Getting power from hydrogen

In this article we explain hydrogen and the principles behind using hydrogen to power vehicles.

> *"I believe that water will one day be employed as fuel, that hydrogen and oxygen which constitute it, used singly or together, will furnish an inexhaustible source of heat and light, of an intensity of which coal is not capable".*
>
> Jules Verne, "The mysterious island 1874"

Hydrogen fuelled Vehicles (Fuel Cell Electric Vehicles (FCEV)) use electrical energy to drive motors that move the vehicle in a similar way to battery powered electric vehicles (BEV). The major difference between the two is FCEVs get their required electrical energy from a chemical process that takes place in a fuel cell fitted to the vehicle while a BEV uses an on-board battery as its electricity source. BEVs need recharging on a regular basis from an external source, often this is done overnight. FCEVs need no external charging.

In a FCEV hydrogen is not burnt in the engine to release its energy in the same way petrol and diesel is instead hydrogen is part of a controlled chemical reaction process that releases its energy as electricity.

What is hydrogen?

Hydrogen, chemical symbol H, is the most plentiful element on earth, it is number one in the Periodic Table of elements, Periodic Table of Elements - PubChem (nih.gov). Hydrogen has the highest energy content of any common fuel by weight, it is this energy we unlock when we use hydrogen in a vehicle. Hydrogen is everywhere but we cannot see it. Two molecules of hydrogen and one molecule of oxygen combined makes a compound, water, which we can see. To make hydrogen useful to us it must first be extracted from the compound it is part of.

Hydrogen is an inflammable gas and must treated accordingly. It is lighter that petrol vapour, and when released into the atmosphere it rises and disperses quickly.

The extraction process

In simple terms electricity is passed through water which breaks it down into its constituent components, hydrogen, and oxygen. This process is called electrolysis. The hydrogen is captured and stored in tanks as a gas.

The source of the electricity for the process is critical. In countries that rely heavily on burning fossil-based fuel to produce their electricity the environmental benefits of using hydrogen to supply the energy source for vehicles is marginal when these are offset against the emissions emitted to the produce the electricity. In New Zealand, where over 80% of our electricity requirements are generated from renewable resources, the environmental benefits of hydrogen stack up good.

Getting hydrogen to the vehicle

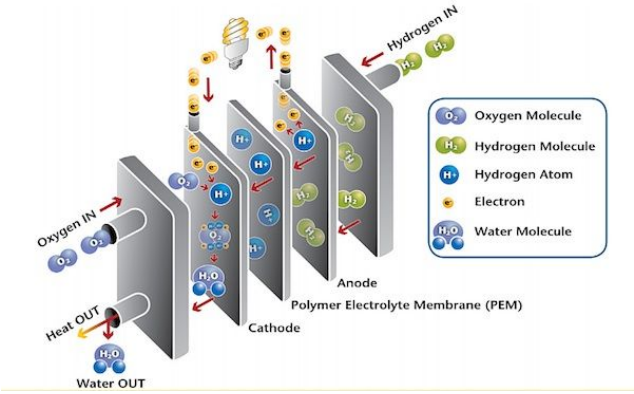
Because hydrogen is a gas it can be compressed and transported in road tankers similar to those used to transport bulk LPG. Storage pressures are high, but it can be stored safely at refuelling stations and is dispensed in a similar way to LPG.

Refuelling a FCEV is fast. A European Federation for Transport and Environment (T&E) report, *Comparison of hydrogen and battery electric trucks,* Campaigning for cleaner transport in Europe | Transport & Environment, suggests that refuelling a European style long-haul truck for a range of

approximately 600 to 800 kilometres should take no longer than 20-minutes. Refuelling time is dependent on the flow rate of the hydrogen dispenser and the volume of gas remaining in the vehicle's tanks.

The fuel cell

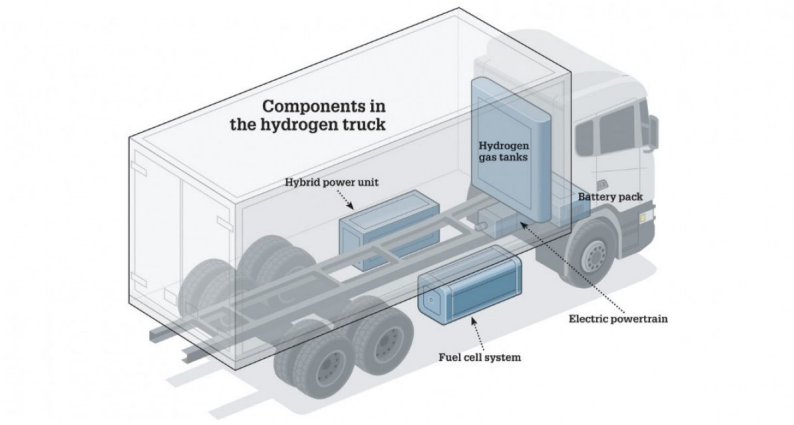
In a fuel cell a reverse process similar to that which separated the hydrogen takes place, reverse electrolysis. In this reverse process the hydrogen from one or more tanks on the vehicle reacts with oxygen in the fuel cell. The oxygen comes from the outside air. The results of this reaction are electrical energy, heat, and water, which is emitted through the exhaust as water vapor. The electrical energy is used to charge a battery, much smaller than ones fitted to a BEV, and to drive electric motors connected to the vehicle's drive wheels and to provide power to the vehicle fitted accessories, such as lights and air conditioning.



Schematic diagram of a fuel cell and the chemical reactions that take place inside it. Image retrieved from https://i.pinimg.com/originals/0d/62/9c/0d629cd17632ae1da57b3436327d556f.jpg

Design of a FCEV

A simplified design layout of FCEV truck is shown below.



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work.html&psig=AOvVaw2NkhjNps8H8sA-5t9CpkBX&ust=1609979840797000&source=images&cd=vfe&ved=0CAIQjRxqFwoTCKCJ3cOIhu4CFQAAAAAdAAAAABAF

BEV or FCEV?

Overseas experience with Battery Electric Vehicles (BEV) and Fuel Cell Electric Vehicles (FCEV) suggest they will complement each in the freight market. BEVs are more suitable for local/urban running where there is ready access to charging stations. FCEVs will be more suitable for intercity/line haul operations because of the distance they can travel on a single top-up of hydrogen.