Hello!

Your First Step to Hydrogen

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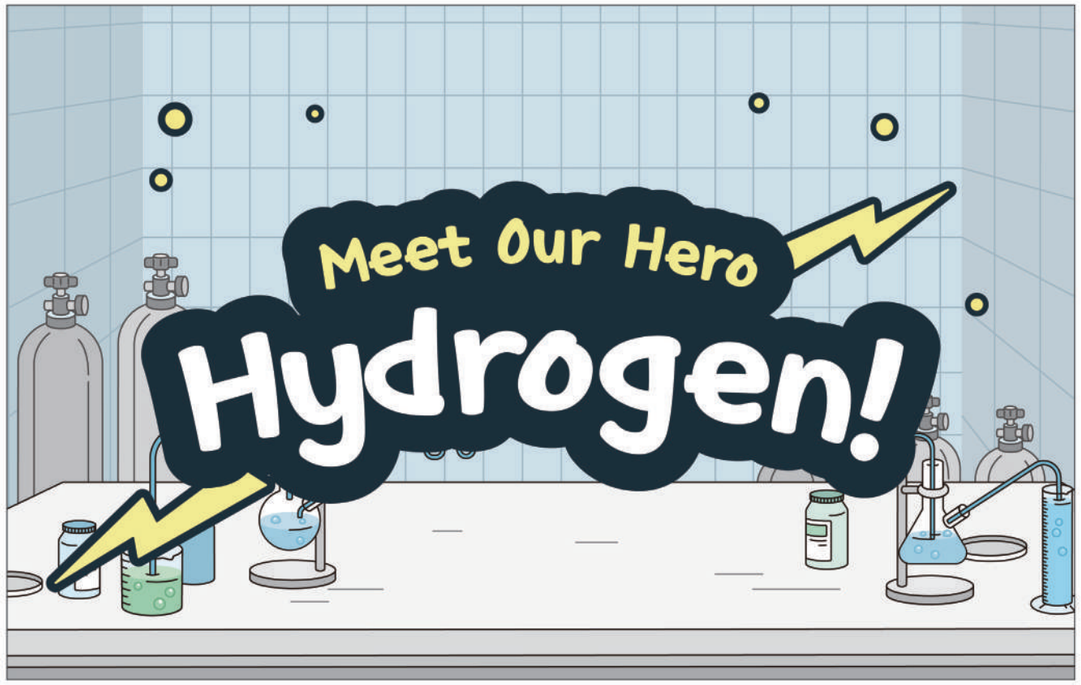
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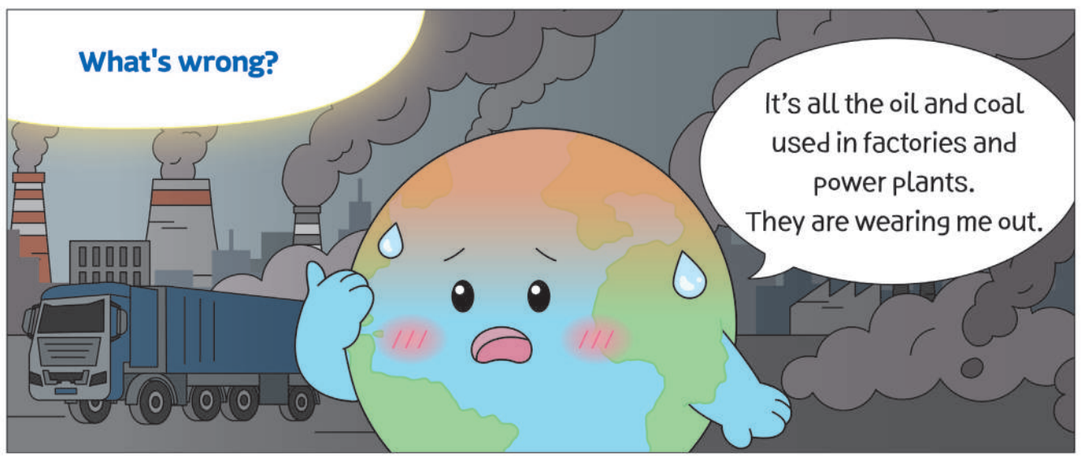
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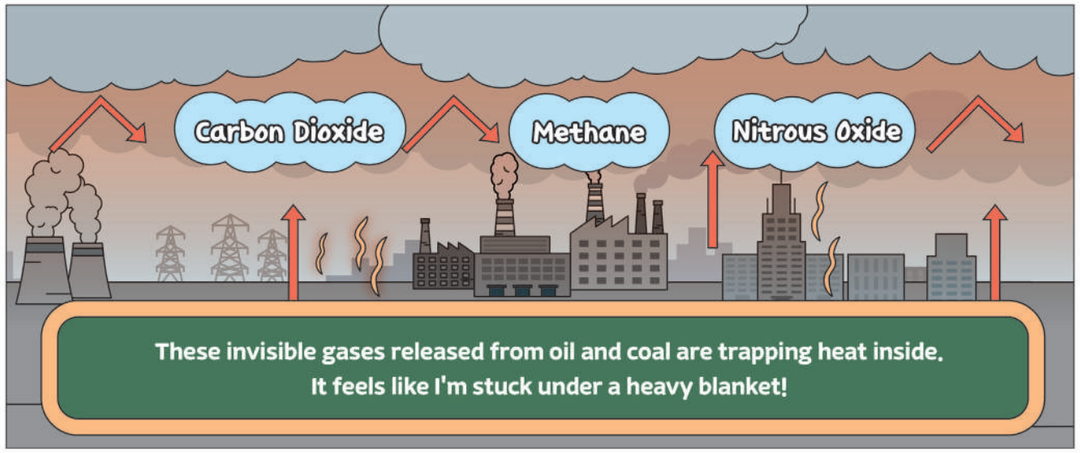
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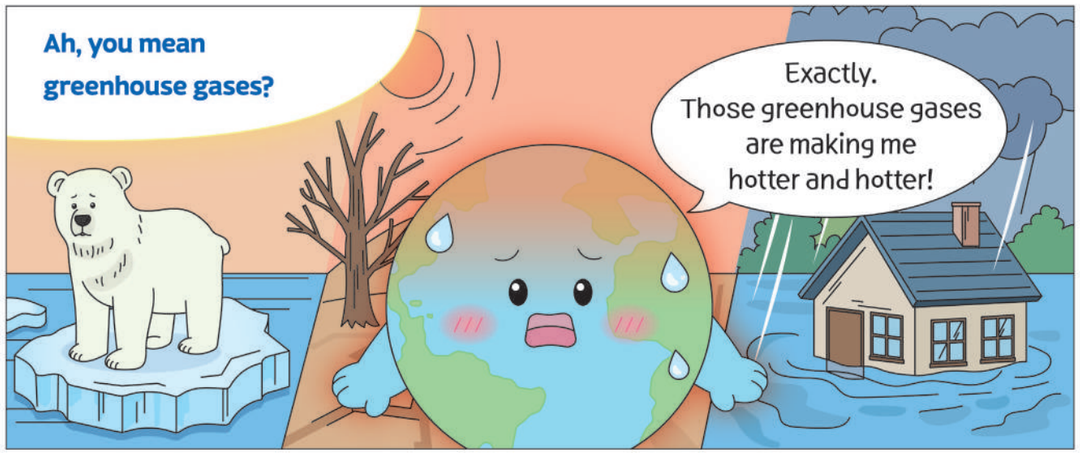
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Meet Our Hero
Hydrogen!

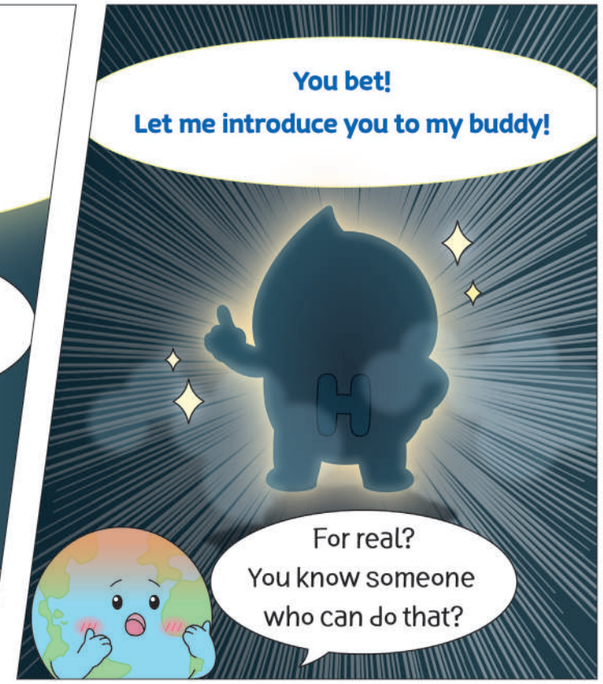

Ugh!
It's boiling
hot!


What's wrong?
It's all the oil and coal
used in factories and
power plants.
They are wearing me out.

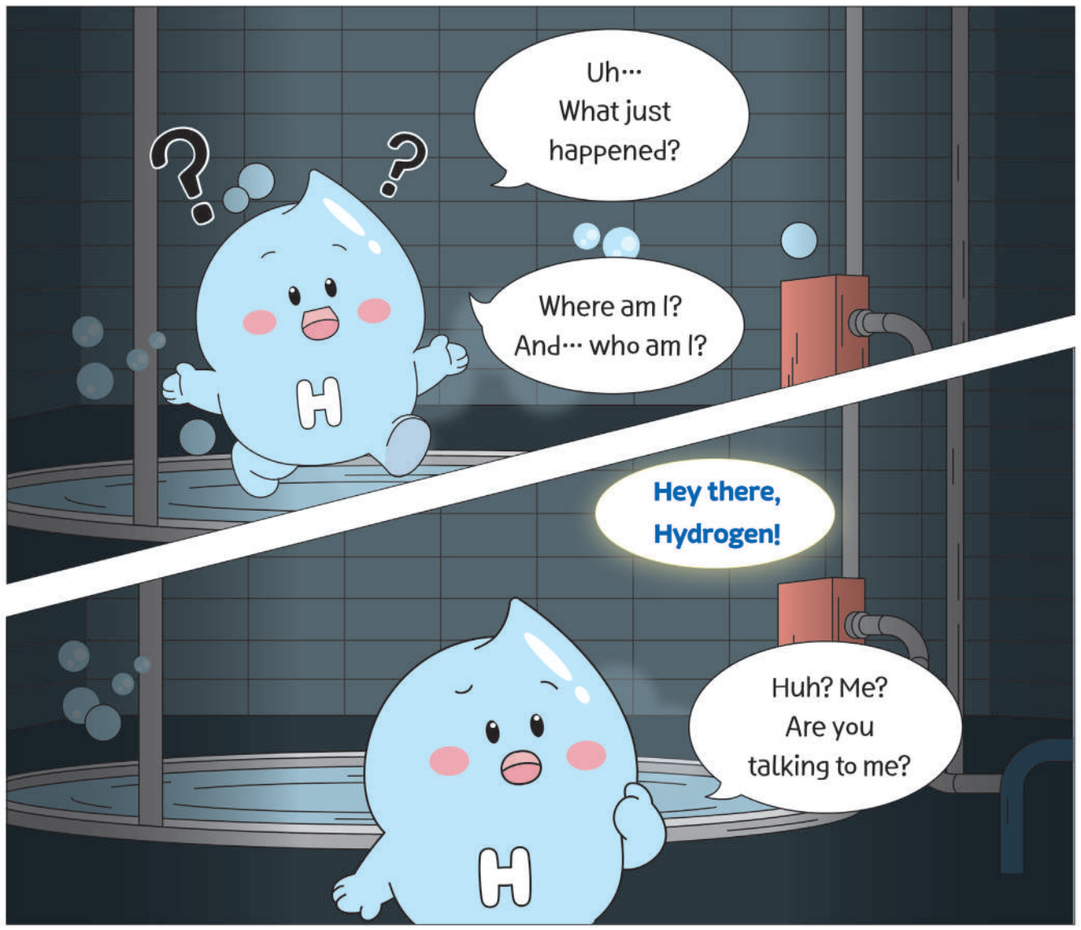

Carbon Dioxide
Methane
Nitrous Oxide
These invisible gases released from oil and coal are trapping heat inside.
It feels like I'm stuck under a heavy blanket!

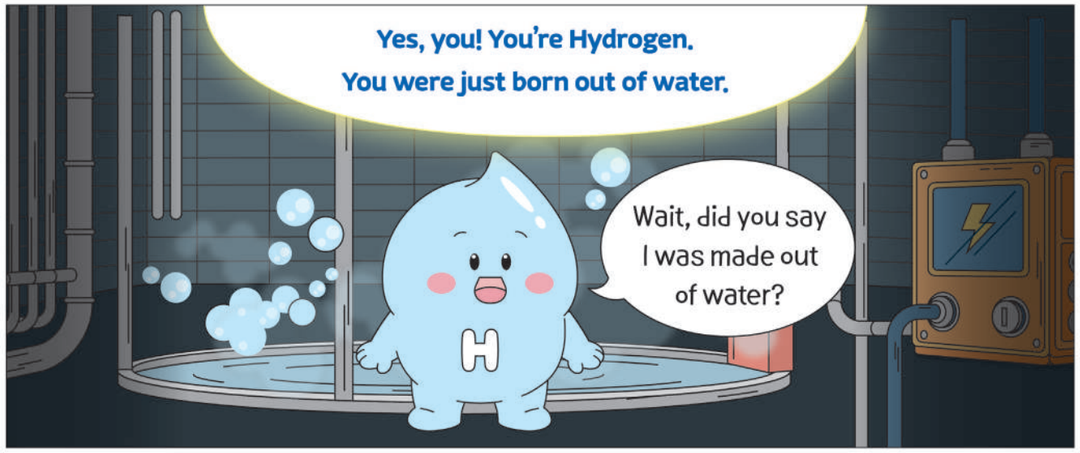

Ah, you mean
greenhouse gases?
Exactly.
Those greenhouse gases
are making me
hotter and hotter!

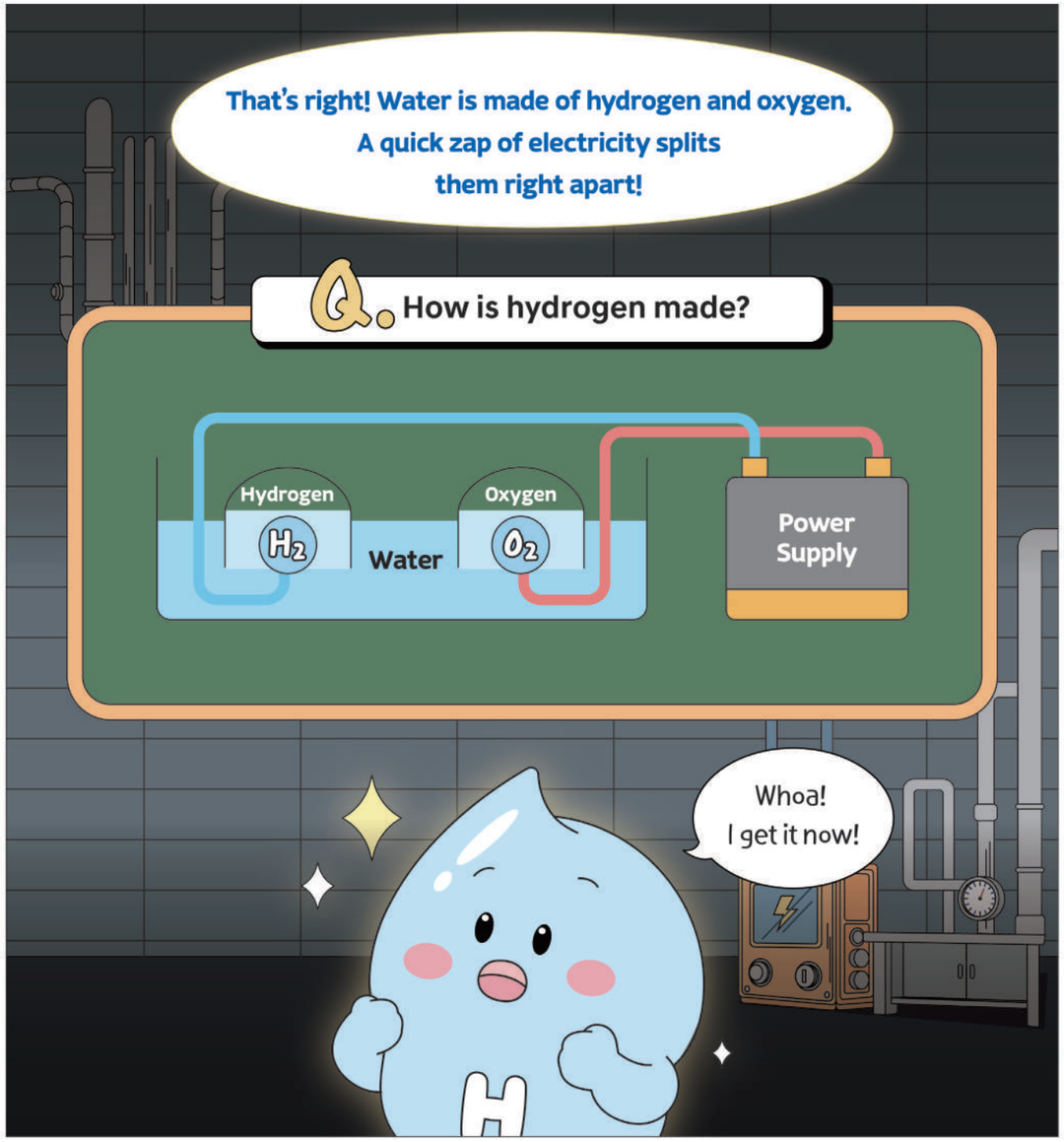

Well, you're in luck!
I know a friend who can help us
create the energy we need
without making you hotter!
I wish someone
could help me out.

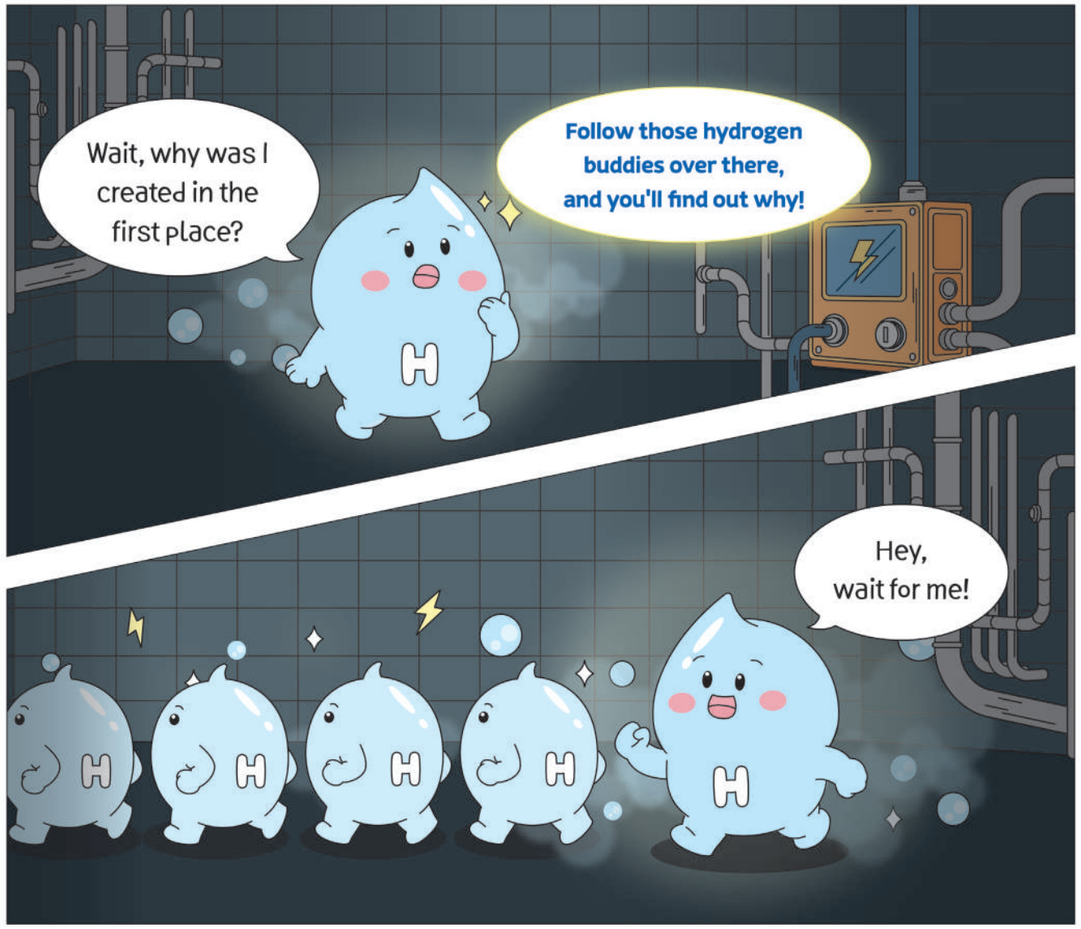

You bet!
Let me introduce you to my buddy!
For real?
You know someone
who can do that?


Zzzzt···
BOOM!

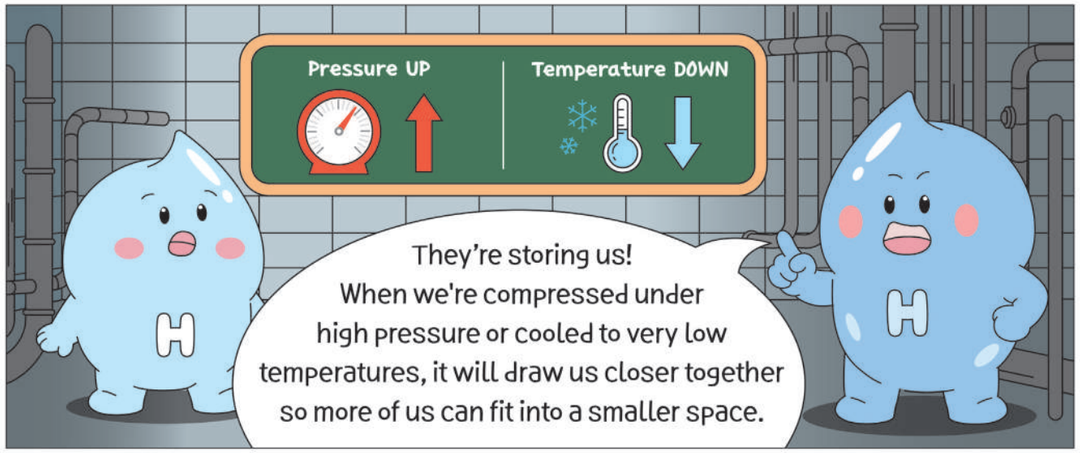

Uh···
What just
happened?
Where am I?
And··· who am I?
Hey there,
Hydrogen!
Huh? Me?
Are you
talking to me?
H
H


Yes, you! You're Hydrogen.
You were just born out of water.
Wait, did you say
I was made out
of water?
H

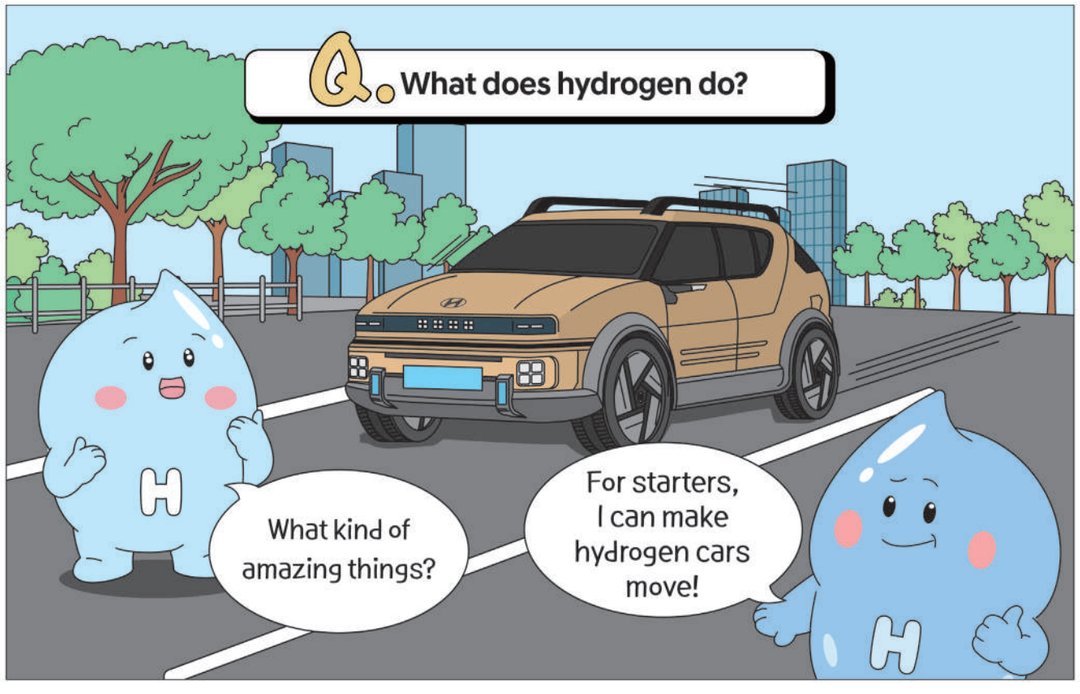

That's right! Water is made of hydrogen and oxygen.
A quick zap of electricity splits
them right apart!
Q. How is hydrogen made?
Hydrogen
H_2
Water
Oxygen
O_2
Power
Supply
Whoa!
I get it now!
H

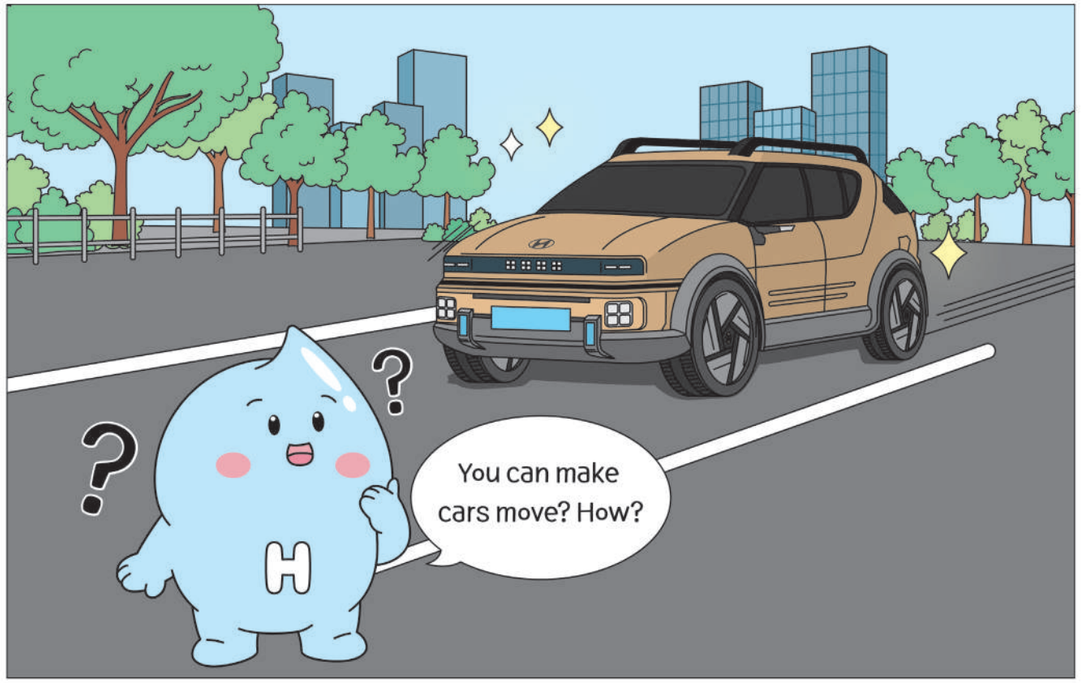

Wait, why was I created in the first place?
Follow those hydrogen buddies over there, and you'll find out why!
Hey, wait for me!

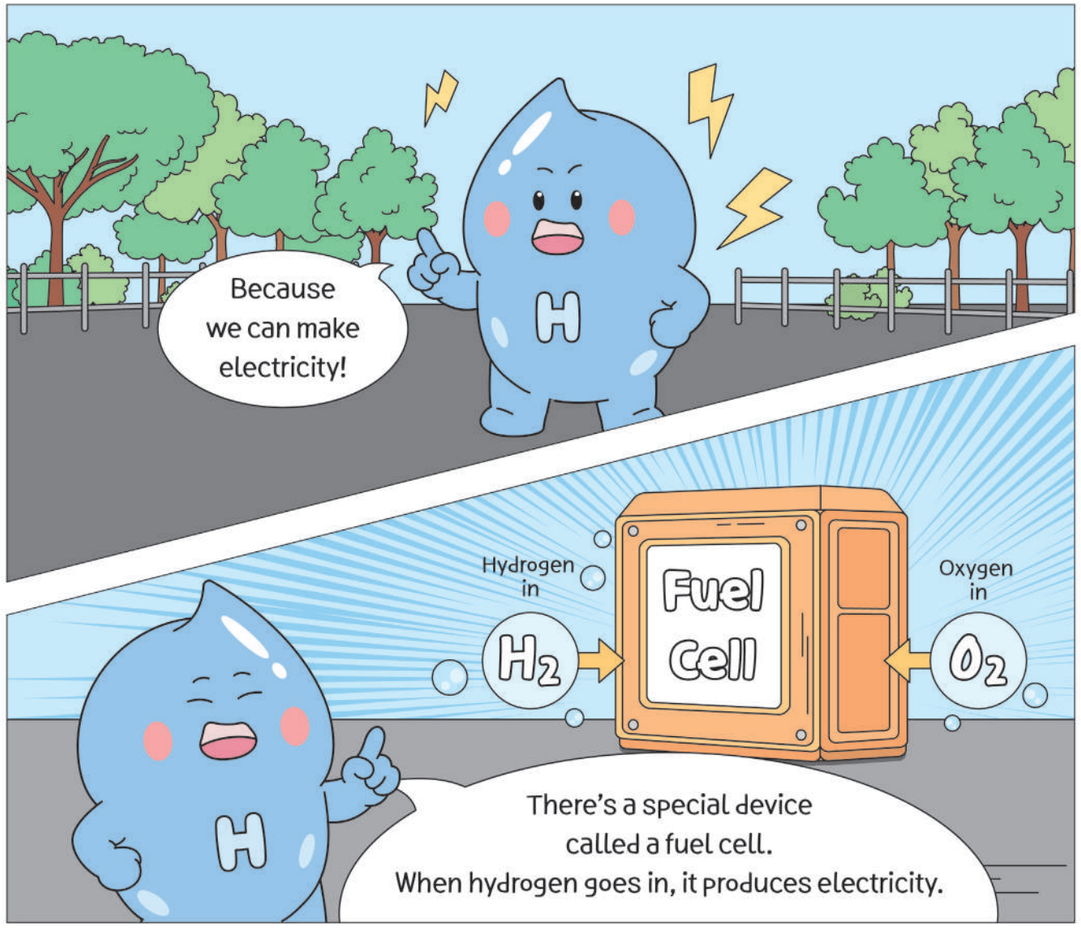

Ugh... why did it get so cramped in here all of a sudden?

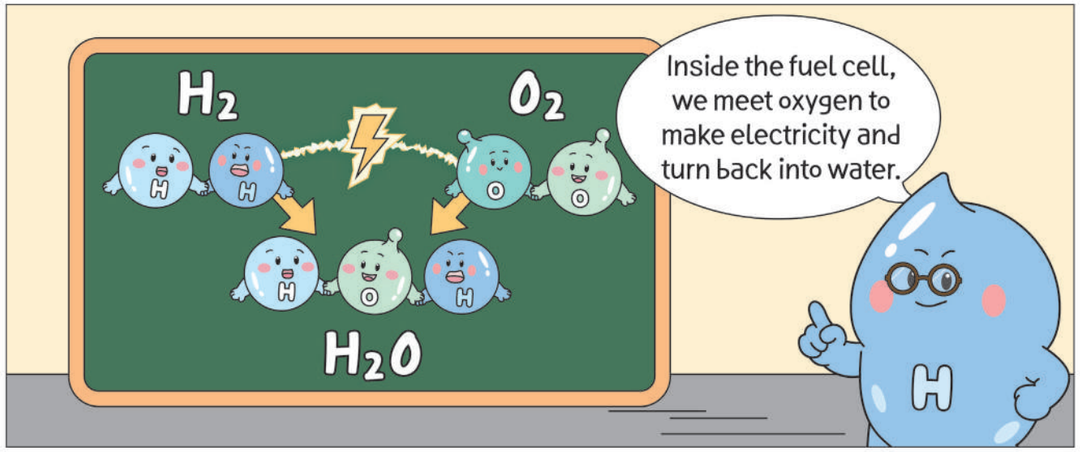

Pressure UP
Temperature DOWN
They're storing us! When we're compressed under high pressure or cooled to very low temperatures, it will draw us closer together so more of us can fit into a smaller space.

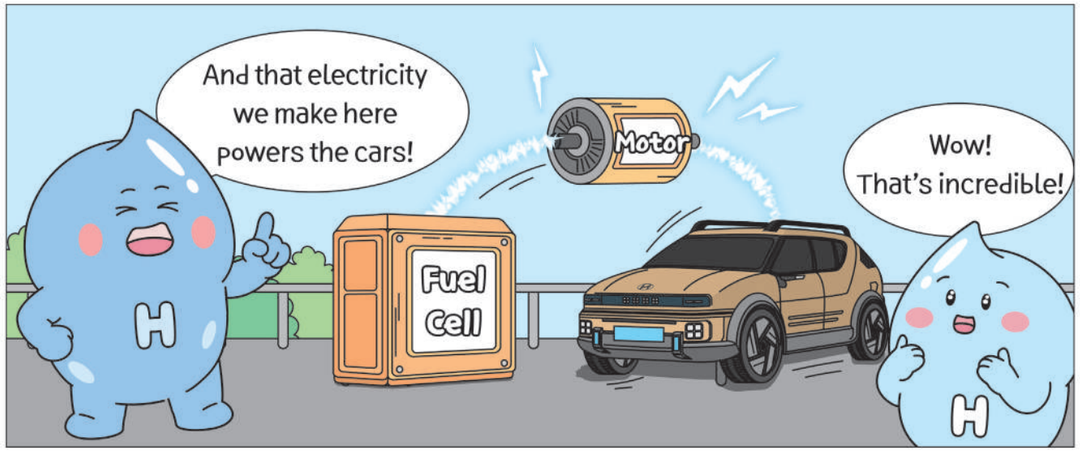

Sounds like you've been through this many times.
For sure! I've done all sorts of amazing things, turned back into water, and then looped right back into hydrogen!

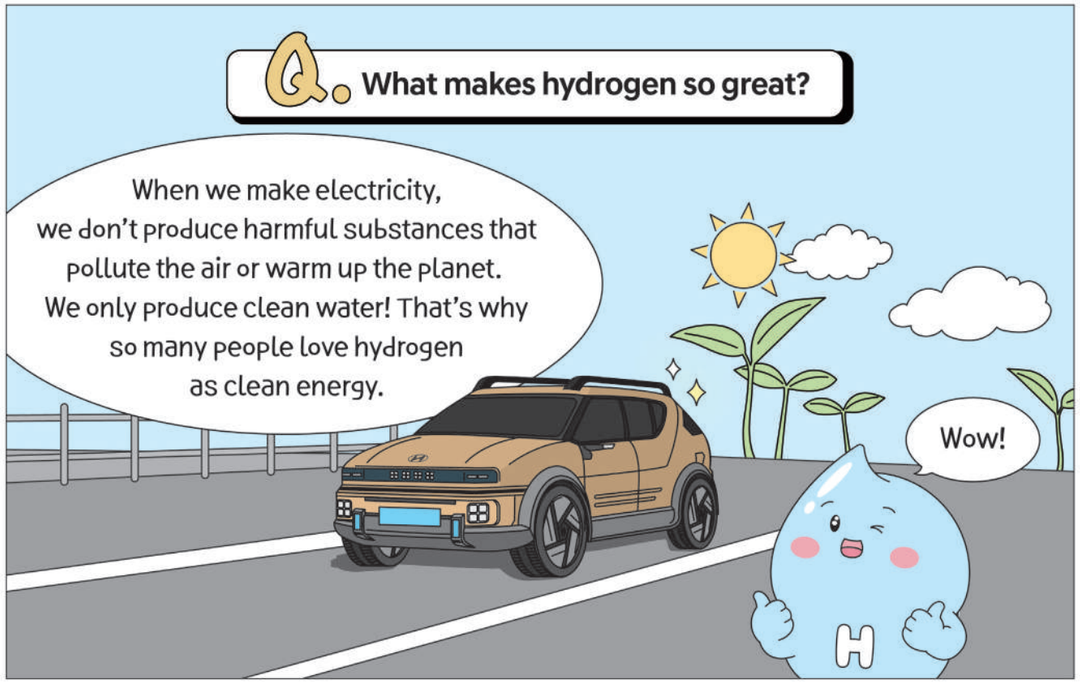

Q. What does hydrogen do?
What kind of amazing things?
For starters, I can make hydrogen cars move!

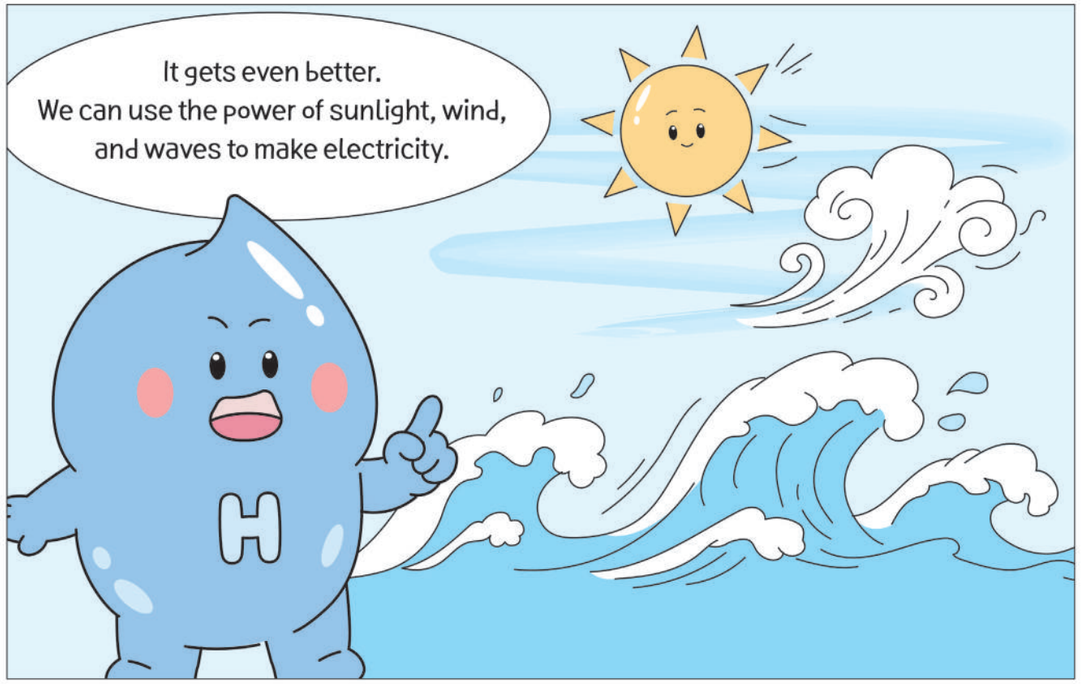

You can make cars move? How?
H

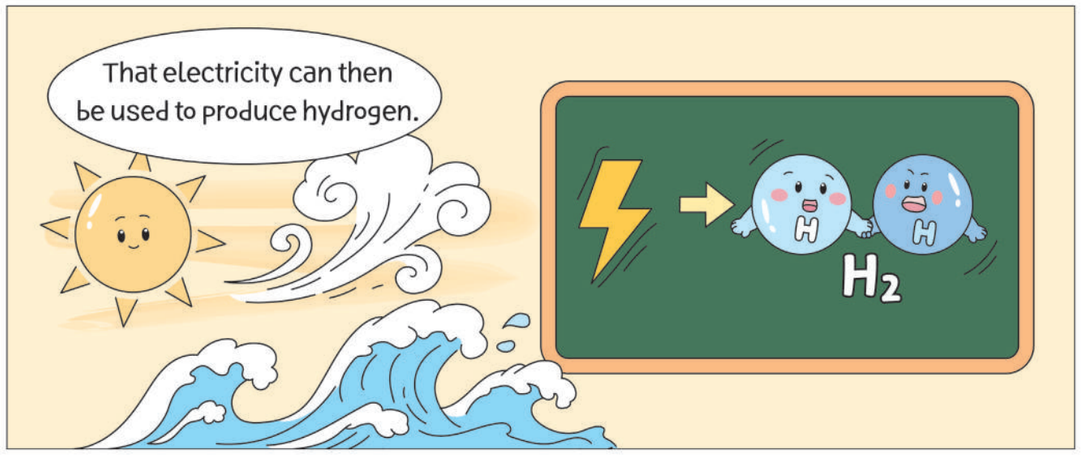

Because we can make electricity!
H
Hydrogen in
H_2
Fuel Cell
Oxygen in
O_2
There's a special device called a fuel cell. When hydrogen goes in, it produces electricity.
H

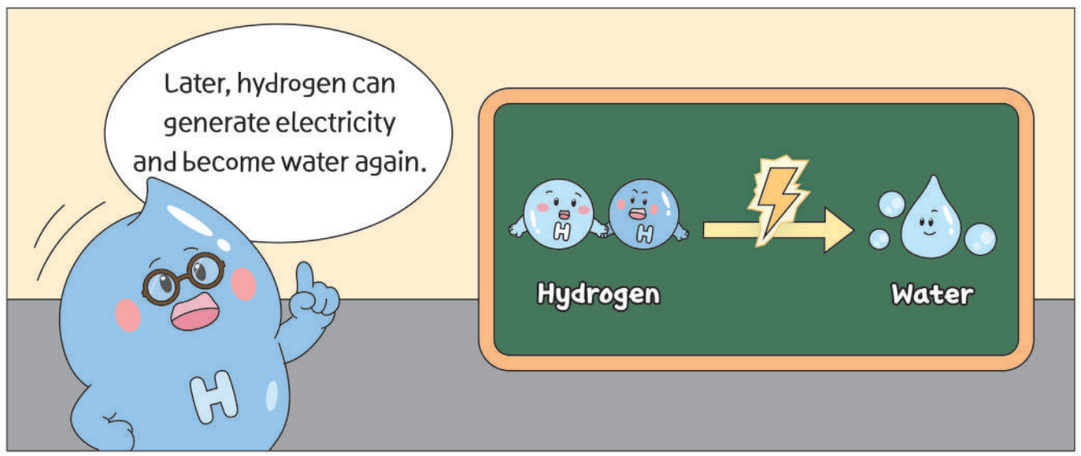

H_2
O_2
H_2O
Inside the fuel cell, we meet oxygen to make electricity and turn back into water.
H

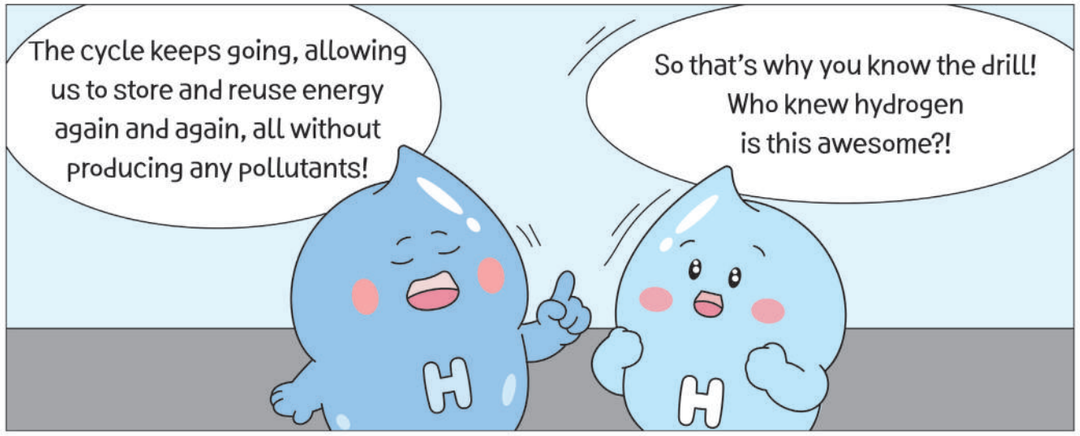

And that electricity we make here powers the cars!
Motor
Fuel Cell
Wow! That's incredible!
H
H

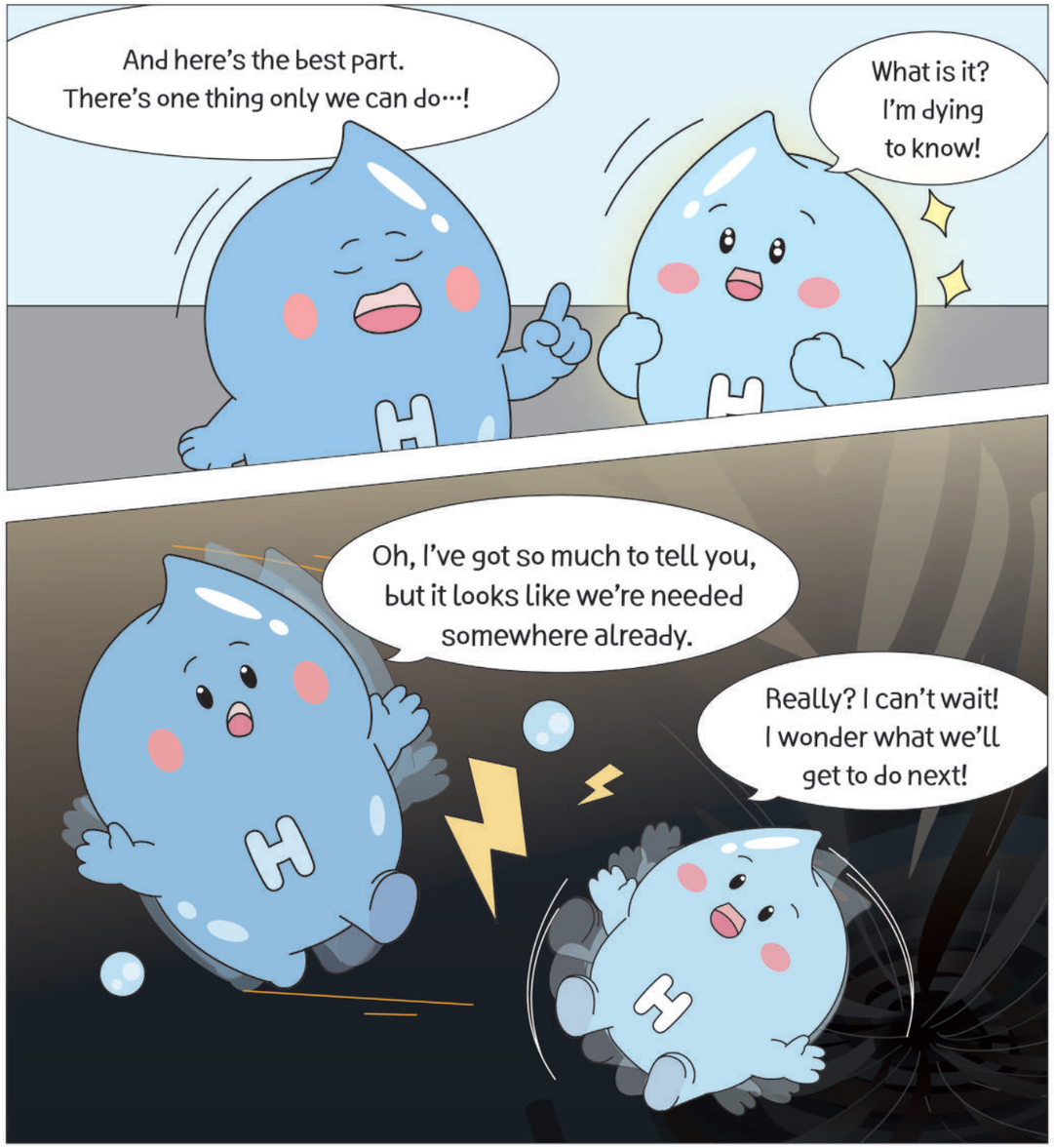

Q. What makes hydrogen so great?
When we make electricity, we don't produce harmful substances that pollute the air or warm up the planet. We only produce clean water! That's why so many people love hydrogen as clean energy.
Wow!
H

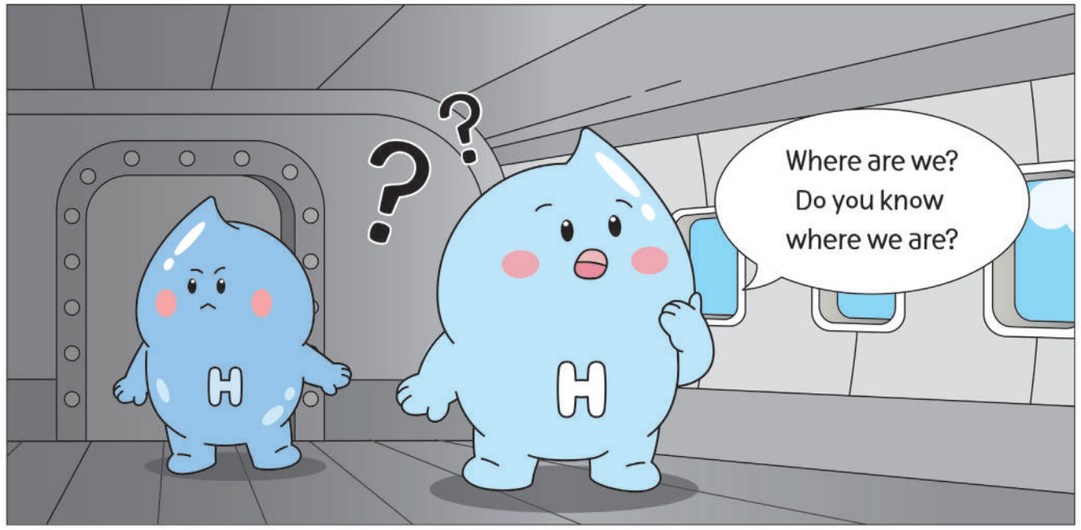

It gets even better.
We can use the power of sunlight, wind, and waves to make electricity.
H

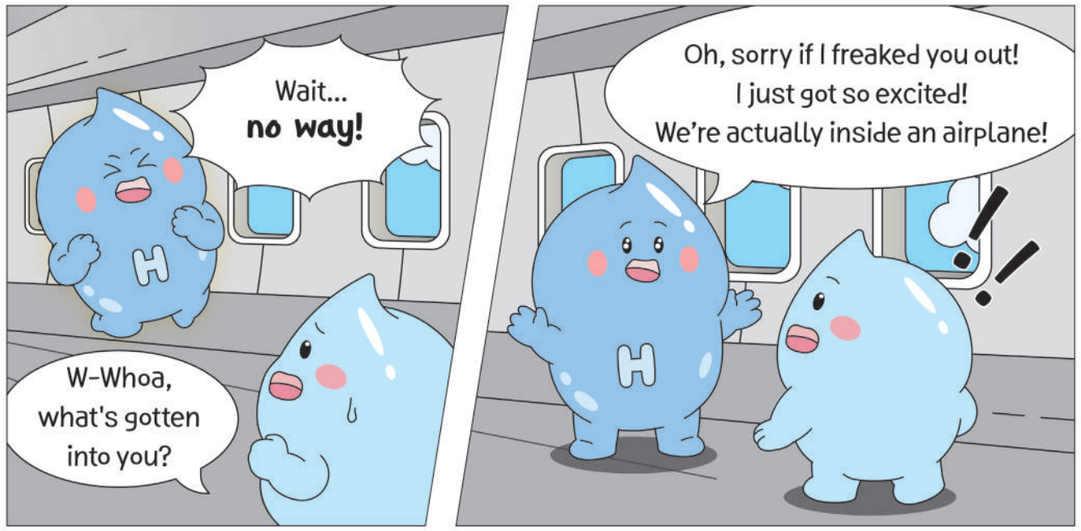

That electricity can then be used to produce hydrogen.
H
H
H_2

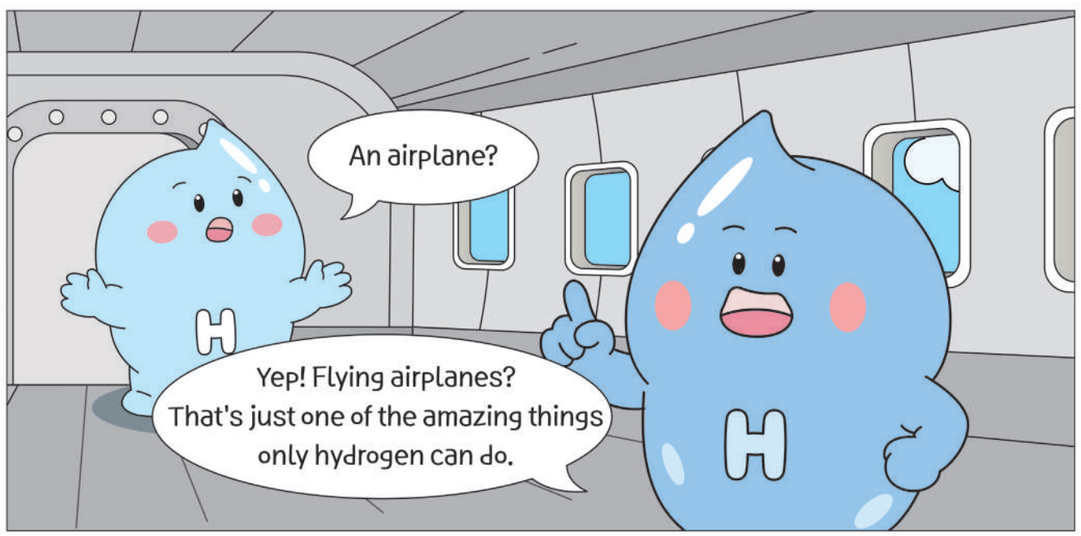

Later, hydrogen can generate electricity and become water again.
H
H
H
Hydrogen
Water

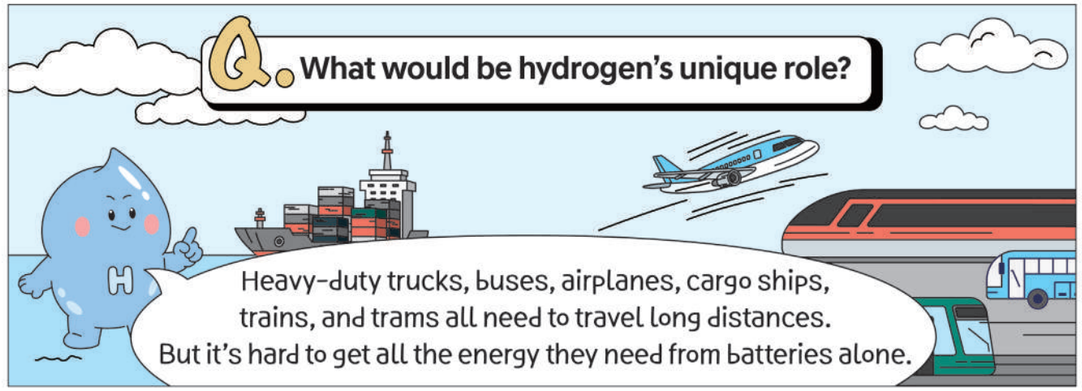

The cycle keeps going, allowing us to store and reuse energy again and again, all without producing any pollutants!
So that's why you know the drill! Who knew hydrogen is this awesome?!
H
H

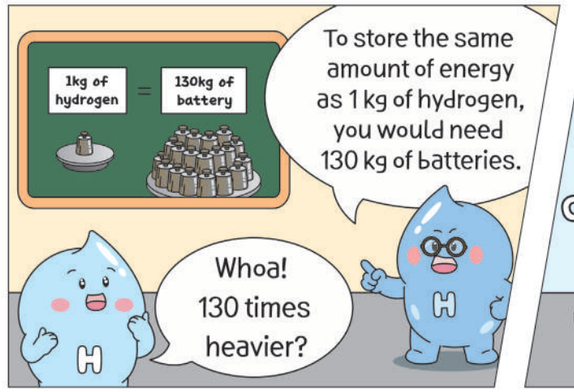

And here's the best part. There's one thing only we can do···!
What is it? I'm dying to know!
Oh, I've got so much to tell you, but it looks like we're needed somewhere already.
Really? I can't wait! I wonder what we'll get to do next!
H
H
H
H


Where are we?
Do you know
where we are?

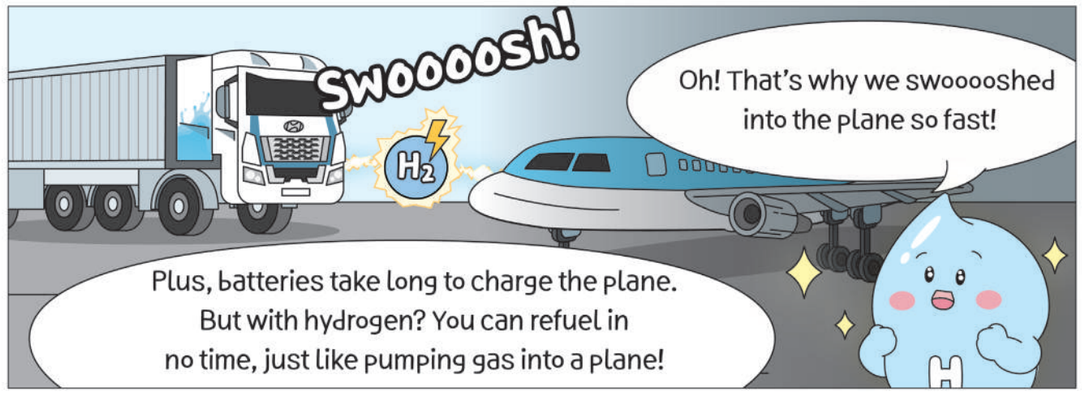

Wait...
no way!
W-Whoa,
what's gotten
into you?
Oh, sorry if I freaked you out!
I just got so excited!
We're actually inside an airplane!


An airplane?
Yep! Flying airplanes?
That's just one of the amazing things
only hydrogen can do.

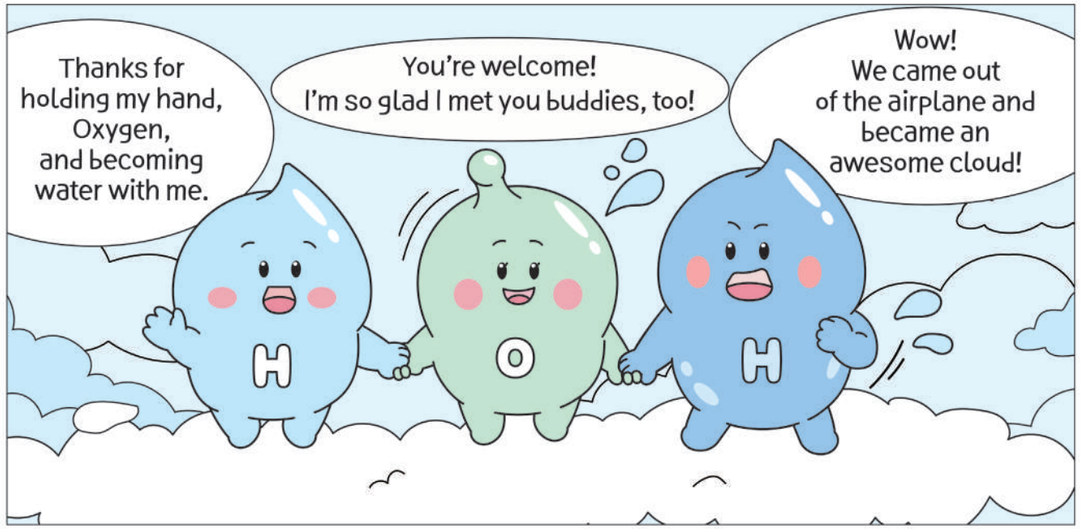

Q. What would be hydrogen's unique role?
Heavy-duty trucks, buses, airplanes, cargo ships,
trains, and trams all need to travel long distances.
But it's hard to get all the energy they need from batteries alone.

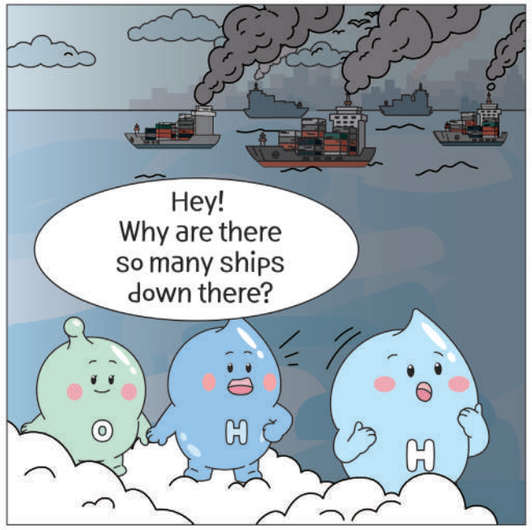

1kg of hydrogen
=
130kg of battery
To store the same
amount of energy
as 1 kg of hydrogen,
you would need
130 kg of batteries.
Whoa!
130 times
heavier?

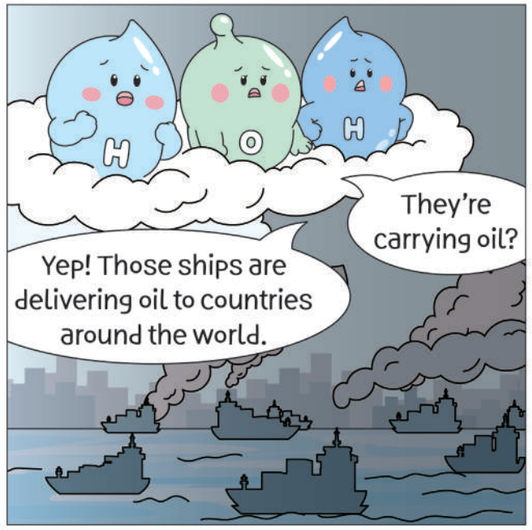

You'd need a battery that big
just to go far? But it would be
way too heavy to even take off!
Crammed full!
Crammed full!

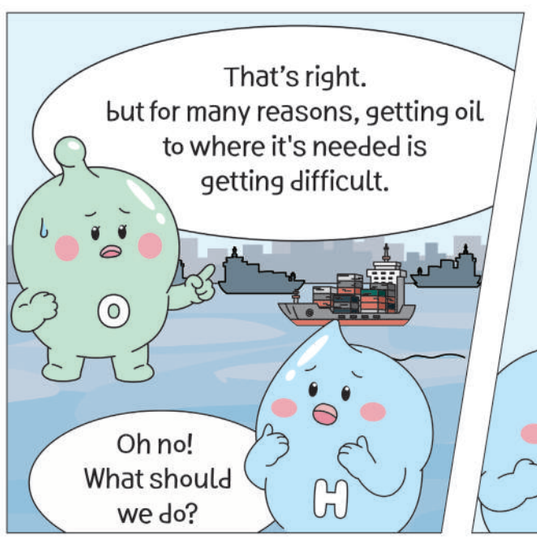

Swoooosh!
H_2
Oh! That's why we swooooshed
into the plane so fast!
Plus, batteries take long to charge the plane.
But with hydrogen? You can refuel in
no time, just like pumping gas into a plane!

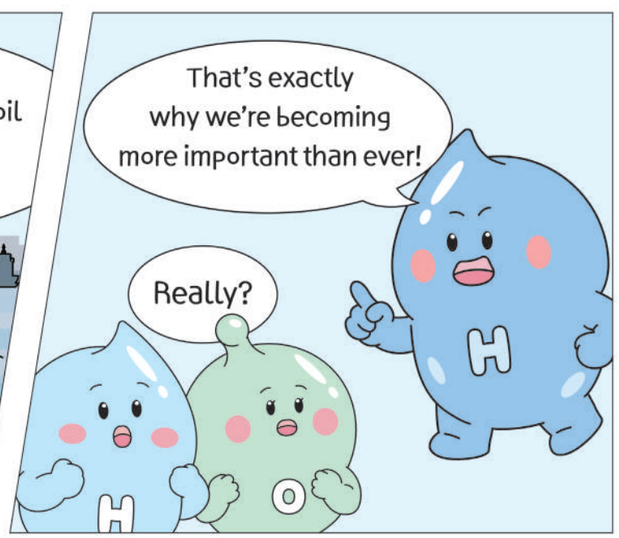

Exactly! Once we power the flight,
we turn right back into water!

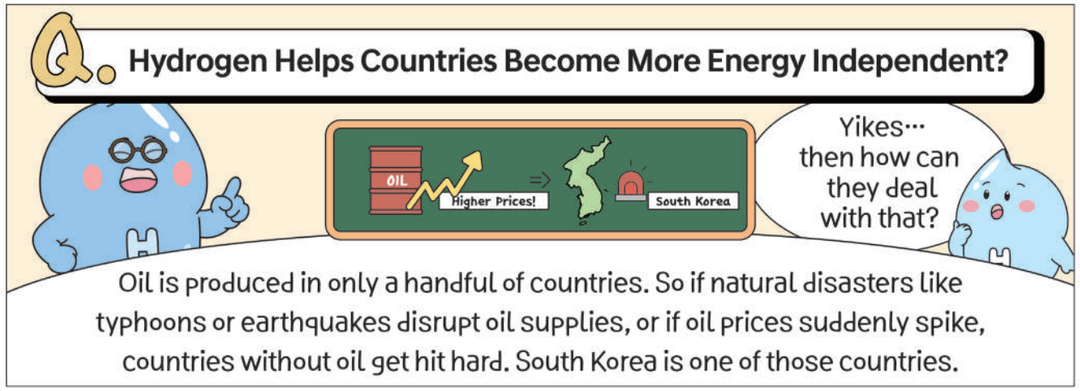

Thanks for holding my hand, Oxygen, and becoming water with me.
You're welcome! I'm so glad I met you buddies, too!
Wow! We came out of the airplane and became an awesome cloud!
H
O
H

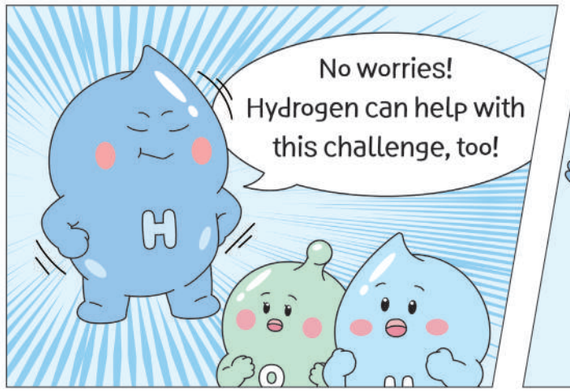

Hey! Why are there so many ships down there?
H
O
H

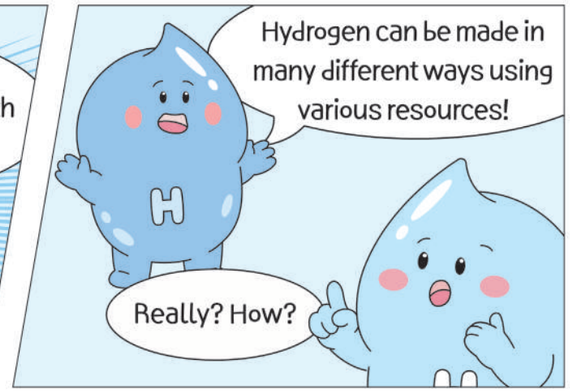

They're carrying oil?
Yep! Those ships are delivering oil to countries around the world.
H
O
H

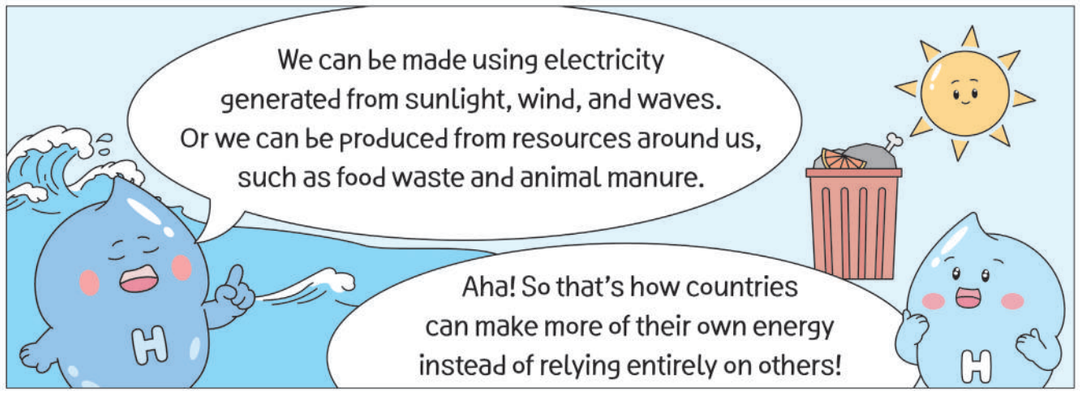

That's right. but for many reasons, getting oil to where it's needed is getting difficult.
Oh no! What should we do?
O
H

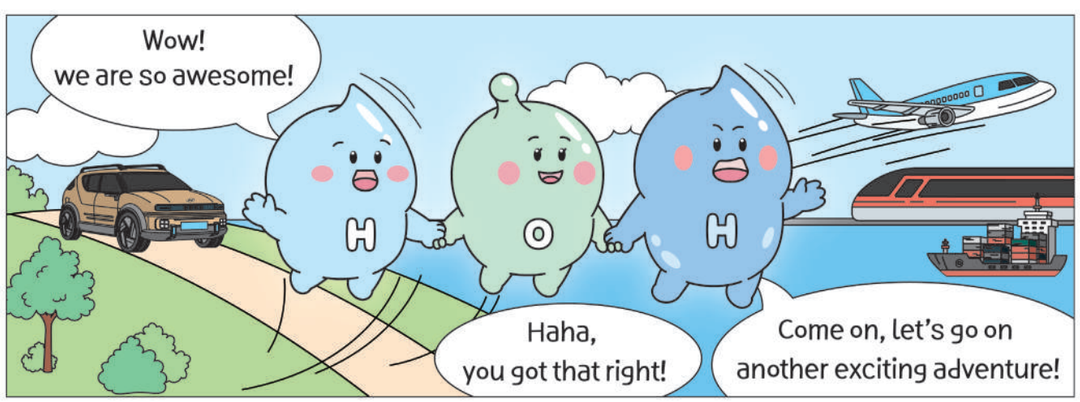

That's exactly why we're becoming more important than ever!
Really?
H
O
H


Q. Hydrogen Helps Countries Become More Energy Independent?
OIL
Higher Prices!
South Korea
Yikes… then how can they deal with that?
H
Oil is produced in only a handful of countries. So if natural disasters like typhoons or earthquakes disrupt oil supplies, or if oil prices suddenly spike, countries without oil get hit hard. South Korea is one of those countries.


No worries! Hydrogen can help with this challenge, too!
H
O


Hydrogen can be made in many different ways using various resources!
Really? How?
H


We can be made using electricity generated from sunlight, wind, and waves. Or we can be produced from resources around us, such as food waste and animal manure.
Aha! So that's how countries can make more of their own energy instead of relying entirely on others!
H


Wow! we are so awesome!
Haha, you got that right!
Come on, let's go on another exciting adventure!
H
O
H

Who Are you, Hydrogen?

All About Hydrogen



Name	Hydrogen
Fun Facts	• Element No. 1! Proudly standing at the front of the periodic table, where all the elements are lined up. • The lightest element in the world, yet the most abundant—making up 75% of the mass of the universe! • Found deep underground, in everyday compounds like water, ammonia, methane, and oil, and even in the building blocks of life such as proteins, fats, and carbohydrates.
Traits	• Super light, spreads fast, and totally non-toxic—making it safe.
Personality	• Prefers hanging out in groups rather than flying solo. • Pairs up with its best friend oxygen to turn into water (H_2O).
Best Features	• Generates power with zero pollutants. • Lightweight, yet packs a massive amount of energy. • Can be produced from diverse sources, including water and waste.
Mission	• Tackle climate change. • Enhancing energy security.

The Most Abundant and Lightest Element in the Universe

Hi! I'm Hydrogen, one of the very first elements born when the universe was created! In fact, I'm also the most abundant element in the universe, making up 75% of its mass. But chances are, you haven't seen me around that often.

That's because I'm 14 times lighter than air. So whenever I'm released into the atmosphere, I shoot right up—sometimes all the way into space. That's why there's very little hydrogen left in Earth's atmosphere. Since I only become a liquid at extremely low temperatures, I'm usually found as a gas in everyday conditions. All of this makes me pretty hard to spot with the naked eye. Even so, I'm everywhere around you—and ready to help solve many of Earth's problems.

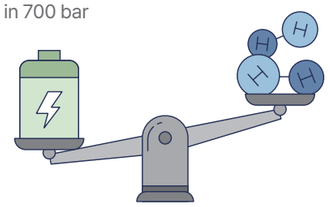
Clean Energy That Produces Only Water

Burning fossil fuels like oil, coal, and natural gas releases carbon dioxide and other pollutants into the air, which is the major cause of global warming, along with other harmful exhaust gases. But when I make energy (electricity), I produce only water.

The same thing happens when I'm created through water electrolysis using renewable energy. That means I produce almost no pollutants or carbon emissions!

Hydrogen vs. Batteries: Weight and Volume for Same Amount of Energy (33.3kWh)

*1kg H_2 in 700 bar



Category	Hydrogen	Battery
Weight	1 kg	130 kg
Volume	24 L	56 L

Lightweight but Powerful

We may be lightweight, but we can hold a lot of energy.

Did you know that you need a whopping 130 kg of batteries just to store the same amount of energy as just 1 kg of hydrogen? That's because hydrogen has a much higher energy density than batteries.

We are also much more efficient than fossil fuels.

With fossil fuels, you have to burn the fuel to produce heat, which is then used to turn a turbine and generate electricity. But we skip those extra steps and make electricity directly through a chemical reaction. That means less energy is lost along the way, making us more efficient.

Better Together

If we—hydrogen—had a personality, we'd be extroverts. We love making friends with other elements!

Because we easily give away or take electrons, you'll rarely find us alone in nature.

Instead, we bond with other atoms to form all kinds of substances, such as water (H_2O), ammonia (NH_3), and methane.

That's why hydrogen can be made from water, a variety of materials, and even waste.

Hydrogen:
The Key to a Carbon-Neutral Future

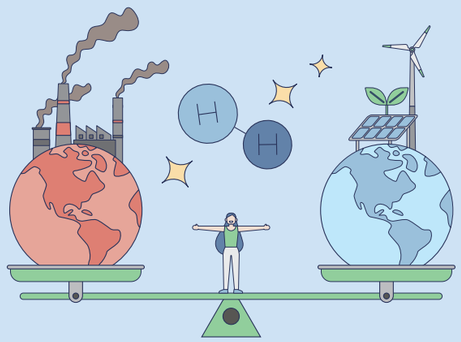
The world is working hard to fight global warming and achieve carbon neutrality.
Carbon neutrality means reducing greenhouse gas emissions, such as carbon dioxide, as much as possible and absorbing or removing the remaining emissions to achieve net-zero greenhouse gas emissions.
Hydrogen is expected to play a crucial role in making carbon neutrality a reality.



Turning Water into Hydrogen with Renewable Energy: Water Electrolysis

One way to produce hydrogen is through a process called water electrolysis. It uses electricity to split water into hydrogen and oxygen.

When the electricity comes from renewable energy sources such as solar or wind power, we can drastically cut carbon emissions. Even when we later use this hydrogen to generate electricity, it does not release carbon emissions either. In short, hydrogen can keep carbon emissions to a minimum—from when it is produced all the way to when it is used.



Hydrogen Leading the Way to Carbon Neutrality

In October 2021, South Korea announced its 2050 Carbon Neutrality Scenario.

Think of the Carbon Neutrality Scenario as a roadmap—it sets clear goals for what needs to be done, when to do it, and how much needs to be achieved to reach net zero by 2050. And hydrogen is a key solution here, driving decarbonization across many sectors from power generation and transportation to major industries like steelmaking, petrochemicals, cement production, and semiconductor manufacturing.
Looking at the infographic below, it's easy to see how hydrogen has earned that title. The plan also calls for between **93% and 100% of hydrogen produced in 2050 to come from water electrolysis powered by carbon-free energy.**

How Hydrogen Is Used across Sectors

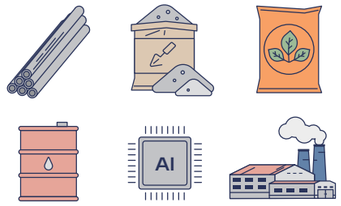
Industry

Hydrogen could play varied roles in manufacturing a wide range of products, from steel and fertilizers to semiconductors and industrial equipment.

Transportation

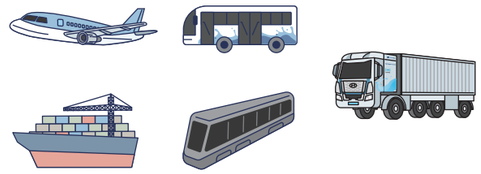
Hydrogen can be used as a fuel to power many different types of transportation.

Benefits and Advantages



Hydrogen replaces traditional fossil fuels, which in turn cuts down carbon emissions.

Steel, cement, fertilizers, oil refining and petrochemicals, semiconductors, and industrial equipment



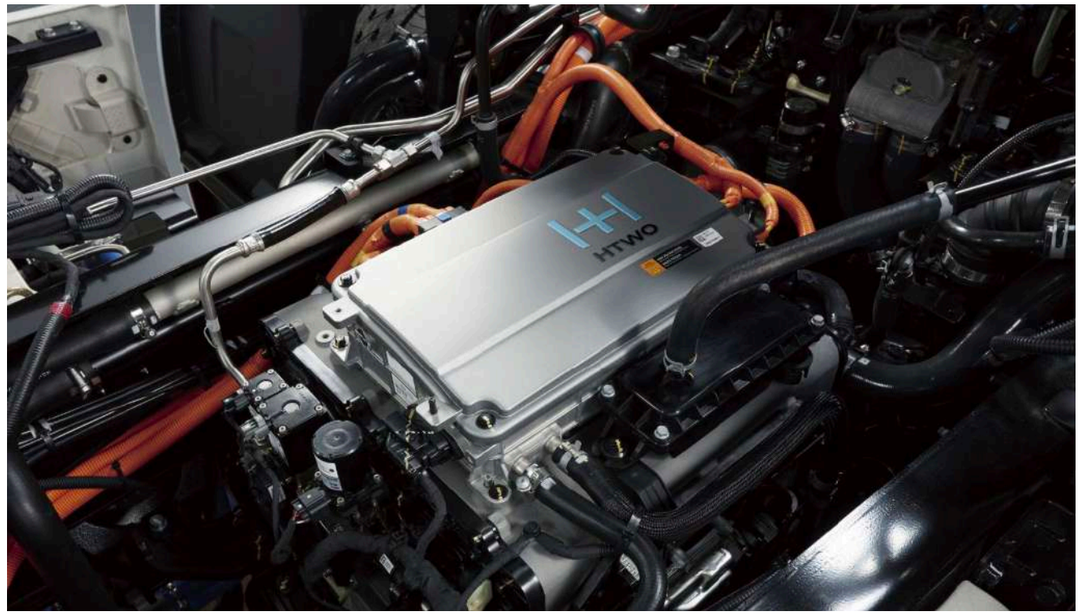
Hydrogen is especially useful for long-distance transport and heavy-duty hauling.

Airplanes, buses, trucks, ships and rail vehicles (trams and trains)

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The Secret behind Hydrogen's Clean Electricity Generation

Did you know hydrogen can be used to generate power?
After generating electricity, all it leaves behind is clean water.
Let's dive into hydrogen fuel cells—the zero-pollution way to make electricity.



Don't Let the Name Fool You: Hydrogen Fuel Cells Are Generators!

The name "fuel cell" might make it sound like a battery that stores electricity. But a hydrogen fuel cell works differently. Instead of storing electricity, it generates electricity directly. Unlike conventional power plants that burn fuel to produce electricity, fuel cells generate electricity through a chemical reaction involving hydrogen. So out of all the elements out there, why hydrogen?

Hydrogen Is Great at Trading Electrons—Perfect for Generating Power!

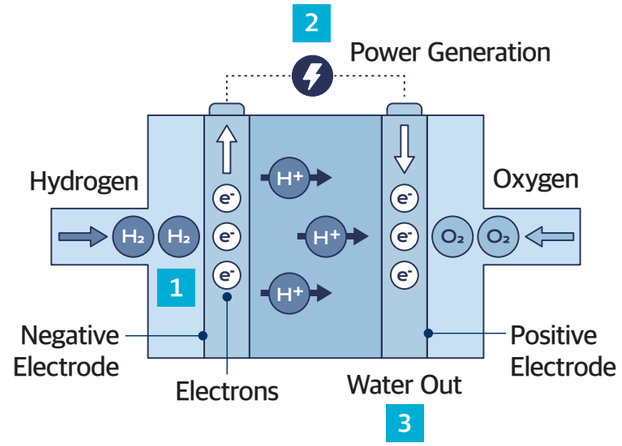
A hydrogen fuel cell generates power by feeding hydrogen to one side and oxygen from the air to the other. We use hydrogen because it gives up its electrons very easily. Once hydrogen releases electrons, oxygen on the other side pulls them in—forcing electrons to flow through a circuit. And that flow of electrons is what we call electricity. After handing over its electrons, hydrogen combines with oxygen and becomes water. That's why fuel cells produce water as their primary byproduct instead of harmful pollutants. Remember how water electrolysis uses electricity to split water into hydrogen and oxygen? A fuel cell simply does that process in reverse!

How a Fuel Cell Generates Electricity from Hydrogen

1 At the negative electrode (-), hydrogen (H_2) is split into hydrogen ions (H^+) and electrons (e^-).

2 The separated electrons (e^-) flow from the negative electrode (-) to the positive electrode (+), creating electricity.

3 The hydrogen ions (H^+) and electrons (e^-) combine with oxygen (O_2) to make water (H_2O).



Hydrogen Fuel Cells, Powering Our World

Today, hydrogen fuel cells are being used as a core of various machines, keeping our world on the move. Perhaps the best-known application of hydrogen fuel cells is the Fuel Cell Electric Vehicles(FCEV). Instead of using a conventional engine powered by fossil fuels, these vehicles run on fuel cell systems. Fuel cell systems can power passenger vehicles and heavier vehicles such as buses, trucks, trams, and trains. Hydrogen fuel cells can also work like generators that produce electricity for buildings right where it is needed.
By generating electricity on the spot, buildings stay fully powered—even if a distant power plant goes down or suffers an outage. That's why they're already hard at work in homes and apartment complexes, as well as places where reliable power supply is critical, like hospitals and factories.

Unlocking the Secret Recipes for Hydrogen

Hydrogen can be found in many different forms on Earth.
That means we can produce hydrogen using a wide range of materials and methods.
As long as we have the right technology, we can generate hydrogen anytime, anywhere.
Ready to unlock the four secret recipes for making hydrogen?

Fossil Fuel-Based

Hydrogen can be made from fossil fuels such as coal and natural gas. In fact, this is how most of the hydrogen is made today.
Hydrogen can be made by reacting natural gas with hot steam under high pressure, or by converting coal into gas under similar conditions. It can also be produced as a byproduct during oil refining. While fossil fuels keep production costs relatively low, this approach has a catch: it releases carbon dioxide. Hydrogen produced from fossil fuels without capturing emissions is called gray hydrogen.
To mitigate these emissions, carbon dioxide can be captured and stored or reused through a process known as CCUS*. When carbon emissions are significantly reduced through CCUS, the resulting hydrogen is called blue hydrogen.

*CCUS:
Carbon Capture, Utilization, and Storage



Water Electrolysis

If you're wondering if there is an even cleaner way to make hydrogen, take a look at water electrolysis. Where can we find most of Earth's hydrogen?
Right in the water! Each water molecule (H_2O) contains two hydrogen atoms (H) and one oxygen atom (O). Besides, unlike other molecules with hydrogen, water is overwhelmingly abundant on the Earth's surface.
During water electrolysis, we add a substance called an electrolyte to boost conductivity, then pass an electric current through water. This process separates hydrogen and oxygen atoms. If the electricity comes from renewable energy sources like solar and wind, the hydrogen produced is called green hydrogen with virtually zero carbon emissions.
Similarly, hydrogen produced through nuclear-powered water electrolysis is called pink hydrogen.



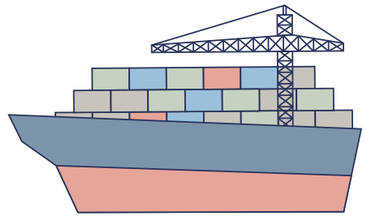
Organic Waste-Based (W2H)

Food waste, animal manure, and sewage sludge…
Just hearing their names, you can almost smell them, right? But these organic wastes can be reinvented into all kinds of useful resources. And hydrogen is one of them. When organic waste breaks down, microorganisms feed on waste and produce biogas, which contains large amounts of methane (CH_4)—a molecule made up of one carbon atom (C) and four hydrogen atoms (H).
When methane is broken down, hydrogen can be separated and collected. This process is known as waste-to-hydrogen, or W2H. Isn't it amazing how something can start as waste and end up as hydrogen?



Ammonia-Based

Ammonia (NH_3) is made up of one nitrogen atom (N) and three hydrogen atoms (H).
Because ammonia contains hydrogen, it can be broken apart to release hydrogen through a process known as ammonia cracking. But if we can already make hydrogen through water electrolysis or from organic waste, why bother with ammonia? The answer lies in storage and transport: ammonia makes moving hydrogen so much easier. Hydrogen is very difficult to store as a liquid because it must be cooled to an extremely low temperature of -253°C. Ammonia, on the other hand, liquefies at a much higher temperature of about -33°C, making it far easier to store and transport. That's why ammonia also serves as a hydrogen carrier. This approach is attracting growing attention as a way to move hydrogen efficiently around the world and extract it right where it's needed.



Clean Hydrogen from Everyday Resources

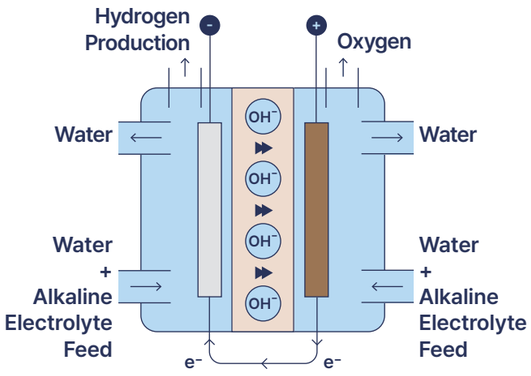


What's the Best Water Electrolysis Recipe for Clean Energy Future?

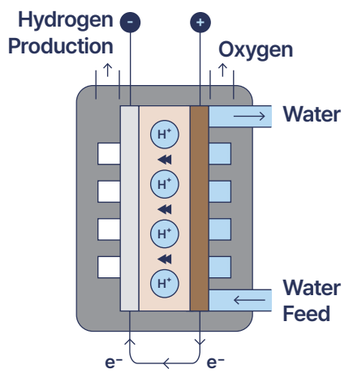
As we learned earlier, water electrolysis uses electricity to split water molecules into hydrogen and oxygen. Water electrolysis stands out as the most promising hydrogen recipe because using electricity from solar or wind power creates clean hydrogen with virtually zero carbon emissions.

In practice, there are several types of water electrolysis. The two most common methods are Alkaline Water Electrolysis and Proton Exchange Membrane (PEM) Water Electrolysis. Alkaline water electrolysis comes with relatively low production costs, but the trade-off is that its large equipment demands a lot of space. PEM, on the other hand, costs a little more, but it is better suited for making high-quality hydrogen with higher purity. What's even better is that PEM can flexibly ramp hydrogen production up or down to match the fluctuating energy from solar and wind power. That is precisely why PEM water electrolysis is stepping into the spotlight in the era of carbon neutrality!

〈 Alkaline Water Electrolysis 〉



〈 PEM Water Electrolysis 〉



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Turning Waste into Hydrogen: Circular Hydrogen Production (W2H, Waste to Hydrogen)

Here's another special recipe to make hydrogen—using biogas produced from waste. Did you know that we are already making hydrogen this way in South Korea? Take Cheongju, for instance, where you'll find the HTWO ENERGY Cheongju, integrated waste-to-hydrogen production and refueling facility.
This facility extracts hydrogen from waste-derived biogas—which is usually used for city gas or heating—and supplies it to fuel the hydrogen fuel cell buses, trucks, and passenger vehicles running across Cheongju and neighboring cities. It produces about 500 kg of hydrogen daily—enough to refuel around 100 NEXOs, one of the well-known FCEVs—with plans to steadily scale up production over time. So, how exactly does organic waste turn into hydrogen? Let's dive into the details of the process!

Step 1: Collecting Waste

Out of all the waste thrown away, organic waste that decomposes easily is collected separately.

Step 2: Capturing Biogas

As organic waste breaks down, it releases biogas containing methane (CH_4), carbon dioxide (CO_2), and other gases.

Step 3: Enriching Methane Gas

Impurities are removed from biogas, leaving behind methane gas that is about 95% pure.

Step 4: Extracting Hydrogen

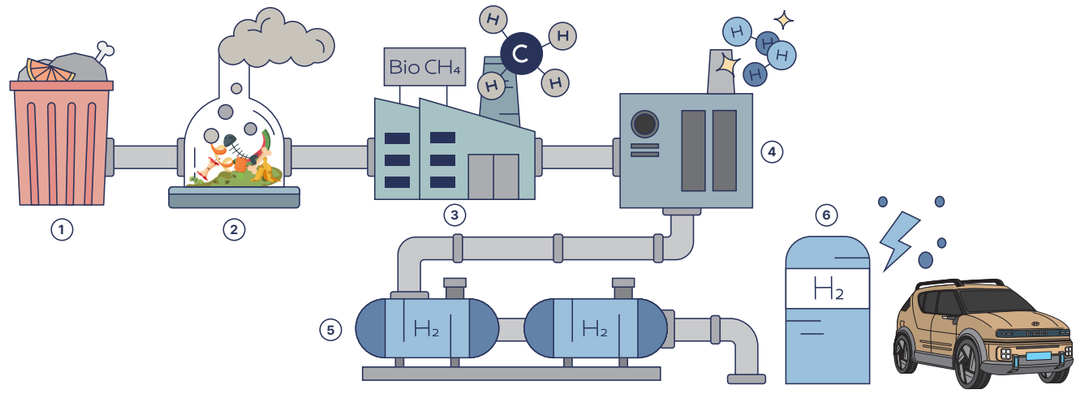
In an environment with extremely high-temperature steam, methane molecules are split to extract hydrogen.

Step 5: Storing Hydrogen

Hydrogen is further purified to remove any remaining impurities and then stored as a gas.

Step 6: Putting Hydrogen to Work

And finally, it's ready to power the FCEVs we drive!



Hydrogen Goes Wherever Energy Is Needed!

Hydrogen can transform in various ways, allowing us to store, transport, and deliver it wherever it's needed.
Although hydrogen is extremely light, it takes up a lot of space as it naturally exists as a gas under normal conditions, so it often needs to be transformed for easier storage and transportation.
So, shall we take a look at the different ways hydrogen can change its form?



Source: Gangwon State Government

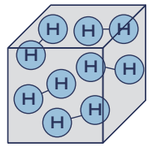
Mission: Deliver Hydrogen All across the Country!

Once hydrogen is properly stored, the next step is to deliver it wherever it's needed.
Hydrogen takes up much less space after being transformed, so it can easily be delivered by truck to places all across the country. Ships can even carry it between countries. In high-demand areas, hydrogen can be sent directly through pipelines, much like natural gas.
Electricity, by contrast, relies on a complex journey—requiring large transmission networks and connections to homes and buildings before reaching us. Meanwhile, hydrogen can be transported over long distances by ship, truck, or pipeline, making it possible to deliver energy to regions where building new power transmission networks is difficult, or even between countries.

Different Ways to Transform and Transport Hydrogen

*Gas state (at room temperature and 1 atm) = 0.0899 kg/m³

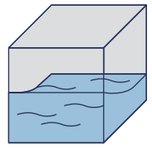
Compressing Hydrogen



This method **uses high pressure to squeeze hydrogen gas to reduce its volume.**
In fact, this is how fuel is currently stored in FCEV such as the NEXO.

42 kg/m³

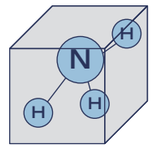
Liquefying Hydrogen



Hydrogen becomes a liquid when cooled to -253°C.
Although it requires extremely low temperatures, liquid hydrogen takes up much less space, making it ideal for large-scale storage and long-distance transport.

71 kg/m³

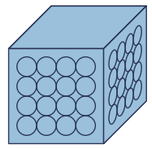
Transforming Hydrogen into Another Substance



Since hydrogen naturally loves bonding with other elements, another great method is to convert it into ammonia or Liquid Organic Hydrogen Carriers (LOHC*) for easier storage and transport.
In fact, ammonia is projected to account for a significant share of international hydrogen trade.

121 kg/m³

Storing Hydrogen in Solid Materials



Hydrogen can be stored by attaching or chemically bonding it to solid materials such as magnesium or titanium. When needed, applying heat or pressure releases hydrogen. It's a safe method that can store the most energy in the same amount of space.

Up to **150** kg/m³

***Liquid Organic Hydrogen Carrier (LOHC):** A compound designed to hold hydrogen inside a liquid organic compound making hydrogen easy to store and transport as a liquid.

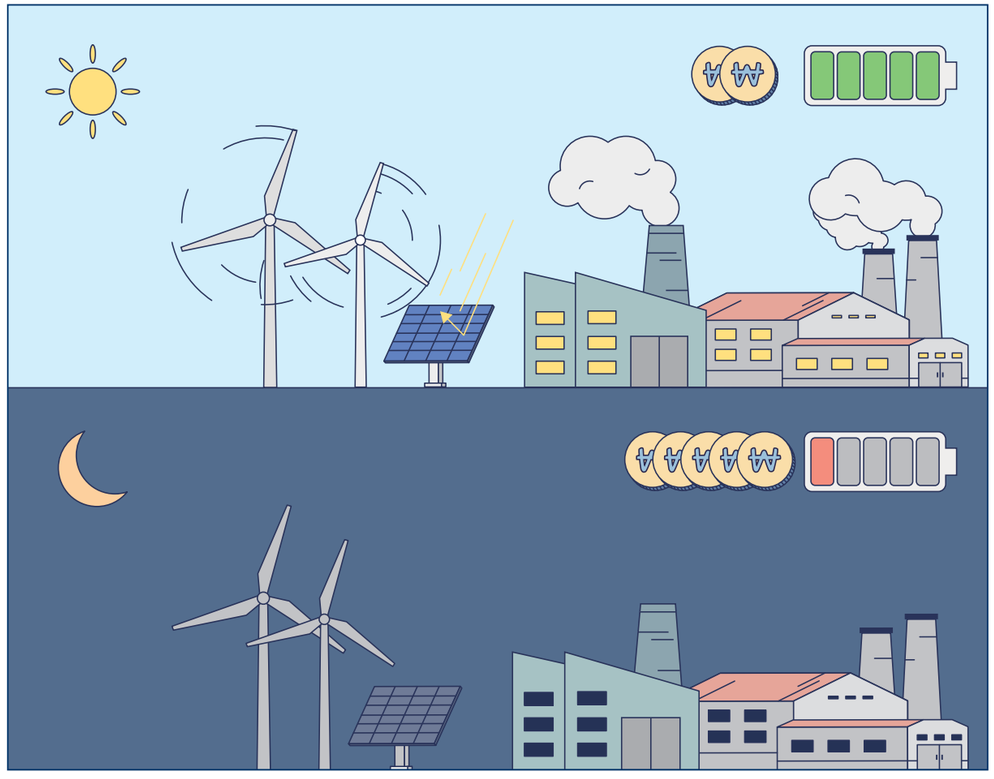
Can Hydrogen Really Be Stored Underground?



Hydrogen is usually kept in special containers built inside storage facilities. But experts are exploring new ways to store hydrogen. One option is to store it underground. It's similar to how natural gas is stored underground as a gas and groundwater is found underground as a liquid. Hydrogen can be stored as a gas or in other forms in depleted oil, gas, and groundwater reservoirs, salt caverns, or in spaces created inside solid rock formations. Underground storage allows large amounts of hydrogen to be stored while making efficient use of space.

Versatile Hydrogen: Capturing Wasted Power

So far, we've learned that hydrogen can be made from many different feedstocks, stored and transported in various ways, and used to generate energy. But that's only part of hydrogen's story! Now it's time to discover its versatile side, working its magic in places you'd least expect. First up, let's start with how hydrogen can help capture electricity that might otherwise go to waste. Why does electricity sometimes go unused? And how can hydrogen capture and store that extra electricity?



Why Industrial Electricity Rates Shifted between Day and Night

On April 16, 2026, industrial electricity prices of S.Korea became lower during the day and higher at night.

Before the new pricing system was introduced, electricity was more expensive during the day than at night. That's because people used the most electricity during the day, which drove the rates up. So why did daytime electricity suddenly become cheaper? It's largely due to the rapid growth of solar power, which adds electricity generation during the day. As a result, there are times when more electricity is produced than people need. Lower daytime rates encourage people to use more of this surplus electricity instead of letting it go to waste.

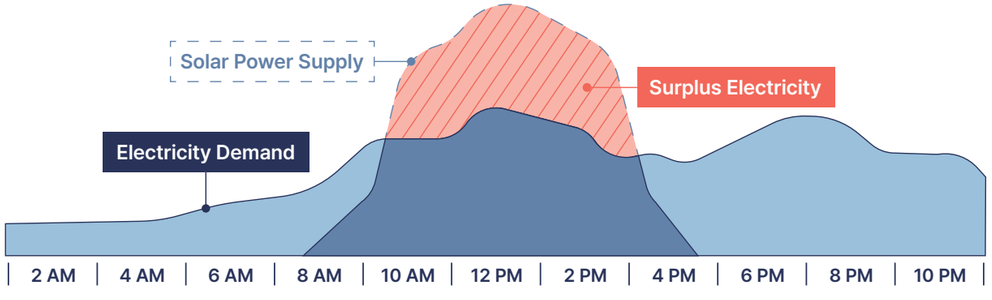
Why Does Electricity Go to Waste?

In the first half of 2025 alone, the total amount of renewable electricity curtailed* nationwide reached 72.3 GWh. That's equivalent to the energy generated by three 1-GW nuclear reactors operating for 24 hours, or roughly the amount of electricity used at home in a day by approximately 35% of South Korea's population. (Office of Rep. Park Ji-hye, National Assembly, 2025)

So why is all this power going to waste? One reason is the rapid increase in electricity generated from renewable sources such as solar and wind power. Renewable energy generation fluctuates dramatically depending on weather conditions. When it's cloudy or dark at night, solar power drops off. And when there's no wind, wind turbines cannot generate electricity either. On the flip side, favorable weather conditions can produce more electricity than is needed. You might wonder, "Why not just send all that extra power through the grid?" The challenge is that power grids can only carry a limited amount of electricity at any given time. Isn't there a way to capture and store this electricity for later use? If we can use or store this surplus electricity instead of wasting it, we can make better use of the energy we already have and avoid the cost of producing even more electricity. We can also reduce pollution along the way.

*When renewable energy produces more electricity than needed, some power generation must be scaled back or shut down. The amount of electricity reduced or lost in this process is known as curtailed electricity.

How Wasted Electricity Occurs



Don’t Waste Power—Store It as Hydrogen



How Can Electricity Be Stored in Hydrogen?

There are two ways to store excess electricity instead of letting it go to waste.

You can either store it in a battery or use that surplus power to produce hydrogen. However, batteries have their limits when it comes to storing large amounts of electricity over long periods. Think about your smartphone. Even the tiny battery inside your phone takes a considerable amount of time to charge up. And even though it only stores enough electricity to power a smartphone, the battery still adds considerable weight. In fact, the battery accounts for roughly 30% of a smartphone’s weight. On top of that, even if you leave your phone completely unused, the stored electrical energy gradually drains away on its own.

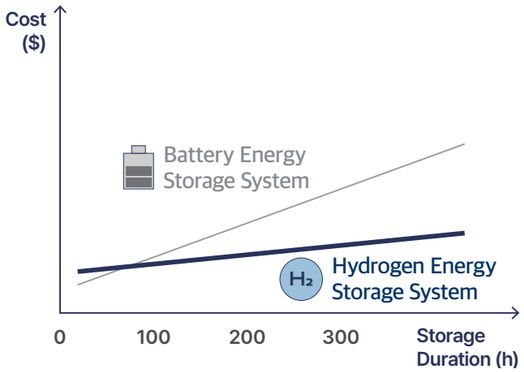
What would happen if we suddenly needed to store a much larger amount of electricity?
The batteries would have to get much bigger, of course. And that would mean longer charging times. It would also cost a lot to make such huge batteries.
Hydrogen, on the other hand, can be made directly using surplus electricity. And compared to batteries, it can store a large amount of energy for a long time in a much smaller space. It’s also much easier to transport to places where energy is needed.

Hydrogen: Bridging the Gap between Energy Supply and Demand

Since hydrogen is capable of storing massive amounts of energy over long periods, it plays a vital role in bridging the gap between power generation and consumption.
Because solar and wind output fluctuates with weather and seasons, we often face alternating power surpluses and shortages. By converting excess electricity into hydrogen, that energy can be stored and later converted back into electricity using fuel cells whenever demand rises! For instance, surplus solar energy generated during sunny summer days can be stored as hydrogen and used to generate electricity during dark, cloudy winter months.
As our reliance on renewables grows in the coming years, energy storage technologies like this will become increasingly critical. In particular, Hydrogen Energy Storage Systems (H-ESS) are gaining the spotlight as an important technology for helping make renewable energy more reliable, thanks to their ability to hold vast energy reserves over extended periods.
What’s more, H-ESS doubles as a clean fuel source for Fuel Cell Electric Vehicles and various industrial applications, making it a cornerstone technology for both today and tomorrow.

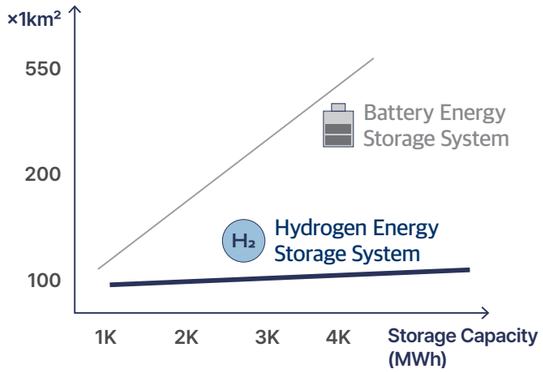
Economic Analysis of Hydrogen Energy Storage Systems (H-ESS)

Storage Duration vs. Cost



Source: Korea Hydrogen Alliance (2026)

Area Required for Storage Capacity



Source: Hyundai Motor Company internal analysis

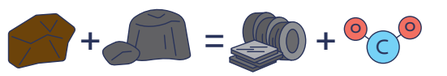
Hydrogen: Beyond What Electricity Can Do

Hydrogen plays a crucial role in reducing carbon emissions in hard-to-abate industries like steelmaking, shipping, and aviation—where direct electrification can be difficult.
In fact, hydrogen is virtually the only solution capable of tackling the decarbonization challenge in these sectors. Now, let's dive in and see how versatile hydrogen is to help reduce emissions across a wide range of industries.

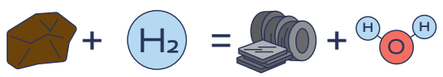
Hydrogen as a Feedstock (Decarbonizing Industries)

Iron naturally reacts with oxygen in the air and becomes oxidized. That's precisely why iron objects rust over time. Iron ore found in nature is no different. In traditional steelmaking, carbon is used to remove oxygen from iron ore in ultra-hot furnaces . But this reaction releases amounts of carbon dioxide—a major driver of global warming. However, **if we replace carbon with hydrogen, hydrogen bonds with the oxygen instead, leaving behind pure iron and emitting nothing but clean water.** Since steelmaking requires large amounts of energy and high temperatures, hydrogen can play an important role in reducing carbon emissions from industry. Beyond steel, hydrogen can also replace fossil fuels in manufacturing cement, chemicals, and fertilizers—serving as both a high-heat energy source and an essential feedstock. Moving forward, hydrogen is poised to become clean energy driver, transforming heavy industries into greener operations. In fact, leading steelmakers in South Korea and around the globe are actively transitioning to hydrogen-based direct reduction technology to achieve decarbonization.

Conventional Reduction Process



Hydrogen-Based Ironmaking



Hydrogen as a Fuel (Decarbonizing Transportation)

Massive cargo ships crossing the globe and long-haul commercial flights emit huge volumes of greenhouse gases. These are sectors where decarbonization technologies are particularly important. Yet, unlike passenger vehicles, powering them with batteries alone is nearly impossible. That's because they require enormous amounts of energy for long periods of time, which would have to make batteries extremely large and heavy. On top of that, the long hours needed to recharge them create another major bottleneck. That's why hydrogen is emerging as a potential solution to address this challenge. **Hydrogen can be refueled quickly and stores a lot of energy relative to its weight, making it well suited for vehicles that need to operate for long periods, such as buses, trucks, airplanes, ships, and trains.**

Cutting Global Emissions with Hydrogen

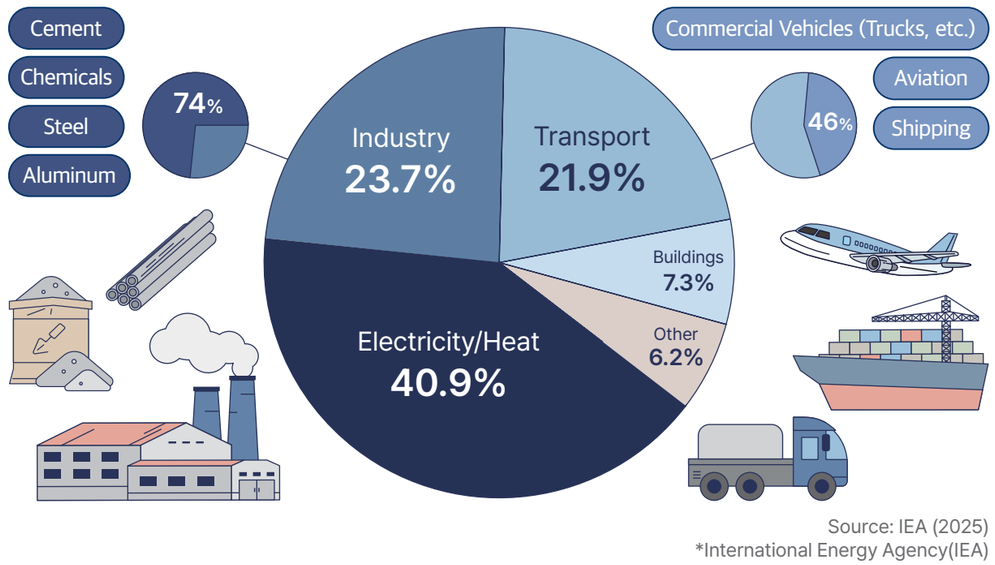
As such, hydrogen can help address challenges that can't be solved simply by replacing fossil fuels with electricity.

Heavy industries like steel, chemicals, and cement—which rely on carbon as feedstock—along with aviation and shipping sectors where heavy batteries are impractical, together account for roughly 11.5 billion tons* of global greenhouse gas emissions. Road transportation—including passenger cars and freight trucks—emits over 6 billion tons of carbon dioxide annually. For this reason, hydrogen is taking center stage as an important solution to slash carbon emissions across all these key sectors. (IEA, 2025)

*All references to "ton" in this publication refer to metric tonnes (1 tonne = 1,000 kg)

Carbon Emissions by Sector

Total Emissions: 38.15 billion tCO_2(2024)



Source: IEA (2025)
*International Energy Agency(IEA)

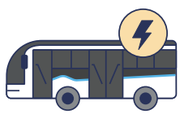
Fuel Cell Electric Vehicles: Going Farther and Faster

Hydrogen is already boasting its amazing versatility in our everyday lives.
Case in point: Fuel Cell Electric Vehicles!
Today, a wide range of Fuel Cell Electric Vehicles are already on the road, demonstrating what hydrogen can do.
Let's explore Fuel Cell Electric Vehicles' unique strengths—from faster refueling times and longer driving ranges to heavy-duty hauling power!

Refuel Faster, Go Farther

Battery Electric Vehicles (BEVs) run on electricity stored in batteries. Fuel Cell Electric Vehicles (FCEVs), on the other hand, use hydrogen, which an onboard fuel cell converts into electricity to power the motor. Both BEVs and FCEVs are eco-friendly because they produce no tailpipe emissions like carbon dioxide and other exhaust gases, but each offers different advantages, allowing drivers to choose what best fits their lifestyle and needs.
So, what makes Fuel Cell Electric Vehicles special? For starters, FCEVs can be refueled much faster than BEVs. **For example, the passenger FCEV NEXO can be fully refueled in just five minutes.** That's at least 10 times faster than charging a standard battery EV. They also offer significantly longer driving ranges on a single refuel. These advantages really stand out for long-haul, heavy-duty commercial transport, such as buses and trucks. **Even for a massive transit bus, a quick 20-minute refuel is all it takes to get back on the road.**

Hydrogen Fuel Cell Bus vs. Battery Electric Bus: Refueling Time and Driving Range

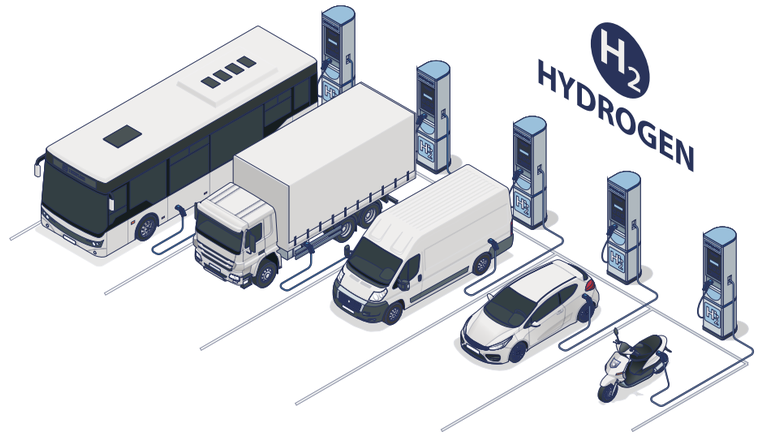
	Hydrogen Fuel Cell Bus (Hyundai UNIVERSE Fuel Cell)	Battery Electric Bus (Other Manufacturer)
		
Refueling/Charging Time (for approx. 960 km of driving range)	Approx. 20 minutes	Approx. 192 minutes
Driving Range (on a single refueling)	Approx. 960 km	Approx. 502 km

*Driving range and charging times can vary depending on external factors.

Carrying More, Hauling Farther

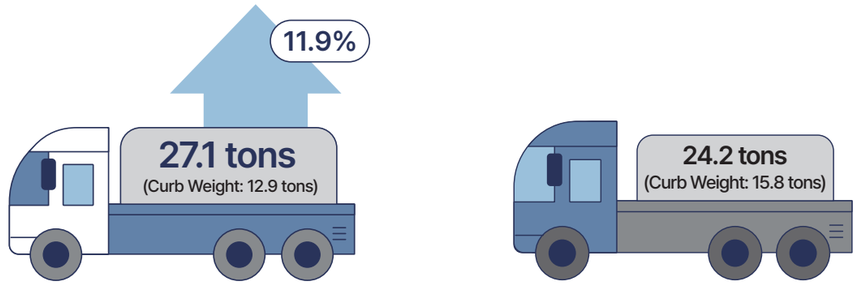
Large, heavy-duty trucks require more energy than standard passenger vehicles.

That means electric trucks need bigger and heavier batteries. Hydrogen fuel cell trucks, on the other hand, have relatively lightweight energy storage systems, allowing them to carry more cargo than their electric counterparts. In fact, for a 40-ton truck, a hydrogen fuel cell truck can haul an extra 3 tons of payload compared to an equivalent electric truck.



Hydrogen Fuel Cell Truck vs. Battery Electric Truck: Cargo Capacity

Hydrogen Fuel Cell Truck (Hyundai XCIENT Fuel Cell)	Battery Electric Truck (Other Manufacturer)



*Based on Korean weight regulations (40 tons)
Assumed values for identical AER (Korean mode (K-WHVC) and loaded truck standard, 866 km) under the same conditions

From Excavators to Burners: Hydrogen Powers More Than Just Cars

As we've seen, hydrogen can play many different roles in our daily lives and industries.
Beyond the familiar vehicles and trucks on our roads, hydrogen is actually making a major impact across many other fields.
So, let's take a look at where hydrogen is putting its capabilities to work in the real world!

Hydrogen Fuel Cell System

Generating electricity through an electrochemical reaction, hydrogen fuel cells power much more than just passenger vehicles—they are actively deployed across industrial and agricultural equipment like generators, excavators, forklifts, and tractors.



Generator



Excavator



Forklift



Agricultural Tractor



Military Vehicle



AGV
(Automated Guided Vehicle)



Ship

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Hydrogen Burner

A hydrogen burner is a device that burns hydrogen together with air to produce high-temperature heat.
It plays an important role across industrial processes that require high heat, including paint ovens, industrial air-handling systems, and boilers.

Paint Oven



Rapidly and evenly dries and cures automotive paint coating

Air-Handling Unit



Quickly heats outdoor air and supplies it indoors

Boiler



Uses high-temperature exhaust gas to heat water in the pipes and distribute it throughout the entire facility

Hydrogen Fuel Cells Aboard Apollo 11

When Apollo 11 made history as the first crewed spacecraft to land on the Moon, it carried three onboard hydrogen fuel cells.

These fuel cells generated essential electricity to power the spacecraft's countless systems, while the pure water produced as a byproduct kept the astronauts hydrated during their mission. Hydrogen fuel cells are especially useful in space, where they hold a major edge over conventional energy sources. That's because the system is reversible—it can produce electricity and water on demand or use electricity and water to generate hydrogen and oxygen when needed.
As humanity looks toward building permanent lunar or Martian bases, hydrogen fuel cells could play an even greater role.

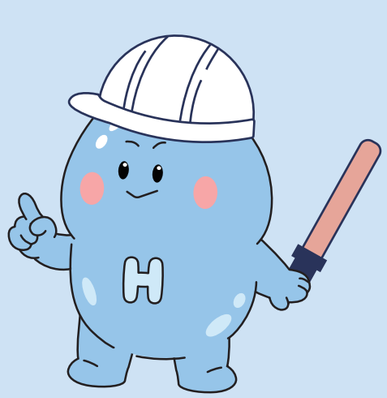


Apollo 11 Fuel Cell Unit

Source: National Air and Space Museum of the Smithsonian Institution

Hydrogen: Advancing Safety

Beneath the surface, hydrogen technologies incorporate multiple layers of safety based on science and engineering.
Let's find out how hydrogen can be used safely in our everyday lives.



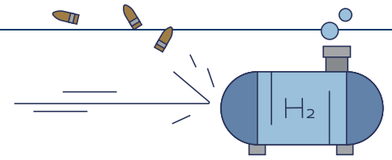
Hydrogen: Safer Because It's So Light

Hydrogen is a colorless, odorless, and non-toxic gas.

It has no color, no smell, and no toxicity.
On top of that, hydrogen is the lightest element on Earth. At room temperature and standard atmospheric pressure, hydrogen gas has a density of 0.0899 kg/m³, making it about 14 times lighter than air. So even if hydrogen leaks, the gas instantly dissipates into the upper atmosphere. It's just like a balloon floating up into the sky. By contrast, fuels like gasoline or household LPG are heavier than air. If they leak, they settle near the ground and pool there for a long time. Since fuels that linger close to the ground carry a much higher risk of ignition, hydrogen's ability to rapidly rise and disperse actually makes it significantly safer.



Hydrogen Tank: Designed to Remain Safe in Extreme Conditions



FCEVs and hydrogen storage facilities use strong tanks specially designed to safely store hydrogen.

These tanks are reinforced with multiple layers of carbon fiber, making them strong and durable enough to withstand extreme conditions. In fact, automakers conduct rigorous tests on hydrogen tanks, including by shooting at them, exposing them to fire, and putting them through powerful crash tests before confirming their safety to hit the market. Thanks to these thorough safety checks, hydrogen can be used safely as clean energy.

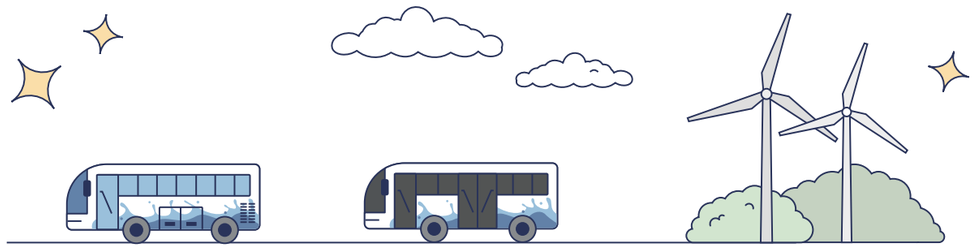
Why Is Hydrogen Safe?

Hydrogen is safer than everyday fuels such as gasoline, LPG, and methane.

Gasoline is what powers most of the vehicles we drive every day. LPG is the gas stored in canisters you usually see at camping sites. Methane is the main gas supplied to homes through city gas networks. According to a comparative risk assessment of major energy sources conducted by the Korea Occupational Safety and Health Agency and the American Institute of Chemical Engineers, if hydrogen's risk level is set at 1, gasoline scores 1.44, LPG 1.22, and methane 1.03, highlighting its strong safety profile. Quite reassuring, isn't it?

To ensure hydrogen is used safely, Korea became the first country in the world to pass a dedicated Hydrogen Act back in February 2020.

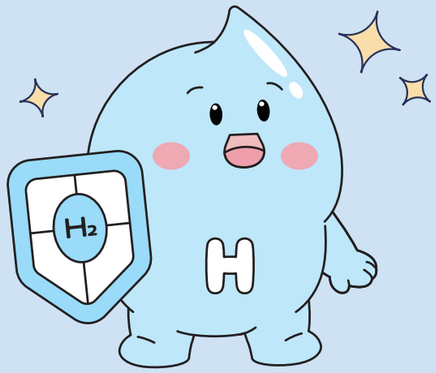
Officially named the Hydrogen Economy Promotion and Hydrogen Safety Management Act, it strictly regulates how hydrogen is produced, stored, transported, and used. Hydrogen refueling stations and storage facilities must meet high safety standards and undergo regular inspections and maintenance. These strict government standards and regulations help ensure hydrogen can be used safely by everyone.



Chapter 5 | Fair

Hydrogen: A Guardian of Energy Security

Many countries currently rely heavily on imports for most of its energy needs.
Why is that? And how can hydrogen help protect our energy security?



Do We Really Import All the Energy We Use Every Day?

South Korea, for instance, relies heavily on other nations for energy simply because it produces almost no fossil fuels like oil, coal, or natural gas. To put it in perspective, roughly 94% of the country's energy resources are imported. (Korea Energy Economics Institute, 2024)

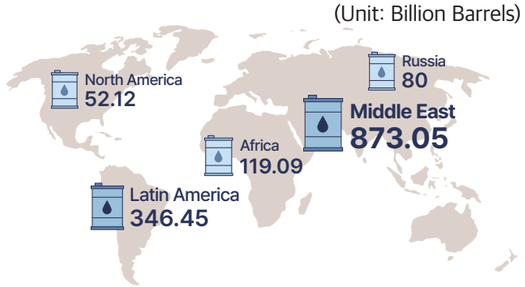
To make matters worse, resource-rich countries with massive underground reserves are few and far between. Take oil, for example—most of it is concentrated in the Middle East, Latin America, and Russia. So if conflict erupts in these regions—or if they decide to cut exports to protect their own interests—it inflicts a massive blow on its economy and industries.



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Global Distribution of Oil Reserves

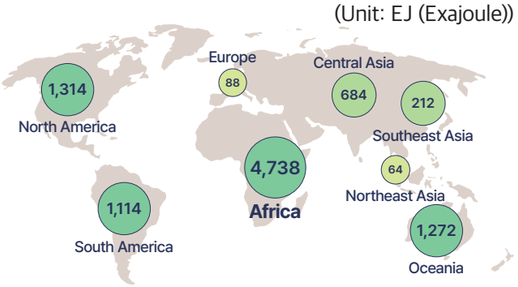
(Unit: Billion Barrels)



Source: OPEC (2026)
*Organization of the Petroleum Exporting Countries (OPEC)

Green Hydrogen Production Potential by Continent in 2050

(Unit: EJ (Exajoule))



Source: IRENA (2025)
*International Renewable Energy Agency (IRENA)
*A massive unit of energy equivalent to 10^{18}J, typically used to measure global or national annual energy production, consumption, and total resource potential.

Hydrogen, Protecting Our Energy Security and Supply Chains!

Energy security refers to a nation's ability to secure a stable and continuous supply of energy.

Many countries put extensive diplomatic effort into securing reliable energy imports from diverse partner nations. But what happens if a major energy-exporting country suddenly reduces or cuts off its supply? You guessed it right—such disruption creates serious energy security challenges around the world. That's because it would become much harder to secure a stable and reliable access to energy. That's why strengthening energy independence and diversifying supply chains are so important. In other words, instead of relying on a single country or source of energy, diversifying energy sources and supply routes helps ensure a more stable energy supply.

And that's where renewable energy and hydrogen come in. Renewable energy harnesses natural resources like sunlight and wind. While conditions vary by region, wind and sunshine exist everywhere on Earth. Unlike fossil fuels—which are locked deep underground only in specific regions—renewables are called universal energy sources accessible to all. The same is true for hydrogen. Hydrogen can be produced from a wide variety of feedstocks, ranging from water to organic waste based biogas. With the right technology, it can be generated virtually anywhere. Just like the map above illustrates. Hydrogen is especially promising as a guardian of energy security—keeping key national infrastructure running even during global energy supply cutoffs.

In fact, the energy sector is increasingly adopting the concept of local production for local consumption.

This approach is more efficient because there is no need to send energy long distances. Since hydrogen can generate power without geographical limits, it is considered a key pillar for achieving true decentralized, localized energy systems. In short, hydrogen helps nations and local communities achieve energy independence while building robust, resilient supply chains for the future.

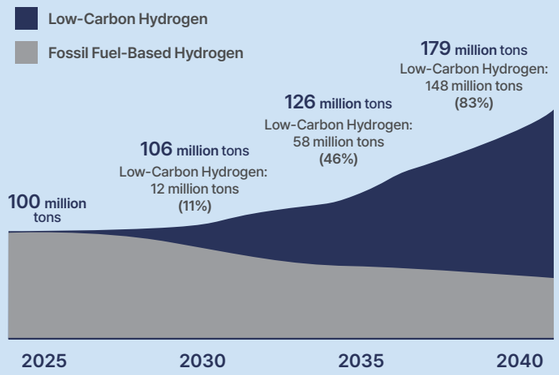
The Growing Global Hydrogen Market

Hydrogen is steadily gaining momentum and expanding its footprint worldwide.
With everything we've learned so far, it's easy to understand why hydrogen is growing fast.
How much hydrogen will the world need in the years ahead, and how massive could this market become?

By 2040: Hydrogen Demand Doubles, Clean Hydrogen Soars 148-Fold



As countries work toward carbon neutrality, demand for hydrogen is expected to continue rising. By 2040, global demand for hydrogen is projected to double compared to current levels.
Clean hydrogen, such as green and blue hydrogen, is expected to grow a whopping 148-fold, capturing a dominant 83% share of all hydrogen used worldwide. (BNEF, 2026)



Global Hydrogen Demand Outlook for Net Zero

Source: BNEF (2026)

Hydrogen Utilization Plans by Major Countries and Regions



U.S.

Capitalizing on its vast natural gas reserves and robust energy infrastructure, the United States is producing low-carbon hydrogen and low-carbon ammonia. Carbon emissions from production are captured, and either stored or reused to reduce overall emissions. Low-carbon hydrogen and ammonia are deployed directly into heavy industries—including oil refining, fertilizers, chemicals, and steel—to drive decarbonization. (U.S. Congress, 2022)



Europe

Much like South Korea, Europe relies heavily on energy imports, prompting early commitments to hydrogen through aggressive legislation and policy frameworks to expand green hydrogen adoption. In particular, it is working to expand the use of green hydrogen in transportation sectors such as heavy-duty trucking and aviation, as well as oil refining and other industrial applications. (European Union, 2023)



India

Harnessing its abundant renewable sources, India aims to become a global export hub for highly cost-competitive green hydrogen and green ammonia. Green ammonia, in particular, serves a dual purpose—power generation and fertilizer production—opening dynamic economic opportunities across multiple sectors. (Ministry of New and Renewable Energy, 2023)



Japan

Japan, a country with limited energy resources, is building a large-scale domestic hydrogen market focused on high-consumption sectors like power generation, steelmaking, chemical manufacturing, and refining. To secure steady, high-volume imports, it has been building international partnerships and investing in strategic cross-border projects to strengthen global hydrogen supply chains. For example, following the 2022 Japan-India Clean Energy Partnership (CEP), Japan has expanded multilateral hydrogen and ammonia supply frameworks to diversify its import channels. (METI, 2023 Revision)



China

China is actively expanding its hydrogen industry, using its abundant renewable energy resources to produce low-cost green hydrogen. It is also encouraging hydrogen consumption by deploying Fuel Cell Electric Vehicles across designated pilot cities, with plans for progressive rollout into broader industrial applications. (State Council of China, 2026)



Middle East

The Middle East, where fossil fuel production and exports have traditionally been major industries, is pivoting toward clean energy to diversify its economy for the post-carbon era. The region plans to become a major exporter of green hydrogen by capturing abundant solar irradiance to generate electricity. (Saudi National Hydrogen Strategy, 2021 / UAE Ministry of Energy and Infrastructure, 2023 / Oman Hydrom, 2024)



Chile

Chile, one of the world's leading producers of copper and lithium, aims to produce low-cost green hydrogen by leveraging its abundant solar and wind resources. This clean energy will first decarbonize mining fleets and industrial equipment locally, before scaling into a major national export engine over the long term. (Ministry of Energy, 2024 Revision)



Canada

With vast geographical distances and extreme winter climates, Canada is actively deploying hydrogen fuel cell technology for long-haul freight logistics. Electric vehicles can generally lose driving ranges in cold weather because low temperatures affect battery performance. That's why Canada is especially interested in Fuel Cell Electric Vehicles, which can travel long distances reliably even in cold climates and can be refueled quickly. (Natural Resources Canada, 2020)



Australia

Blessed with abundant solar and wind resources, Australia is channeling its renewable advantages directly into large-scale green hydrogen production. Transitioning beyond raw iron ore exports, the country aims to create additional value by using hydrogen to refine its iron ore into green Direct Reduced Iron (DRI). This strategy positions Australia to capture far higher industrial returns in the emerging green steel market. (DCCEEW, 2024)

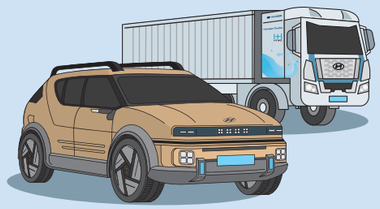
Global Hydrogen Frontiers: Korea's Hydrogen Companies

Hydrogen is already becoming part of our everyday life.
In particular, South Korea is home to world-leading capabilities and technologies across key areas of the hydrogen industry. The country is taking the lead, with more Fuel Cell Electric Vehicles on our roads than almost any other country.
Ready to take a closer look at South Korea's hydrogen ecosystem?

South Korea: A Global Leader in FCEVs

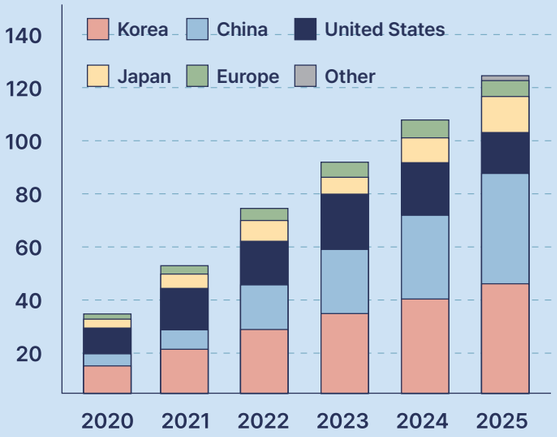
South Korea stands at the global forefront of hydrogen fuel cell technology, actively driving the evolution of the FCEV market.

Beyond developing and manufacturing state-of-the-art Fuel Cell Electric Vehicles, Korea is continuously expanding its refueling statio Along with China, which is rapidly deploying hydrogen fuel cell buses and trucks, Korea is building global competitiveness and leading the growth of the Fuel Cell Electric Vehicles industry.



Fuel Cell Electric Vehicles by Country (2025)

(Unit: 1,000 vehicles)

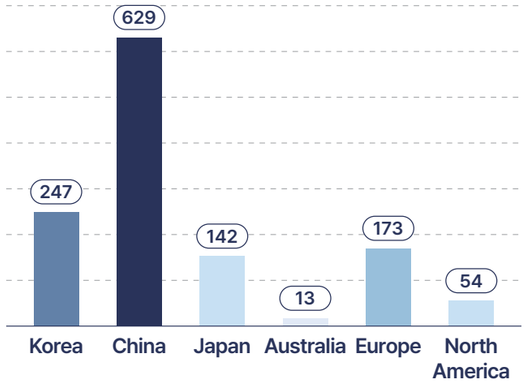


Source: IEA (2026)

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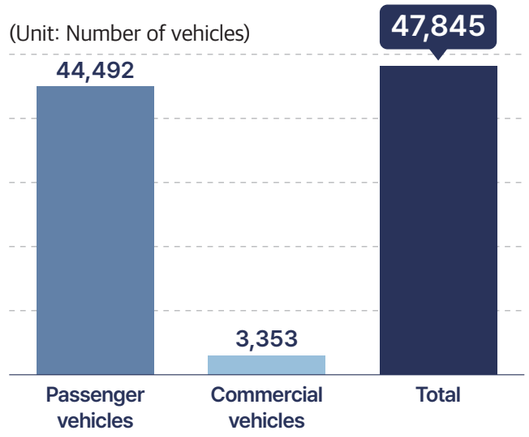
Hydrogen Refueling Stations (2026)

(Unit: stations)



FCEVs in Korea (2026)

(Unit: Number of vehicles)



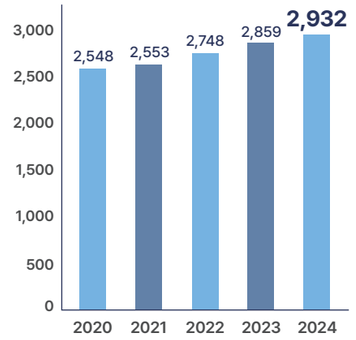
Source: Korea - Zero-Emission Vehicle Integrated Portal (2026) / China - China Hydrogen Alliance (2026) / Japan - Next Generation Vehicle Promotion Center (2026) / Australia - CSIRO (2025) / Europe - HRS Availability Map (2026) / North America - Alternative Fuels Data Center (2026)

South Korea's Hydrogen Industry

South Korea is already home to around 3,000 hydrogen-related companies involved in producing, storing, and transporting hydrogen. More than 36,000 people are currently employed in this fast-growing sector. (Ministry of Climate, Energy and Environment & Korea Hydrogen Alliance, 2025) As the hydrogen ecosystem becomes fully integrated into our society by 2040, it is projected to generate roughly 420,000 new jobs and deliver an annual economic value of about 43 trillion KRW. (Government Hydrogen Economy Roadmap, 2019)

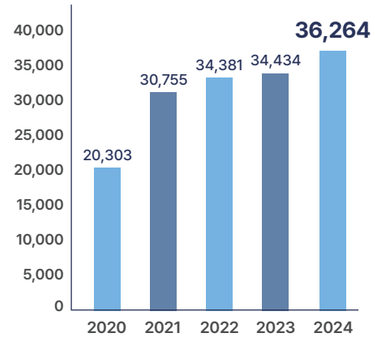
Number of Hydrogen Companies in Korea

(Unit: Number of Companies)



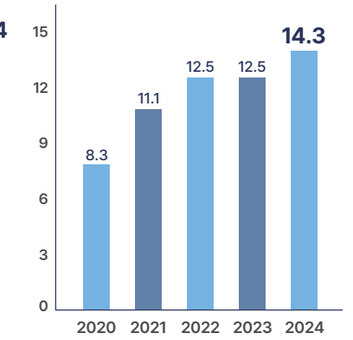
Number of People Working in Korea's Hydrogen Industry

(Unit: Number of Workers)



Hydrogen Industry Revenues in Korea

(Unit: KRW 1 trillion)



Source: Ministry of Climate, Energy and Environment & Korea Hydrogen Alliance (2025)

Hydrogen Powers the Place Where We Live

There are cities that run on hydrogen.
A city that uses hydrogen as an energy for homes, transportation, industry, and many other parts of everyday life is called a ‘hydrogen city’. Ready to explore a hydrogen city?

A Vibrant Hydrogen City Powered by a Living Ecosystem

A hydrogen city is, quite simply, a city that runs on hydrogen.

It is built around a connected hydrogen ecosystem that links every stage of hydrogen’s journey—from its creation to its final use. Much like a natural ecosystem, every single step—production, storage, transport, and practical application—is seamlessly woven together into a single, continuous system. **Hydrogen is produced and stored within the city, then delivered directly to where it’s needed to generate clean electricity and heat.**

Hydrogen-powered buses and waste collection trucks navigate the streets, while buildings rely on stationary fuel cells to generate their own power on site. Homes, schools, and hospitals can use electricity and heat made with hydrogen, while hydrogen refueling stations supply fuel to vehicles. For this living system to thrive and run smoothly, every facility across the hydrogen ecosystem must stay closely synchronized.



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The Hydrogen Value Chain: From Production to Use

Upstream
Production

Feedstock

- Renewable Energy
- Nuclear Energy
- Ammonia
- Oil or Naphtha (Petrochemicals)
- Coal
- Biogas (Resource Circulation)
- Natural Gas

Production Technologies

- Water Electrolysis
- Ammonia Cracking
- By-product Gas Purification
- Biogas Reforming

Midstream
Storage & Distribution

- Pipeline Network
- Dispatch Facilities
- Land Transportation (High-Pressure & Gas Liquefaction)
- Maritime Transportation (Liquefied Hydrogen & Ammonia)
- Hydrogen Storage Facilities (Gas, Liquid & Solid)
- Stationary Refueling Stations
- Mobile Refueling Stations
- Packaged Refueling Stations

Downstream
Applications

Industry

- Steel
- Semiconductors
- Petrochemicals
- Fertilizers
- Cement
- Industrial Equipment (Burners)

Transportation

- Aircraft & Ships
- Vehicles (Including Special-Purpose Vehicles)
- Rail Vehicles (Trams & Trains)

Power Generation

- Power Generation

Could My Town Run on Hydrogen?

Hydrogen cities are emerging across Korea.

Becoming a hydrogen city isn't simply about switching the energy source to hydrogen. It means transforming the whole industrial system from a carbon-based economy to a hydrogen economy, while achieving carbon neutrality, boosting local economies, and creating new jobs.
Each city is transforming into a unique hydrogen city tailored to its regional strengths and needs. Cities with well-developed industries can use hydrogen in connection with those industries, while areas undergoing urban renewal can use it to build better housing and transportation infrastructure. Regions with abundant wind and solar energy use that renewable electricity to produce and utilize green hydrogen.

Could your community be turning into a hydrogen city, too?
Let's check the map to see what kinds of hydrogen cities are being developed across the country!



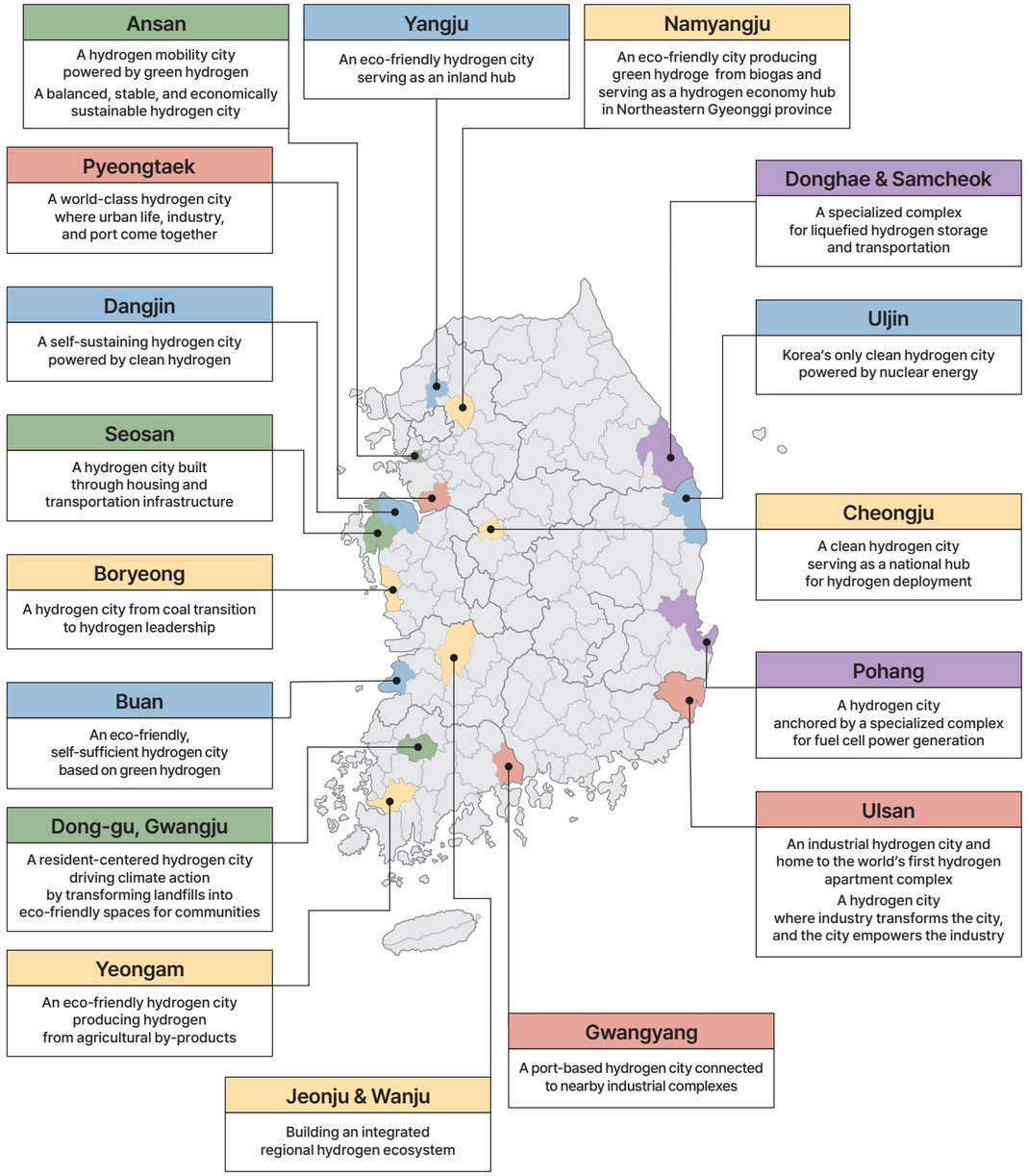
Hydrogen-Specialized Complexes: Hubs for the Hydrogen Industry

Unlike hydrogen cities that focus on everyday use, some regions are dedicated specifically to advancing the hydrogen industry through collaboration between companies and research institutes.

These designated areas are known as Hydrogen-Specialized Complexes. They serve as high-tech industrial parks where businesses and research centers connected across the full hydrogen value chain—from production, storage, and transport to end-use application—are clustered together. In other words, they act as strategic hubs where companies team up to develop new technologies and expand the hydrogen market. Currently, Donghae-Samcheok in Gangwon Province and Pohang in Gyeongsangbuk-do Province have been designated as specialized complexes, with each region fostering a tailored hydrogen industry by capitalizing on its unique regional strengths.

Hydrogen Cities: Korea at a Glance

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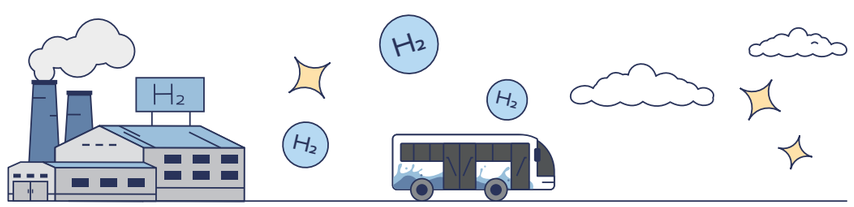


Source: Status of Designated Hydrogen Cities Nationwide, Ministry of Land, Infrastructure and Transport (As of January 2026)
* Categories and descriptions have been adapted from official announcements and slogans to clearly highlight each city's hydrogen deployment plans.

How Hydrogen Is Transforming Our Communities

Along with hydrogen cities officially designated by the Ministry of Land, Infrastructure and Transport, several other regions are also building hydrogen-powered communities tailored to their local characteristics and strengths.
Incheon, Saemangeum, and Jeju are prime examples.
Let's take a closer look at how each of these cities and regions is putting hydrogen to work!

Jeonbuk Province: A Hydrogen City Centered on Everyday Life and Transportation



Jeonbuk Province is building a thriving hydrogen ecosystem around Wanju and Jeonju.

Since 2019, Jeonbuk Province has been carrying out various projects and initiatives based on a basic plan to grow its hydrogen industry in line with the government's Hydrogen Economy Roadmap. Hydrogen fuel cell buses and hydrogen refueling stations are already being introduced and operated in different parts of the province.
A national industrial complex specializing in hydrogen is also being developed around Wanju, and the province plans to take part in Hyundai Motor Group's Saemangeum project to build a future city centered on robotics, AI, and hydrogen.

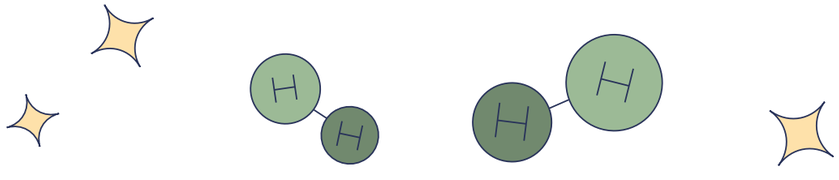
Pyeongtaek: A Port-Centered Hydrogen City



Pyeongtaek integrates Pyeongtaek Port with nearby industrial complexes, enabling hydrogen production, transport, and application to take place seamlessly in a single hub.

Since being selected as a pilot hydrogen city by the Ministry of Land, Infrastructure and Transport in 2022, Pyeongtaek has been working to develop hydrogen infrastructure throughout the city. The city is building an urban energy model that connects hydrogen produced near Pyeongtaek Port with residential, industrial, and port facilities in the Free Economic Zone. Its core objective is to construct a 15-kilometer hydrogen pipeline network—completing an urban hydrogen supply infrastructure that reliably transports hydrogen from the production base to the Hydrogen Mobility Complex, automotive cluster, and Hydrogen City Support Center.

Jeju Island: Ideal Place for the Transition to Clean Hydrogen



Jeju Island produces hydrogen directly using wind and solar power.

By harnessing its abundant renewable energy, Jeju aims to become a global green hydrogen hub that produces green hydrogen for transportation, power generation, and industry as a whole. The island is gradually expanding its green hydrogen production and demonstration facilities while increasing real-world demand by supplying hydrogen to fuel cell electric buses and vehicles.
Building on its abundant renewable energy resources and hydrogen potential, it has officially adopted the Jeju 2035 Carbon Neutrality Vision Through Energy Transformation, steadily advancing toward a net-zero future.

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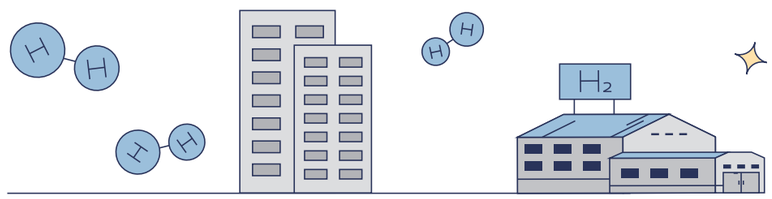
Cheongju:
An Inland Hydrogen City Powered by Resource Circulation



Cheongju turns biogas made from local waste, sewage, and other sources into hydrogen.

In 2025, Cheongju was selected for the 2026 Hydrogen City Development Project led by the Ministry of Land, Infrastructure and Transport. The city plans to invest a total of KRW 40 billion (Approx. USD 30 million) to expand its local hydrogen infrastructure. In 2026, the city also plans to work with Hyundai Motor Group to build a waste-to-hydrogen production and refueling facility, HTWO ENERGY Cheongju, create a circular hydrogen ecosystem and expand clean hydrogen production. Leveraging its strategic location at the heart of South Korea, Chungcheongbuk-do Province aims to leap forward as a key hub for hydrogen logistics and distribution while supporting hydrogen infrastructure management, expanding hydrogen mobility adoption, and promoting clean transportation to help achieve carbon neutrality and boost the local economy.

Ulsan:
Korea's Largest Hydrogen City



Ulsan is Korea's largest hydrogen city, accounting for about 50% of the country's hydrogen production. (Ulsan Metropolitan City, 2026)

Home to Korea's first hydrogen refueling station opened in 2009, Ulsan now sees nearly 4,000 Fuel Cell Electric Vehicles on its roads and 16 operating hydrogen refueling stations. The city boasts major industrial complexes where key sectors—including automotive, shipbuilding, and petrochemicals—are densely clustered. These industries both produce and use hydrogen, making Ulsan a leading industrial hydrogen city. Of course, the hydrogen produced in these industrial complexes is also supplied to other parts of the city. Ulsan features hydrogen power plants that generate electricity, as well as carbon-neutral hydrogen apartment complexes heated by the by-product thermal energy from those plants. Ulsan does offer a real glimpse of what a hydrogen-powered society could look like!

Incheon:
A City Connected by Its Ports, Airports, and Hydrogen



Incheon is building a hydrogen-powered society by connecting hydrogen production, storage, transportation, and use through its port and airport infrastructure.

Equipped with one of the world's largest liquefied hydrogen production plants—capable of producing 30,000 tons annually—along with supporting refueling networks, Incheon is expanding Fuel Cell Electric Vehicles adoption and spearheading the hydrogen mobility era.
The city is also utilizing its ports and airport to secure a stable hydrogen supply while broadening its use across logistics and industrial sectors. With an integrated hydrogen ecosystem that connects everything from production to storage, transportation, and use, Incheon is growing into a leading hydrogen hub for the greater Seoul metropolitan area.

Saemangeum: A Future City for Robotics, AI and Hydrogen

In Saemangeum, Jeonbuk Province, the government, local authorities, and Hyundai Motor Group are working together to build a future city centered on robotics, AI, and hydrogen. The vision goes beyond mere hydrogen production—it's about creating a next-generation high-tech ecosystem that seamlessly powers diverse future industries.

For many years, Saemangeum has been seen as a region with strong potential for development and growth. With its vast land area and strategic location, it is now gaining more attention as a hub for emerging industries. Capitalizing on Saemangeum's vast natural assets, the government continues to push forward a vision to make it a world-class city of tomorrow—one where renewable energy, advanced technologies, and green hydrogen flourish together while boosting balanced regional growth.

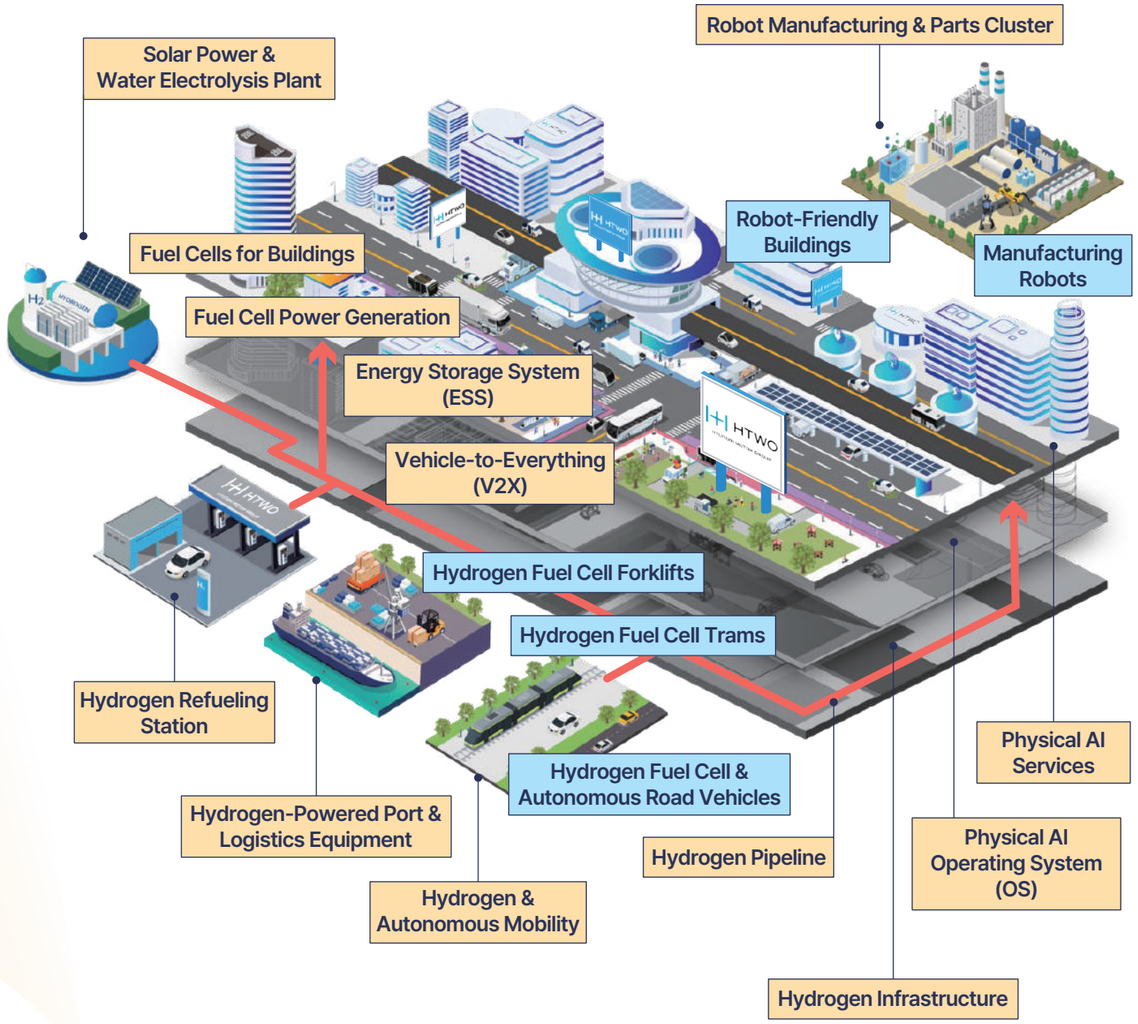
To help make this vision a reality, local authorities and Hyundai Motor Group are also actively supporting Saemangeum's development. Today, a landmark project is underway in Saemangeum to use its vast land and abundant solar and wind resources to produce green hydrogen and support next-generation high-tech sectors. **This collaborative eco-friendly initiative holds significance as a sustainable, green project jointly driven by the public sector, local government, and private companies.**

Shall we take a closer look at what this exciting project entails? Hydrogen produced from Saemangeum's renewables will serve as one of power sources driving tomorrow's key industries—including AI data centers, robot manufacturing plants, hydrogen refueling stations, and port logistics. The goal goes beyond local hydrogen production to create an integrated future ecosystem that connects renewable energy, hydrogen, and advanced industries.

It's an exciting vision for the future, isn't it? **These efforts are also expected to reduce reliance on imported fossil fuels while enhancing Korea's energy security and supply chain resilience.** Saemangeum, a leading city for clean energy and future industries in Korea! Let's stay tuned to see how this visionary city continues to evolve in the years ahead!



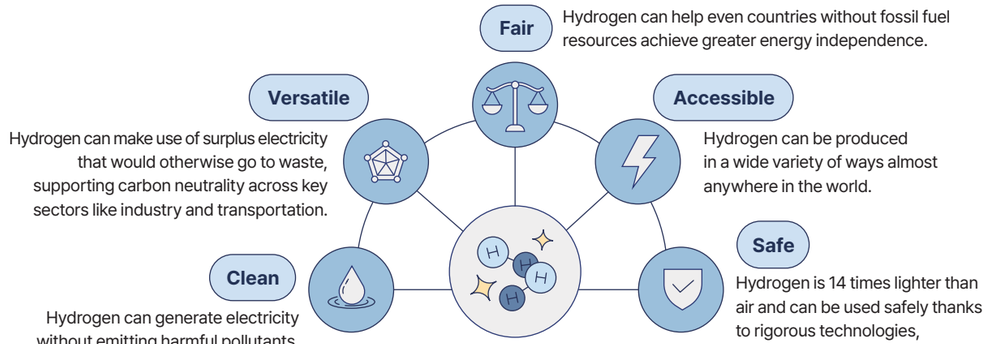




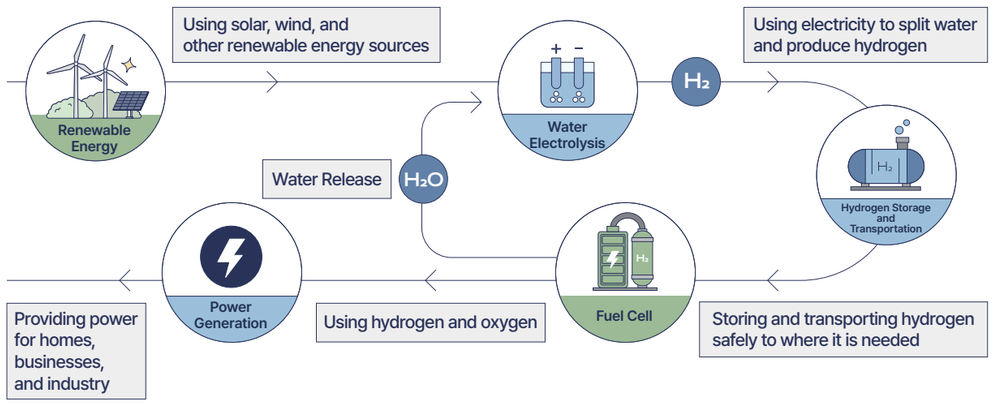
Hydrogen at a Glance



Why Hydrogen?



The Green Hydrogen Cycle



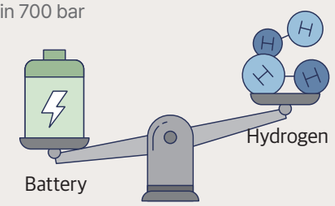
HTWO
HYUNDAI MOTOR GROUP

Hydrogen: An Important Energy for Today and Tomorrow

The primary reason hydrogen is gaining traction as a vital energy for both today and tomorrow is its ability to store vast amounts of energy and deliver it efficiently and cost-effectively wherever it is needed.

Hydrogen vs. Batteries: Weight and Volume for Storing the Same Amount of Energy (33.3kWh)

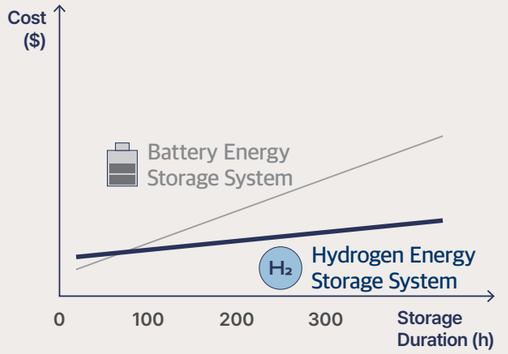
*1kg H_2 in 700 bar



Category	Hydrogen	Battery
Weight	1 kg	130 kg
Volume	24 L	56 L

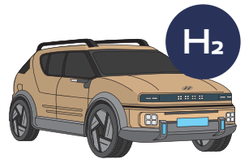
Economic Analysis of Hydrogen Energy Storage Systems (H-ESS)

Source: Korea Hydrogen Alliance (H2KOREA) (2026)



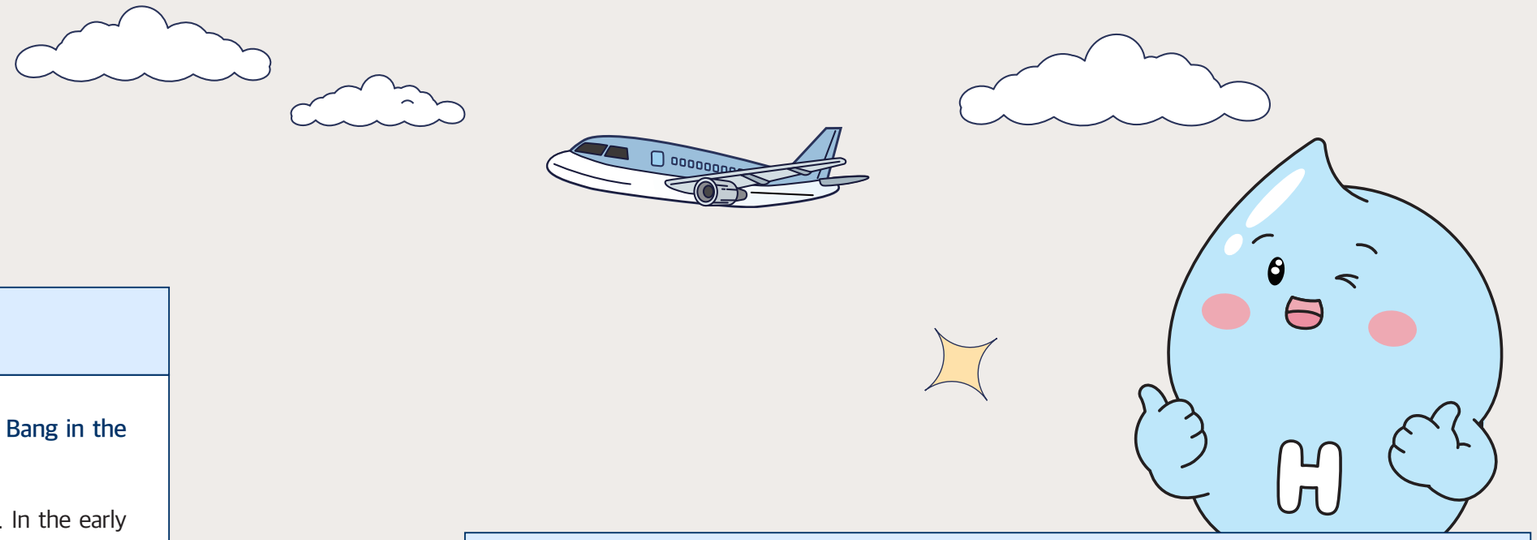
What Makes Fuel Cell Electric Vehicles Special

Fuel Cell Electric Vehicles offer great convenience thanks to their short refueling times and long driving ranges. They are also environmentally friendly vehicles, emitting only water while on the road, rather than harmful exhaust gases.

	Fuel Cell Electric Vehicle (NEXO)	Hydrogen Fuel Cell Bus (Hyundai UNIVERSE Fuel Cell)
		
Refueling Time	**Approx. 5 minutes**	Approx. 20 minutes
Driving Range (on a single refueling)	**Approx. 720 km**	Approx. 960 km

*Charging time may vary depending on the vehicle condition and charging environment.

Getting to Know Hydrogen: Q&A



Q1. Why is hydrogen so abundant in the universe?

That's because hydrogen was one of the very first elements formed after the Big Bang in the birth of the universe.

Hydrogen is the simplest element, made up of just one proton and a single electron. In the early universe, there was so much energy that more complex elements couldn't form. As a result, hydrogen was able to form much more easily than other elements.

Over time, vast amounts of hydrogen and other matter pulled together through gravity to form stars and galaxies. Even today, most stars—including our Sun—generate light and heat through the nuclear fusion of hydrogen. To this day, hydrogen accounts for roughly 75% of all mass in the universe. Heavier elements that we see all around us, such as oxygen, carbon, and iron, make up only a tiny fraction of the entire universe—less than 1%.

Q2. If hydrogen is everywhere, why do we need to produce it?

Hydrogen naturally tends to bond with other elements rather than exist by itself.

Because of this property, hydrogen is considered highly reactive.

As a result, hydrogen is almost always found in compounds such as water (H_2O), ammonia (NH_3), and methane (CH_4), rather than on its own.

So, to use hydrogen, we first need to separate and extract it from those compounds. That process of separation and extraction is what we commonly refer to as hydrogen production. Hydrogen can be produced through water electrolysis or extracted from fossil fuels like coal, oil, and natural gas, as well as organic waste such as food waste, sewage sludge, and livestock manure. Unlike oil or natural gas, hydrogen isn't a resource found only in certain parts of the world. With the right technology, it can be produced virtually anywhere.

Q3. Isn't hydrogen dangerous?

The idea that hydrogen is dangerous is a common misconception.

Hydrogen is colorless, odorless, and non-toxic. Hydrogen's autoignition temperature—the point at which it ignites on its own—is 585°C. That is more than twice that of gasoline's 247°C, meaning the chance of spontaneous combustion is extremely low.

Because hydrogen is the lightest element and about 14 times lighter than air, it rapidly rises and disperses if leaked, leaving virtually no risk of suffocation or toxicity. The myth that hydrogen is inherently dangerous likely stems from its association with hydrogen bombs.

However, the hydrogen used in hydrogen bombs has been artificially altered in structure and is completely different from the naturally occurring hydrogen used as a conventional fuel.



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Getting to Know Hydrogen: Q&A

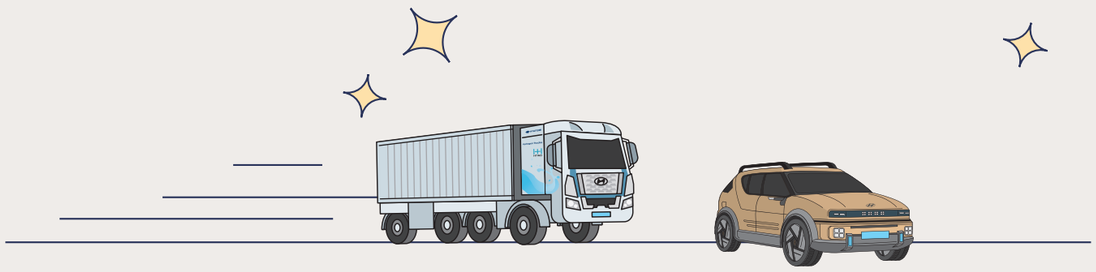
Q4. What's the biggest difference between FCEVs and BEVs?

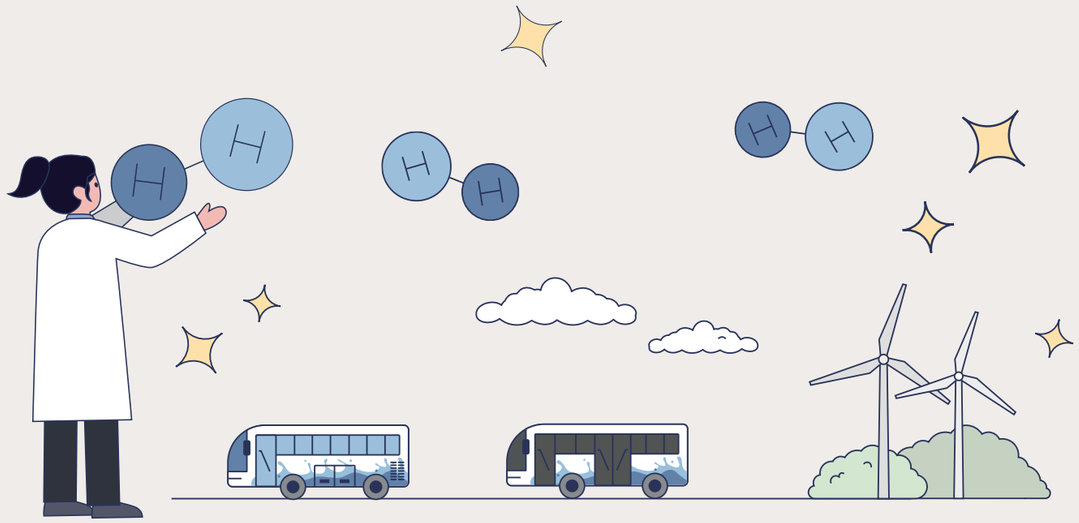
While often referred to simply as hydrogen cars, their full name is Fuel Cell Electric Vehicles(FCEVs). Just like battery-electric vehicles (BEVs), they ultimately run on electricity.

Though both are powered by electricity, the way they source their electricity is fundamentally different. BEVs store electricity produced outside the vehicle—from the grid—in their battery and uses it to power the vehicle. FCEVs, on the other hand, utilize hydrogen stored in their fuel tanks to generate their own electricity via an onboard fuel cell.

In short, BEVs charge their batteries with grid electricity, whereas FCEVs are refueled with high-pressure gaseous hydrogen (700-bar for passenger vehicles) and convert it into electricity as they drive. These distinct mechanisms give each vehicle type its own set of characteristics and advantages. BEVs require large, heavy high-capacity batteries to maximize energy storage, which adds significant weight to the vehicle. Although charging can take longer, BEVs benefit from a much wider and more accessible charging network. FCEVs, by contrast, run on hydrogen that is both lightweight and highly energy-dense.

By mass, **hydrogen boasts an energy density 133 times higher than lithium-ion batteries**. This enables longer driving ranges on a single fill while allowing vehicles to carry heavier cargo or more passengers thanks to their lighter curb weight.

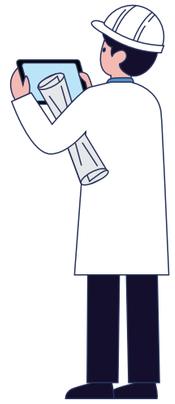




Q5. I want to become a hydrogen expert, too! What jobs are available in the hydrogen industry?

The hydrogen industry offers a wide range of jobs and careers across the entire value chain, from production and storage to transportation and end-use applications.

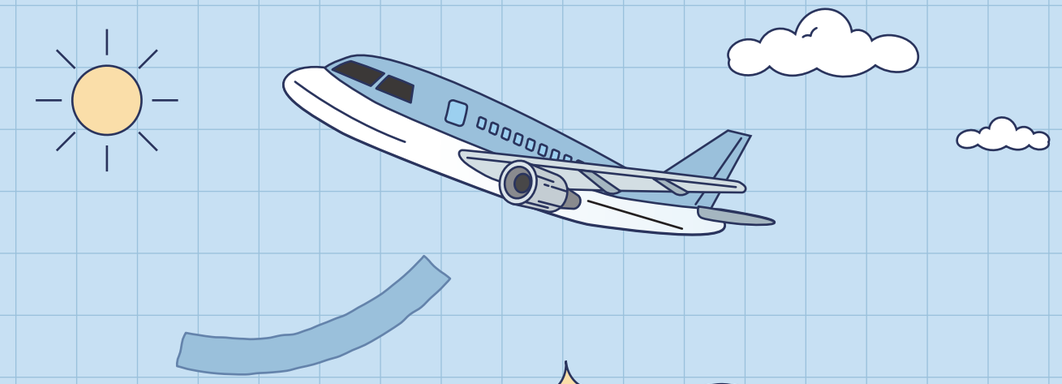
Let's explore a few key roles across the industry! First, R&D specialists like **Hydrogen Energy Researchers** develop new technologies and discover more efficient ways to produce, store, and utilize hydrogen across the board. **Hydrogen Engineers** design and build production facilities, storage systems, transportation networks, and other hydrogen infrastructure. They also engineer and manufacture hydrogen-powered products and technologies, including fuel cell systems and Fuel Cell Electric Vehicles. **Safety Managers** oversee and ensure the safety of hydrogen facilities, while Testing & Quality Engineers evaluate the durability and safety of hydrogen equipment and manage its quality. There are also jobs that help the hydrogen industry grow by developing policies and planning new business opportunities.

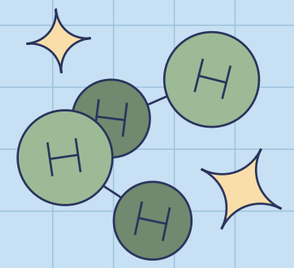


Because the industry is so diverse, there is no single major or career path required to work in hydrogen. If you stay curious about hydrogen and pursue what genuinely excites you, you'll naturally find your path to a rewarding career in this exciting sector.

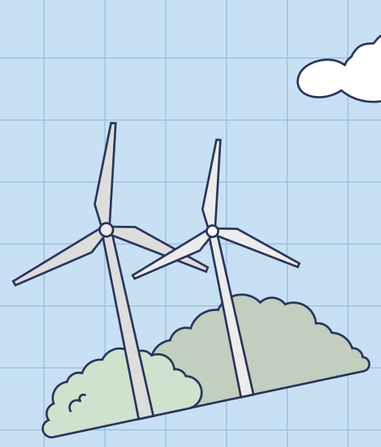
Appendix

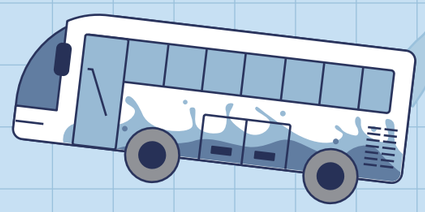
Hyundai Motor Group Hydrogen Heritage and HTWO's Key Businesses





Green Hydrogen



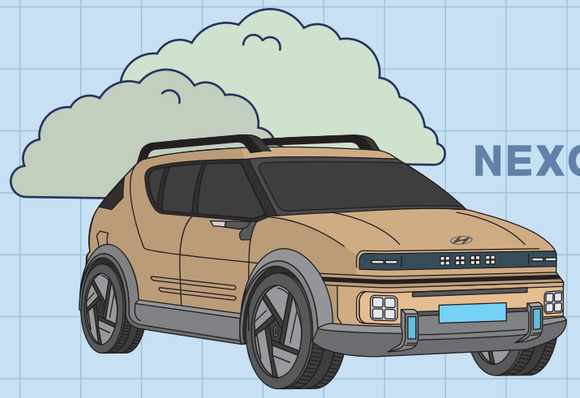


UNIVERSE Fuel Cell



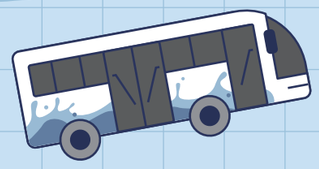
XCIENT Fuel Cell Truck





NEXO

ELEC CITY Fuel Cell



Nearly Three Decades of Leading the Hydrogen Industry

For almost 30 years, Hyundai Motor Group has been at the forefront of hydrogen technology innovation, helping shape the future of the industry.
Starting with hydrogen fuel cell R&D in 1998, the Group has set numerous landmark milestones—including becoming the first in the world to mass-produce both fuel cell passenger vehicles and heavy-duty commercial vehicles. The NEXO, launched in 2018, has seen over 40,000 cumulative global sales, to set a world record for hydrogen passenger vehicles. Guided by its unwavering vision for hydrogen, the Group continues to drive progress—initiating hydrogen refueling station operations in 2022 and producing Korea's first hydrogen fuel cell tram in 2023.

1998



Began R&D on Fuel Cell Systems

Hyundai Motor Company

2000



Developed the First FCEV Prototype

Hyundai Motor Company

2013



Launched the World's First Mass-Produced FCEV, the Tucson ix35 Fuel Cell

Hyundai Motor Company

2018



Launched Hyundai's First Dedicated FCEV, the NEXO

Hyundai Motor Company

2019



Launched the World's First Hydrogen Fuel Cell City Bus, the ELEC CITY Fuel Cell

Hyundai Motor Company

2020



Launched the World's First Mass-Produced Hydrogen Fuel Cell Heavy-Duty Truck, the XCIENT Fuel Cell

Hyundai Motor Company

2021



Began Operating Tube Trailers at the Hydrogen Distribution Center

Hyundai Glovis

2022



Unveiled High-Performance FCEV Concept, the N Vision 74

Hyundai Motor Company

2023



Launched the XCIENT Fuel Cell Tractor
United States

Hyundai Motor Company

2023



Launched the World's First Hydrogen Fuel Cell Coach Bus, the UNIVERSE Fuel Cell
Korea

Hyundai Motor Company

2023



Produced Korea's First Hydrogen Fuel Cell Tram

Hyundai Rotem

2024



Unveiled the FCEV Concept, INITIUM

Hyundai Motor Company

2025



Launched the Second-Generation FCEV, the All-New NEXO

Hyundai Motor Company

2025



Launched the New XCIENT Fuel Cell Tractor
United States

Hyundai Motor Company

HTWO
HYUNDAI MOTOR GROUP

HTWO's Hydrogen Value Chain: From Production to Use

HTWO provides solutions that meet a wide range of customer requirements and needs across every stage of the hydrogen value chain, from production and storage to transportation and use. By bringing together the capabilities of its affiliates across the entire hydrogen business value chain, Hyundai Motor Group is expanding its footprint beyond mobility to lead the global energy transition.

UPSTREAM
(Production)

HYUNDAI
HYUNDAI ENGINEERING & CONSTRUCTION
HYUNDAI ENGINEERING CO., LTD.
HYUNDAI Rotem

- Water Electrolysis
- Organic Waste Decomposition (Waste-to-Hydrogen)
- Hydrogen Extraction

MIDSTREAM
(Storage, Transportation & Refueling)

HYUNDAI
HYUNDAI GLOVIS
HYUNDAI Rotem

- Tube Trailer
- Ammonia (Storage & Transportation)
- Liquefied Hydrogen (Storage & Transportation)
- Solid Hydrogen (Storage)
- Stationary Hydrogen Refueling Station
- Mobile Hydrogen Refueling Station
- Packaged Hydrogen Refueling Station
- L2G Refueling (Liquid to Gas)

DOWNSTREAM
(Utilization)

HYUNDAI
KIA
HYUNDAI STEEL
HYUNDAI GLOVIS
HYUNDAI Rotem

- Passenger Vehicle (NEXO)
- Rail Vehicles (Trams & Trains)
- Heavy Equipment (Forklifts, Construction Equipment, etc.)
- Military Vehicles (All-terrain Vehicle)
- Fuel Cell System
- Power Generator
- Power Pack
- Low-Carbon Steel
- Hydrogen Burner
- Aviation
- Commercial Vehicles (Trucks, Buses, Car Carriers, etc.)
- Ships & Port Equipment

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