

The Hydrogen Economy

So what's all the fuss about?

When hydrogen gas is combined with oxygen, it produces energy, with water as the only by-product. In this respect hydrogen lives up to its billing as a clean fuel of the future. The reaction can be most simply performed by burning the hydrogen gas in air, indeed car engines can be made to run on hydrogen with reasonably straightforward modifications to their design.

A second method of using the energy stored in hydrogen is the fuel cell, where the hydrogen combines with the oxygen in an electrochemical cell, producing an electrical current. Fuel cells are silent, with no moving parts, and have demonstrated efficiencies greater than 80%, although 50% is more common in practice.

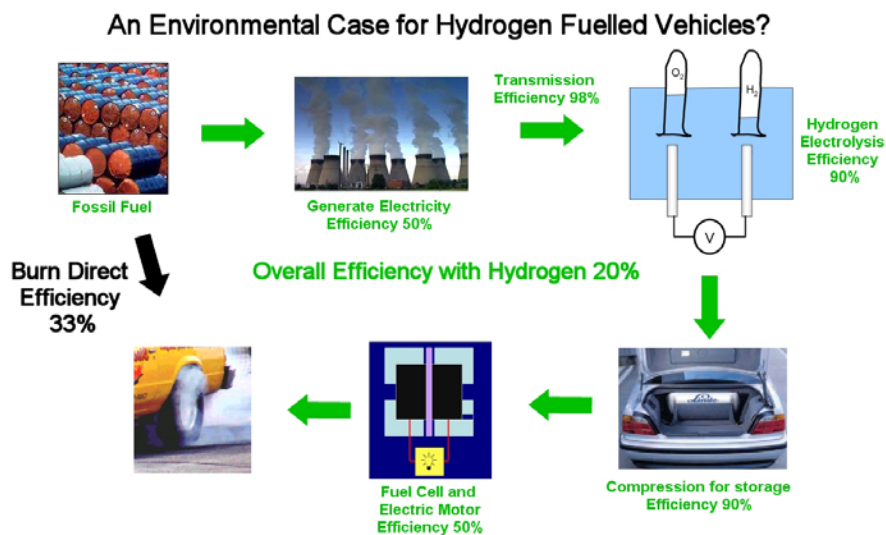
The USA announced a \$1bn programme to research hydrogen technologies in 2003. The EU did the same in 2002, but is spending \$2bn.

Sounds great, where's the catch?

Although hydrogen is the most abundant element in the universe, it is a very reactive and hardly exists on the Earth in its gaseous form. Most of the hydrogen on the Earth is already bound to oxygen as a water molecule, or to carbon in fossil fuels. Hydrogen must be manufactured, and it is the energy required to do this that is often overlooked in the rush to proclaim its status as a green fuel.

In fact, the most common way to manufacture hydrogen today is from fossil fuels. Stripping the hydrogen from natural gas is currently the most economic route, **but these methods all produce carbon dioxide as a by product**. What many people missed about the US announcement of investment in Hydrogen fuels was the emphasis that will be placed on developing new technologies that will use America's reserves of coal to make the hydrogen. George Bush's interest in hydrogen is firmly aimed at reducing America's reliance on other countries for fuel.

The emphasis in the EU is more on environmental goals. The cleaner way to make hydrogen is to use electricity to split water into hydrogen and oxygen gases. Well, it looks that way until you ask how the electricity is made in the first place. Virtually all electricity today is made from burning fossil fuels, so **this method also produces Carbon Dioxide**. In essence, running hydrogen fuelled vehicles only moves the pollution elsewhere.





Indeed, as the figure shows, burning the fossil fuel directly in the vehicle produces less carbon dioxide emissions than to burn a fossil fuel to make electricity to make hydrogen to drive a car.

So it's all a swizz then?

Not quite. Hydrogen could be made in the future from renewable energy sources. Plants use sunlight water and carbon dioxide to manufacture carbohydrates, from which hydrogen could then be made, releasing the carbon dioxide back into the atmosphere in a closed loop (and carbon neutral) system.

Clean electricity generated from solar cells, wind turbines or wave energy could be used to electrolyse water to make hydrogen. This obviously avoids the issues of burning fossil fuels to make hydrogen. However, the amount of hydrocarbon fuel displaced by using renewable electricity to replace oil, coal or gas fired power stations is nearly twice the amount that would be displaced using that electricity to make hydrogen to run vehicles.

So if your goal is to cut carbon dioxide emissions, you shouldn't use renewable electricity to power hydrogen vehicles until you have replaced your whole electricity supply with renewable energy.

Indeed, there are other ways to reduce carbon dioxide emissions from vehicles - increased fuel efficiency is one obvious approach. Vegetable oils can be processed to replace diesel in conventional, unmodified engines. Because the oils are made by plants, which took carbon dioxide from the atmosphere to grow, burning them is a closed-loop system that doesn't increase the overall levels of carbon dioxide in the atmosphere.

Governments might be better off focusing their legislation and research expenditure on more pragmatic, less glamorous technologies such as these.