POWER SUPPLY

THE INTERNAL COMBUSTION ENGINE WILL STILL HAVE A KEY ROLE TO PLAY AFTER 2040, SAYS MAHLE POWERTRAIN.

Engineers at MAHLE Powertrain are confident that the internal combustion engine (ICE) has a bright future up to 2040 and beyond, despite recent UK government announcements. Engine downsizing, hybridisation and alternative fuels all need to remain as part of OEMs' powertrain development strategies if performance and environmental targets are to be achieved.

Life for automotive manufacturers, especially in the powertrain department, is increasingly more complicated. Given the rush towards pure EVs by most global OEMs and the recent statement by the UK government to outlaw vehicle powertrains that solely run on fossil fuels by 2040, it's easy to see why many powertrain engineers see themselves at a technology crossroads.

And, while political aspirations in the UK and other western economies are anticipating an EV-only future, pragmatic engineers need to balance political desires with the laws of physics. Whatever the detail of the 2040 diktat, it's highly likely that some form of engine hybridisation will be central to powertrain development for the next few decades at the very least.

Moreover, the recently introduced Real-world Driving Emissions (RDE) test puts OEMs under even more pressure to deliver clean, efficient engines. Given the much more dynamic and variable nature of the legislative requirements facing vehicle manufacturers, MAHLE Powertrain is taking a much more consultative approach to the engine development process. Rather than designing, building and testing internal combustion engines to order, the team is increasingly providing OEMs with advice and guidance on the best powertrain fit, given a host of different variables including vehicle power needs, fuelling infrastructure and the political environment.

Mike Bassett, chief engineer at MAHLE Powertrain, said: **"The complex tapestry of available infrastructure, fuel type, local environmental targets and the OEMs' preferred powertrain technology puts a huge amount of responsibility on the vehicle manufacturer when it comes to deciding the most appropriate source of power. Be it pure EV, mild or full hybrid, gasoline, diesel, compressed natural gas (CNG) or even hydrogen, the choices can be a little bewildering."**

"And, given the speed of governments across the world to legislate towards zero tail-pipe emissions, this task will only become more onerous for powertrain teams within the global OEMs."

Consulting engineers at Northampton-based MAHLE Powertrain believe that OEMs need to keep their options open for as long as possible, before committing to a specific technology in the ICE, mild hybrid, full hybrid or pure EV category.

MAHLE Powertrain has been working intensely over recent years to develop a range of technologies that help OEMs to explore the options available in the areas of engine downsizing, alternative fuels and hybridisation.

Three areas of development where MAHLE Powertrain is investing significantly at present are engine downsizing, alternative fuel exploration and hybridization.

ENGINE DOWNSIZING

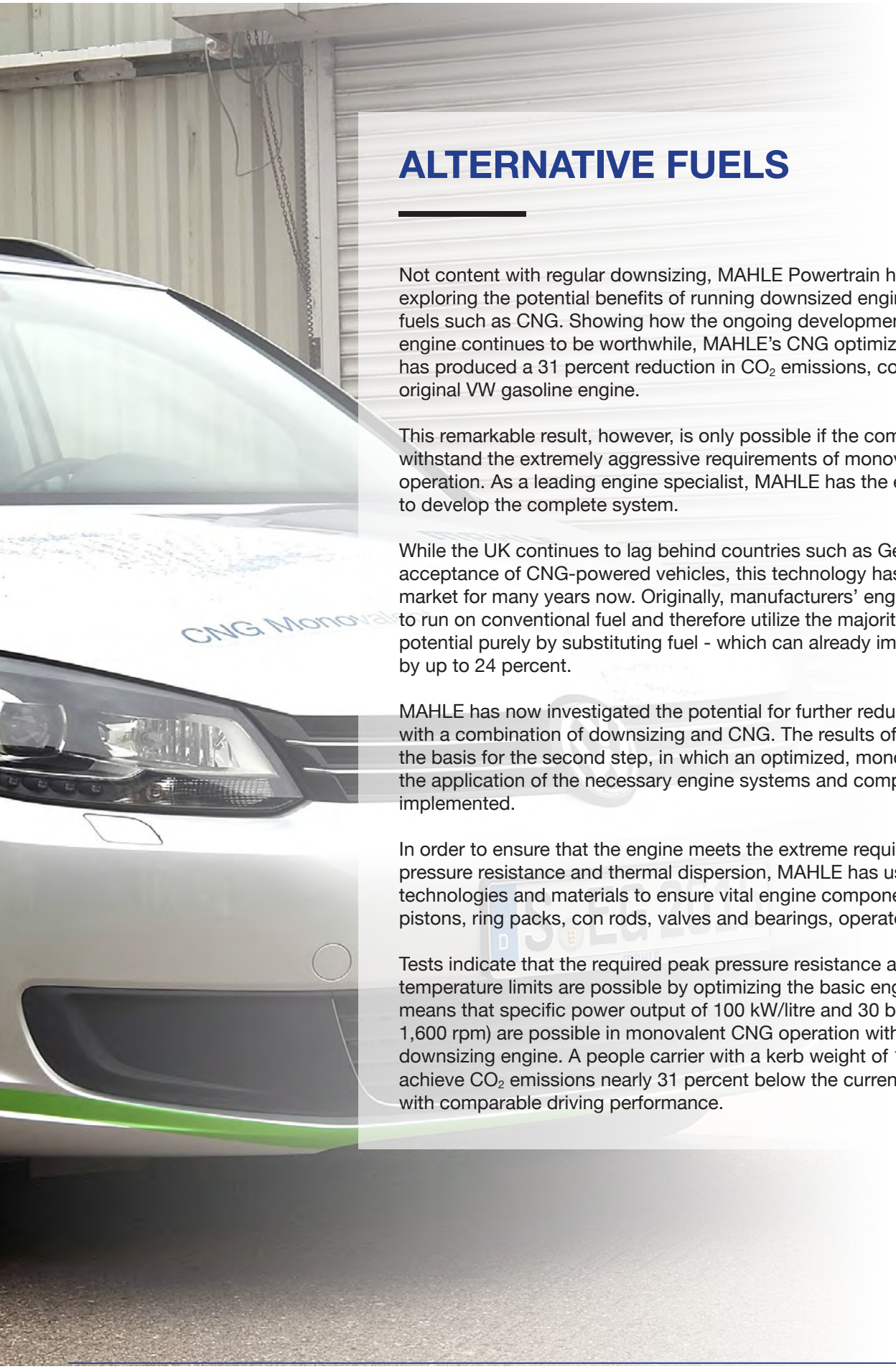
Back in 2007, the research team at Northampton began development on a new heavily downsized, 1.2 litre, 3-cylinder, gasoline engine which achieved, at that time, ground-breaking levels of specific torque (BMEP). Referred to as the DI-3 engine, this unit replaced the original V6 engine in a standard VW Passat.

Still representing the gold standard for engine downsizing, the DI-3 has gone on to impress designers and powertrain engineers across the world, thanks to the recent addition of a larger turbocharger, in conjunction with a 48V electric supercharger (developed by Aeristech Ltd). In this configuration, the DI-3 has the ability to generate 160 kW/litre and 35 bar BMEP – that's slightly more power than the 2.0 litre TGDI engine installed in the VW Golf GTi which was adapted by MAHLE Powertrain to showcase its eSupercharged DI-3 engine.

This latest demonstrator vehicle also features 48V mild-hybridisation and is able to recoup some of the energy normally lost during braking events, further helping with the power and efficiency of the complete system in the vehicle. MAHLE Powertrain is able to seamlessly integrate its technology into existing vehicles in a fast, and cost-effective manner, thanks to the introduction of MAHLE's Flexible ECU (MFE) – a development control unit, including software, that allows extremely rapid and flexible functional integration and comprehensive implementation of processes from the first prototype to series production.

Mike Bassett commented:

> **"With the new RDE test procedures now in force, getting the most efficient performance possible out of downsized engines over a wide operating range is the key challenge over the coming years, as OEMs seek to meet forthcoming vehicle CO_2 targets. 48V mild-hybridisation is set to be a key technology which is widely adopted to help achieve these targets."**



ALTERNATIVE FUELS

Not content with regular downsizing, MAHLE Powertrain has also been exploring the potential benefits of running downsized engines on alternative fuels such as CNG. Showing how the ongoing development of the combustion engine continues to be worthwhile, MAHLE's CNG optimized engine design has produced a 31 percent reduction in CO_2 emissions, compared to the original VW gasoline engine.

This remarkable result, however, is only possible if the components can withstand the extremely aggressive requirements of monovalent CNG operation. As a leading engine specialist, MAHLE has the expertise required to develop the complete system.

While the UK continues to lag behind countries such as Germany in the acceptance of CNG-powered vehicles, this technology has been on the market for many years now. Originally, manufacturers' engines were designed to run on conventional fuel and therefore utilize the majority of the CO_2 potential purely by substituting fuel - which can already improve emissions by up to 24 percent.

MAHLE has now investigated the potential for further reducing CO_2 emissions with a combination of downsizing and CNG. The results of this work formed the basis for the second step, in which an optimized, monovalent design and the application of the necessary engine systems and components will be implemented.

In order to ensure that the engine meets the extreme requirements for pressure resistance and thermal dispersion, MAHLE has used an array of new technologies and materials to ensure vital engine components, such as the pistons, ring packs, con rods, valves and bearings, operate to an optimal level.

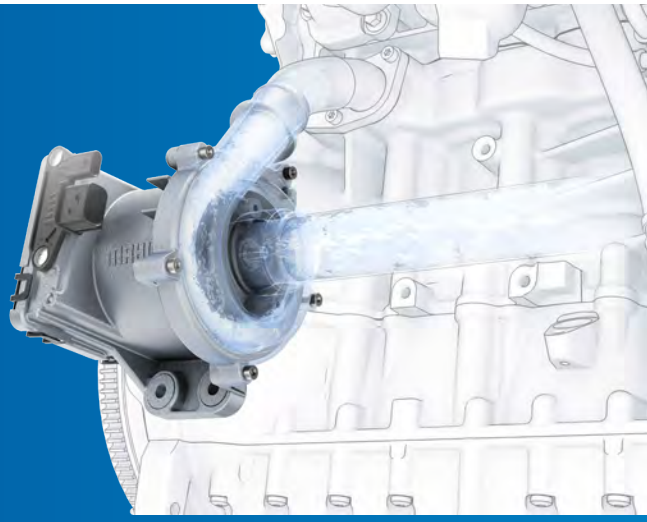
Tests indicate that the required peak pressure resistance and higher temperature limits are possible by optimizing the basic engine. This also means that specific power output of 100 kW/litre and 30 bar BMEP (above 1,600 rpm) are possible in monovalent CNG operation with the MAHLE downsizing engine. A people carrier with a kerb weight of 1,800 kg can thus achieve CO_2 emissions nearly 31 percent below the current gasoline variant with comparable driving performance.

HYBRIDISATION

MAHLE's eSupercharged, downsized, 48V demonstrator vehicle is a prime example of the mild-hybrid engine in action. However, hybridization should not be restricted to immediate support of the combustion engine, with boosting, start-stop functionality, or hybridization, for instance. MAHLE's experience points to a far more integral role that should entail advanced measures in the vehicle, such as thermal management or the electrification of engine accessories.

Mike Bassett explains:

> **"We've shown that even relatively small steps in electrification can achieve a sustainable effect in the combustion engine powertrain with a conventional 12V electrical system. For example, electric actuators enable faster and more precise control of the combustion engine. Simply by replacing the pneumatic wastegate actuator with an electric variant, which MAHLE has been supplying for large-scale production applications since 2009, CO_2 savings of approximately two percent can be achieved. Rounded out by additional 'light' electrification steps, such as electric thermostats, EGR valves, power steering motors, and stop-start functionality, CO_2 savings of up to eight percent in total can be demonstrated."**



MAHLE 48V coolant pump reduces CO_2 emissions

Indeed, electrification of engine accessories provides further off-loading and support of the combustion engine. When uncoupled from the belt drive, not only do these provide packaging advantages owing to discretionary placement options, but mechanical losses in the combustion engine are also eliminated. The energy for electric engine accessories can be produced by means of recuperation (KERS–like technology).

Specifically, with the 48-volt electrical system in mind, MAHLE anticipates a high prevalence of electric engine accessories and is continuously expanding its portfolio to include electric coolant pumps, air conditioning compressors and radiator fans, among others.

THE ROAD AHEAD

Given the fast-moving nature of the various emissions regulations across different territories, the choices facing powertrain engineers for future models is complex. While the powertrain technologies available - such as EVs, CNG, hydrogen fuel cells or mild / full hybrids, is almost endless – one thing is certain; the internal combustion engine will continue to play a central role in vehicle propulsion for decades to come.

The role of consultancies such as MAHLE Powertrain is to support OEMs through the complete powertrain development process, from initial scoping, through to prototyping, testing, vehicle integration and final assembly. And, with so many exciting new developments on the horizon, MAHLE Powertrain continues to invest in the technology and facilities that put it and its clients ahead of the curve.