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Hydrogen station

A **hydrogen station** is a storage or filling station for hydrogen. The hydrogen is dispensed by weight.^{[1][2]} There are two filling pressures in common use. H70 or 700 bar, and the older standard H35 or 350 bar. California no longer requires that hydrogen stations carry H35, so this standard is becoming obsolete.

Contents

Hydrogen filling stations by country

Asia

Japan

China

South Korea

Europe

Germany

France

Iceland

Italy

Netherlands

Denmark

Belgium

Norway

Sweden

Switzerland

United Kingdom

North America

Canada

United States

Delivery methods

Types of recharging stations

Hydrogen highway

Hydrogen home stations

Daily recharging capacity

Disadvantages

Pollution

Volatility

Supply

Costs

See also



Hydrogen fueling pump

References

External links

Hydrogen filling stations by country

A global map of hydrogen filling stations is available.^[3]

Asia

As of June 2020, there are 178 publicly available hydrogen fuel stations in operation.^[4]

Japan

As of June 2020, there are 114 publicly available hydrogen fuel stations in operation.^[5]

Japan built a number of hydrogen filling stations under the JHFC project from 2002 to 2010 to test various technologies of hydrogen generation.^[6] By the end of 2012 there were 17 hydrogen stations and 19 new stations were expected to be installed by 2015.^[7] The Japanese government expects to add up to 100 hydrogen stations under a budget of \$460 million. That amount covers 50% of the installation costs, with the last stations operational by 2015.^{[8][9]} JX Energy expects to install 40 stations by 2015,^[10] and another 60 between 2016 and 2018.^[11] Toho Gas and Iwatani Corp^[12] After that, they expect to install an additional 20 stations.^[13] Toyota Tsusho and Air Liquide made a joint venture to build 2 hydrogen stations, which were planned to be ready by 2015.^[14] Osaka Gas planned 2 stations for 2014–15.^[15] A task force led by Yuriko Koike, Japan's former environment minister, and supported by the country's Liberal Democratic Party, was set up to oversee the process.^[16]

China

As of June 2020, there are 27 publicly available hydrogen fuel stations in operation.^[17]

South Korea

As of June 2020, there are 33 publicly available hydrogen fuel stations in operation.^[18]

As of 2018, approximately 18,000 fuel cell electric vehicles (FCEV) were produced in Korea (domestic demand: 9,000 vehicles), which means that more hydrogen recharging stations are required across the country. In response to the rising demand for FCEVs, the Korean government established plans to increase the number of hydrogen recharging stations to 310 by 2022.^[19]

Europe

As of June 2020, there are more than 177 stations in Europe and 43 under construction.^{[20][21][22]}

Germany

As of June 2020, there are 84 publicly available hydrogen fuel stations in operation and 21 under construction.^[20]

France

As of June 2020, there are 5 publicly available hydrogen fuel stations in operation and 2 under construction.^[20]

Iceland

As of June 2020, there are 3 publicly available hydrogen fuel stations in operation.^[20]

Italy

As of June 2020, there is one publicly available hydrogen fuel stations in operation.^[20]

Netherlands

As of June 2020, there are 4 publicly available hydrogen fuel stations in operation and 3 under construction.^[20]

Denmark

As of June 2020, there are 6 publicly available hydrogen fuel stations in operation and 1 under construction.^[20]

Belgium

As of June 2020, there are 2 publicly available hydrogen fuel stations in operation.^[20]

Norway

As of June 2020, there are 6 publicly available hydrogen fuel stations in operation and 4 under construction.^[20]

Sweden

As of June 2020, there are 4 publicly available hydrogen fuel stations in operation.^[20]

Switzerland

As of June 2020, there are 3 publicly available hydrogen fuel stations in operation and 4 under construction.^[20]

United Kingdom

As of June 2020, there are 11 publicly available hydrogen fuel stations in operation and 1 under construction.^[20]

In 2011 the first public hydrogen station opened in Swindon.^[23] In 2014 HyTec opened the London Hatton Cross station.^[24] On March 11, 2015, the London Hydrogen Network Expansion project opened the first supermarket-located hydrogen refuelling station at Sainsbury's in Hendon.^[25] Aberdeen opened its first hydrogen station in 2015, in Kittybrewster, for buses and council vehicles. In 2018 this station opened to the public, and in 2017 a second station was opened in the suburb of Cove Bay. Hydrogen stations in Bedfordshire and Stratford were scheduled to open to the public before 2016.^[26] The HyFive project had 3 stations planned for London by 2015.^[27] On October 9, 2014, the British government announced funding of £11 million to have 15 public hydrogen refuelling stations built at the end of 2015.^[28] In September 2015, Shell and ITM Power announced a strategic siting partnership for the placement of an initial three ITM hydrogen refuelers on Shell forecourts in London and the South East of the UK.^[29]

North America

Canada

In 2018, Shell Canada launched an initiative to build hydrogen fueling stations starting with the first in Vancouver. They planned on building at least two more within the city.^[30]

United States

As of August 2020, there were 44 publicly accessible hydrogen refueling stations in the US, 42 of which were located in California.^[31]

- Arizona: A prototype hydrogen fuelling station was built in compliance with all of the prevailing safety, environmental and building codes in Phoenix to demonstrate that such fuelling stations could be built in urban areas.^{[32][33]} As of August 2020, no publicly accessible stations were in operation in Arizona.^[31]
- California: As of August 2020, there were 42 stations.^[31] Hydrogen station development was encouraged and subsidized by the California Fuel Cell Partnership, and under Governor Arnold Schwarzenegger's California Hydrogen Highway program.^{[34][35]} In 2013, Governor Brown signed AB 8, a bill to fund up to 100 hydrogen stations.^[36]
- Connecticut. As of August 2020, one publicly accessible station was in operation in Connecticut.^[31]
- Hawaii opened its first hydrogen station at Hickam in 2009.^{[37][38]} In 2012, the Aloha Motor Company opened a hydrogen station in Honolulu.^[39] As of August 2020, however, only one publicly accessible station was in operation in Hawaii.^[31]
- Massachusetts: The French company Air Liquide completed construction of a new hydrogen fuelling station in Mansfield, Massachusetts in October 2018, one of four stations they built

as part of an expansion of the hydrogen fuelling infrastructure in the Northeastern U.S.^[40] The only other hydrogen fuelling station in Massachusetts is located at the Billerica, Massachusetts headquarters of fuel cell manufacturer Nuvera.^[41] As of August 2020, no publicly accessible stations were in operation in Massachusetts.^[31]

- Michigan: In 2000, the Ford Motor Company and Air Products & Chemicals opened the first hydrogen station in North America in Dearborn, MI.^[42] As of August 2020, no publicly accessible stations were in operation in Michigan.^[31]
- Missouri's only hydrogen filling station is located at the Missouri University of Science and Technology campus.^[43] As of August 2020, no publicly accessible stations were in operation in Missouri.^[31]
- Ohio: A hydrogen filling station opened in 2007 on the campus of The Ohio State University at the Center for Automotive Research. This station is the only one in Ohio.^[44] As of August 2020, no publicly accessible stations were in operation in Ohio.^[31]
- Vermont: A hydrogen station was built in 2004 in Vermont in Burlington, VT. The project was partially funded through the United States Department of Energy's Hydrogen Program.^[45] As of August 2020, no publicly accessible stations were in operation in Vermont.^[31]

Delivery methods

Hydrogen recharging stations can be divided into off-site stations and on-site stations depending on how they supply hydrogen to vehicles (whether they produce their own hydrogen or not). Hydrogen recharging stations that have been built across Korea at the moment are mostly off-site (tube trailer-type) stations.

Sort	Method
Off-site hydrogen recharging station (Hydrogen supplied from an external source)	Hydrogen supplied from an external source Hydrogen produced from a plant is supplied via pipelines, tube trailers, etc.
On-site hydrogen recharging station (Hydrogen produced directly at the station)	Hydrogen produced by extracting (reforming) natural gas, electrolysis, etc. at the recharging station

Types of recharging stations

Hydrogen highway

A hydrogen highway is a chain of hydrogen-equipped filling stations and other infrastructure along a road or highway. Italy and Germany are collaborating to build a hydrogen highway between Mantua in northern Italy and Munich in southern Germany.

Hydrogen home stations

Hydrogen home stations come in different types.

- A solar powered water electrolysing hydrogen home station is made of solar cells, power converter, water purifier, electrolyzer, piping, hydrogen purifier,^[46] oxygen purifier, compressor,^[47] pressure vessels^[48] and a hydrogen outlet.^[49]
- A more complete home station would combine the solar home system on the inlet with natural gas and a Steam reformer,^[50] and convert the storage tank to a fuel cell microCHP system to produce heat and electricity for the house. (The excess electricity would go back to the grid to become part of a distributed generation resource.)
- Integrated systems that convert solar energy photo electrochemically are more efficient than splitting water.^[51]

Daily recharging capacity

Currently, the hydrogen recharging stations built by Hyundai Motor Group can recharge up to 70 Hyundai Nexo^[52] vehicles per day, assuming that the station is open for 14 hours daily.^[53] However, hydrogen recharging stations without high-pressure (900bar) storage tanks may require some additional downtime to repressurize the hydrogen in its recharging system if they refuel too many vehicles in a day. In the future, hydrogen recharging stations moving forward will feature more robust equipment (minimum 1,200 kg/day for a 24-hour business day) to make sure they can serve a greater number of FCEVs.

Disadvantages

Pollution

As of 2019, 98% of hydrogen is produced by steam methane reforming, which emits carbon dioxide.^[54] The bulk of hydrogen is also transported to fueling stations in trucks, so pollution is also emitted in its transportation.^[55]

Volatility

Hydrogen fuel is hazardous because of its low ignition energy, high combustion energy, and because it easily leaks from tanks.^[56] Explosions at hydrogen filling stations have been reported.^[57]

Supply

Hydrogen fuelling stations generally receive deliveries by truck from hydrogen suppliers. An interruption at a hydrogen supply facility can shut down multiple hydrogen fuelling stations due to an interruption of the supply of hydrogen.^[58]

Costs

Since the turn of the millennium, filling stations offering hydrogen have been opening worldwide. However, they are far from replacing the existing extensive gasoline fuel station infrastructure, which in the US alone numbered 168,000 gas stations, in 2004,^[59] which generated revenues of US\$536 billion in 2014.^[60] According to Joe Romm in his book *The Hype About Hydrogen* (2004), replacing these would cost a half trillion U.S. dollars.^[61] According to NREL, a hydrogen fueling station costs between \$1 million and \$4 million to build.^[62]

According to hydrogen industry group h2euro.org, the cost of the necessary European-wide hydrogen fueling infrastructure could be five times lower than the cost of the charging network required for battery and plug-in hybrid vehicles.^[63] When viewed as cost per station, EV stations are cheaper than the \$3 million per hydrogen station.^[64] However, the reason that hydrogen infrastructure could be less expensive than electric, even though the individual station cost is higher, is quicker vehicle fueling and longer refueling intervals, thus needing far fewer hydrogen stations per million fuel cell cars than charging stations per million battery electric cars.^[65]

See also

- [Cascade storage system](#)
- [HCNG dispenser](#)
- [Hydrogen vehicle](#)
- [Hydrogen production](#)
- [Hydrogen storage](#)
- [Hydrogen reformer](#)
- [Hydrogen piping](#)
- [Hydrogen leak testing](#)
- [Hydrogen sensor](#)
- [Autonomous building](#)
- [Microgeneration](#)
- [Virtual power plant](#)

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External links

- [H2Map.com](http://www.h2map.com) (<http://www.h2map.com>) Map of hydrogen refueling stations in the UK
- [H2stations.org](http://www.h2stations.org) (<http://www.h2stations.org>) Map of hydrogen refueling stations worldwide (GIS)
- [California Fuel Cell Partnership Map](https://cafcp.org/stationmap) (<https://cafcp.org/stationmap>) Map of hydrogen fueling stations in California, with real-time status reports
- [EUhyfis](http://www.euhyfis.com/) (<http://www.euhyfis.com/>)
- [ISO-TC 197](http://www.iso.org/iso/standards_development/technical_committees/list_of_iso_technical_committees/iso_technical_committee.htm?commid=54560) (http://www.iso.org/iso/standards_development/technical_committees/list_of_iso_technical_committees/iso_technical_committee.htm?commid=54560)

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