



Market Intel

Pathways for clean vehicles and fuels, advanced technologies, mobility and autonomous rides, and multi-modal transportation



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Let's look at the manufacturers and their vehicles

Here's a comprehensive list of car and truck makers that have announced or rolled out fuel cell vehicles to retail buyers, fleet, commercial, and transportation clients, and to government agencies.

BMW

As previously presented, BMW has series production started for hydrogen-powered cars. That will start with a small series of BMW hydrogen cars is expected to roll out before the end of 2022. The BMW X sport utility model will also be coming out in a hydrogen-powered version. That may happen through the alliance BMW has had with Toyota since 2013 to jointly build a fuel cell vehicle. In August, BMW sales chief told *Nikkei* that the company will start mass producing and marketing a FCV by 2025. He didn't reveal any more details but it could be tied to the iX5 concept SUV revealed last year by BMW at the International Motor Show Germany in September. ¹

Bosch

German parts and electronics supplier Bosch is investing \$200 million in its auto parts factory in South Carolina to produce fuel cell stacks. The company thinks it will be well positioned for the zero-emission trucks to be powered by hydrogen. Bosch said it will be adding about 350 employees there, and expects the production to be up and running by 2026. Electric truckmaker Nikola would be one of the clients, Peter Tadros, Bosch's North American head of powertrain solutions for that arm of the company. ²

Capacity Trucks

This small company based in Longview, Texas, is a subsidiary of REV Group, Inc. It has built what it calls as the first North American hydrogen fuel cell electric hybrid terminal truck. The company already has two hydrogen fuel cell trucks in operation at the Port of Long Beach, Calif., that came from a 2019 grant. These hydrogen hybrids can provide power backup when the electric battery needs recharging; the terminal truck is designed for operation in intermodal, port, and warehouse applications. The company had produced a battery electric vehicle

Daimler Truck

Since last year, a Mercedes-Benz GenH2 Truck fuel-cell prototype has been going through intensive testing in Germany – both on the in-house test track and on public roads. Daimler Truck is now putting another prototype into operation to test the use of liquid hydrogen. The refueling process has been set up by French industrial gases company Air Liquide – with two 40 kg tanks filled with cryogenic liquid hydrogen at minus 253 degrees Celsius. As mentioned, Daimler's Freightliner is working with Cummins on fuel-cell trucks that are scheduled to hit the market next year. This has

¹ BMW fuel cell SUV to enter mass production as soon as 2025: executive, *Nikkei*, Aug. 12, 2022

² Bosch Is Investing \$200 Million To Make Fuel Cells For Hydrogen Trucks In South Carolina, *Forbes*, Aug. 31, 2022

come to be as fuel cells are increasingly seen as a viable — although expensive — nonpolluting solution for long-haul trucking.

Gaussin Group

Gaussin Group is a technology company based in France that designs, assembles and offers zero-emission, smart and connected vehicles for freight transportation and people



mobility to enable off-road and on-road applications. It has three offerings – starting off with its Hydrogen-Powered Racing Truck (see photo) that delivered the world’s first hydrogen racing truck for the 2022 Dakar Rally in January. The second one, an APM 75T Electric or Hydrogen Terminal Tractor is an electric terminal tractor dedicated to container terminals and heavy-duty industrial applications.

Third, the Hydrogen Electric ATM 38T Yard

Hostler is a fully autonomous yard tractor for distribution centers, logistic hubs, container depots, and industrial applications.

General Motors

Just like its launch of the EV1, General Motors has been testing out alternative fuels and technologies for several years,. In 2007, the automaker launched Project Driveway, the first large-scale consumer test for hydrogen fuel cell cars with real drivers operating the vehicle under real world conditions. GM had intended to use that data to launch fuel cell vehicles off its production line by 2015. But like the EV1, GM didn’t stay committed to the new technology. GM has been broadening its view of where it’s technology may end up. Earlier this year, the Detroit automaker announced that it would be supplying hydrogen-powered generators that will be used at construction sites, music festivals, data centers, and by the military. GM expects there will be other clients in this space – outside passenger cars.

Hino Trucks

Nearly two years ago, Hino Trucks announced that it was building a Class 8 hydrogen fuel cell electric truck. The company made good on this promise with the reveal of its first Class 8 Hino XL8 prototype powered by a hydrogen fuel cell electric drivetrain, at the 2021 ACT Expo in Long Beach, Calif. But that may be put on hold for now after a series of scandals came out this year in Japan for the Toyota subsidiary. Shipments of its trucks have been suspended due to possible falsification of engine data including those concerning its vehicles’ emissions and fuel efficiency.

Honda

This Japanese automaker at first took an early lead in new market with its Clarity fuel cell sedan that was available in limited numbers. But that model ended production in August 2021, along with its plug-in hybrid edition. But the company has continued developing fuel cell vehicles and exploring the potential of hydrogen stations that

efficiently generate hydrogen from renewable energy – which would be a big plus in gaining support for the vehicles and the fuel. Another achievement, Honda has produced a Smart Hydrogen Station (SHS) which comes pre-packaged and ready, and enables local energy generation. The portable external power output device can be used by households and public facilities; and can “get connected” for emergency use during disaster situations. They started being installed in Japan about five years ago, but no word yet on if and when they’ll come to the U.S. The company did announce its plan to install a stationary fuel cell power station at its U.S. corporate campus office in Torrance, Calif., earlier this year. Honda’s CEO Toshihiro Mibe has made comments in recent years that pure EVs might be a better path for his company, and that its testing has found hydrogen was not necessarily feasible for use in cars.

Hyundai

Hyundai has been committed to hydrogen fuel cell vehicles, but the technology and refueling is still in a fairly early state. The company has manufactured and sold about 1,500 of its Nexo SUVs primarily in California. Perhaps the Korean manufacturer will be



more like its Japanese competitor, Toyota, striving to make its presence known in the hydrogen commercial truck segment. In 2020, the automaker shipped the first units of its XCIENT heavy-duty truck over to Switzerland – with about 1,600 of these trucks rolled out by 2025. In late October 2022, the company announced that it shipped 47 units of the hydrogen-powered, zero-emission commercial trucks to

23 Swiss companies, which are using them for logistics, distribution and supermarket fulfillment. It’s been proud to label it as the world’s first mass-produced heavy-duty fuel cell truck. Powered by 190-kW hydrogen fuel cell system, XCIENT Fuel Cell can travel approximately 400 km (about 248.5 miles) on a single charge, the company said.

Hyzon Motors

Hyzon is rather unique – a small startup devoted to hydrogen fuel cell-powered commercial trucks with four of them rolled out since its founding in 2020. Based in Rochester, N.Y., the company began being publicly traded in mid-2021, and now has presence in North America, Europe, Asia, and Australia. The company has joined the Hydrogen Europe network, and has committed to rolling out 1,000 hydrogen trucks and setting up 25 refueling stations in that region by 2025.

As for Hyzon’s four-vehicle lineup:

Hyzon Class 8

350-500 mile range

429 hp continuous

Sold in North America, Australia

Hyzon Hymax Series

400-680 kilometer range (about 258.5 to 422.5 miles)

Multiple configurations available

Sold in Europe, Australia, Asia

Hyzon High-Floor Coach

200-250 mile range

261 hp continuous

Sold in North America, Europe, Australia, Asia

Hyzon Refuse

125 mile range

435 hp continuous

Sold in North America, Europe, Australia

Kenworth

Last year in April, the commercial truckmaker showed off the Kenworth T680 day cab fuel cell electric vehicle at a Dept. of Energy press conference on Capitol Hill in Washington, D.C. Energy Secretary Jennifer Granholm announced \$60 million in funding for 24 research and development projects, including projects related to battery and electrification technologies and the transportation industry aimed at driving down emissions. In September of this year, Kenworth and Toyota announced that they're jointly designing a heavy-duty, Class 8 fuel cell electric vehicle that can replace their diesel-powered trucks. It's part of the Zero- and Near-Zero Emissions Freight Facilities (ZANZEFF) "Shore to Store" project at the Port of Los Angeles, the Los Angeles basin, and the Inland Empire. Kenworth designed and built the Class 8 T680 FCEVs, while Toyota designed and built the powertrain's fuel cell electric power system powered by hydrogen. The T680 FCEV has a range of about 300+ miles when fully loaded to 82,000 lbs. (GCWR), and with no downtime between shifts for charging and the short 15- to 20-minute fill time, the FCEVs could run multiple shifts a day and cover up to 400 to 500 miles.

Nikola

Nikola Motor has run the gamut as a pioneer in bringing fuel cell and battery electric trucks to trucking companies -- to a company spiraling downward for not delivering on its ambitious production commitments, and for having its founder indicted. That man, Trevor Milton, was found guilty of one count of securities fraud and two counts of wire fraud by a Manhattan federal district court jury in October, followed by a \$100 million bond until sentencing in January.

There's been a bright spot in the haze, with European truckmaker Iveco forging a partnership with a new management team at Nikola. The startup was able to begin

production of the battery-electric Nikola Tre at its new plant in Coolidge, Ariz., in March. That was followed in September with the two truck manufacturers announced at the IAA Transportation commercial vehicle show in Hanover, Germany. They were able to formally launch the Nikola Tre battery-electric vehicle and unveiled the beta version of the European Nikola Tre fuel cell electric vehicle.

In the second quarter, the company built 50 of the Tre BEV units and then delivered 48 of them to its dealers. The goal is to increase the production rate by the end of the year. The company says its sticking to its target of producing 300 to 500 units of the Tre BEV by the end of 2022. The company is also in the process of expanding its plant and should be completed by the first quarter of 2023. The fuel cell truck is scheduled to enter its production phase by the end of 2023.

Toyota

Toyota's Mirai fuel cell car has taken the lead in hydrogen fuel cell electric vehicles in the world, last year beating the Hyundai Nexo as the top selling fuel cell model. While it has led the way, it's a telling sign of the limited reach of fuel cell vehicles around the world. At end of last year, global sales totaled 17,940 units for the Mirai; the top-selling markets were the U.S. with 9,274 units, Japan with 6,618, and the rest of the world with 2,048, Toyota reports. Much of that has been in California with its refueling stations, incentives, and public interest in new technologies and sustainability.

Trucks are becoming potentially even more important for Toyota on the hydrogen-fueled vehicle side of the business. The push for zero emission vehicles in California and other markets has helped the Japanese automaker conduct more research and transition over the hydrogen-powered vehicles through alliances with other vehicle makers and government agencies. These agreements include:

- As mentioned earlier under the Kenworth Truck Co. profile, Toyota and Kenworth in 2021 announced the completion of their operations in the Zero- and Near-Zero Emissions Freight Facilities (ZANZEFF) "Shore to Store" project at the Port of Los Angeles, the Los Angeles basin, and the Inland Empire.
- Toyota Motor Europe, CaetanoBus, and [Air Liquide](#) in May of this year signed an agreement related to the development of hydrogen-based transport options. The Japanese automaker said it would create "closer cooperation in developing opportunities for hydrogen mobility projects in several European countries." CaetanoBus is based in Portugal and part of Toyota Caetano Portugal and Mitsui & Co.
- Toyota had a similar deal set up in late 2020 with Kenworth that was similar to the the announcement made last year at the Ports of Los Angeles and Long Beach. Toyota Logistics Services and Southern Counties Express each received a Kenworth T680 Class 8 truck powered by a Toyota fuel cell electric drivetrain. Both of these zero-emissions trucks are being used for drayage operations in the two ports.

Volkswagen

The German automaker is working on a new fuel cell that is much cheaper than the current ones and promises hydrogen cars that can travel 2,000 kilometers (about 1,243 miles) on a single tank. While CEO Herbert Diess has said the company will not be entering the fuel cell vehicle space, there's something at stake here. Volkswagen put in a patent application with the German company Kraftwerk Tubes.

Sascha Kühn, Kraftwerk CEO said in an interview with Business Insider Germany that they'll be using a ceramic membrane instead of the usual plastic one. Kühn said: "The big advantage of our solution is that it can be produced much cheaper than polymer fuel cells and it does not require any type of platinum," a precious metal that makes the product more expensive. Kühn compared the technology to solid-state batteries with vast energy storage capacity. Both have almost the same electrolytes and a similar material structure. The difference is that, while solid-state batteries use a compact material to store energy, in fuel cells that role is assumed by hydrogen in gas form, Kühn said.

Westport Fuel Systems



Westport is an established engine manufacturer in commercial vehicles, usually of the alternative fuel variety. The company has most recently entered the hydrogen vehicle sector with a new fueling system. The company displayed its H2 HPDI fuel system-equipped demonstrator truck at IAA Transportation 2022 in Hanover, Germany, in September 2022. The H2 HPDI is designed for use in internal combustion engines. The system, when fueled with hydrogen, offers more power and torque than diesel while dramatically reducing emissions.

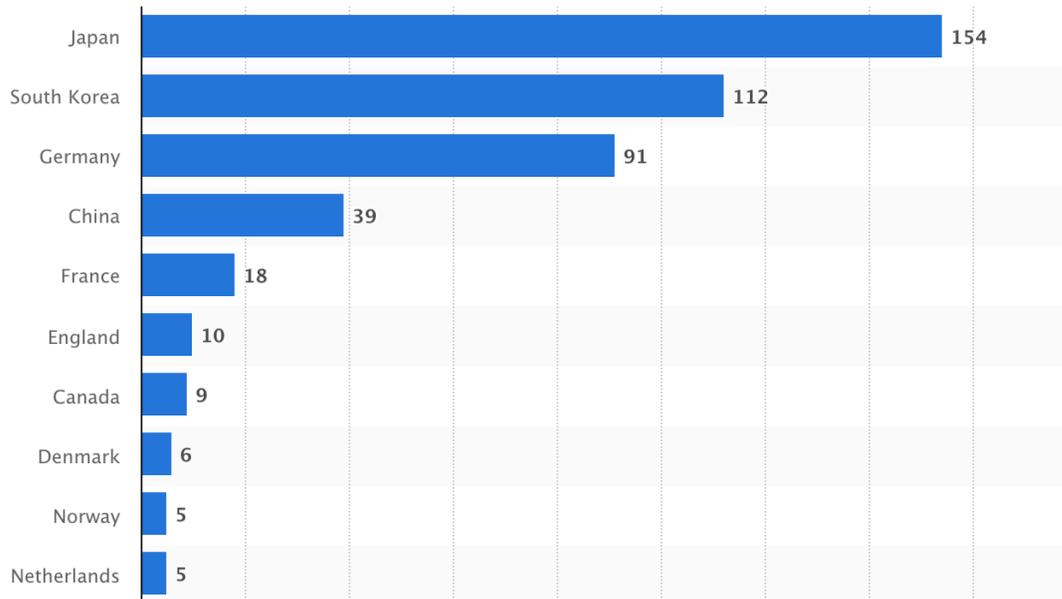
The system was made for heavy-duty vehicles that is expected to substantially reduce CO2 emissions and deliver greater energy efficiencies while allowing continuity

with existing engines and manufacturing assets. It offers up to 20% more power, 15% more torque, and 10% higher efficiency than diesel. |

Hydrogen stations in California — and everywhere else

Hydrogen Stations in: California: 56
Hawaii: 1
Total: 57

Number of hydrogen fueling stations for road vehicles worldwide as of 2021, by country (Top 10 excluding the U.S.)



Source: Statista

The fueling infrastructure for hydrogen stations is still thin around the world. Japan, South Korea, and Germany are in the top spots. Japan and South Korea have seen their governments expand support for the fuel and technology substantially in recent years. The U.S. and China have made commitments to be farther along by this point; but it's still in its beginning phases in the world overall and the U.S. and China have committed far more resources to plug-in electric vehicles and the needed charging infrastructure.

Finding a good, reliable, and clean source of hydrogen for fuel cell vehicles has been one of the challenges to overcome. That's still an expensive, complex process that has made it to a new level in the recent past in terms of finding "green hydrogen" – hydrogen extracted through clean energy such as renewables. Green hydrogen is produced using renewable electricity to power an electrolyzer that splits water into hydrogen and oxygen. The gas is then burned to produce power and emits only water

vapor and warm air. This contrasts with “grey hydrogen” production, which is powered by natural gas.

Let’s look at where it all stands

Hydrogen as a fuel and fuel cell technologies are gaining more interest and support, but not necessarily for hydrogen fuel cell electric vehicles. An example of this came from Amazon in 2022. A deal was made with Plug Power to supply 10,950 tons per year of green hydrogen for its transportation (fork lifts) and building operations starting in 2025. Green hydrogen is expected to replace grey hydrogen, diesel, and other fossil fuels as it continues to make moves to decarbonize its operations. Grey hydrogen comes from natural gas, or methane, using steam methane reformation but without capturing the greenhouse gases made in the process, according to National Grid. Green hydrogen is produced by splitting water into hydrogen and oxygen using renewable electricity.

Here are a few of the common issues/questions that come up.....

Safety: Hydrogen fuel cell vehicles are usually considered as safe as any other car; since the high-pressure tanks are designed to survive even the highest-speed crashes without leaking or breaching. While hydrogen skeptics routinely cite the Hindenburg explosion of 1937, the hydrogen tanks and their hardware would likely survive even if the rest of the car were destroyed in a crash. No injuries or deaths specific to the hydrogen components have been recorded in the relatively small number of HFCVs sold to date.

Advantages of fuel cell vehicles: They’re similar to drive as battery electric vehicles — quiet and smooth to drive — and they emit no carbon dioxide or other harmful exhaust, just water vapor. They also lack the charging time problem that EVs have; it takes just five minutes or so to refill them for another 300- to 400-mile trip.

And disadvantages: Hydrogen stations are all in California, except for one in Hawaii. And while there were supposed to be 100 them in place by now in California, there are just 60. An even bigger challenge is that you can’t always refuel at the 60 stations. Hydrogen Fuel Cell Partnership offers a Station Status report in its website. That will tell you how many of the pumps are available for refueling.

When it comes to competition, electric vehicles still have HFCVs beat. Their product selection, pricing, reliability, access to charging, charging speed, and the experience of long-term owners and drivers, has HFCVs soundly beat for now.

Pricing

- The 2022 Toyota Mirai's price range starts at \$49,500
- The 2022 Hyundai Nexu price range starts at \$59,435

Buyers in California have been able to get an \$8,000 federal tax credit and \$4,500 state rebate, bringing the purchase price way down. Of course, rebates will vary by state, but California has been the only state so far with a hydrogen refueling network.

Car shoppers should also keep in mind that Toyota and Hyundai could offer manufacturer incentives on purchasing these cars — which have been known to shave off about \$20,000 from the MSRP.

What will it take to see growth?

To support deployment, the fueling infrastructure must continue to grow and the hydrogen fuel supply chain needs to mature and expand to ensure reliable, safe, and environmentally clean hydrogen production and delivery to hydrogen fueling stations. Green hydrogen is getting a lot of play this year from supporters of sustainability, and a lot of it is ending up in commercial applications.

Other continued developments across the FCEV and hydrogen fueling industry are also necessary for FCEVs to become a larger part of California's ZEV market. High initial costs for FCEVs and hydrogen fuel must decrease over time to make the vehicles a viable and affordable option for a wider consumer base. Fleets and trucking companies can tap into a lot of incentives in California to convert over to H2VVs for their heavy-duty trucks, but a lot will need to be cleared out before that growth becomes steady.

Development of codes, standards, streamlined permitting, and other policies require continual attention, improvement, and updating to promote growth of the hydrogen fueling market while protecting consumers and providing industry with predictable guidelines to participate in the market. That comes down to how the fuel gets there — pipelines or fuel trucks, the dispensers that give out the hydrogen, and the vehicles being manufactured that must comply with federal safety standards.

But there certainly are a few bright spots:

- **The industry has its own publication** now in the [H2 Bulletin](#), which was launched in 2020 aiming to provide the premium intelligence service for hydrogen professionals and timely news and information for the hydrogen and global clean energy markets.
- **Conferences have broken through the Covid-19 moratorium** with the World Hydrogen Conference coming up Oct. 11-13, 2022, at the World Trade Center in Rotterdam. The second Hydrogen Americas Summit is taking place Oct. 10-11, 2022, in Washington, D.C. It's co-sponsored by the U.S. Dept. of Energy and the Sustainable Energy Council.
- **Industry groups are thriving** with the former California Fuel Cell Partnership now becoming the [Hydrogen Fuel Cell Partnership](#). The [Fuel Cell and Hydrogen Energy Association](#) continues to produce industry events and reports for the American industry — and is also active with major companies from Europe and other regions.