

# Freeing the Road:

## *Shaping the future for autonomous vehicles*

### The future is here

Autonomous vehicles (AV) have long seemed like something from *Tomorrow's World* – a technological development that politicians, regulators and policymakers could put off thinking about until long into the future. Now, with the first mass market AVs set to roll off the production line, Europe's policymakers must fast catch up with technological and commercial reality. AVs not only have the potential to fundamentally reshape Europe's strategically vital automotive industry; they will change how citizens interact with motor vehicles, transform patterns of connectivity, and offer social and environmental benefits to the whole of society. The future vision is of a driverless, safer and more efficient transport system that will connect individuals and businesses throughout Europe.

European countries are beginning to engage with the changes that AVs will bring. However, to reap the benefits of the new transport technology, leadership will be needed at all levels to maximise the potential of AVs in the 21st century. A number of countries – notably Germany, Spain and the UK – have 'dipped their toes in the water' by allowing test driving of AVs on their roads. But the measures needed for the widespread adoption of driverless technology will require a more rigorous response from European policymaking institutions at the EU, national, regional and city level. At all those levels of government, there is an imperative to act now.

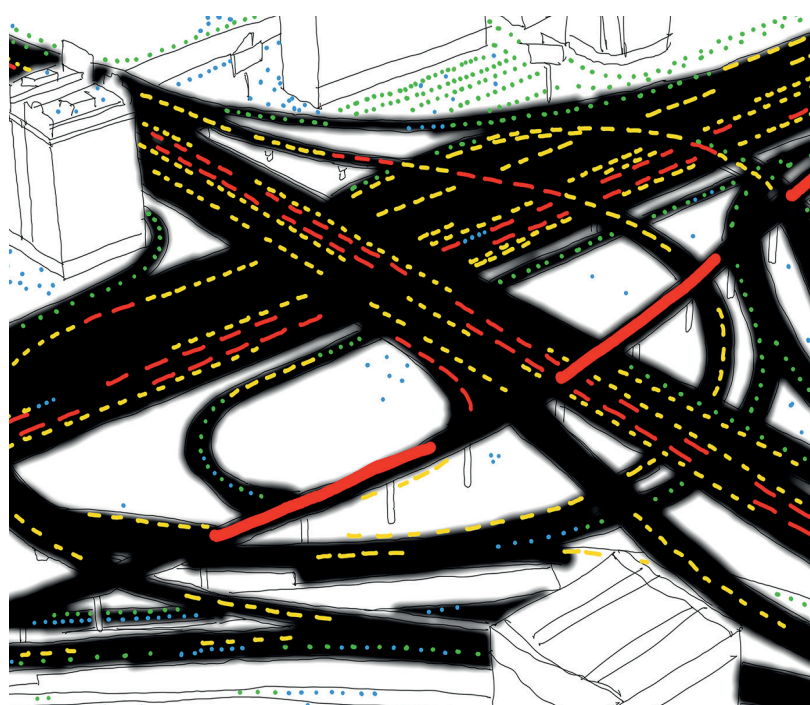
### The potential economic benefits are enormous

If – and this study outlines the reasons why this remains a big if – policymakers get the big picture right and put in place rules that properly promote the change, the economic benefits of autonomous drive (AD) for Europe will be very significant indeed.

Our original economic analysis shows that, in such a scenario, autonomous vehicles will start adding 0.15 per cent to Europe's annual growth rate in the decades to come. As a result, the European (EU-28) gross domestic product will, cumulatively, be 5.3 per cent higher in the year 2050 than currently, by which time autonomous vehicles will have contributed a total of €17tn to GDP.

The benefits of autonomous vehicles will be enormous, but they remain to a degree uncertain. The three sources of uncertainty originate from consumers, car manufacturers and policymakers – each with different, but interlocking, perspectives. Car manufacturers aim to best harness technology to satisfy consumer preference and thereby maximise sales, but all the time are necessarily guided by public policy. Consumers choose products that they believe best fit their needs and which they feel comfortable and secure with. Whereas policymakers have a substantial range of alternative strategies to choose between the need to balance consumer interests, the public good and the need for economic innovation.

How the demands and wishes of these three different groups come to mesh and exactly how they manifest themselves will be the key to determining the speed and penetration of the take-up of AD and the consequent economic impact.



For the purpose of our economic analysis we have categorised into specific scenarios three possible ways in which the commercial, consumer and policy variables over AD could play out:

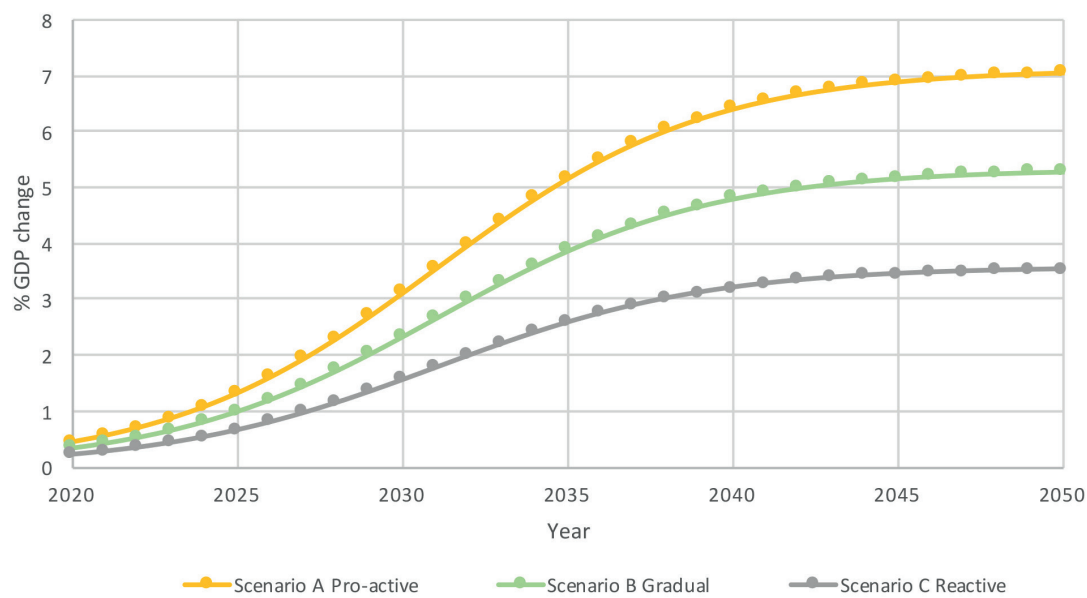
**A) PROACTIVE:** In this scenario autonomous vehicles are swiftly introduced and accompanied by benevolent policy with foresight that aims at maximising benefits. The public sector offers R&D support, supplies necessary infrastructure, and engages spatial and labour market opportunities proactively. Consumers rapidly feel comfortable with AD and manufacturers are able to deliver mass market models that satisfy emerging public appetite.

**B) GRADUAL:** Autonomous vehicles are introduced at pace forecast by the industry; consumer scepticism is overcome, but slowly. Public policy only reacts to market failures meaning the accrual of autonomous vehicle benefits are permitted but not aided.

**C) REACTIVE:** Autonomous vehicle technology development is delayed by unforeseen developments. Policy aims to promote status quo in the industry by subsidising current incumbents and stringent regulation for the labour market in the transport sector.

The progress of autonomous vehicle development and which policy decisions are taken will determine which costs and benefits translate to society.

Autonomous vehicles and GDP



In looking at the economic impact of AD, assessing the productivity potential of automated vehicle technology is central.

Autonomous vehicle supply-side effects on the economy

Effect	Market mechanism	Maximum Productivity impact
Value of in-vehicle time	Travel cost, labour supply	2% - 3%
Road congestion	Travel cost, commuting distance	0.5% - 1%
Road accidents	Expected travel cost	2%
Fuel-efficiency	Environment, public health, travel cost	0.5%
Road infrastructure	-	-
Build environment	Urban structure, city density	2% - 4%
Labour market	Labour supply	1% - 5%



What is striking is that the largest productivity gains stem from the built environment in cities and the labour market. These gains are in addition to the traditional and more obviously anticipated benefits – the decrease in road accidents, the ‘in-vehicle’ time gains, and road congestion reduction. Although not as large as the employment and built environment gains they remain significant; for example, in the year 2030 reduced road congestion and accident prevention produce an annual gain GDP gain of around €100bn.

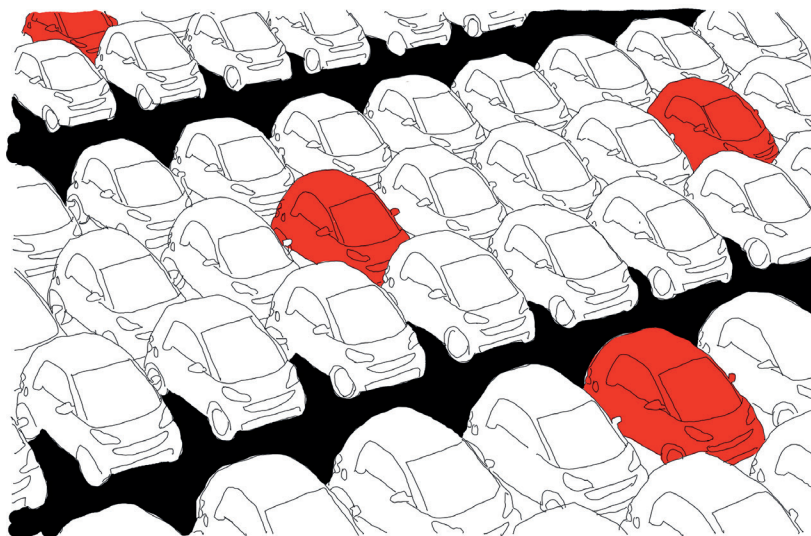
## It remains a big if

We have demonstrated that in numerical terms the economic consequences and benefits of AD will be huge. Autonomous vehicle technology will affect the entire population and thereby its consequences will be felt at all levels of government: from the mayor to the ministry.

Therefore, our strong message to policymakers is to get ready and prepare for what is, literally, just down the road. Government at all levels needs to be aware of the, ultimately positive but significant and potentially temporarily destabilising, economic consequences of such a significant economic revolution. Strong policy positions will be needed to adequately prepared to ensure Europe takes full advantage of the opportunities opening up and minimises the level of disruption, especially to the labour market.

## The dangers of getting it wrong

The transition to a driverless future will require policymakers to properly embrace and understand the seismic impact on the economy and the future of not just transport but research, work, and businesses beyond those most obviously involved. They will need to focus their policy changes on making the transition as beneficial as possible for the population as a whole, not just early adopters. Put simply, this means that the transformation of transport from conventional to autonomous vehicles must be understood in a wider context of societal and political change, making sure that reforms are supported by the public. This is a precondition for the transition to AD to itself be a success, not only a necessity for the public good to be achieved. One will not happen without the other. The dangers of getting it wrong are real and present. The first industrial revolution saw the ‘luddites’ literally try to smash the new technology; the danger if AD is not introduced in an inclusive way is that rejection of it becomes part of a spreading anti-tech, anti-growth sentiment among the electorate. In getting the policy right one size won’t fit all; solutions will need to be tailored to the demands of specific cities and regions.



## Boosting connectivity, not excluding the ‘left behind’

A key factor in maintaining public support will be ensuring public transport provision works in successful combination with autonomous vehicles. These can serve as a substitute or complement to public transit. For large- and medium-sized cities that offer high-quality public transit, autonomous vehicles will complement existing transit systems. In this scenario it will allow large welfare benefits, eg greater provision for those who, for whatever reason, cannot use currently designed public transport, but who would find an autonomous vehicle easier (eg making current door-to-school disabled transport easier and cheaper). In small cities and rural areas, autonomous vehicles will enable cost-realistic, demand-responsive public transport to be provided, where currently the costs of drivers make such provision unrealistic.

## Letting citizens decide

The coming of AD will entail a very serious review of the way we use space, road and otherwise, especially in urban areas. The process of that review offers great opportunities to not only accommodate the needs of AD but to utilise the very process, and the space liberated, to make a wider impact on improving the urban experience for all. Citizens are the ones with the most in-depth and intimate knowledge of the particularities of private and public transport within their own communities. As such, and because urban planning has the greatest potential to impact their day-to-day lives, those citizens are best placed to offer solutions or innovative ways to both integrate autonomous vehicles into their communities and how to alter urban space in light of the opportunities that autonomous vehicles usher in.

## AD will ultimately benefit the labour market – but only with the right planning

One of the popular ‘fears’ about AD is that this form of automation will automatically damage levels of employment as driving jobs are rendered obsolete. In headline terms there is indeed obvious initial displacement of jobs in the transport sector, but our study finds that the boost to overall economic growth will outweigh these over time. It will be up to national governments to provide adequate social safety measures to avoid unnecessary upheaval and stress to workers during the transition process and reduce market barriers to job creation in the new emerging areas. They will need to ensure the provision of high-quality education and training to unlock opportunities in jobs that are undergoing a transformation. Politicians will need to make sure that they embrace technology and innovation, but not at all costs and regardless of the social consequences.

## Expanding connectivity

The report finds that there must be jointly agreed connectivity standards in order to ensure seamless cross-border operation of AVs. An automated, connected car should not stop working just because it crosses over from one European region to another.

When connected autonomous vehicles process their surroundings, they can generate up to 1 gigabyte of data per second. This vast quantity of information can be utilised to help all other autonomous cars learn to drive. Since it will be crucial for fully autonomous cars to be able to communicate with each other, the rolling out of 5G connectivity across Europe will be imperative.

Similarly, satellite systems will play a vital role in securing reliable mapping tools for autonomous vehicles. These may need to be used in tandem with 5G to ensure reliability, meaning the European commission might use the Galileo satellite network to improve driverless technology.



## Intelligent and connected vehicle-to-grid solutions

Connectivity can also be a key driver of air pollution control and intelligent energy management systems, absorbing information from the environment and feeding it back to the driver, network or energy grid. In this process intelligent vehicle-to-grid technology would be capable of charging AVs and permitting them to transmit stored energy from their batteries back to the electricity grid. A connected AV fleet could be crucial in meeting local energy demands at peak consumption times, acting not only as a consumer but also as a supplier of green energy.



## Protection of drivers and passengers

The cybersecurity of autonomous vehicle technology will have to be subject to rigorous standards. The security consequences of a malicious breach could be immediately life threatening. These standards will need to be decided, and policed, at the European level.

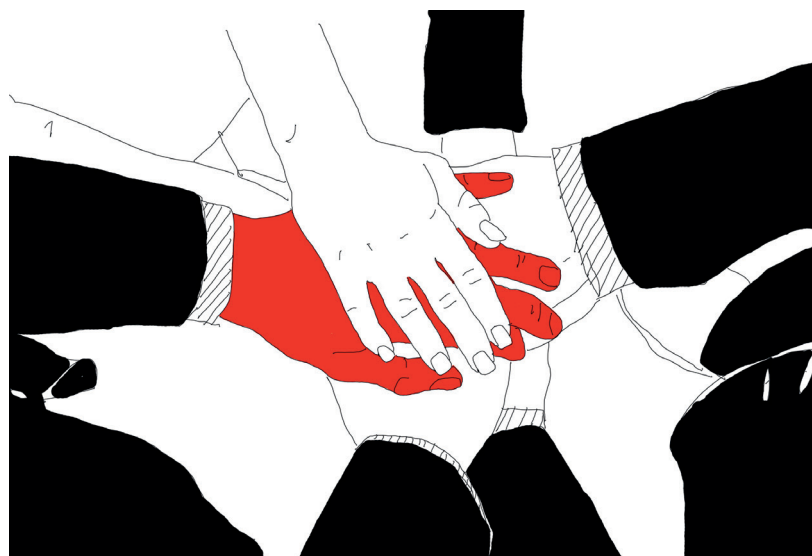
There are also privacy concerns, both to users and for the protection of agents external to the autonomous vehicle is also pivotal. For example, how should the external video and audio be stored? In order to address these concerns, the EU should host a roundtable with the appropriate directorate-general groups and industry and concerned civil society, so as to draft policies that are coherent with current European privacy laws.

## Fostering research and development

The implementation of autonomous vehicle technology will require the formation of broader alliances for research and development (in the short term) and manufacturing (in the medium/long term). These alliances should seek to bring together the traditionally dominating OEMs with technology companies, platforms, academics, insurance companies, and SMEs. It is essential that research and development related to autonomous cars is supported by governments, and that the positive and disruptive impact that including SMEs in these research consortiums is appreciated. Doing so will positively influence the adoption rates of autonomous vehicle technology in each country.

Two very different commercial forces, OEMs and technology companies, today dominate research into and implementation of AV technology. But the wall between tech and manufacturing (software and hardware) is set to crumble rapidly.

The most innovative technology breakthroughs stem often from publicly-funded research projects which are applied by SMEs, who have the flexibility and capacity to take bigger risks than corporate entities. The big OEMs have understood this trend. For instance, startup Autobahn is a spin-off from Daimler, which gives up to 10 innovative tech entrepreneurs access to a global network, expertise and venture capital. Government needs to appreciate this new way of working as much as industry already is.



From our conversations it is evident that we can expect significant shifts in the shape automobile industry, caused by two developments which will change the way how we understand mobility. First, it will emerge that over time individual owners feel they are buying a service rather than a vehicle. Second, as car-sharing and ride-sharing offer greater economic benefits to some users than traditional ownership models, we can expect to see younger ‘early adopters’ use these methods to fulfil their transport needs. The same is true for rapidly expanding metropolitan areas in emerging markets, such as in China or India, with huge traffic problems where car-sharing offers a more efficient and cleaner way of transport.

Such a significant change in the nature of the automotive industry makes it far from certain whether traditional OEMs or tech companies will win the race for the driverless future – if the OEMs are to thrive they will need to evolve into new tech/manufacturing hybrids.

## The regulatory setting: debates and reforms in key countries

Having conducted extensive research on the current political and regulatory landscape across key European markets, the report makes three key findings.

The first is that all four of the countries examined have laid the foundations for the testing of highly automated and autonomous vehicles on both test sites and public roads, but have not yet resolved the issue of full autonomy for public use. For full 'driverless' autonomy to be introduced considerable further legislative and regulatory change will be needed.

The second key point is that the industrial policy behind AV technology reflects, to a considerable extent, individual national and cultural circumstances – both the particular patterns of domestic manufacturers, research clusters and business landscape but also political culture.

Third, it is clear from our analysis that arguably the biggest task for policymakers is the harmonisation of international and national legislation. It was a recurring theme throughout our conversations with policymakers, regardless of country, that whatever initiatives were taken on the national level only international coordination will allow full adoption of AD.

## **Germany**

German policymakers have taken a pragmatic approach to getting rules in place that allow AV test drives and regulating commercial use of highly automated and autonomous driving systems. In what could serve as a blueprint for other countries, a new bill proposes the installation of black box recorders into vehicles to determine whether person or machine was in charge at the moment when an accident happened.

Those laws that need to reflect the ethical, moral and consumer protection issues of full autonomy will be subject to the recommendations of an expert commission and dealt with at a later stage, most likely after the general election in autumn 2017.

## **United Kingdom**

The British government has been explicit that, despite a hitherto more 'hands off' industrial policy compared to most other European countries, it is aiming for the UK to be at the forefront of the development of autonomous vehicles.

The government is adopting a non-regulatory or light-touch approach to the testing and implementation of automated vehicle technology, with the aim of encouraging long distance and large scale testing on public roads in challenging and diverse traffic and weather conditions. The aim – a not unfamiliar one for UK policy – is that such a light-touch, industry-friendly approach makes the UK become seen as the most 'AV friendly' place to do business and, thus, continue to be an attractive location for foreign direct investment (FDI).

## **Spain**

While the competencies devolved to each of the regions in Spain vary greatly, regulations concerning autonomous cars and the legislation pertaining to tests of self-driving cars has been drafted and passed centrally by the Spanish Directorate General of Traffic, which is part of the Ministry of the Interior. It is applicable nationally.

The directorate has stressed that all citizens have a right to a safe transport network, in which all individuals have their respective responsibilities. Its vision is backed by six main objectives that were elaborated to guide national directives and have the aim of reducing the socioeconomic impact of traffic accidents in the decade from 2011 to 2020.

Although Spain currently has established a set of leading automated driving clusters, which seek to take advantage of regional investment and alliances, a period of protracted political uncertainty threatens the development of relevant legislation and may have eroded the rate of foreign and national investment in the sector. The seeming resolution of the political deadlock could positively impact on Spain's position as one of the European countries leading in self-driving technology.

## International and EU law

The regulation of vehicles is also heavily affected by international and European law. On the international level, the 1968 Vienna Convention on Road Traffic, designed to facilitate international road traffic, contains principles defining both the admissibility and liability of new technology. The United Nations' Vienna Convention on Road Traffic states that 'every moving vehicle or combination of vehicles shall have a driver' and that 'every driver shall at all times, be able to control his vehicle'. For that reason, it has been seen as an impediment to the deployment of self-driving cars on public roads in the 74 countries that have ratified the convention, including all European countries besides Spain and the United Kingdom.

In order to overcome this barrier, several European countries which are keen to implement self-driving cars have been pushing for an amendment to the convention – including the governments of Germany, Italy, France, Germany, Belgium and Austria. They highlight the evolved stage of the development of self-driving technology in Europe. In light of this effort, in March 2014 a new paragraph was added to Article 8 of the 1968 Convention on Road Traffic so as to allow a car to drive itself insofar as the vehicle's system "can be overridden or switched off by the driver".

On the European level the European commission mainly sets the rules for the approval for cars sold in member states. This legal framework is largely determined by Directive 2007/46 EC, and Regulation (EC) No 661/2009, which do only partially spell out technical requirements but refers to the applicability to the majority of ECE regulations. This means that the UN regulations set the pace and the EU follows. In particular, legislation concerning connectivity, privacy, and data protection would need to be determined at the EU level for that greater level of automation to be adopted on Europe's roads.

In order to fully take advantage of all the economic potential of connected and autonomous vehicles new regulations must also guarantee a level playing field for manufacturers, promote competition and show ensure the digital infrastructure is updated; only then will Europe achieve a seamless introduction of AD across the continent.

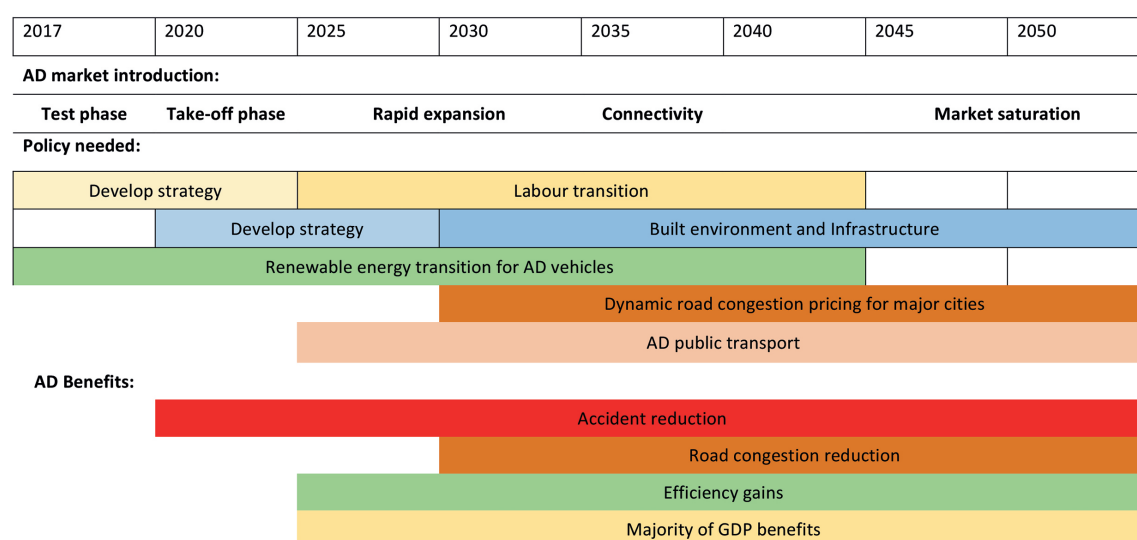
## Conclusions and recommendations

Europe's policymakers should be under no illusion: a future of autonomous driving is upon us. It cannot be dismissed, and is not going to go away. There is a real chance for the continent to seize the chance to maximise the economic and social good. But it will require urgent, concerted and coordinated action. The report makes a series of policy recommendations on this basis. Governments should seek to:

1. **Adjust national legislation and strike a balance between public concerns about safety and security and the development of technology.**
2. **Harmonise international and national legislation to promote common European traffic policy; and exploit vast economic benefits of AV technology to ensure Europe triumphs in the global race of a driverless future.**
3. **Think green: promote the introduction of electric and hybrid powertrains.**
4. **One size will not fit all: encourage dialogue between local stakeholders in municipalities and regions to promote connectivity and individual local policy and infrastructure solutions.**
5. **Foster integration of AV technology in public and private transport sector to create seamlessly frictionless world of transport.**
6. **Let the citizens decide: democratise the developments of urban space to shape the city of the future.**
7. **Ensure equitable access to mobility for all and develop strategies of how to balance prices between transport providers.**

8. Make IT-skills a priority in education at all levels, in particular at apprenticeship level, to be prepared for the shifts in domestic and international labour markets.
9. Make greater efforts to invest in European data infrastructure (free flow of data) within and across borders.
10. Foster research and development partnerships between small (SMEs) and large car manufacturers and suppliers, IT firms, academia and insurers.
11. Think service: provide the conditions for shared-ownership and ride-sharing models, especially in urban spaces and in addition to public transport, bicycles and pedestrians.
12. Encourage public acceptance and behavioural change.

### Timeline of AV adoption



The above timeline plots the policy actions that will be needed and the consequent economic benefits that will follow as AVs are progressively introduced into the market. Working on the assumption that the first commercially produced AVs come to the market in the 2020s, we expect most of the benefits, such as accident reduction, the majority of GDP gains and efficiency gains to kick in almost immediately or by 2025 as they are directly related to traffic and the economic environment as a whole. A substantial reduction in road congestion starts somewhat later as this coincides with a more widespread use of AD and connectivity between cars and infrastructure.

On the policy side, national and local decision-makers must take immediate actions on skills demand in labour markets as AVs are likely to have a substantial impact on employment in the transport sector, accounting for roughly 4.5 per cent of total employment in the EU. Also urgent and relevant should be a policy discourse on renewable energy transition for AV vehicles, such as vehicle-to-grid solutions, because a driverless future is very likely to feature electric or hybrid engines rather than traditional combustion ones.

*This document is based on the detailed research carried out for Policy Network's 64-page special report:  
**Freeing the Road: Shaping the future for autonomous vehicles***