Can The World Really Afford A Hydrogen Economy?

James Morris 06:00am EDT

Despite the much greater sales success of battery electric vehicles (BEV) over fuel cell electric vehicles (FCEVs), there's still a huge amount of interest in hydrogen as the green replacement for fossil fuels. The first hydrogen-powered train in the UK made its maiden voyage last week, and the EU is putting a lot of force behind the technology with its hydrogen strategy published in July. From the user's perspective, hydrogen seems like the obvious heir to oil-based internal combustion engines. You arrive at a pump, five minutes later you can have a full tank of fuel, and off you drive, in the same fashion as the last 100 years. But behind the scenes, there are major reasons why this is not such an eco-friendly future for personal transportation.

Is hydrogen really as eco-friendly for cars as has been suggested?

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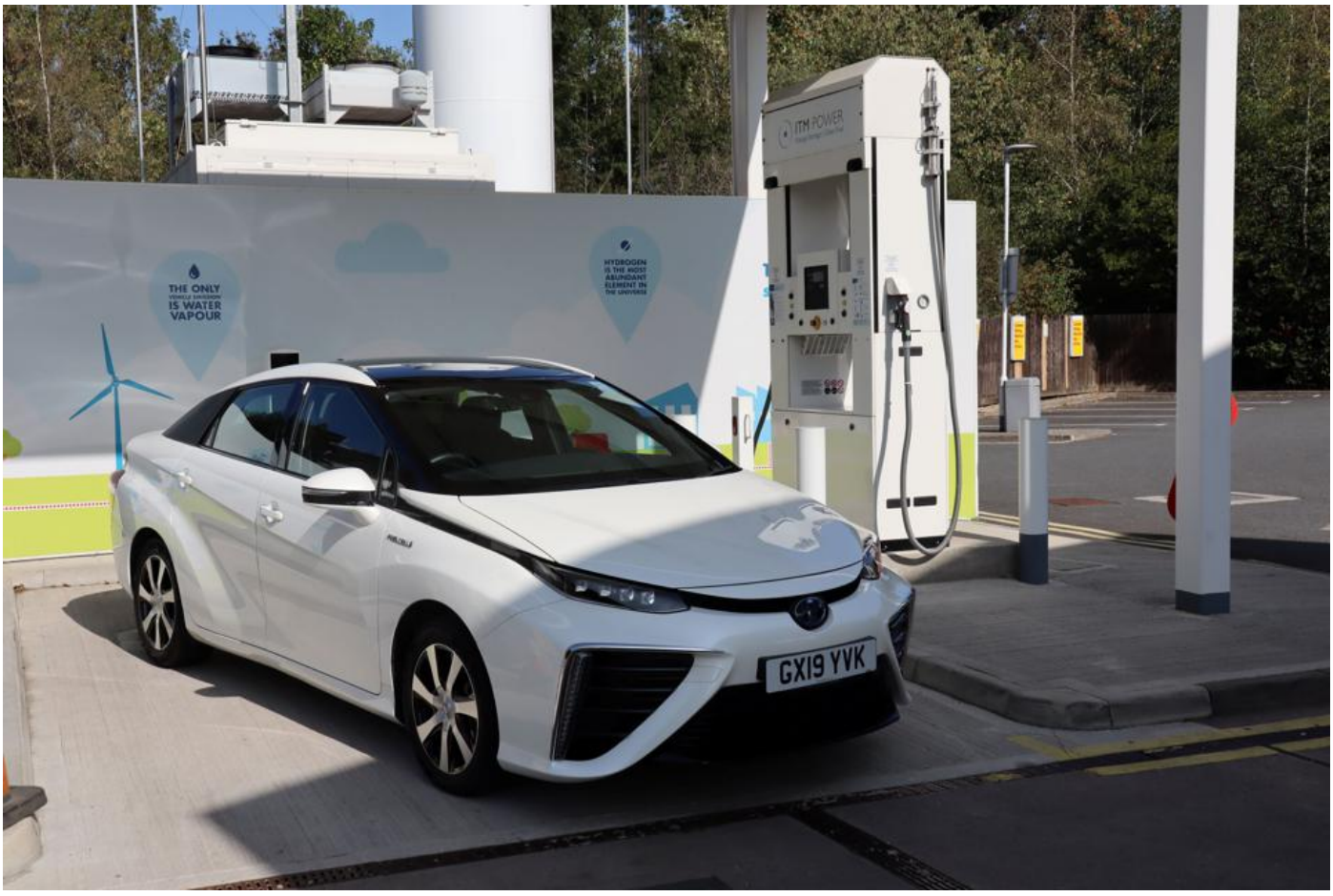
Having recently borrowed Toyota's Mirai, the world's first mass-produced FCEV, I can confirm there's nothing wrong with the hydrogen concept as a driving experience. The Mirai is supremely comfortable, although it makes an odd whine when accelerating and isn't very quick by EV standards. The new Mirai due in 2021, with rear-wheel-drive and 30% more range, looks like an even more promising proposition. Toyota has implied that it could be quite sporty and a potential competitor to the Tesla TSLA -0.9% Model S. Hyundai's Nexo FCEV, on show at the SMMT Drive Zero event, is similarly luxurious as the Mirai.

However, these are not viable cars for everyday users in most parts of the world right now. There are currently only 10 refuelling stops in the UK, mostly

around London, which means you would need to be quite lucky to live near one. There are 42 hydrogen stations in California, making this a more sensible location to own a FCEV, and California is also the region with the highest number of this vehicle type (8573 at the last count). However, there were 22,620 EV charging points in California a year ago, and in the UK in October 2020, 19,705 charging devices across 12,444 locations. In comparison, the number of hydrogen refueling locations in either London or California is insignificant. Also, whereas a BEV can recharge from a regular house plug in an emergency using a so-called "granny" charger, if you run out of hydrogen in your FCEV, good luck. You will be calling the tow truck.



Hydrogen refueling stations are scarce and the fuel expensive.

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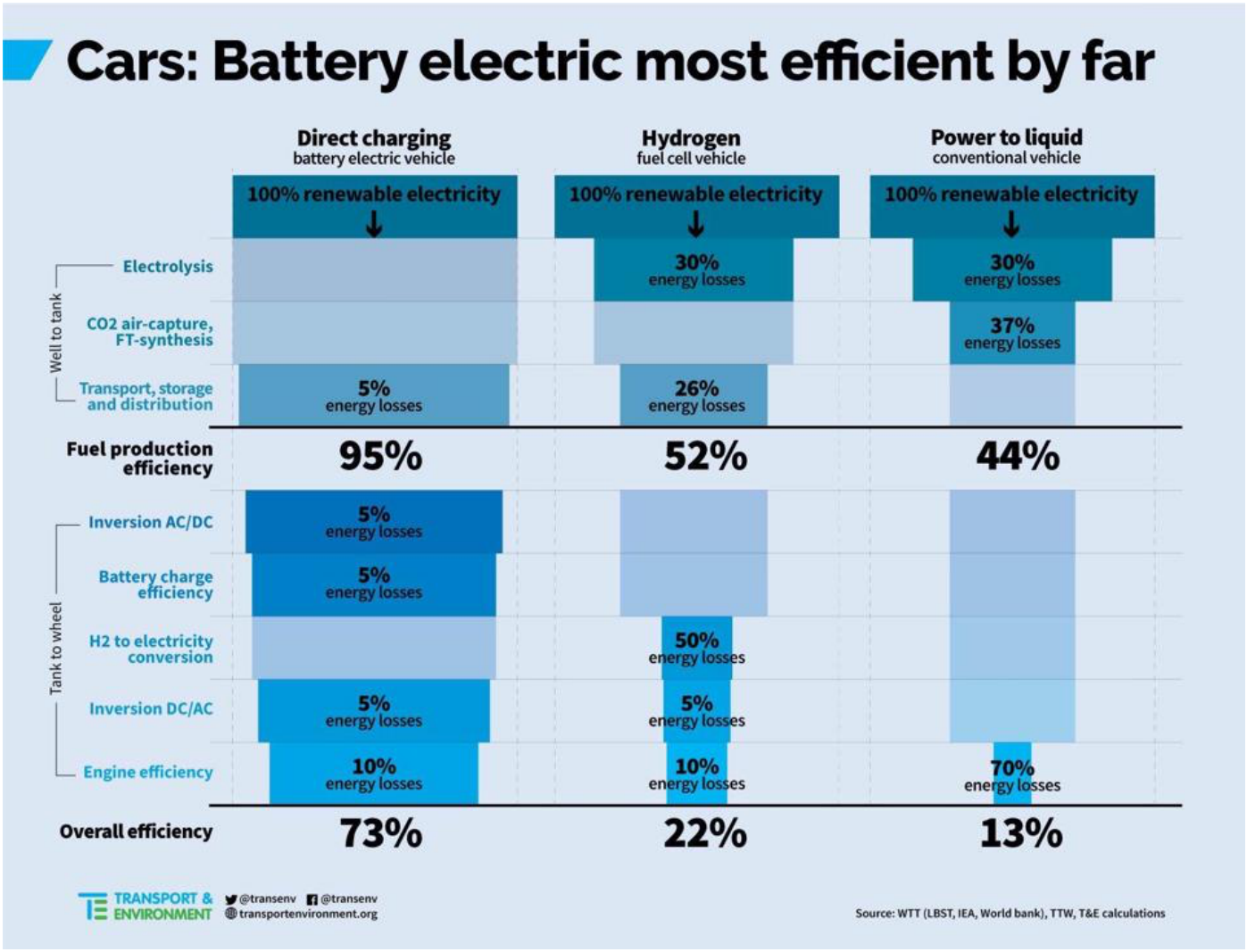
Another issue is the cost of hydrogen. In the UK, its priced at £12 per kg, and

the average price in California is $16.51. With the Mirai capable of 60 miles per kg of hydrogen, that is more than five times the price per mile in the UK compared to an average BEV and even more in the US, where electricity tends to be cheaper. In fact, in the US it would probably cost less to run a fossil fuel vehicle per mile. IHS Markit INFO +0.5% has forecast that renewables-led green hydrogen could be cost competitive by 2030, and the price will be down 30% by 2025. But it needs to be 300% cheaper or more to even come close to the price per mile of a BEV.

All these issues are ones of early adoption. FCEVs are essentially where BEVs were a decade ago, and if sales took off these problems would slowly recede. There would be more refueling spots and the price of hydrogen would go down. The bigger issue is in the green credentials of the technology in general, which are questionable. Hydrogen is stuck between a rock and a hard place. On the one hand, you can obtain it from natural gas, which produces either carbon monoxide or carbon dioxide as a by-product depending on the method used and therefore misses the point of "zero emissions". This is called "blue hydrogen", and although the CO/CO2 is more easily contained than what comes out of a car tailpipe, the process is still producing greenhouse gases.



Graph showing relative efficiencies of battery-electric, fuel-cell electric, and fossil fuel ... [+]

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Much more promising from an eco-friendly perspective is “green hydrogen”. This is produced using electrolysis of water, merely releasing oxygen as a by-product. The refueling station requires a water supply and electricity to produce fuel on-premises. But this is very inefficient, losing 48% of the electricity supplied converting water to hydrogen and oxygen. Batteries in comparison will store almost all the electricity supplied. Whichever source the hydrogen has, it then loses about 50% more of its energy being converted back to electricity in the vehicle’s fuel cell to drive the motor. The by-product may be non-polluting water, but you have lost a lot of energy to get there and, with blue hydrogen, created some greenhouse gases as well.

Most hydrogen proponents understandably prefer the green version, even though it's the more inefficient in terms of energy usage and also currently very much in the minority, with just 1% of hydrogen produced in this way globally. With renewable electricity sources, green hydrogen is as non-polluting as a BEV powered by renewables. However, since you are losing so much of the electrical power in the process of converting electricity to and from hydrogen, it needs abundant energy to make this inefficiency less important. There are surpluses that could be used due to renewables being at peak delivery when demand isn't high enough to use it all. For example, Toyota claims that 8.7TWh of wind power has gone to waste in the last decade, enough to produce 156,000 tons of hydrogen. This is a valid argument – we could use hydrogen to store surplus energy, ready for vehicular uses later. There are also larger vehicles where the weight and space required for sufficient battery power is likely to outweigh the inefficiency of green hydrogen, such as aircraft and ships.

The inefficiency of hydrogen's electrolysis and fuel cells make it far more wasteful of energy than ... [+]

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But using hydrogen to store surplus electricity supply is still not widespread, and for personal cars, hydrogen has too many negatives compared to battery electric. Even though EV charging infrastructure is nowhere near what it needs to be, it's a decade ahead of hydrogen refueling, and likely to remain so. Electricity is also much cheaper than hydrogen while being able to refuel at home by plugging into your domestic supply is a lifestyle-changing capability.

The big problem, though, is how much power FCEVs waste compared to BEVs - 78% versus 27%, according to Transport & Environment. In a world where we need to be saving power rather than throwing it away, this is

something the world cannot afford. While it's more forgivable to promote hydrogen for vehicle types where batteries don't make sense, pushing FCEVs as cars, when this technology is around three times less efficient compared to BEVs, is completely the wrong direction for a more environmental future of transportation.