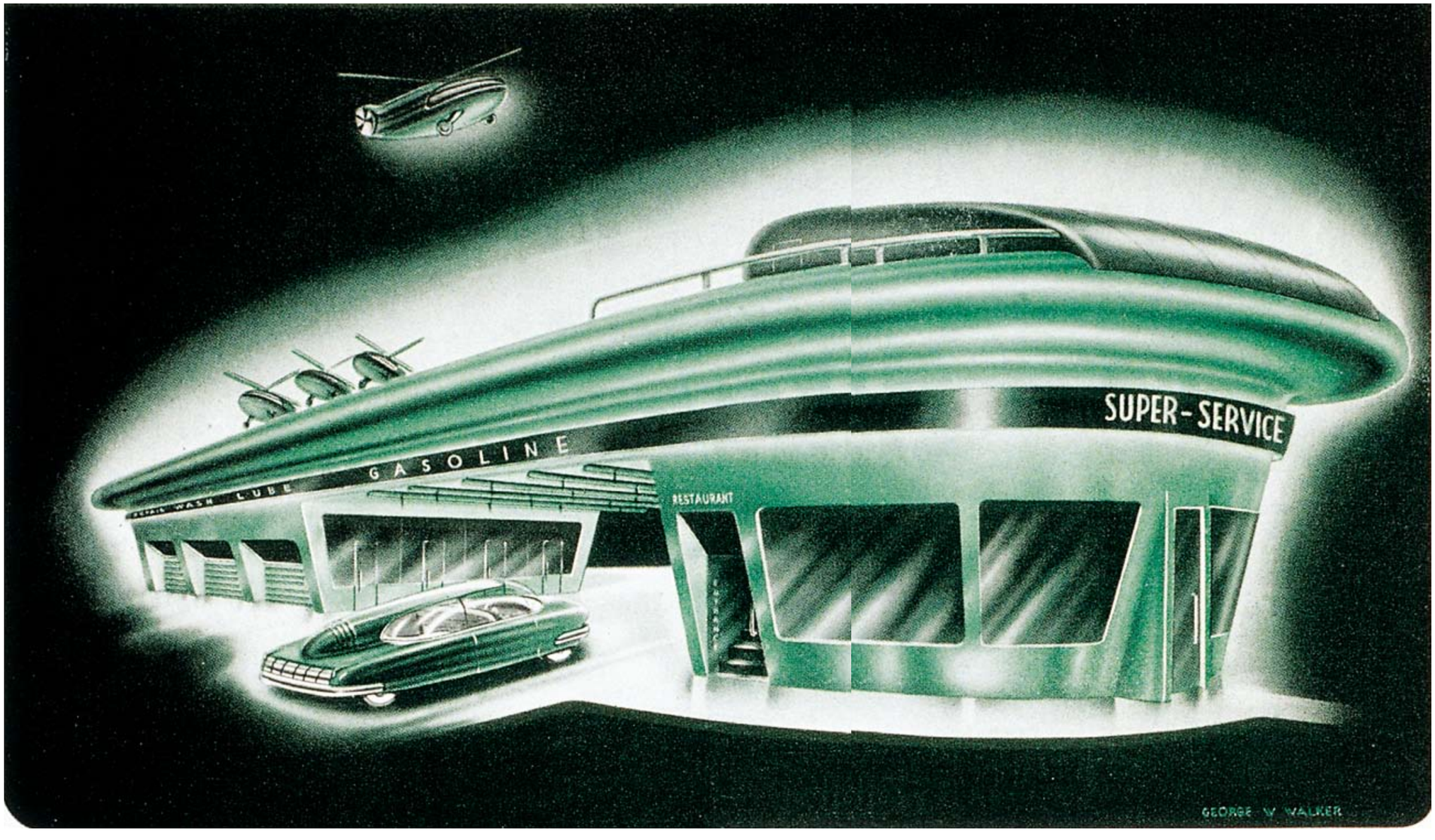
by Jon Lawson

Future fuel

What will power vehicles of the future? A look at the current contenders may help us find the answer



It is now just over 100 years since Rudolph Diesel debuted his internal combustion engine. It was quite a departure from the great external combustion engines, driven by steam, that had worked so well over the previous centuries. Diesel's idea was to take vegetable oil, inject it into a closed cylinder and use a piston to compress it. The resulting temperature increase was sufficient to make the fuel explode, which forced the piston down again. A crank assembley was used to turn the up and down movement of the piston into useful torque.

The idea may be more than a century old, but the piston engine shows no signs of being overtaken by anything else – not in the near future at least.

That is not to say there has been no improvement. It wasn't long before someone, although exactly who is disputed, realised that by using a more volatile grade of fuel with some sort of additional igniter (the fore runner to the spark plug) a lighter, cheaper, engine could be constructed, giving mobility to the masses.

Although Diesel's original engine didn't rely on anything so crude as mineral oil, its derivatives have now come to dominate the transportation fuel market. The vast majority of modern motors run on either petrol or diesel – a fact that is starting to cause concern in environmental and political circles throughout the world.

But let's not look back. The first step to solving a problem is to identify it. Some environmentalists argue that the use of mineral oil-based fuels is adding huge quantities of carbon dioxide to the atmosphere, causing the planet to overheat with potentially disasterous consequences. Also emitted are various volatile hydrocarbons, toxic carbon monoxide and three separate oxides of nitrogen, often just called NOx, among other nasties. What's more, diesel engines emit carbon in the form of minute soot particles, currently in the dock charged with asthma offences.

WHAT TO DO?

The problems can be tackled one by one. Let's start by assuming that the majority of current engines should be able to carry on with the minimum of modification. The car-

A HYDROGEN-POWERED BMW STOPS FOR FUEL

bon circle problem could, in theory, be tackled by the use of so called 'bio-fuels'.

For compression ignition engines vegetable oil-based biodiesel is a real possibility. Many vegetable oils, such as rape seed oil, could (and in some cases already are) be used as a diesel substitute and because the carbon released during combustion has already been sucked out of the atmosphere as the plants grow, the fuel is classed as carbon-neutral. Raw rape seed oil has a far higher viscosity than many modern engines are designed to cope with, so either the fuel or the engine needs to be modified. Both prospects have galvanised back yard mechanics everywhere.

When changing the fuel, the viscosity has to be reduced to fall within the parameters of modern engine design. This is often done by transesterification, a process that even provides a useful byproduct – the raw material for soap. However it has its drawbacks, as the chemistry requires catalysts such as methanol, which can be difficult to handle safely.

This has led some to look at modifying the engine. Raw vegetable oil will actually achieve a very similar viscocity to mineral diesel if heated to around 70-80ºC. Serendipity decided that this is around the temperature of an engine's coolant, meaning that a simple heat exchanger can be used to change the viscosity, so long as starting and stopping is done on mineral oil diesel, so fuel filters and injectors are never clogged. Some car makers have fitted heat exchangers around fuel filters, making engines easy to convert.

There are some who even run their vehicles on filtered waste cooking oil from fast food joints – making fuel costs negligible. Owners report that the smell of the exhaust is far more appetising as well.

The above, however, does not apply to every diesel engine. For long-term use there have been problems with certain types of high-pressure fuel pumps, as well as some wear issues with direct injection engines. The cetane rating is lower with vegetable oil, so some highly optimised modern engines struggle to cope, especially on cold mornings. Old fashioned indirect injection engines with heavy-duty ancillaries seem to cope well – reports of commercial vehicle operators running engines for 250,000 miles on biodiesel abound.

Spark ignition enthusiasts are not being neglected on the bio-fuel front. Race car enthusiasts have always experimented with different fuel compounds to give extra power. One in particular – ethanol – can be made from various materials including sugar. It's manufacture is therefore carbon neutral. Like vegetable oil, it can be mixed with its mineral oil counterpart as an extender (up to five per cent with no engine modification) but can also be used nearly neat if minor modifications are made.

Ford has just launched a bioethanol version of the Focus in the UK. The Flex Fuel Vehicle (FFV) has hardened valves and valve seats, with a sensor to detect what mixture of unleaded gasoline/bioethanol is heading towards the injectors. The sensor then tells the ECU what combustion conditions to create to get the motor running. Wider fuel pipes are used to make up for a slight reduction in the bioethanol's energy content, and a block warmer enables easy starts on cold mornings.

Ford's approach is not just to put the model on sale, but also to work with local authorities, as well as environmental and farmers' groups, to get a refueling infrastructure up and running. The company has said

1. 3.3-litre V6 petrol engine
2. Front power unit (Front electric motor, generator, power split planetary gear, motor speed reduction planetary gear, E-CVT)
3. High Voltage battery
4. Power control unit (Inverter, boost converter, converter DC/DC)
5. Rear power unit (Rear electric motor)

"The problem is that huge amounts of land would need to be devoted to growing the raw materials"

that there will be 200 Ford Focus FFVs in Somerset in the next two years.

Despite this recent advance, and similar moves in other countries, the world still lags behind Brazil, where billions of gallons a year are already used in various fuel mixtures.

Both biodiesel and bioethanol could go a long way to closing the carbon circle. The problem is that huge amounts of land would need to be devoted to growing the raw materials for plant-based fuel manufacture. This doesn't look like a viable option right now.

Perhaps that is why some car manufacturers are looking at ways of making their vehicles more economical. Hybrid technology is growing in popularity, from small economy models to large SUVs, several options are now available. The Lexus RX400h Synergy Drive is a case in point. Like all SUVs it is a large, heavy vehicle that ordinarily would need a lot of fuel to keep it motivated. However, by installing electric motors to aid the 3.3 litre gasoline-powered conventional engine, overall CO_2 emissions have been reduced and greater economy achieved.

The system works by using several different combinations to achieve maximum mile-

MOTORSPORT COULD BE THE KEY TO GETTING THE PUBLIC INTERESTED IN ALTERNATIVE FUELS. FIONA LEGGATE'S BTCC ASTRA RUNS ON BIO-ETHANOL

age. When slow speeds are required, the vehicle is powered by the electric motors. When more vigorous driving is needed, the engine's output is divided to drive the wheels as well as power a generator that charges the high-voltage drive battery as well as feeding power to the electric motors. Although much of the underlying technology has been available since the 1970s, it is only recently that the software has been available to make it work for car manufacturers. It also bypasses the traditional problem of electric vehicles – recharging. Another obvious environmental flaw with electric vehicles is that the electricity to charge them up has to made by something – usually coal-fired or nuclear power stations, neither of which have a reputation for being environmentally benign.

Fuel cells are also receiving some interest at the moment. Instead of using an engine, a chemical reaction in the cell creates an electric current that drives a motor to propel the vehicle. The ideal fuel is hydrogen – but more of that later. Despite large investments by many companies, fuel cells have yet to find their place in the automotive market. The technology just isn't ready. However, there are spin offs that may keep investers interested. For example, some commentators believe that in the future laptops, cell phones and maybe even homes will be powered by fuel cell technology. The only emissions are water and heat.

But fuel cells are not the only creations that can use hydrogen. More conventional engines also have a liking for it. In fact, hydrogen has been a serious contender for many years. Gasoline-powered piston engines can run on hydrogen with relatively minor modifications – the engine itself has never been the problem. As well as on-board storage, it's the refueling infrastructure that causes the difficulties.

To tackle the problems, and spread the cost, BMW, GM and Honda have partnered up to develop tank couplings for liquid hydrogen. Although the fuel can be delivered in its gaseous state, the low density would mean frequent stops at filling stations, so liquid is the prefered option. Although experimental hydrogen filling stations do exist, the technology is still in its infancy and rapid proliferation is unlikely.

So which fuel is likely to become dominant in this century? If we assume that relying on mineral oil-based fuel is not an option, then in the short to medium term we may see a steady increase in the use of hybrids, but with bio-fuels instead of diesel or gasoline. Taxation may play a part and lower fuel taxes for bio-fuels are crucial for further uptake.

Another thing that is crucial for future fuels is image. For years environmentally friendly vehicles have been perceived, rightly or wrongly, as being slow and dull to drive. Hopefully motorsport can change that image, as will better vehicles available for the general public to buy.

Looking to the longer term, it's probably going to be hydrogen that keeps us all mobile. How fuel cells fair against more conventional engines will be interesting to see... could the piston engine still be the dominant power plant in another 100 years? ■

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