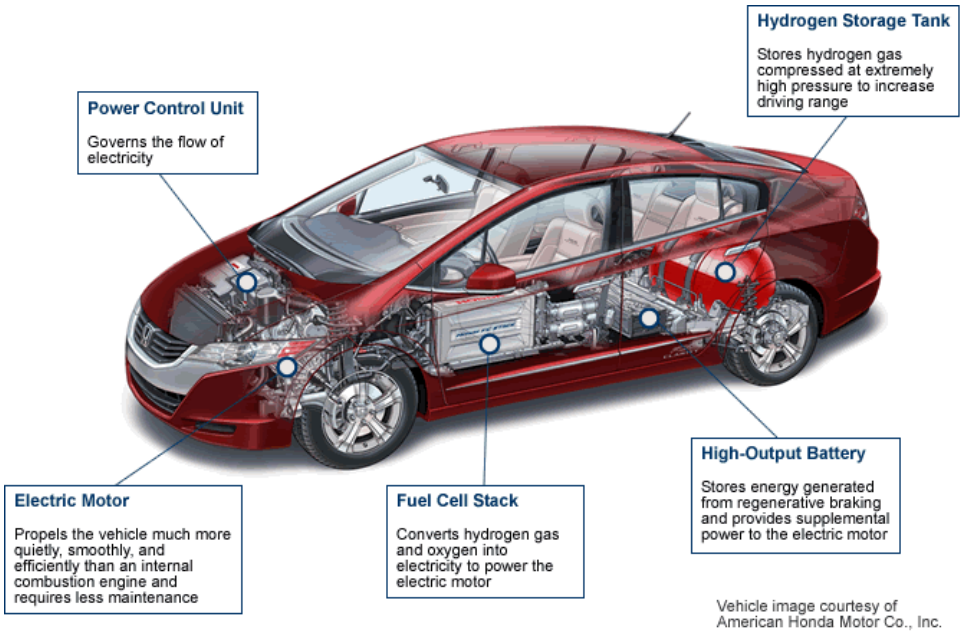
Hydrogen as an alternate fuel for vehicles

Since last century engineers have been producing and testing FCVs (Fuel Cell Vehicles), the process to build them is very slow and expensive but will someday provide a car, which is able to run on hydrogen and oxygen outputting zero harmful emissions for the planet. Billions of dollars have already been spent on research and manufacturing and in a few years time experts claim that these vehicles will replace current gasoline-based automobiles. However, as any other commercial product on the market, the fuel cell cars have their advantages and disadvantages, which begs the question: Will hydrogen be an alternative to gasoline as a fuel for our cars in 20 years time?

Some might believe this is a great alternative to gasoline vehicles, since hydrogen constitutes for 90% of all existing atoms in the universe and we will therefore never run out of it, unlike oil. Yet, it is also the lightest element, thus any hydrogen that purely exists on Earth will shoot out instantly to space, therefore the only remaining hydrogen that exists on the planet is in water molecules and in natural gas. Fortunately, there are currently two ways of producing the hydrogen needed to run these cars: by electrolysis of water or by a process called steam reformation, which separates hydrogen from carbon in natural gas. Both processes have their advantages and disadvantages. For example, using natural gas to produce hydrogen is less expensive than electrolyze water, but if the point of running cars on hydrogen is to reduce the consumption of fossil fuels then this method is not good, since natural gas is a non-renewable source. On the other hand, electrolyzing water is a slower process that might be more expensive but it is not using any fossil fuels, other than to produce the initial electricity, therefore the whole process involving the production and use of the car is cleaner than using natural gas as a resource.

Inside the car there is an even more complex process involving the transformation of pure hydrogen and oxygen to electricity, giving as residue only water and heat energy. The fuel cell, an electric generator, is able to do this by passing the hydrogen through the anode and oxygen through the cathode; with this each element is separated from their corresponding negative charged particles (electrons), which then go through an electrical circuit to produce about 1.6 V, just enough to power a small home appliance. Therefore a stack of fuel cells is used, which contains hundreds of cells working in parallel. To further increase the power given to the car's electrical motor an extra battery has been fitted into the front of the car, which outputs electrical energy when braking. When enough electrical energy is produced an electric motor converts this energy into mechanical energy, to propel the car. Both these processes have an efficiency of about 80%, yielding a total efficiency inside the car of about 64%. Honda, the manufacture of the leading FCVs has achieved an efficiency of 60% in its flagship hydrogen-based car, the FCX Clarity first introduced in 2008.



This complicated method obviously creates a lot of challenges for engineers, which they have to overcome to make these cars as spacious, safe, efficient and cost-effective as possible while not sacrificing any performance. The two main problems in achieving this challenge are the storage of hydrogen and the durability and reliability of the fuel cell. There are various methods to store hydrogen, either as its currently done, in a high pressure environment to decrease the space each hydrogen atom takes and increase its driving range as the pressure rises, or in its densest form as a liquid at zero Kelvin, or finally inside solid objects through absorption, adsorption and other chemical reactions. The method currently used, storing hydrogen at a high pressure is the most economic now but is still very expensive, heavy and spacious. The second method increases the driving range of the vehicle since hydrogen in its densest form occupies less space than at any given pressure, but it is not a viable option because the costs increase by far and other issues arise since in the whole process inside the car hydrogen has to be at zero Kelvin, meaning at -273 degrees. The last method, experts agree is the best choice to store hydrogen in the long run, however the development of this technique is still in early stages. The second problem in building these cars is the durability and reliability of the fuel cells. Right now they are estimated to last for about 120,000 km, however experts say that for the car to be feasible to the general public it has to be able to run for 250,000km before needing a replacement.

Another issue for companies attempting to make FCVs popular in the future is the lack of infrastructure from where customers can obtain hydrogen to use their cars. A big change in groundwork is required to make these cars a viable alternative to people. Some analysts expect the price of building the amount of hydrogen stations throughout the USA required to reach all Americans to be as high as half a trillion dollars. Right now there are only 20 functioning stations in California, with an expansion plan of 8 more later this year. However, some experts agree that another more cost-effective solution, rather than installing thousands of hydrogen

delivery systems, is to implement a small hydrogen plant into customers' garages as an alternative to fueling up at a hydrogen station. This is still in research, as a great leap in technology is needed for customers to have a medium sized, and not very expensive hydrogen converter in their homes. For all these reasons, fuel cell cars can only be leased in California and other countries like Germany or Japan, where there is a very limited infrastructure for these cars. The number of fuel cell cars on the streets is of roughly 300 worldwide.

Therefore, in recent years there have been endless debates on whether these cars will be worth investing in, since there are already less clean but cheaper alternatives to FCVs like hybrid cars. Vehicles using electricity and gasoline are called hybrid cars and they cost around $40,000 compared to hydrogen-fueled cars, which cost about $400,000 now. The vast majority of citizens will not be able to afford these cars, for this reason only a few cars can be leased in several countries. However, in the future these costs will dramatically reduce while engineers continue to innovate cheaper methods that make fuel cell cars work properly. The two main options for customers who do not want to use gasoline are: the electric cars and the FCVs. Experts claim that electric cars are not be very customer-friendly since they have a very limited driving range, of about 160 km and decreasing after each complete recharge, before their battery is depleted and have to leave them at night somewhere where there is an electrical outlet, not a very convenient way for the vast majority of people. Therefore, leaving only as a viable option to eco-friendly customers the FCVs that have in contrast a driving range of up to 400km on one tank of hydrogen, giving about 95km per kg of hydrogen, which is equal to about a gallon of gasoline.

If all these challenges are surpassed in the future many benefits to society will be seen. For example, the dramatic reduction in green house gases, which affects the planet's average temperature, will stop the planet from heating up as it has done for over 200 years now. The evolution to fuel cell cars will also help reduce USA's and other countries dependence on other oil producing nations for petrol, helping to keep the economies of these countries free of the volatile prices of gasoline. This will consequently lead, in many decades, to a hydrogen-based economy in the more developed countries, meaning all the energy needed to power vehicles, buildings and electronic devices will come from the most abundant element on the universe, not from petrol or electricity. This term was first used in 1970 during a conference at the GM technical center and it refers to the change from any source of power being used now to hydrogen, which will create a cleaner and simpler way to power up anything from computers to cars. However, for these changes to happen globally the customer acceptance towards the product, in this case the FCVs, has to be excellent and therefore exceed everyone's requirements in order to be become a fast selling product. Also to meet the demand for these cars almost all, if not all companies have to start producing them, not only firms like Honda or GM.

Another point that will imminently take us to the use of hydrogen as our main fuel is the fact that eventually the planet will run out of oil, some expect this to be between the year 2050 and 2100. However, governments do not want oil to finish before making this transition, since there are others manufacturing uses of oil, thus an alternative fuel has to become popular in the

next decades. However, a downside of this forward shift, in economic terms is that many countries operate based on the exportation of oil, their main driving economic factor. For instance, if Qatar's main buyers of oil like the USA suddenly stop buying as much oil as before the country will enter an economic recession, which it will be difficult to get out of since they depended so much on this exportation. Therefore, a change in the fuel we use now cannot be made globally since other factors can affect a country's decision, for example the lack of economic resources and also the need to keep selling oil to some countries.

In conclusion, it can be said that progress will be made towards making the transition to using hydrogen as a fuel in the next years or decades in first-world countries like the USA, Japan and probably in Europe, however, it will not reach the current level of market penetration the gasoline already has, even in those countries. In other regions of the world like Latin America and parts of Asia this transition will be seen even at a slower rate, even if governments are committed to being eco-friendly, the economic factor will lead it to be impossible in such a short period of time. Even though, the evolution to another fuel from gasoline will not be completely made in 2030 it is possible to say it will happen towards the end of the year 2060 worldwide, giving enough time to most countries to accommodate to all the changes required to support hydrogen as their main fuel.

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