

FUEL CELL & HYDROGEN TECHNOLOGY



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www.bumhanfuelcell.com

Bumhan Vision

We will
become a company
trusted by customers and
fulfilling social responsibilities
**with the best technology
and products.**

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With the world's best technology,
**we prepare for a successful
tomorrow with customers.**

In this competitive global market for high-pressure compressors, where high-value vessel development and production requires special attention, Bumhan has long been gearing up in each area of the two categories for marine compressors(- for vessel main engine and turbine start-up equipment, marine equipment, and drilling lines in the undersea expedition) and inland compressors(for high-voltage current-circuit breaker power transmission and distribution equipment, high-pressure breathing air compressors, and power plant equipment including nuclear power plants and aerospace equipment experiments).

Bumhan has developed the hydrogen fuel cell technology for a submarine and successfully produced the world's second hydrogen fuel cell for a submarine. With the success from supplying our hydrogen fuel cell products to military markets, now we are expanding our business to domestic and gradually abroad. Through a combination of continuous efforts by our technology institute and all of our employees' unified passion for excellence, we are indeed committed to maintaining our leading position in the high-pressure air compressor and hydrogen industry. Bumhan Fuel Cell Co., Ltd. promises to continue to grow as a worldwide industry leader, ready to respond to the changes and demands of the global market.

CEO
Young Sik Jung

Bumhan Overview

Bumhan's
new growth started.



Bumhan R&D center InMagok, Seoul



Headquarter(Changwon)



Bumhan building(Changwon)



Technology center(Changwon)



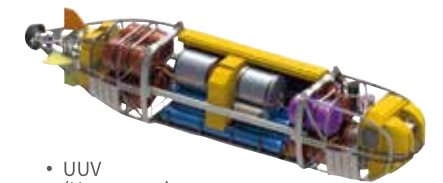
Vietnam cable factory (Danang)

Bumhan established in 1990, aims to create its own brand value and secure its place in the competitive global market. We are a research and development-oriented company specialized in designing and manufacturing high-pressure air compressors and the hydrogen products. The new R&D center was established in Seoul in 2020 to continue innovative development to be in a position to meet the rising demand for changing technology trends.

Fuel cell - Development History

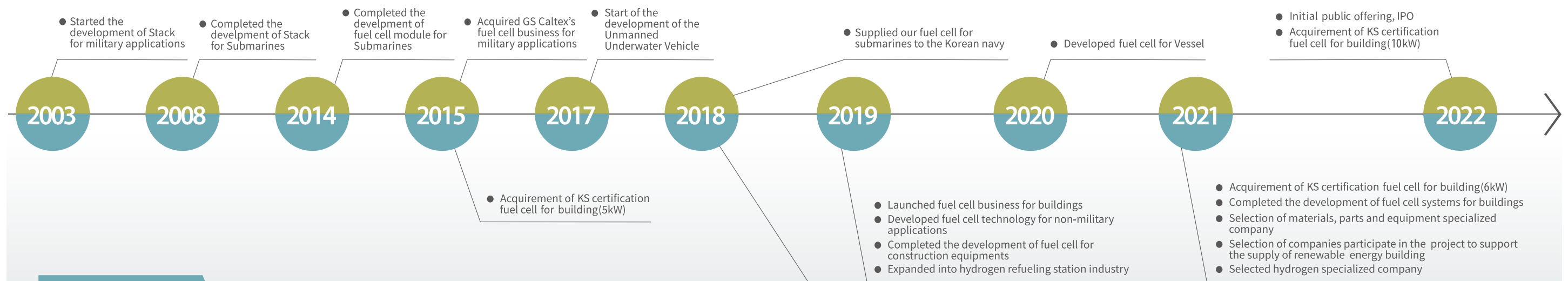
Based on the Know-how of fuel cell technology for military application, we are expanding our business to the fuel cell for civilian market.

- Bumhan Fuel Cell module loaded into Chang Bogo III, ROKS Dosan Ahn Changho class submarine in 14th Sep. 2018. The world's second developed fuel cell module for submarine.



• UUV (Unmanned Underwater Vehicle)

Fuel cell for Military Applications



Fuel cell for Non-Military Applications



• Fuel cell for constructions equipment

Fuel cell - Building

Fuel cell system for Buildings

Fuel cell features

- Power generation : 5kW, 6kW , 10kW
- Easy to installation / Easy to move
- Supply local heating and cooling as well as heat for industrial facilities
- Manage all products 24 hours through a web-monitoring system
- Respond to load fluctuations in real time
- Easy to operate with a control panel
- Obtained certification : 5kW KGS, KS(2019), 6kW KGS, KS (2021), 10kW KGS, KS (2022)



Certification & Quality warranty

Bumhan Fuel Cell products have complied with not only industrial standards such as KS, KGS, ISO but also quality management standards such as ISO9001, ISO14001, and ISO45001



BHH050 (5kW Hydrogen)

Specifications

Category	Contents
Related Power	5kW
Gen. efficiency	Over 48%
Total efficiency	Over 90%
Output voltage	AC220V (Single-phase)
Operation mode	Grid connection
Size (W/D/H)	500x650x1,400(mm)
Fuel	Hydrogen (Purity : 99.9%)
Pressure	0.5 bar
Operating Temp.	-20 ~ 45°C
Starting time	< 10 min

BNH050 (5kW LNG)

Specifications

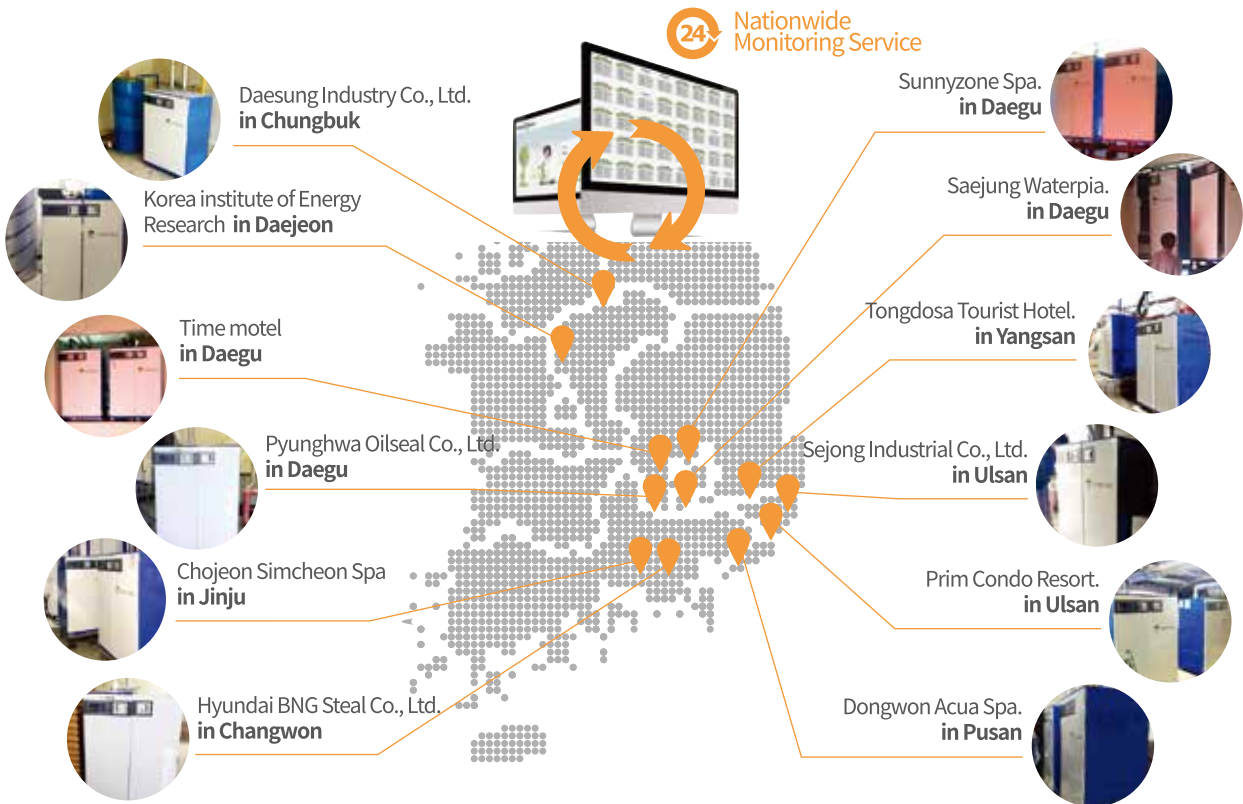
Category	Contents
Installation site	Indoor
Rated output	5kW±10%
Gen. efficiency	Over 36%
Total efficiency	Over 94%
Output voltage	AC220V (Single-phase)
Operation mode	Grid connection
Thermal Output	Maximum 7kW
Size (W/D/H)	1,000x650x1,400(mm)
Weight	500kg(Dry condition)
Noise level	59dB(A)
Hot weater storage tank	Installation separately
Hot water temperature	Maximum 65°C
Exhaust type	Forced flue type(FF)

BNH060 (6kW LNG)

Specifications

Category	Contents
Installation site	Indoor
Rated output	6kW±10%
Gen. efficiency	Over 36%
Total efficiency	Over 94%
Output voltage	AC380V (Three-phase four wire)
Operation mode	Grid connection
Thermal Output	Maximum 8.5kW
Size (W/D/H)	1,000x650x1,400(mm)
Weight	550kg(Dry condition)
Noise level	59dB(A)
Hot weater storage tank	Installation separately
Hot water temperature	Maximum 65°C
Exhaust type	Forced flue type(FF) or Forced Exhaust (FE)

Installation cases of Bumhan's Fuel cell systems and Web-monitoring Maintenance service



Fuel cell - Building

BNH100 (10kW LNG)

■ Specifications

Category	Contents
Installation site	Indoor
Rated output	10kW ± 10%
Generation efficiency	Over 36%
Total efficiency	Over 94%
Output voltage	AC380V (Three-phase four-wire)
Operation mode	Grid connection
Thermal output	Maximum 14kW
Size (W/D/H)	1,300x800x1,700(mm)
Weight	800kg(Dry condition)
Noise level	59dB(A)
Hot water storage tank	Installation separately
Hot water temperature	Maximum 65°C
Exhaust type	Forced flue type(FF) or Forced Exhaust(FE)

BNH250 (25kW LNG)

■ Specifications

Category	Contents
Installation site	Indoor
Rated output	25kW ± 10%
Generation efficiency	Over 36%
Total efficiency	Over 94%
Output voltage	AC380V (Three-phase four-wire)
Operation mode	Grid connection
Thermal output	Maximum 35kW
Size (W/D/H)	1,500x1,300x1,700(mm)
Weight	1,800kg(Dry condition)
Noise level	59dB(A)
Hot water storage tank	Installation separately
Hot water temperature	Maximum 65°C
Exhaust type	Forced flue type(FF) or Forced Exhaust(FE)

■ Applications of Building



Apartment



House / Townhouse



Edifice



Hospital



Resort



Spa

Fuel cell - Technology

Bumhan Fuel Cell has obtained various patents related to fuel cell technology. Based on production factories of fuel cells for buildings and R&D center in Korea, we have advanced core technology of components such as stack, fuel reformer and electric converter.

■ Intellectual Property Rights

- Acquired Hyundai-steel's fuel cell technology
- Has obtained 99 patents

■ Core Technologies for Systems



Stack



System planning and test

■ Secured world's advanced technology with our skilled manpower in our own manufacturing factory



Fuel cell technology for submarines



Manufacturing factory for fuel cells in Changwon



Magok Fuel Cell R&D Center in Seoul



Fuel Cell - Stack & Powerpack

Bumhan Fuel Cell and Powercell, a Swedish leading fuel cell company, have been entering into a technology development agreement in the fuel cell stack and power module business.

Fuel cell stack



V Stack

P Stack

Model	Capacity(kW)	Size(W/D/H, mm)	Fuel
V Stack	3 ~ 35	490 * 155 * Max 459	Natural gas reformed hydrogen, Hydrogen
P Stack	49 ~ 125	420 * 156 * Max 582	Hydrogen

Fuel cell system



PS-5

MS-30

MS-100

Model	Capacity(kW)	Size(W/D/H, mm)	Stack type
PS-5	1 ~ 5	440 * 557 * 1218	V Stack
MS-30	10 ~ 30	415 * 641 * 696	V Stack
MS-100	50 ~ 100	Custom-made	P Stack

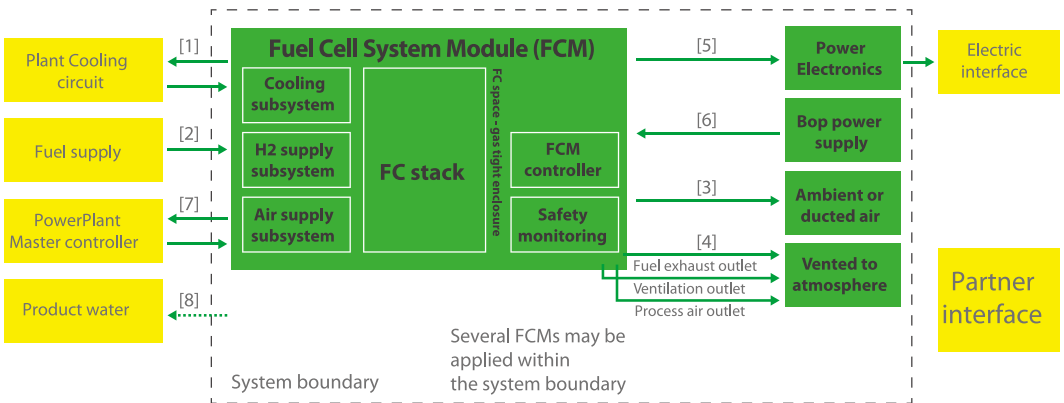
Large capacity-parallel fuel cell system



PowerCell MS-100

Fuel Cell Power Plant Preliminary Technical Data	Specification
Subsystem	14 X PowerCell MS-100
Max. continuous net power	1.0 MW
Nominal electric outputs ¹	800 VDC
Maximum Waste Heat	1.2 MW
Fuel	Hydrogen
Size	40ft container

¹ Depending on electric configuration (tbd)



Fuel Cell - Mobility

Hydrogen fuel cell for mobility
Bumhan Fuel Cell is developing a 'hydrogen mobility' to revitalize the hydrogen economy.

Fuel Cell - Ship

We commercialized fuel cells for military applications such as submarines and unmanned vehicles.
Also we are developing fuel cells for vessels



Category	Contents
Related output	Over 20kW
Electrical Efficiency	Over 45%
Fuel	Hydrogen
System	Fuel cell + battery hybrid system



Category	Contents
Related output	Over 100kW
Electrical Efficiency	Over 45%
Fuel	Hydrogen
System	Fuel cell + battery hybrid system



■ Powerpack

Category	Contents
Related power	5~100kW
Size(W/D/H)	780*590*357(mm)
Electrical Efficiency	Over 45%

■ Application Field



Excavator (Compact)



Excavator (Full-mid size)



Fuel Cell Electric Bus



Category	Contents
Related output	Over 120kW
Electrical Efficiency	Over 63%
Fuel	Hydrogen, Oxygen
System	Fuel cell + Secondary battery hybrid system



Category	Contents
Related output	3kW
Electrical Efficiency	Over 63%
Fuel	Hydrogen, Oxygen
System	Fuel cell + Secondary battery hybrid system

Hydrogen Refueling Station

Bumhan Fuel Cell is pushing forward the Hydrogen refueling station business, a milestone in the hydrogen society. As a first step, we became a member of Hydrogen Energy Network, a special purpose company in Korea.

The Hydrogen Refueling Station business was started with Bumhan entering as a shareholder of HyNet (2019) and achieved a total 22 HRS orders by 2021, now in operation or under construction. Hydrogen compressors and dispensers, and core parts of hydrogen refueling station system have been developed to manufacture our own products in house for domestic market and foreign market.

■ On-site or Off-site hydrogen refueling station



■ On-site hydrogen refueling station

Category	Contents
The way of supplying hydrogen	Hydrogen reformer
Hydrogen compressor	Discharge pressure 90MPa
Hydrogen Storage tank	50MPa/103MPa
Dispenser	Valid for 70MPa(including network)
Chiller	-33°C ~ -40°C

■ Off-site hydrogen refueling station

Category	Contents
The way of supplying hydrogen	Tube Trailer
Hydrogen compressor	Discharge pressure 90MPa
Hydrogen Storage tank	50MPa/103MPa
Dispenser	Valid for 70MPa(including network)
Chiller	-33°C ~ -40°C

| Moving & Installation Hydrogen Refueling System

- Hydrogen-Reformer
- Hydrogen Compressor
- Hydrogen Storage Tank
- Disper



Moving & Installation Hydrogen Refueling System



Hydrogen-Reformer System



Hydrogen Compressor



NG & LPG Reformer

■ Moving&Installation Hydrogen Refueling System

Category	Contents
The way of supplying hydrogen	Tube Trailer or Hydrogen Reformer
Charging Time	5kg / 3min
Charge Capacity	2 storage / 1hr
Dispenser	Valid for 70MPa(including network)
Freezing machine	-33°C ~ -40°C

■ Hydrogen Reformer

Category	Contents
Fuel	LNG or LPG
Hydrogen purity	Over 99.999%
Co-concentration	Below 70%
Reforming efficiency	Over 70%
Hydrogen output	Over 320kg/day