CONNECTED AND AUTOMATED MOBILITY: THE UK ECONOMIC AND MARKET OPPORTUNITIES

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To unlock the full economic and social benefits of CAM we must now take the next step and ensure the UK becomes a leading location for its commercial rollout

CONTENTS

THE £66 BILLION OPPORTUNITY

For more than a century, the UK has been at the forefront of technological innovation that shaped the movement of people and goods. Today, the UK automotive sector is investing in connected and automated mobility (CAM) technology that will shape mobility for the next century and improve the way we travel and goods are delivered.

Thanks to government-industry partnership that stretches back to early 2015 when the first CAM collaborative R&D and demonstration projects began, the UK has come a long way and is today one of the leading locations in the world for testing and trialling CAM technology. However, to unlock the full economic and social benefits of CAM it is essential that we now expend every effort to take the next step and ensure the UK also becomes a leading location for the commercial rollout of CAM.

The arrival of CAM will enable the British public to experience increased safety benefits, potentially lower insurance premiums in the future and more comfortable and less stressful journeys, while businesses and sectors such as logistics, agriculture, mining, construction, public administration and defence could benefit from more efficient movement of goods and industrial processes. CAM could also offer people with restricted mobility, or who are unable to drive, the freedom to travel and has the potential to improve traffic efficiency when deployed in substantial numbers, leading to better air quality and lower emissions. But perhaps the most significant benefits of CAM are those that could accrue to the UK economy, creating jobs, spawning new business models and driving growth across automotive and other related sectors.

To better understand and quantify the potential economic opportunity of CAM to the UK, SMMT, working with and funded by Innovate UK, along with partners the Automotive Council and Zenzic, commissioned consultants KPMG to conduct a study. The study sought to answer the following questions:

- What are the potential socio-economic benefits of CAM to the UK?
- In which sectors are the highest growth opportunities for CAM technology likely to be found?
- What are the key enablers towards realising the socio-economic opportunities?

The study's key findings show that CAM could deliver annual economic benefits as high as £66 billion by 2040 and an estimated additional 342,000 additional jobs overall in the economy, of which 12,250 are in automotive manufacturing. The technology is also expected to save 3,900 lives and prevent 60,000 serious accidents between now and 2040.

However, realising the significant socio-economic benefits that CAM has the potential to offer is highly dependent on several key government interventions that will pave the way for a safe and well-planned commercial rollout of CAM. These range from bringing forward regulatory reforms and committing to an ambitious package of funding support to widening skills development and implementing a proactive public communications programme jointly with industry.

Mike Hawes Chief Executive
The Society of Motor Manufacturers and Traders (SMMT)

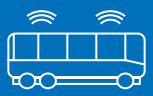
CONNECTED AND AUTOMATED MOBILITY

What is CAM?

Connected and automated mobility (CAM) refers to vehicles with technology that enables them to safely drive themselves with no human input in some places and conditions[1] and to connect with each other and the infrastructure, as well as the services that are spawned by the application of the technology.

CAM CAN GENERALLY BE UNDERSTOOD IN TERMS OF THREE OVERARCHING APPLICATIONS:

Passenger cars fitted with automated driving features



Automated passenger services

Automated delivery, logistics and industrial vehicles

Table 1: **The applications of connected and automated mobility**

Applications	Passenger cars fitted with automated driving systems	Automated passenger services	Automated delivery, logistics and industrial vehicles
Brief description	– Nominally with a driver who is able to resume driving whenever personally desired or requested by the vehicle – SAE Level 3 or SAE Level 4	– Services/operations run by an operator – Likely to be operated without a driver and vehicle could have no steering wheels and pedals – Could include some form of remote driving (teleoperation) – SAE Level 4	– May be used with or without a driver – If without a driver, services/operations are likely overseen by an operator and vehicle could have no steering wheels and pedals – Could include some form of remote driving (teleoperation) – SAE Level 4
Examples of high-level use cases and sectors	– Automated Lane Keeping System (low and/or high speed, motorway only) – Advanced highway pilot (high speed, motorway only) – Urban traffic pilot – Automated Valet Parking (the only example where no driver is needed)	– Pods, shuttles and robotaxis for on-demand ride-hailing or scheduled services. – Self-driving buses/minibuses for on-demand ride-hailing or scheduled services. – Off-road services for on-demand ride-hailing or scheduled services; could be in public spaces (e.g. university campus) or on private land (e.g. factories, resorts)	– Adapted vans or bespoke light commercial vehicles for urban and/or last mile goods deliveries. – Trucks, vans or adapted heavy duty vehicles inter-urban, middle mile and/or port-to-hub/depot logistics. – Specialist off-road logistics and industrial vehicles; most likely on private land (e.g. construction sites, airports, ports, factories, quarries, mines, farms)

State of technology and market readiness

Passenger cars fitted with Automated Lane Keeping System (ALKS), the world's first internationally approved automated driving feature established under UN Regulation 157, are now commercially available in certain markets. Britain now has the necessary regulations in place to allow for the arrival of the first cars fitted with this feature. A government-commissioned study suggests 40% of new cars in the UK could have automated driving capabilities by 2035[2].

Automated ride-hailing services that carry fee-paying passengers are already running in several cities in the US and China. Automated long-haul trucks and middle-mile commercial vehicles carrying goods are currently being commercially deployed in several states in North America, while specialist automated industrial vehicles are already being used in enclosed private land such as mines, quarries and factories in several places around the world. Commercial rollout of these "driverless"[3] services on British roads and public spaces is not yet possible until the necessary regulatory reforms are completed.

Meanwhile, most new cars and vans on British roads today are equipped with some form of connectivity that enables them to connect to mobile networks. This enables the rollout of connected vehicle and telematics services such as infotainment, traffic advisory, WiFi hotspot and fleet management. In the future, it is expected that short-range communications technology will be more widely available in vehicles, thus enabling the commercial introduction of vehicle-to-vehicle and vehicle-to-infrastructure communication services.[4]

Since 2015 government and industry have jointly invested over £600 million in more than 100 CAM projects involving collaborative research and development, trials, demonstrations, feasibility studies and the creation of testbeds. This considerable investment has resulted in the creation of homegrown CAM capabilities including technology developers and component suppliers. The Law Commission had also completed an extensive four-year regulatory review, the recommendations from which now form the basis for forthcoming wider regulatory reforms.

While the UK is already one of the leading locations in the world for testing and trialling CAM technology, government and industry must now embark on the next phase by working closely to ensure the UK also becomes a leading location for the deployment of CAM. This will involve addressing the following four challenges:

- Maturing the technology to ensure it is safe and operational in its intended environments;
- Passing legislation and developing a fit-for-purpose regulatory framework for deployment;
- Educating the public to build social acceptance and ensure safe and responsible use of the technology; and
- Spawning the right business models to deliver on the sizeable economic promise of CAM.

Government and industry have invested over £600 million in more than 100 CAM projects

The study

Is there evidence to support the notion that CAM has the potential to deliver innovation-driven economic growth to the UK? Through a combination of rigorous qualitative and quantitative methods that involved in-depth interviews with industry, stakeholders and, crucially, potential CAM customers across various sectors; an extensive survey; comprehensive literature review; and economic modelling using a Computable General Equilibrium approach, KPMG carried out a study on our behalf to better understand and quantify the potential economic opportunity of CAM to the UK. Evidence from the study was combined with deep industry insights to produce several key recommendations. Salient findings from the study are summarised in the following sections.

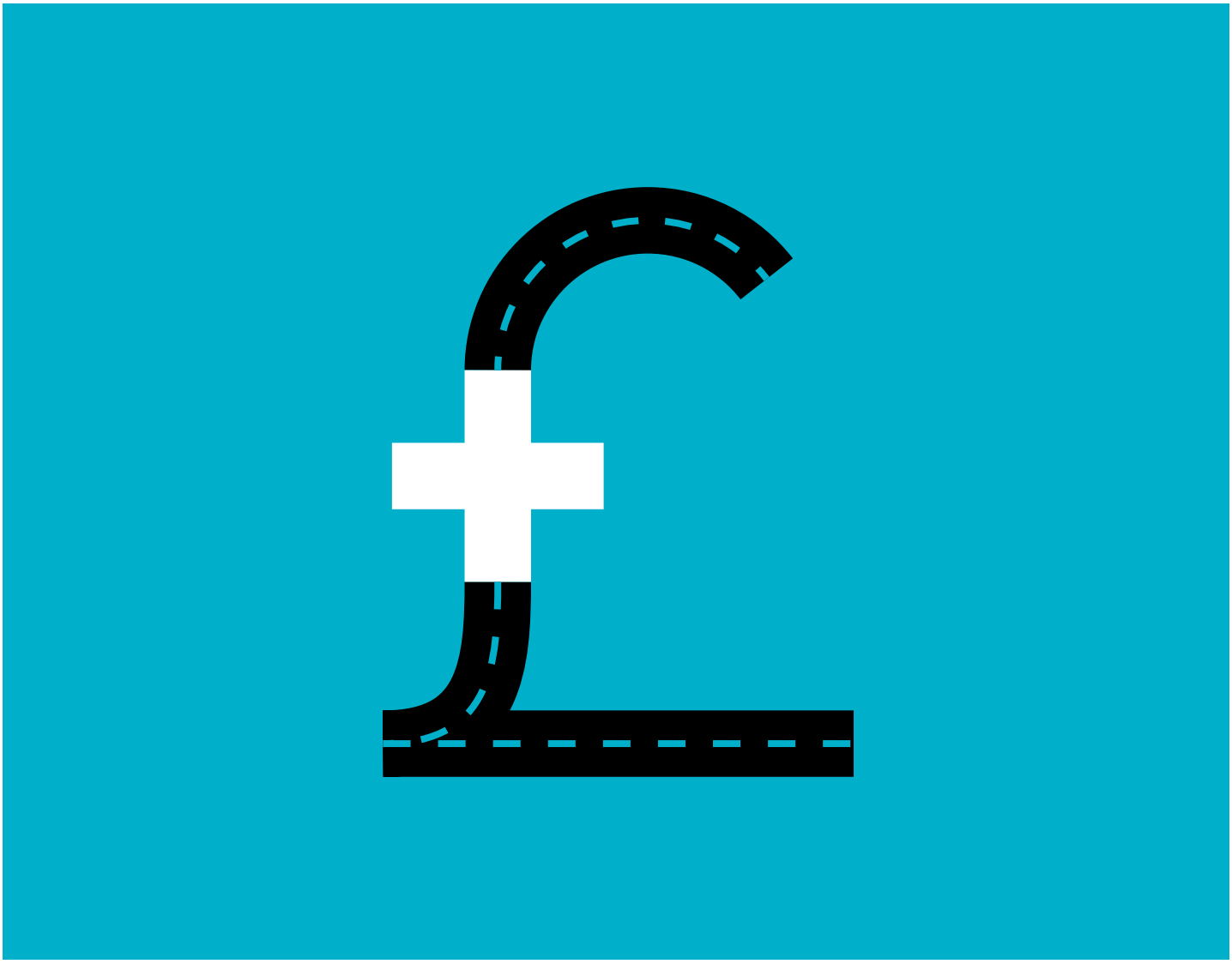
1 An automated vehicle is a vehicle equipped with an automated driving system and defined under the Automated and Electric Vehicles Act 2018 as "designed or adapted to be capable, at least in some circumstances or situations, of safely driving themselves" and "may be lawfully used on roads or other public places in Great Britain". This definition is compatible with Levels 3 and above under the industry convention SAE J3016 and international technical regulation under the auspices of the UNECE.

2 Connected Places Catapult (2021), Market Forecast for Connected and Autonomous Vehicles, available at https://assets.publishing.service.gov.uk/media/5f64af8fd3bf7f7238f230a3/connected-places-catapult-market-forecast-for-connected-and-autonomous-vehicles.pdf.

3 The term "driverless" used in this report refers to No User-in-Charge (NUIC) vehicles as defined by the Law Commission of England and Wales and the Scottish Law Commission. A NUiC vehicle is a vehicle equipped with one or more automated driving features designed to perform the entire dynamic driving task without an individual who is in the vehicle and in a position to operate the driving controls while an automated driving feature is engaged.

4 Examples of short-range vehicular communication services, using technology and radio spectrum that are different to the more common cellular-based long-range communications, include Green Light Optimal Speed Advisory (GLOSA), In-vehicle Signage, Emergency Vehicle Warning, Intersection Collision Warning and Electronic Emergency Brake Warning.

01
THE POTENTIAL SOCIO-ECONOMIC IMPACT OF CAM



Economic impact framework and key assumptions

CAM has the potential to create significant economic opportunities for commercial and non-commercial users, the producers of the technology and the corresponding supply chain, as well as deliver substantial welfare impacts for society. To reflect economic theory, our analytical framework (Figure 1) separates real economic impacts from welfare impacts in order to provide an understanding of the overall opportunity for different users, as well as for the economy and society as a whole. A brief explanation of each component can be found in Appendix A.

All three CAM applications set out in Table 1 (see page 4) are included in the analytical framework. Based on insights from a survey, stakeholder interviews and literature research, it is assumed that, enabled by regulatory reforms and supportive private-public investment, CAM adoption in the UK begins in earnest in the second half of this decade and becomes commercially widespread by the end of the 2030s. These assumptions on the scale and pace of CAM adoption are set out in Tables 2 and 3.

Table 2: **Assumptions on adoption of connected and automated mobility in on-road vehicles by 2040**

On-road vehicle types	Proportion of on-road vehicles in the motorparc that are		
	Connected	SAE Level 3 conditionally automated	SAE Level 4 highly automated
Cars, taxis and private hires (including ride hailing)	87%	10%	14%
Light commercial vehicles	87%	7%	9%
Heavy commercial vehicles	87%	3%	12%
Buses and coaches	87%	7%	9%

Figure 1: Analytical framework for the economic and social impact of connected and automated mobility

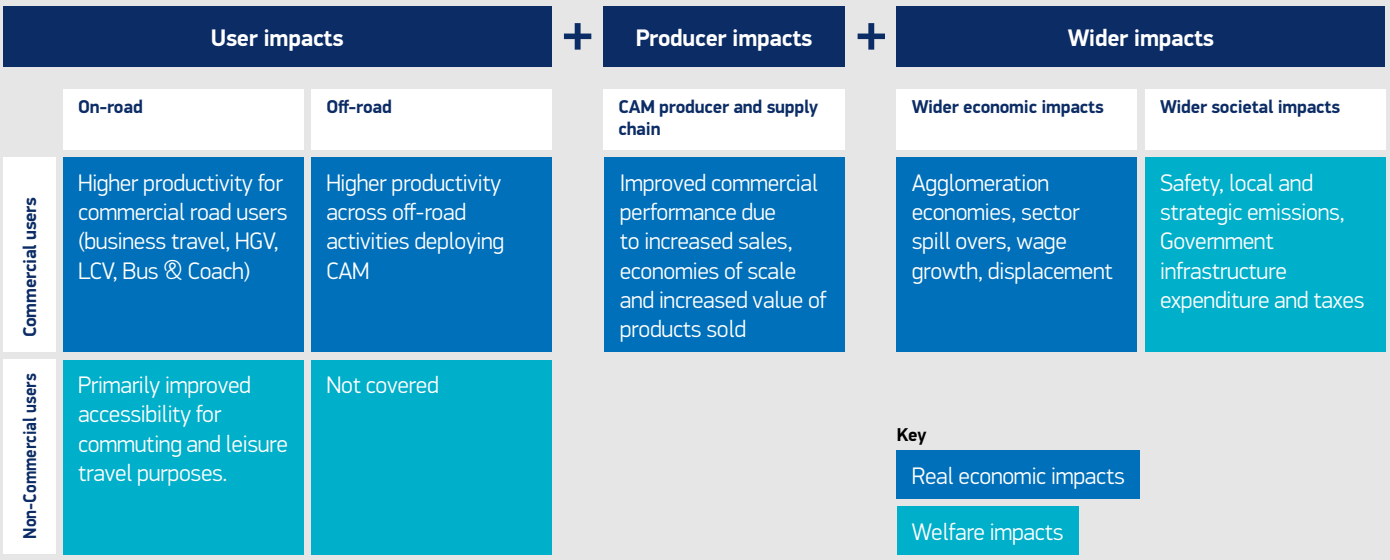


Table 3: **Assumptions on adoption of connected and automated mobility in off-road vehicles**

Sector	Assumed year of use case initial adoption	Asset lifecycle	Implied adoption rate relative to on-road
Off-road logistics	2029	8-15 years	x3.0
Agriculture	2028	7-15 years	x2.0
Mining	2027	8 years	x3.0
Construction	2031	4-15 years	x1.5
Public administration and defence	2031	5-15 years	x1.0

The £66 billion prize

Assuming widespread adoption by 2040, relative to the baseline today, the annual economic benefit of CAM could be as high as £66 billion. Just over half of this total, £34 billion, is real economic impact, which accrues to improved commercial and business outcomes for CAM users, increased output from producers of CAM and enhanced opportunities for the wider supply chain and adjacent sectors such as telecoms, digital services, insurance, retail and media.

The remaining £32 billion is welfare impact, which includes benefits accruing to consumers who experience a transformation in the ease and efficiency at which they can travel, which in turn could lead to wider economic benefits and improved productivity. Another key societal benefit is expected to be improvement in on-road and off-road safety, with fewer fatalities and serious accidents, which could then create spillover economic effects such as reduced welfare and insurance payouts. There is likely to be an increase in the level of government expenditure on roads but this is offset in part by an increase in indirect and corporation taxes.

Sensitivity tests applied to the modelling suggest that the annual economic impact could range from £55 billion to £77 billion, with the real economic impact between £29 billion and £42 billion. Even the lower end of the sensitivity analysis shows that the economic impact of CAM is substantial enough to warrant its serious consideration as a high-potential engine of innovation-driven growth for the UK.

On-road CAM applications are expected to generate 63% (£42 billion) of the annual economic benefits by 2040, with the remainder (£24 billion) coming from off-road applications (see Figure 3, page 9). Among the on-road segments, private passenger cars and car-based passenger services such as taxis, private hires and ride-hailing are the dominant CAM use cases in terms of the impact on the economy, albeit mostly welfare rather than real economic impact, accounting for 87% (£36 billion) of the £42 billion opportunity delivered by on-road CAM applications.

While the £66 billion annual economic prize is significant, enhanced interventions could bring forward these benefits and deliver increased impact by 2040. For example, increased private-public investments that lead to earlier scale adoption of CAM could enhance the economic benefits by between 15% and 68% by 2040. Bringing the economic benefits forward by a year would deliver an additional £10 billion in total economic impact by 2040, while frontloading the benefits by three years would generate an additional £29 billion. Accelerated deployment that brings the benefits of early CAM adoption forward by five years would lead to an additional £45 billion of economic impact by 2040, which suggests the opportunity cost of not delivering the benefits of CAM earlier could be equally significant.

Figure 2: **The potential economic impact of connected and automated mobility by 2040**

	Impact Area	Central Scenario Impact (£bn)	Earlier adoption scenarios		
			1 year forward (£bn)	3 years forward (£bn)	5 years forward (£bn)
Users	Productivity increases and cost savings to on-road businesses	6	7	9	11
Users	Reduced journey times and improvements to non-commercial road users	35	41	52	61
Users	Increases in productivity and cost savings to off-road businesses	16	17	22	27
Producers	Increased demand and improved productivity for CAM producers and supply chain	3	3	3	3
Wider economic and societal	Safety benefits from lower on-road accidents and mobility accidents at work sites	3	4	5	5
Wider economic and societal	Wider economic impacts associated with increased road use and increases in taxation	10	12	15	17
Wider economic and societal	Cost due to increased vehicle usage	(7)	(8)	(11)	(13)
	Total impact	66	76 +10	95 +29	111 +45
	Real economic impact	34	39 +5	49 +15	58 +24

Impact on jobs and safety

It is estimated that CAM adoption will lead to an additional 342,000 jobs overall in the economy by 2040, of which 12,250 are additional jobs in automotive manufacturing. The manufacturing employment impact is relative to the increase in the Gross Value Added of the automotive manufacturing sector, while the jobs created in the wider economy are consistent with the relative increase in Gross Domestic Product aligned to the real economic impact of CAM.

These figures also imply significant spillover, or multiplier, effects that accrue to adjacent sectors, as substantial job creation occurs across the economy thanks to improvements in productivity and the greater mobility of workers. Adjacent sectors such as telecoms, retail and creative industries including digital and media will also generate additional jobs as they serve new markets created by CAM.

29,742 people were killed or seriously injured in road collisions in Britain in 2022[5], while human error is a contributory factor in up to 88% of all road traffic accidents[6]. Widespread CAM adoption could contribute to improvements in on-road and off-road safety, with an estimated 3,900 fewer fatalities and a reduction of around 60,000 serious accidents over the period between 2023 and 2040. The greatest proportion of these are in passenger vehicle segments, both privately owned cars as well as passenger transport services, which are expected to account for up to 80% and 87% of the reductions in fatalities and serious accidents respectively.

Connected vehicle features that warn of road hazards ahead or a vehicle approaching at speed at a blind intersection could reduce accidents by helping to improve driver decision making, while automated driving technology is likely to result in significant reduction in human errors that lead to accidents. Even in off-road environments, there could be a reduction of accidents between 15% and 78%, depending on use cases, due to a combination of a decrease in, or mitigation of, human errors and reduced time, or presence, of staff working in hazardous environments.

Figure 3: **On-road applications generate the greater proportion of economic benefits by 2040**

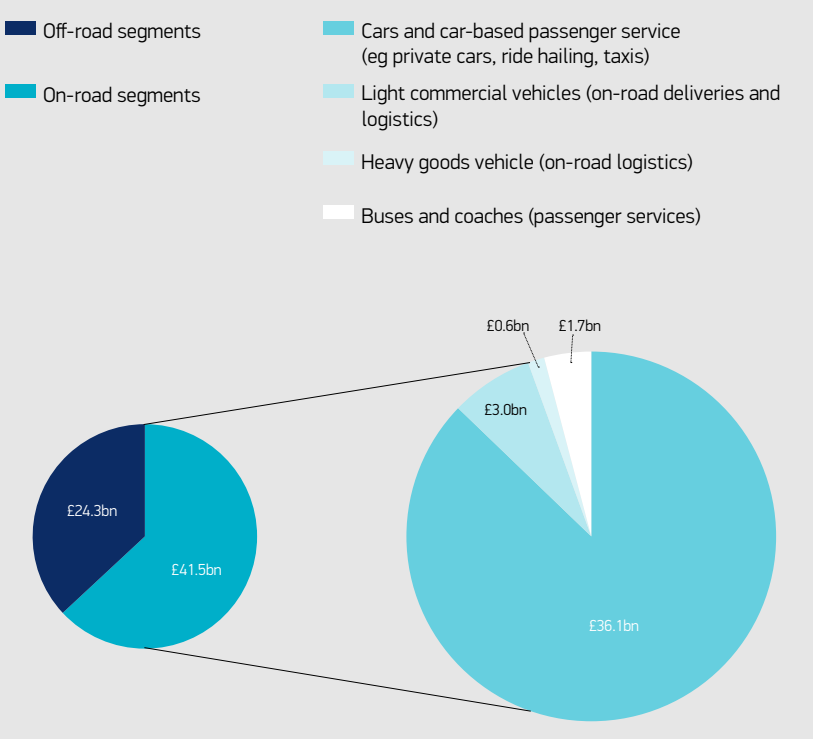


Figure 4: **The potential impact of connected and automated mobility on jobs and road safety by 2040**

342,000
Additional jobs in the overall economy

12,250
Additional jobs in automotive manufacturing

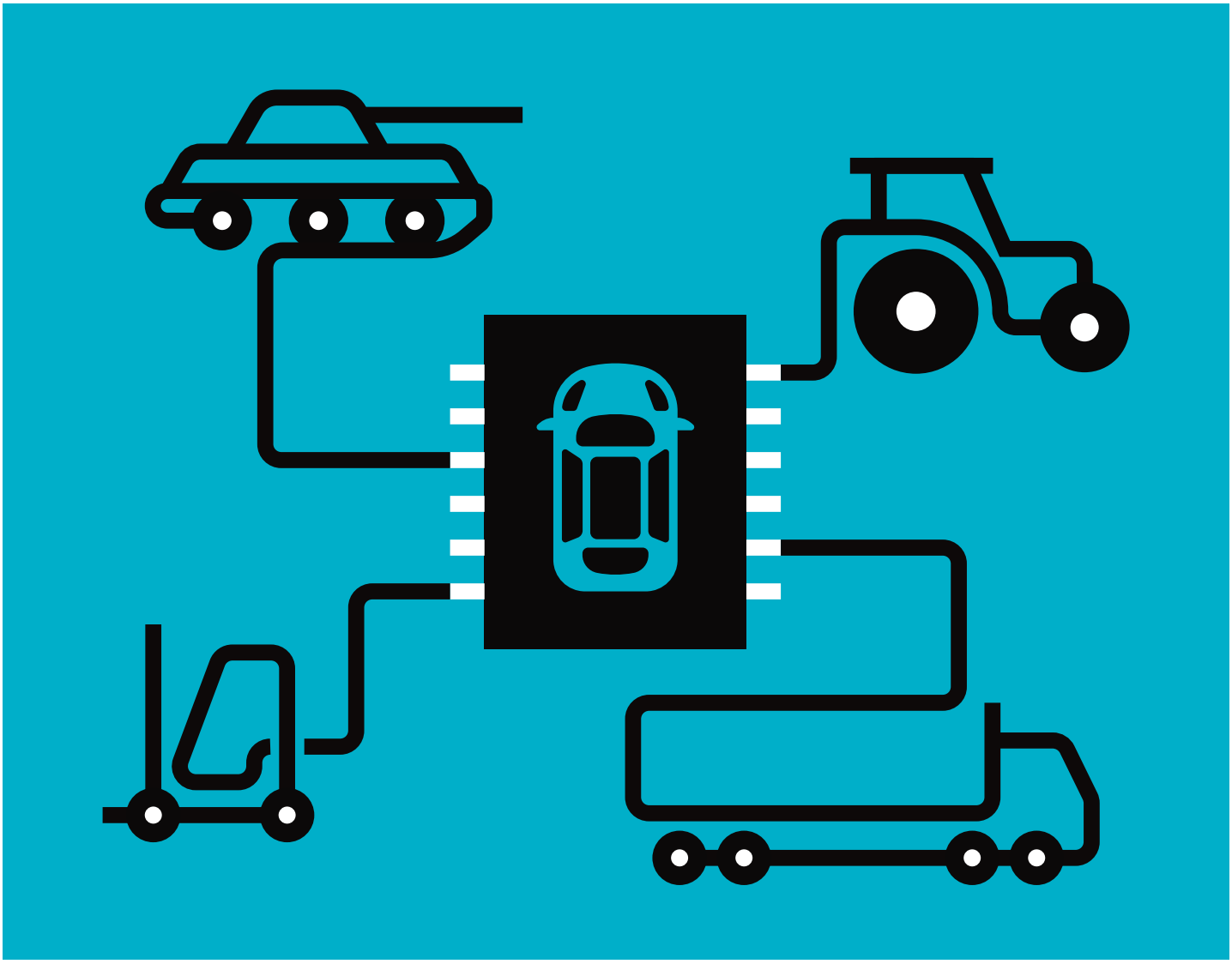
3,900
Lives saved (2023-2040)

60,000
Serious accidents prevented (2023-2040)

5 Department for Transport, "Reported road casualties Great Britain, annual report: 2022", 28 September 2023, available at https://www.gov.uk/government/statistics/reported-road-casualties-great-britain-annual-report-2022/reported-road-casualties-great-britain-annual-report-2022.

6 HM Government press release, "Self-driving buses, shuttles and delivery vans could soon hit UK roads thanks to £40 million government-funded competition", 23 May 2022, available at https://www.gov.uk/government/news/self-driving-buses-shuttles-and-delivery-vans-could-soon-hit-uk-roads-thanks-to-40-million-government-funded-competition.

02
NEW MARKET OPPORTUNITIES FOR CAM



Sectors where CAM adoption could be most impactful

While the first of the three CAM applications in Table 1, i.e. passenger cars fitted with automated driving features, is by now relatively well understood and has been analysed in previous studies,[7] the other two applications, which are mostly predicated on "driverless" technology, require a deeper understanding of the markets where the greatest growth opportunities for CAM can be found.

To better understand the size of the market and the potential pace of CAM uptake in automated passenger services and automated delivery, logistics and industrial vehicles, we have identified eight sectors (Figure 5), and a number of individual use cases within each of these, where CAM is likely to have the most impact on the movement of people and goods and the production process, or business operations. These eight sectors, which account for 16% of the UK economy and a similar percentage of all employment, form the key building blocks within the economy and are critical enablers for production and trade across other sectors.

Within each of these sectors, main use cases for land-based CAM adoption were identified along with their key characteristics. Through interviews with and surveys of potential CAM customers in these sectors, the market size for CAM technology was estimated and the average use case CAM deployment year and the average CAM uptake rate were established. Potential benefits and barriers to adoption of CAM within each sector were also uncovered (see Appendix B). Identifying the key sectors where CAM growth opportunities are the greatest is important for helping private and public sector stakeholders to focus investment in the most strategic areas.

Figure 5: **Sectors with potential new market opportunities for connected and automated mobility**

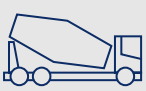
Off-road sectors

Agriculture
This refers to the use of vehicles, such as tractors, harvesters, and other farm equipment, to support agricultural activities, such as planting, harvesting, and transporting crops. SIC Code – 01 to 03

Defence
This refers to the use of vehicles by military agencies for various purposes, such as transportation of troops, removal of hazards and delivering of firepower.
SIC code – 84 (covers public admin & defence)

Off-road logistics
This refers to the use of vehicles, such as HGVs and other machinery, for transporting goods and materials in off-road environments such as warehouses. This also includes the movement of people and goods land-side at ports and airports. SIC codes – 49-53 (a)

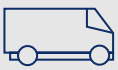
Mining
This refers to the use of vehicles, such as HGVs, drillers, and excavators, in the mining industry to extract and transport minerals and other resources from the ground.
SIC Code – 05 to 09



Construction
This refers to the use of vehicles, such as bulldozers, cranes, and diggers, in the construction industry to support building and infrastructure projects.
SIC Code – 41 to 43

On-road sectors

On-road passenger services
This refers to the use of vehicles, including buses, private hires and taxis, for transporting people on public roads. SIC Code – 49-53 (a)



On-road logistics
This refers to the use of vehicles, such as HGVs and vans, for transporting goods and materials on public roads. This includes activities such as delivery, and transportation of goods between warehouses, stores and people's homes.
SIC Code – 49-53 (a)

Public administration
This refers to the use of vehicles by government agencies for various public services such as road maintenance, healthcare and other services.
SIC code – 84 (covers public admin & defence)

7 See for example, SMMT and Frost & Sullivan (2019), Connected and Autonomous Vehicles: Winning the Global Race to Market, available at https://www.smmt.co.uk/wp-content/uploads/sites/2/SMMT-CONNECTED-REPORT-2019.pdf; and Connected Places Catapult (2021), Market Forecast for Connected and Autonomous Vehicles, available at https://assets.publishing.service.gov.uk/media/5f64af8fd3bf7f7238f230a3/connected-places-catapult-market-forecast-for-connected-and-autonomous-vehicles.pdf.

CAM market attractiveness

An estimate of the potential cumulative market size for each sector has been developed through bottom-up market sizing of the individual use cases. For the purposes of this study, use cases have been allocated into a single category as per the sector they predominantly operate in. For example, heavy goods vehicles sit within the on-road logistics sector although they also operate in mining, construction and other sectors.

Although starting from a relatively low base at around just £2 billion per annum by 2030, the size of the UK CAM market across the eight identified key sectors is expected to grow significantly within the decade that follows and could be as large as £24 billion per annum by 2040. On-road logistics, which includes urban and last-mile delivery of goods using vans or bespoke light commercial vehicles, and middle-mile and inter-urban logistics between ports, hubs and depots using trucks, vans or adapted heavy goods vehicles, is the most lucrative sector, with a market size of £15.2 billion per annum by 2040.

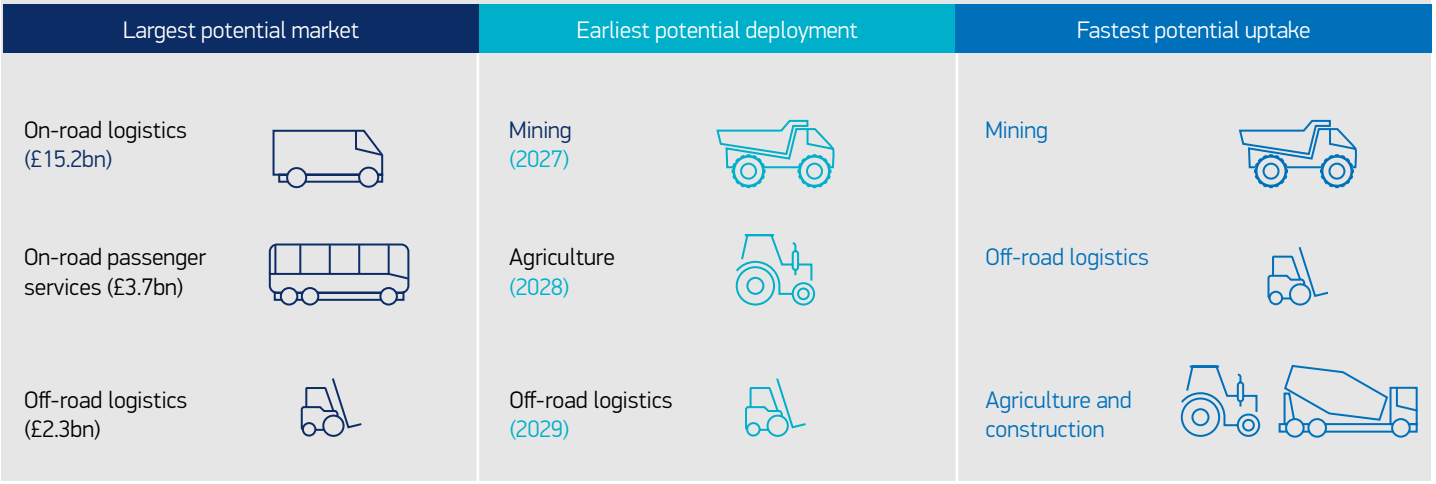
This is followed by on-road passenger services, a CAM market worth £3.7 billion annually, which is a sector primed for automated buses, minibuses, shuttles, ride-hailing, private hires and taxis. The third largest sector in terms of market size is off-road logistics, at £2.3 billion per annum. At the other end of the market size spectrum, defence (£108 million), public administration (£290 million) and construction (£330 million) are sectors that are comparatively less lucrative for CAM.

Although the on-road sectors offer the largest markets for CAM in the UK, the off-road sectors offer the earliest deployment opportunities and the fastest uptake. The mining sector could be where CAM is deployed in meaningful scale the soonest, by 2027. This is followed by agriculture a year later and off-road logistics by 2029. CAM technology used on enclosed private land is not normally subject to the same strict regulations that govern road-going vehicles, but mostly come under the purview of health and safety legislation. In addition, the regimented nature of the tasks CAM technology is expected to perform in environments where there are likely to be fewer people means the barriers to CAM adoption are relatively lower than on public roads or spaces. For the same reasons, the fastest CAM uptake is likely to be in mining and off-road logistics, followed by agriculture and construction.

Table 4: **UK connected and automated mobility market size by sectors**

	Estimated UK CAM market size p.a.		
Sector	by 2030	by 2035	by 2040
Agriculture	£60m	£525m	£1,670m
Mining	£250m	£675m	£950m
Construction	£10m	£99m	£330m
Defence	£3m	£30m	£108m
Logistics (off-road)	£851m	£2,011m	£2,273m
Logistics (on-road)	£540m	£4,400m	£15,200m
Public administration	£2m	£45m	£290m
On-road passenger services	£100m	£1,250m	£3,650m
Total	£2bn	£9bn	£24bn

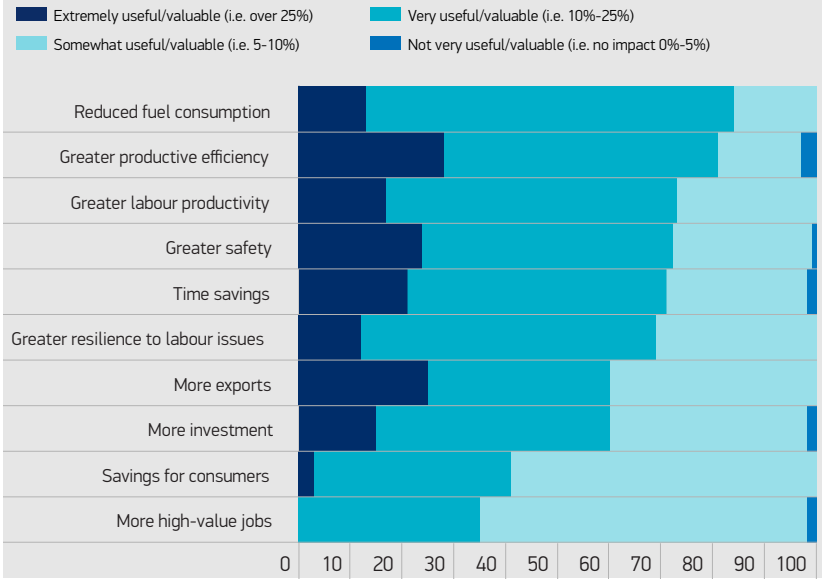
Figure 6: **Top three sectors with largest market, earliest deployment and fastest uptake of connected and automated mobility**



As the survey reveals that nearly one in three sampled organisations typically spend more than a quarter of their expenditure on mobility, or transport, efficiency gains from CAM are the most frequently cited benefits of adopting the technology. Reduced fuel consumption is seen as the greatest benefit to businesses, particularly those in the logistics and passenger services sectors, where even a 1% or 2% reduction could translate into significant cost savings.

Productive efficiency gains from better optimising business operations and increasing uptime of assets and increased labour productivity through the automation of regimented tasks and reallocation of staff to higher skilled activities are seen as the next two greatest gains from adopting CAM. These are followed by increased safety on the road as well as in off-road conditions, including in risky environments such as mines, quarries and military operations.

Figure 7: **Expected benefits and business gains from connected and automated mobility adoption**



Case study: **Use case example: on-road logistics – heavy goods vehicles**

Description of use case:
A heavy goods vehicle with SAE Level 4 automation to be used for on-road logistics operations for the delivery of goods across the country.

Expected adoption time: 5-10 years

Description of use case:
Activities automated: Transportation of goods; and delivery and vehicle driving.

Relative importance of activities to sector = High

Benefit 1	Benefit 2	Benefit 3	Benefit 4
Cost savings	Fuel efficiency	Improved safety	Improved productivity

Impact of benefits:
Through efficient driving techniques (e.g. truck platooning), a range of benefits including, reduced levels of congestion, journey times, accidents and fuel consumption (with a 10% to 20% uptick in fuel efficiency expected from the use of CAM technology due to improved route planning and driving). Cost savings are therefore estimated to be from 30%-60% due to these lower fuel, driver and insurance costs. Improved productivity and uptime from less breaks and assets being able to be operated throughout the night.

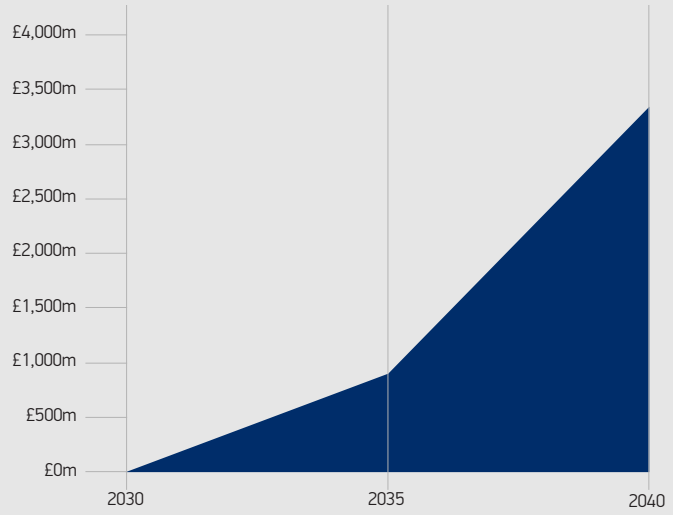
Challenges:
– Technology still to be tried and tested in real life environment
– Currently not commercially viable
– Full benefits not currently realisable

Potential interventions to accelerate uptake:
– Regulatory reforms to enable real world deployment
– Funding support for vehicle purchase

Market sizing
An estimate view of the potential cumulative market size for HGVs has been developed through a bottom-up market sizing approach of the individual use case

	Estimated UK CAM market size p.a.		
Use case	**by 2030**	**by 2035**	**by 2040**
HGV	£120m	£1,000m	£3,500m

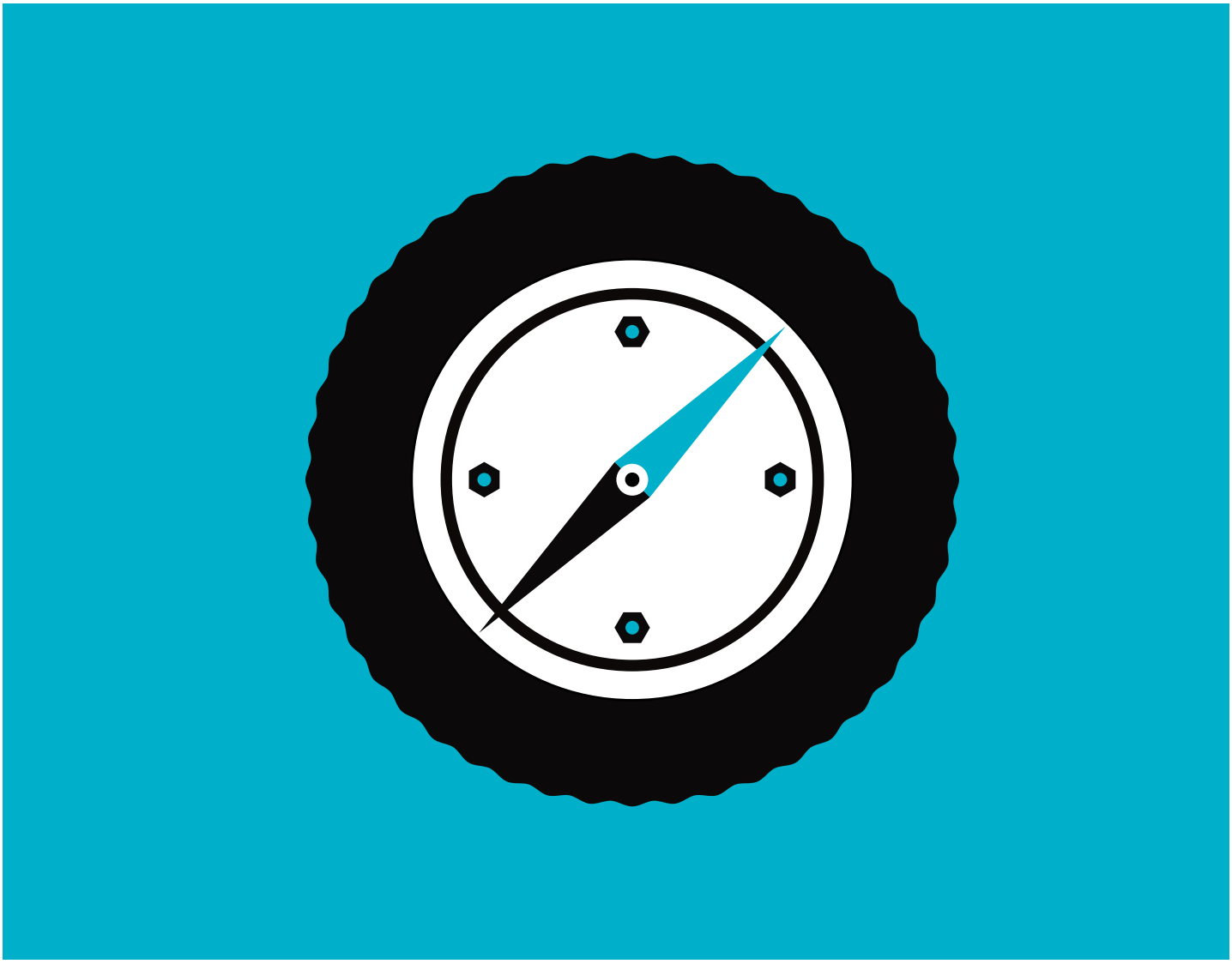
Automated HGV market size



03
KEY CHALLENGES AND RECOMMENDATIONS

The £66 billion economic opportunity that CAM offers will not be realised by default. Inaction will almost certainly result in a missed opportunity to capture the sizeable benefits that innovation-driven growth can deliver through CAM, as investment and commercial deployment will find locations of choice elsewhere in Europe and beyond. The significant economic and social benefits that CAM could deliver are motivating many countries to position themselves as world leaders in the development and deployment of the technology.

The economic and social gains by 2040 will only be realised if commercial deployment of CAM begins in earnest in the **second half of this decade.** This is necessary to ensure CAM rollout achieves at least a relatively small but meaningful scale by 2030, which then precipitates significant growth towards widespread adoption by 2040. Realising the economic and social benefits of CAM will require the following four key interventions that can only be achieved through strong partnership between government and industry.



New legislation and regulatory reforms

The full commercial rollout of certain CAM applications in the UK, particularly those of a "driverless" variety, is not yet possible due to the lack of legal certainty in removing the human driver and the absence of a comprehensive regulatory framework that covers key aspects such as approvals, authorisation, in-use monitoring, passenger permits, commercial communications, liability, data retention and new criminal offences.

The government aims to have a full regulatory framework in place by 2025 for the commercial deployment of all CAM applications,[8] providing the basis on which commercial rollout can begin in earnest in the second half of this decade. To realise its own policy ambition, government, legislators, industry and stakeholders must work closely to ensure any barriers to regulatory reforms are removed and that there is no delay to tabling new legislation on self-driving vehicles in the remainder of this Parliament. Ensuring these reforms are **completed on time** is of paramount importance to the competitiveness and attractiveness of the UK as a location of choice for the rollout of CAM, as Britain is already behind key markets in Europe in completing regulatory reforms that enable full deployment.

Finance, funding and de-risking of investment

Government financial support should be carefully targeted and aimed at encouraging commercial deployment. Targeted grant funding for advanced research and development should be devoted to supporting CAM technologies that are close to reaching Technology Readiness Level 9 ahead of pilot and full deployment. As the initial outlay for CAM technology may be prohibitively high and risky to certain businesses, especially small and medium enterprises, government should consider providing appropriate deployment funding to de-risk private sector investment that can ultimately create multiplier growth effects.

Promising British start-ups in the CAM supply chain have often found it challenging to access large-scale private investment. Each private funding round in the US raises typically at least 15-20 times the amount of capital a similar funding round in the UK could deliver. Government could consider co-investing in a minority stake in high-potential but risky British CAM ventures, with a clear plan to exit once the start-ups begin to scale, become post-revenue and can demonstrate a realistic pathway to future profitability. Public investment is also critical in ensuring our national digital and physical infrastructure is fit for purpose for CAM deployment. Near-ubiquitous mobile coverage on the 245,100-mile-long British road network is a necessity.

Skills development

The development and deployment of CAM will require substantial new skills in software development, robotics, cyber security and data analytics – the very areas where there is currently a dearth of talent. An Automotive Council survey at the start of 2023 found there were approximately 7% production labour vacancies in the automotive supply chain, compared with a UK national average of c.3.4%, with soaring demand for emerging skills requirements in digitalisation, software and electrical engineering.

Upskilling and reskilling of current workers will support the uptake of CAM use cases in their respective sectors, where jobs will likely involve both digital and physical elements. Towards this end, government should champion the delivery of a long-term, online National Upskilling Platform for automotive and advanced manufacturing, and support workforce upskilling through the reform of the Apprenticeship Levy, allowing a proportion of unspent Levy funds to be focused on priority training areas such as software and digitalisation.

Public communications

Bringing the public along every step in the journey from CAM trials to ultimately widespread CAM deployment is critically important for acceptance of the technology. People who have had an opportunity to try out CAM for themselves ahead of deployment are less likely to resist the introduction of the technology and more likely to accept CAM as a viable alternative for getting around or receiving goods delivery.

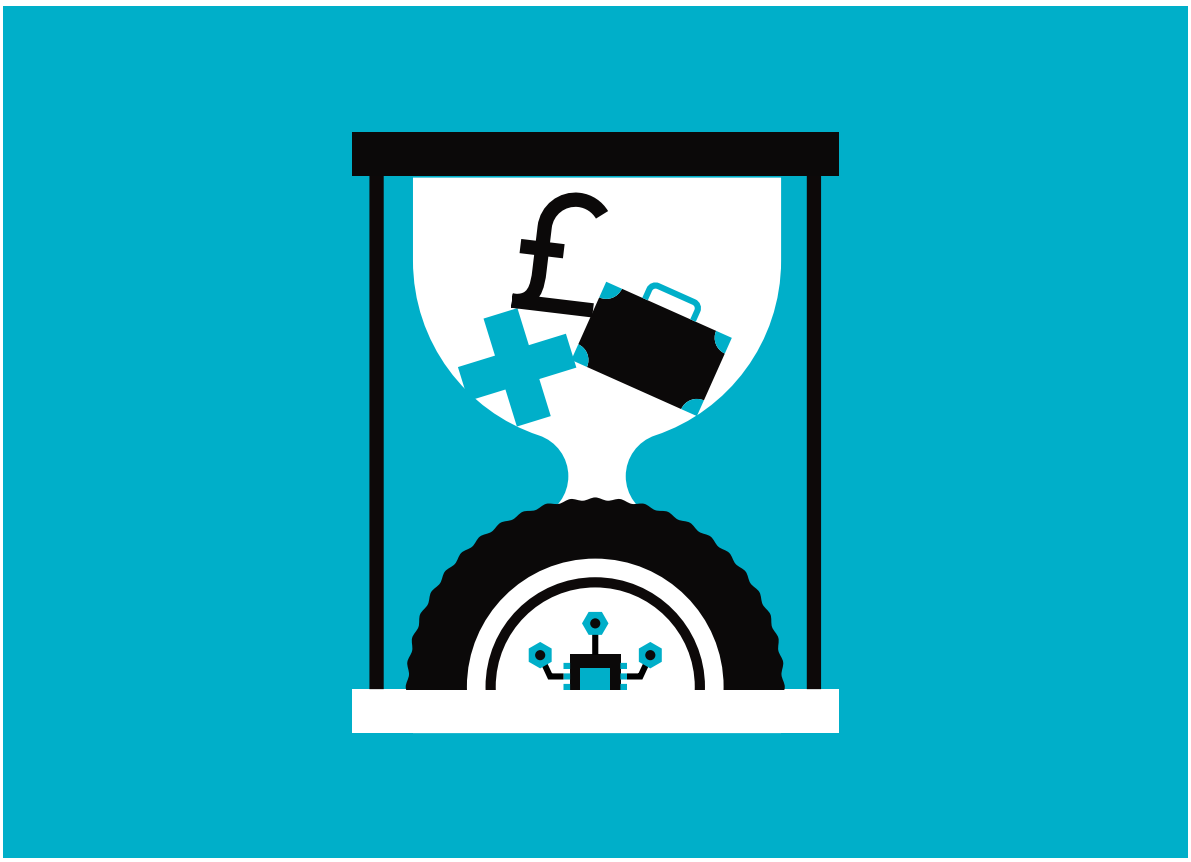
Government-industry partnership is pivotal in delivering an optimal programme of public education and communications that seek to inform, bust myths and address misconceptions, in addition to promoting the safe use of CAM technology and co-existence with other road users. Government's highly valuable Great Self-Driving Exploration project[9] should be reprised and expanded to include more communities, locations and types of CAM applications. In collaboration with government, we have recently published a communications toolkit aimed at helping businesses and industry stakeholders to communicate about self-driving vehicles to the public using plain language and consistent terminology.[10]

8 Centre for Connected and Autonomous Vehicles policy paper, "Connected and Automated Mobility 2025: Realising the Benefits of Self-driving Vehicles in the UK", 19 August 2022, available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1099173/cam-2025-realising-benefits-self-driving-vehicles.pdf.

9 Department for Transport (2023), The Great Self-Driving Exploration: A citizen view of self-driving technology in future transport systems, available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1166512/great-self-driving-exploration-citizen-view-of-self-driving-technology.pdf.

10 AV-DRiVE Group (2023), Self-driving Vehicle Communications Toolkit, version 2, available at https://www.smmt.co.uk/industry-topics/technology-innovation/self-driving-vehicle-communications-toolkit/.

SUMMARY AND CONCLUSION



CAM has the potential to deliver annual economic benefits as high as £66 billion by 2040 and an estimated additional 342,000 additional jobs overall in the economy, of which 12,250 are in automotive manufacturing. The technology is also expected to save 3,900 lives and prevent 60,000 serious accidents between now and 2040. With efficiency and productivity gains in transport and business operations as the biggest motivation for CAM adoption, the most lucrative markets can be found in the on-road sectors, while deployment readiness and pace of uptake are expected to be highest in the off-road sectors.

However, realising the significant economic and social benefits of CAM is highly dependent on ensuring full regulatory reforms are completed by the middle of this decade, providing ambitious funding support to de-risk private investment and stimulate innovation-driven growth, supporting the upskilling and reskilling of workers and the development of new digital and software skills, and bringing the public along in the journey through effective education and communications.

The opportunity is now. Inaction is not an option if we are to ensure UK Automotive remains a global force in the development and adoption of new technology that will shape mobility for the next century and improve the way we travel and goods are delivered. With the right interventions and close collaboration between government and industry, we can ensure CAM delivers for the British people, our economy and the planet.

APPENDICES

Appendix A: The components of our analytical framework for the economic and social impact of connected and automated mobility

Component of CAM analysis		Purpose of the analytical component	Key inputs
Analytical Approach	a) On-road impacts	Generalised Journey Time (GJT) impacts associated with CAMs for on-road users both commercial (passenger transport and on-road logistics) and non-commercial using DfT appraisal assumptions. Note: only commercial benefits contribute to "real" economic impacts.	– Transport forecasts and TAG data book – Adoption schedule and impact level assumptions – Demand and supply elasticities
	b) Off-road impacts	Understand the productivity impact associated with CAMs for the six other 'use case' sectors and flow through for sector output, producers and wider economy.	– Use case sector base data (inc. GVA, labour/capital input) – Adoption schedule and impact level assumptions
	c) CAM Producer and supply chain	Understand the direct productivity impact for CAM producers and supply chain.	– Automotive producer and supply chain base data (inc. sales, GVA, labour/capital input) – Outputs from (a) and (b)
	d) Wider economic impacts	Understand the indirect productivity gains from improved connectivity through agglomeration economies. This also includes safety, environmental and congestion impacts.	– Economy wide impacts, following TAG – Outputs from (a), (b) and (c)

Appendix B: Key use cases and adoption characteristics of connected and automated mobility across sectors

Sector	Size in UK economy	Key use cases	Key characteristics	Average asset lifespan	Average est. use case deployment year	Average CAM uptake rate	Key benefits	Key challenges
Agriculture	£13bn (1% of economy)	- Tractor unit - Grasscutter	- Enclosed environment - Variety of activities with base vehicle	12 years	2028	Medium	- Improves safety - Improves productivity - Operational resilience - Cost savings	- Supporting infrastructure availability (e.g. 5G) - Resistant to change - Cost of new technology
Mining	£13bn (1% of economy)	- Extraction - Movement of mining goods	- Enclosed, hazardous environment - Small industrial settings - Capital intensive	5 years	2027	Fast	- Improves safety - Improves productivity - Operational resilience - Cost savings	- Legislation (e.g. health and safety) - Supporting infrastructure (e.g. 5G) - Operating conditions
Construction	£113bn (6% of economy)	- Excavator - Concrete mixer	- Multi-operating environment - Variety of activities with base vehicle	10 years	2031	Medium	- Improves safety - Improves productivity - Operational resilience - Cost savings	- Complex operating environments and stakeholder landscape - Data standardisation - Public perception
Defence	£105bn (inc. PA(a)) (5% of economy)	- Combat vehicle - Reconnaissance - Explosive clearance	- Hazardous conditions - Multi-terrain - Unique sector	12 years	2032	Slow	- Improves safety - Improves environment analytics	- Complex operating environments - Technology capabilities - Ethical concerns
Off-road logistics	£41bn (2% of economy)	- Forklift - Airport and port logistics	- Enclosed environment - Small industrial settings - Connecting hubs for other sectors	11 years	2029	Fast	- Improves safety - Improves productivity - Operational resilience - Cost savings	- Workforce skills - Data interoperability - Public perception
On-road logistics	£13bn (1% of economy)	- Heavy goods vehicle - Light goods vehicle	- Publicly operating environment - Movement of goods	13 years	2030	Slow	- Efficiency gains - Operational resilience - Cost savings	- Public perception - Legislation (on-road) - Proven technology readiness
Public administration	£105bn (inc. Defence[a]) (5% of economy)	- Emergency service vehicles - Road and land maintenance	- Publicly operating environment - Provision of niche services	9 years	2032	Slow	- Efficiency gains - Operational resilience - Cost savings - Improves accessibility	- Legislation (on-road) - Public perception - Proven technology readiness
Passenger transport	£10bn (0.5% of economy)	- People transportation	- Publicly operating environment - Movement of people	13 years	2030	Slow	- Efficiency gains - Operational resilience - Cost savings	- Legislation (on-road) - Public perception - Proven technology readiness

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