrogen	Bio gas
Fuel consumption	25m ³ /hr	74m ³ /hr	44m ³ /hr
Efficiency(LHV)	Over 42%(Electricity) / Over 91%(Total)	Over 48%(Electricity) / Over 93%(Total)	Over 40%(Electricity) / Over 84%(Total)
Features	Automatic operation , grid-connected , low level noise (less than 65dB)		
Size	5.5m x 2.2m x 3.4m		
Weight	14 tons	13.5 tons	14 tons
Output voltage	210V or 220V / Three phase / 50Hz or 60Hz		
Exhaust gas	NOx less than 5ppm, SOx and Dust Less than 1ppb	NOx, SOx and dust no emissions	NOx less than 5ppm,SOx and dust less than 1ppb

Applications for Power Generation

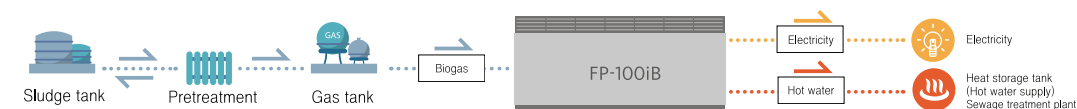
Private power generation business (hospital/sauna/sport center/hotel)



By-product hydrogen power plant



Sewage treatment power plant



Installation Cases

More than 29 units of 100KW PAFC system are operating for private power generation business in Korea



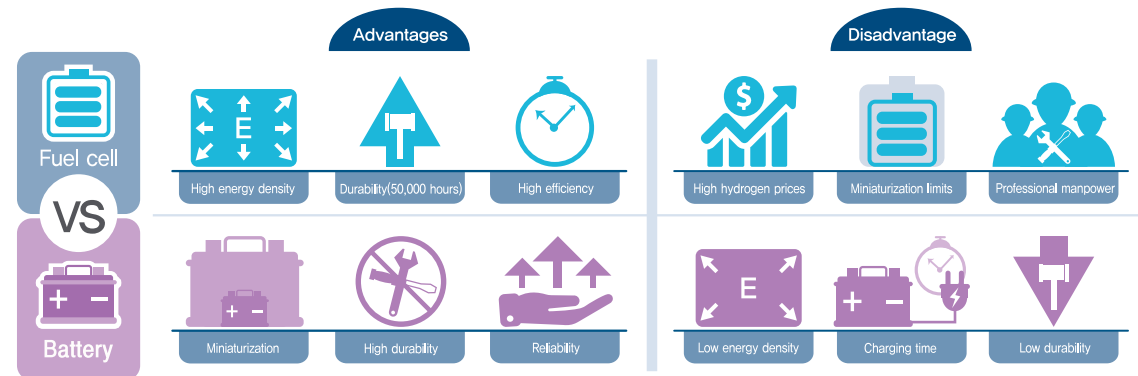
1. Training center / 100kW / Korea / 2018
4. Iron works(Hydrogen) / Japan / 2010

2. Personal fuel cell power plant/ 800kW / Korea / 2017-2019
5. Sewage treatment plant (Bio gas) / Japan / 2002

3. Sauna / 100kW / Korea / 2018

Introduction

The fuel cell powerpack that we produce is a module package system and has a higher energy density than the battery. It is suitable for electrical power source and an alternative to the battery, which requires a lot of energy. Fuel cell powerpack is an assembly of the fuel cell, fuel tank, power conversion unit(inverter), and module control unit system.



Products

Customers can select the capacity they want by using the module package system.

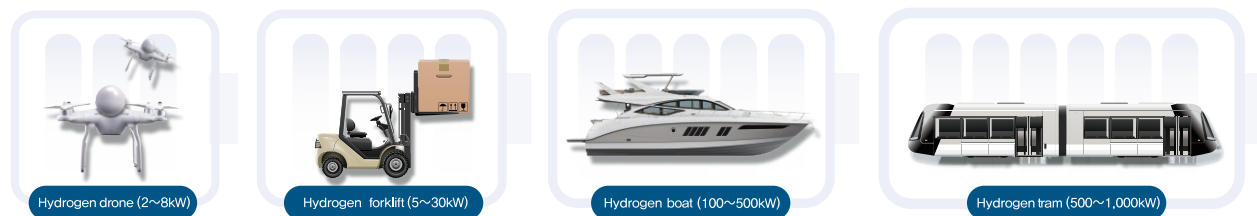


Specifications

Power generation	~5kW
Fuel	H ₂
Efficiency(LHV)	Over 45% (Electricity)
Features	Quick start up time, zero emission of SO _x , NO _x , CO, CO ₂
Start-up time	Within 10 sec
Applications	Drones, forklifts, trams, boats, compact generators

Applications

Fuel cell powerpack can be widely used in industry field because it has higher (energy density compared to the ordinary battery.)



S-Fuelcell

Headquarters

20 Pangyoeyeok-ro 241Beongil, Bundang-gu, Seongnam-si, Gyeonggi-do, Republic of Korea (3F MiraeAsset Tower)

T E L +82-70-4613-4900 F A X +82-70-4613-4999 E-mail sales@s-fuelcell.com

Q1 Center

(16648) 66, Saneop-ro 156beon-gil, Gwonseon-gu, Suwon-si, Gyeonggi-do, Republic of Korea

T E L +82-70-4613-4900 F A X +82-70-4613-4999 E-mail sales@s-fuelcell.com

S-Mobility Solution

Headquarters

(16648) 66, Saneop-ro 156beon-gil, Gwonseon-gu, Suwon-si, Gyeonggi-do, Republic of Korea.

T E L +82-70-4613-4900 F A X +82-70-4613-4999 E-mail sales@s-fuelcell.com

S-Energy

Headquarters

20 Pangyoeyeok-ro 241Beongil, Bundang-gu, Seongnam-si, Gyeonggi-do, Republic of Korea (3F MiraeAsset Tower)

T E L +82-07-4339-7100 F A X +82-70-4339-7199 E-mail inquiry@s-energy.com

Factory

260, Gapcheon-ro, Yuseong-gu, Daejeon, Republic of Korea

T E L +82-42-717-7100

F A X +82-42-717-7199

E-mail inquiry@s-energy.com

S-Energy Chile

Ave. del Valle Norte 961, Of.1701, Huechuraba, Santiago, Chile

T E L +56-22-604-8111

E-mail sales.cl@s-energy.com

S-Energy America

1170 North Gilbert Street, Anaheim, CA 92801, U.S.A.

T E L +1-949-281-7897

F A X +1-949-281-7893

E-mail sales.us@s-energy.com

S-Energy Japan

8F, MJ Abeno Bldg., 1-5-1, Maruyama-dori, Abeono-ku, Osaka-shi, Osaka, Japan

T E L +81-6-4703-5388

F A X +81-6-4703-5387

E-mail sales.jp@s-energy.com

S-Power

Headquarters

20 Pangyoeyeok-ro 241Beongil, Bundang-gu, Seongnam-si, Gyeonggi-do, Republic of Korea (3F MiraeAsset Tower)

T E L +82-70-4339-7100 F A X +82-70-4339-7199 E-mail inquiry@s-energy.com