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DEVELOPMENT OF TRANSPORT OF THE FUTURE

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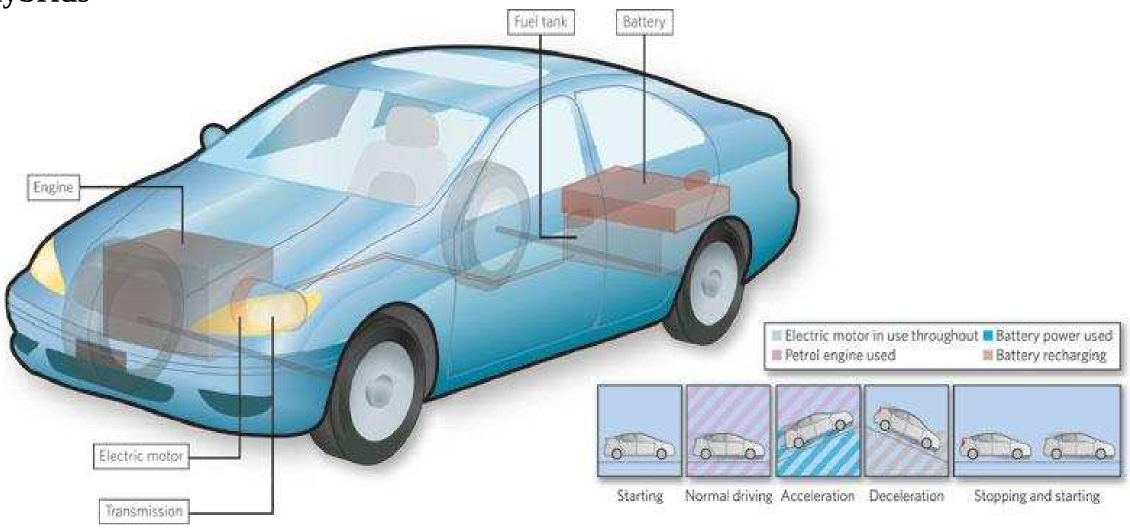
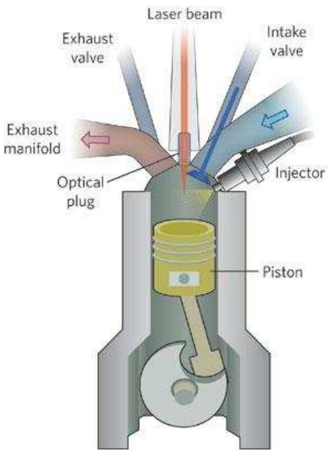
With the world's love of cars showing little sign of abating, manufacturers are under increasing pressure to make vehicles less polluting and oil dependent. Duncan Graham-Rowe explores some of the technologies that could keep us on the road.

Hybrids



One way to reduce the energy cars consume is to recycle it. Hybrid vehicles use the combustion engine to charge up a battery that provides extra power to the engine when accelerating, thus reducing fuel consumption. 'Regenerative braking', in which the electric motor provides resistance to the drive train to help slow the vehicle, converts the kinetic energy into electricity, which is then stored for later use. The benefits of hybrids can really be seen during town driving — the fuel savings may be only a few per cent on longer trips. Fleets of hybrids could also provide a place to store electricty on a large scale, helping in the use of various renewable technologies .



Laser injection

Replacing spark plugs with laser-pulse ignition systems may sound over the top, but it makes sense, says Andrew Scarisbrick, supervisor for UK government and university collaborations at Ford Motor Company's Dunton Research and Engineering Centre near Basildon. Laser ignition systems can reduce fuel consumption and emissions because they give better control of where in the cylinder the spark occurs. Ideally, the spark should be as far from the cylinder walls as possible, so that the flame front is less able to form harmful nitrous oxides. But this technology is still a good few years off, Scarisbrick says. "At the moment the cost is astronomic."

Engenius

One goal is to make existing combustion engines more efficient. Last year, the gauntlet was thrown down with the X-Prize Foundation's Automotive X Prize, a US$10-million bounty for whoever can develop a car that can do 100 miles per gallon.

Automotive engineering company Ricardo UK, based in Sussex, has made some headway, designing an engine that can switch between two-stroke and four-stroke modes. The company claims this could reduce fuel consumption by 27% and emissions by a similar amount. Four-stroke engines carry out the four stages of air intake, compression, combustion and exhaust in four strokes of a piston, whereas two strokes take just two strokes of the piston. Four strokes are more fuel-efficient at constant high speeds, whereas two-strokes are more efficient when accelerating or pulling a heavy load. Software in Ricardo's concept engine, 2/4 SIGHT, controls hydroelectric valves that switch between four-stroke mode during cruising to two-stroke mode when accelerating or hill climbing.

Better batteries

One reason electric vehicles have never taken off is the lack of decent battery technologies. Lithium-ion batteries are currently the best candidates for cars because they deliver power much more quickly than others. But they only carry enough charge to last for around 100 miles before needing recharging. They also have to be replaced every couple of years. And in extreme circumstances they can catch fire or explode. So, many car manufacturers, including Toyota with the Prius hybrid vehicle, have opted for nickel metal hydride batteries, which pack less punch than the lithium-ion ones but last longer and are safer.

Companies such as Massachusetts-based A123Systems are finding new ways to squeeze more life out of a battery. The cathodes within batteries degrade with repeated use and recharging. So A123Systems has developed a birdcage-like nanostructure of lithium iron phosphate surrounding the cathode that prevents it from expanding and contracting during charging and discharging, and so stops the cathode wearing down so quickly. According to the company, its batteries have a potential lifetime ten times that of conventional ones. And although they are not as powerful as the regular lithium-ion batteries, they are a vast improvement on the nickel metal hydride type.

Control freak

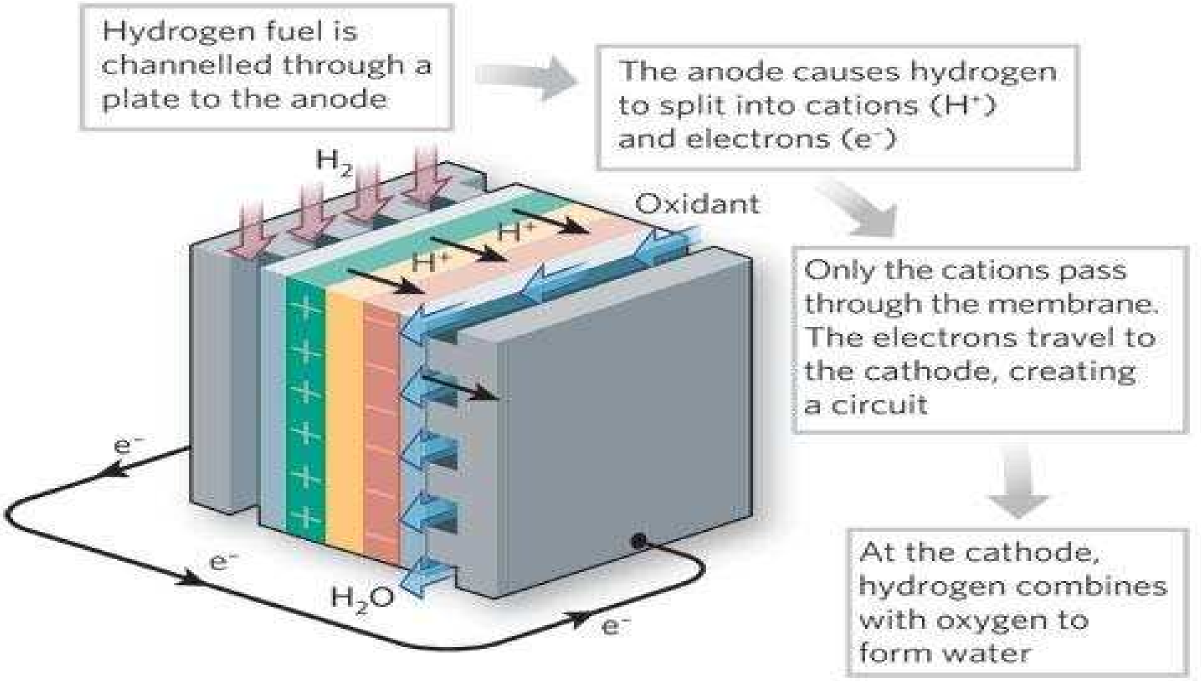
Even subtle alterations to the way cars handle on roads can improve fuel efficiency. Drive-by-wire technology would remove the mechanical linkages between the controls and the brakes, throttle and steering mechanisms. Computers continually interrogate sensors about the car's handling and the road conditions to calculate, for example, the optimal throttle position at that moment. Most countries currently require a mechanical linkage between the steering wheel and wheels themselves, so manufacturers would have to persuade governments that the technology is safe.

Better by design

The electric two-seater renewable energy vehicle (TREV), developed at the University of South Australia in Adelaide, was designed to carry only two people because, according to its creators, 90% of urban trips require no more than two seats.

Thinking along similar lines, the Californian company Aptera recently launched a two-seater electric car (pictured) that it claims has the most energy-efficient and lowest-drag shape that can surround two people sitting side-by-side. Even its wing mirrors are replaced with rear-facing cameras and internal monitors. Use of composite materials makes the three-wheeler very light, just 680 kilograms, placing less of a drain on its plug-in electric motor. According to the company, it can go from 0 to 60 miles per hour in ten seconds and has a top speed of 85 mph.

Hydrogen fuel



Widely tipped to replace oil as a transportation fuel, hydrogen has nearly three times the energy density of petrol by mass, and when used to power fuel cells it produces only steam as a waste product. Most large car manufacturers are developing some form of hydrogen-powered car.

But there are major obstacles to overcome before hydrogen could become a mainstream fuel — how to produce, transport and store it. "Hydrogen requires a huge infrastructure change that's not likely to happen for a long time," says David Sims-Williams, an engineer at Durham University, UK. Producing it using renewable sources of energy is extremely inefficient, and the vast majority of hydrogen is currently produced from coal or natural gas, which is less than ideal.

Another major problem is that, even in liquid form, hydrogen has a tenth the density of water. So hydrogen has less than a third of the energy density of petrol by volume. As things stand, a car's fuel tank would not only have to be cooled to below −250 °C to keep the hydrogen liquid but would also have to be many times larger than existing ones.

In 2003, the US Department of Energy issued a challenge to scientists to develop new materials that can store enough hydrogen to make up 6% of the material's total mass. Frantisek Svec at Lawrence Berkeley National Laboratory in California has developed a nanoporous polymer that adsorbs hydrogen atoms reversibly on its surface, allowing much higher densities to be stored. But the hydrogen is only 1.5% of the polymer's mass, still way short of the target.