Green cars move into top gear

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Under pressure from governments, car manufacturers are developing greener vehicles that run on fuels other than petrol. Peter Gwynne looks at the alternatives.

City slicker

By 2020 more than 1 billion cars will vie for space on the world's roads, compared with the 400 million cars that exist today. The growing number of cars and the demand for fuel will call for improvements in fuel efficiency on a scale that will only be possible with new types of engine and fuel.

Whether any specific technology will gain the industrial dominance that petrol-fuelled engines achieved in the 20th century remains to be seen. But plenty of greener alternatives to the internal-combustion engine have started to emerge from showrooms in Europe and North America. Fuel cells, ethanol, electricity and hybrids of electric and petrol power represent the most promising sources of propulsion.

What has stimulated the quest for alternative-fuel cars? European nations with their crowded roads have a history of encouraging more efficient engines. But North America is not far behind. Tough restrictions on the emissions of pollutants from both individual cars and fleets of vehicles sold by manufacturers have played a key role in persuading American car makers to undertake research on greener vehicles. For example, the US government's corporate average fuel economy (CAFE) standards specify that car manufacturers must reach an average of 27.5 miles per gallon for fleets of cars and 20.7 miles per gallon for light trucks. (In other words cars must be able to travel 100 km on 8.6 litres of petrol, while trucks must consume less than 11.4 litres over the same distance.) Even though the US Senate recently turned down a tightening of the CAFE targets, existing goals are almost impossible to achieve without the availability of some clean-burning alternative-fuel vehicles.

Within the US, California sets much of the agenda for green cars. The state, which tries to balance its residents' utter dependence on the car with the effort to maintain clean air, sets rigid targets for the emission of hydrocarbons, carbon dioxide and nitrogen oxides from new cars and light trucks. California's mandate that the six leading car makers produce over 4000 zero-emission cars from next year has helped to stimulate the development of green vehicles.

From hydrogen to ethanol

Forward thinking

Fuel cells represent the most futuristic method of propulsion as well as the cleanest; they mix oxygen with hydrogen - a potential fuel of the future - from a pure source or a hydrogen-rich compound such as methanol, and they emit only water vapour (see Fuel cells eye up the mainstream market, pages 30-31 print version only). "Fuel-cell vehicles have tremendous potential to contribute to the goals of sustainable transportation systems and the use of renewable energy," says Ben Knight, vice president of Honda R&D America.

Engineers have long used fuel cells to power spacecraft. But their application to Earth-based vehicles has scarcely moved beyond the pre-prototype stage. Nevertheless, several car makers have demonstration models that run on fuel cells. Ford has the P2000, a saloon powered by fuel cells from Ballard's transportation division in Burnaby, Canada. Ballard also provides fuel cells based on pure hydrogen for the DaimlerChrysler Necar 4, a small vehicle designed for local travel.

A key barrier to the mass acceptance of alternative-fuel cars is the lack of infrastructure for anything but petrol-fuelled vehicles. However, that situation has also begun to change. Last year Honda opened a hydrogen production and fuelling station near Los Angeles, and early this year the California Fuel Cell Partnership (CaFCP) unveiled a methanol fuelling station in

West Sacramento. "We are making great progress to demonstrate alternative fuels for fuel-cell vehicles," says CaFCP's chairman Don Huberts.

Cars that burn another alternative fuel have already reached the market without having to face the issues of fuel delivery. That fuel is E85, a blend of 85% ethanol and 15% petrol. Ethanol has the environmental advantage of burning more cleanly than petrol, emitting fewer hydrocarbons and less benzene and carbon dioxide. For drivers in the US concerned about the political and economic costs of imported oil, E85 has the added bonus that the ethanol is derived almost entirely from corn grown in the American mid-west.

The National Ethanol Vehicle Coalition, based in Jefferson City, Missouri, estimates that more than 2.3 million "flexible-fuel vehicles", which can run on both E85 and petrol, will be on the road by the end of the current model year. Manufacturers of such vehicles include the "big three" US car makers - DaimlerChrysler, Ford and General Motors - and the Japanese companies Isuzu and Mazda. The flexible-fuel vehicles range from saloon passenger cars to pick-up trucks and minivans.

New life for battery cars

Electric cars have a long research history, but until recently they had little to show for the work in terms of commercially viable cars for a mass market. That has begun to change with improvements in battery technology and the introduction of new models by American car manufacturers.

Electric cars have obvious green advantages. They emit no pollutants and have impressive energy efficiencies. Until now, however, they have been limited by a lack of range per single electric charging and a lack of speed.

Those limitations are less important for short journeys in and around cities and other densely populated areas than for longer drives. Indeed, in 1998 the American National Highway Traffic Safety Administration defined a new type of car: the low speed/neighbourhood electric vehicle (LSV). These vehicles must meet all the standards specified for other cars but can travel no faster than 40 km per hour. They are designed to complement conventional cars rather than compete with them.

The DaimlerChrysler's GEM and Ford's Th!nk neighbor fulfil the criteria for LSVs. Looking like high-tech golf carts, the vehicles run off six 12 V batteries, which give them a range of about 48 km for an 8 hour charging session.

Electric cars are not restricted to the LSV niche. In 2000 Ford brought out the Th!nk city for the European market. This vehicle, introduced to the American market in January with upgrades such as air conditioning and power steering, can be driven on motorways at speeds of up to 90 km per hour and has a range of 85 km per charge. "It is an affordable, fun-to-drive alternative transportation choice when a full-function car is not needed," says Jim O'Connor, Ford's division president.

General Motors' second-generation EV1, meanwhile, has an extremely aerodynamic shape, a top speed of 129 km per hour, and a range of 88-153 km when powered by lead-acid batteries. A nickel-metal-hydride battery pack can increase that range to 120-209 km. In fact, improvements in battery technology promise to make electric cars more competitive with petrol-powered vehicles in all driving situations. Ford's prototype e-Ka uses lithium-ion batteries, which weigh about one-third as much as lead-acid batteries, giving the vehicle a range of about 200 km at a speed of 80 km per hour between charges.

Twin power

Perhaps the most promising alternative vehicle technology - and the one that is as close to significant commercial use as ethanol-powered cars - is the hybrid electric vehicle. A hybrid car uses both an internal-combustion engine and an electric motor. The concept improves fuel efficiency by allowing the electric motor to take over tasks that involve high fuel usage, such as starting the engine, rapid acceleration and climbing hills.

The dual nature of the power source offers several forms of greenness. The support provided by the electric motor means the petrol engine is smaller and more efficient than that in a

conventional internal-combustion car. The electric motor also permits the petrol engine to shut down entirely during certain parts of a journey, such as while waiting at traffic lights. In addition, regenerative braking captures energy from the internal-combustion mode and stores it in the batteries. As a result, hybrids do not need to be recharged, unlike pure electric cars, and their exhausts emit significantly less carbon dioxide than those of petrol-powered cars.

The two best known hybrid electric cars currently on the market are the Honda Insight and the Toyota Prius. The Insight combines several technologies to gain maximum fuel efficiency. Its light aluminium body makes it 225 kg lighter than the Honda Civic. Meanwhile, its small engine and lean-burn technology means it can travel 100 km on just 3.3 litres of petrol for motorway driving. And its teardrop shape makes it one of the most aerodynamically efficient cars on the market.

The Prius gains its efficiency largely from two technical approaches. The electric engine powers the car entirely up to a speed of 24 km per hour before allowing the petrol-driven engine to switch on. And a power-splitting device that brings together the petrol engine and electric motor ensures that the engine operates at its most efficient load and speed most of the time, eliminating the need for a gearbox.

America's "big three" manufacturers have also developed hybrid vehicles, under a partnership with the Department of Energy called the Hybrid Electric Vehicle Programme that started in 1993.

The major car makers are not alone in developing green vehicles. The Solectria Corporation of Woburn, Massachusetts, has developed components of hybrid electric-drive systems - including AC-induction drive motors with regenerative braking, high-efficiency motor controllers, battery chargers, and other accessories and monitoring systems - that help to power road cars, school buses, delivery trucks and solar racing cars. Overall, the parts made by the company power more than 2000 vehicles worldwide. And, like the larger manufacturers, the company is seeking to expand its green niche to a broad mass market.

About the author

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