Table of contents

V. Connected autonomous vehicles: the future of mobility and their role in achieving net zero

Charles Christie
Nathalie Moreno
William Smith
Addleshaw Goddard

1. Introduction

The automotive industry is undergoing a revolutionary transformation, propelled by advancements in technology and the pursuit of safer, more efficient transportation. At the forefront of this transformation are connected autonomous vehicles (CAVs), which combine the power of connectivity, artificial intelligence and automation to redefine the driving experience.

In this chapter, we will look at the potential of CAVs, the existing legislative landscape and the work needed to be done to allow the widespread introduction of CAVs on public highways.

2. Understanding connected autonomous vehicles

CAVs are vehicles equipped with advanced technologies that enable them to operate without human intervention, using a combination of sensors, cameras, radar systems and sophisticated algorithms in combination, to enable a CAV to understand its immediate surrounding environment sufficiently such that it can determine the calculated risks and make appropriate 'decisions' accordingly.

CAVs communicate with their surroundings, including other vehicles, infrastructure, and even pedestrians, through wireless connectivity. The Occupational Road Safety Association reports that 94% of road

traffic incidents are attributable to human error. A significant 42% of the 118,404 UK road traffic incidents analysed by British police in 2011 were caused by a driver failing to look properly. A further 21% were caused by a driver failing to judge the other vehicle's speed and path.[1] It is widely understood that the introduction of CAVs would remove this element of human error from the driving activity in favour of a form of artificial intelligence which would determine calculated actions based on the surrounding environment and known variables such as weather. In theory this will be a significant step towards enhancing safety on the roads.

3. Self-driving and levels of automation

The level of automation of a CAV can differ greatly, and some vehicles will be advertised as having autonomous vehicle capabilities without really being capable of driving without a human. Indeed, in response to investigations by the US National Highway Traffic Safety Administration and the Securities Exchange Commission in 2022 a class action was brought by drivers against Tesla for overstating the company's 'Autopilot' technology. This was followed by a claim by Tesla shareholders in February 2023 when the Tesla share price fell 5.7% on 16 February 2023 following the recall of Tesla vehicles instigated by the US National Highway Traffic Safety Administration.

To provide a clear framework for categorising the various levels of automation in vehicles, The Society of Automotive Engineers established the classification system that we've adapted in Table 1.

4. Benefits of connected autonomous vehicles

CAVs offer an array of capabilities that can revolutionise the way we travel:

- *Enhanced safety:* CAVs leverage advanced sensor systems and artificial intelligence algorithms to continuously monitor their surroundings, detecting potential risks and reacting faster than human drivers. They can mitigate accidents caused by human errors, such as distracted driving or fatigue.
- *Improved efficiency:* By leveraging real-time data and communication with other vehicles and infrastructure, CAVs optimise traffic flow, reducing congestion and improving fuel efficiency. They can also choose the most efficient routes based on traffic conditions and environmental factors.
- *Intelligent navigation:* Connected features allow CAVs to access up-to-date mapping and traffic information, enabling them to make informed decisions about the best routes and avoid road closures or traffic jams. This results in faster and smoother journeys.
- *Seamless connectivity:* CAVs enable passengers to stay

Table 1: Levels of automation in vehicles

Level 0	No automation	At this level, the vehicle is entirely controlled by a human driver, with no automated assistance or features.
Level 1	Driver assistance	Level 1 introduces basic automation features, such as cruise control or lane-keeping assistance, which can assist the driver but still require their continuous attention and control.
Level 2	Partial automation	Vehicles at this level offer more advanced driver-assistance systems, capable of simultaneously controlling steering, acceleration and braking under certain conditions. However, the driver is still responsible for monitoring the driving environment.
Level 3	Conditional automation	Level 3 vehicles can take full control of the driving task under specific conditions and environments, allowing the driver to disengage from actively monitoring the vehicle. However, the driver must be ready to resume control when prompted by the vehicle.
Level 4	High automation	At this level, the vehicle can perform all driving functions under predetermined conditions and environments without requiring any human intervention. However, a human driver can still take control if needed.
Level 5	Full automation	Level 5 represents the pinnacle of automation, where vehicles are fully capable of operating independently without any human interaction, regardless of the environment or driving conditions.

Source: Table created by authors based on The Society of Automotive Engineers classification system.[2]

connected to the digital world while on the move. With integrated infotainment systems, passengers can access entertainment, productivity tools and stay connected to their devices, enhancing the overall travel experience. This connectivity even extends to the ability for vehicle users to make payments (whether for parking, road tolls or even cinema and theatre tickets) electronically via the vehicle – much like contactless payments on mobile phone devices today.

- *Eco-friendly transportation:* The advanced algorithms and connectivity in CAVs enable efficient energy management. They can optimise speed, acceleration and braking, reducing fuel consumption and emissions, thereby contributing to a greener future.

5. Connected autonomous vehicles and net zero

Specifically, the adoption of CAVs can play a significant role in supporting the push for net zero mobility. Ways in which CAVs can contribute to achieving a transport system with minimal or no greenhouse gas (GHG) emissions include:

- *Electrification:* CAVs are often designed with electric or hybrid powertrains, reducing or eliminating reliance on fossil fuels. Electric vehicles (EVs) produce zero tailpipe emissions and, when coupled with renewable energy sources (for use in both the manufacturing process and the powering of the CAV), they offer a cleaner and greener alternative to traditional internal combustion engine (ICE) vehicles. CAVs can accelerate the transition to electric mobility by driving demand for EVs and supporting the expansion of charging infrastructure.
- *Efficiency and traffic optimisation:* CAVs can optimise traffic flow and reduce congestion through advanced communication and coordination between vehicles. By leveraging real-time data, CAVs can choose the most efficient routes, adjust speeds to minimise stop-and-go traffic and optimise energy consumption. This leads to reduced fuel consumption and emissions, making transportation more environmentally friendly.
- *Eco-driving and energy management:* CAVs can employ advanced algorithms and predictive analytics to optimise energy management. By analysing factors such as traffic conditions, road topography and weather patterns, CAVs can optimise acceleration, deceleration and cruising speeds to maximise energy efficiency. This eco-driving approach helps minimise energy waste and reduce emissions.
- *Modal shift and shared mobility:* CAVs can facilitate a shift from individual car ownership to shared mobility models. By providing convenient, on-demand transportation, CAVs can encourage people to use shared services like ride-hailing and carpooling. Shared mobility reduces the overall number of vehicles on the road, leading to lower emissions and overall improved resource utilisation.
- *Intelligent infrastructure integration:* CAVs can interact with smart infrastructure to enhance efficiency and sustainability. For instance, they can communicate with traffic signal systems to optimise signal timings, reducing idle times and congestion. CAVs can also utilise infrastructure-integrated charging stations,