

hydrogen fuel cells for cars – a better path to follow?



Thanks to Sir David Attenborough, and even more recently Greta Thunberg and the Extinction Rebellion protestors, at last there is widespread public awakening to climate change. It has been a long haul.¹ Time has been consumed by arguing whether humans have made it happen (i.e. there would be no change under way if it was not for humans); and/or whether humans are making a natural change go faster and more furiously. The fact is that it is happening.

As it is not an exciting thought to escape to another planet, only to find it already quarried and trashed by the same nations and corporations that have done those things to Earth, we need to get moving to protect the life support systems provided by our present bruised and chewed-up planet.

In working through the huge agenda of things we must do, consistently high on the list is the need to stop using oil-based fuels for vehicles. This will bring urgently needed improvement in air quality in densely trafficked areas, and save thousands of us from premature death and debilitating illnesses. It will also reduce our carbon footprint. No argument to be had about this.

While bunker-fuel-burning ships and jet-fuelled air travel is more harmful to us, political and tax-based resources are being committed primarily to encourage use of electricity to power cars, and now also lorries. There are steps along this path, technologically, and all credit to *Green Car Reports*,² which (in the writer's experience) is the best website to follow on this topic without being either too nerdy or Jeremy Clarkson about it. It classifies the hybrids which share the goal of reducing the amount of petrol and reducing emissions in this way:

- **Hybrid electric vehicle (HEV)** – a standard petrol engine with a high-voltage battery and an electric motor, both providing drive, separately or together. The Toyota Prius is the best known, and the model is now in its 22nd year.
- **Mild hybrid**, which have one electric motor and an engine generator – they cannot drive only on

electric power, even for a short distance. Honda 154 and GM were the pioneers here. Now virtually every maker will start to fit the latest generation of mild hybrids to at least some models. Manufacturers include Audi, BMW, Hyundai, Kia, Mercedes-Benz, and Volkswagen.

- **Full hybrid**, which may have two electric motors plus an engine. Manufacturers are Ford, General Motors, Honda, and Toyota/Lexus.

Full hybrids have these generic forms:

- **Battery electric vehicle (BEV)**, in which power is supplied by a battery pack with zero emissions. The first generation from 2011 to 2015 had ranges of 60-90 miles, except for the Tesla Model S, at more than 200 miles. Now, less expensive cars are available with a range in excess of 250 miles.
- **Plug-in hybrid electric vehicle (PHEV)**, in which battery packs are enlarged and can be plugged into a charging point. Manufacturers have been Ford, Honda, Toyota, and the Jaguar I-Pace. PHEVs have ranges of 12-97 miles on electric power only (further if more gently driven). Once battery packs are depleted, they revert to using their petrol engine, operating like regular HEVs. They may switch on their engine at any point if power demand is high.
- **Extended-range electric vehicle (EREV)**, which stays all-electric under every circumstance until the battery is depleted. Then its engine switches on to run a generator that provides energy to turn the wheels. The first generation was the Chevrolet Volt. Others since have been the 2012 Fisker Karma (now the 2017 Karma Revero), and the BMW i3 REX (range-extended).

Because of 'range anxiety', which is a major cause of resistance in the market,³ planning policy changes, tax incentives and other government initiatives aim to require charging points to be installed as widely as possible in town centres, at transport interchanges, and at places of work, leisure and other commercial attractions, motorway service areas, garage forecourts, and (via street lamps) in an increasing number of kerb-side parking spaces. Home-based charging has always been possible, of course, via long cables from an appropriate socket.



David Lock

Electric vehicle charging points in Stony Stratford Market Square – both parking spaces taken, but neither vehicle is plugged in, and one point (with red lights showing) is not working

But there is an uneasy feeling that this dash to electric charging infrastructure is unambitious technologically, and is a relatively short-life expensive lurch. Reminiscent, maybe, of the Rabbit infrastructure that spread nationwide in the early days of mobile phones (one had to stand near a sign to get a signal on a Rabbit phone – think Chas and Dave) and was soon obsolete.⁴ Similarly, Mercury phone boxes⁵ were omnipresent for a short time, soon to become obsolete. Perhaps the infrastructure of electric charging points and their trailing cables will become obsolete relatively quickly, too, because:

- Reserving scarce parking spaces (especially ones better placed than others) for the exclusive use of a particular minority who have use of a particular type of car is not fair. It is virtue-signalling parking, by virtue-signalling car drivers, and the spaces are a wasteful land use when empty (as they so frequently are). If one day the masses go electric, the privileged supply of parking will cease.
- Charging takes too long.⁶ It is OK for people who can leave a vehicle all day, but for busy people with multiple places to be and things to do, range anxiety bears down.
- The electricity from the grid has to be generated somewhere. While the contribution from renewable sources has grown faster than most people expected – in April 2018 the UK went for three consecutive days without using fossil fuels to make electricity⁷ – nuclear is included within the

definition of ‘renewable’, which sticks in the throat given the burdens of that technology.⁸ The point is that the supply of electricity to a low-emission vehicle is the supply of a commodity that is mostly not emissions free in its making.

- The distribution of the electricity from the point of generation to garage socket, lamp-post or charging point involves a huge consumption of resources in labour and materials.
- Charging points are ugly street clutter, and intrusively illuminated at night.

The dash to electricity is not the action of a government that claims to be open-minded on technology. For example, in 2018 the government directed £246 million to battery technology, but only £23 million into hydrogen and fuel cells,⁹ which appear to be on a more innovative and worthwhile path to follow.

Fuel cell technology is not to be confused with hydrogen internal combustion (i.e. simply using hydrogen instead of an oil-based fuel). It has been found that it is impractical to store enough hydrogen to achieve useful range through combustion, and there are noxious exhaust emissions.

Fuel cells¹⁰ were invented by Sir William Grove in 1839, and generate power by producing electrons directly, with no moving parts. As a result, they are very efficient and reliable. Moreover, they are almost silent and, other than electricity and heat, they

produce only water vapour. Maintenance is minimal. Each 'cell' works by passing hydrogen gas, and air, separately past an anode and cathode plate, respectively, which are sandwiched by an ion-conducting electrolyte, the flow of electrons through which creates the power. Sufficient power is achieved by having 'stacks' of cells to drive the vehicle.

The present disadvantages of fuel cell vehicles currently include high cost, range anxiety, and the need for hydrogen gas fuelling installations. Three manufacturers offering fuel cell vehicles in pioneering California have been Honda (the FCX Clarity), Hyundai, and Toyota. In January 2019 Hyundai delivered its first Nexo fuel cell vehicle with an officially rated range of 380 miles to a customer in Southern California.¹¹

Fuel cells are getting smaller and more energy-dense and are now roughly the size of cabin baggage – with the potential to become even smaller in next-generation form. As the number of electric and electrified vehicles builds, fuel cells might increasingly function as part of the electric vehicle ecosystem. The advantages of this technology are such that it will reduce the demand on national grid power generation, reduce or remove the need for power batteries (which are presently heavy, use some scarce materials, and are not always recycled), and make redundant the avalanche of electricity charging infrastructure that is arriving to clutter public and semi-public spaces right now. This technology deserves parity of UK investment, at the very least.

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Notes

- 1 A jargon-free primer on the UK's trajectory on this subject is still provided by *The Potential Effects of Climate Change in the United Kingdom* (UK Climate Change Impacts Review Group. HMSO, 1991); and it is worth following the succinct 1994 progress report *Climate Change: The UK Programme* (Cm2427. HM Government. HMSO, 1994), issued following commitments made at the UN's Earth Summit in Rio in 1992 and the UK's ratification of the UN Framework Convention on Climate Change in 1993. The 1994 report shows a narrowing of focus (and attempts to offload some obligations to the private sector) in that period, but there has been an avalanche of research reports and political commitments made (and broken) since then. More accessible may be *Rising to the Climate Crisis – A Guide for Local Authorities on Planning for Climate Change* (TCPA and RTPI. TCPA, Dec. 2018, Second Edition. www.tcpa.org.uk/planning-for-climate-change), and the TCPA's distinguished Vice-President,
- 2 See the *Green Car Reports* website, at www.greencarreports.com
- 3 See 'Range Anxiety' – Should I be anxious?. Webpage. Drive Green, Oct. 2018. <https://drive-green.co.uk/2018/10/09/range-anxiety-should-i-be-anxious/>
- 4 Wikipedia explains (for which, thanks) that Rabbit was a British location-specific (Telepoint) telephone service. It was backed by Hutchison, launched in 1992, and allowed subscribers to carry specially designed (CT2) home phone handsets and make outgoing calls whenever they were within 100 metres of a Rabbit transmitter. The service ceased 20 months later, in December 1993, with 2,000 subscribers at that time. The failure is mainly attributed to the fall in cost of analogue mobile phones from Cellnet and Vodafone, which also accepted incoming calls. Wall-mounted metal signs advertising the Rabbit base stations are antique curiosities in various locations
- 5 Wikipedia records (thanks again) that Mercury Communications was formed in 1981 as a consortium of Cable & Wireless, Barclays, and British Petroleum (BP) as an experiment in competition, primarily with British Telecom. It was first licensed in 1982; and became a full Operator in 1984, operating public pay-phones in the UK – notable for their three designs, by Fitch & Company, Machin Designs, and architects John Simpson & Partners, named but not illustrated by Patrick Wright in *Archives, Documentation, and Institutions of Social Memory: Essays from the Sawyer Seminars* (University of Michigan Press, 2007). This initiative proved not to be profitable and was sold in 1995. Some obsolete installations linger
- 6 See 'Green Car Glossary: vehicles, emissions, fuels, electric cars, powertrains energy (updated)'. *Green Car Reports*, Jul. 2017. www.greencarreports.com/news/1084971_green-car-glossary-vehicles-drivetrains-emissions-fuels-energy
- 7 A Vaughan: 'UK runs without coal power for three days in a row'. *The Guardian*, 4 Apr. 2018. www.theguardian.com/business/2018/apr/24/uk-power-generation-coal-free-gas-renewables-nuclear
- 8 See, for example, the six articles in the 'Nuclear's wastelands' series written by Andrew Blowers in the Aug. and Sept. 2017 and Jan., Mar., May/June and Sept. 2018 issues of *Town & Country Planning*
- 9 Via OLEV (the Office for Low Emission Vehicles) – see A English: 'Can a hydrogen fuel-cell car survive the 1,000-mile trial?'. *The Daily Telegraph*, 23 Feb. 2019. www.telegraph.co.uk/cars/features/can-hydrogen-fuel-cell-car-master-1000-mile-trial/
- 10 See the Fuel Cell Systems website, at www.fuelcellsystems.co.uk, from which this information is distilled, with thanks
- 11 B Halvorson: 'Hyundai sets lease terms for Nexo fuel-cell vehicle, makes first delivery'. *Green Car Reports*, 3 Jan. 2019. www.greencarreports.com/news/1120713_hyundai-sets-lease-terms-for-nexo-fuel-cell-vehicle-makes-first-delivery