



After our decades-long love affair with petrol- and diesel-powered vehicles, escalating environmental concerns, the recent oil-price spike and the global financial crisis mean the era of greener cars and trucks is fast gearing up. **Rachel Sullivan** looks at recent developments and the opportunities ahead.

'We still love our cars and are heavily reliant on them,' says Monica Richter, Sustainable Australia Program Manager at the Australian Conservation Foundation (ACF).

'However, there has been a 20 per cent decline in new car sales over the past year, combined with a marked shift towards smaller, greener cars. This means that if the local car manufacturing industry wants to survive, it has no choice but to become more fuel-efficient and greener all round.'

According to worldwide studies, changing the behaviour of car users is as important as infrastructure or technological change. Understanding how we actually use our vehicles is set to become one of the key shapers of the

green car market, says Dr Gary White, Research Manager at the Cooperative Research Centre for Advanced Automotive Technology, known as the Auto CRC.

'We found that when statistics of how far people travel each day are analysed, on average it is less than 120 km per day, well within the range of an electric car, for example.'

'People are also starting to realise a car that can do all things isn't necessarily the best car to own – a car that has the capacity to tow a boat, a trailer or a caravan is simply not as energy efficient as a commuter car.'

It is hoped this fundamental shift in consumer attitudes, along with incentives provided by the federal government's

US-based Tesla Motors' electric speed machine, the Roadster Sport, is now available. Tesla Motors

Green Car Innovation Fund – a billion dollar provision for local vehicle and component manufacturers to make tangible improvements to vehicles – will give designers and manufacturers the impetus they need to design much smaller, more efficient vehicles for the Australian market.

Power by mixed sources

When we talk about 'green' vehicles as part of reducing emissions and resource use, the green element breaks down into fuels, materials used, manufacturing process footprints and life-cycle efficiencies.

'Fifteen per cent of total greenhouse gas emissions are generated in transport,' says Dr White. 'Over a year's use of a family car, that amounts to an average of 5 tonnes of carbon dioxide emitted per vehicle, or eight kilograms for every 25 kilometres of travel.'

'Emissions systems are quite effective at reducing noxious greenhouse gas (GHG) emissions, which also include nitrous oxide and carbon monoxide, but, unlike the US and EU, we only have an industry agreement about reducing fuel

'But the price of fuels needs to be very high and stay there to make that economic. Under extreme pricing and supply conditions that option is available, although it is not viable to make fuels out of gas or coal without carbon capture and storage (CCS) mechanisms, which would push the price up again.'

According to new research by CSIRO, producing biodiesel from large-scale algae farms could be viable if overall costs of fuel are taken into account. High CO₂

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consumption and greenhouse emissions – there is nothing in the legislation to force GHG emissions reductions in Australian vehicles.'

One option for reducing transport-related GHGs is biofuels, says Dr John Wright, Director of CSIRO's Energy Transformed Flagship.

'There are heaps of alternatives we can lean on to produce fuels in Australia. At the moment the fuel mix available in Australia is unremarkable. All heavy and most light trucks use diesel, cars use petrol, and the remainder – about three per cent – is LPG used by high-duty vehicles such as taxis,' he says.

The next step for both cars and some light trucks will be the increasing use of E10, a 'duel-fuel' mix of 10 per cent ethanol and 90 per cent petrol, then E85 (85 per cent ethanol, 15 per cent petrol) as biofuels production increases.

'Some countries, like Sweden and Brazil, produce vehicles with duel-fuel capability, but at this stage we just don't have that much ethanol,' he continues. 'With second generation ligno-cellulosic processing able to turn sawdust, grasses and waste products into ethanol, and even algae into biodiesel, we will have a biomass base that doesn't compete with food becoming viable in Australia.'

'Our modelling shows biofuels and E85 in particular have a significant role to play in the future.'

Synthetic fuels can also be produced from natural gas and coal, Dr Wright says.

emissions from industry could feed into the farms, only established on non-arable land, therefore negating the issue of competing land use. Algal farms also have a very low environmental impact compared with crops that are grown for biodiesel.

Electrifying changes

Most of the commentators *ECOS* spoke to believe that electric vehicles, which generate no greenhouse gas emissions when powered by renewable energy, will be the winners in the green vehicle stakes.

It is likely they will become a significant part of the vehicle market over the next few years, with both mainstream and boutique manufacturers planning to release electric vehicles in the foreseeable future.

Hydrogen cars, often discussed promisingly, emit only water vapour. Renewable energy can be used to power the electrolysis process that splits water molecules to generate pure hydrogen. Hydrogen is also available as a by-product of processing hydrocarbons, and of methane (natural gas). The drawback is the cost of supporting storage and supply infrastructure. At present, Australia has no commercial hydrogen filling stations, so it is unlikely we will see them on our roads in the near future.

Honda, however, has made a working-model hydrogen fuel cell car – the FCX Clarity – available for lease in California (see <http://automobiles.honda.com/fcx-clarity>). It stores 5 kg of hydrogen for a range of around 400 km. Honda intends to address the fuel infrastructure problem by producing a home electrolyser to allow car users to 'refuel' using the existing electricity transmission infrastructure.

Electric vehicles have had bad press because of their lack of range, so to gain real traction in the Australian market they need to be able to recharge quickly, easily and regularly. Better Place, an Israel-based company, announced a deal in 2008 with AGL Energy and Macquarie Capital Group to raise funding for an electric vehicle (EV) network powered by renewable



Honda's FCX Clarity, powered by hydrogen, is driving California's streets. Honda

FOCUS



The UltraBattery clocked up 100 000 miles during extensive testing in a hybrid vehicle.

Advanced Lead-Acid Battery Consortium

energy in Victoria. Supported in part by the government's Innovation Fund, Better Place's scalable sustainable mobility model, which envisages a network of charge spots and battery switch stations, has already been adopted by Israel and Denmark, and is expected to 'go live' in Australia in 2012.

To take advantage of changing consumer sentiment, Auto CRC's Dr White says manufacturers wanting to jump into the EV market have the option of retrofitting electric engines to existing vehicle designs. This will give them a quick entry into the market and ensure their existing investment in chassis design and manufacture is not lost. Australian entrepreneur Ross Blade of Blade Electric Vehicles (www.bev.com.au) is already fitting electric motors to Hyundai chassis, and is preparing to sell kits.

'Electric motors have exciting performance, and the great thing is that their emissions are stable, not subject to the vagaries of the driver,' says Blade. 'Taking up this transport option will allow us to move the energy source to a place where we have control – we can buy green electric power, but not green petrol.'

Electric vehicles have fewer components and can be designed to be lighter, requiring less energy to move or stop, and recover energy through what is called regenerative braking, a mechanism that reduces vehicle speed by converting and storing kinetic energy for future use.

Thanks in part to research by CSIRO's Energy Transformed Flagship, battery

technology for storing this energy, and therefore increasing vehicle performance, is also improving at a rapid pace.

'We are seeing a convergence of all improvements coming through to produce a practical vehicle for average, everyday use,' says the Flagship's Dr Wright.

'Twenty years of research has culminated in the UltraBattery, a device that integrates a lead acid battery and a supercapacitor in one unit cell, harnessing the best of both technologies and producing a battery with high power discharge and charge and a long, low-cost life.

'Supercapacitors can be charged an infinite number of times, without degradation over time. The UltraBattery is very efficient, giving the same performance as the nickel hydride battery currently used in hybrids, but costs a third of the price, and has been shown to have many times the life of an old-fashioned lead acid battery.'

He says while research continues into reducing the battery's weight, the technology is currently licensed to a Japanese company and one in the United States, and the race is on to get it into a commercial car.

Morgan Stanley analysts believe the cheaper prices associated with the new generation of batteries will lead to cheaper hybrids and drive annual worldwide demand for the cars to 3 million by 2020.

In the meantime, there is a range of promising petrol/electric hybrid technologies either already available in Australia, such as the Toyota Prius, or coming to market, such as the Honda Insight planned for release in 2010, and the first Australian-built Hybrid Camry, which will start rolling off local production lines in 2010. The Camry was recently showcased at the Melbourne Motor Show alongside the Mitsubishi i-MiEV, set to become Australia's first battery-electric passenger vehicle after its release next year. The Camry's development is being supported by the Green Car Innovation Fund.

Holden, expected to be another big winner from the Innovation Fund, has announced plans to release a locally

Cars made from seaweed?

The global financial crisis and climate change are accelerating the need to develop alternatives, according to Paul Beranger, Corporate Manager for Design at Toyota Australia. The company is looking into the use of lightweight, non-oil based materials in car manufacture.

'Initially, we are looking at non structural applications – "cosmetic" parts of the vehicle, such as trims – then later we will turn our attention to how these alternative materials can be used structurally, such as in bumpers,' he says.

'One material we are looking at is seaweed, which is widely available, but not widely used commercially.'

'However, we can't use a material that hasn't gone through the same processes



Toyota's Hybrid Camry concept vehicle. Toyota

as existing parts, such as life-cycle testing, recyclability, durability, appropriateness for safety and serviceability. Repairs during the life of a part are easy with plastics and sheet metal, but seaweed-derived parts may require innovative approaches.'



CSIRO research suggests that algae can be a source of affordable and relatively benign biofuel. CSIRO

built smaller car, although company representatives were unable to discuss any green-tech features it might have, other than its smaller size. The Australian car-maker is also planning to import a right-hand drive version of the Chevy Volt, a

fuel, and while it is not carbon-free, it is better than diesel. We can also run trucks on biodiesel, and E10 diesel is available in Australia now.' Hybrids may be another option.

In 2008, TNT Express Australia put 10 Hino Hybrid trucks into service, becoming the first business in Australia to start operating a fleet of diesel-electric hybrids as replacements for conventionally powered vehicles. The new vehicles are expected to reduce TNT's greenhouse gas emissions by an average of 1600 kilograms of CO₂ a year per vehicle.

While this is a start, Richter says the ACF is most concerned about commercial light vehicles – delivery vans, plumbers' vehicles, etc. 'This is an ageing and growing fleet, and we expect the emissions from this group to double by 2020.'

Power Freight, a Sydney-based courier company, identified this issue some time ago and has since claimed to be the country's first carbon-neutral freight company with green innovations

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plug-in hybrid car that will be launched in the US in late 2010, and in Australia some time after that.

Trucks: the heavy road toll

It's not only cars that need upgrading – all transport areas need to be doing their bit to cut life-cycle resource consumption and emissions, says ACF's Monica Richter.

'At the moment our freight system is heavily reliant on trucks for transport as the freight rail system hasn't been upgraded for the last 25–30 years. To bring it up to speed, and for it to become a viable alternative to road transport, substantial investment will be needed.'

John Wright agrees. 'At the moment big trucks use diesel and when the price of fuel goes up so does the cost of food, leading to other negative economic and social consequences.' But with the switch to electric or hydrogen-powered trucks expected to be a very long way off, he says he would like to see a move to powering big trucks with Liquefied Natural Gas (LNG).

'We have an indigenous supply of this

throughout its offices and its fleet.

'We already use low emissions vehicles, and will acquire electric and hybrid vehicles as the fleet grows and the technology and infrastructure become commercially available,' says Managing Director Mark Power.

'We are also trying to consolidate runs, so that where we might have a vehicle regularly travelling backwards and forwards across the city, by consolidating we will reduce fuel consumption generally, and wear and tear on the vehicles which adds to their life-cycle costs.'

Despite the emergence of exciting new vehicle technologies, Richter sees just how big the task of replacing our soon-to-be-obsolete ageing transport fleet is. 'We can't get too hung up on technologies – if the transport sector is going to reduce emissions by say 20 per cent by 2020, we are going to have to invest heavily in infrastructure and many more people are going to have to start walking or cycling to work.'

'It's as simple as that.'

Driving on air



Deakin University's T2 concept (top) and the AIRPod, developed by the 'Air car' team at French company MDI. Deakin University, MDI

Deakin University's entry for the Ford Global Challenge to design a Model T for the 21st century was one of two winning designs selected by Ford to be showcased at its US headquarters. The car, known as T2 (T-squared), runs on compressed air, with some compressed natural gas for longer distance travel.

'Compressed air requires less change to current infrastructure than other alternate sources,' says Dr Bernard Rolfe, the Deakin Project Leader.

Former French Formula One engineer Guy Negre is the driving force behind a production-ready range of compact compressed-air-driven commuter vehicles that can seat four and travel as far as 300 km on one tank of compressed air.

The cars feature a lightweight tubular aluminium chassis, shock-absorbent foam that exceeds EU, US and Australian safety standards, and body panels manufactured from hemp and other organic materials.

Locally, the projected market for the 'air car' includes onsite vehicles, such as at airports, and semi-centralised commuter applications, where the vehicles might provide the missing link between major public transport networks and the local suburb. See www.theaircar.com.