



# Autonomous driving in scheduled services of local public passenger transport

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**VDV** Die Verkehrs-  
unternehmen



**HOCHBAHN**

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# At a glance

**Autonomous driving opens up fundamentally new opportunities to make local public passenger transport more flexible and more appealing – while at the same time improving its cost-effectiveness. The benefits of autonomous driving are most evident in the realm of scheduled bus services. In the long term, automating these services will engender significant cost reductions and efficiency improvements vis-à-vis today’s driver-operated services. This creates an opportunity for cities and municipalities to expand their local public passenger transport earnings-neutrally – i.e., to increase the modal share of local public passenger transport without raising its current operational costs.**

**What is needed to ensure that autonomous vehicles can be deployed in scheduled services in a timely manner is coordinated action taken by the various stakeholders:**

## → Industry

- Accessible, driverless roboshuttles (5 m) and robo midibuses (8 m) should be put into series production as soon as possible.
- Robobuses with the dimensions of standard city buses (12 m) should follow shortly after, but at the latest within a period of 5 to 7 years.
- Greater commitment is needed from German and European manufacturers to provide local public passenger transport with driverless systems that can compete with leading international competitors.

## → Politics

- To stimulate the market ramp-up, initial funding is required for the procurement and operation of the relevant vehicles and software systems.
- Funding should be focused on model regions. Fragmentation into isolated individual projects should be avoided.
- The practicability of regulations should be further improved, including with regard to the approval processes for operating permits and operating areas.
- The legal framework must be further adapted for the operation of autonomous vehicles in local public passenger transport and of buses, in particular (e.g. as regards passenger transport with test permits, vehicle width, use of the oncoming lane in case of obstacles).

## → Local public passenger transport operators

- Local public passenger transport operators (PTOs) should jointly develop and harmonise their product requirements, processes, systems, and quality control metrics in order to enable industry-wide scalability in Germany based on industry-wide standards.
- PTOs should prepare at an early stage to cooperate in new ways, both regionally and on a supra-regional level, in the field of driverless services.
- The implications for the workforce must be discussed at an early stage within the framework of employee co-determination and considered a priority in strategic planning.

## → Cooperation at the European level

- Close cooperation between European cities and PTO under the aegis of the German and European associations of transport companies, VDV and UITP, should ensure a continuous exchange of knowledge and experience.
- The objective is to establish a clear industrial policy perspective for the comprehensive scaling of marketable solutions in the European local public passenger transport.
- Autonomous mobility in local public passenger transport is not some vague promise for the future, but a concrete opportunity. The decisive factor is that we must act now – jointly and in a coordinated and strategic manner.

# 1. Goals

**The transport sector is facing a radical transformation. In the foreseeable future, driverless vehicles – and thus driverless mobility services – will serve major cities and rural areas alike. This presents public transport operators (PTOs) with the challenge of fundamentally rethinking not only the conditions for their participation in the market and their success, but also the processes involved in providing their services.**

In a paper detailing its strategy for autonomous driving in road traffic titled “Die Zukunft fährt autonom” (The Future of Driving is Autonomous, BMDV, 2024), the Bundesministerium für Digitales und Verkehr (BMDV, German Federal Ministry for Digital and Transport) describes the change in trend towards driverless mobility and states its goal of strengthening Germany as an innovative hub for autonomous driving. In its strategy, it places particular emphasis on its intention of implementing the legal framework created for this in a practical manner by transferring fully automatic driving in all of Germany (SAE Level 4) from its trial status today into regular operations. According to the BMDV, this applies particularly to local public passenger transport. In its recently published position paper “Local public passenger transport of the future operates autonomously” (VDV 2025), the Verband Deutscher Verkehrsunternehmen e. V. (VDV, national sector association of German transport companies) welcomes the BMDV’s strategy and calls for a political prioritisation of funding programmes for autonomous driving in local public passenger transport.

It goes without saying that, in urban areas such as the Hamburg metropolitan area, local public passenger transport plays a key role in the mobility transition (i.e. sustainable, efficient, and simultaneously attractive transport of the future). However, the political objective of offering well-developed, convenient, and carbon-neutral transport services is increasingly at odds with the financial reality of public budgets. Like many other German PTOs, Hamburger Hochbahn AG (HOCHBAHN) aims at significantly increasing passenger numbers by 2035 despite tight financial headroom. To this end, operational cost-effectiveness and efficiency will need to be further increased. Conventional bus services alone will not suffice to achieve the desired growth in passenger numbers in an economically viable manner.

Whether it is in fact possible to improve the cost-effectiveness and availability of public mobility services by means of autonomous driving depends on a number of factors – among them the availability on the market of vehicles which are suitable for deployment in local public passenger transport in terms of passenger capacity and accessibility; the maturity of self-driving systems and their eligibility for securing approvals; acceptance by the public; and the cost structures which will emerge for driverless operations. These aspects will be examined in greater detail in the following chapters. The goal is to demonstrate that within just a few years autonomous driving is likely to become a pivotal lever for the mobility transition, while local public passenger transport will be a crucial use case for this cutting-edge technology. Due to high passenger numbers, the most important form by far in which services will be provided, in the view held at HOCHBAHN, will be driverless scheduled services.

At the same time and in accordance with the request made by VDV, HOCHBAHN intends to draft a concrete implementation scenario from the perspective of a large provider of local public passenger transport. This is meant to inspire other PTOs in two ways: to evaluate the potential with regard to traffic planning and economic viability and to derive their own scenarios for a ramp-up. The intended outcome is a common market perspective for policy makers and the industry in the European region.

<sup>1</sup> BMDV Strategy | The Future of Driving is Autonomous: [https://www.bmv.de/SharedDocs/EN/publications/strategy-for-autonomous-driving.pdf?\\_\\_blob=publicationFile](https://www.bmv.de/SharedDocs/EN/publications/strategy-for-autonomous-driving.pdf?__blob=publicationFile)

<sup>2</sup> VDV Position Paper | Local public passenger transport of the future operates autonomously: <https://www.vdv.de/vdv-positions-papier-autonomes-fahren-im-oePNV-e.pdf>

## 2. Analysis of autonomous driving

**As part of the ALIKE project funded by the Federal Ministry for Digital and Transport, HOCHBAHN is currently road-testing, together with other partners, an autonomous on-demand shuttle service in Hamburg. The project will be completed at the end of 2026. In parallel with the ALIKE project, HOCHBAHN has carried out a twelve-month analysis project to identify the factual decision-making basis for the possible use of driverless vehicles in scheduled services of local public passenger transport.**

### **This project focused on the following questions:**

- What driverless vehicle designs are currently being developed (e.g. car, “people mover” or shuttle, bus)?
- Which performance characteristics specifically relevant for local public passenger transport do the vehicles have (e.g. passenger capacity, accessibility, lifespan, range, operating conditions)?
- Which technological level of maturity do the vehicles have, and which self-driving and other software systems are necessary to operate them?
- When can type approvals and series production be expected?
- Which manufacturers are already able to submit binding quotes in tender procedures by PTOs?
- What are the cost structure and economic viability, including all direct and indirect costs, expected to look like for the operation of driverless fleets? Is it genuinely realistic to expect cost advantages over today’s driver-operated services?

In the analysis, third-party studies were evaluated, interviews were held with relevant manufacturers, and in-depth workshops were carried out, some of them in combination with on-site visits and test drives. In addition, domestic and European partners in local public passenger transport (including from Norway, the Netherlands, Switzerland, Austria) were in contact to exchange and take into account current experiences and developments in the sector.

What follows below is an assessment of the current market situation that is based on these findings.

Since the supplier landscape can be expected to develop further over the next few years, this assessment can only offer a snapshot and is to be understood accordingly. In view of high initial investments, lengthy development timeframes, and difficulty in forecasting sales potential, recent years have seen mergers and acquisitions among both vehicle manufacturers and software producers, in some cases also the withdrawal from the market of relevant companies, and the discontinuation or ambiguous positioning of projects – a trend that is likely to continue. On the other hand, the management consultancy Berylls’ witticism that “[i]t doesn’t matter when you ask the question – the breakthrough for autonomous driving (AD) is always five years away,” (Berylls 2023) can now be regarded as having been clearly disproved. Already today, US-American and Chinese companies such as Waymo, Baidu Apollo, or WeRide are transporting millions of passengers in driverless vehicles in challenging inner-city traffic environments and without safety drivers, albeit in a market framework that is less strictly regulated compared to that in Europe.

Against the background of major advances in the field of autonomous driving systems – including sensor technology, environment detection, prediction, manoeuvre planning, and vehicle control systems –, the crucial question today is no longer whether autonomous driving will come, but who is one step ahead of the competition and brings driverless vehicles to market maturity that can be deployed effectively in local public passenger transport operations.

<sup>3</sup> Autonome OnDemandShuttles: <https://www.hochbahn.de/autonom>

<sup>4</sup> <https://www.berylls.com/autonomousdrivingdisillusionmentorthecalmbeforethestorm/>

## 2.1 Categories of driverless vehicles

As a general rule, HOCHBAHN classifies the driverless vehicle concepts being developed by various manufacturers into four categories (designs) (Figure 1):

- Robotaxi (driverless car)
- Roboshuttle (driverless minibuses for approx. 10 passengers)
- Robomidibus (medium-sized driverless buses for approx. 30–40 passengers)
- Robobus (driverless city buses)

At a global level, the focus of development efforts lies quite clearly on the robotaxi category. Ride hailing providers such as Uber, Lyft, or Didi are aiming, and in some cases are already beginning, to adapt their fleets accordingly.

Robotaxi vehicles can play a certain role in public transport to provide a supplementary on-demand option, e.g. to bridge the “last mile” in less densely populated regions. This vehicle category, however, is often not fully accessible. It also remains to be seen to what extent, if any, on-demand services will remain a field of activity for PTOs once demand-responsive driverless robotaxis gradually become available everywhere and at affordable prices. To prevent robotaxi services from inducing additional traffic, the focus in Germany should remain on scheduled services and on-demand services integrated into local public passenger transport for urban and rural regions.

### Vehicle types

Vehicle type	Robotaxi	Roboshuttle	Robomidibus	Robobus
Example of vehicle				
Approx. length	4 – 5 m	5 m	8 m	12 m
Approx. number of passengers	4	10+	30+	70+
Examples of manufacturers	Volkswagen Nutzfahrzeuge, NIO <small>Too small for scheduled services and not fully accessible, therefore not taken into account</small>	HOLON, Schaeffler, Renault/WeRide	Karsan/ADASTEC, eVersum	MAN, IVECO, Daimler

N.B.: The availability of driverless articulated and high-capacity buses is currently not foreseeable – for that reason they are not taken into account below.

Figure 1: Categorization of driverless vehicles (own presentation; image source: Pony.ai, HOLON, ADASTEC, MAN)

At the other end of the spectrum is the category of robobuses, which is highly relevant for PTOs. In contrast to several Chinese companies, the established German and European manufacturers have not shown any targeted efforts so far to bring such a vehicle to market maturity. In view of the greater market volume, the focus of the domestic industry seems initially to be on automated lorries, possibly with the intention of later transferring the technology to robobuses. Despite initial research projects such as BelIntelli in Berlin and MINGA in Munich, the positioning of German companies, in particular, in the future market for robobuses remains mostly uncertain. For Chinese companies, in turn, entry into the European market is proving a challenge, e.g. as regards approval procedures, dealer networks, and political reservations

about relying on Chinese partners in areas concerning critical infrastructure. Unlike in their home market of China, they are therefore likely to be less visible in Europe.

The categories roboshuttle and robomidibus offer an interesting compromise for PTOs between market availability and vehicle size. With their development driven forward by, in some cases, new and innovative companies, these vehicle models are specifically designed with the requirements of local public passenger transport in mind. They are designed to be accessible and provide sufficient passenger capacity, at least for some bus routes, e.g. in suburban or rural areas without pronounced peaks in school bus service.

## 2.2 Current pilot projects

To prepare technical systems, operating processes, staff, and not least passengers and the general public for regular driverless operation, pilot projects are indispensable not only for manufacturers, but also for PTOs as the future fleet operators.

The regulatory framework for pilot projects in Germany has been shaped with a view towards progress and safety aspects through changes to the German Straßenverkehrsgesetz (StVG, Road Traffic Act) and the introduction of the Autonome-Fahrzeuge-Genehmigungs-und-Betriebs-Verordnung (AFGBV, Autonomous Vehicle Approval and Operation Ordinance, 2021). In the context of trial permits, the capabilities and limits of the driving system are tested initially in small fleets with safety drivers in the vehicles. All current projects for automated driving in Germany have received the corresponding permits. It is only when it has been demonstrated that no overriding of the driving system by a human driver is necessary anymore that safety drivers can be dispensed with and the type approval for a driverless vehicle can be issued. This step is still pending in Germany but is expected to be reached in the coming two to three years.

Relevant pilot projects involving PTOs are currently being carried out, for instance, in Hamburg, Hanover, Munich, Leipzig, and Darmstadt/Offenbach, but also in many cases elsewhere in Europe (e.g. Oslo, Rotterdam, Stavanger, Switzerland, Luxembourg). Creating synergies and cooperation networks among the projects is essential to their common success. Such networks should not only include the PTOs themselves, but also stakeholders from local public passenger transport, federal, state, and municipal authorities, as well as policymakers and the scientific community (VDV 2025).

As regards the funding of pilot projects, the public sector has so far been involved mainly in small-scale projects of limited duration that made use of only a few vehicles. These projects offer important first operating experiences and findings, including suggestions for the further development of vehicles based on feedback from test passengers and operators. At the same time, it is becoming apparent that the learning curve achievable from those various small projects is limited. In the next step, targeted funding of model regions will be required over the coming years to stimulate the market ramp-up and to get driverless fleets into live operation in local public passenger transport.



## 2.3 Expected timeline for systematic deployment in local public passenger transport

Based on the analysis project carried out, HOCHBAHN assumes that the first type approvals for driverless vehicles in regular operation in Germany will be issued at the end of 2026 or the beginning of 2027. These approvals will probably be for cars, i.e. in the vehicle category of robotaxis. In particular, it seems very likely that the type approval for the ID.Buzz AD vehicle developed by Volkswagen Nutzfahrzeuge and

MOIA, which is currently already being tested in Hamburg, will be issued. The type approval for those vehicle categories that are of greatest interest for PTOs, i.e. roboshuttle and robomidibus, will probably follow with a delay of about one year. HOCHBAHN expects that type approvals at least for the autonomous Karsan e-ATAK and for the HOLON urban will be issued, possibly also for further vehicles.

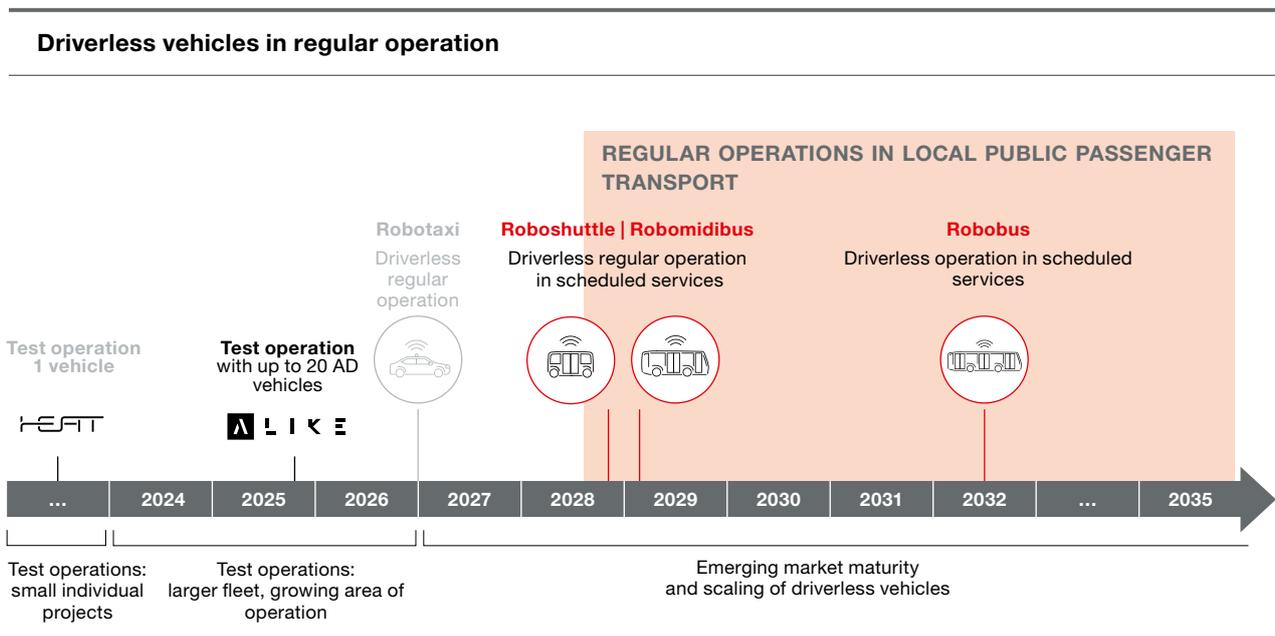


Figure 2: Timeline with start of deployment of driverless vehicles in regular operations of local public passenger transport (own presentation)

However, passenger transport operations can only commence once the PTO operating the service has obtained, in a second step that follows the issuance of the type approval by the Kraftfahrt-Bundesamt (KBA, German Federal Motor Transport Authority), the approval of the operating area from the competent Land authority. This approval covers, but is not limited to, the network of intended lines to be served, the implementation of safety procedures in operation, the interaction between the vehicle and the operating control system (control centre, technical supervision), as well as the personal qualifications of the assigned staff. This second step will take time, as well, seeing as there is not yet any established administrative or operational procedure in place. In addition, manufacturers require sufficient notice to build up their production capacities and to establish maintenance, repair, and spare-parts processes.

All in all, HOCHBAHN expects that the first series-produced driverless roboshuttles and robomidibuses will be able to be deployed in regular operations of local public

passenger transport as of 2028/2029 (Figure 2). This includes the full achievement of SAE Level 4 in Germany. For robobuses, HOCHBAHN does not expect regular operations to commence before 2032.

### Maturity and availability of vehicles

- Roboshuttles and robomidibuses are expected to be available **as of approx. 2028/29 with type approvals** for driverless deployment in regular operations of local public passenger transport.
- **Robobuses (12m)** are expected to be deployed in regular operations on the market only from approx. 2032 onwards.
- It is assumed that **articulated and high-capacity robobuses** will not yet be available in the 2030s.

## 2.4 Economic viability of driverless vehicles in local public passenger transport

In cooperation with a renowned management consultancy, HOCHBAHN developed profitability calculations for the deployment of driverless vehicles in regular operations of local public passenger transport and contrasted them with conventional bus operations. Based on the expected timeline for the service readiness of autonomous vehicles (Figure 2), three examples of deployment scenarios were considered:

- **scenario 1: deployment of roboshuttles from 2029 onwards**
- **Scenario 2: deployment of roboshuttles and robo-midibuses from 2029 onwards**
- **Scenario 3: deployment of robobuses from 2032 onwards**

In all these deployment scenarios the extent is examined to which conventional electric rigid buses can reasonably be replaced by driverless vehicles – in the case of roboshuttles and robomidibuses this would be on less heavily used lines in peripheral areas, for example. After having ascertained in this first step the degree to which the operating costs for buses could be reduced in mathematical terms, said degree was then used in a second step to expand the offering in line with demand, e.g. in the shape of additional driverless lines or community buses. The analysis was made for the Hamburg urban area on the basis of today's bus route network.

In order to estimate the costs that are to be expected for future driverless bus services, the following was taken into

account: market research, interviews with experts, manufacturers' information on the investment and operating costs of the various vehicle categories, and data owned by HOCHBAHN on personnel costs, maintenance, and bus depot infrastructure. All influencing factors and cost types known today – e.g. amortization, financing costs, insurance, approval and permit fees, energy, operating personnel, cleaning, repairs, technical supervision by the control centres etc. – were taken into account in as comprehensive a way as possible to eventually calculate the full costs per vehicle kilometre (i.e. total cost of ownership per km, TCO/km). This was initially done without taking into account any Land or federal funding that may be available (although in the assessment of HOCHBAHN this will be indispensable as initial funding). The robotaxi category was not considered in this analysis, since for scheduled services it is only suited to a limited extent due to its small passenger capacity and limited accessibility.

Since the full costs per vehicle kilometre (TCO/km) and the assumed fleet size mutually influence each other – for instance, in traffic planning a lower total cost of ownership (TCO) leads to a larger fleet, and, due to economies of scale, a larger fleet leads, in turn, to a lower TCO – both factors were approximated on an iterative basis by an interdisciplinary team consisting of members of the HOCHBAHN financial division and capacity planning departments. The result was a number in the order of 500 driverless vehicles which could be reasonably put into service in Hamburg up to 2035. The following cost estimates therefore refer to a fleet of this size.

### HOCHBAHN AD business case

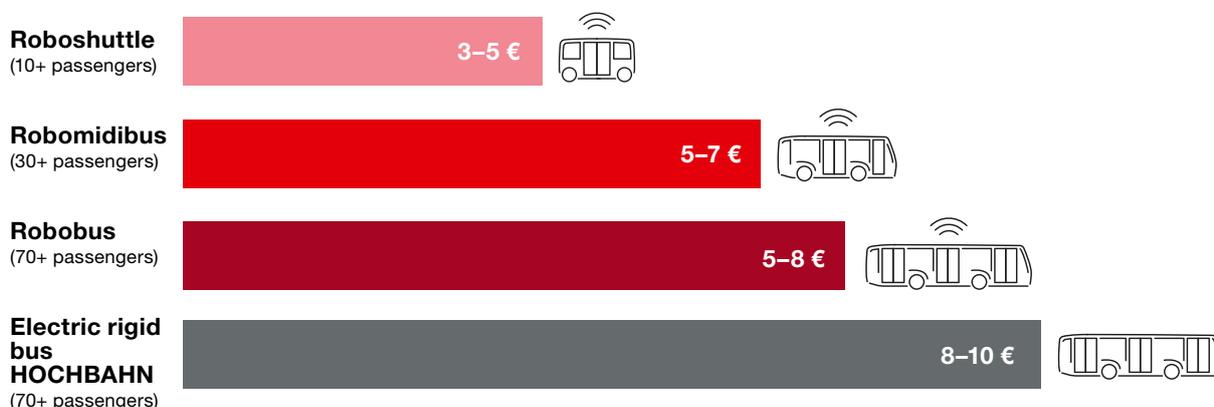


Figure 3: Comparison of vehicle categories by total costs per vehicle kilometre (forecast up to 2035, as per: April 2025)

## Distribution of costs

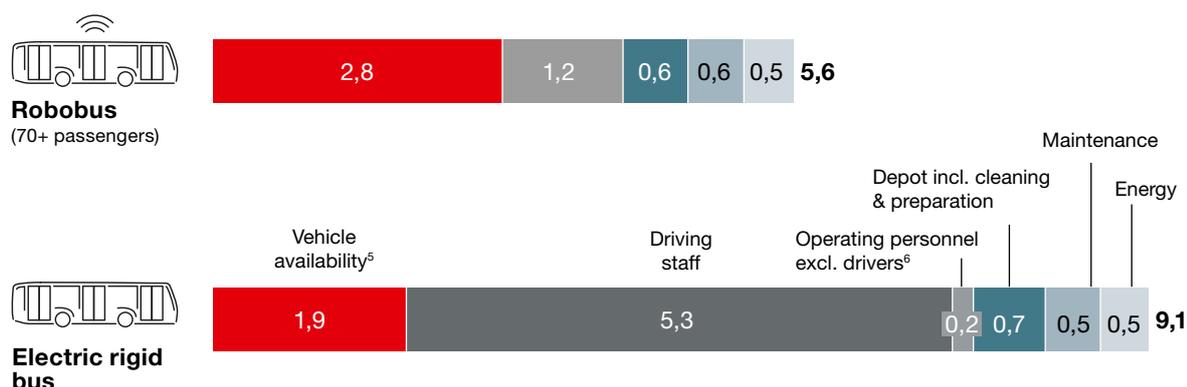


Figure 4: Comparison of robobus und E solo bus by total costs per vehicle /km as a percentage (Forecast up to 2035, as per: April 2025)

### The following conclusions result from this:

The **total costs per vehicle kilometre (TCO/km) of a conventional driver-operated electric rigid bus** – which have already seen a significant rise across the sector in recent years – are expected to **continue to rise**, reaching some EUR 8-10 per km in 2035 (Figure 3).

The **total costs per vehicle kilometre (TCO/km) of driverless vehicles** are expected to be considerably **lower** in 2035 than those of **a conventional electric rigid bus** (Figure 3 and Figure 4).

The cost advantage of driverless vehicles over conventional electric rigid buses will **continue to increase** in future due to **technical progress and economies of scale**. On top of this, there is additional potential in the flexible and efficient deployment of the vehicles resulting from the lack of restrictions applicable in shift scheduling for driver-operated services. These potential savings have not yet been factored into the HOCHBAHN profitability calculations.

When measured by vehicle kilometres driven, **small driverless vehicles are more economical than larger ones**. If the line concerned has low passenger volumes – **e.g. in off-peak times or in rural areas** – roboshuttles in particular can fully leverage their cost advantage. In view of their limited passenger capacity, however, they are less suitable for high passenger-volume lines, since the higher number of vehicles required would quickly overcompensate for the lower costs per vehicle kilometre.

Looking in detail at the Hamburg bus network broken down to the individual lines, we see **many deployment scenarios, where a capacity of 30 to 40 passengers is quite sufficient, for robomidibuses** to replace a conventional electric rigid bus, thus realizing a cost saving of approx. 30 per cent. As long as driverless robobuses are not yet available on the market, the focus for Hamburg would therefore seem to be on scenario 2 above. In this, the optimal number of robomidibuses in economic terms would probably exceed that of roboshuttles to a significant degree.

<sup>5</sup> Amortization, approval and permit fees, operating area, software fees, insurance costs, interest

<sup>6</sup> Fleet management, planning (operations), operational control / control centre incl. technical supervision (remote), passenger area surveillance (safety), traffic monitoring & incident management (field), customer service autonomous operations

Compared to today's electric rigid buses, the operating costs of driverless vehicles will not only decrease significantly, but will also show structural change. Costs of capital will play a larger role, while personnel costs will play a smaller role than they do today. New job profiles in operations planning, systems monitoring, and passenger services will be created and, in the first few years, will demand a high number of staff – among other reasons due to strict regulatory requirements in terms of daily pre-departure checks, frequent safety checks and general inspections. Overall, however, those profiles will not reach the work volumes of today's driving operations and will tend to decrease as the maturity level and ubiquity of autonomous driving technology increases. .

**To summarize, HOCHBAHN expects that, once a scaled driverless fleet is fully operational, operations in 2035 will be cost-neutral compared to conventional, driver-operated electric buses. HOCHBAHN operates on the assumption that it will even become possible in many cases to expand services within the framework of existing budget planning.**

#### **Economic viability of driverless operations**

- Taking into account investment and operating costs, bus services with driverless vehicles is even **more economical than today**.
- The altered **cost structure for personnel** is a major driver of **cost savings** – despite the required expansion of resources in systems control and monitoring.
- Against the backdrop of technological progress and rising personnel costs for driver-operated services, driverless operations are expected to offer a **growing cost advantage** over time.



# 3. Next steps for the introduction of autonomous fleets in local public passenger transport

**The HOCHBAHN analysis project on the market maturity and economic viability of driverless vehicles shows that these are likely to be available for regular local public passenger transport operations in three to four years and, in the long term, will enable more economically viable, flexible, and efficient operations compared to driver-operated electric buses. HOCHBAHN therefore expects that driverless operation – when it has reached a scalable and fully operational state – will create leeway for the expansion of services and can contribute to increasing the modal share of local public passenger transport in spite of tight public-sector budgets.**

On this basis, HOCHBAHN has set itself the strategic goal of actively supporting manufacturers in the development and market launch of autonomous vehicles suitable for deployment in local public passenger transport and carrying out pilot projects in an operative context for both roboshuttles and robomidibuses as early as possible. In this way, HOCHBAHN intends to systematically prepare for the future of driverless bus operations while at the same time, together with VDV, sending a signal to the industry and policy makers that mutual efforts must be stepped up to provide better and more cost-effective local public passenger transport through the implementation of driverless scheduled services of local public passenger transport in Germany and Europe.

HOCHBAHN and VDV aim to create close ties with further PTOs in order to share knowledge, reduce costs, and establish common standards across the entire sector. It must be the common goal of all PTOs to prevent the emergent market from becoming fragmented into isolated local projects. Instead, a coordinated approach driven by a spirit of partnership should reduce complexity for all those involved – including in particular manufacturers and public authorities – so that a rapid and comprehensive introduction of driverless local public passenger transport services becomes possible.

The next concrete step in this development that HOCHBAHN is taking is to test three roboshuttles and three robomidibuses from at least two different manufacturers in scheduled services (“the trial phase” in “Project 3plus3”, Figure 5). In contrast to similar pilot projects in Germany so far, these vehicles are intended to have operating permits for regular services and for defined areas so that they can be deployed without a safety driver on board in the course of the project and be used by the general public without any further requirements having to be met (the “open user group”). The plan is to deploy the vehicles on existing lines and to have them meet the usual quality standards of the Hamburger Verkehrsverbund (local public passenger transport association of Hamburg). The goal of the three-year trial phase is to develop all the necessary capabilities, processes, systems, and experience to be prepared for a substantive upscaling of the driverless fleet from 2028/29 on. This explicitly also includes an intensive analysis of passenger feedback, the development of human resources strategies for the long-term transition of bus services, and their discussion at an early stage in the context of employee co-determination.

## Ramp-up of the vehicle fleet

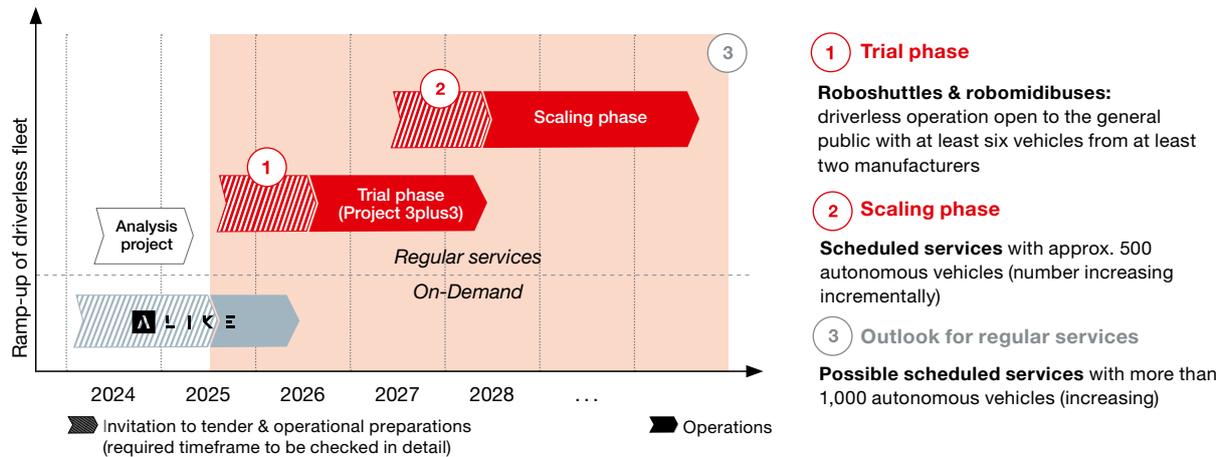


Figure 5: Phases in the introduction of driverless vehicles at HOCHBAHN (own presentation)

HOCHBAHN will make its concepts and the findings gained through the “3plus3” project available to VDV and to other PTOs in order to contribute to a sector-wide joint learning process.

HOCHBAHN expects the transition from the driverless trial phase to regular operations to take place in 2028/29 (the “scaling phase”, Figure 5). Based on current levels of knowledge, a total of 500 roboshuttles and robo-midibuses can be deployed in a first scaling step across the Hamburg urban area, taking into account all PTOs, in a manner that makes sense economically and in terms of transport. As soon as driverless robobuses the size of today’s city buses become available from about 2032 onwards, HOCHBAHN

expects that conventional driver-operated buses that have reached the end of their lifespan will be replaced, step by step, with robobuses. As a result, the anticipated total number of roboshuttles, robomidibuses and robobuses in Hamburg local public passenger transport will increase over the 2030s to around 1,000 vehicles. This does not include articulated and high-capacity buses, for the market maturity of which HOCHBAHN does not foresee a concrete timeline, nor electric rigid buses, which are intended to remain driver-operated for particular reasons.

# 4. Requirements for scaling

**For the successful introduction and scaling of driverless vehicles in local public passenger transport, certain framework conditions and success factors need to be put in place. Policy makers, public authorities, and PTOs are called upon to play an active role in shaping these conditions.**

## → Availability of vehicles

In order for manufacturers to commence series production of driverless vehicles for the German local public passenger transport market in a timely manner, an early, close, and ongoing dialogue between PTOs and the industry is required. PTOs should not see themselves one-sidedly in the role of a “consumer” who simply waits for technically mature driverless vehicles to become available. Instead, they should assume the role of a partner in innovation, that actively accompanies their development and testing. Collaborative, iterative learning by manufacturers and PTOs is vital, given the disruptive nature of autonomous driving and the resultant wide range of questions it raises in terms of technology, legal issues, operations, and human resources.

A fragmentation of efforts into too many small-scale projects would be less than ideal. Instead, a limited number of larger projects should be implemented which should be carried out in close cooperation both with each other and with manufacturers and the local public passenger transport sector. These projects should be of sufficient duration and be adequately staffed to develop fundamental requirements for vehicles and operational management systems, but also for planning, operative and approval processes, as well as KPI systems for performance and quality control, and to promote these as industry-wide standards from which all PTOs stand to benefit. This standardization not only facilitates product development for manufacturers, but avoids inefficient stand-alone solutions and reduces complexity for all sides, so that at the end of the day the procurement processes are simplified and streamlined.

## → Funding requirements

While driverless operations in a scaled and fully operational state can contribute in a significant way to improving the cost-effectiveness of local public passenger transport, initial funding will still be necessary in the following trial and development phase – especially as long as operating personnel are still present in the vehicles. Public-sector funding should be focused on model regions which can ensure sufficient critical mass and continuity to pool knowledge and experience as focal points for the entire local public passenger transport sector. For reasons of both transport policy and industrial policy, the cities, Länder and the federal government should actively promote such model regions and provide appropriate funding. HOCHBAHN suggests that such funding be designed for a period of five to seven years and be based on the framework of the existing e-bus funding.

## → Legal framework

PTOs and VDV should speak with one voice at the national and EU level in order to campaign for practical solutions in the implementation of autonomous driving and to minimize bureaucratic obstacles. Major concerns, for instance, include simplifying standardising, and speeding up the approval procedures for operating areas across all federal Länder, simplifying (and ideally automating) daily pre-departure checks at bus depots, and making qualification requirements for the technical supervision in the control centres appropriately flexible.

### → Strategic human resources planning

Looking ahead, autonomous driving will lead to a far-reaching transformation of job profiles, work processes, and workforce structures. New job descriptions, e.g. in the field of monitoring and operations control, will need to be designed and the requirements as to qualifications defined, while training concepts and possible career paths for existing employees will need to be developed. Other job profiles, e.g. for today's driving staff, will become obsolete. In order for this transition to succeed, the change processes must be strategically prepared at an early stage and actively looked after throughout the company.

Central to this process is a forward-looking human resources strategy that actively shapes the change process, involves employees, and fosters broad acceptance across the board among the workforce, political circles, and the general public.

### → Regional and supraregional cooperation

The more successful the local public passenger transport sector is from the outset in focusing on cooperation and common standards in the implementation of autonomous driving, the more the door will open for forms of regional and supraregional cooperation of the future – and thus for types of synergy potential. Unlike conventional bus operations, which centre around driving staff, driverless operations offer the option of spatially outsourcing parts of the value chain and merging them with those of other PTOs. Obvious examples include activities in remote monitoring and control, but also in customer information and booking systems, data supply, quality analysis, and reporting. Control centres, the installation and operation of which require considerable expenditure, can operate across entire networks and cities. For smaller companies or in rural areas, novel regional or supraregional forms of cooperation can be vitally important in making the implementation of driverless services in rural areas economically viable even with small fleets.

It is in the hands of the PTOs today to lay the foundations for their future cooperation and efficiency by working together from the outset and ensuring the interoperability of their processes and systems.



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