

Hydrogen: fuel of the future



IN TWENTY YEARS Iceland will be the "Bahrain of the North". Thorsteinn Sigfusson, professor of physics at the University of Iceland in Reykjavik and chairman of Iceland New Energy, says the island is set to become birthplace of the hydrogen economy – providing electricity, heating its buildings through the long winters, and running its buses, trucks, cars and even trawlers. And selling the new wonder-fuel to the world.

It is early days yet, Sigfusson admits. Just three buses, so far. But unlike most hydrogen-powered buses, which fill up with hydrogen made from old fuels such as oil, Reykjavik's buses will run on hydrogen made by splitting water, using hydroelectricity generated from Iceland's raging rivers. The umbilical cord to fossil fuels has been cut.

Both oil companies and automobile manufacturers say hydrogen is the fuel of the future. Ford chairman Bill Ford told a Greenpeace conference in late 2000 that hydrogen "will finally end the 100-year reign of the internal combustion engine. Fuel cells, which run on hydrogen, a renewable resource, have zero emissions. Fuel cells could be the predominant automotive power source in 25 years."

There are compelling reasons for change. Emissions of carbon dioxide from internal combustion engines are stoking the greenhouse effect faster than anything else. And burning oil in engines fills our cities with smogs that kill hundreds of thousands every year. Technological improvements to cut emissions from conventional cars cannot keep pace with the rising tide of vehicles. There will probably be a billion on the world's roads by 2020, one for every seven people.

Hydrogen gas is a combustible fuel just like oil or natural gas. But unlike them, it is ubiquitous, inexhaustible and clean. It can be made either by extracting it from a conventional hydrocarbon fuel, or by splitting water into its component elements: hydrogen and oxygen.

BMW has developed a prototype car that burns hydrogen, and hopes to have a network of hydrogen filling stations across Europe by 2010. "Our vision is that, from the year 2020, more than a third of all BMW vehicles sold in Europe will be hydrogen-powered," says company chairman Joachim Milberg.

But many believe that, rather than burning hydrogen, the key to the new fuel's success in the 21st century is likely to be the development of the hydrogen fuel cell – a portable and versatile energy storage medium, rather like a souped-up battery, that can power an electric motor. This has become a practical proposition with the development in the mid-1990s of a dramatically more powerful fuel cell that could fit under the bonnet of a conventional car. Till then, fuel cells delivered around 170 watts per litre. A Vancouver company, Ballard Power Systems, had raised that to more than 1 300 watts.

Suddenly, you can drive across the USA on hydrogen without adding to the atmosphere anything more noxious than a bathtub of water. The first mass-produced cars run using hydrogen fuel cells will be in the showrooms by 2004. Ford, General Motors, Toyota, DaimlerChrysler, Nissan and Honda all have designs in the works. Ferdinand Panik, director of DaimlerChrysler's fuel-cell project in Germany, reckons hydrogen fuel cells will power a quarter of new cars world-wide by 2020.

Amory Lovins, of the Rocky Mountain Institute in Colorado, believes this change could signal the start of a revolution in car-making that will massively increase their efficiency and reduce pollution. His non-profit institute is dedicated to bringing this about through the development of what he calls the Hypercar, through using lighter materials and better engines. The internal combustion engine, he points out, converts barely 20 percent of its fuel energy into traction, whereas electric motors can have an efficiency of up to 80 percent.

Is hydrogen safe? The image of the 1937 Hindenburg airship disaster still looms large, even though cars are already carrying round tanks of dangerously explosive liquid. "Hydrogen is less hazardous than gasoline," says Lovins.

The critical question now is how the hydrogen is produced. Initially, much of it will be made by "reforming" readily available hydrocarbon fuels such as methanol or natural gas. This can be done either at the filling station, or in small onboard reformers. There are clear greenhouse gains here. Rob Macintosh of the Pembina Institute for Appropriate Development in Alberta has analyzed how much carbon dioxide would be emitted from making and using enough fuel to drive a standard car across Canada. A gasoline-burning car emits 248 kilos, most of it as exhaust gases. A car with an onboard reformer chalked up between 80 and 190 kilos, depending on the fuel being reformed.

Some favor this route. But instead of "reforming" hydrocarbons, hydrogen can also be made by running electricity through water, splitting it into hydrogen and oxygen. This requires a lot of energy, however. And if that energy came from burning fossil fuels, the gains in terms of reduced emissions of greenhouse gases would be minimal. So the key to the "hydrogen economy", to breaking the link to fossil fuels, is to deploy renewable sources of this energy.

That is why Iceland, with its abundant potential for generating hydroelectric and geothermal energy, is so excited. All that energy is not a lot of use to a country of a quarter of a million people. But if it could be used to generate hydrogen – effectively converting it into a new, portable form of energy – it would become a money-spinner. Other countries could set up hydrogen manufacturing plants using solar or wind power.

To take over the world, hydrogen will need a whole new hydrogen infrastructure, costing perhaps trillions of dollars. But we have to start somewhere. Hence the interest in kick-starting the hydrogen economy either in smog hot-spots such as southern California, or in areas of abundant "green" energy for hydrogen production, such as Iceland. Iceland has the great advantage that you do not drive to or from it. It would be easy to convert the entire island to hydrogen.

The hydrogen age could be closer than we think. Certainly, the route map is slowly emerging. But who will get on the road first? Right now, rewiring up at the front of the grid is Iceland.

Article by Fred Pearce