

# Fuel Cell System

Hydrogen for Humanity





# HTWO

## Driving the Energy shift

Hydrogen is a great solution that acquires and utilizes energy from nature.

With Carbon Neutrality becoming the most urgent challenge to humanity, HTWO intends to shift the current energy paradigm with Hydrogen Fuel Cell System.

From automobiles to power generation—discover the potential of HTWO's hydrogen and fuel cell technology, which will make the future of our civilization more sustainable.

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# Why Hydrogen?

Energy for today and for all tomorrows

In the face of a global climate crisis, the world is directing its attention toward hydrogen as an environment-friendly energy solution.

Hydrogen has an unlimited supply and does not emit CO2 from production to utilization. Governments and industries are renovating their energy structure to be centered on renewable energy sources and fuel cells.

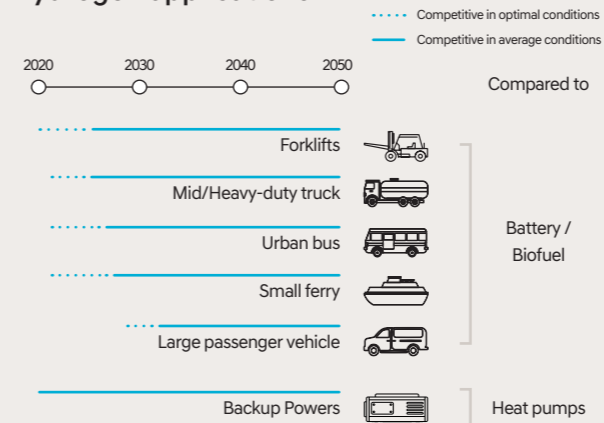


# Hydrogen & Fuel Cell Solution, Growing in Competitiveness

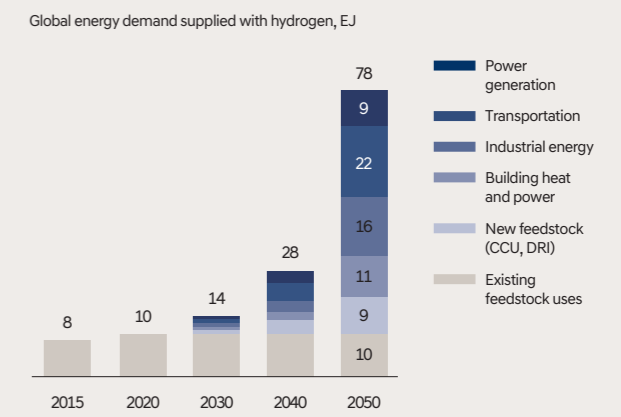
The global rise in concern about climate change led to the Paris Agreement and the reinforcement of the UN IPCC, diminishing the competitiveness of fossil-fuel-based technologies. In contrast, hydrogen and fuel cell technology is becoming attractive and feasible alternative for fossil fuels.

Hydrogen and fuel cell usage is expected to increase as its cost decreases from the advancement of related technologies and the growth in its market. Hydrogen council estimates that the demand of hydrogen will increase up to 78EJ by 2050.

## Cost competitiveness trajectories of hydrogen applications <sup>1)</sup>



## Hydrogen demand could increase remarkably by 2050 <sup>2)</sup>



<sup>1)</sup> Hydrogen Council (2020). Path to hydrogen competitiveness. A cost perspective  
<sup>2)</sup> Hydrogen Council (2017). Hydrogen scaling up

## Clean Energy

Can be produced with renewable source

Hydrogen can be acquired through electrolysis. Using sustainable energy sources for the process, humanity could harvest an unlimited amount of clean energy entirely from nature: Water yields hydrogen, hydrogen powers the fuel cell, and the fuel cell powers a vehicle. The hydrogen recombines with oxygen and forms water.

## Safety

Safe enough compared to the other conventional fuels

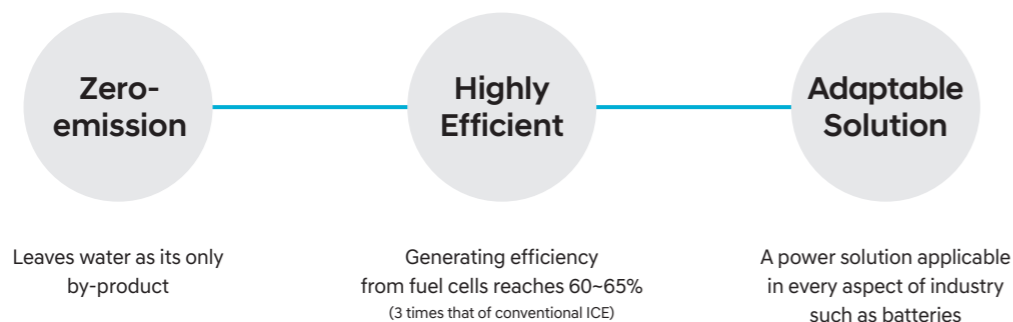
Some question the safety of the hydrogen. Hydrogen does have inherent risks when not treated properly. However, this fact applies not only to hydrogen, but any other conventional fuels. Any other conventional fuels such as gasoline or natural gas could also be exposed to danger, when not treated properly.

## Energy Carrier

Can deliver clean energy in high density

Hydrogen is efficient in its transport and distribution. It can be distributed as gas or liquid, alleviating logistic burden. Hydrogen facilitates storage management as well, capable of being deposited in a large amount for an extended period. It also has a higher gravimetric energy density, three to four times higher than that of fossil fuels, making it the most efficient method in terms of management.

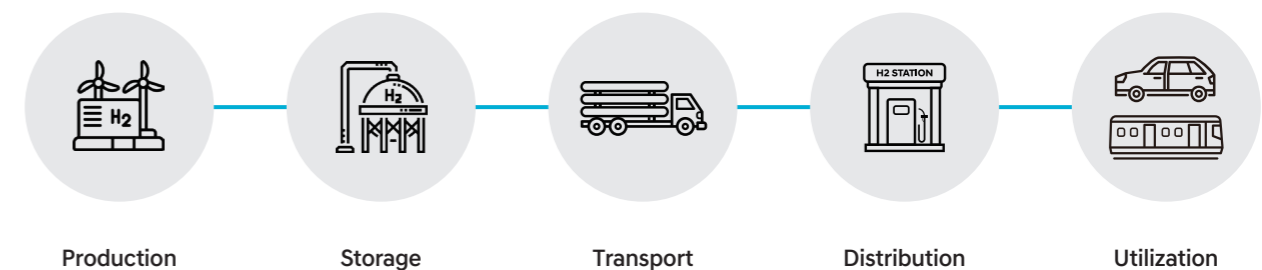
# Fuel Cell, An Idealistic Power Source for Everything



# Hydrogen Value Chain, A Virtuous Cycle for Hydrogen-Driven Society

Every aspect of the entire process, from energy production to consumption, must change to make a successful shift into a hydrogen society.

The change would be possible only through achieving coordination in hydrogen production, distribution, and utilization. The global community has already begun its shift toward a hydrogen society. HTWO intends to support its endeavor by making hydrogen technology versatile.



# HTWO : 'Hydrogen for Humanity'

Hyundai Motor Group pursues not only an advancement in technology but also an advancement for humanity. The development of FCEVs and fuel cell technology, on which our competitors have not focused, was a part of the pursuit.

Hyundai Motor Group now desires to share the benefit of its hydrogen technologies with every member of human civilization via its fuel cell business brand HTWO. Hydrogen for Humanity—this mission of HTWO will propel humankind toward a brighter future.

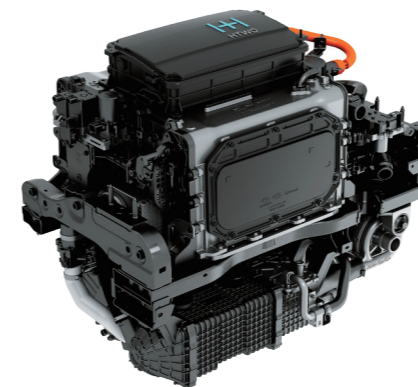


## HTWO, Hydrogen Fuel Cell Business

Becoming the first company to mass-produce FCEV in 2013, Hyundai Motor Company is leading the hydrogen-powered passenger car and commercial vehicle markets. With the reliability of its fuel cell technology under harsh and unforgiving conditions proven, HTWO is expanding its business to every field requiring energy, including the global OEM, ships, trams and power generation market.

## Hydrogen Fuel Cell System

Fully contained fuel cell system including fuel management system, thermal management system, etc.



### Performance

Power (Net)	85kW
Max. Current	300 A
Output Voltage	250 ~ 450 V <sup>1)</sup>
Max. System efficiency	62%

### Reactants

Hydrogen specification	ISO 14687
Hydrogen supply pressure	~ 17±1.5Bar (abs)

### Physical

Operating ambient temperature	-30 ~ +45°C
Storage temperature	-30 ~ +75°C <small>* recommend the room temperature</small>
Dimensions (mm <sup>l</sup> )	892 × 703 × 728 <small>* excluding wiring</small>
Dry / Wet Weight	175kg / 185kg
Volume	453L

1) With DC-DC converter : 450 - 828V

Commercialized fuel cell vehicles



Expanding the application of Fuel cell system



Automobiles (for the other OEMs)



Ships



Trams



Power Generations

## Features

### Proven technology : Mass produced system

- Reliable in performance / Durability / Cold start (Available to operate in extremely cold weather)

### World-class technology

- Maximized efficiency : 62% with optimized design
- Awarded "10 Best engines" (by WardsAuto, 2019)

### Scalable & Easy to apply

- Multiple systems can be applied according to power requirement (e.g. dual systems applied to Hyundai's Heavy duty truck and bus)
- Variety of projects (prototype, demo, serial-production) ongoing by our partners



## Proven Technology Through FCEVs

Since the launch of the fuel cell development project in 1998, Hyundai Motor Group has been continuing research for the last 20 years.

This experience allowed Hyundai Motor Group to be the first in the industry to mass-produce FCEVs. Hyundai is expanding its FCEV product line based on such expertise.



## HTWO's Experience

From automobiles to power generation, HTWO has proven the adaptability of its fuel cell to various fields of industry. HTWO is discussing with numerous partners for implementation of fuel cell in their businesses. HTWO is also leading several projects for the commercialization and production of goods equipped with its hydrogen technologies.

HTWO is open to partners for the paradigm shift toward a hydrogen society.

2018

### 2<sup>nd</sup> generation FCEV 'NEXO' (global sales 27,000+, '22.07)

Equipped with High-Efficiency Fuel Cell System  
Driving range : 666km (WLTP) | System Efficiency : 60%

As commercial and convenient as internal combustion engines  
Warranty : 10 years / 160,000km | Charging time : less than 5 minutes

Internationally Recognized Safety  
KNCAP : Grade 1 | US NCAP : 5★ | IIHS : TSP+ | Euro NCAP : 5★



2020

### 'XCIENT Fuel Cell' heavy duty truck (For European market)



- First to manufacture hydrogen-powered heavy trucks
- 47 exported to Switzerland ('22.06), 27 to Germany ('22.10)

Fuel Cell Output : 160kW | Motor Output : 350kW  
Tank Capacity : 32kg | Driving range : 400km

### 'ELEC CITY Fuel Cell' city bus



- 220+ Buses in Operation in Korea ('22.07)
- Successful test operation in Munich ('21.06)

Fuel Cell Output : 180kW | Motor Output : 300kW  
Tank Capacity : 34kg | Driving range : 474km

2022

### Universe fuel cell express bus



### Fuel cell water spray truck



### Fuel cell garbage compactor truck



## Automotive

Passenger Vehicle



- HTWO's fuel cell readily applicable, proven from Hyundai's mass-produced FCEVs

Commercial Vehicle



- Currently under discussion with various OEMs to apply HTWO's fuel cell system to their products

## Non-Automotive

Tram



- Railway vehicle without exhaust gas or noise; does not require electric wires/substations, making it economical
- Railway vehicle manufacturers currently developing/validating prototypes

Special Vehicle



- Fuel cell's fast charging ensures longer uptime; enhancing work efficiency
- Development/validation in process with industrial machine makers

Marine Application



- Can serve as the main engine & sub-engines for various ships/vessels
- Developing/validating propulsion system using fuel cell with marine propulsion maker

## Power Generation

Stationary



- Modularized system enables flexible capacity upon demand
- HTWO is currently testing a 1MW-class power generation system in Ulsan, Korea

Mobile



- Provides power in areas lacking infrastructure
- Currently operating at venues for motorsports, film production, and other events
- HTWO is providing a prototype to EV motorsports (ETCR)

Emergency



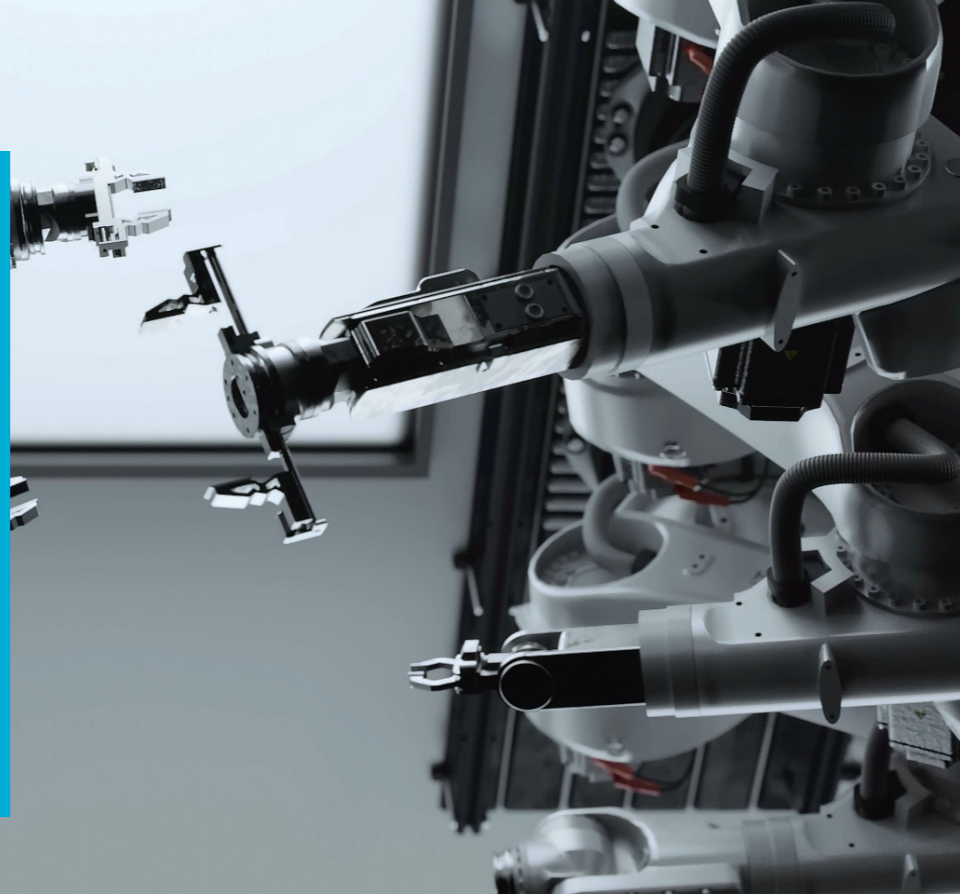
- Provides auxiliary power to confront demand peaks and emergencies
- Factories/data centers considering installation



# A Total Solution for Hydrogen & Fuel cells

As a fuel cell brand of Hyundai, HTWO shares the R&D center, fuel cell manufacturing plants, and global service network with Hyundai Motor Company.

HTWO provides an integrated solution for introducing fuel cell in your business based on its technological know-how in the automobile industry, manufacturing/mass-production capability, and quality control solution.



## Hydrogen Vision 2040

As a smart mobility solution provider, Hyundai Motor Group strives to utilize fuel cell as a power source for various mobilities. Hyundai ultimately aims to make hydrogen an energy source for anyone, anything, and anywhere, leading a shift toward a hydrogen-driven society.

### For more to be privileged from the technology

With advanced technology, HTWO is expanding the scope of application

- Reduce the system cost to make fuel cell technology affordable
- Downsize the components for easy packaging
- Enhance durability to reduce maintenance cost
- Build partnerships to achieve economies of scale
- Creating H2 demand by expanding the use of hydrogen



## R&D

### Technical Feasibility Review

- Analysis of customer requirements
- Reviews technical feasibility
- Feasibility reviews on the packaging, power system and part specifications, etc.

### Engineering Support

- Provides customers with technical information required to apply fuel cell
- Supports feasible revision of H/W and S/W specifications

### Onsite support services

- System installation
- Quality inspection at all stages
- Supervision of trial operation



Hydrogen fuel cell R&D center, Korea

## Plant

### System Supply

- Ensure the stable supply
- Delivery of fuel cells for mass production
- Managing all aspects of production and the supply chain



Chungju plant, Korea  
(capacity : 23,000+/yr)

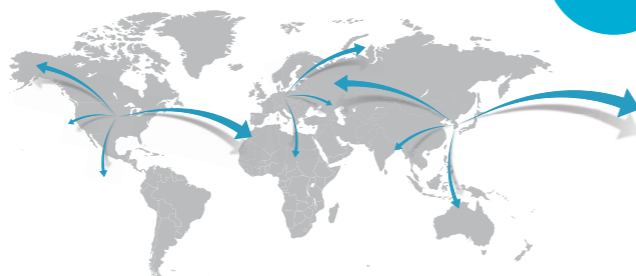


HTWO Guangzhou plant, China  
(capacity : 6,500/yr)

## After Sales

### Customer Service

- Operating a global customer service network
- Provides warranty, repair, parts supply for stable operation



Total Solution

## A companion for the sustainable future

HTWO is preparing for the hydrogen society as a long-lasting partner



\* Trailer Drone : Futuristic hydrogen-powered logistics commercial vehicle concept



