Autonomous vehicles: what role do they have in the mobility transition?

Finished research
Begin: February 2020
End: March 2021

At a time when companies and governments are focusing all their energy on innovation, autonomous vehicles seem to embody the quintessential breakthrough that promises to revolutionize the future of automobility. Throughout the world, all eyes are on the activities of Google and Uber and the announcements of American, European and Asian manufacturers, attracting great attention from the media. In this context, the Mobile Lives Forum commissioned the French think tank La Fabrique Écologique to carry out a study aimed at determining the degree to which autonomous vehicles (excluding the transport of goods) could potentially contribute to the transition to a more sustainable world.

Research participants

- La Fabrique Écologique

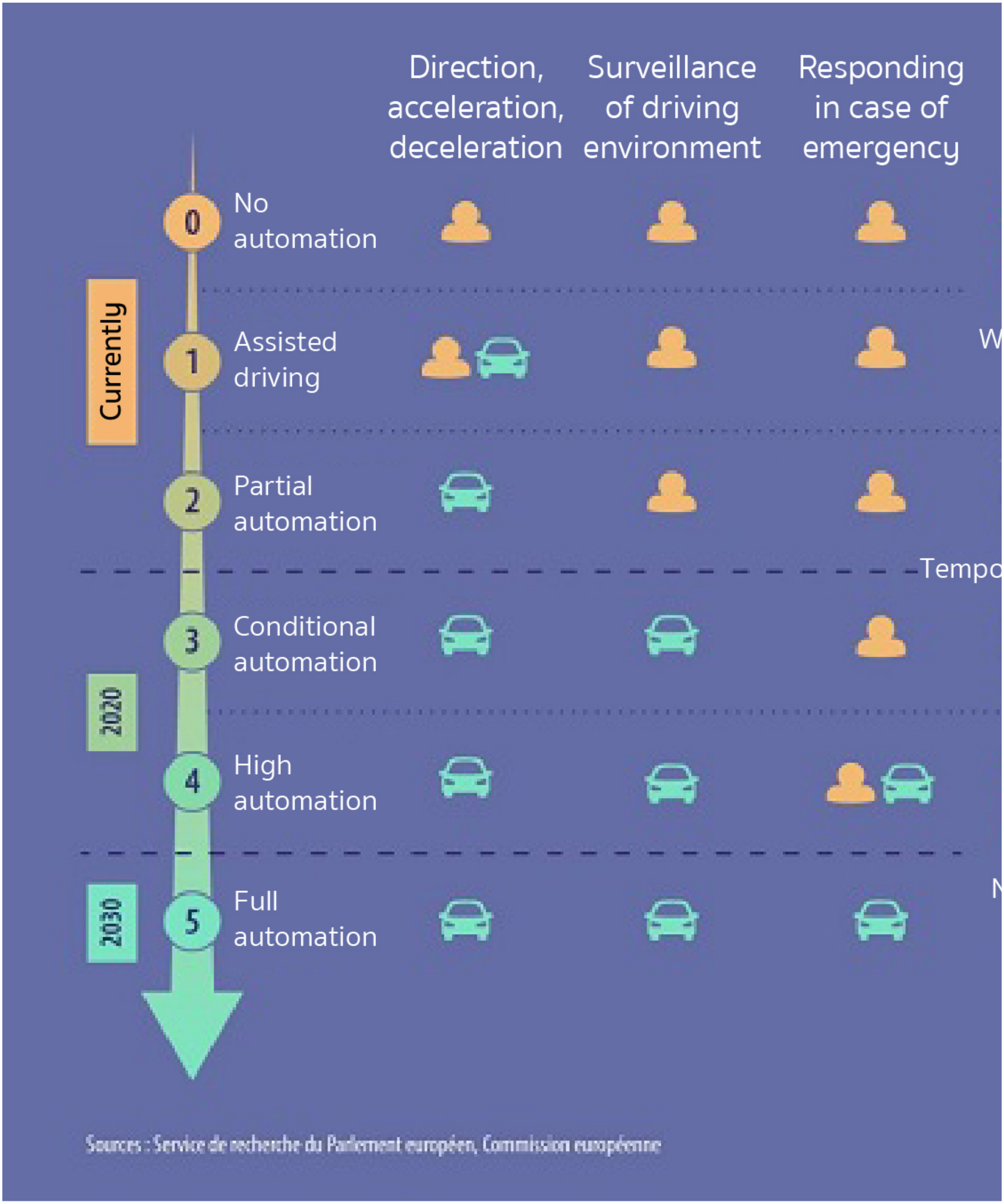
The object of the study

For several years now, autonomous vehicles have generated great enthusiasm. They're presented as the future of motorized mobility, whether in terms of safety, services or ecology, and they seem to challenge the relevance of traditional public transport. Yet many questions remain. What really are autonomous vehicles? What are their possible uses? What is required for their functioning? Who are the stakeholders involved in their development? And above all, to what extent and under what conditions can they contribute, in France, to the ecological transition of the passenger transport sector by 2050? The methodology of the study led by La Fabrique Écologique is based on a review of both gray and peer-reviewed literature (technical and theoretical) devoted to autonomous vehicles, as well as on nine semi-structured interviews with stakeholders involved in their construction and deployment: national politicians, executives from the automobile industry, researchers involved in related development programs, etc. [1] The purpose of these interviews was to gather knowledge from the stakeholders on the advances made in the field of autonomous vehicles and to understand the worldviews which drive these choices. This study only covers passenger transport, thereby excluding the transport of goods.

The results

A term that covers a complex and polymorphic reality

An autonomous road vehicle can be an individual or shared vehicle (car-sharing service, robotaxi, self-driving shuttle). Since their inception, autonomous vehicles have been assumed to be electric due to the synchronicity between these two innovations. But they don't necessarily have a thermal or electric motor, nor do they require certain types of energy in particular (natural gas, hydrogen, etc.). There are still many uncertainties about the kinds of engines and energy sources they will be able to use. An autonomous vehicle doesn't refer to a stable technical object, but rather to a continuum of incremental improvements on the traditional car. Autonomy is segmented into 5 levels, the first two of which are actually driver-assistance systems that are already widely available in the current market. It's only from level 3 that we can truly speak of autonomous driving, but still limited by certain conditions (for example driving in a separate lane, without bicycles or pedestrians) and requiring a driver that can assume control at any given time. Level 4 refers to complete autonomy under certain weather conditions and in certain geographical areas, whereas level 5, which is still a way off, designates complete autonomy in all circumstances.



Autonomous vehicles are characterized by technologies that enable their functioning without human intervention. Numerous onboard sensors make it possible to analyze the environment and generate gigantic amounts of data which are then processed by artificial intelligence systems in charge of the autonomous driving. These sensors have to work together in order to record every event, regardless of the weather or traffic conditions. There are therefore many different technologies in use: 3D cameras, radars, lidars (that measure distance with light) and high-definition real-time maps which can supplement the data recorded by the sensors. The generated data is then processed by the autonomous driving software which transforms it into trajectory or speed instructions. This data is also communicated to other autonomous vehicles and road infrastructure systems to increase the quantity of information and therefore its reliability. This information redundancy is the necessary condition for automated driving, and as it requires a high level of connectivity, it will probably be dependent upon the mass deployment of 5G.

Massive investments

Such technological demands require colossal investments, first and foremost in research and development. An international study by The Brookings Institution estimates that between 2015 and 2017, 80 billion dollars were invested in autonomous vehicles, mainly in R&D. While today, a large part of these investments come from private parties, the cost of deploying the necessary infrastructure to allow autonomous vehicles to operate (road markings, road signs, digital equipment, developing separate lanes, etc.) will undoubtedly be borne mainly by states and local authorities.

A global competition

Research and development on autonomous vehicles has been driven by intense global competition between different players. Traditional players in the automotive industry, manufacturers (Renault and Peugeot in France) and their equipment manufacturers see it as an opportunity to renew the car system by selling vehicles equipped with even more features. The big tech companies (Google, Uber, etc.) are aiming for total autonomy, which would ensure their control over the added value linked to the production and circulation of data. By freeing up time for drivers, autonomous vehicles would also present an opportunity to offer new onboard digital services. For these private players as well as for certain public entities (transport operators, local authorities), autonomous vehicles would allow them to reduce operating costs by eliminating or relocating jobs; by getting rid of the need for drivers, the cost of service could be reduced by 60% to 70%. Finally, states have also embarked on the international race to develop autonomous vehicles, with the United States and China currently ahead of the pack. The challenge for Europe is to strengthen its presence in the various markets connected to autonomous vehicles (digital mapping, electronic components, 5G, etc.) and to breathe new life into national automotive industries. In this context, France plans to become “the most advanced country for welcoming autonomous vehicles” (Idrac report [2]). This strategy is primarily aimed at preserving its automotive industry, the country's second largest employer, but it also presumes a model of society. Autonomous vehicles are seen as a way of tackling social and territorial inequalities by focusing on three priority issues: rural areas, people excluded from mobility who cannot buy or use a car and non-competition with active modes (walking and cycling). The Idrac report also presents autonomous vehicles as a green alternative insofar as they would be electric, they would allow more fluid and thus more efficient driving, they could be lighter thanks to better safety features that would render obsolete some current equipment, and they would promote a modal shift by complementing public transport. To deploy its strategy, France relies on consortiums with different public and private actors as well as on experiments in various territories, enabling local authorities to get involved in the race for autonomous vehicles.

Potentially catastrophic ecological consequences

Three scenarios are currently considered for the development of autonomous vehicles: first, individual mobility with cars for private use, supported by car manufacturers; second, on-demand mobility based on fleets of robotaxis, supported by digital technology players; and third, collective mobility with autonomous shuttles, supported by public actors (local authorities and transport operators).

- First scenario: the individual autonomous vehicle

In addition to the considerable environmental impacts linked to the mass development of high-tech vehicles, as well as the risk of increasing inequalities due to the cost of acquiring an autonomous vehicle, the “individual mobility scenario” could lead to significant changes in lifestyles. Freed from the task of driving, motorists could develop other onboard activities, resulting in new daily schedules and practices, deployed over larger areas, with longer and more frequent trips as they are less constraining. This would increase the number of vehicles on the road and therefore create an added need for vehicle production and energy to power them.

- Second scenario: fleets of robotaxis

The main players in this scenario, in which drivers aren’t needed on board anymore, are the tech giants. The “on-demand mobility scenario” could also increase social and territorial inequalities (private pricing; uneven deployment based on territorial profitability, thus favoring densely populated areas), as well as road congestion if it just adds to existing road traffic.

These rebound effects, which are common to the first and second scenarios and which have been highlighted by numerous studies [3] analyzing the environmental consequences of deploying autonomous vehicles, could lead the general energy consumption of all vehicles to triple at worst, or to be halved at best. This doesn’t even account for the energy impact related to the huge amounts of data that will be exchanged by vehicles [4] and will very likely require the deployment of 5G, nor does it include the CO_2 emissions linked to the production, installation, maintenance, renewal and waste management of a host of onboard devices and road infrastructures.

- Third scenario: autonomous shuttles

The third scenario, that projects the development of autonomous shuttles for collective passenger transport, brings together several very different services depending on the needs of the territories.

Internal transportation service for large establishments

Vehicle providing internal transportation within large establishments (factories, hospitals, university campuses, etc.)

The periurban minibus

A minibus providing the internal transport within periurban residential areas, with a fixed route or dynamically adapting to demand.

An application using self-driving buses to help strengthen the supply at a constant cost, on routes where there is high potential for modal shift.

Reinforcing the urban routes

Automating a pre-existing bus route can increase the service frequency and operating

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Source : atelier robomobile

These shuttles could have a positive impact, but their deployment (developing the technology, creating the infrastructure, etc.) risks preparing the ground for the mass development of less positive uses. In order to restrict the development of autonomous vehicles to areas that could benefit from them the most, public authorities would need to implement very strong regulations, yet at the moment they are neglecting the most advantageous uses: in France, of the 16 experiments carried out under the national EVRA project (Expérimentation du Véhicule Routier Autonome, or Autonomous Road Vehicle Experimentation), only two focused on collective mobility in rural areas, despite such territories being presented as the most relevant both from an ecological standpoint (limiting solo driving) and from a social one (connecting isolated areas that are poorly served by public transport).

A deployment that is out of step with the climate emergency

Elon Musk, the CEO of Tesla, has promised to deliver an autonomous vehicle capable of driving in all conditions - rain, snow, fog, at night - in all territories and in the presence of pedestrians and cyclists, by the end of 2021. However, international legislation adopted by 58 UN countries including France came into force in January 2021, imposing traffic conditions on the use of level 3 autonomous vehicles [5] (carrying up to 8 people) that are far more restrictive than what Musk is announcing. Such vehicles will only be allowed to travel with a seated driver (seatbelt fastened), at speeds not exceeding 60 km/h and only on roads where the opposing traffic is separated by a physical barrier and from which pedestrians and cyclists are absent. It remains to be seen under what conditions level 4 and 5 vehicles will be allowed to travel. In any case, non-industrial actors, whether researchers (CNRS) or public authorities (Idrac report), don't expect to see the mass deployment of fully autonomous vehicles before 2050 - that is to say after the deadline set by the National Low Carbon Strategy (SNBC, Stratégie Nationale Bas Carbone) to achieve carbon neutrality. Consequently, autonomous vehicles clearly can't make a valid contribution to the race against climate change, to which countries have committed with targets in 2030 [6] and 2050.

Directing investments towards truly ecological solutions

While the development of autonomous vehicles and of the necessary infrastructures for their operation requires considerable investments - both private and, in the future, increasingly public (development, adapting existing infrastructures, etc.) - the report by La Fabrique Écologique for the Mobile Lives Forum shows that autonomous vehicles can, at best, only contribute marginally to the decarbonization of mobility, and that they won't achieve mass deployment in time to reach carbon neutrality in 2050. Worse, their growth risks sharply increasing transport-related CO_2 emissions, in particular resulting from this new subset of vehicles (increased travel distances, competition from public transport, or even soft mobilities), from the mass production of vehicles, electronic equipment and infrastructure, as well as from the colossal amount of generated data. This situation reveals a kind of schizophrenia among public authorities that seem unable to coordinate economic, social and ecological issues. A cross-disciplinary approach spanning all relevant departments would allow the challenges relating to mobility to be understood as a whole and pave the way for new levers that are cheaper as well as more efficient, realistic and inclusive. From an ecological perspective, it is therefore useful and urgent to encourage the French government to design, invest and deploy a new mobility system that combines public rail (autonomous or not) and road transport, light and low-tech cars and active modes, and even to rethink land use planning so as to avoid unnecessary CO_2-emitting trips.

In the near future, a working group made up of scientists, civil society representatives, and environmental or sustainable development experts will be set up and led by La Fabrique Écologique and the Mobile Lives Forum to focus on low-tech vehicles in order to propose pragmatic and concrete recommendations.

Download the full report (in French only)

Notes

1 The following individuals were interviewed: Vincent Abadie, senior expert on ADAS and autonomous vehicles at PSA; Sylvain Belloche, Cerema, head of autonomous vehicles; Jean-Bernard Constant, digital manager for the Coeur de Brenne community of cities; Michèle Guilbot, research supervisor in law, deputy director of the Accident Mechanisms Laboratory (Laboratoire Mécanisme d'accidents), Transport-Health-Safety Department, Gustave Eifel University (formerly Ifsttar); François Jarrige, lecturer in contemporary history at the University of Burgundy; Cécile Lagache, Hervé Philippe and Arantxa Julien, DGITM (General Directorate for Transport, Infrastructure and the Sea), in the taskforce on innovation, digital technology and territories; Florent Laroche, transport economist at LAET CNRS; Christian Long, mobility assessment specialist; Stephane Rabatel, CEO of VedecomTech.

3 Saujot, Brimont and Sartor, 2017, "Accelerating sustainable mobility with autonomous vehicles," Issue Brief no 02/17, IDDRI, https://www.iddri.org/en/publications-and-events/decryptage/accelerating-sustainable-mobility-autonomous-vehicles; Wadud, MacKenzie and Leiby, 2016, "Help or hindrance? The travel, energy and carbon impacts of highly automated vehicles." Transportation Research Part A: Policy and Practice, No. 86 (April), p. 1-18, https://www.researchgate.net/publication/286202541_Help_or_hindrance_The_travel_energy_and_carbon_impact_of_highly_automated_vehicles; Brown, Repac, Gonder, 2013, "Autonomous Vehicles Have a Wide Range of Possible Energy Impacts," NREL / PO-6A20-59210, NREL, University of Maryland, https://www.osti.gov/biblio/1090163-autonomous -vehicles-have-wide-range-possible-energy-impacts-poster; Stephens, Gonder, Chen, Lin, Liu, Gohlke, 2016, "Estimated Bounds and Important Factors for Fuel Use and Consumer Costs of Connected and Automated Vehicles," NREL / TP-5400-67216, NREL, Golden, CO (United States) , https://www.osti.gov/biblio/1334242-estimated-bounds-important-factors-fuel-use-consumer-costs-connected-automated-vehicles; etc.

4 As a connected vehicle could produce up to 1 GB per second, a French person could produce an average 1.3 million GB per year.

5 There are now 5 levels of autonomy, the first two of which are driver-assistance systems. Real autonomy occurs (in certain conditions) from level 3, with level 5 designating full autonomy in all conditions.

6 The European Union pledged in December 2020 to reduce its global CO_2 emissions by at least 55% by 2030.

Mobility

For the Mobile Lives Forum, mobility is understood as the process of how individuals travel across distances in order to deploy through time and space the activities that make up their lifestyles. These travel practices are embedded in socio-technical systems, produced by transport and communication industries and techniques, and by normative discourses on these practices, with considerable social, environmental and spatial impacts.

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- Cars / motorcycles
- Futures
- Digital technologies

Policies

- Cars
- Ecological transition

To cite this publication :

La Fabrique Écologique (07 February 2020), « Autonomous vehicles: what role do they have in the mobility transition? », Préparer la transition mobilitaire. Consulté le 19 December 2024, URL: https://forumviesmobiles.org/en/project/13211/autonomous-vehicles-what-role-do-they-have-mobility-transition

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