AUTOMATION

Can automated vehicles help save carbon?

With all the hype around automated vehicles, can the technology help improve energy use and emissions from transport? Or is there no benefit? *Neil Wallis* and *Dr Zia Wadud* explore.

Barely a week passes without further news or speculation about developments in the area of vehicle autonomy. The idea of the 'self-driving car' has moved beyond the automotive and specialist press and captured the imagination of the wider public and media.

A host of industry and associated stakeholders have joined the bandwagon, heralding autonomous vehicles as the standard-bearers of 'the fourth industrial revolution'.

Politicians have not been slow to seize the opportunity. 'Driverless cars will see our journeys become faster, cleaner and safer. The UK is leading the way in developing the technology needed to make this a reality thanks to our world-class research base,' said Sajid Javid, former Secretary of State for Business, Innovation and Skills last Spring. 'Such advances in technology prove the fourth industrial revolution is just around the corner and our determination to be at the forefront is why we're attracting top names from across the globe for real-world testing,' he said.

The UK's Department for Transport (DfT) says there are, potentially, five key benefits from the adoption of connected and automated vehicles (CAVs):

- creating more 'free time' for vehicle users while travelling;
- improving safety;
- reducing emissions;
- easing congestion; and
- increasing access to vehicles for everyone.

Recognising the potential in this area, the Departments of Transport and Industry have set up a separate division with a budget of £200mn to oversee developments in this area – the Centre for Connected and Automated Vehicles (CCAV).

Research by KPMG also highlights the potential economic benefit to the UK of CAVs, suggesting that a high level of automation could result in the creation of 25,000 new manufacturing jobs, and 320,000 additional new jobs in total. KPMG also backs up the DfT's claim on safety, projecting a reduction of 25,000 accidents saving 2,500 lives and an extra £51bn of economic and social benefit per year by 2030.

While the excitement around this emerging technology is reaching fever pitch, how can we differentiate the reality from the hype?

Levels of automation

Earlier this year, the Low Carbon Vehicle Partnership (LowCVP) and the Institution of Mechanical Engineers (IMechE) commissioned the University of Leeds Institute for Transport Studies to investigate one key area – what is the potential for cutting emissions resulting from the introduction of greater levels of vehicle autonomy and connectivity?

The resulting report, *Automated Vehicles: Automatically low carbon?* was presented at the LowCVP's annual conference in June.

As the Leeds University report explains, it is important to initially clarify the vocabulary around CAVs. The terms 'autonomous' and 'automated' vehicles are not interchangeable; rather the key characteristics are automation and connectivity. Vehicle automation can take place alongside connectivity, for example between vehicles or between vehicles and infrastructure, or both, in order to coordinate traffic.

Also, not all automated vehicles are driverless. Far from it, in fact. The Society for Automotive Engineers (SAE) identifies five levels of automation (**see Table 1**), and only Level 5 is the truly driverless one in which the vehicle can go from point A to B without any driver intervention after the destination is fixed. Many high-end vehicles already come equipped with Automated Driver Assistance Systems (ADAS), and this falls within Levels 1 and 2 of the SAE definition. However, Levels 3 to 5 – high to full automation – have been confined to carefully controlled trials.

Moving to these higher levels of automation depends not just on the development of robust and fully tested technology but on radical revisions to the regulatory environment surrounding road-use and associated issues such as driver training, insurance and, possibly, road design and layout. It looks likely that some of these challenges may prove more intractable than the on-vehicle technology.

Volvo Cars plans to begin one of the UK's most ambitious automated driving trials next year, aiming to speed up the introduction of the technology with plans to also use real families in the trials. Unsurprisingly for a carmaker that has built a reputation on vehicle safety, Volvo focuses on the potential reduction in accidents.

Volvo says that 'Drive Me London' will begin in early 2017 with a limited number of semi-autonomous driving cars and expand in 2018 to include up to 100 autonomous cars.

Automated carbon reductions?

The Leeds report for the LowCVP focused on validating the claim that CAVs will reduce overall vehicle emissions and contribute to progress on carbon and anti-pollution targets.

The implications of growing automation in the automotive sector are complex and difficult to predict with certainty. Some of the claims made for fully automated cars may undermine other objectives. If, for example, the adoption of CAVs creates more free time for vehicle users this would be expected to increase the demand for mobility and thus limit progress on cutting congestion and emissions.

The study suggests that a combination of connectivity, automation plus shared vehicle

> *In order to make car travel greener with fully automated vehicles, much more work needs to be done to encourage shared car ownership or the development of 'mobility service' provision as an alternative to private ownership*

ownership and use has the potential to make car travel greener and cheaper, cutting energy use and helping accelerate the introduction of low carbon vehicles. However, these energy and carbon benefits are by no means guaranteed and will require strategic policy interventions to maximise their positive impacts.

The prospects for system-wide improvements in energy efficiency and emissions may derive more from progress through coordination and 'smart connectivity' between vehicles and infrastructure than as a direct result of vehicle automation, though the latter can also offer benefits.

Several other specific conclusions emerged:

- The net impact of the technical developments will ultimately depend on how their introduction spurs further innovation in vehicle and transport system design combined with mobility service provision.
- At full automation (ie 'driverless' vehicles), the efficiency and emissions impacts are highly dependent on the degree to which the current paradigm of individual private car ownership transitions to new models of shared access and use.
- Automation and connectivity together can result in some vehicle-level energy efficiency benefits.
- Full automation could help to accelerate the transition to low carbon vehicles by reducing the practical difficulties often anticipated with these vehicles such as refuelling or recharging.
- Most of the large-scale benefits of fully automated vehicles can only materialise when they are widespread and affordable, which is likely to take several decades.
- There is a real risk of an increase in travel and so associated energy use and carbon emissions.

These findings suggest that automated vehicles are clearly not – at least, automatically – going to be the panacea for tackling climate change or dealing with air quality problems. The potential benefits or costs to the society depend not on the technology, but on how we use this technology. Achieving the desired combination of outcomes related to carbon, energy, air quality, safety and accessibility will need careful, synergistic and timely policy design with coordination between the automotive and telecommunication industries, transport system operators and mobility service providers.

	SAE level	Name	Steering, acceleration, deceleration	Monitoring Driving Environment	Fallback Performance of Dynamic Driving Task	System Capability (Driving Modes)	Timeline
Human monitors environment	0	**No automation** The full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	🧍	🧍	🧍	n/a	Now
Human monitors environment	1	**Driver assistance** The *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	🚗 🧍	🧍	🧍	Some driving modes	Now
Human monitors environment	2	**Partial automation** The *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	🚗	🧍	🧍	Some driving modes	Now
Car monitors environment	3	**Conditional automation** The *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	🚗	🚗	🧍	Some driving modes	2017
Car monitors environment	4	**High automation** The *driving mode*-specific performance by an automated driving system of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	🚗	🚗	🚗	Some driving modes	2025
Car monitors environment	5	**Full automation** The full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	🚗	🚗	🚗	All driving modes	2025

Table 1. Different levels of automation (adapted from SAE and KPMG)

Source: LowCVP

Innovative policies and regulations

In order to make car travel greener with fully automated vehicles, much more work needs to be done to encourage shared car ownership or the development of 'mobility service' provision as an alternative to private ownership. Government policy can provide a supportive environment for new mobility services to develop by delivering open data protocols, supporting technology incubation and providing local authorities with resources to enhance skills and offer incentives to local mobility service companies.

New style regulations or innovative policies are also likely to be required to encourage manufacturers to provide efficiency optimising features like automated eco-driving, eco-routing, platooning or energy saving algorithms in the vehicles.

The first known death resulting from the operation of a self-driving car – in May this year – was recently disclosed by Tesla Motors. A Tesla blogpost said: 'Against a bright spring sky, the car's sensors system failed to distinguish a large white 18-wheel truck and trailer crossing the highway. The car attempted to drive full speed under the trailer, with the bottom of the trailer impacting the windshield of the Model S.'

There have also been several crashes involving Google's self-driving cars since they began testing last year but the company says all the crashes were a result of human error. However the accidents raised doubts about the cost of maintaining driverless cars, should damage to their sensors and other equipment be caused as a result of errors by human drivers.

We know that there are risks – as there are for most new technologies. We need to be careful, proactive and to work in partnership to resolve the difficulties and challenges to reap the greatest potential benefits of vehicle automation and intelligent connectivity. ●

Neil Wallis is Head of Communications at the LowCVP and Dr Zia Wadud is Associate Professor at the University of Leeds Institute for Transport Studies.

The Automated Vehicles: Automatically low carbon? study can be viewed at **bit.ly/2dPmRwD**