

**We Make  
Free Energy Planet**



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 S-Fuelcell  S-Energy  S-Power  S-E&C

# FREE ENERGY PLANET

*S-Fuelcell* strives to create a world  
where everyone can freely use clean  
and unlimited energy.



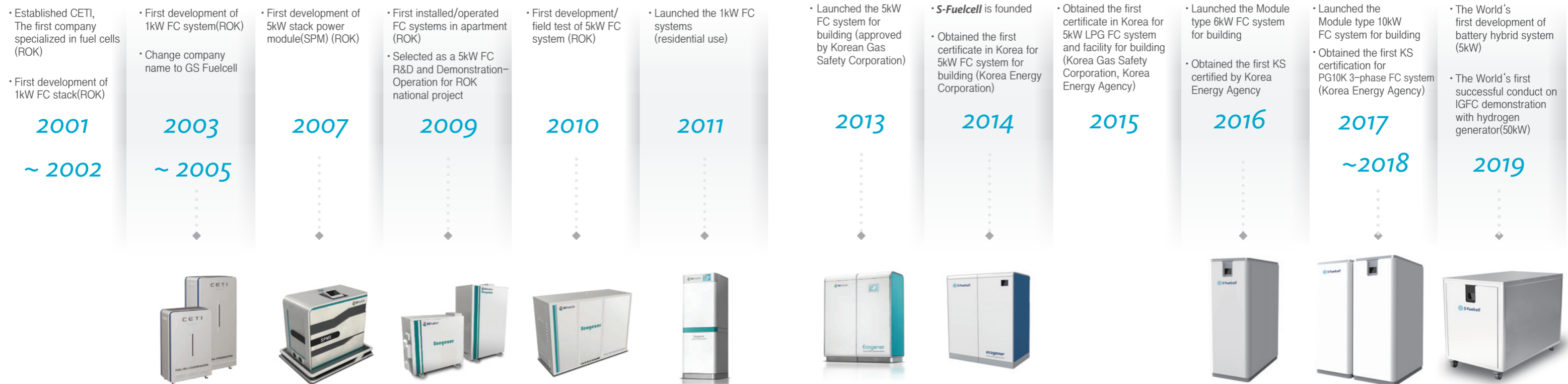
# S-Fuelcell

**S-Fuelcell** has been leading domestic fuel cell R&D since 1989. Having started out as Korea's first company specializing in fuel cells in November 2001, **S-Fuelcell** developed exclusive technologies in the key areas of fuel cell, such as the fuel cell stack, the hydrogen extractor and the integrated system design.

**S-Fuelcell** has conducted a number of national projects and demonstration projects related to fuel cells. With various product groups, including fuel cell systems for homes, buildings and hydrogen generation systems, **S-Fuelcell** is the First-class fuel cell company in Korea.

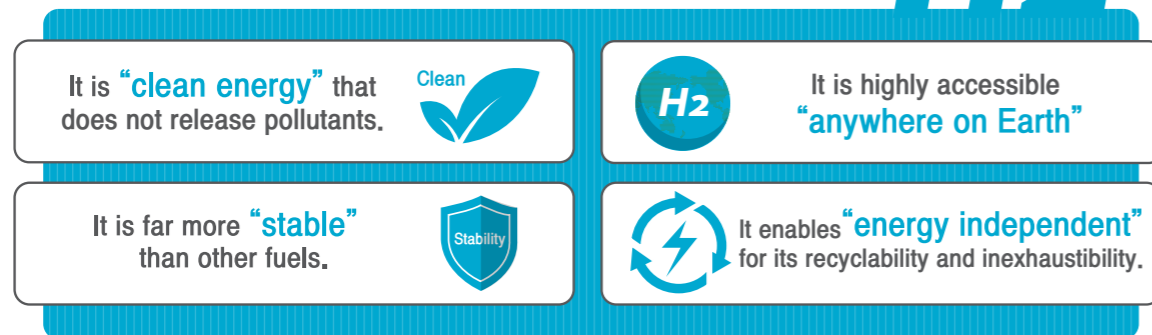
Free Energy Planet

## History



## What is Hydrogen Energy?

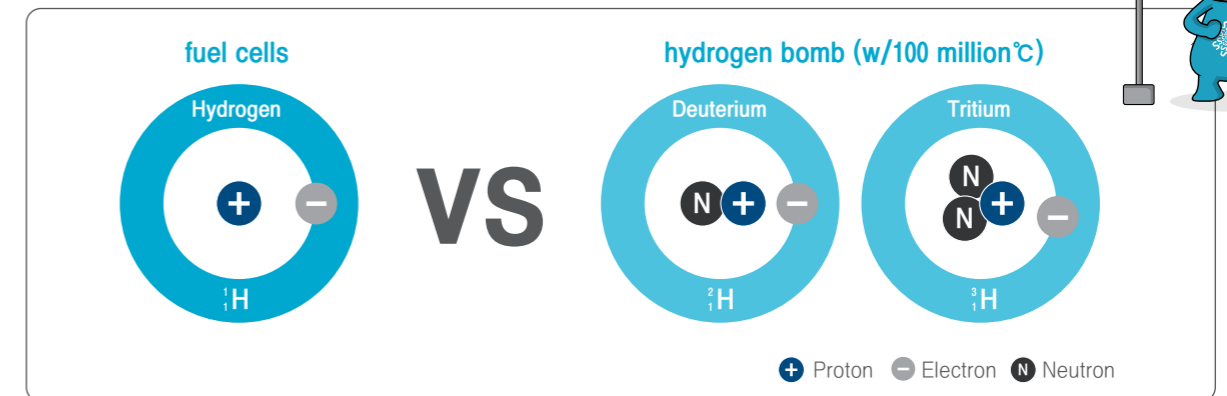
### About Hydrogen Energy



## Is Hydrogen Safe?

### Hydrogen in Fuel Cell has no Risk of Explosion.

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

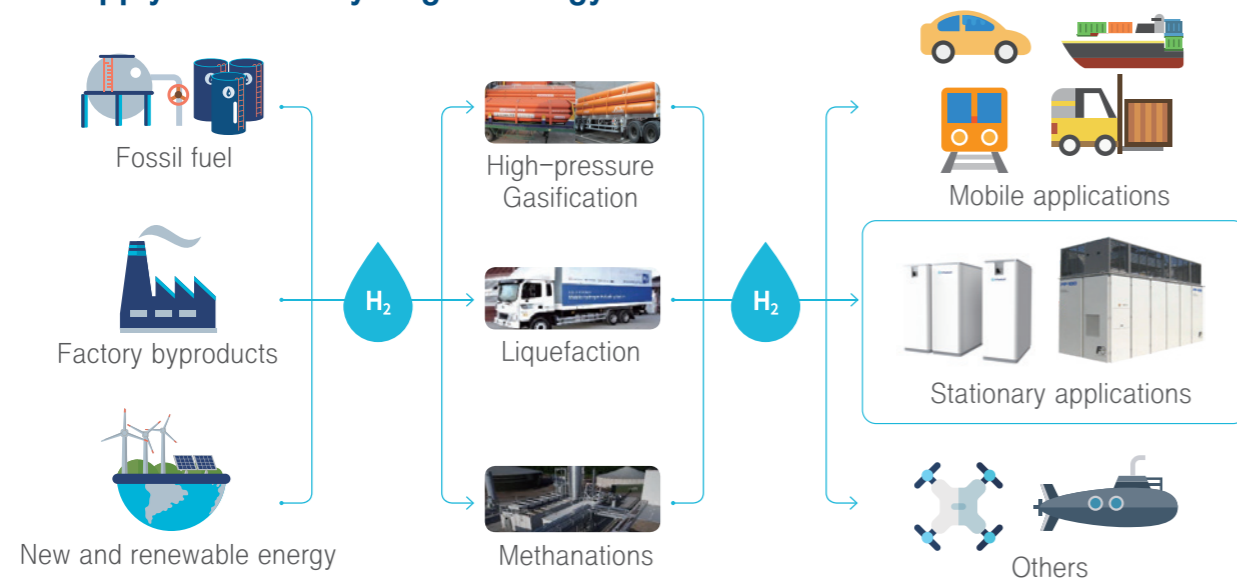


Source: Hydrogen Isotopes : Hydrogen, Deuterium, Tritium

Hydrogen is a safe energy source.



### Supply Chain of Hydrogen Energy



#### Merits of Hydrogen Energy

##### Production

- Hydrogen can be produced by a variety of energy sources and methods

##### Storage · Transportation

- Hydrogen can be liquefied and pressurized to be stored in high-pressure tank, and transported by tanks and pipe lines

##### Utilization

- Contrary to other renewable energy sources, fuel cells can be applied to various areas that use the current energy system, including industrial and transportation fields

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

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

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

Source - KOSHA MSDS, DIPPR

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

[Relative risk assessment by fuel]

## Korea Hydrogen Economy Activation Policy

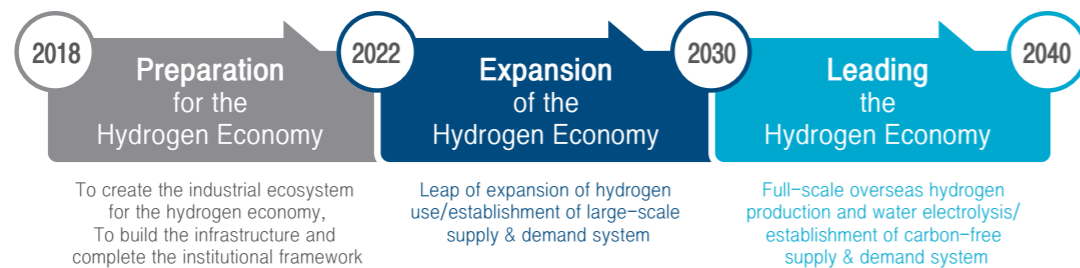
### Master plan for realizing an eco-friendly hydrogen economy

Announcing and promoting the 'Hydrogen Economy Activation Roadmap' which set the goals for each 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. It will enter into force one year after the date of its enactment.



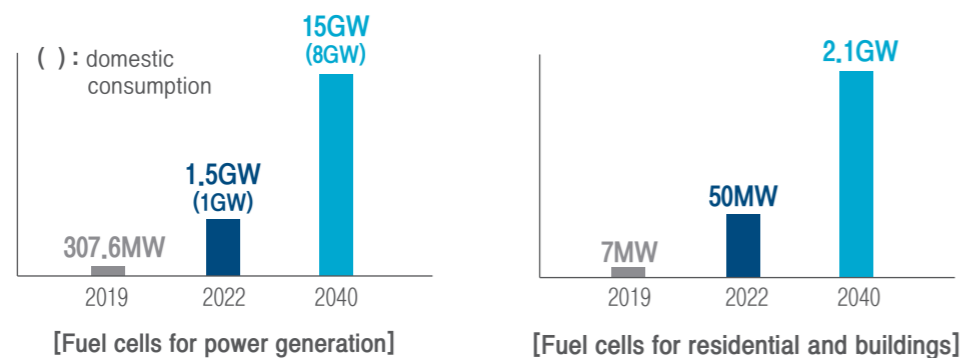
### Hydrogen Economy Activation Roadmap(Korean Government, Jan. 2019)

To become a leader of the hydrogen economy by 2040. To create the industrial ecosystem for the hydrogen economy. To secure future growth engines and reduces greenhouse gas emissions, by switching to the hydrogen economy.



### Fuel Cell Supply Goal on Power Generation, Residential and Building (Cumulative value)

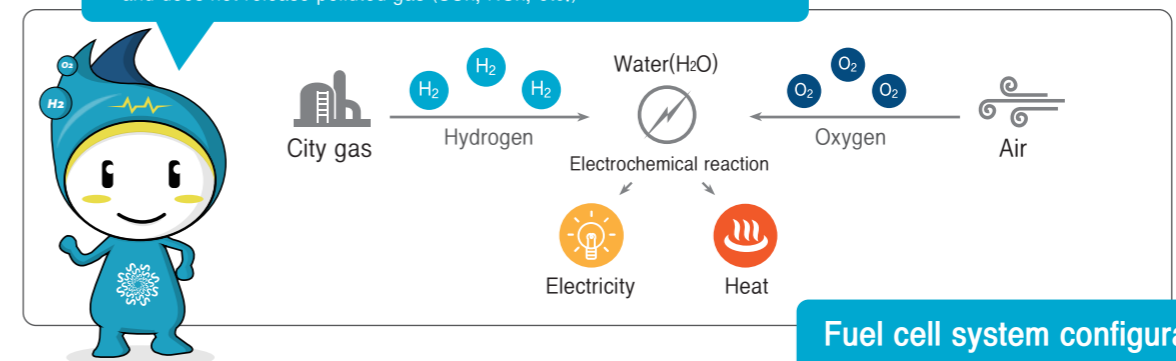
The Korean Government plans to supply 15GW of fuel cells for power generation (8GW domestic) and 2.1GW of fuel cells for residential and buildings (940,000 households) by 2040.



## Fuel Cell Principle and System Configuration

### What is a fuel cell?

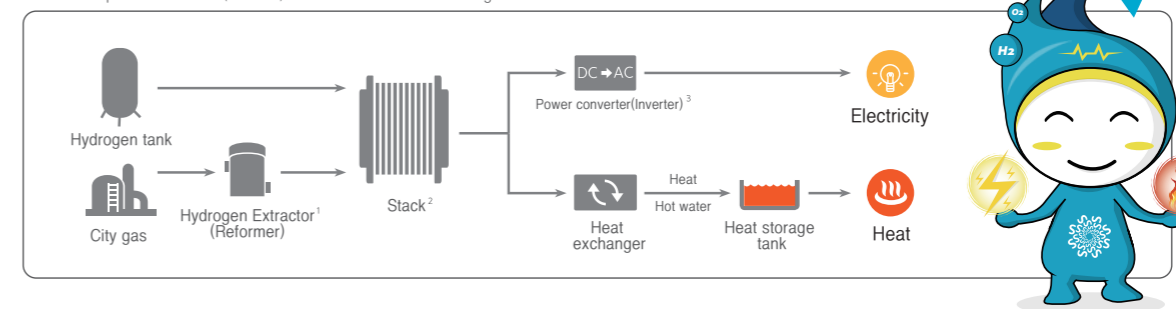
A fuel cell is a clean energy source that generates energy through the chemical reaction between hydrogen and oxygen (in the air), and does not release polluted gas (SOx, NOx, etc.)



### Fuel cell system configuration

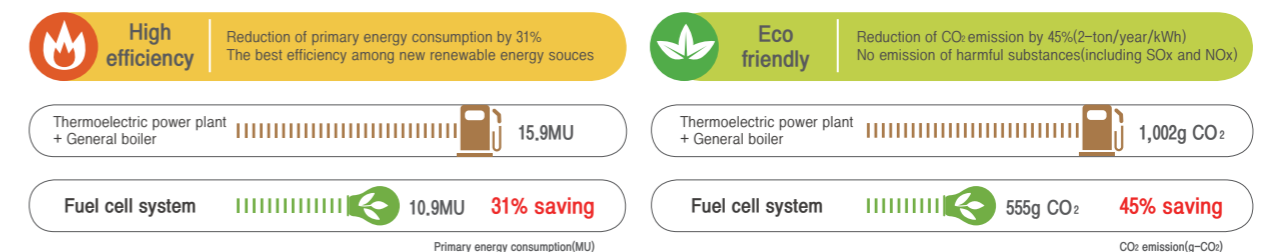
A fuel cell can supply electricity and heat at the same time, and is a highly efficient power generation system with its overall efficiency of 85%.

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 CO<sub>2</sub> emission by 45% to compare with other energy sources.



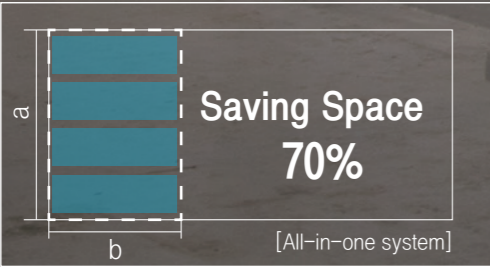
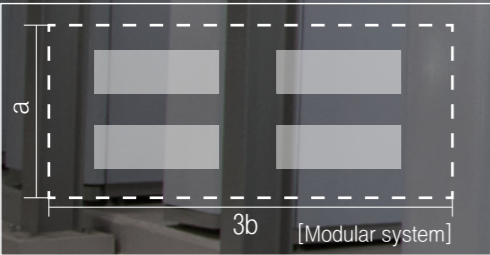
Fuel Cell System for Commercial Buildings (All-in-one System)

5~10kW PEMFC System

NG5Km ~ NG10K/PG10K

Power generation (Electricity/Heat)	NG5Km	5kW / 7.0kW(Hot water around 60℃)
	NG6Km	6kW / 8.4kW(Hot water around 60℃)
	NG10K/PG10K	10kW / 14kW(Hot water around 60℃)
Fuel	LNG / LPG	
Fuel consumption	0.25m <sup>3</sup> /hr/kW (LNG) / 0.13m <sup>3</sup> /hr/kW (LPG)	
Efficiency(LHV)	Over 35%(Electricity) / Over 85%(Total)	
Features	No water required for chemical reactions, Automatic operation, Web-based operation, Load operation(50%, 75%, 100%)	
Size	NG5Km	650 X 1,300 X 1,800 mm
	NG6Km	650 X 1,300 X 1,800 mm
	NG10K/PG10K	1,320 X 1,300 X 1,800 mm
Power	220V(Single phase) / 380V(Three phase)	
Start-up time	Within 1 hour	
Applications	Offices, Small buildings, Apartment complex	

All-in-one system installation



Minimized installation space for Utility as well as A/S  
Up to 5 modules can be connected  
A/S space needs only front and back side

Fuel Cell System for Commercial Buildings (Modular system)

1~5kW PEMFC System


NG1K~NG5K / PG1K~PG5K

Power generation (Electricity/Heat)	NG1K/PG1K 1kW / 1.4kW (Hot water around 60℃) NG5K/PG5K 5kW / 7.0kW (Hot water around 60℃)
Fuel	LNG / LPG
Fuel consumption	0.25m³ /hr/kW (LNG) / 0.13m³ /hr/kW (LPG)
Efficiency(LHV)	Over 35%(Electricity) / Over 85%(Total)
Features	No water required for chemical reactions, Automatic operation, Web-based operation, Load operation(50%, 75%, 100%)
Size	NG1K/PG1K 600 x 600 x 1,600 mm NG5K/PG5K 1,850 x 650 x 1,400 mm
Power	220V(Single phase)
Start-up time	Within 1 hour
Applications	Offices, Small buildings, Apartment complex




Hana Bank Main Branch / 85kW / 2016

New Product / Custom Order



1kW Fuel Cell System



1~50kW Hydrogen Generation System

NG1K/ PG1K2020 new	
Power generation (Electricity/Heat)	1kW / 1.4kW (Hot water around 60℃)
Fuel	LNG / LPG
Fuel consumption	0.25m³ /hr/kW (LNG) / 0.13m³ /hr/kW (LPG)
Efficiency(LHV)	Over 35%(Electricity) / Over 85%(Total)
Features	No water required for chemical reactions, Automatic operation, Web-based operation, Load operation(50%, 75%, 100%)
Size	500 x 600 x 1,500 mm
Power	220V(Single phase)
Start-up time	Within 1 hour
Applications	Offices, Small buildings, Apartment complex

HG1K~HG50KCustom Order	
Power generation (Electricity/Heat)	1~50kW / 0.7~35kW (Hot water around 60℃)
Fuel	Hydrogen
Fuel consumption	0.75m³ /hr/kW
Efficiency(LHV)	Approx. 50%(Electricity) / Over 85%(Total)
Features	Quick start up time(Within 3 minutes), Low level noise(Less than 45dB), zero emissions of SOx, NOx and CO
Size	Depends on capacity
Applications	Hydrogen station, Auxiliary Power Source and Emergency Power Generator for buildings



Battery\_Hybrid Fuel Cell System  
(Actual product may vary due to product enhancement.)

NG5KhCustom Order	
Power generation (Electricity/Heat)	Rated power 5kW / 7.0kW (Hot water around 60℃) (Battery capacity) 9kWh
Fuel	LNG / LPG
Fuel consumption	0.25m³ /hr/kW (LNG) / 0.13m³ /hr/kW (LPG)
Efficiency(LHV)	Over 35%(Electricity) / Over 85%(Total)
Features	Off-grid operation / SOC(State-Of-Charge) follow-up operation Automatic operation / Web-based monitoring Up to 7kW(electricity) peak demand
Size	1,200 x 650 x 1,400 mm(Excluding heat storage tank)
Power	220V(Single phase)
Start-up time	Within 1 hour
Applications	Auxiliary Power Source and Emergency Power Generator for buildings Installable for buildings, Hospital, Hotel, etc.

# Fuel Cell System for Power Generation

## 100kW PAFC System

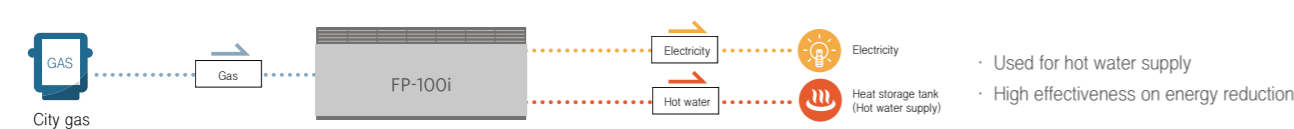
	FP-100i	FP-100iH	FP-100iB
Power generation (Electricity/Heat)	100kW / 123kW (Hot water around 60℃)	100kW / 99kW (Hot water around 60℃)	100kW / 116kW (Hot water around 60℃)
Fuel	LNG	Hydrogen	Bio gas
Fuel consumption	22m <sup>3</sup> /hr <sup>*</sup>	74m <sup>3</sup> /hr	44m <sup>3</sup> /hr
Efficiency(LHV)	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
Power	210V or 220V / Three phase / 50Hz or 60Hz		
Exhaust gas	NOx Less than 5ppm, SOx and Dust Less than 1ppb	NOx, SOx, Dust No emissions	NOx Less than 5ppm, SOx and Dust Less than 1ppb

<sup>\*</sup> City gas Korean Standard 25m<sup>3</sup> /hr

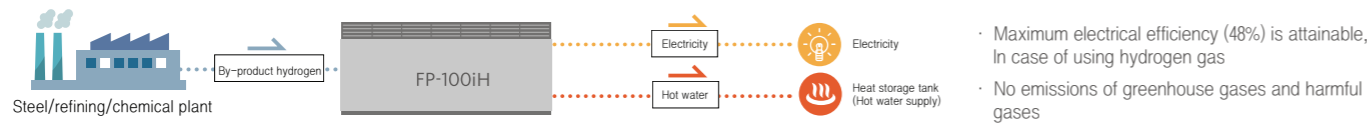
Private power generating business / 800kW / 2017~2019

## Application Cases for Power Generation

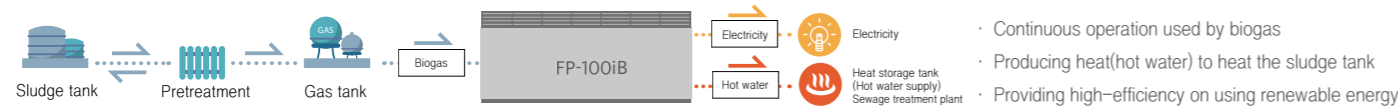
### Private power generating business (hospital/sauna/sport center/hotel)



### By-Product Hydrogen generating plant



### Sewage treatment facility



## Fuel Cell System for Power Generation Installation Cases

100kW PAFC Systems have been installed and operated in Korea (More than 17 units).



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

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

3. Sauna / 100kW / 2018

# Fuel Cell System for Buildings Installation Cases



1. Lotte Castle apartment / 100kW / 2017  
4. Hana Bank Main Branch / 85kW / 2016  
7. University Of Seoul's memorial hall / 17kW / 2018

2. Seoul Dragon City(Hotel complex) / 146kW / 2016  
5. Gyeongbuk Provincial Government Building (New) / 60kW / 2014  
8. Jeju Dream Tower / 120kW / 2019

3. Eulji Twin Tower / 48kW / 2019  
6. Majestar City / 50kW / 2015  
9. G-square / 180kW / 2020



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