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Hydrogen: Fuel cell or ICE solution?

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The race to net zero has been on for some time. Electric vehicles (EVs) were seen as the answer, with OEMs racing to develop hybrid and full electric vehicles to meet emissions targets. OEMs proudly unveiled new electric vehicle models, and sales of EVs began to rise. Hydrogen was also being explored as a potential solution, both in fuel cell operation and in combustion engines.

Then EVs started getting some negative press, with anxiety over range and available charging options, lower residual values for EVs[1], and higher insurance costs driven by higher write-off rates[2]. By September 2024, ACEA confirmed that the electric car market was on a continual downward trajectory and called on EU institutions to "come forward with urgent relief measures"[3] to promote sales of EVs in order to meet manufacturer CO_2 emission targets, which come into effect in 2025.

Meanwhile, hydrogen was making waves, particularly in the heavy-duty sector. In 2023, engineers at JCB Power Systems in the UK unveiled a hydrogen combustion engine[4], developed by using and adapting established engine technology with readily available components. Their prototype backhoe loader, fitted with the new hydrogen motor, could do everything its diesel-powered equivalent could do. The company described hydrogen as a "better way", saying, "On a practical level, a hydrogen motor uses similar technology to existing propulsion systems. It's also robust, cost-effective and it could be integrated into all forms of powertrain. Most importantly, a familiar technology and lack of complexity make hydrogen an ideal zero-carbon solution for our customers, with demand being met by our existing, high quality manufacturing supply chain."

JCB installed one of its super-efficient hydrogen engines into a 7.5 tonne Mercedes-Benz Sprinter van to demonstrate the potential of hydrogen ICE vehicles. The white van retrofit was completed in just two weeks.

How do hydrogen vehicles actually work?

There are two main types of hydrogen-propelled vehicles: a hydrogen fuel cell and a hydrogen-fuelled vehicle, and they both work in different ways.

A hydrogen-fuelled vehicle replaces conventional road fuel with compressed hydrogen gas or liquid gas. In these vehicles, the pressurised gas or liquid is injected directly into an engine's pistons, and combustion takes place like a normal internal combustion engine (ICE) vehicle. The primary emission from hydrogen combustion is water, a property that makes it an environmentally attractive fuel.

Most modern ICEs wouldn't require much modification to run on hydrogen gas or liquid, but

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1 https://autovista24.autovistagroup.com/news/mmu-bev-residual-values-suffer-across-europe-in-april/

2 https://www.reuters.com/business/autos-transportation/scratched-ev-battery-your-insurer-may-have-junk-whole-car-2023-03-20/

3 https://www.acea.auto/press-release/european-auto-industry-calls-for-urgent-action-as-demand-for-evs-declines/

4 https://www.jcb.com/en-gb/campaigns/hydrogen durability has not been proven in these systems, and appropriate lubricants are needed. These need to be formulated to minimise the potential for pre-ignition events, as well as manage increased levels of water in the crankcase to prevent corrosion, sludge formation and reduce wear.

Specific engine management and filters can remove airborne contaminants such as NOX and SOX present due to the air intake for combustion to unmeasurable levels of emissions. The hydrogen gas is less dense than petrol or diesel, and the by-product of the combustion process is water vapour. Like conventional ICEs, hydrogen-fuelled vehicles still require specialist engine lubricants.

In a hydrogen fuel cell, instead of burning hydrogen gas, as is the case with hydrogen ICE-fuelled vehicles, the vehicle produces electricity through a chemical reaction between hydrogen from the storage tank and oxygen from the air in a fuel cell stack.

The stack powers the heart of the vehicle and generates electricity in the form of direct current (DC) from electrochemical reactions that take place in the fuel cell. Unlike a conventional battery, which stores electrical energy made elsewhere and releases it, hydrogen is an energy source in itself and releases some of its energy in an electrochemical reaction in the fuel cell. Electricity is then produced on demand.

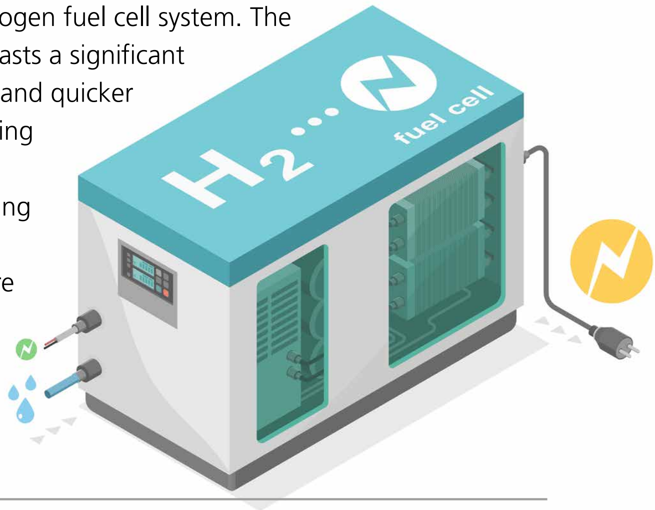
The main advantage for vehicle owners is that, unlike pure electric vehicles, refuelling a tank for a hydrogen fuel cell from a pump takes less than five minutes. In contrast to ICEs, hydrogen fuel cell vehicles require no engine lubricants, though specialist fluids are required for transmission, braking and cooling systems. Service stations could be converted to dispense hydrogen gas or liquid with extensive changes required, and refuelling will take as much time as conventional fuels.

Lubes'n'Greases recently reported that hydrogen ICE vehicles were "Out of the EV Race"[5]. The article pointed to a report issued by UK-based technology research company IDTechEx, which said that the physics of hydrogen make it unlikely that cars can use it as a very-low emissions combustion fuel. "for a passenger car to run on hydrogen combustion and achieve a range comparable to a petrol/diesel ICE, it would need an enormous storage vessel," according to IDTechEx.

So, is it the end of the road for hydrogen? Not so. The OEMs seem to be putting hydrogen fuel cells on the agenda. Back in November 2023, Hydrogen Fuel News reported, "Forget fuel cells, Toyota says hydrogen ICE is the best option for its off-road SUV", yet in September 2024, the same publication reported that BMW and Toyota had agreed a new partnership to create a brand-new fuel cell powertrain and launch "series production" hydrogen cars before the close of 2028[6].

Earlier this year, Hyundai outlined their approach to hydrogen in their "Hydrogen Vision 2040: A roadmap toward a hydrogen society", saying that hydrogen fuel cells are "pivotal in assessing the technological prowess of FCEVs". In June, the company hailed the progress of its XCIENT fuel cell electric heavy-duty trucks, which surpassed a cumulative driving distance of 10 million km in Swiss fleet usage, described as "a testament to the world-class hydrogen fuel cell technology's long-term reliability.[7]"

In June, Tesla CEO Elon Musk unveiled his hydrogen powered car, the Model H, which is expected to debut in 2026. The announcement came as a surprise to many, as Musk has openly criticised hydrogen as an emissions solution in the past. Tesla has successfully developed a hydrogen-powered vehicle, incorporating a hydrogen fuel cell system. The car boasts a significant range and quicker refuelling times, including a way to store



5 *https://www.lubesngreases.com/lubereport-americas/9_37/hydrogen-ices-out-of-the-ev-race/*

6 *https://www.hydrogenfuelnews.com/hydrogen-cars-bmw-and-toyota/8566842/*

7 *https://ecv.hyundai.com/global/en/newsroom/press-releases/hyundai-motors-xcient-fuel-cell-trucks-achieve-record-of-10-million-km-total-driving-distance-in-switzerland-BL00200524*

hydrogen at much higher densities, addressing the challenge of the space required to store hydrogen within the car.

Whilst vehicle supply chains are global, individual governments have a critical role to play in supporting the net zero transition. Whether electric or hydrogen, investing in charging or refuelling infrastructure and tax incentives will encourage drivers to make the switch rather than simply forcing OEMs to sell cars that motorists might not want to buy.

H_2 generation is attracting a lot of investment in different methods. Green hydrogen is a 'clean energy' made using electricity from renewable energy sources, such as solar or wind power, to electrolyse water. Green hydrogen currently only makes up a small percentage of overall hydrogen production, but increased investment will help reduce costs over time, just as energy from wind power has reduced in price.

In the meantime, many motorists will hang onto their current ICE vehicles for as long as possible, as shown by the already ageing vehicle parc. According to the latest ACEA Vehicles on European Roads 2024 report, passenger cars are now, on average, 12.3 years old in the European Union, vans 12.5 years, trucks 13.9 years and buses 12.5 years. The data shows a marked rise since 2018 when cars were, on average, 10.5 years old, vans 10.5 years old, and trucks and buses 11.7 years old.

For lubricant and specialist fluid manufacturers, this means committing to a more extensive and complex product range for the near future, catering to the needs of much older vehicles as well as the latest models and a variety of powertrains. Backwards compatibility will be a critical advantage in limiting sku counts by creating solutions for a wider range of vehicles.

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